Photo credit: Gerry Kichok

City of Maple Ridge

South Alouette & Kanaka Creek

Integrated Stormwater Management Plan

FINAL - September 2021

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Kanaka Creek near Thornvale Creek (Urban Systems, 2014)

1

1 INTRODUCTION

1.1 What is an Integrated Stormwater Management Plan?

The minimum regional objective of integrated stormwater management planning is to "strive to maintain existing watershed health and achieve no-net-loss on a watershed basis".[1] To achieve this, the ISMP process examines the relationships between land use planning and development, drainage servicing, and environmental protection.

An ISMP outlines actions and plans to support and promote the growth of a community in a way that maintains (and ideally enhances) the health of a watershed. Because of the integrated nature of its scope and the way in which it is developed, as a watershed-level document an ISMP can be a powerful tool to help a community realize its vision.

[1] Metro Vancouver's Template for Integrated Stormwater Management Planning (2005)

Core components of an ISMP include the following:

Land Use	• Growth projections, land use patterns and priority watersheds • Area Plans and active development applications
Environment	• Identify aquatic and terrestrial habitat values and opportunities • Senior government regulations and approvals • Geosciences (geotechnical and hydrogeology / groundwater) • Monitoring and watershed health tracking
Infrastructure and Drainage Systems	• Inventory and performance assessment of existing components, including natural assets • Identify pieces required to effectively support growth, while protecting environmental values • Monitoring and adaptive management
Engagement and Communication	• Establish effective inter-departmental linkages • Leverage community members and other authorities • Secure support from community leaders and senior officials • Draw on knowledge of other organizations and interest groups
Policy and Finance	• Policy and criteria to guide future growth and redevelopment • Ensure policy documents are complete and aligned • Implementation priorities, responsibilities, and schedules • Financing and cost recovery considerations

1.2 Drivers for Integrated Stormwater Management Planning in the City

Legislative Requirements

The City's initial regulatory driver for conducting ISMPs was Metro Vancouver's 2002 Liquid Waste Management Plan (LWMP), which was updated in 2010 as the Integrated Liquid Waste and Resource Management Plan (ILWRMP).

As a condition to the approval of the ILWRMP, the BC Ministry of Environment (MOE) stipulated that all member municipalities in Metro Vancouver must complete ISMPs for their urban and semi-urban watersheds. As a member municipality of Metro Vancouver, the City of Maple Ridge is required to do so. The LWMP endorses the view that stormwater is a resource that, when managed properly, can be utilized to protect and ideally enhance watershed health. The LWMP outlined an approach to integrated stormwater management planning that considered drainage, environment and land use planning functions within a watershed. The intent was to address potential stormwater management impacts on a community and its values, such as population growth and densification, recreation, agriculture, fisheries, wildlife, flood protection, transportation, and other related issues.

City Directives Related to Watershed Health and Climate Change Adaptation

The importance of environmental values and protecting watershed health has long been recognized by the City. Through key corporate documents – the 2013 Official Community Plan (OCP); the 2007 Corporate Strategic Plan (CSP); the 2007 Sustainability Action Plan (SAP); and the City of Maple Ridge Strategic Plan 2019-2022 – the City provides strategic direction that supports integrated stormwater management planning. These documents include high-level objectives and policies that support ISMP objectives. The OCP places emphasis on healthy watersheds and acknowledges the significance of surrounding Crown lands and partnerships with other jurisdictions to overall sustainability. It also includes a natural features framework for watershed health. The OCP also includes statements regarding smart growth; biodiversity conservation; ecological health; movement corridors for wildlife, fish and people; climate change adaptation; economic accountability and responsibilities; natural assets; and social objectives related to liveability, and mental and physical wellbeing.

The notion of integration is inherent in the City's value statement on stewardship, which states that the City will "consider the long-term consequences of actions, think broadly across issues, disciplines and boundaries and act accordingly". This statement mirrors the core objectives of an ISMP.

In addition to these high-level directives, the City has also developed numerous bylaws and corporate policies that support integrated stormwater management, as discussed further in Section 3.0.

Climate Change

Climate change, and the uncertainty around what exactly it will bring and when, means that communities need to take an adaptive approach to watershed management and community development. Warmer summers and changes in annual precipitation are just a couple of the anticipated impacts of climate change to communities in the Lower Mainland, and this will have implications for stream health and how stormwater is managed. Contemporary integrated stormwater management planning needs to have some adaptive capacity to address these issues, and this will be explored as the ISMP is developed.

Growth and Development

A regional Urban Containment Boundary (UCB) has been established as a long-term area for urban development across Metro Vancouver. Within the UCB, nine urban centres have been identified, including the City's Town Centre. The City's OCP also identifies specific areas of growth, including the Town Centre and Silver Valley area (which are located within the South Alouette watershed) and the Albion area (which is located within the Kanaka Creek watershed). Integrated stormwater management planning is a strong tool for achieving these growth objectives as well as environmental protection.

1.3 An ISMP for the South Alouette and Kanaka Creek Watersheds

This ISMP has been prepared for the South Alouette and Kanaka Creek watersheds in the City of Maple Ridge, British Columbia (BC). The City is jointly developing ISMPs for these watersheds because of the overlapping objectives and benefits the process provides to the City. The City is making a significant investment in the future of Maple Ridge and the watersheds through the development of these plans.

The Study Area is comprised of the approximately 310 square kilometers (km^2), or 31,300 hectares (ha), of the South Alouette and Kanaka Creek watersheds, of which 160 km^2 (16,360 ha) lie within the municipal boundary of the City of Maple Ridge (**Figure 1.1**). Included within the watershed boundaries but beyond the jurisdiction of the City are parts of Golden Ears Provincial Park, the City of Pitt Meadows, the District of Mission, and the University of British Columbia Research Forest. The Study Area is located within the traditional territory of the Coast Salish People, including Katzie First Nation and Kwantlen First Nation.

1.4 Planning Process

This ISMP was prepared in three Parts:

Part 1 summarized the background information and established the baseline (existing) conditions of the watersheds and considerations for the ISMP as it is further developed.

Part 2 explored the likely outcomes of future conditions through the application of planning future land use change, climate change, and potential changes in criteria or standards. This assessment provides the basis for the management strategy.

Part 3 defines the management strategy and adaptive management framework to best address the issues identified in Part 1 and Part 2.

1.5 Desired Outcomes

A desired outcome of the ISMP planning process is that the ISMP is ultimately endorsed by City Council. For this to happen, the following outcomes must also be achieved:

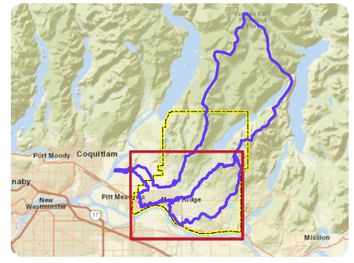
- The ISMP aligns with and supports the City's OCP;
- Stakeholders are engaged and supportive;
- The ISMP reflects the City's unique regulatory, land use, and environmental conditions;
- Existing stormwater and environmental management practices are considered and improved upon; and
- Recommendations are justifiable, clear, feasible, and prioritized.

South Alouette and Kanaka Integrated Storm Water Management Plans

Study Area

Blaney Creek Watershed
South Alouette Watershed
Katzie Slough Watershed
North Alouette Watershed
Fraser Watershed
Kanaka Watershed
Whonnock Watershed
Thornhill Watershed

Natural Watershed Boundary
Creeks
UBC - Malcom Knapp Research Forest
BCIT Woodlot
Provincial Protected Areas
Metro Vancouver Parks
Municipal Boundary



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m

Coordinate System:
NAD 1983 UTM Zone 10N

Data Sources:
City of Maple Ridge
City of Pitt Meadows
BC MoE
NR Canada

Project #:	1279.0025.01
Author:	BG
Checked:	GS
Status:	FINAL
Revision:	M
Date:	2021 / 9 / 1

URBAN SYSTEMS

FIGURE 1.1

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1.6 Collaboration, Communication, and Engagement

Leadership to implement the ISMP will ultimately come from the City, and inter-departmental collaboration will be required to successfully do so. Ultimately, City Council will decide whether to endorse the ISMPs. This will happen when there is understanding and support for the ISMP recommendations across City departments and the local community. Input into the ISMP process is therefore sought from all those who have an interest in the ISMP outcomes, with a strong focus on working together to achieve the desired outcomes of the process.

As evidenced by the desired outcomes of the ISMP, engagement with external stakeholders is important to earning their support and achieving the ultimate desired outcome of Council endorsing the ISMP.

To help assess the general public's perceptions of the watershed and its overall health the City of Maple Ridge published a public online survey from July 19 to August 19, 2019. The survey was advertised on the City website, their Facebook page, and in the local newspaper. Results are presented in Section 6 Community Survey Summary, herein.

In November 2019 an early draft of the ISMP was presented to the City's Environmental Management Committee ahead of the report being presented to Council on March 31, 2020.

In early 2021 a Draft copy of this ISMP was distributed to a number of external stakeholder groups and agencies for feedback. A number of them responded with written comments, following which one on one consultation discussions occurred through spring and early summer 2021. Some communities and stakeholders invited to provided feedback did not respond to the invitation or did not have comments on the ISMP.

The following stakeholder groups are acknowledged and thanked for the valuable input to this final document.

- Agricultural Land Commission
- Alouette River Management Society (ARMS)
- Alouette Valley Association (AVA)
- BC Hydro
- BC Parks
- Department of Fisheries and Oceans
- DK Bowins and Associates
- Kanaka Education & Environmental Partnership Society (KEEPS)
- Metro Vancouver
- Ministry of Agriculture, Food and Fisheries
- Ministry of Environment
- Ministry of Forests Lands Natural Resource Operations and Rural Development
- Thornhill Aquifer Protection Society
- UBC Malcolm Knapp Research Forest
- BC Conservation Foundation (Wildsafe BC Program)

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PART 1 – BACKGROUND AND BASELINE ASSESSMENT

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2 BUILDING ON OUR FOUNDATION

The City has a long history of watershed and environmental management, having been an early adopter of the environmental management paradigm. Over the years, the City has undertaken numerous studies and planning initiatives, which has provided a strong foundation on which to develop its ISMPs. Furthermore, a comprehensive set of regional, local, and provincial/federal regulations and policies guide integrated stormwater management practices in the City.

In Part 1, city staff from various departments participated in a workshop to initiate the project and set the stage for working collaboratively to make decisions to guide and shape the ISMP. The workshop was complemented by an online survey distributed to City staff in advance, which helped shape the content of the workshop. Workshop #1 focused on the following outcomes:

- Collective understanding of what an ISMP is and the process for developing an ISMP for the South Alouette and Kanaka Creek watersheds;
- Collective understanding of the importance of participating in the process for developing the ISMP;
- The sharing of insights on limitations or challenges that may influence the recommendations of the study; and
- Making key decisions to inform the development of an effective C&E strategy.

A key takeaway of the first workshop was the list of desired outcomes of the ISMP planning process, as described above. Throughout the course of developing the ISMP, other workshops were held with city staff from various departments.

2.1 Regional Framework

The following regional regulatory framework influences stormwater management in the South Alouette and Kanaka Creek watersheds:

Regulations, Policies, and Guidelines	Implications for Stormwater Management in the Study Area
Metro Vancouver 2040: Shaping Our Future – Metro Vancouver Regional Growth Strategy Bylaw No. 1366, 2010, with amendments to October 30, 2015	• States specific goals, strategies and policies to guide future growth, land use planning, and environmental management. • Guides land use by stating the urban containment boundary, town centre, industrial area, agricultural area, and conservation areas.
Metro Vancouver ILWRMP, 2010	• Provides the legislated direction for developing and implementing the ISMP, including monitoring and adaptive management. • Under the LWMP, municipalities have committed to updating bylaws to require on-site stormwater management sufficient to meet criteria established in ISMPs or the region-wide baseline.
Metro Vancouver Template for Integrated Stormwater Management Planning (Kerr Wood Leidal, 2005) – referred throughout this report as "the Template for ISMPs"	• Sets out a consistent approach to developing ISMPs for Metro Vancouver municipalities • A key feature of the Template for ISMPs is the introduction of the Watershed Health Tracking System to assess and monitor progress towards the minimum regional objective of achieving "no net loss" in watershed health over time.
Metro Vancouver Stormwater Source Control Guidelines (2012)	• Provides guidelines for the design of green infrastructure and can be used as a reference for municipalities and designers.
Metro Vancouver Monitoring and Adaptive Management Framework (Metro Vancouver, 2014)	• Provides guidance on environmental monitoring of upland and lowland watercourses, including frequency, parameters, and reporting requirements.

2.2 Local Framework

Stormwater management is regulated locally through the following regulations, policies, and guidelines:

Regulations, Policies, and Guidelines	Implications for Stormwater Management in the Study Area
Building Bylaw No. 6925-2012	• States that site topography should gravity feed into the municipal storm system. • Mandates that gravity drainage must be used, but changes may be possible with additional approval.
Development Cost Charges Imposition Bylaw No. 6462-2007	• Outlines potential costs for drainage for different types of development.
Development Procedures Bylaw No. 5879-1999	• Establishes procedures to amend an OCP or a Zoning Bylaw, and to issue a permit. • Prescribes that all buildings within 50m of the top of bank of a watercourse require a Watercourse Protection Development Permit (WPDP). • Requires a Natural Features Development Permit (NFDP) before any clearing, grading or construction activity begins in the development permit area. • The application for a WPDP or NFDP must include an environmental assessment. • A full Environmental Impact Assessment (EIA) may be required, including a conceptual storm water management plan that encourages site source controls and meets the requirements of the municipal Watercourse Protection Bylaw. • Applications for Temporary Industrial or Temporary Commercial Use permits require drainage plans and sediment and erosion control plans. • Application for a Wildfire Development Permit (WDP) must include a detailed site plan and/or air photo indicating all proposed watercourse setbacks, steep slopes, stormwater detention, drainage works, and servicing infrastructure.
Drainage Facilities Control Bylaw No. 2680-1979	• Controls connections to the storm sewer system and charges for the construction of access culverts and ditch enclosures. • Requires municipal approval for the construction of any access culvert or ditch enclosure, any facility in or upon a drainage ditch, or connection to a municipal storm sewer or drainage ditch. • Prohibits the deposition of material of any kind into a drainage ditch.
Financial Plan 2015-2019 Bylaw No. 7145-2015	• Outlines property tax increase for improvements to drainage.

Regulations, Policies, and Guidelines	Implications for Stormwater Management in the Study Area
Official Community Plan Adoption Bylaw No. 7060-2014	• States objectives and policies to guide the City's long-term community planning decisions. • Guides land use and servicing across the City and specifically for the Albion Area, Silver Valley Area, and Town Centre Area. • The OCP was amended in in 2014, and it is a desired outcome of the ISMP that it supports and aligns with the OCP. • Specific components of the OCP that are relevant to the ISMP are described further in Section 2.2. • Requires a Natural Features Development Permit for all areas designated Conservation on Schedule B or all areas within 50 m of an area designated Conservation on Schedule B of the OCP; all lands with an average slope greater than 15 percent; and all floodplain areas and forest lands identified on Schedule C. • Requires a Watercourse Protection Development Permit for all development and subdivision activity within 50 m of the top-of-bank of all watercourses and wetlands identified on Schedule C of the OCP. • Sets out guidance for erosion and sediment control, stormwater management, and vegetation management in NFDP Areas and WPDP Areas.
Off-Street Parking and Loading Bylaw No. 4350 - 1990	• Lots with more than 4 stalls require grading and drainage to dispose of surface water.
Pesticide Use Control Bylaw No. 6413-2006	• Establishes requirements for permits to use or apply pesticides for cosmetic purposes • Outlines permitted pesticides • Establishes requirements around the application of pesticides in the vicinity of wells, water bodies, channels, and wetlands.
Soil Deposit Regulation Bylaw No. 7412-2017	• Depositing area must not interfere with natural water features. Any interference requires a permit and remediation. • Must adhere to Water Act and Waste Management Act. • Must not be within 50m of watercourse top of bank.
Soil Removal Bylaw No. 6398-2006	• Damage must be repaired by permit holder. • Natural water features shall be protected and kept free from silt and pollution. • Permit applications must include drainage control plans.
Subdivision and Development Servicing Bylaw No. 4800-1993	• All watercourses will be accounted for in the permit application. • All parcels are required to connect to a storm water drainage system.

Regulations, Policies, and Guidelines	Implications for Stormwater Management in the Study Area
	• Design Criteria Manual provides the minimum engineering criteria that drainage analyses and servicing must meet, including a three-tier approach to stormwater management.
Town Centre Development Permit Guidelines	• Pursuant to the OCP • Based on smart growth principles
Tree Protection Bylaw No. 7133-2015	• No tree removal is permitted within a conservation area (i.e., within the streamside protection and enhancement area as defined in the Streamside Protection Regulation), unless it is a hazard tree • No tree removal is permitted on slopes over 25% or land subject to a geotechnical covenant or habitat protection covenant, unless it is a hazard tree • When cutting a hazard tree within a conservation area, larger pieces of the tree and the tree stump are to be left for fish and wildlife habitat • Replacement trees must be installed as outlined in the bylaw • Outlines tree management plan requirements for removal of more than 20 trees and clearing of more than 500 m^2
Watercourse Protection Bylaw No. 6410-2006	• Prohibits the pollution and obstruction of any drainage systems. • Implement erosion and sediment control measures – specific details available for different types of lots. • Stormwater management practices must adhere to DFO guidelines. • Environmental Monitors must be appointed to ensure watercourse integrity for works affecting watercourses. • Uses BC Reg 10/2001, Streamside Protection Regulation (SPR), which exceeds current federal and provincial regulations • Regional/provincial three-tier onsite source control requirements
Watercourse Protection Development Permit Area Guidelines	• Pursuant to the OCP • Described as a schedule to the Development Procedures Bylaw 5879-1999 (see description above)
Zoning Bylaw No. 7600-2019	• The City has recently (2021) adopted its new zoning bylaw that sets minimum requirements for permeable surfaces. It also limits the lot coverage with buildings.
Local Area Service – Policy 5.01 (2009)	• Sets the conditions under which the City will consider installation of local services. • Supports residential installation of services.
Development of Lands Adjacent to Kanaka Creek Regional Park – Policy 6.03 (1993)	• Establishes that urban development's adjacent to the park are to retain a buffer zone and consider easements, tree preservation, increased building setbacks, or parkland designation as a means of retaining the buffer zone.

Regulations, Policies, and Guidelines	Implications for Stormwater Management in the Study Area
Environmental Development Permit	A development permit (DP) is required for any clearing, building, or development related activity where properties are: • within 50 metres of a watercourse or wetland area • on slopes greater than 15% • located within a floodplain • within 50 metres of an area designated as conservation on the Official Community Plan "Schedule C Natural Features Map" • within a wildfire interface DP area
Regulation of Earth Fill Within Floodplains – Policy 9.10 (2012)	• Any earth filling must be signed off by a qualified professional who can confirm the impacts on the hydraulic system.
Untidy and Unsightly Premises Bylaw 6533-2007	• Requires the removal of six noxious weeds.
Control of Surficial and Groundwater Discharge in the Area Bounded by 207 Street, 124 Avenue, 224 Street and the Crest of the Fraser River Escarpment – Policy 6.23 (see Appendix E)	• For lands within 300 m of the crest of the Fraser River escarpment, stormwater recharge / infiltration systems and ponding are prohibited. • Surface discharge over the banks of the Fraser River escarpment are prohibited, unless conveyed in a closed pipe. • Landscape ponding is not permitted

2.3 Provincial and Federal Framework

The following pieces of provincial legislation may influence the ISMP:

- Agricultural Land Commission Act
- Dike Maintenance Act
- Drainage, Ditch and Dike Act
- Drinking Water Protection Act
- Environment and Land Use Act
- Environmental Assessment Act
- Environmental Management Act (and Waste Discharge Regulation)
- Fish Protection Act (and Riparian Areas Regulation)
- Fisheries Act
- Groundwater Protection Act
- Integrated Pest Management Act
- Water Protection Act
- Water Sustainability Act / Water Act and regulations

The Province has also developed several applicable guidelines for stormwater management planning, including:

- Stormwater Planning: A Guidebook for British Columbia (2002)
- Beyond the Guidebook 2010: Implementing a New Culture for Urban Watershed Protection and Restoration in British Columbia (2010)
- Develop with Care 2012: Environmental Guidelines for Urban and Rural Land Development in British Columbia (2012)
- Underground Stormwater Infiltration: Best Practices for Protection of Groundwater Resources in British Columbia

The following pieces of federal legislation may influence the ISMP:

- Fisheries Act
- Canada Water Act
- Pest Products Control Act
- Canadian Environmental Protection Act
- Species at Risk Act
- Canada Wildlife Act
- Canada Marine Act

The federal government has also developed the following draft guideline for the protection of fish:

- Urban Stormwater Guidelines and Best Management Practices for Protection of Fish and Fish Habitat

Kanaka Creek near Thornvale Creek (Urban Systems, 2014)

3 RELEVANT PLANS AND STUDIES

3.1 Official Community Plan

As described above, the City's OCP is a bylaw; however, it is set out as a plan for guiding decisions across the municipality around economic development, land and resource use planning, transportation planning, maintaining and improving the natural and man-made environment and providing municipal services and public facilities. Guiding land use in the OCP is described further in Section 3.0.

The high-level goals of integrated stormwater management are inherent throughout the OCP, as they connect strongly to the community's values and vision, and the OCP's guiding principles, goals, objectives, and policies.

The OCP also establishes development permit area guidelines, which as described above, relate to stormwater management planning.

3.2 Albion Area Plan

The Albion Area Plan, established in the OCP, provides direction on land use, density, form, character, and phasing for the Albion Area.

The Albion Area Plan provides relatively limited stormwater management-related policy, and can be summarized as follows:

- Multi-family development policy is to retain natural vegetation where possible, and to conduct a geotechnical assessment if required

- Development in this area is subject to the Natural Features policies in the OCP
- Multi-family and Intensive Residential Development must also adhere to the Design Guidelines in the Development Permit Guidelines
- No specific TIA or EIA targets have been established for this area
- No specific stormwater management policies have been established for this area

3.3 Silver Valley Area Plan

The Silver Valley Area Plan, established in the OCP, provides direction on land use, density, form, character, and phasing for the Silver Valley Area. It is based on the concepts and principles described in the Silver Valley Area Planning Study, completed in 2001. Compared to other area plans, the Silver Valley Area Plan is quite comprehensive in its integration of stormwater management practices with development.

It describes existing environment conditions and environmentally sensitive areas, which are unique to the area and discussed further in this ISMP, and then establishes specific guiding principles for development in Silver Valley, including:

- Environment first;
- Sustainable approaches;
- Integrated community;
- Adaptability; and
- Healthy community.

The plan further establishes specific development principles for planning and urban design; environment, open space, and recreation; infrastructure; and economics.

The plan also sets out principles for stormwater management, including:

- Retention of native topsoil;
- Minimal interception of groundwater flow;
- Maximizing stormwater infiltration;
- Minimizing impervious surfaces;
- Watercourse base flow maintenance; and
- Utilization of stormwater treatment ponds.

The Silver Valley Area Plan establishes a target impervious area limit of 15% for the entire area.

The Silver Valley Area Plan and the actual development are considered relatively advanced for stormwater management, setting an example for low-impact development on steep terrain. The successes and challenges of stormwater management in the Silver Valley area will be further explored with City staff and stakeholders as the ISMP is developed and options are considered for this and other areas.

3.4 Town Centre Area Plan

The Town Centre Area Plan, established in the OCP, was adopted in 2008. It provides direction regarding land use, density, form, character, and phasing for the Town Centre Area.

The Town Centre Area Plan is based on "smart growth" principles, goals and objectives, including the following that are particularly relevant to stormwater management planning:

Principle 3:	**Work in harmony with natural systems: respect, maintain and restore the natural functioning of the landscape.**
Goals:	• Preserve, enhance and capitalize on natural amenities and create new ones • Protect natural systems from the impact of development
Objectives:	• Respect and enhance riparian areas and water resources • Protect and enhance a range of wildlife habitats • Reinstate historical streams • Increase quality and amount of green space in the Centre • Establish a green system that is linked throughout the Centre and beyond • Reduce the generation of water pollution and waste • Manage pollution and waste with best management practices

Principle 4:	**Buildings and infrastructure are greener and smarter: optimize the economic, social and ecological impact of buildings and infrastructure, and consider green infrastructure and buildings and natural drainage systems.**
Goals:	• Make it easier to be environmentally friendly • Combine new technologies with rediscovered approaches
Objectives:	• Manage urban stormwater with green infrastructure methods • Identify and act on appropriate urban ecology opportunities • Minimize environmental impact of erosion and waste disposal during construction • Provide incentives for the development of environmentally friendly buildings • Adopt green building and infrastructure standards • Educate on environmental benefits of growing smarter • Increase quality, function and amount of mandatory public/open/green space built by developers • Require sustainable buildings and building systems • Develop green infrastructure that provides for multiple land uses

The "Green Infrastructure" section of the Town Centre Area Plan includes various approaches and policies for achieving these stormwater management-related goals and objectives, including:

- Protection of natural features
- Enhancing urban ecology
- Building local partnerships to support environmental stewardship
- Rainwater management practices, including bioretention areas, rainwater gardens, bioswales, landscaped curb bulges on right-of-ways, rainwater harvest for irrigation, and green roofs.
- Within the Alouette River watershed, an infiltration rate of 90% for on-site and off-site development is encouraged where it is appropriate and feasible with other policies.

The Town Centre Area plan does not include specific targets for TIA or EIA, but it otherwise provides relatively comprehensive direction for stormwater management.

3.5 Environmental Management Strategy

Stemming from the City's OCP and its emphasis on the natural environment, the high rate of population growth, new challenges such as climate change, and community interest, the City decided to undertake an Environmental Management Strategy (EMS), which was completed in 2014. The purpose of developing the EMS was to understand the ongoing challenges, to identify opportunities and viable options, and to determine priorities and next steps with respect to environmental protection and management.

A community engagement process incorporated the input of stakeholders and the public into the EMS. In general, there was strong support for many of the City's existing environmental management tools and programs. Residents' top priorities for environmental management were to protect ecosystems, trees and forests, and aquifers, and to improve enforcement and limit sprawl.

The EMS has three goals:

- Goal A: Conserve and manage our natural assets;
- Goal B: Design and build sustainable neighbourhoods; and
- Goal C: Improve communications and environmental awareness.

Within each of these goals, the EMS provides objectives, strategies and actions for the City's existing tools that need fine tuning, as well as some new policies and processes to complement existing tools.

The implementation plan identified the resources, proposed phasing, relative priority and responsibilities for each proposed action. The following are some of the high priority actions recommended for implementation in the short term:

- Update Soil Deposit Bylaw;
- Prepare Tree Preservation and Management Bylaw;
- Prepare a system for encouraging and documenting all of a project's sustainable development practices in an integrated manner;
- Consider incentives such as density bonus, density transfer, developer cost contribution (DCC) reductions or priority processing;
- Integrate monitoring and enforcement into policies and processes;
- Consider an Environmental Advisory Committee; and

- Consider providing more resources to the environment section with the City to better manage, administer and enforce bylaws, conduct outreach, collaborate with stakeholders, and to generally implement the EMS.

The information, community input, and recommendations in the EMS provide a strong foundation for moving forward with integrated stormwater management planning.

3.6 Past and Current Drainage Studies and Plans

Numerous studies and plans have been completed over the years to guide stormwater management as the community develops, including:

- North Alouette and South Alouette Rivers Additional Floodplain Analysis Phase 2 – Technical Investigations (Northwest Hydraulics Consutlants, 2016)
- Agricultural Drainage Assessment – Ridge Shopping Centres Development, Albion Flats, North of 105th Avenue, Maple Ridge, BC (Draft) (Golder Associates, 2013)
- Albion Area Plan in the Official Community Plan (City of Maple Ridge, 2013)
- Silver Valley Area Plan in the Official Community Plan (City of Maple Ridge, 2013)
- Town Centre Area Plan in the Official Community Plan (City of Maple Ridge, 2013)
- Maple Ridge Storm Analysis Summary (Wedler Engineering, 2012)
- North Alouette and South Alouette Rivers Assessment and Floodplain Analysis (Northwest Hydraulics Consultants, 2010)
- Albion Watershed Master Drainage Plan (EarthTech, 2005)
- Albion Flats East Environmental Land Use Issues and Constraints (Envirowest Consultants, 2002)
- Albion Meadows Drainage Study (Beesley, 2002)
- Albion Meadows Report on Stormwater Management Strategy (Beesley, 2002)
- Section 9 Water Act Application, Spencer Creek Drainage Works (Envirowest Consultants, 2001)
- Albion Master Drainage Plan (UMA, 1995)
- Silver Valley Master Drainage Plan (UMA, 1995)
- Summary Report on Stormwater Management Strategy for the Cottonwood Area (Kerr Wood Leidal, 1994)
- Watercourse Inventory and Ravine Stability Assessment (Kerr Wood Leidal, 1994)
- District of Maple Ridge Drainage Survey (Dayton & Knight, 1985)
- District of Maple Ridge Kanaka Creek Drainage Area (Dayton & Knight, 1985)
- OCP SPR Classification Scheme (Stott, 2005)

Relevant information from these studies and plans is incorporated in the baseline assessment and referenced throughout this report.

The City is currently working to develop several studies and plans, including the following:

- Green Infrastructure Management Strategy - The Green Infrastructure Management Strategy will provide greater direction on the selection and application of Green Infrastructure.
- Lougheed Transit Corridor Study https://lougheedstudy.mapleridge.ca/
- North East Albion Land Use and Servicing Concept - https://www.mapleridge.ca/2214/North-East-Albion-Land-Use-and-Servicing

- Quantitative Risk Assessment - Fraser River Escarpment Area - The Quantitative Risk Assessment of the Fraser River Escarpment Area will provide a better understanding of conditions within the escarpment and support updates to the City's Escarpment Policies 6.23 and 6.24.
- Yennadon Lands Review - https://www.mapleridge.ca/2424/Yennadon-Lands

3.7 Other Technical Information

The City has also developed an inventory of technical data relevant to the ISMP, including the following:

- Aerial photography (2011, 2016)
- Asset inventory provided February, 2015 (GIS)
- Environmentally sensitive areas (GIS)
- Creek erosion inventory (2000-2003)
- 2013 OCP land uses
- Groundwater table mapping (predicted) (2001)
- IDF curve update (included in the 2015 Design Criteria)
- Historical, limited water quality and benthic invertebrates data (late 1990s and early 2000s)
- Recent water quality and benthic invertebrates data (2014-2015)
- Recent flow monitoring data (2014-2015)
- Surficial geology mapping (2002)
- Watercourse mapping and classifications (GIS) (2005)
- Well mapping (2000)
- Wildlife movement corridors (GIS)
- Bridge and culvert inspection sheet (2015)

These data were key sources of information in the development of the Part 1 report.

Hennipen Creek at Fern Crescent (Urban Systems, 2014)

4 THE SOUTH ALOUETTE AND KANAKA CREEK WATERSHEDS TODAY

4.1 Overview of the Watersheds

South Alouette

The South Alouette watershed is illustrated on **Figure 4.1**. The South Alouette is a 5th Order[2] stream with a length of approximately 31 km. The South Alouette River originates on Mount Robie Reid where drainage flows into Alouette Lake. Flows from Alouette Lake are controlled by the Alouette Dam, operated by BC Hydro. Flows from Alouette Lake are then conveyed west by the South Alouette river, where it converges with the North Alouette to form the Alouette River. The Alouette River flows west to the Pitt River and ultimately to the Fraser River, which conveys flows to the Salish Sea (Strait of Georgia). The Alouette River is a proclaimed BC Heritage River. The lower 8 km of the South Alouette is tidally influenced. Parts of the South Alouette River are also diked.

The South Alouette watershed is a large watershed, approximately 250 km^2 (25,128 ha) in size, of which approximately 100 km^2 (10,197 ha) lie within the City's municipal boundary. The remaining area falls within the jurisdiction of the City of Pitt Meadows, the District of Mission, and the Province of BC Parks (Golden Ears Provincial Park). The South Alouette watershed is bound by the Kennedy watershed to the west; the Fraser watershed to the southwest, the Kanaka Creek watershed to the southeast; and the North Alouette and Blaney Creek watersheds to the north.

[2] Stream order is a measure of the relative size of a stream, based on the number of tributaries to it, and it ranges from 1st Order through 12th Order. The smallest streams are 1st through 3rd Order, and are considered headwater streams.

Within the City's municipal boundary, the watershed can generally be characterized into the following "zones" (illustrated on **Figure 4.1**), with each zone having similar land use, drainage and environmental characteristics:

- Zone 1: Urban area in the lower watershed
- Zone 2: Rural area spanning the lower and parts of the upper watershed
- Zone 3: Agricultural area in the lower watershed
- Zone 4: Natural area in the upper watershed

There are numerous tributaries to the South Alouette River, including the following and as shown on **Figure 4.2:**

- Apple Creek
- Baillie Creek
- Balbanian Creek
- Coho Creek
- Cordin Creek
- Dogwood Creek
- Hardy Creek
- Hennipen Creek
- Latimer Creek Legion Creek
- McKenney Creek
- Morse Creek
- Millionaire Creek
- North Millionaire Creek
- Roberts Creek
- T1
- T2

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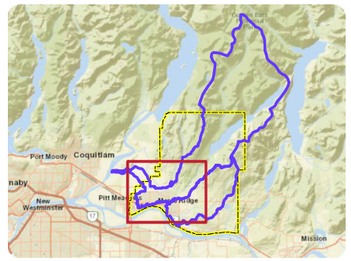
South Alouette and Kanaka Integrated Storm Water Management Plans

South Alouette Watershed – Overview

Blaney Creek Watershed
Zone 3 - Natural Uplands
Zone 4 - Resource Uplands
Zone 5 - Agricultural Lowlands
North Alouette Watershed
South Alouette Watershed
Zone 4 - Resource Uplands
Zone 1B - Urban Uplands
Zone 2 - Rural Lowlands
Katzie Slough Watershed
Zone 1A - Urban Lowlands
Fraser Watershed
Kanaka Watershed
Zone 2 - Rural Lowlands
Zone 1 - Urban Lowlands
Thornhill Watershed

Natural Watershed Boundary
Watershed Boundary Zones
Creeks
UBC - Malcom Knapp Research Forest
Provincial Protected Areas
Metro Vancouver Parks
Municipal Boundary



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Coordinate System:
NAD 1983 UTM Zone 10N

Data Sources:
City of Maple Ridge
City of Pitt Meadows
BC MoE
NR Canada

Project #:	1279.0025.01
Author:	BG
Checked:	GS
Status:	FINAL
Revision:	M
Date:	2021 / 9 / 1

URBAN SYSTEMS

FIGURE 4.1

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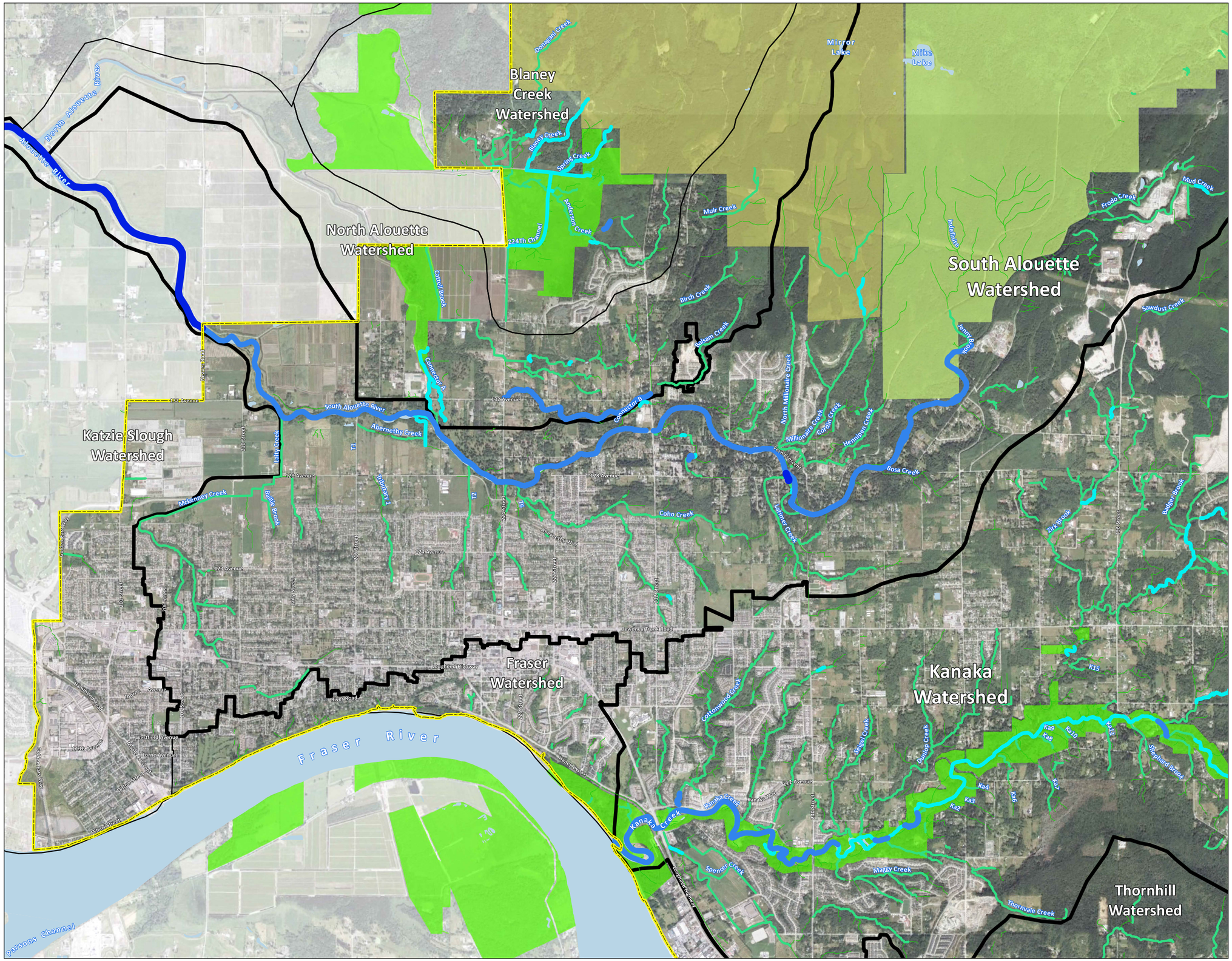
South Alouette and Kanaka Integrated Storm Water Management Plans

South Alouette Watershed – Watercourses



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British Columbia

Natural Watershed Boundary

Creek Wetted Width

- < 1.0 m
- 1.1 - 4.0
- 4.1 - 10.0
- 10.1 - 40.0
- 40.1 - 405.0 m

- UBC - Malcom Knapp Research Forest
- Provincial Protected Areas
- Metro Vancouver Parks
- Municipal Boundary

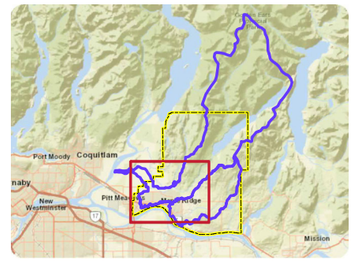

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FIGURE 4.2

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Kanaka Creek

Kanaka Creek is a 3rd Order stream with a length of 22 km that originates in mountainous terrain on Blue Mountain to the east of Alouette Lake, and generally flows southwest to its confluence with the Fraser River. The lower 4 km of Kanaka Creek are influenced by the tidal portion of the Fraser River.

The Kanaka Creek watershed is approximately 60 km^2 (6,180 ha) in size, and it is almost wholly within the City's municipal boundary (6,160 ha). Within the municipal boundary, it is characterized by the following "zones" (illustrated on **Figure 4.3**) with each zone having similar land use, drainage and environmental characteristics:

- Zone 1: Urban area in the lower watershed
- Zone 2: Rural area, spanning the lower and parts of the upper watershed
- Zone 3: Natural area in the upper watershed

A key feature of the watershed is Kanaka Creek Regional Park, which is under the jurisdiction of Metro Vancouver and runs the length of Kanaka Creek from Dewdney Trunk Road southwest to its confluence with the Fraser River.

The Kanaka Creek watershed is bound by the Fraser watershed to the west; the Fraser River to the south; the Thornhill and Whonnock watersheds to the south and southeast; and the South Alouette Watershed to the northwest.

There are numerous key tributaries to Kanaka Creek, including the following:

- Cottonwood Creek;
- Dunlop Creek;
- Fishook Creek;
- Horseshoe Creek;
- KA1 through KA7;
- Maggy Creek;
- Mainstone Creek;
- Morely Creek;
- Rainbow Creek;
- Salamander Creek;
- Seigel Creek;
- Spencer Creek;
- Tamarack Creek;
- Tea Creek; and
- Thornvale Creek.

Watercourses in Kanaka Creek watershed are shown on **Figure 4.4**.

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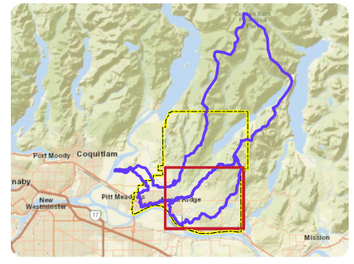
South Alouette and Kanaka Integrated Storm Water Management Plans

Kanaka Creek Watershed – Overview

Natural Watershed Boundary
Watershed Boundary Zones
Creeks
UBC - Malcom Knapp Research Forest
BCIT Woodlot
Provincial Protected Areas
Metro Vancouver Parks
Municipal Boundary



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Date:	2021 / 9 / 1

URBAN SYSTEMS

FIGURE 4.3

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British Columbia

South Alouette and Kanaka Integrated Storm Water Management Plans

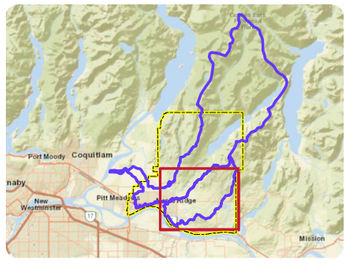
Kanaka Creek Watershed – Watercourses

Natural Watershed Boundary

Creek Wetted Width

- < 1.0 m
- 1.1 - 4.0
- 4.1 - 10.0
- 10.1 - 40.0
- 40.1 - 405.0 m

UBC - Malcom Knapp Research Forest
BCIT Woodlot
Provincial Protected Areas
Metro Vancouver Parks
Municipal Boundary



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URBAN SYSTEMS

FIGURE 4.4

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4.2 Existing Land Use

South Alouette

Existing land use in the South Alouette watershed is illustrated on **Figure 4.5**, based on current zoning information provided by the City. As previously described, the watershed is comprised of different "zones", for which existing development is summarized as follows:

- **The urban area** is characterized by development in the lowlands, in the vicinity of the Town Centre, and in the uplands of the Silver Valley area. The urban area is characterized primarily by single family land use, with higher-density residential development west of Laity Street and south of 123 Avenue; north of Dewdney Trunk Road between Laity Street and Wicklow Avenue; and north of Dewdney Trunk Road between 222 Street and 226 Street. Commercial development flanks the Lougheed Highway, which transects the South Alouette watershed in an east-west direction just north of the Fraser River. Parks are located throughout the urban lowlands and the riparian area along McKenney Creek (south of Golden Ears Way to Lougheed Highway) serves as a considerable green space in the otherwise developed neighbourhood. The Silver Valley Area currently includes primarily a mix of low-, medium- and high-density residential use.
- **The rural area**, which spans the lower watershed and part of the upper watershed, is characterized primarily by large-lot, rural residential and suburban development.
- **The agricultural area**, in the lowlands northwest of the Alouette River, is comprised primarily of agricultural development. The land is currently zoned as A-1, which allows for some uses that may involve development with a relatively high impervious area, such as rental stable use; agricultural use; and medical marijuana commercial production use (in the Agricultural Land Reserve only). It does not include intensive greenhouse use. All buildings and structures in the A-1 area together shall not exceed a lot coverage of 60%.
- **The natural area** in the upper watershed is characterized primarily by large forested areas zoned primarily for agricultural uses. However, some institutional development exists in the uplands, including the UBC Malcolm Knapp Research Forest and the Fraser Regional Corrective Centre, and some industrial development is located in the vicinity of 142 Avenue and 256 Street.
- **The resource area** in the uplands is characterized primarily by relatively small pockets of industrial and institutional development, at the border with the Kanaka watershed.

The existing total impervious area (TIA) for each zone was computed based on the City's 2011 and 2016 aerial photographs. Forest, grass, fields and water were considered to be pervious; gravel was considered semi-impervious; and pavement and roofs were considered impervious. Areas north of the orthographic extent are mostly forested and were assumed to be 100% pervious. Results are shown in **Table 4.1**. Inventory of future land use is discussed in Section 7.

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South Alouette and Kanaka Integrated Storm Water Management Plans

South Alouette Watershed – Existing Land Use

Zone 5 - Agricultural Lowlands

Zone 3 - Natural Uplands

Zone 4 - Resource Uplands

Zone 4 - Resource Uplands

South Alouette Watershed

Blaney Creek Watershed

North Alouette Watershed

Silver Valley Area Plan

Zone 1B - Urban Uplands

Zone 2 - Rural Lowlands

Katzie Slough Watershed

Zone 1A - Urban Lowlands

Town Centre Area Plan

Kanaka Watershed

Zone 2 - Rural Lowlands

Fraser Watershed

Zone 1 - Urban Lowlands

Albion Area Plan

Albion Flats Area Plan

Thornhill Watershed

Fraser River

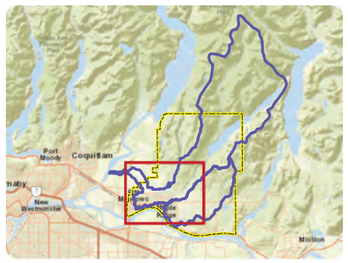
Natural Watershed Boundary

Watershed Boundary Zones

Area Plan Boundary

Zoning Category

- Agricultural
- Upland Agricultural
- Commercial
- Industrial
- Park and School
- Institutional
- Suburban and Rural Residential
- Single Family Residential
- Medium Density Residential
- High Density Residential
- Mobile Home Residential
- Comprehensive Development
- Land Use Contract
- Creeks
- Municipal Boundary



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Coordinate System:
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Data Sources:
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City of Pitt Meadows
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NR Canada

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FIGURE 4.5

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Table 4.1 South Alouette Watershed – Total Impervious Area Summary (Existing Conditions)

Watershed Zone	Total Area (ha)		Impervious Area (ha)		Percent Impervious	
	Total	Municipal	Total	Municipal	Total	Municipal
Agricultural	559	559	36	36	6%	6%
Natural	22,233	7,302	2	2	0.01%	0.03%
Rural	679	679	61	61	9%	9%
Urban Lowlands	1,058	1,058	395	395	37%	37%
Urban Uplands	277	277	24	24	9%	9%
Resource	322	322	30	30	9%	9%
South Alouette Total	**25,128**	**10,197**	**548**	**548**	**2%**	**5%**

Kanaka Creek

Existing land use in the Kanaka Creek watershed is illustrated on **Figure 4.6**, based on current zoning information provided by the City. As previously described, the watershed is comprised of different "zones", for which existing development is summarized as follows:

- **The urban area** in the lower watershed is characterized primarily by single-family residential development, higher-density residential development, and comprehensive development. Key developments include the Cottonwood and Albion areas. The extent to which these neighbourhoods are built out will be confirmed with the City as the ISMP is developed. These areas encompass lands north and southeast of Riverfront and Kanaka Creek's lower reaches. They encompass almost all of the catchment areas of Salamander, Horseshow and Rainbow Creeks, and the entire Cottonwood Creek catchment. These areas represent some of the most recent developments in Maple Ridge, which have also implemented stormwater management controls. Reviewing the outcomes of these developments will be something to explore as part of the ISMP process.
- **The rural area** spans the lower watershed and parts of the upper watershed, and is characterized primarily by large-lot, rural residential and suburban development. It features single-family residential development south of Kanaka Creek, and between 248 Street and 250 Street, north of 118a Avenue and south of Halnor Avenue. It also features an industrial area on the lower slopes of the uplands.
- **The natural area** in the upper watershed is characterized by forest and is zoned primarily for agricultural uses. However, some industrial development exists in the uplands at the boundary with the South Alouette watershed.
- **The resource area** in the uplands is characterized primarily by relatively small pockets of industrial and institutional development, at the border with the South Alouette watershed.

A primary feature of the Kanaka Creek watershed is Kanaka Creek Regional Park, a 400-ha park that is overseen by Metro Vancouver. The park flanks either side of Kanaka Creek, from its confluence with the Fraser River for approximately 11 km east to the community of Webster's Corners. The park features significant forested areas as well as the following features:

- A trail network, picnic area and boat launch at the Fraser Riverfront, west of the Lougheed Highway at Haney By-pass;

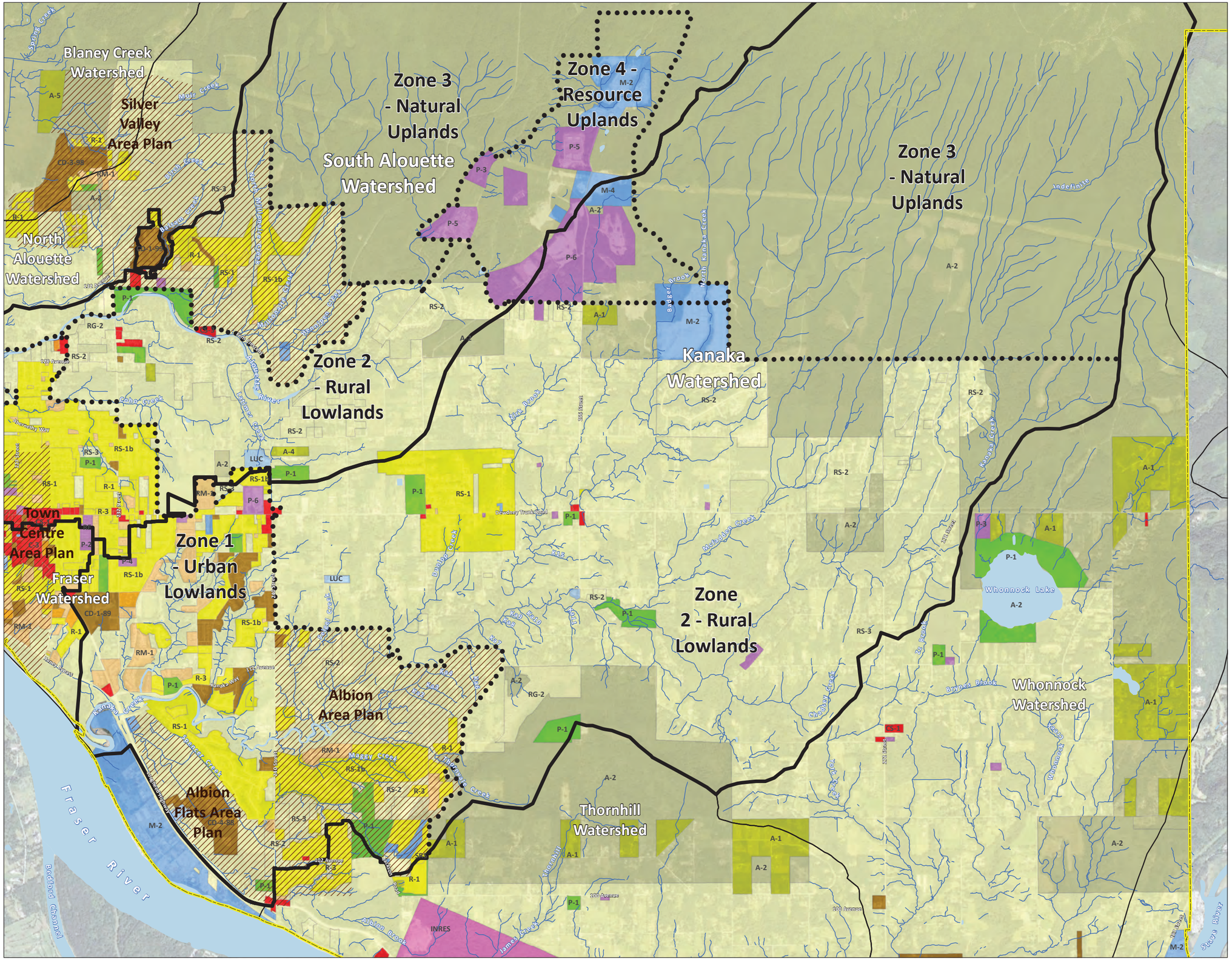
- A trail network, picnic area and campfires at Cliff Falls, roughly at the intersection of 116 Avenue and 251 Street; and
- The Bell-Irving Kanaka Creek Fish Hatchery, where 256 Street crosses Kanaka Creek.

Metro Vancouver provides preservation and enhancement of the park in partnership with the Kanaka Education and Environmental Partnership Society (KEEPS) and the Pacific Parklands Foundation.

The existing total impervious area (TIA) for each general area and the overall watershed was computed based on 2011 aerial photography provided by the City. Forest, grass, fields and water were considered to be pervious; gravel was considered impervious; and pavement and roofs were considered impervious. Results are shown in **Table 4.2** below.

Table 4.2 Kanaka Creek Watershed – Total Impervious Area (Existing Conditions)

Watershed Zone	Total Area (ha)		Impervious Area (ha)		Percent Impervious	
	Total	Municipal	Total	Municipal	Total	Municipal
Natural	2,103	2,083	48	47	2%	2%
Rural	2,777	2,777	181	181	7%	7%
Urban	1,199	1,199	243	243	20%	20%
Resource	156	156	11	11	7%	7%
Kanaka Creek Total	**6,235**	**6,215**	**483**	**482**	**8%**	**8%**


Blaney Creek Watershed
Silver Valley Area Plan
North Alouette Watershed
Zone 3 - Natural Uplands South Alouette Watershed
Zone 4 - Resource Uplands
Zone 3 - Natural Uplands
Zone 2 - Rural Lowlands
Kanaka Watershed
Zone 1 - Urban Lowlands
Town Centre Area Plan
Fraser Watershed
Albion Area Plan
Albion Flats Area Plan
Thornhill Watershed
Zone 2 - Rural Lowlands
Whonnock Watershed
Whonnock Lake
Fraser River
Bedford Channel
INRES
Blaney Creek
Murr Creek
Burbidge Creek
Alouette River
Kanaka Creek
Bonson Creek
Millionaire Creek
Hammond Creek
Cohoe Creek
Loutet Creek
Albion Slough
Maple Creek
Bayer Brook
North Kanaka Creek
Indefinite
Kanaka Creek
Bowdoin Trunk Road
Boulder Creek
Wickenden Creek
Kids Kids
Kids
Kids
Chapin Creek
Brown Creek
Tributary
Tributary
Tributary

4.3 Topography

South Alouette

Topography in the South Alouette watershed ranges from roughly sea level in the agricultural lowlands to approximately 2,085 meters (m) above mean sea level (mamsl) in the natural uplands, as shown on **Figure 4.7**.

- **The urban area** and **agricultural area** are generally flat or undulating, with slopes ranging from 0% to 5%. Watercourses in this area are considered lower-gradient.
- **The rural area** transitions from relatively flat or undulating terrain to the lower slopes of the mountains, with slopes averaging around 10%. Watercourses in this area are generally considered lower-gradient.
- **The natural and resource uplands** are characterized by generally steep slopes, averaging over 60%. Watercourses in the upper watershed are higher-gradient. Three distinct regions in the Silver Valley area are created by the North Alouette River and Millionaire Creek systems: uplands and moderate slopes (up to 20 degrees, or 36%); steep valley slopes (20 to 45 degrees, or 36% to 100%); and floodplain.

Kanaka Creek

Topography in the Kanaka Creek watershed ranges from 0.5 mamsl in the urban lowlands to 1,057 mamsl in the natural uplands, as shown on **Figure 4.8.**

- **The urban area** is characterized by relatively flat urbanized terrain and steeper slopes down to watercourses. They average slope is about 13%.
- **The rural area** is generally similar to the urban lowlands; average slope is about 14%.
- **The natural and resource uplands** are characterized by relatively steep slopes, with the average slope around 22%.

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MAPLE RIDGE
British Columbia

South Alouette and Kanaka Integrated Storm Water Management Plans

South Alouette Watershed – Topography

Elevation Classes

- -0 - 5 m
- 5.1 - 10
- 10.1 - 15
- 15.1 - 20
- 20.1 - 25
- 25.1 - 50
- 50.1 - 75
- 75.1 - 100
- 100.1 - 125
- 125.1 - 150
- 150.1 - 175
- 175.1 - 200
- 200.1 - 225
- 225.1 - 250
- 250.1 - 300
- 300.1 - 350
- 350.1 - 400
- Natural Watershed Boundary
- Creeks
- Municipal Boundary

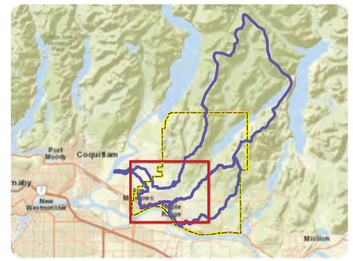

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FIGURE 4.7

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South Alouette and Kanaka Integrated Storm Water Management Plans

Kanaka Creek Watershed – Topography

Elevation Classes

- -0 - 5 m
- 5.1 - 10
- 10.1 - 15
- 15.1 - 20
- 20.1 - 25
- 25.1 - 50
- 50.1 - 75
- 75.1 - 100
- 100.1 - 125
- 125.1 - 150
- 150.1 - 175
- 175.1 - 200
- 200.1 - 225
- 225.1 - 250
- 250.1 - 300
- 300.1 - 350
- 350.1 - 400
- 400.1 - 450
- 450.1 - 500
- 500.1 - 550
- 550.1 - 600
- 600.1 - 650
- 650.1 - 700
- 700.1 - 750
- 750.1 - 800
- 800.1 - 850
- Natural Watershed Boundary
- Creeks
- Municipal Boundary

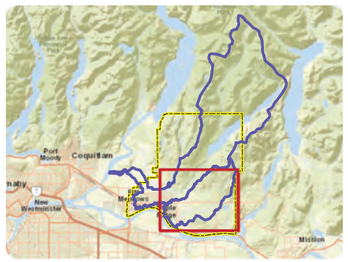

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FIGURE 4.8

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4.4 Terrestrial Systems Inventory

The South Alouette and Kanaka watersheds support a wide variety of terrestrial habitats across the range of zones previously described, from relatively undisturbed forested areas in the natural uplands, to rural and urban residential areas with riparian buffers, to agricultural lowlands behind a dike.

The study areas are located within the Coastal Western Hemlock Very Dry Maritime biogeoclimatic sub-zone (CWHxm). Climax vegetation in the CWHxm subzone typically consists of Douglas-fir, western hemlock and western redcedar. Salal, dull Oregon grape and step moss is common within the understory. These climax communities are likely to exist only in the upper portions of the watershed away from human disturbance, although the riparian corridors within residential areas currently do have this habitat available to a large extent.

The following tree species were noted during the November 2015 site visit along various riparian corridors within both watersheds:

- alder
- western redcedar
- hemlock
- bigleaf maple
- vine maple
- Himalayan blackberry
- salmonberry
- black cottonwood
- Sitka spruce
- Douglas-fir
- birch
- willow
- fern
- red-osier dogwood

The riparian areas within the South Alouette and Kanaka watersheds are also likely to have a diversity of wildlife species, including: black-tailed deer, black bear, river otter, mink, deer mouse, coyote, raccoon, osprey, snowy owl, ruffed grouse, numerous waterfowl species and shorebirds, garter snakes, painted turtle, western toad, red-legged frog, bullfrog, northwestern salamander, long-toed salamander and rough-skinned newt. The following is a list of species at risk that are likely present within the study area of one or both watersheds:

- Band-tailed Pigeon (Patagioenas fasciata)
- Barn Owl (Tyto alba)
- Barn Swallow (Hirundo rustica)
- Coastal Tailed Frog *(Ascaphus truei)*
- Great Blue Heron (Ardea herodias fannini)
- Grizzly Bear (Ursus arctos)
- Marbled Murrelet (Brachyramphus marmoratus)
- Olive-sided Flycatcher *(Contopus cooperi)*
- Oregon Spotted Frog *(Rana pretiosa)*
- Pacific Water Shrew *(Sorex bendirii)*
- Painted Turtle (Chrysemys picta)
- Spotted Owl (Strix occidentalis)
- Western Screech-owl (Megascops kennicottii)
- Western Toad (Anaxtrus boreas)
- Wolverine (Gulo gulo luscus)
- Short-eared Owl *(Asio flammeus)*
- Monarch (Danaus plexippus)
- Horned Lark (Eremophila alpestris strigata)
- Peregrine Falcon (Falco peregrinus anatum)
- Streambank Lupine (Lupinus revularis)
- Vesper Sparrow (Pooecetes gramineus affinis)

South Alouette

A search of the BC Conservation Data has indicated the following species at risk have confirmed habitat within the Alouette River watershed:

- Mountain Sneezeweed (*Helenium autumnale)*
- Pointed Rush (Juncus oxymeris)
- Green Heron (Butorides virescens)
- Painted Turtle (*Chrysemys picta)*
- Great Blue Heron (Ardea herodias fannini
- Northern Red-legged Frog (*Rana aurora)*
- Grappletail (Octogomphus specularis)
- Emma's Dancer (*Argia emma)*

As part of the City's Environmental Management Strategy, environmentally sensitive areas (ESAs) were inventoried. **Figure 4.9** shows the high-, moderate- and low-rated ESAs and ESA wetlands in the South Alouette watershed, as well as potential locations of species at risk and unique land forms. As shown on **Figure 4.9**, the South Alouette watershed features fairly significant tracts of high-rated ESAs throughout the watershed, and ESA wetlands in the lowland agricultural area.

Kanaka Creek

Kanaka Creek is largely within the Kanaka Creek Regional Park. This park covers over 12 km of the length of the stream, from the Fraser River and past Dewdney Trunk Road. The habitat along the creek within this park is largely forested, with a mix of residential and agricultural land surrounding the park. Lower Kanaka Creek is a low velocity, meandering stream with wetlands and other low-lying grassy habitats. Upper Kanaka Creek flows through steeper forested terrain. A search of the BC Conservation Data has indicated the following species at risk have confirmed habitat within the Kanaka Creek watershed:

- Roell's Brotherella (Brotherella roellii);
- Green Heron (Butorides virescens);
- Oregon Forest Snail (*Allogona townsendiana);* and
- Northern Red-legged Frog (*Rana aurora).*

Figure 4.10 shows the high-, moderate- and low-rated ESAs and ESA wetlands in the Kanaka Creek watershed, as well as potential locations of species at risk and unique land forms. As shown on **Figure 4.10**, the Kanaka Creek watershed features significant tracts of high-rated ESAs throughout the watershed and particularly throughout Kanaka Creek Regional Park and in the vicinity of the bluffs bordering the Thornhill watershed. There are large tracts of ESA wetlands between 240th Street and Riverfront.

4.4.1 Invasive Species Management

An invasive species is any plant or animal species that is introduced into an environment where the species is not native. There are numerous examples of plants, insects, birds and animals that have been transplanted from their natural environments, either by accident or intentionally, into areas where they end up having a serious impact on the natural ecosystem.

In some cases, climate change is contributing factor in some plant and animal species creating environmental damage as the plants and animals extend into new areas, or the natural controls against them collapse. The Pine Beetle is often noted as an example of how the warmer and shorter winters contributed to the massive infestations in BC.

Noxious weeds that are part of the City's Untidy and Unsightly Premises Bylaw No. 6982 (PDF) are:
Canada Thistle (Cirsium arense)

- Bindweed or Morning Glory (Convolvulus)
- Couch Grass (Agropyon repens)
- Purple Loosestrife (Lythrum salicaria)
- Giant Hogweed (Heracleum mantegazzianum)
- Japanese Knotweed (Polygonum cuspidatum) – a priority for management by Metro Vancouver Parks

In 2018 the City enacted its amended Soil Deposit Regulation Bylaw (7412-2017) requiring an *"Invasive species, including noxious weeds, assessment and management plan to ensure that additional problem species are not transferred to or from the property, and to ensure that the extent of the species is not spread across the property as a result of any soil deposit activity."*

Maple Ridge has been working on the issue of non-native plant control and management for several years. The Lower Mainland has some of the most favourable growing conditions in Canada, and as people moved to this region from all around the world; they brought plants and trees with them to plant on their properties. BC's Lower Mainland has one of the largest diversities of tree species in the nation.

The City has a dedicated section on its website for Invasive Species & Pests Invasive Species & Pests | Maple Ridge, BC providing significant information about species of concern and what residents can do to contribute to their management.

The City recently mapped invasive plants within the City and retains contractors annually to eradicate them. Allocated budgets are focused on removal currently, with desire to increase funding for native species replanting where invasives are removed. ARMS, KEEPS, Metro Vancouver and a number of other volunteer organizations carry out ongoing projects to remove invasive plants and plant native species.

4.4.2 Mosquito Control

The City of Maple Ridge contracts to Metro Vancouver for the control of mosquito populations. Metro Vancouver carries out their work according to a Mosquito Pest Management Plan (PMP) approved by the BC Ministry of Environment. Metro provides extensive information on the mosquito control program on their public website.[3] Their Mosquito Pest Management Plan [4] describes the treatments and their potential effects on non-target species, which in summary states that bacterial agents applied have not been shown to have adverse environmental impacts when applied according to label directions, and no lasting adverse effects on populations of invertebrates or other non-target aquatic organisms.

Detention ponds are not specifically targeted for mosquito control. If treatment is applied to detention ponds, treatment would be timed for the start of the pond life-cycle, when there are no predators to manage the mosquito population naturally and only if the pond is directly affecting residents. If a pond is producing mosquitoes in numbers enough to cause annoyance, then the likelihood of non-target organisms in the water body is small.

[3] http://www.metrovancouver.org/services/parks/learn/natural-resource-management/wildlife-management/Pages/default.aspx

[4] Metro Vancouver Regional District Mosquito Pest Management Plan for the Control of Nuisance

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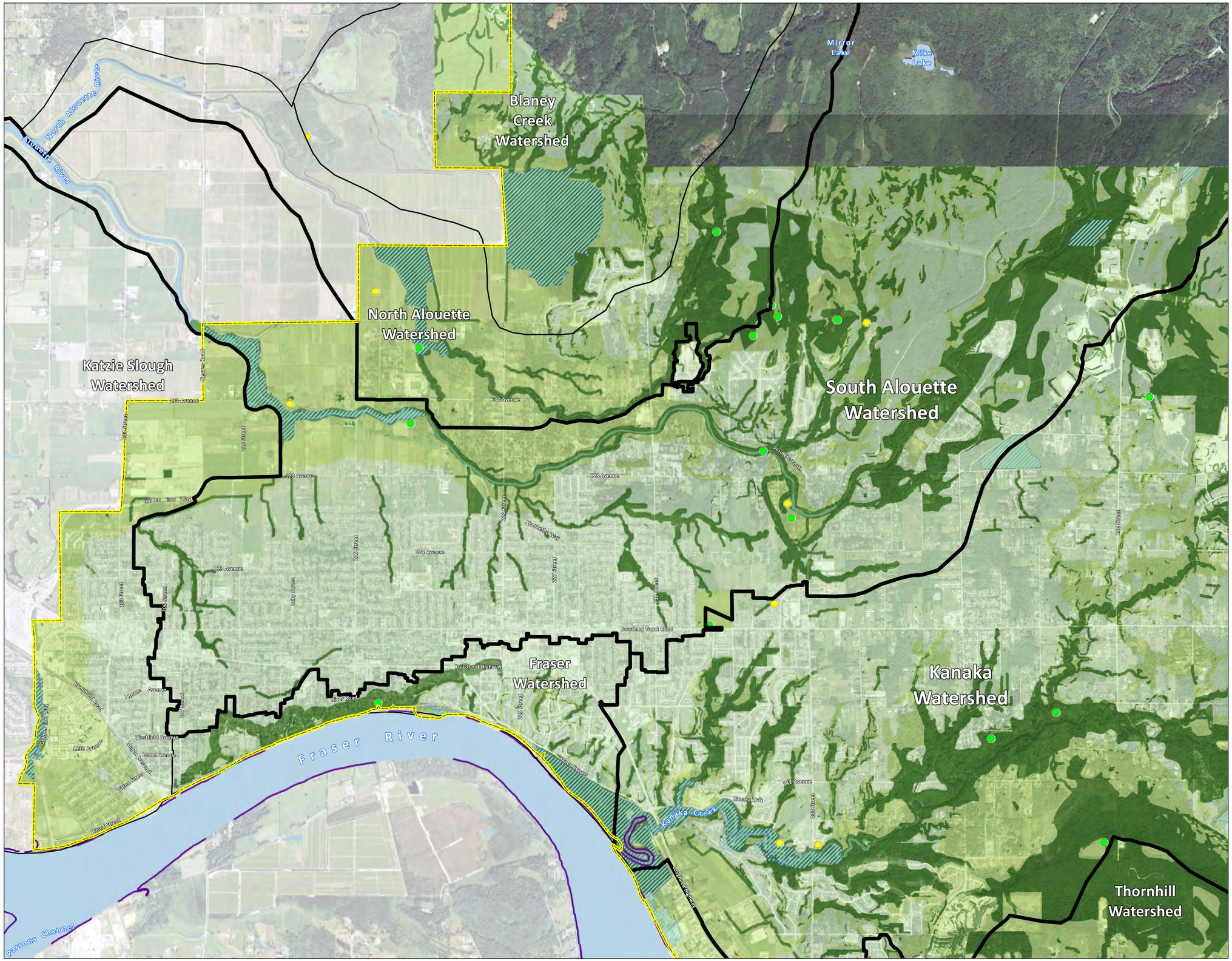

MAPLE RIDGE
British Columbia

South Alouette and Kanaka Integrated Storm Water Management Plans

South Alouette Watershed – Terrestrial Habitat

- Species At Risk Act - SARA
- Unique Landform and Natural Heritage
- ESA Foreshore

ESA Rating

- High
- Moderate
- Low
- ESA Wetlands
- Natural Watershed Boundary
- Municipal Boundary

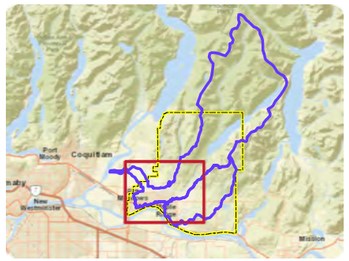

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FIGURE 4.9

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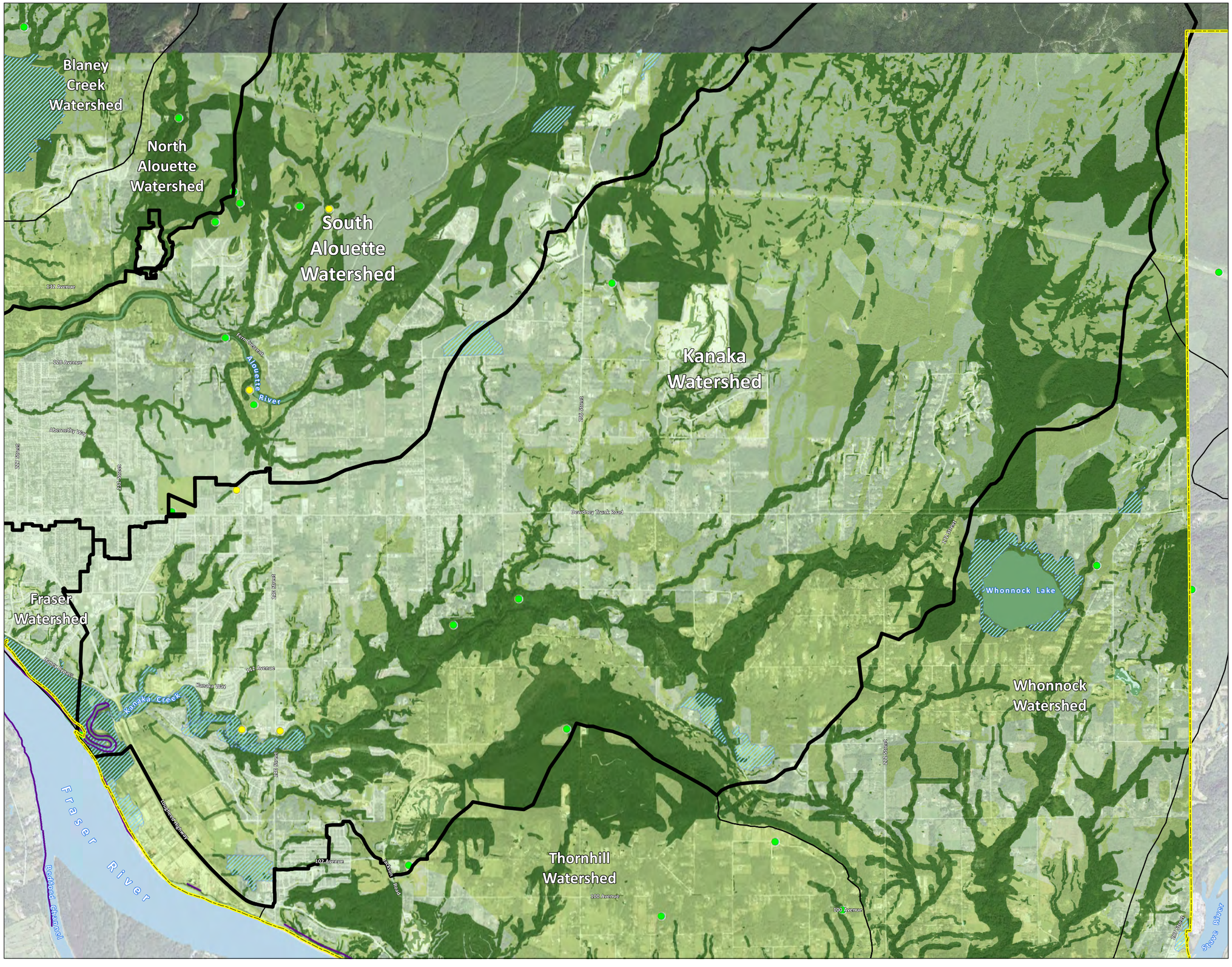

MAPLE RIDGE
British Columbia

South Alouette and Kanaka Integrated Storm Water Management Plans

Kanaka Creek Watershed – Terrestrial Habitat

- Species At Risk Act - SARA
- Unique Landform and Natural Heritage
- ESA Foreshore

ESA Rating

- High
- Moderate
- Low
- ESA Wetlands
- Natural Watershed Boundary
- Municipal Boundary

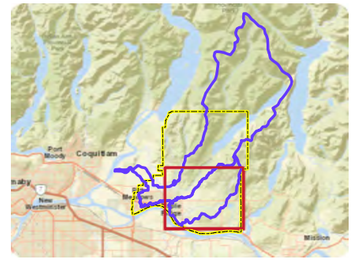

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FIGURE 4.10

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4.5 Aquatic Species and Habitat Inventory

The City's Environmental Management Strategy served as a strong foundation for developing the environmental inventory in this ISMP, in addition to other environmental reports and provincial databases; including:

- BC Habitat Wizard (Provincial database)
- Van Dischoek, P. (2001). Kanaka Creek Juvenile Steelhead Sampling Program. Prepared for the Kanaka Education and Environmental Partnership Society, Maple Ridge, BC. Aquatic Resources Ltd.
- Slaney, P., C. Hryhorczuk, A. Bigsby (2005). Habitat Assessments and Restoration Prescriptions for the Corrections Reach of the Alouette River. Prepared for BC Hydro Bridge Coastal Restoration Program. Greater Georgia Basin Steelhead Recovery Plan.

To supplement this background information, a site visit was conducted on November 19, 2015, with the following objectives:

- Observe stream characteristics;
- Observe potential barriers to fish passage; and
- Assess riparian vegetation species and riparian corridors.

Public access points were used to gain entry to several streams including: South Alouette River, Kanaka Creek, T2 Creek, Millionaire Creek, North Millionaire Creek, Hennipen Creek, Thornvale Creek, Cottonwood Creek, Dunlop Creek, as well as several unnamed tributaries.

4.5.1 South Alouette

The resources noted above demonstrate presence of at least 29 fish species, including several invasive fish species. The following are fish species known to occur in the South Alouette River.

- Brassy Minnow
- Brown Catfish
- Bull Trout
- Carp
- Chinook Salmon
- Chum Salmon
- Coastal Cutthroat Trout
- Coho Salmon
- Cutthroat Trout
- Cutthroat Trout (Anadromous)
- Dace (General)
- Dolly Varden
- Kokanee
- Lake Trout
- Lamprey (General)
- Largescale Sucker
- Longnose Dace
- Longnose Sucker
- Mountain Whitefish
- Northern Pikeminnow
- Oriental Weatherfish
- Peamouth Chub
- Pink Salmon
- Prickly Sculpin
- Pumpkinseed
- Rainbow Trout
- Redside Shiner
- River Lamprey
- Sculpin (General)
- Sockeye Salmon
- Steelhead
- Stickleback (General)
- Sucker (General)
- Threespine Stickleback

No major fish barriers are known to exist on the South Alouette except for the BC Hydro dam at the outlet of Alouette Lake Reservoir. However, the City of Maple Ridge has provided information that indicates the presence of two waterfalls on the South Alouette River. Both waterfalls were not observed during the site visit due to difficult access/private lands. However, the waterfall indicated in the vicinity of 128th Avenue is not likely to be a major fish passage barrier given the topography of the surrounding area. The uppermost waterfall, located approximately 5 km downstream of Alouette Lake Reservoir, has a higher likelihood of being a major fish passage barrier given the steeper terrain in the general area. The mainstem of the

South Alouette River supports significant historic populations of pink salmon, chum salmon, steelhead and coho salmon, and the tributaries support spawning and rearing coho salmon and coastal cutthroat trout (Slaney, *et al.,* 2005). Chinook salmon, after a period of absence, have re-colonized the South Alouette in very small numbers (Slaney, *et al.,* 2005).

Of the tributaries to the South Alouette River, several are fish-bearing. These, and potential barriers to fish passage along the streams, are summarized below:

Balbanian Creek	This creek provides rearing habitat to coho salmon as well as rainbow and cutthroat trout. There is a possible barrier to upstream fish passage at the culvert under 232 St, approximately 1 km above the confluence with the South Alouette River (BC Habitat Wizard, 2015).
Coho Creek	Coho Creek is an important tributary to the South Alouette River as it has a spawning run of chinook, coho, chum and pink salmon. Steelhead, cutthroat trout and rainbow trout are also known to inhabit Coho Creek but for which life stage(s) is unclear (BC Habitat Wizard, 2015).
Hennipen Creek	Hennipen Creek is known to provide spawning habitat to chum and coho salmon and likely rearing habitat for coho salmon. Steelhead and cutthroat trout are also known to utilize Hennipen Creek but it is not known for which life stage(s). There are also two possible barriers to fish passage; the first at the culvert beneath Fern Crescent and the other a series of cascades approximately 100 m to the east of 129 Avenue (BC Habitat Wizard, 2015). Thus, only the lower reaches of this stream are likely accessible to anadromous salmonids.
Latimer Creek	This South Alouette tributary is known to contain chinook, chum and coho salmon, as well as cutthroat and rainbow trout. However, the extent of usage by the aforementioned species is not known. An exposed clay barrier near 244 Street may prevent further upstream fish passage (BC Habitat Wizard, 2015).
Legion (Morse) Creek	This stream is less than 1 km in length and is known to contain chinook and coho salmon as well as cutthroat and rainbow trout. The culvert at 224 Street at Abernathy Way may be a barrier due to its excessive length (BC Habitat Wizard, 2015).
McKenny Creek	This creek provides rearing habitat to juvenile coho as well as rainbow and cutthroat trout. A long culvert between 121 and 122 Avenue is probably not fish passable (BC Habitat Wizard, 2015).
Millionaire Creek	Millionaire Creek provides spawning habitat to chinook, coho, chum and pink salmon. Steelhead, rainbow and cutthroat trout and mountain whitefish are also present (BC Habitat Wizard, 2015).
North Millionaire Creek	North Millionaire Creek is a high gradient stream and is known to contain cutthroat and rainbow trout. It is possible that the cascades above 130 Avenue are an upstream barrier to fish passage. A small section of North Millionaire Creek above the 133 Avenue bridge was walked during the November 19th site visit and no fish were noted. However, upstream habitat appears conducive to salmonid spawning and rearing, but it is unknown if fish are able to access the area above the cascades. In the absence of conclusive evidence, upstream areas of North Millionaire Creek should be treated as fish-bearing.

T2 Creek	T2 Creek is approximately 1.4 km in length and has a substrate dominated by gravel and fines with some boulders. The extent to which fish utilize this stream is unknown although it is possible given the direct connection to the South Alouette River.

An inventory of streams in the South Alouette watershed is shown on **Figure 4.11**.

4.5.1.1 Hydroelectricity Generation

Alouette Dam, photo credit to BC Hydro website (Alouette system (bchydro.com))

The information contained in this subsection are paraphrased from the BC Hydro website (Alouette system (bchydro.com)) and supplemented through communications with BC Hydro.

The Alouette Dam was constructed in the late 1920s and is part of BC Hydro's Alouette-Stave-Ruskin hydroelectric system which generates clean electricity for customers across the province.

The construction of the Alouette Dam and creation of the Alouette Lake Reservoir introduced fundamental changes to the watershed. In addition to creating a large reservoir, the dam also cut off fish access to the upper reaches of the Alouette system and regulated the flow of water down the South Alouette River.

BC Hydro operates the Alouette Dam and Reservoir in accordance with its Water Use Plan, Water Use Plan Orders and Water Licences.

Water Use Plans

The Province created the Water Use Planning (WUP) Guidelines in 1998, to balance power production with competing water uses. Between 1999 and 2004, 23 WUPs were developed through a consultative process for 31 BC Hydro facilities.

The Alouette Water Use Plan Review Consultative Committee was comprised of representatives from BC Hydro, Katzie First Nation, provincial and federal government agencies, municipal governments (City of Maple Ridge), and local stakeholders,

including Fraser Regional Correctional Centre (ALCO hatchery) and Alouette River Management Society (ARMS) (ALU WUP CC Report 2006).[5]

Fish Passage – Alouette River / Alouette Lake

BC Hydro currently uses a combination of spring releases from the dam and a trap and truck program to provide sockeye with downstream and upstream fish passage, respectively.

In the spring, as part of the Alouette Water Use Plan Order, a surface flow of 3 cubic meters per second is released from the spillway between April 15 and June 14 to facilitate Sockeye smolt outmigration. Annual monitoring has been conducted since 2005 to estimate the number of Sockeye smolts out-migrating from the Alouette Lake Reservoir. The estimated yearly average is approximately 13,000 smolts.[6]

The trap and truck method provides returning salmon with passage above the dam. Since 2005, an average of 32 Sockeye salmon have returned to the South Alouette river.[7]

Year	Estimated Smolts	Adult Returns	Ocean Survival
2005	7,900	-	0.66%
2006	5,064	-	0.76%
2007	62,423	38	0.08%
2008	7,957	54	1.48%
2009	3,704	45	0.19%
2010	12,363	115	0.36%
2011	30,729	11	0.03%
2012	648	45	0.46%
2013	5,385	10	0.03%
2014	11,523	0	0.06%
2015	583	4	0.71%
2016	-	6	-
2017	17,394	3	0.05%
2018	31,643	15	0.25%
2019	0	15	-
2020	1,473	85	-
Average	**13,253**	**32**	**0.39%**

Source: Borick-Cunningham (2021)

[5] https://www.bchydro.com/toolbar/about/sustainability/conservation/water_use_planning/lower_mainland/alouette.html

[6] Borick-Cunningham, G. 2021. Alouette Watershed Sockeye-Fish Passage Feasibility Project Year 4 COA-F21-3365-F21-F-3365-DCA. Prepared for Fish & Wildlife Compensation Program, Burnaby, BC.

[7] Borick-Cunningham, G. 2021. Alouette Watershed Sockeye-Fish Passage Feasibility Project Year 4 COA-F21-3365-F21-F-3365-DCA. Prepared for Fish & Wildlife Compensation Program, Burnaby, BC.

Fish Entrainment – Alouette Lake to Stave Lake

Image Credit: Alouette system (bchydro.com)

Fish entrainment is the process whereby fish upstream of flow management structures are swept downstream as a function of operations and/or fish behaviour. The impacts of the Alouette-Stave Diversion Tunnel (ALU tunnel) operations, when water is diverted from Alouette Lake Reservoir to Stave Lake Reservoir (a different watershed from the South Alouette), on smolt outmigration success and potential entrainment is unknown but a study is currently underway.

Fish Passage Decision Framework

The Fish Passage Decision Framework is a seven-step process that outlines the advancement, evaluation, implementation and funding of fish passage restoration projects at their facilities. It was developed in 2008 by BC Hydro, the Department of Fisheries and Oceans and the Government of B.C. to ensure proposed fish passage is both biologically and technically feasible. The framework is a structured process designed to ensure proposed fish passage improvements will be biologically, technically and financially feasible.

The Alouette River Salmon Restoration Program (ARSRP) is within the Fish Passage Decision Framework noted above. The ARSRP Committee (formerly known as the Sockeye Re anadromization Program) consists of representatives from Indigenous Nations, DFO, the Government of B.C., BC Hydro, Alouette River Management Society and technical support.

In 2017, the ARSRP Committee identified smolt production from the Alouette Reservoir as a key factor limiting salmon restoration to the Alouette watershed, and subsequently proposed the implementation of a sockeye hatchery to assess its feasibility as a restoration option. However, in 2020 the ARSRP and Katzie First Nation identified smolt outmigration and entrainment as priorities for assessment prior to consideration of a sockeye hatchery program.

As part of its updated study plan ARSRP is implementing two studies to investigate the impacts of BC Hydro's Alouette operations on smolt outmigration success, both at the dam and the diversion tunnel between Alouette and Stave Lake reservoirs.

1. In spring 2021, an experimental operation at Alouette Dam was implemented to investigate whether increased spillway flows will result in increased outmigration. The experimental operation released an average flow of approximately 8.5 cubic meters per second to the South Alouette River. Sockeye smolt outmigration numbers were monitored in South Alouette River from April 15 to June 14 to determine if the increased flow was a benefit to smolt outmigration.
2. To estimate the proportion of smolts entrained at the tunnel relative to the number of smolts outmigrating past the Alouette Dam to the South Alouette River, the ARSRP is implementing hydroacoustic monitoring at the ALU tunnel from spring 2021 through summer 2022.

Hatchery Operations

The ALLCO Hatchery is operated by BC Corrections and raises Chinook, Pink, Coho and Chum salmon. Fish are gathered using a fish fence and trapping system located near the hatchery on the Alouette River.

Flood Protection

BC Hydro's Alouette dam and reservoir were designed and built to store water for power generation. However, a related outcome of the storage for power generation is that the Alouette Lake Reservoir can provide some flood attenuation, depending on the volume of inflows and the reservoir elevation.

BC Hydro operates the Alouette dam and reservoir according to water licences and the Water Use Plan Order, which were issued by the Province of British Columbia. It also operates the dam according to the Operations, Maintenance and Surveillance Manual for Dam Safety which is submitted to and accepted by the provincial dam safety officer for Alouette Dam.

During storm events the system may experience high inflows and high reservoir situations, resulting in higher than normal volumes of water being passed over the spillway into the South Alouette River. When combined with high tributary inflows, there may be potential for flooding areas downstream of the dam.

Recreation

Alouette Lake Reservoir is a popular spot for swimming, windsurfing, water-skiing, canoeing, boating and fishing. Golden Ears Provincial Park, one of the largest parks in the province is situated next to the reservoir and hosts over 600,000 visitors annually.[8]

4.5.2 Kanaka Creek

The resources noted above demonstrate presence of 11 species of fish in Kanaka Creek; however, given its direct connection to the Fraser River, it is likely that more species inhabit this system. The following is a list of the fish species known to occur in Kanaka Creek.

- Chum Salmon
- Coho Salmon
- Cutthroat Trout
- Cutthroat Trout (Anadromous)
- Pink Salmon
- Rainbow Trout
- Sculpin (General)
- Steelhead
- Stickleback (General)
- Threespine Stickleback
- Westslope Cutthroat Trout

[8] Golden Ears Park Management Plan, 2013

At Cliff Falls Park, approximately 7.2 km upstream of the Fraser confluence, there are falls on both forks of Kanaka Creek. These falls are 7 m and 10.5 m in height, respectively, and form an absolute barrier to fish passage (van Dishoeck, 2001). Approximately 800 m downstream, there is a second set of falls between 2 m and 2.5 m in height, which form a barrier to upstream fish passage for all species of fish with the exception of adult steelhead (van Dischoek, 2001). The canyon section between the two sets of falls provides limited spawning habitat. However, the reach between 240th Street and the lower set of falls provides the majority of salmonid spawning and rearing habitat available in the entire watershed (van Dischoek, 2001). The lower reach of Kanaka Creek (downstream of 240th Street) does provide some habitat to rearing coho and is tidally influenced.

Information regarding tributaries is limited, but it should be assumed that any tributary has the capacity to provide fish habitat, if not directly then indirectly through contribution of water and nutrients to downstream fish habitat. Specific information regarding fish species and potential fish barriers was noted based on available information for the following tributaries:

Cottonwood Creek	Cottonwood Creek confluences with the tidal-influenced lower section of Kanaka Creek. Salmonid habitat is likely in this system, although it likely provides rearing habitat to coho salmon. There is a weir above Kanaka Way that is fish passable due to the presence of a fish at that location (BC Habitat Wizard, 2015).
Dunlop Creek	This creek provides spawning habitat to coho and chum salmon and rearing areas for juvenile coho. Cutthroat trout are also known to inhabit this stream (BC Habitat Wizard, 2015). Dunlop Creek empties into a key spawning area, sensitive to erosion and pollution that may occur in the creek.
Horseshoe Creek	Horsehoe Creek provides habitat to coho salmon (BC Habitat Wizard, 2015).
Maggy Creek	Maggy Creek is a very small Kanaka Creek tributary with a length of approximately 1.3 km. However, it is known to contain cutthroat trout (BC Habitat Wizard, 2015).
McFadden Creek	Another very small tributary with a length of only 0.34 km, McFadden Creek is known to provide habitat to cutthroat trout (BC Habitat Wizard, 2015). McFadden Creek flows into Kanaka Creek at the intake for the Bell-Irving hatchery, which is sensitive to erosion and pollution that may occur in the creek.
Rainbow Creek	Rainbow Creek has a length of 1.18 km and is known to provide habitat to coho salmon (BC Habitat Wizard, 2015).
Salamander Creek	With a length of 1.26 km, this small tributary is also known to provide habitat to coho salmon (BC Habitat Wizard, 2015).
Spencer Creek	Spencer Creek is known to provide spawning habitat to coho salmon. Cutthroat trout are also known to inhabit this creek (BC Habitat Wizard, 2015).
Thornvale Creek	Thornvale Creek is a small tributary of Kanaka Creek that is known to contain coho salmon and cutthroat trout (BC Habitat Wizard, 2015).

An inventory of streams in the Kanaka watershed is shown on **Figure 4.12**.

4.5.3 Salmon Survival and Fish Count Data

ARMS has been collecting spawner fish count data at four locations between 2007 and 2020, showing significant variability year to year as shown in the table below. For each creek there are 1 to 3 years of data missing. The vast majority of the counts are Chum salmon.

Location	Lowest Year Live Count / hour	Highest Year Live Count / hour
Millionaire Creek at 129 Avenue near Fern Crescent	4	64
Latimer Channel of South Alouette River near 128 Avenue and 239 Street	72	1128
Coho Creek near 127 Avenue west of 226 Street	4	124

(Data provided by ARMS and compiled by the City of Maple Ridge)

The Department of Fisheries and Oceans Canada maintains a database of fish presence in its "NuSEDS" (New Salmon Escapement Database System)[9]. Count data is available from 1951 to 2013 in the South Alouette River, and 1951 to 2017 in Kanaka Creek. The specific species of salmon counted is not always consistent year to year, but in most years multiple species are counted. The data shows high fluctuation in counts from year to year with no apparent trend over the entire timeframe of counts. The fluctuating numbers is extremely complex, so presenting fish count numbers herein this ISMP may be misleading. There are many variables that impact salmon at various life stages such as habitat destruction/ encroachment, natural resource pressures (logging /mining), water extraction, pollution events that impact water quality, warmer ocean temperatures / currents, ocean productivity, commercial overfishing, predation, competition amongst species, etc. None of these are causes specific to Maple Ridge alone.

Notwithstanding fluctuating counts on local rivers, it is understood that Pacific salmon populations face grave threats, as described in DFO's 2019 "State of Canadian Pacific salmon: responses to changing climate and habitats" report. Highlights of that report are provided at https://www.dfo-mpo.gc.ca/species-especes/publications/salmon-saumon/state-etat-2019/ebook/index-eng.html

In June 2021, DFO issued a news release (link below) stating that Pacific salmon are "experiencing drastic population declines due to a combination of climate, habitat and harvesting pressures" and that "bold, transformative action is needed now to stabilize, protect and rebuild West Coast salmon stocks for the ecosystems and communities that depend on them, before it is too late." The news release provided information on a new program, the "federal government's $647.1 million Pacific Salmon Strategy Initiative (PSSI) announced in Budget 2021, and a full commitment to work in partnership with local organizations and groups in its development and delivery. The strategy will represent the largest-ever Government investment in efforts to save Pacific salmon, and aims to stop the declines now while helping rebuild populations over the longer term." Information on the PSSI can be found at https://www.dfo-mpo.gc.ca/campaign-campagne/pss-ssp/index-eng.html

[9] NuSEDS-New Salmon Escapement Database System - Open Government Portal (canada.ca)

It is recommended that the City support efforts to rebuild salmon stocks by seeking opportunities to partner with DFO, the province and others to implement the recommendations of this ISMP.

News release: https://www.canada.ca/en/fisheries-oceans/news/2021/06/canada-launches-transformative-effort-to-save-pacific-salmon.html

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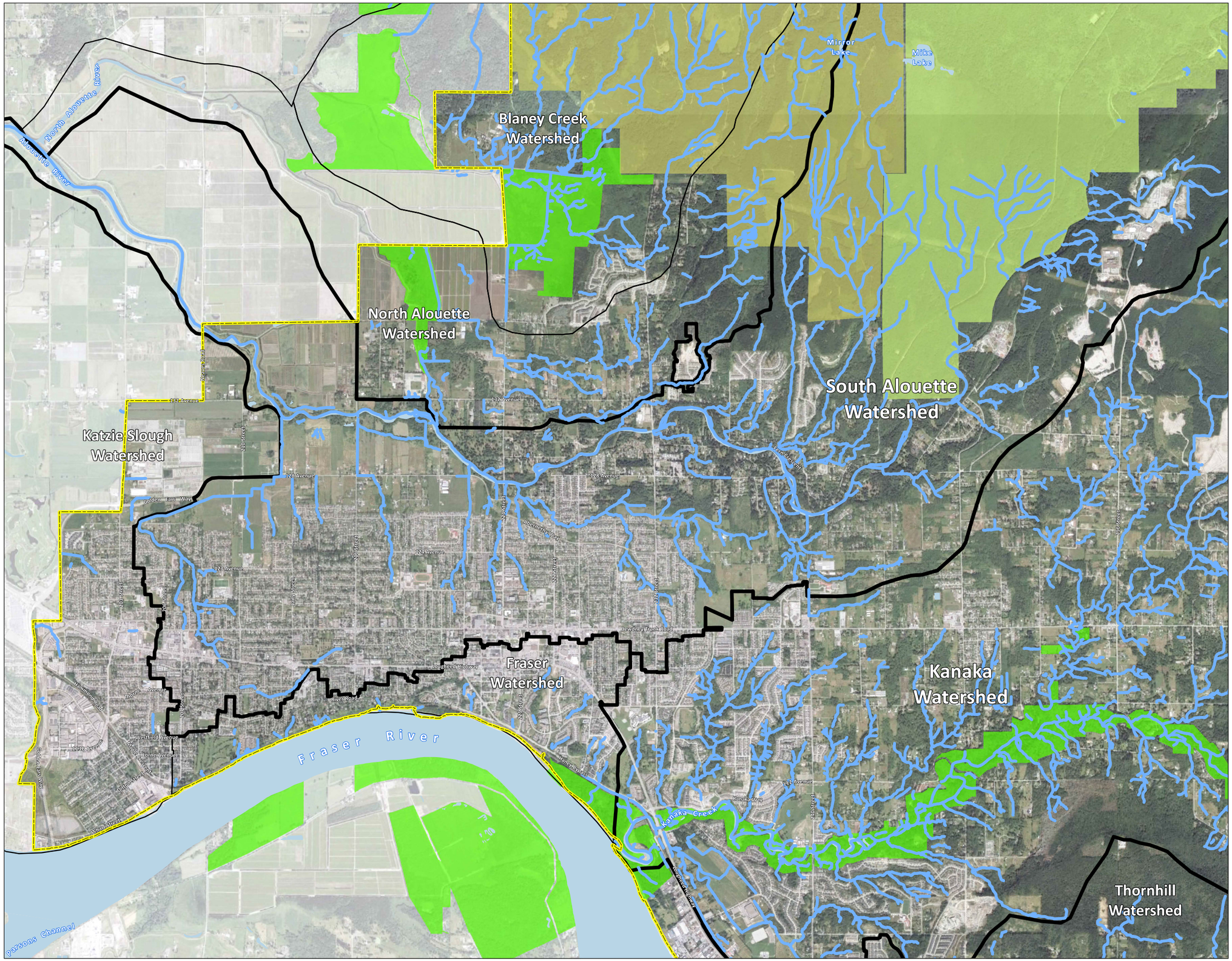
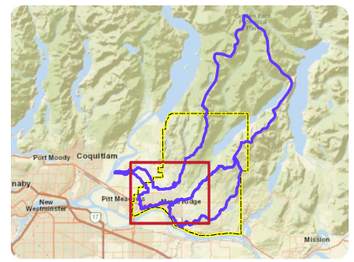


South Alouette and Kanaka Integrated Storm Water Management Plans

South Alouette Watershed – Aquatic Habitat

- Stream
- Natural Watershed Boundary
- UBC - Malcom Knapp Research Forest
- Provincial Protected Areas
- Metro Vancouver Parks
- Municipal Boundary



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Coordinate System:
NAD 1983 UTM Zone 10N

Data Sources:
City of Maple Ridge
City of Pitt Meadows
BC MoE
NR Canada

Project #:	1279.0025.01
Author:	BG
Checked:	GS
Status:	FINAL
Revision:	M
Date:	2021 / 9 / 1

URBAN SYSTEMS

FIGURE 4.11

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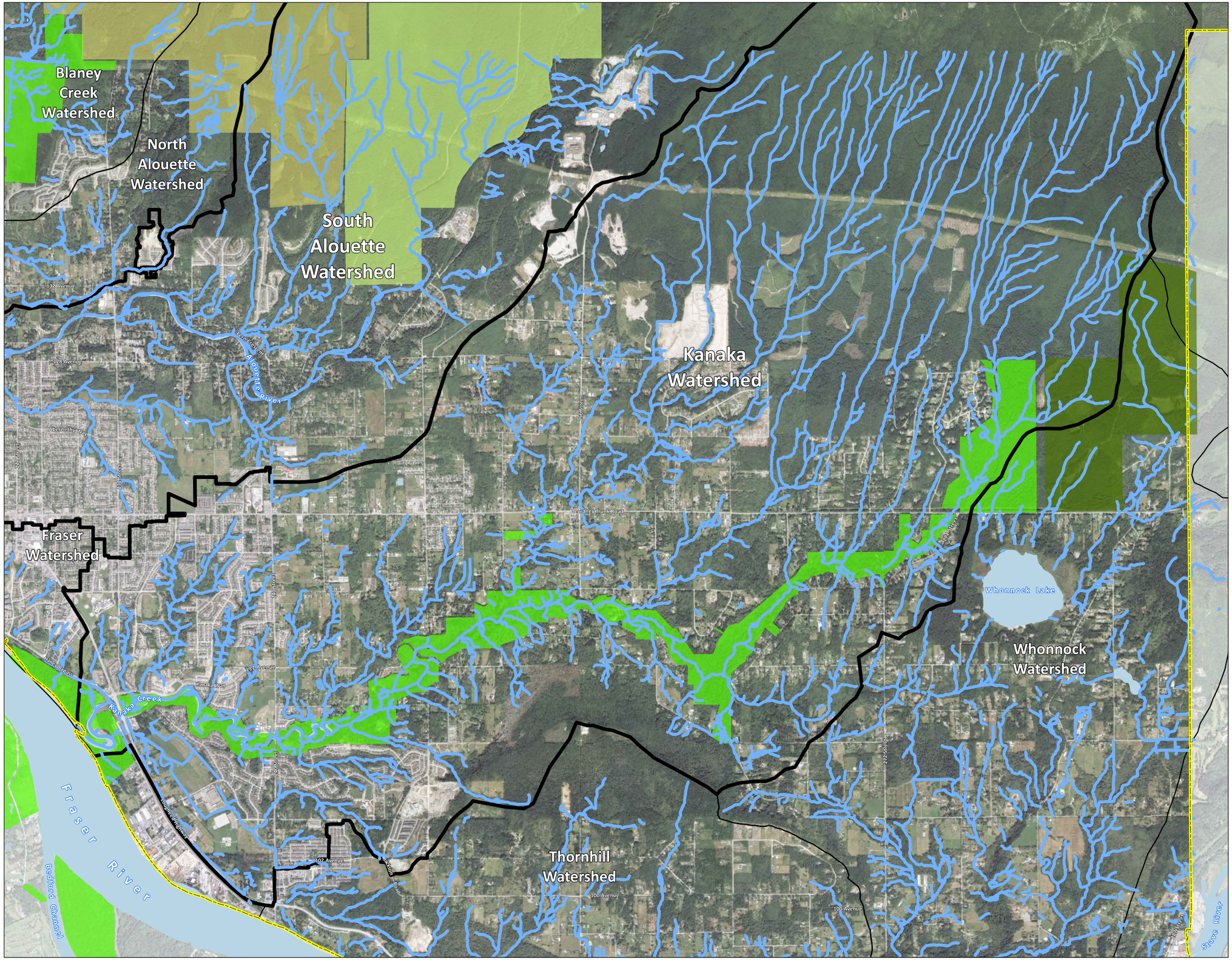
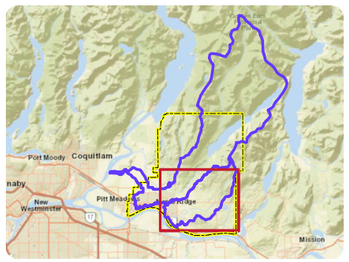


MAPLE RIDGE
British Columbia

South Alouette and Kanaka Integrated Storm Water Management Plans

Kanaka Creek Watershed – Aquatic Habitat

- Stream
- Natural Watershed Boundary
- UBC - Malcom Knapp Research Forest
- BCIT Woodlot
- Provincial Protected Areas
- Metro Vancouver Parks
- Municipal Boundary



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Coordinate System:
NAD 1983 UTM Zone 10N

Data Sources:
City of Maple Ridge
City of Pitt Meadows
BC MoE
NR Canada

Project #:	1279.0025.01
Author:	BG
Checked:	GS
Status:	FINAL
Revision:	M
Date:	2021 / 9 / 1

URBAN SYSTEMS

FIGURE 4.12

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4.6 Water Quality Analysis

Historical Monitoring

Water quality monitoring has been undertaken in the past by local interest groups such as the Alouette River Management Society and the Kanaka Education and Environmental Partnership Society for field parameters (pH, water temperature, dissolved oxygen, turbidity and discharge) at numerous locations in the Kanaka and South Alouette watersheds, including:

- Cottonwood Creek;
- Horseshoe Creek;
- Thornvale Creek;
- Dunlop Creek;
- Seigel Creek;
- Rainbow Creek;
- Salamander Creek;
- Spencer Creek;
- Dogwood Creek;
- Morse Creek;
- Cordin Creek;
- Balbanian Creek;
- Coho Creek;
- Latimer Creek;
- T1, T2, T4, T6, T8, T9, T10, T11. T12;
- Anderson Creek;
- Cattell Brook;
- North Millionaire Creek;
- Millionaire Creek;
- Hennipen Creek;
- McKenny Creek; and
- Laity Creek.

The field parameter water quality data were collected between February 1997 and March 2000. Benthic invertebrates monitoring was also undertaken during the same timeframe, as discussed in **Section 4.8**. Due to the specific purpose and methodology of more recent monitoring as per Metro Vancouver's Monitoring and Adaptive Management Framework (MAMF) (discussed below), the more recent monitoring data were used for the assessment of existing watershed conditions.

Recent Monitoring under the MAMF

In 2014 and 2015, water quality monitoring was conducted as part of an ongoing program undertaken specifically to support the ISMP program and to fulfill the requirements under Metro Vancouver's MAMF. The scope, methodology and results are summarized in a draft report provided as **Appendix A** (Kerr Wood Leidal, 2016).

Two sub-watersheds from each of the South Alouette and Kanaka watersheds were selected for water quality monitoring as part of the City's monitoring and adaptive management program. Sub-watersheds were selected based on a 2014 study by Urban Systems according to multiple criteria but generally on the basis that they can be considered reasonably representative of different types of sub-watersheds in the City:

- South Alouette study area – T2 Creek at 124 Avenue: typical of an urban lowland sub-watershed and expected to experience infill development.
- South Alouette study area – Millionaire Creek at Fern Crescent: an upland sub-watershed, with recent urban development and a naturalized upper watershed area, expected to experience future development.
- Kanaka Creek study area – Dunlop Creek at 110 Avenue – typical of a rural sub-watershed, with some development in the upper reaches and expected to experience further rural development.
- Kanaka Creek study area – Spencer Creek at 240 Street – typical of a rural, developed sub-watershed.

The above sub-watersheds were monitored over two periods for water quality: one during wet season flows (November-December 2014) and one during dry season flows (July-August 2015). In both cases, monitoring was undertaken on a weekly

basis for a period of five consecutive weeks, as per MAMF protocol, which allows for comparison with the BC Water Quality Guidelines.

Samples were analysed for water quality parameters shown below in **Table 4.3**:

Table 4.3 Monitoring and adaptive management program - monitoring parameters

	Core MAMF Parameters	Additional Parameters
GENERAL	• turbidity* • dissolved oxygen* • water temperature* • pH** • conductivity**	• specific conductivity • total dissolved solids • salinity • oxygen reduction potential • alkalinity • hardness (as $CaCO_3$)
NUTRIENTS	• nutrients	-
MICROBIOLOGY	• e. coli • fecal coliforms	-
METALS	• iron • cadmium • copper • lead • zinc	• total metals • dissolved metals

* Primary indicators under MAMF

** Secondary indicators under MAMF

As described in the KWL report, the water quality data were classified by the following system, based on a comparison of the results to the BC MOE approved water quality guidelines (BCWQG) for the protection of aquatic life and recreational use.

Good priority indicator	Suggests that water quality for this parameter, at this location, is good. No further monitoring is required for five years. No adaptive management is required based on this result.
Satisfactory priority indicator	Suggests that water quality is either closely approaching a level of concern for this parameter or is already in non-attainment with provincial water quality guidelines. Consideration should be given to supplemental water quality monitoring and/or adaptive management actions.
Needs attention priority indicator	Suggests that water quality is in non-attainment with provincial water quality guidelines. Supplemental water quality monitoring and/or adaptive management actions are recommended.

Summary of Results

Results from the 2014/2015 water quality monitoring are provided in full in the report in **Appendix A**.

All four sites, SA-1, SA-2, K-1, and K-2, had mean water quality parameter values that were either approaching or exceeding guidelines in either the wet or dry season. The parameters approaching or exceeding guidelines during the wet season at each site were as follows:

- SA-1 (T2 Creek at 124 St): turbidity, E. coli, fecal coliforms, total copper, total zinc, and conductivity;
- K-1 (Dunlop Creek at 110 Ave): turbidity, fecal coliforms, total iron, total zinc, and conductivity; and
- K-2 (Spencer Creek at 240 St): turbidity, total iron, total copper, total zinc, and conductivity.

Dry season parameters approaching or exceeding guidelines during the dry season were as follows:

- SA-1 (T2 Creek): E. coli, fecal coliforms, dissolved oxygen, temperature, and total copper;
- SA-2 (Millionaire Creek): E. coli, dissolved oxygen, and temperature;
- K-1 (Dunlop Creek): Dissolved oxygen, E. coli, total iron, total zinc, and conductivity; and
- K-2 (Spencer Creek): E. coli, turbidity, dissolved oxygen, and temperature.

Observations and Recommendations

Based on the results, the following observations and recommendations were made in the monitoring report provided in **Appendix A:**

- All four sites had mean water quality parameter values that were either approaching or exceeding guidelines in either the wet or dry season.
- Review the Spencer Creek catchment and consider additional investigate sampling to identify potential sources of turbidity within the watershed, as they may be originating from a point source;
- Consider investigative sampling to identify potential sources of microbiological parameters in T2 Creek and Millionaire Creek in the South Alouette Watershed, and identify adaptive management actions to address the issue;
- Further investigate and identify adaptive management actions to address the aquatic health of T2 Creek;
- Investigate opportunities to mitigate low dissolved oxygen levels and high-water temperature measurements in all creeks during the dry season;
- Investigate and manage adaptively for other parameters of concern (needs attention category) or approaching levels of concern (satisfactory category) in these watersheds; and
- Continue to monitor stormwater quality at least every five years at each site using the same set of parameters.

From the available information, the following is recommended for further consideration:

- Undertake annual water quality sampling for three consecutive years to allow an evaluation of data where there can be a consideration of inter-annual variability. The focus for this sampling could include the broad range of substances in the current monitoring scope, with parameters to be removed or monitoring frequency reduced after the three-year period, when a better determination can be made with respect to importance of the various parameters to water quality concerns.
- Due to the ability to monitor temperature, dissolved oxygen, pH and turbidity in the field, increased monitoring for these parameters should be considered. The focus for dissolved oxygen would be the late summer/early fall, when flows are low and water temperatures are elevated. Monitoring of pH will allow direction to be set on potential trends

for particulate metals to move into the dissolved form. The monitoring scope could also include consideration of changes during and after storm events.

4.7 Sediment Quality Analysis

The benthic sediment data are limited and are summarised in the March 1988 *Report on the 1987 Benthos and Sediment Monitoring Program* (Swain, L.G. and D.G. Walton). Given the age of this information, it should be considered with caution.

As part of that sampling program, one site near the mouth of each of the South Alouette River and Kanaka Creek was sampled. The samples were analysed for the following parameters:

- Chlorophenols;
- Polychlorinated biphenyls (PCBs);
- Metals; and
- Organic, inorganic and total carbon.

This report indicated that many of the metals were present above the analytical detection limit. Many of these metals are ubiquitous in nature, and the particulate form of the metals are not necessarily able to impact aquatic life either in the water column or in the sediments. The report concluded that the metal concentrations were low in the Alouette River and in Kanaka Creek, compared with other tributaries to the Fraser River, the mainstem of the Fraser River and the Pitt River.

For the Alouette River, the only metal noted to be of potential concern was nickel with a concentration of 69.6 µg/g dry weight. The data for chlorophenols and PCBs indicated concentrations that were below the analytical detection limit. The data for total, organic and inorganic carbon also indicated that these parameters were all lower in the Alouette River (and Kanaka Creek) than any of the other sites sampled. The BC Water Quality Guidelines for the Protection of Aquatic Life and CCME Sediment Quality Guidelines for the Protection of Aquatic Life were also reviewed to compare parameters sampled to the Guidelines. Relevant sediment quality guidelines (to the parameters which were sampled) were only found in the CCME Guidelines. Of those relevant guidelines, the Alouette River only had detectable levels of chromium, copper, lead, mercury and zinc. Each of those parameters was well below the CCME Sediment Quality Guideline for the Protection of Aquatic Life (Probably Effect Level).

The data for total, organic and inorganic carbon also indicated that these parameters were all lower in the Kanaka Creek than any of the other sites sampled. The BC Water Quality Guidelines for the Protection of Aquatic Life and CCME Sediment Quality Guidelines for the Protection of Aquatic Life were also reviewed to compare parameters sampled to the Guidelines. Relevant sediment quality guidelines (to the parameters which were sampled) were only found in the CCME Guidelines. Of those relevant guidelines, Kanaka Creek only had detectable levels of chromium, copper, lead, mercury and zinc. Each of those parameters were well below the CCME Sediment Quality Guideline for the Protection of Aquatic Life (Probably Effect Level).

Sediment sampling was not completed as part of KWL's scope of work, as it is not a requirement under Metro Vancouver's MAMF. Based on the available background information on sediments, regular monitoring to assess sediment quality is not recommended; rather, emphasis should be placed on water quality monitoring.

4.8 Benthic Invertebrates

Benthic invertebrates, or aquatic insects, can be used to provide an indication of the health of a stream or watershed given their diverse and abundant nature, their sensitivity to human disturbance, and the ease in their identification and sampling (HB Lanarc & Raincoast Applied Ecology, 2009). A multi-metric rating system known as the "Benthic Index of Biotic Integrity" (B-IBI) measures benthic communities and assigns a score to a watershed or stream based on the presence or absence of benthic invertebrates. B-IBI has been shown to be a function of impervious area and riparian forest integrity in a given watershed, and for these reasons it is one of three key indicators used to assess watershed health and assign a Watershed Health Tracking Score under the Template for ISMPs. The WHTS is discussed further in **Section 4.9**.

The B-IBI combines 10 metrics into a single numerical index by comparing observed biological and ecological patterns to region-specific expectations, which for this study are for the Pacific Northwest. The 10 B-IBI metrics are:

- Total number of taxa (abundance)
- Number of Ephemeroptera (mayfly) taxa
- Number of Plecoptera (stonefly) taxa
- Number of Trichoptera (caddisfly) taxa
- Number of long-lived taxa
- Number of intolerant taxa
- Percent of tolerant individuals
- Percent of predator individuals
- Number of clinger taxa
- Percent dominance

A B-IBI score of 10 is an indicator of poor watershed health, while a score of 50 is an indicator of excellent watershed health. An extremely healthy watershed with a score of 50 is expected to be found in a pristine, untouched area which has never experienced development, whereas an unhealthy watershed with a score of 10 is likely to be found in a highly-developed area with a high level of impervious area and low riparian area. Watersheds with high B-IBI scores are likely to be inhabited by salmonid species while lower scoring watersheds are likely to have fewer species of fish and lower densities of salmonids.

The multi-metric B-IBI score can be used to quickly rank watercourses in terms of quality, management/restoration priority, etc. The disadvantage to using a multi-metric score such as the B-IBI is that the details of what is occurring in the system may be overlooked. Furthermore, it should be noted that the B-IBI system and the interpretation of its data is based on mountain streams and is not necessarily comparable to streams and ditches found within the lower reaches of the South Alouette watershed. Thus, evaluating stream health strictly based on the B-IBI score can be inaccurate; however, it is one tool that can be used to assess change in overall watershed health over time.

Historic Monitoring

Benthic invertebrate's data were collected by local environmental stewardship groups during February and March of 2000. The available data indicated the abundance of pollution-intolerant species but did not contain enough metrics to calculate a B-IBI score. As was the case with the water and sediment quality data, the historic benthic invertebrate's data represent an isolated sampling event and are not useful for identifying trends in watershed health or response to development or other human activities. Therefore, the assessment of existing watershed conditions is based on more recent monitoring conducted as part of the City's monitoring and adaptive management program, discussed below.

Recent Monitoring under the MAMF

In 2015, benthic invertebrates monitoring was conducted as part of an ongoing program undertaken specifically to support the ISMP program and to fulfill the requirements under Metro Vancouver's MAMF. The scope, methodology and results are summarized in the draft report provided as **Appendix A.**

Two sites from each of the South Alouette and Kanaka Creek watersheds were selected for benthic invertebrates monitoring. These locations are in the vicinity of the following:

- South Alouette study area – T2 Creek at 124 Avenue;
- South Alouette study area – Millionaire Creek and Fern Crescent;
- Kanaka Creek study area – Dunlop Creek at 110 Avenue; and
- Kanaka Creek study area – Spencer Creek at 240 Street.

Benthic invertebrates were sampled during the dry season.

Summary of Results

Results from the 2015 monitoring are provided in full in the report in **Appendix A**. They are summarized for T2 Creek and Millionaire Creek in **Table 4.4**:

Table 4.4 Benthic invertebrates monitoring results for South Alouette sub-watersheds

Parameter	T2 Creek	Millionaire Creek
Total Taxa Richness*	18	40
Mean B-IBI*	14.0	26.6

*Composite of three replicate samples

Results from the 2015 monitoring are provided in full in the report in **Appendix A**. They are summarized for Dunlop Creek and Spencer Creek in **Table 4.5**:

Table 4.5 Benthic invertebrates monitoring results for Kanaka sub-watersheds

Parameter	Dunlop Creek	Spencer Creek
Total Taxa Richness*	40	31
Mean B-IBI*	28.0	23.6

*Composite of three replicate samples

Observations and Recommendations

- Based on the biological condition rankings found in the MAMF that correspond to these B-IBI scores, biological conditions were fair in Dunlop Creek and Millionaire Creek, poor in Spencer Creek, and very poor in T2 Creek.
- It is recommended that benthic invertebrates monitoring be conducted every 2 to 5 years to establish a trend in B-IBI scores.

4.9 Watershed Health Tracking System

Overview of the System

In addition to the general environmental inventory from the background review, monitoring results, and the site visit, the overall health of the South Alouette and Kanaka Creek watersheds was assessed using the Watershed Health Tracking System (WHTS), which is outlined in the Template for ISMPs.

Under Metro Vancouver's MAMF, an overall "biological condition rank" is assigned to the watershed based on the B-IBI score. In the absence of actual B-IBI monitoring data, a predicted B-IBI score, and therefore biological condition rank, can be determined by assessing two other key indicators of watershed health:

- Percent Riparian Forest Integrity (%RFI); and
- Impervious area, as percent total impervious area (%TIA) or percent effective impervious area (%EIA).

A high %RFI value and a low %TIA value characterize a watershed that is in very good health, and will have a relatively high predictive, and theoretically actual, B-IBI score. Conversely, watersheds with low %RFI and high %TIA are generally considered to be in poor health and will have a relatively low B-IBI score.

For this ISMP, predictive B-IBI scores were computed for the entire South Alouette and Kanaka watersheds and the sub-watersheds, and these scores were compared to the actual B-IBI results for the sub-watersheds from the 2015 dry weather monitoring period. Based on the results, an overall biological condition rank was then assigned to each watershed.

An overview of how %RFI, %TIA, and predictive B-IBI were determined is provided in the following sections; this is then followed by a summary statement of the overall biological condition rating based on the results. A detailed description of the rationale for the WHTS methodology and its limitations is described in the Template for ISMPs.

Riparian Forest Integrity

Riparian forests not only provide habitat for terrestrial species, but contribute the following critical features to aquatic ecosystems:

- Shading to moderate water temperature;
- Large woody debris for fish habitat;
- Bank stabilization; and
- Insect drop and leaf litter for allochthonous production.

RFI is dependent in part on natural physical features such as soils, aspect, and elevation. However, it is also dependent on management practices such as development setbacks; i.e., the extent to which development is permitted to encroach on streams. For this reason, %RFI is assessed on the basis of forested area within a defined setback area. A watercourse with a high %RFI will be in good condition, with plenty of forested area, whereas a watercourse with a low %RFI will have relatively less forest area and more impervious area.

The Template for ISMPs assumes the use of a 30-m setback on both sides of a watercourse over its entire length for the calculation of %RFI;. For this ISMP, %RFI was computed for the City's defined setbacks to determine the impact of the City's current setbacks on watershed health (in combination with TIA). The City's setbacks are defined in GIS based on work conducted by the City (Stott, 2005), and are generally applied in practice as follows:

- 15 m from top of bank (TOB) for food- and nutrient-bearing systems. Watercourses in upland areas, on hillsides over 25% are generally considered to be food and nutrient bearing unless they are larger tributaries/watercourses with an abundance of pools, riffles, and opportunities for habitat that supports resident fish populations throughout the year.
- 30 m from TOB for fish-bearing watercourses where there is available riparian area to do so
- Larger watercourses such as the Alouette River or Kanaka Creek automatically qualify for Streamside Protection Setbacks of 30 m from top of bank or high-water mark, whichever is the greater of the two.
- Watercourses within lowland areas below larger hillsides with slopes over 25% are often considered to be fish bearing or have the potential to be fish bearing unless proven otherwise.
- In the case of urban infill areas, setbacks are typically 15 m where possible.

As shown above, the majority of these systems receive a 30-m setback unless there is an inability to do so based on lack of riparian area or historical land uses. For example, presence of existing structures and infrastructure along the majority of the streamside protection and enhancement area (SPEA) surrounding the watercourse.

To compute an estimate of %RFI, image classification (Interactive Supervised Classification) was run on the 2011 Maple Ridge MrSID image (0.1 m) using 18 training samples to calculate pervious / impervious areas by watershed boundary using ArcGIS 10.2.2 software. Training samples consisted of polygons drawn over features on the orthophoto, then attributed (classified) with the surface they represent. Forest, grass, fields and water were considered to be pervious; gravel was considered semi-impervious; and pavement and roofs were considered impervious. Areas north of the orthographic extent are mostly forested and were assumed to be 100% pervious.

Impervious Area

Increased impervious area is a consequence of urbanization, with correspondent and significant effects on the hydrologic cycle (Shuster *et al.,* 2005). Specific effects attributable to increases in impervious area include:

- Shorter lag times between onset of precipitation and flow increases in surface water;
- Higher run-off peaks and total volume of runoff; and
- Reduction in infiltration and subsequent reduction in groundwater recharge.

An increase in impervious area is associated with increased rates of erosion, sedimentation, reduced water quality and possible loss of fish habitat. Cumulatively, these effects can have adverse impacts on fish populations, benthic invertebrates, and ultimately the terrestrial ecosystem.

There are two metrics that can be utilized to assess impervious areas:

- Total Impervious Area (TIA): assumes that impervious surfaces do not provide any infiltration;
- Effective Impervious Area (EIA): considers impervious surfaces that are connected to stormwater infrastructure and the potential effects of stormwater mitigation measures (bioswales, green roofs, etc.).

For the purpose of this Part 1, TIA was used for the WHTS, as there was insufficient information at the time of reporting on the application and effectiveness of current stormwater management practices. TIA was computed based on the City's orthophoto, using GIS analysis and the same methodology used to compute TIA for the various land use "zones" previously described. Forest, grass, fields and water were considered to be pervious; gravel was considered impervious; and pavement and roofs were considered impervious. Areas north of the orthographic extent are mostly forested and were assumed to be 100% pervious.

Predictive B-IBI and Comparison to Actual Results

A predictive B-IBI score was computed for the South Alouette and Kanaka Creek watersheds using the WHTS from the Template for ISMPs.

Summary and Overall Biological Condition

Table 4.6 provides a summary of the %RFI, %TIA, comparison of predicted and measured B-IBI scores, and the overall biological condition ranking of the watersheds according to Metro Vancouver's MAMF.

Table 4.6 Summary of Watershed Health Tracking System and Biological Condition

	South Alouette Watershed			Kanaka Creek Watershed		
	T2 Creek	Millionaire Creek	South Alouette (overall)	Dunlop Creek	Spencer Creek	Kanaka (overall)
%RFI	61%	63%	58%	62%	60%	65%
%TIA	39%	3%	2%	11%	10%	8%
Predicted B-IBI*	16.18	35.62	36.24	26.21	26.73	29.01
Measured B-IBI **	14.00	26.60	-	28.00	23.60	-
Biological Condition Rank ***	Very poor	Fair	Fair	Fair	Poor	Fair

*Using the Watershed Health Tracking System (WHTS).

**2015 dry weather monitoring period.

**According to Metro Vancouver's MAMF. Based on actual B-IBI scores where available.

Observations and Recommendations

Based on results of the WHTS, the following observations and recommendations are made:

- The observed patterns in total taxa richness and B-IBI results generally correlate with the level of riparian forest and impervious area observed in each of the subcatchments sampled at the time of the 2015 dry weather monitoring (KWL, 2016), and during the November 2015 site visit. During the November 2015 site visit, riparian corridors for both watersheds were observed to be generally intact, except for lower sections of the watersheds, which are diked and altered by past land use practices.
- The range in results is to be expected, with T2 Creek having the lowest biological condition rank and Millionaire Creek and Dunlop Creek having the highest. T2 Creek is a highly urbanized sub-watershed, with older upstream

development. Conversely, the Millionaire Creek sub-watershed has recently undergone development and current stormwater management practices have been applied there. In theory, modern stardards and practices should result in better habitat protection than historic ones. . There is an opportunity to improve watershed health in the T2 subcatchment (and similar subcatchments) using appropriate stormwater management practices at the time of redevelopment and infill development, such as by reducing TIA (or EIA), or increasing setbacks and RFI.

- The predicted and actual B-IBI scores for the Millionaire Creek sub-watershed differ quite significantly. This may be due to a variety of factors, such as site selection and its suitability as habitat for benthic invertebrates, and/or there may be a negative influence on benthic invertebrates, such as water quality. It is not possible to determine the reason from the available information; more data and potential field investigation may be required.
- Overall, the actual B-IBI scores and their associated biological condition rank under the MAMF are based on one set of monitoring data, and together they provide an indication of watershed health but they should not necessarily be taken as conclusive on their own. More monitoring is required to establish a better understanding of the current health of the benthic invertebrate's community, and water quality.

4.10 Hydrogeological Conditions

The hydrogeological conditions of a watershed (i.e., the soil and groundwater conditions) play a strong role in the watershed's response to rainfall events. Hydrogeological conditions are often highly variable, even within the same watershed, contributing to the complex nature of stormwater management. The two primary variables are: soil type and its hydraulic conductivity (a property that indicates the soil's relative ability to transmit water); and groundwater elevation.

For the purpose of this ISMP, soil and groundwater mapping for the South Alouette watershed was based on data provided by the Province and Agriculture Canada. Based on this information, a three-dimensional hydrogeological model was developed to define the fundamental hydrological building blocks of aquifers, aquitards, bedrock topography, and hydraulic gradients for the watershed, and relate these to surface-water infiltration and stormwater management.

The following sections summarize the hydrogeological conditions of the watersheds. The accuracy of information available in the literature could not be confirmed with in-situ soil data. More information on the hydrogeological conditions within watersheds, and the methodology of assessing them, can be found in **Appendix B.**

South Alouette

Most urban areas within the South Alouette watershed are underlain by moderately well- to well-drained soils. Some of the rural zone is moderately poor to poor draining. Agricultural areas in the watershed generally are poor to very poor draining. Soils in the natural zone are generally moderately well to rapidly draining.

The north half of the urban and rural areas (i.e., the lowlands) and the natural area (uplands) in the South Alouette watershed is comprised of generally high-permeability soils. Surficial geology of the south half towards the Kanaka Creek watershed is generally lower permeability. Thick accumulations (50-100m) of overburden underlie the urbanized areas south of the South Alouette watershed.

According to Provincial data, there are two sand and gravel aquifers and two bedrock aquifers in the South Alouette watershed, as summarized in **Table 4.7** below, also provides an indication of the vulnerability of each aquifer. The Provincial government classifies aquifers on the basis of their level of development and vulnerability to contamination. Aquifers are then ranked according to their vulnerability using hydrogeological and water-use criteria.

Table 4.7 Summary of Aquifers in the South Alouette Watershed

Aquifer Number	Aquifer Material	Description	Vulnerability	Demand
38	Sand and gravel	Alouette	Moderate	Low
39	Sand and gravel	East Pitt River	High	Low
897	Bedrock	North Shore Alouette River	Moderate	Low
898	Bedrock	West side North Alouette River	Low	Moderate

No aquifers were identified underlying the urbanized area of the South Alouette watershed. The confined Alouette Aquifer underlies part of the rural zone and agricultural zone of the South Alouette watershed. It may extend below the urbanized zone, but this could not be confirmed based on the available data. Aquifers in the South Alouette watershed are shown on **Figure 4.13**.

By filtering the soil properties according to drainage, texture and water table characteristics, four soil groups were distinguished, summarized in **Table 4.8**.

Table 4.8 Soil Groups Based on Soil Drainage and Flow Characteristics

Soil Group	General Description	Runoff Characteristic	Infiltration Characteristic
1	Imperfect to Very Poor. Seasonally high water table, flooding, seepage. Potential discharge; slow recharge, if any.	High runoff	Low infiltration
2	Moderately Well to Well. Perched water table or observed seepage, indicating a confining low-permeability layer. Variable recharge or discharge, depending on season and location.	Moderate runoff	Moderately low infiltration
3	Moderately Well to Rapid. Rapid infiltration, no confining layer. Potential recharge.	Low runoff	High infiltration
4	Moderately Well to Rapid. Relatively thin overburden over bedrock or till confining layer; steep terrain. Mountain block /bedrock recharge.	High runoff	Low infiltration

The implications of these characteristics for stormwater runoff and discharge are summarized below:

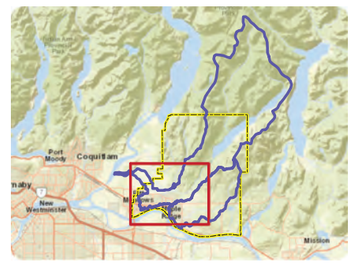
- Soil Group 1: Areas with poor drainage characteristics due to the prevalence of fine-grained material with low infiltration rates. These areas correspond to groundwater discharge zones primarily. Groundwater discharge or high water table conditions will also typically occur in low-lying areas, reducing the capacity of infiltrating rain water and runoff.
- Soil Group 2: Areas that are well to moderately well-drained that nevertheless have a perched water table or where seepage is observed, indicating a confining impermeable layer, and likely a lack of direct connectivity with the deeper groundwater regime. These areas likely correspond to groundwater discharge areas, locally confirmed by the presence of springs, seepage zones and seasonally high water table.
- Soil Group 3: Areas that are well to moderately well-drained that also display potential connectivity between the shallow and deeper groundwater regimes. These correspond to areas with the highest potential for rain water infiltration and groundwater recharge.
- Soil Group 4: Areas that are well or rapidly drained due to the presence of a thin overburden layer over bedrock, or consolidated till, combined with steep terrain. These are typically upland areas where recharge to the fractured bedrock aquifer system is likely to occur.

The extents of these four soil groups in the South Alouette watershed are shown on **Figure 4.14**.

South Alouette and Kanaka Integrated Storm Water Management Plans

South Alouette Watershed – Aquifers

Licensed Spring
BC Wells Database
Aquifer - Bedrock
Aquifer - Unconsolidated
Natural Watershed Boundary
Creeks
Municipal Boundary



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City of Maple Ridge
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URBAN systems

FIGURE 4.13

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South Alouette and Kanaka Integrated Storm Water Management Plans

South Alouette Watershed – Soil Drainage and Aquifer Recharge Potential

Soil Drainage and Aquifer Recharge Potential

1. Slow Recharge / Seepage Discharge Areas:
   - Poor to very poor drainage
   - Poor to moderately poor drainage
   - Moderately poor to imperfect drainage
2. Slow Recharge / Seasonal Discharge Areas:
   - Moderately well drained
   - Well to moderately well drained
3. Rapid Recharge / Alluvial Areas:
   - Moderately well to well drained
   - Well drained
   - Well to rapidly drained
4. Mountain Block Recharge Areas:
   - Well to rapidly drained
   - Natural Watershed Boundary
   - Creeks
   - Municipal Boundary

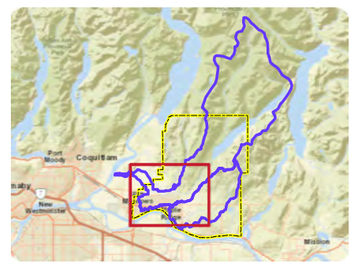

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FIGURE 4.14

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Kanaka Creek

The soils in the urban and rural areas of the Kanaka Creek watershed are variable, ranging from very poor to well-draining. Soils in the natural zone are generally moderately well to rapidly draining. The surficial geology of the Kanaka Creek watershed is generally comprised of low-permeability soils. Thick accumulations (50-100m) of overburden underlie the urbanized areas in the Kanaka Creek watershed.

According to Provincial data, there are two sand and gravel aquifers and two bedrock aquifers in the Kanaka Creek watershed, as summarized in **Table 4.9**.

Table 4.9 Summary of Aquifers in the Kanaka Creek Watershed

Aquifer Number	Aquifer Material	Description	Vulnerability	Demand
19	Bedrock	Grant Hill	Moderate	Moderate
154	Bedrock	Northwest of Whonnock Lake	Moderate	Low
970	Sand and gravel	South of Grant Hill	Moderate	Moderate
26	Sand and gravel	Kanaka/Whonnock Creek	Moderate	Moderate

The confined Kanaka-Whonnock Aquifer (#26) underlying part of the rural zone in the Kanaka Creek watershed has moderate vulnerability to contamination from surface activities or stormwater runoff. Aquifers in the Kanaka Creek watershed are shown on **Figure 4.15.**

By filtering the soil properties according to drainage, texture and water table characteristics, four soil groups were distinguished, as previously described. Soils that are well to moderately well-drained with coarse textured materials in the database are likely groundwater recharge areas and may be suitable for enhanced stormwater infiltration strategies. The extents of these four soil groups in the Kanaka Creek watershed are shown on **Figure 4.16.**

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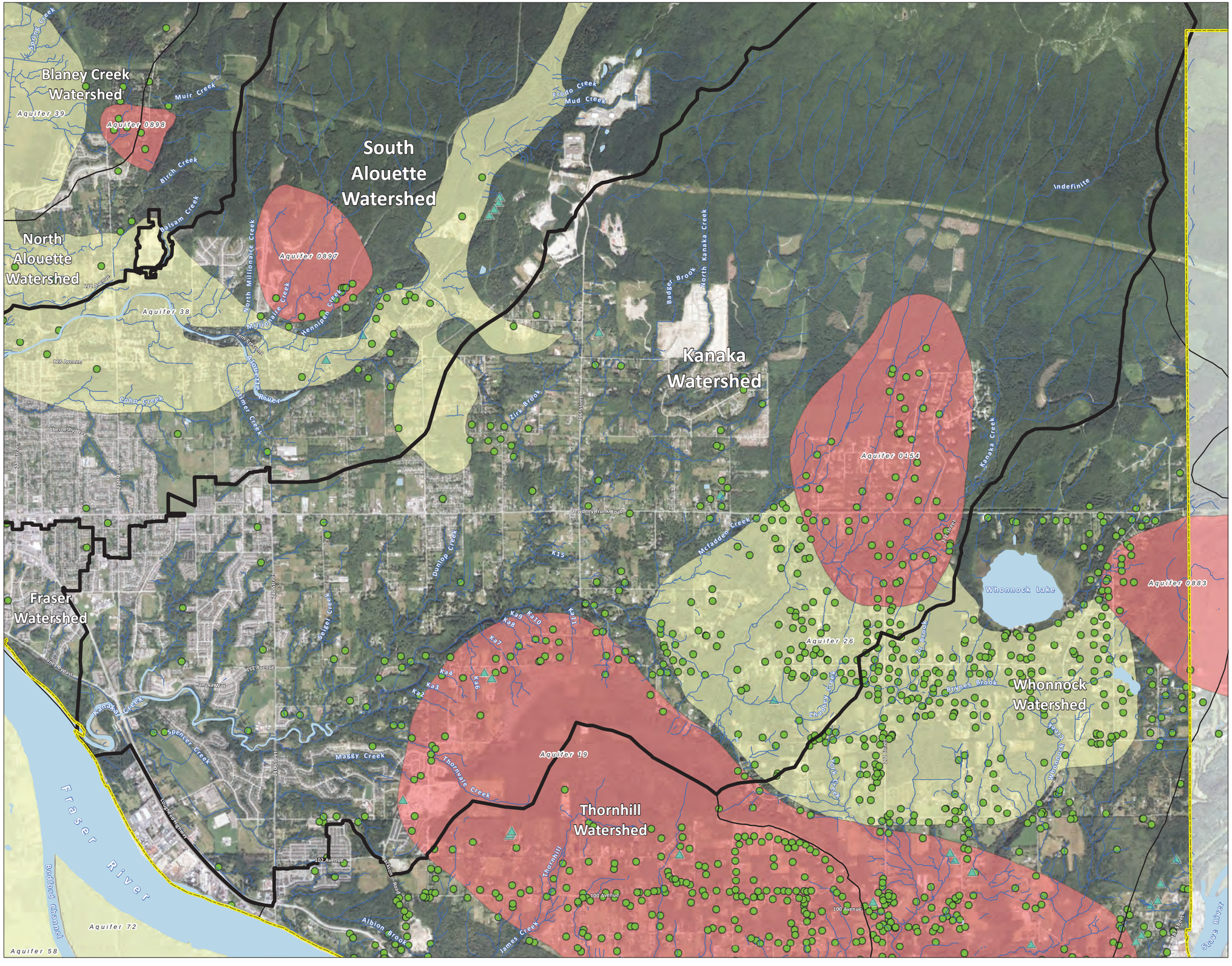

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South Alouette and Kanaka Integrated Storm Water Management Plans

Kanaka Creek Watershed – Aquifers

- Licensed Spring
- BC Wells Database
- Aquifer - Bedrock
- Aquifer - Unconsolidated
- Natural Watershed Boundary
- Creeks
- Municipal Boundary

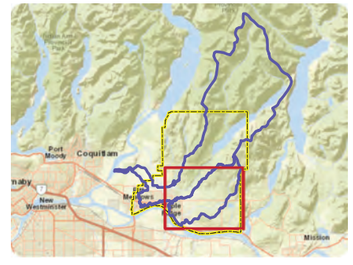

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FIGURE 4.15

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South Alouette and Kanaka Integrated Storm Water Management Plans

Kanaka Creek Watershed –
Soil Drainage and Aquifer Recharge Potential

Soil Drainage and Aquifer Recharge Potential

1. Slow Recharge / Seepage Discharge Areas:
   - Poor to very poor drainage
   - Poor to moderately poor drainage
   - Moderately poor to imperfect drainage
2. Slow Recharge / Seasonal Discharge Areas:
   - Moderately well drained
   - Well to moderately well drained
3. Rapid Recharge / Alluvial Areas:
   - Moderately well to well drained
   - Well drained
   - Well to rapidly drained
4. Mountain Block Recharge Areas:
   - Well to moderately well drained
   - Well to rapidly drained
   - Natural Watershed Boundary
   - Creeks
   - Municipal Boundary

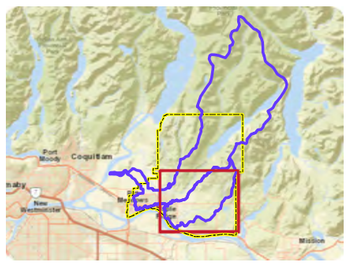

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FIGURE 4.16

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4.11 Drainage Systems

Drainage infrastructure in the South Alouette and Kanaka Creek watersheds was inventoried from the City's GIS data and background reports. The drainage system is generally comprised of piped infrastructure, open channels / ditches, natural watercourses, and detention ponds. The original natural drainage patterns in the watersheds (with the exception of the undeveloped upper watersheds) have been altered over time due to development, including the addition of ditches, embankments, dikes, and land filling.

South Alouette

Piped infrastructure in the South Alouette watershed is shown on **Figure 4.17.** In general, runoff is directed to the piped or open channel system before discharging to surface water. For localized developments with a drainage pond, stormwater is directed first to the pond before being conveyed further downstream. In the natural uplands, runoff is generally conveyed overland to the natural watercourses, except for the Silver Valley Area, in which engineered stormwater management practices have been implemented.

Stormwater generated in the Silver Valley Area Plan has been managed according to the City's recent regulations such as the Watercourse Protection Bylaw, and industry best management practices (BMPs) for low-impact development (LID). Developments within Silver Valley have utilized stormwater management practices to meet the City's new standards for stormwater management, which has included road-side rain gardens discharging to detention ponds and on-lot stormwater management practices (City of Maple Ridge, 2014; KWL).

Kanaka Creek

Piped infrastructure in the Kanaka Creek watershed is shown on **Figure 4.18.** In general, runoff is directed to the piped or open channel system before discharging to surface water. For localized developments with a drainage pond, stormwater is directed first to the pond before being conveyed further downstream. In the natural uplands, runoff is generally conveyed overland to the natural watercourses.

More detailed information was available for infrastructure in the Albion Area from the following reports and studies:

- Albion Area Plan
- Albion Meadows Drainage Study (Bland Engineering, 2002)
- Albion Watershed Master Drainage Plan Update (2005)

The lowland Albion Flats area is located within the Fraser River floodplain and has been diked along the Fraser River and along Kanaka Creek to high ground with non-standard dikes (BC MOE, 2009). According to the Albion Meadows Drainage Study (Bland Engineering Ltd., 2002) the CP Rail embankment transects the diked area: on the river side, floodboxes and a pump station discharge flows into the Fraser River; on the north side of Lougheed Highway, which is under the jurisdiction of Diking District 13, a floodbox and pump station discharge flows into Kanaka Creek.

The 2002 drainage study reported that due to the relatively impervious soils, measures such as infiltration pits, bioswales, gravel parking areas, etc., would likely have negligible effect on lowland flooding. The study recommended that a storm drain be constructed along 240th Street, discharging directly to the Fraser River, in order to accommodate flows. This pipe was later constructed. Additionally, a detention facility in the slough between the sports field and the fairgrounds/ice rink complex was constructed to reduce peak flows and improve water quality in the Spencer Creek ditch.

The City conducted a detailed drainage investigation of the Albion Flats area in 2019 and 2021.

The North East Albion Area Concept Plan has been prepared on the same premise as the Silver Valley Area, with a strong emphasis on a three-tiered, distributed rainwater management source controls focused on both water quality and quantity.

4.11.1 Lot Serviceability

The serviceability of properties is variable across the city. Some properties in the developed urban area are not provided with any drainage servicing, or have no drainage servicing other than a roadside ditch. Drainage improvements for these areas would generally involve extending the storm sewer network into these areas. To date, residents wishing to have storm sewers installed on their block have had the option of doing so through Local Area Servicing (LAS). Storm sewers have also been constructed at developer's cost to service new development as it occurs.

Storm sewers with catch basins will improve drainage but will not provide effective roadway and shoulder drainage without benefit of curb & gutter. This increases the cost of providing effective drainage servicing where no servicing currently exists. Another consideration is that once storm sewers are installed, rainwater will be delivered downstream more quickly, potentially causing negative impacts. As such, it is important to consider downstream impacts as part of a catchment-level master plan analysis.

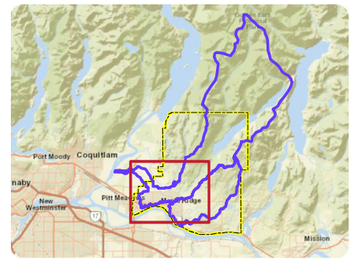
Two urban areas with a number of parcels not having drainage servicing are within the bounds of Laity-216 Street and Dewdney Trunk Road-124 Avenue, and an area between 216-222 Streets and River Road to Lougheed Highway. These areas exist within the Fraser River Escarpment. The City's Escarpment policy titled *Control of Surficial and Groundwater Discharge in the Area Bounded by 207 Street, 124 Avenue, 224 Street and the Crest of the Fraser River Escarpment* limits opportunities for on-site drainage in this area. The policy includes statements prohibiting water discharge to ground or rock-pits. Landscape ponding is also not permitted. Given the policy, actions to improve drainage on private property are limited. The City is completing a review of the Fraser River Escarpment policy in 2021/2022. The outcome of this study is expected to provide supportive information for developing drainage improvement plans/policy in these areas. This will inform Master Drainage Plans that can examine these areas in more detail (see section 13.5.6).

MAPLE RIDGE
British Columbia

South Alouette and Kanaka Integrated Storm Water Management Plans

South Alouette Watershed – Piped Drainage Infrastructure

Natural Watershed Boundary
Creeks
Drainage Pipes
Detention Ponds/Facilities
UBC - Malcom Knapp Research Forest
Provincial Protected Areas
Metro Vancouver Parks
Municipal Boundary



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Coordinate System:
NAD 1983 UTM Zone 10N

Data Sources:
City of Maple Ridge
City of Pitt Meadows
BC MoE
NR Canada

Project #:	1279.0025.01
Author:	BG
Checked:	GS
Status:	FINAL
Revision:	M
Date:	2021 / 9 / 1

URBAN SYSTEMS

FIGURE 4.17

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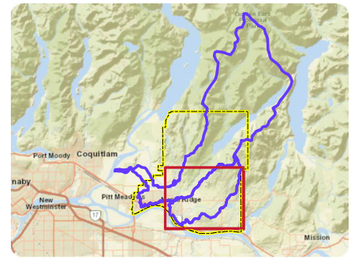
MAPLE RIDGE
British Columbia

South Alouette and Kanaka Integrated Storm Water Management Plans

Kanaka Creek Watershed – Piped Drainage Infrastructure

- Natural Watershed Boundary
- Creeks
- Drainage Pipes
- Detention Ponds/Facilities
- UBC - Malcom Knapp Research Forest
- BCIT Woodlot
- Provincial Protected Areas
- Metro Vancouver Parks
- Municipal Boundary



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Coordinate System:
NAD 1983 UTM Zone 10N

Data Sources:
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Project #:	1279.0025.01
Author:	BG
Checked:	GS
Status:	FINAL
Revision:	M
Date:	2021 / 9 / 1

URBAN SYSTEMS

FIGURE 4.18

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Kanaka Creek near Thornvale Creek (Urban Systems, 2014)

5 EXISTING DRAINAGE SYSTEM PERFORMANCE

5.1 Reported Drainage Issues

Reported drainage issues include:

- High stream levels have been observed at Millionaire Creek and Fern Crescent (South Alouette Watershed), which is of possible concern since the upstream catchment is still developing and more impervious area is expected.
- Metro Vancouver's Kanaka Creek Regional Park Management Plan (2004) discusses concerns related to water quality, summer base flows and 'flashy' response to rain events.
- Flooding of lands in the Albion Flats area.
- Flooding southwest of 123rd Avenue and 230th Street
- Flooding in and around the Town Centre area during the 1 in 100 year event rainfall that occurred in September 2018
- McKenney Creek south of Golden Ears Way, between 210th and 203rd Streets overflows to an adjacent farm field during large rain events
- Localized flooding at various locations

5.2 Silver Valley Green Infrastructure and Performance Monitoring

As previously discussed, stormwater generated in the Silver Ridge development in the Silver Valley Area Plan (South Alouette watershed) has been managed according to the City's recent regulations such as the Watercourse Protection Bylaw, and industry BMPs. The stormwater management system in the Silver Ridge development in Silver Valley represented the first large-scale application of engineering on-lot and road-side rain gardens in Metro Vancouver, and a significant learning

opportunity for the City regarding the effectiveness of LID. Therefore, a three-year monitoring program was undertaken to enhance the City's understanding of the effectiveness of these stormwater management techniques. The following parameters were monitored throughout 2005 to 2008:

- Flow and rock pit water level in roadside rain gardens;
- Rainfall and temperature;
- Flow from the Phase 1 development site (outfall to Anderson Creek); and
- Water levels in the downstream detention pond.

Results demonstrated that the roadside rain gardens were performing as expected, capturing up to 89% of the 5-year dry weather event and between 80% and 89% for events under the 2-year design event. The monitoring program results also produced some recommendations for refining the design. Overall, the monitoring program results for the Silver Ridge development suggest that the City's recent stormwater management practices have the potential to provide effective drainage servicing that protects the environment.

However, this experience also demonstrated inadequate funding for maintenance. For subsequent developments, the City then started forming Local Area Service (LAS) agreements to provide funding for Green Infrastructure (GI), which has resulted in the City looking after 20 LAS's which has created administration challenges. The City has stopped creating LAS's and manages GI on a City-wide basis. The City is in process of developing a Green Infrastructure Strategy document in which typologies, design guidelines and maintenance requirements will all be addressed.

5.3 Hydrologic and Hydraulic Modelling

5.3.1 Purpose and Scope

GeoAdvice Engineering Inc. (GeoAdvice) was retained by the City, in partnership with Urban Systems, to develop a hydraulic and hydrologic model of the South Alouette and Kanaka Creek drainage systems. The purpose was to determine stormwater runoff volumes and flow rates under various storm events, and to define potential improvements to drainage management practices necessary to service future growth and to adapt to climate change.

Modelling was conducted at a watershed scale; it was beyond the scope of the baseline assessment to conduct modelling at the neighbourhood or lot level. The model was developed in InfoSWMM. As the field data from the hydrometric stations in the study area suggested that groundwater interflow into the creek system is likely occurring, the groundwater modeling capabilities available in InfoSWMM were also utilized.

Modelled drainage system elements included manholes, pipes (400 mm in diameter or greater), watercourses comprising the primary system (rivers and major creeks), online flow control structures, detention ponds connected to the truncated

system, and subcatchments. Smaller mains were only included as required for connectivity. Roadside ditches and catchbasins were not included in the model database.

A summary of the modelling is provided in this section; additional detail is provided in GeoAdvice's technical memorandum in **Appendix C**.

5.3.2 Model Development and Criteria

The baseline assessment was developed, calibrated and applied to define existing hydraulic and hydrologic conditions, which included the following features:

- A total study area size of 31,858 ha;
- Six rain gauges;
- 543 subcatchments;
- 120 km of creek channels;
- 64 km of stormwater mains;
- 2.7 km of culverts; and
- 37 detention controls, whether ponds of storage pipes and tanks. (only those that are directly connected to the truncated drainage system were modelled).

Hydrometric data collected by Tetra Tech EBA, Inc. (Tetra Tech) and data available from the provincial Water Office were used together with precipitation data from Metro Vancouver to develop the model. Hydrometric data sources are summarized in **Table 5.1** below:

Table 5.1 Summary of Hydrometric Data Sources

Watershed	Station	Source
South Alouette	Millionaire Creek at Fern Crescent	Tetra Tech / City of Maple Ridge
	T2 Creek at 124th	Tetra Tech / City of Maple Ridge
	Alouette River at 232nd Street (08MH005)	Water Office
Kanaka Creek	Dunlop Creek at 110th Avenue	Tetra Tech / City of Maple Ridge
	Spencer Creek at 240th Avenue	Tetra Tech / City of Maple Ridge
	Kanaka Creek at 112th Avenue (08MH076)	Water Office

The drainage criteria described in the City's Design Criteria Manual (Updated October 2015) were used to define standard modeling parameters and the drainage infrastructure design criteria:

- The minor system must convey runoff from a 10-year design event.
- Minor flows must be detained and released at the 2-year predevelopment rate unless otherwise approved by the City.
- Conveyance systems must accommodate the 10-year post-development flow.
- The major system must safely convey runoff from a 100-year design event. Where directed by the City, the 100-year shall be detained to a 10-year pre-development rate.

Agricultural and Rural Development Subsidiary Agreement (ARDSA) criteria were also developed to define the level of drainage necessary for good on-farm drainage. Only major watercourses within the ARDSA areas were included in the model. Criteria used for model evaluation were provided from the *Agricultural Drainage Criteria* (BC Ministry of Agriculture, Food and Fisheries, 2002), as outlined in **Appendix C.**

As a conservative approach, all design storms were simulated under winter conditions when soils are saturated. Furthermore, the Design Criteria Manual specifies that precipitation data in areas above the 150-m contour line be applied a multiplication factor of 1.4.

Since specific water depth/pipe Diameter (d/D) or peak flow rate/full pipe flow (q/Q) criteria are not provided in the City's Design Criteria Manual, simulation results for existing culverts, pipes and creeks were analyzed for their hydraulic performance as measured against criteria commonly used in the industry:

- If q/Q is less than 1.05 and d/D is greater than 1.0 for less than 15 minutes, the pipe is shown as under-capacity (green).
- If q/Q is less than 1.05 and d/D is greater than 1.0 and lasts longer than 15 minutes, the pipe is shown as at capacity (yellow).
- If q/Q is more than 1.05 and d/D is greater than 1.0 and lasts longer than 15 minutes, the pipe is shown as surcharging (red). In terms of service level, this indicates flooding.
- Nodes where hydraulic grade line (HGL) has reached or exceeded ground elevation is shown as red, indicating flooding.

Modelling was conducted for wet weather conditions to be conservative.

5.3.3 Calibration

The drainage model was calibrated to field flow data collected by Tetra Tech and the Water Office. Hydrologic parameters such as infiltration, groundwater flow, and impervious percentages were each adjusted in an iterative manner, within reasonable ranges, until an agreement was achieved. Commentary on the key calibration factors and results for each modelled catchment is provided in **Table 5.2** below; more details are in **Appendix C**.

Overall, the calibrated model is able to adequately estimate the runoff response for both small and larger rainfall events and is able to generally match the observed hydrographs for most sites. As shown below, uncertainty in the flow data for the Kanaka Creek and T2 Creek hydrometric stations exist; as such, the model was not calibrated further to match flows from these two sites. The calibration agreement can be considered acceptable for the purpose of completing the hydraulic capacity analyses for the ISMP.

Table 5.2 Hydrologic and Hydraulic Model Calibration Commentary

Flow Monitoring Catchment	Calibration Commentary
Millionaire (South Alouette)	The Millionaire Creek sub-watershed consists of primarily agricultural land with a large portion of suburban and rural residential. The lower impervious land use is paired with high percentage of soils with higher infiltration conductivity. These conditions support low runoff, high infiltration, and high groundwater discharge. The primary calibration factor for this site was therefore the soil infiltration rates and groundwater flow parameters. The model results are very good and generally replicate rainfall event peak flows and flow hydrograph shape. The average peak flow and volume error is approximately 16% and 14%.
T2 (South Alouette)	The T2 Creek sub-watershed consists of primarily single and multi-family residential with some ICI land uses. The soils in the area have moderate runoff and moderate infiltration potentials. These conditions support high runoff, moderate infiltration, and possible groundwater discharge. The model over predicts peak flow rates and volume by a large factor and provides an indication that the sub-watershed area is smaller than the area the model captures; however, this was not confirmed. The Tetra Tech report also indicates fairly high measurement error for this hydrometric station.
Alouette River	The Alouette River sub-watershed consists of primarily agricultural land with some suburban and rural residential land uses. The soils in the area generally promote low runoff and moderate to high infiltration potentials. These conditions support low runoff, high infiltration, and high groundwater discharge. The watershed also encompasses the Millionaire creek sub-watershed and Alouette Lake. The primary calibration factor for this site was therefore the soil infiltration rates and groundwater flow parameters, with particular attention to the potential flows from Alouette Lake. Periodic sudden, high flows were observed in the flow records throughout the calibration period that do not correlate with the occurrence of precipitation. These high flows are suspected to be operational discharges from Alouette Dam, operated by BC Hydro; however, this could not be verified with the information available. Field data from the month of January 2015 was used for calibration as the data did not indicate any suspicious flows. The average peak flow and volume error is approximately 32% and 8%. The model under-predicts peak flows of the larger storm and slightly over- predicts peak flows of the smaller storm. The hydrograph shape had an excellent match with observed flows. The focus of ISMP modeling was the lands and streams tributary to the Alouette River, not the Alouette River itself. Information on Alouette River hydraulics is available as part of the extensive

Flow Monitoring Catchment	Calibration Commentary
	river modeling study conducted by Northwest Hydraulic Consultants titled. "North Alouette and South Alouette Rivers Floodplain Analysis" (2016).
Dunlop (Kanaka Creek)	The Dunlop Creek sub-watershed consists of primarily suburban and rural residential with a third single family residential land uses. The soils in the area have high to moderate runoff and low to moderate infiltration potentials. These conditions support moderate runoff, moderate infiltration, and high groundwater discharge. The primary calibration factor for this site was therefore the percent of directly connected impervious areas of suburban and rural residential land uses and groundwater flow parameters. The model results generally replicate peak flows and flow hydrograph shape. The model over-predicts the flow hydrograph's recession limb and under-predicts the peak flows for some of the smaller storm events. The average peak flow and volume error is approximately 12% and 33%.
Spencer (Kanaka Creek)	The Spencer Creek sub-watershed consists of primarily suburban and rural residential, single family residential, and ICI land uses. The soils in the area have low runoff and moderate to high infiltration potentials. These conditions support moderate runoff and possible groundwater discharge. The primary calibration factor for this site was therefore the percent of directly connected impervious areas of suburban and rural residential land uses and groundwater flow parameters. The model over-predicts the peak flows of larger storms and under-predicts the smaller storms. However, the model replicates the recession limbs very well. The average peak flow and volume error is approximately 37% and 10%.
Kanaka Creek	The Kanaka Creek sub-watershed consists of primarily agricultural land and suburban and rural residential land uses. The soils in the area generally promote moderate runoff and moderate infiltration potentials. These conditions support moderate runoff, moderate infiltration, and moderate groundwater discharge. As the hydrometric station was commissioned in August 2015, the period of record is fairly short. The calibration storm events for this site were from the period August 28 – November 3, 2015. The observed flow data for this station had greater peaks and volume for the land uses and rainfall that occurred. The model results were not able to replicate the peak flows nor the volume observed at this site, even when assuming saturated soil conditions. The average peak flow and volume error is approximately 52% and 46%. The quality of the field data from the Water Office for this site is uncertain, as flows could not be verified by Water Office.

The model calibration process was used to estimate the percent Effective Impervious Area (%EIA) (also referred to as Ximp or directly connected impervious area), for each catchment as presented in **Table 5.3** below. These values are specific to the monitored catchments, however provide a good indication of similar areas within the collective watersheds. The Total Impervious Areas (TIA) noted here are also for the monitored catchments, whereas the TIA noted in the environmental assessment section are for the collective watersheds.

Table 5.3 Estimated Impervious Fractions for Modelled Subcatchments After Model Calibration

Hydrometric Station	Area (ha)	Percent Total Impervious Area	Percent Effective Impervious Area
Millionaire Creek	440	8%	4%
T2 Creek	80	42%	38%
Dunlop Creek	270	24%	11%
Spencer Creek	80	20%	12%
Alouette River	3,270	7%	3%
Kanaka Creek	4,590	11%	3%

Model calibration demonstrates that for those catchments not dominated by dense urban development, which are all catchments listed in **Table 5.3** except T2, there is significant reduction of %EIA over %TIA. This means that there is good disconnection between the impervious area and the drainage system. However, not unexpectedly, the T2 catchment is dominated by denser development and inherently has more direct connections between the impervious surface and the drainage systems, yielding only a modest reduction in %EIA from %TIA.

5.3.4 Minor System Capacity Analysis

The 10-year, 24-hour design storm was simulated to assess the hydraulic capacity of the existing minor drainage system. The results described below and further detailed in **Appendix C** should not be considered conclusive; rather, they point to potential capacity limitations and areas of potential concern within the system.

South Alouette Watershed: Potential capacity limitations in the trunk piping system were found primarily in older neighbourhoods, such as the Town Centre, where other forms of stormwater management have not been applied. Capacity limitations also appear southwest of 123rd Avenue and 230th Street where flooding in the past 15 years has been observed.

Limited concerns were found in the Silver Valley area where recent stormwater management practices have been applied.

Kanaka Creek Watershed: Performance of the minor drainage system in the Kanaka Creek watershed was found to be variable. There are a significant number of on-line control manholes that intentionally induce surcharging to detain water within the pipe system to protect downstream watercourses. As a general statement, the portions of the system with the greatest limitation are those along Dewdney Trunk Road at and east of 240th Street, and trunk pipes in the vicinity of 232nd Street between 116th Avenue and 118th Avenue.

123rd Avenue at 230th Street Sub-Catchment

Over the last 15 years, there is a sub-catchment along 230th Street near 123rd Avenue that has been hit by repeated flooding incidents. The stormwater network in the study area consists of 3.3 km of sewers, servicing approximately 200 single-family homes. The network discharges to Balbanian Creek, a tributary of the South Alouette River.

This ISMP analysis has identified that for the 1:10 year design event significant surcharge is expected for the portion of trunk sewer on Gee Street between Rogers Avenue and Eagle Avenue.

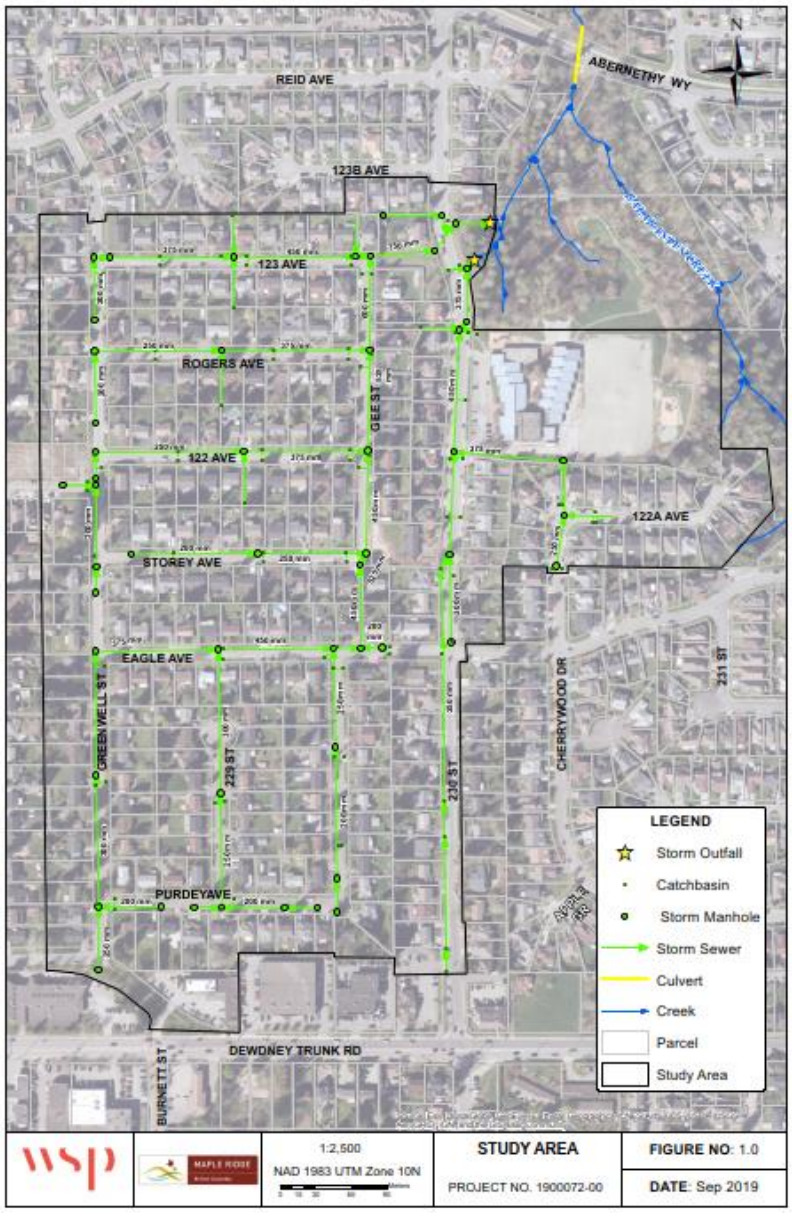
In 2019, the City engaged WSP to conduct an analytic study of this system (limits in **Figure 5.1** right). This followed an earlier 2010 study for this same system that recommended system improvements that were completed by the City in 2014, but flooding persisted, with the most recent major flood occurring in September 2018.

The latest preliminary analysis in 2019 by WSP matches the performance identified by the ISMP, again indicating significant surcharge in a 1:10 year design event on Gee Street between Eagle Avenue and Rogers Avenue. This surcharging then extends further upstream within the smaller local system not captured by the ISMP trunk analysis.

WSP recommended the City undertake flow monitoring that would allow for model calibration and verification of upgrades proposed to be undertaken in addition to the 2014 upgrades. The City has now completed the flow monitoring and has retained a consultant to calibrate the model, verify upgrade requirements for the 10 year storm and review options for improving drainage for rainstorm events that exceed a 10 year return period.

This comparative demonstration between the macro ISMP study and the detailed WSP study adds confidence to the results of the ISMP. The purpose of the ISMP is to raise awareness to areas of concern

Figure 5.1 - 123rd Avenue at 230th Street Sub-Catchment



for the trunk system, which then leads to more refined exploration at the local level in order to formulate a concise capital program.

5.3.5 Major System Capacity Analysis

The 100-year, 24-hour design storm was simulated to assess performance of road crossing culverts and confirm where surface major flow paths are required (spare capacity does not exist in minor system). The results described below and further detailed in **Appendix C** should not be considered conclusive; rather, they point to locations where the overland flow paths should be further assessed.

South Alouette Watershed: Modelling indicated that the main channel of Kanaka Creek fills during a 100 year event (and in some reaches the 10 year event), however Kanaka has a floodplain which is expected to activate during major flows.

The model showed McKenney Creek overflowing its banks in a section between 203 and 210 Street, matching reports that the stream overflows its banks (an agricultural dike/spoil from channel excavation) during heavy rains at this location.

In February 2016 Northwest Hydraulic Consultants (NHC) completed a complementary study for the City titled "North Alouette and South Alouette Rivers Additional Floodplain Analysis, Phase 2 – Technical Investigations Completion Final Report". This was a detailed and focused study of the hydraulic performance of the floodplain which was not the intent of this ISMP. Therefore, this NHC study should be consulted for more information about the floodplain areas.

Kanaka Creek Watershed: With exception to deeply incised ravines, natural watercourses have over bank floodplain which will activate during major flows. This phenomenon is shown in the results of the analysis for the major event.

5.3.6 ARDSA Capacity Analysis

Potential capacity limitations do exist within ALR lands during the ARDSA 10-year, 2-day storm event, and the ARDSA 10-year, 5-day storm event, respectively. This analysis is limited to identifying if it can be expected that the conveyance system will breach under these events, not fully evaluate whether the ARDSA criteria are being met or exceeded. That analysis would need comprehensive floodplain dynamic analysis of storage and flood duration, as well as dry weather free board depth, none of which is part of this study. The ARDSA criteria does allow flooding during these events, provided that the flooding is limited in duration. The results presented herein are simply indicative of where flood breach is expected. A dedicated agricultural drainage assessment study would be required to ascertain whether or not the ARDSA criteria are being achieved.

Isolated potential capacity limitations were found for both design events in the South Alouette watershed. More potential capacity limitations were found for the Kanaka Creek system.

Summary

Under all design storms, potential capacity limitations were primarily located in older neighbourhoods, and in the lower reaches of McKenney Creek and Kanaka Creek[10].

In general, analysis suggests that the systems within both the South Alouette and Kanaka Creek watersheds are performing reasonably well against established criteria. There are some on-line controls that do cause **intended** surcharging in an

[10] Main channel only, excluding the floodplain. Refer to Section 8.9 Floodplain Analysis.

oversized piping system to provide detention. Figures representing system performance under existing conditions are presented in Section 9 along with discussion about future condition performance.

Only if and when modeling predicts flooding to surface is further exploration prioritized to more fulsomely evaluate risk. However, this works is beyond the scope of this ISMP. Management responses to address potential capacity limitations with the existing drainage system will be identified and prioritized following modelling of the future development condition.

Millionaire Creek, Upstream (Urban systems, 2014)

6 COMMUNITY SURVEY SUMMARY

To help assess the public's current perceptions of the watershed and its overall health the City of Maple Ridge published a public online survey from July 19 to August 19, 2019. The survey was advertised on the City website, their Facebook page, and in the local newspaper. Participation was voluntary and the City received a total of 25 responses. This is a summary of those responses.

6.1 Where Participants Live

Survey respondents were asked what postal code area they live in. The map on the following page (**Figure 6.1**) shows the areas where the survey respondents reside. It is noted that some of the responses were obtained in locations outside the ISMP study area.

6.2 Current Impacts and Awareness

Survey participants were asked about the current impact and awareness of the watersheds in their neighbourhoods. **Figure 6.2 and Figure 6.3** summarize the responses.

Based on our survey responses, 60% of respondents (15 out of 25) have been impacted by flooding in their neighbourhood and 88% of respondents (22 of the 25) are aware of the importance of natural features for drainage.

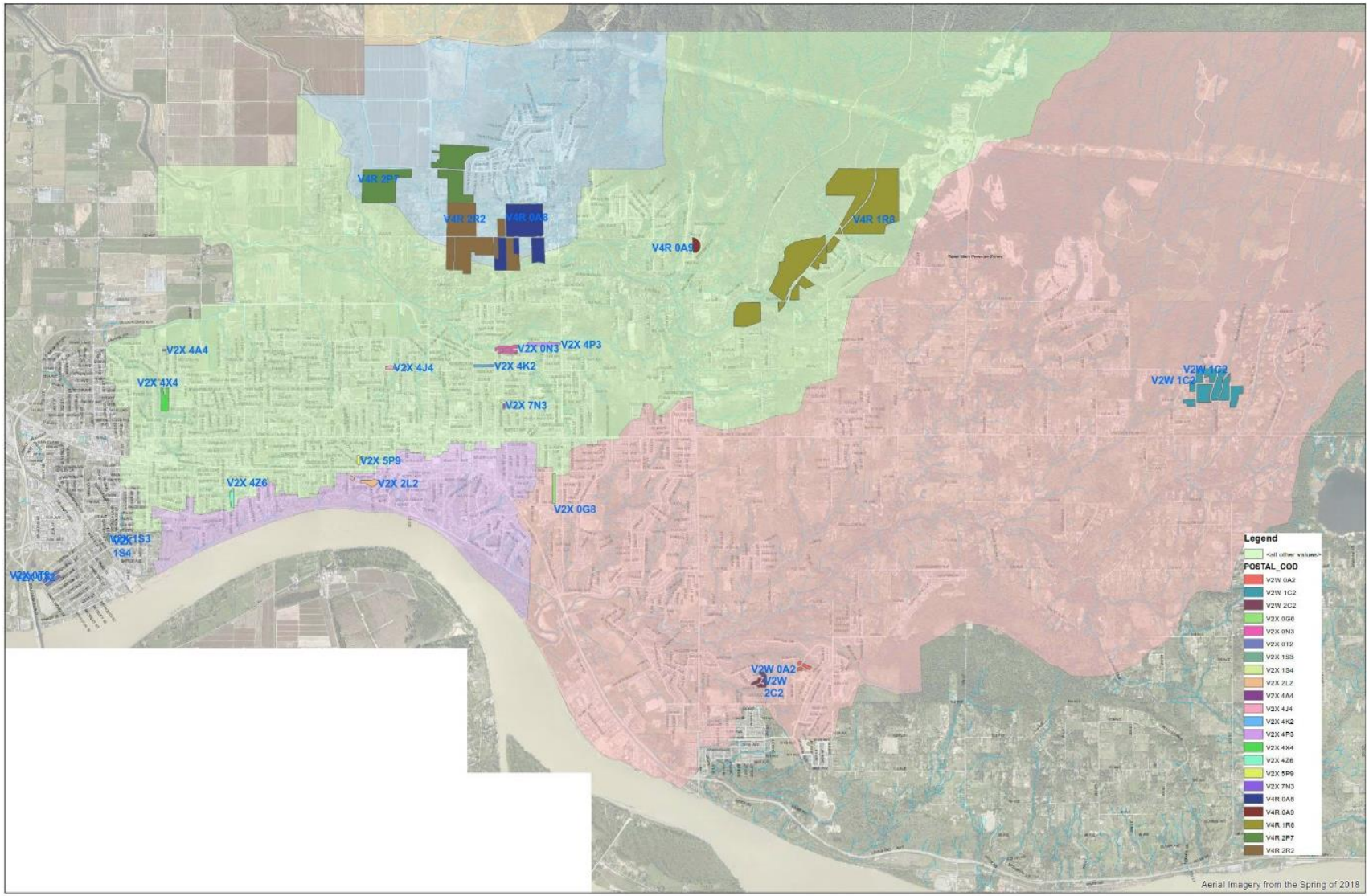


Figure 6.1 - Survey Participant Postal Code Areas

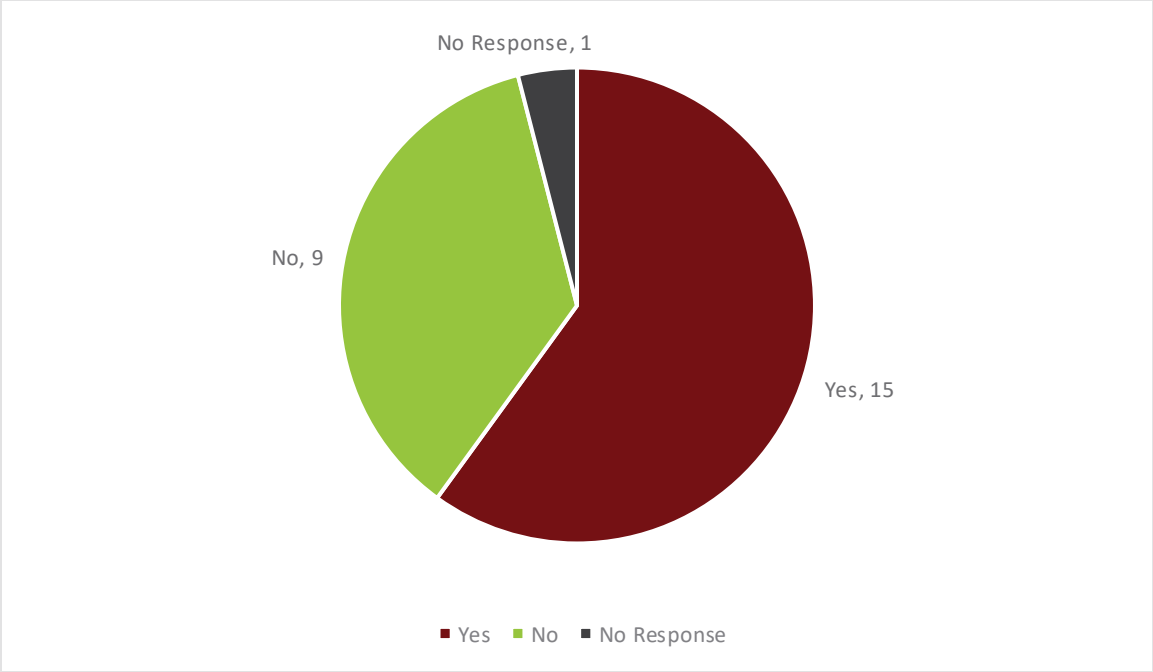


Figure 6.2 - Have you experienced flooding in your neighbourhood?

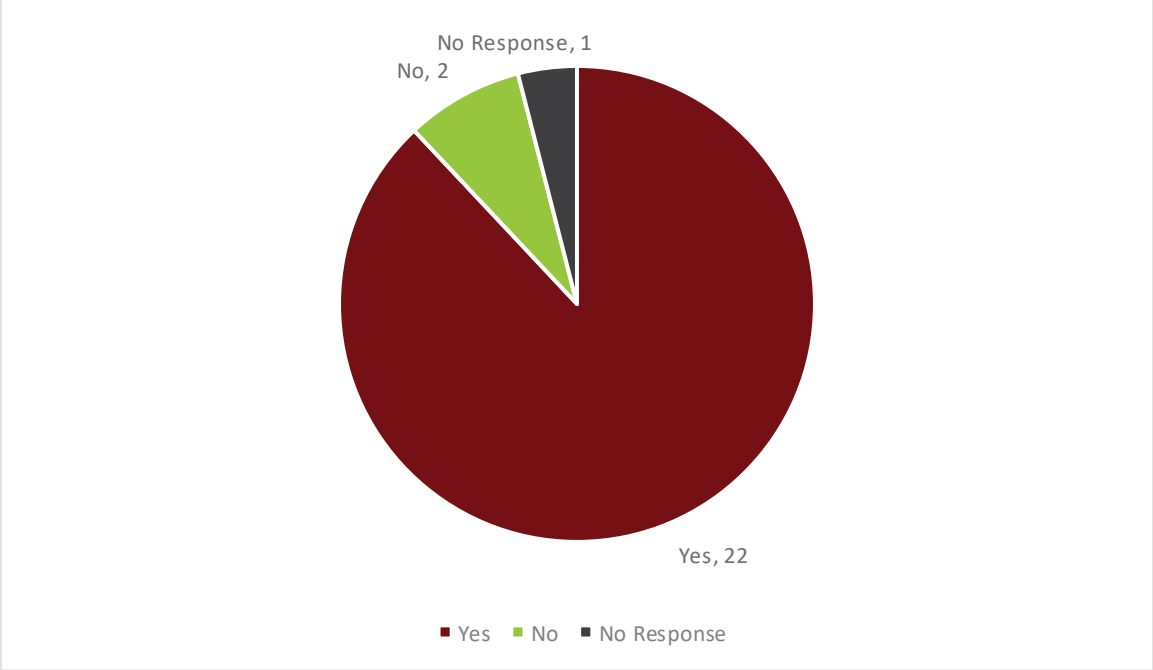


Figure 6.3 - Are you aware of how natural features are important for drainage?

6.3 Impressions and Importance of the Watershed

Survey participants were asked about their impression of the watershed health for three separate areas: rural, suburban, and urban areas. **Figure 6.4 through Figure 6.6** interpret the comments on a scale ranging from "Poor" to "Good" with additional "No Comment / No Response" and "I don't know" options.

Respondents were able to leave comments, and there was a common theme throughout each of the areas. The majority of respondents believe the watershed health to be poor and attribute the new developments in the area to be largely responsible for this.

In regard to the rural watershed health, 8 of 25 respondents believe the health of the watershed is poor, and 10 responses specifically mention how development has negatively impacted the watershed.

Representative Comments

"I'm not sure that enough is being done to protect these natural features from the effects of urbanization"

"The way the area is being developed puts severe pressure on the natural environment and is destroying the forests and watersheds"

"Excessive stream side development is degrading the natural flood control"

When asked about the suburban areas, 12 of the 25 respondents believe the health of the watershed to be poor, and 13 of 25 respondents mention the negative impacts of development near the watershed. A few participants speak to the fact that newer developments appear to be taking the natural drainage features into consideration and build around them, and several respondents also mention that they would like to see developers utilizing better materials and technologies to help with drainage.

Representative Comments

"There has been a large amount of development…where too many homes have been built too close together and note enough grass, trees, etc. has been maintained"

"New developments will be better equipped to deal with drainage and work with/around existing watershed elements"

"We need to think about using new technologies of pervious pavements and move away from using so much impervious surfaces to channel and move stormwater out of our systems"

By far, the majority of survey respondents believe the watershed health in urban areas to be poor (15 of 25 respondents). Again, respondents believe the main culprit for this is development that removes natural drainage features and is too close to the waterway. Participant said that old development and infrastructure is seen as not able to address the additional runoff, and new developments are not considering or maintaining the existing natural drainage features.

Representative Comments

"Old infrastructure that does not address runoff rates or water quality. Recent downtown improvements could have integrated modern runoff facilities and did not"

"Too much concrete & pavement. Not enough green spaces and permeable surfaces"

"Existing drains may be at capacity already as evidenced by the street flooding earlier this year"

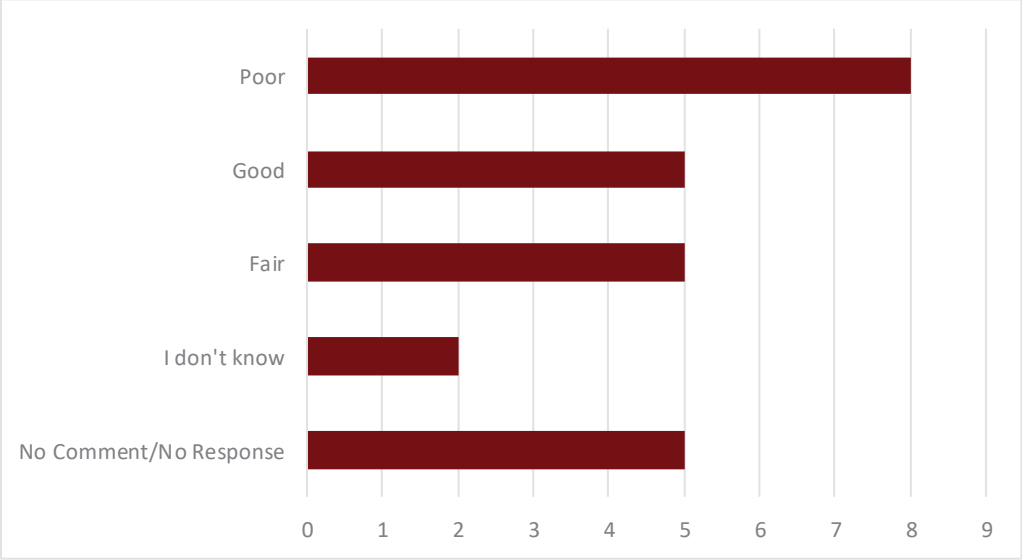


Figure 6.4 - Your Impression of watershed health (rural areas)

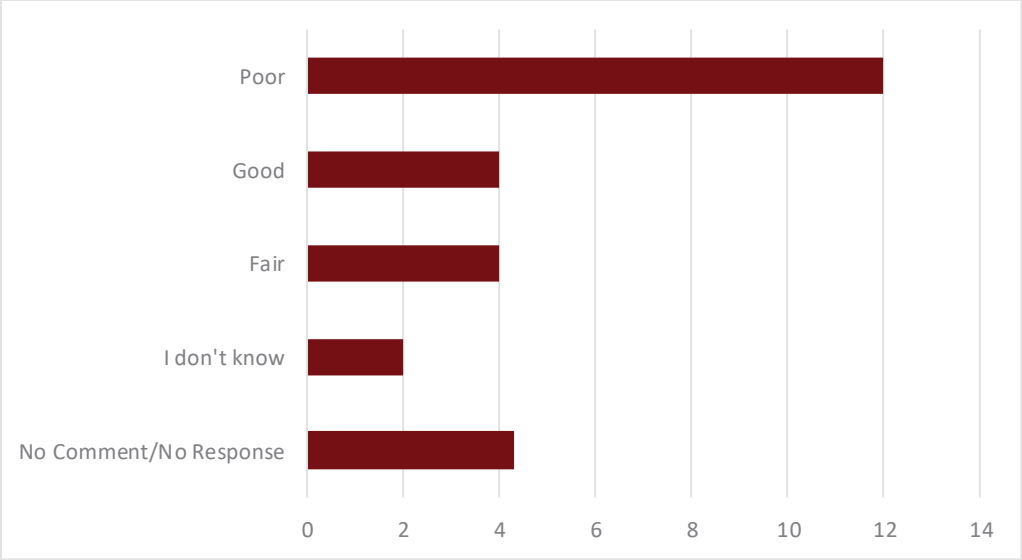


Figure 6.5 - Your impression of watershed health (suburban areas)

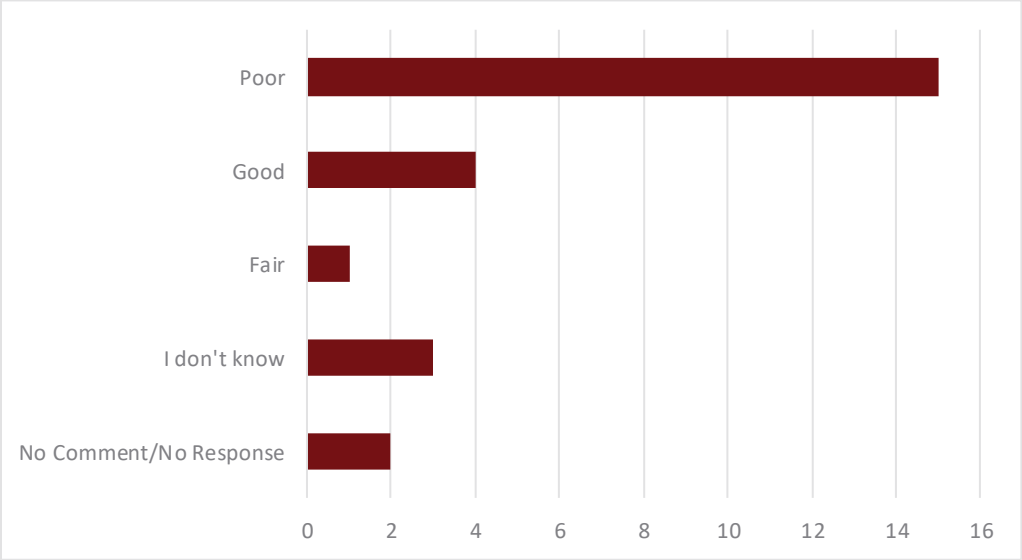


Figure 6.6 - Your impression of watershed health (urban areas)

6.4 Support for the Watersheds

In the last two questions, participants were asked to identify how important the health of the watershed is, and the level of investment they would support for drainage improvements. The responses ranged from moderate to significant importance/investment, with an additional option of "need more information". Responses are summarized in **Figure 6.7 and Figure 6.8.**

Participants overwhelmingly responded that the health of the watershed is important to them, with more than 70% (18 or 25) saying significantly important. When asked about how much investment into drainage improvements they would support, the majority of respondents (19 of 25) would support moderate to significant investment.

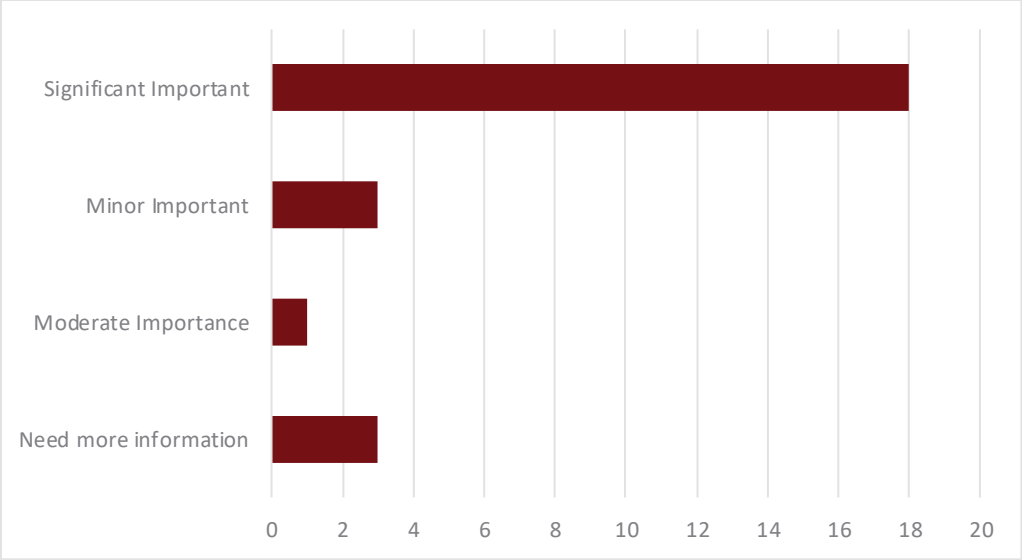


Figure 6.7 - How important is health of watersheds to you?

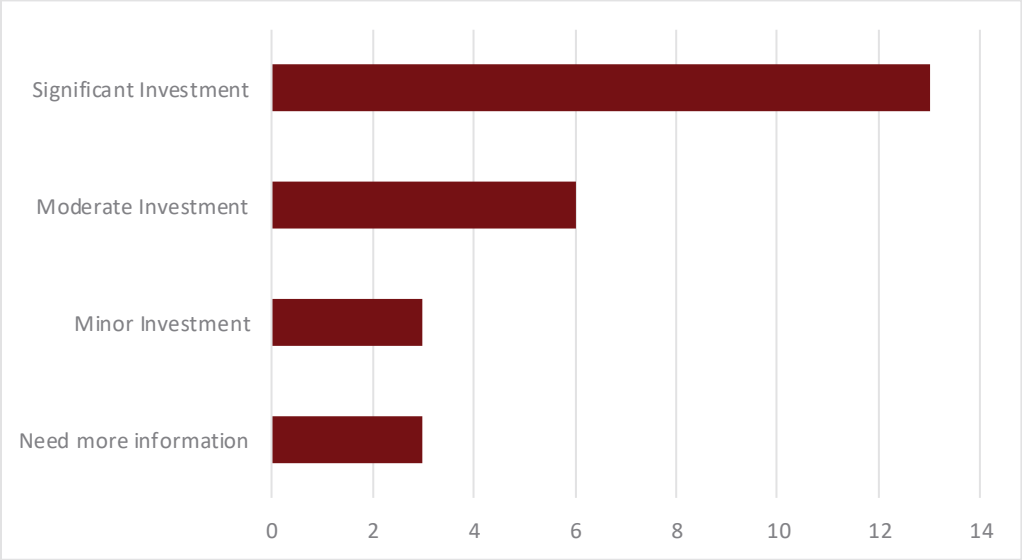


Figure 6.8 - What level of investment drainage improvements would you support?

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PART 2 - FUTURE CONDITIONS ASSESSMENT

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Based on the OCP, Area Plans, and pattern of infill development, the projected change in land use is predicted. The City completed their Design Criteria Manual in 2015, requiring a multi-tiered approach to stormwater management.

Dialogue with City staff revealed that, to a large part, developers are achieving rainwater management goals, with the exception of retention storage for Low Density and Medium Density residential developments. After considering soil types, parcel size, Building Code site drainage requirements and site stability, developers often directly connect roof leaders to a non-perforated storage sump with an orifice to regulate flow rate, which is then directly discharged to the storm sewer system. This system, as described, does not offer an opportunity for retention of rainwater falling on impervious surfaces other than what may occur from limited depression storage or evaporation.

Future condition modeling has been conducted that represents the above conditions for a variety of single event storms, including the MAR event, a range of 1:10 year events, a range of 1:100 year events, the defined ARDSA events and a small sample of continuous simulation. System performance was then determined based on a wide range of indicators, including peak flow and maximum hydraulic grades lines in the conveyance system, creek flow volumes, and through computation of an erosion potential index (EPI) for sample creek segments.

Kanaka Creek near Thornvale Creek (Urban Systems, 2014)

7 FUTURE LAND USE

The City's 2013 Official Community Plan (OCP) (Bylaw No. 7060-2014, Schedule B Generalised Future Land Use Plan) lays out how the City of Maple Ridge will grow and what and where land uses will be. The most recent land use files received from the City were on April 26, 2017. Part 2 of the ISMP process assesses the City's current watershed management practices and predicts what the expected watershed outcomes are likely to be based on those practices and applying the OCP land use. The exception is the Kanaka Business Park area, which is designated primarily as residential in the OCP but which we have assigned as industrial based on direction from City staff.

7.1 Relevant OCP Principles, Goals, and Objectives

The OCP identifies a number of specific principles, goals, and objectives that are specifically aligned with rainwater management and achieving watershed protection into the future. Relevant excerpts for the OCP are as follows:

Vision: The City will strive to protect its Community Values into the future, as it becomes more vibrant and prosperous, offering residents a strong local economy, stable and special neighbourhoods, thoughtful development, a diversity of agriculture, and respect for the built and natural environment.

Principles:

1	Protection of agricultural lands is considered a strong element of protecting environmental values.
12	Collaboration with other authorities, including but not limited to the ALC and Metro Vancouver, is essential to ensuring that municipal objectives can be met.
23	The community values the protection of environmentally sensitive areas including, water (for its intrinsic value, habitat and aquifer recharge), areas of natural beauty, forests, etc.
24	The community recognizes the environmental contribution made by lands within the ALR (also see Principle 1).
25	There is value in integrating natural features of the environment into development through planning and design.
26	Overall environmental protection demands a comprehensive, "smart growth" approach.
38	Expanding services concurrently with development is regarded by the community as good planning and development practice.

Goal 1 – Create a compact urban area

Strategy 1.2: Focus growth in urban centres and frequent transit development areas

Strategy 1.3: Protect rural areas from urban development

Goal 3 – Protect the environment and respond to clime change impacts

Strategy 3.1: Protect conservation and recreation lands

Strategy 3.2: Protect and enhance natural features and their connectivity

Strategy 3.4: Encourage land use and transportation infrastructure that improve the ability to withstand climate change impacts and natural hazard risks

Objectives for citizen engagement and community connections:

- provide opportunities for citizens to increase their understanding of the community and to have a voice in decisions being made that affect them in their community life.

Objectives for natural features:

- a comprehensive approach based on ecosystem principles incorporating land, water and air into a single framework
- a perspective that anticipates climate change and strives to reduce its causes while mitigating its effects

7.2 Area Plans

The City has conducted a number of Area Plans, and it is understood that those approved by Council have been incorporated into the OCP.

Generally speaking, land use changes are expected to unfold as follows:

- The Town Centre Area and the Urban Areas will experience primarily infill development;

- The Silver Valley Area is not yet built out, and will experience greenfield development;
- The Albion Area is not yet built out, and will experience greenfield development;
- All other relevant areas will experience greenfield development as per the land use plan.

7.3 OCP Land Use Categories

Land use designations within the OCP are discretized into very specific types more refined than is necessary for this ISMP. As such, designations of like character have been grouped into 10 primary types, as noted in **Table 7.1** below.

Table 7.1 – OCP Land Use Categories

Forest Forest Riparian	***Agricultural*** Agricultural	***Industrial*** Industrial Industrial Parks Rural Resource Infill General Employment
Parks Neighbourhood Park Open Space Park Parks & Open Space Park in the ALR Conservation	***Rural Residential/Suburban Residential*** Rural Residential Estate Suburban Residential Suburban Residential	***Civic & Institutional*** Institutional Civic
Commercial Town Centre Commercial Tourist Commercial Village Commercial Neighbourhood Commercial Commercial	***Low Density Residential*** Urban Residential (infill) Single-Family Residential Single-Family Compact Residential Low/Medium Density Residential Low Density Urban Low Density Multi-Family	***Medium Density Residential*** Medium Density Residential Medium Density Multi-Family Low-Rise Apartment Ground-Oriented Multi-Family Eco Clusters
High Density Residential Medium and High-Rise Apartment Flexible Mixed-Use Medium and High-Rise Apartment High Density Residential Medium/High Density Residential		

The initial baseline condition represented in the Part 1 report was based on measuring impervious surfaces using a 2011 aerial photo provided by the City at the launch of the ISMP study. As such, future condition contained herein accounts for land use change that has occurred between 2011 through 2016, and then accounts for land use change predicted to the future, as defined by the OCP. These areas represent Greenfield development. In addition, there are a few areas of the City; the Town Centre Area, for example, that are undergoing redevelopment through infill. The boundaries of anticipated infill development, and the degree of change expected over the foreseeable future, were identified by City staff.

Predicted land use changes for both the Kanaka and South Alouette watersheds are described in **Figure 7.1** – Future Land Use Servicing Schematic for overall context, whereas **Figure 7.2 through Figure 7.4** are provided at a larger scale for clarity. The figures also note the presumed location where managed rainwater discharge will occur from each sub-catchment.

The distribution of Greenfield Development for the two watershed is presented in **Table 7.2** below.

Table 7.2 – Distribution of Greenfield and Infill Development

	South Alouette	Kanaka Creek
Recent Greenfield Development (2011 – 2016)	**34.8 ha / 0.1%**	**112 ha / 1.8%**
Future Greenfield Development	**202 ha / 0.8%**	**468 ha / 7.7%**
Total Area of Greenfield Development	**237 ha / 0.9%**	**580 ha / 9.5%**
Area of Infill Development	**957 ha / 3.7 %**	**596 ha / 9.8%**
Total Watershed Area (*)	**25,553 ha**	**6,087 ha**

Percentages are of the total watershed area

(*) – Total watershed area has been modified slightly from the Part 1 report based on further refinements representing future conditions

As described by **Table 7.2** above, both in sheer area, and the percentage of the total watershed, development within the Kanaka Creek watershed is expected to far exceed that of the South Alouette watershed.

For the purposes of assessing potential impact at a local level, two sub-watershed in the Kanaka Creek watershed, and two sub-watersheds in the South Alouette watershed have been considered, as outlined in **Figure 7.1 through Figure** 7.4. The sub-watersheds are the same as those for which the watershed health score was computed in the Part 1 report. A summary of the future land use parameters associated with these four sub-watersheds are presented in **Table 7.3** below.

Table 7.3 – Sub-Watershed Parameters

	South Alouette Watershed		Kanaka Creek Watershed	
	T2 Creek Sub-Watershed	Millionaire Creek Sub-Watershed	Dunlop Creek Sub-Watershed	Spencer Creek Sub-Watershed
Total Sub-Watershed Area	117 ha	452 ha	277 ha	96 ha
Area Expected to Redevelop	23 ha (1)	57 ha	41 ha	34 ha
Percent of Area to be Redeveloped	20% (only occurring through infill)	13%	15%	35%

(1) redevelopment within the T2 catchment will only occur through infill. The area noted assumes an infill rate of 20% as defined by the City.

Land use and their associated parameters have assumed to remain as per the existing condition (Part 1) for all areas that are not specifically identified as a redevelopment area.

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South Alouette and Kanaka Integrated Stormwater Management Plans

Future Land Use Servicing Schematic

South Alouette Watershed

Kanaka Watershed

20 % anticipated infill development over 30 year time horizon

20 % anticipated infill development over 30 year time horizon

5 % anticipated infill development over 30 year time horizon

Indefinite

Fraser River

Bedford Channel

Sturgeon Slough

Mirror Lake

Mike Lake

Spring Creek

Muir Creek

Birch Creek

Gatell Brook

Mud Creek

Millionaire Creek

Cadger Brook

Caho Creek

Kanaka Creek

Spencer Creek

Mabby Creek

Whonnock Lake

Brimacombe Creek

Brown Creek

Alder Brook

James Creek

Sprott Creek

Bonson Creek

Fern Creek

Browns Brook

Dewdney Trunk Road

Lougheed Highway

River Road

Golden Ears Way

224th

232 Avenue

128 Avenue

123 Avenue

102 Avenue

100 Avenue

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Assumed Future Roadway
Presumed Drainage Outfall
Recent Development (2011 - 2016)
Future Development Densification
Future Infill Development
Natural Watershed Boundary

Official Community Plan

- Urban Reserve
- Agriculture
- Forest
- Commercial
- High Density Residential
- Medium Density Residential
- Low Density Residential
- Rural Residential / Suburban Residential
- Industrial
- Parks & Open Space
- Parks within the ALR
- Civic & Institutional
- Creeks
- Drainage Pipes
- Detention Ponds
- Parcel
- Municipal Boundary
- Existing Creek Setbacks

500 250 0 500 1,000
m

Coordinate System:
NAD 1983 UTM Zone 10N

Data Sources:
City of Maple Ridge
City of Pitt Meadows
BC MoE
NR Canada

Project #:	1279.0025.01
Author:	BG/LP
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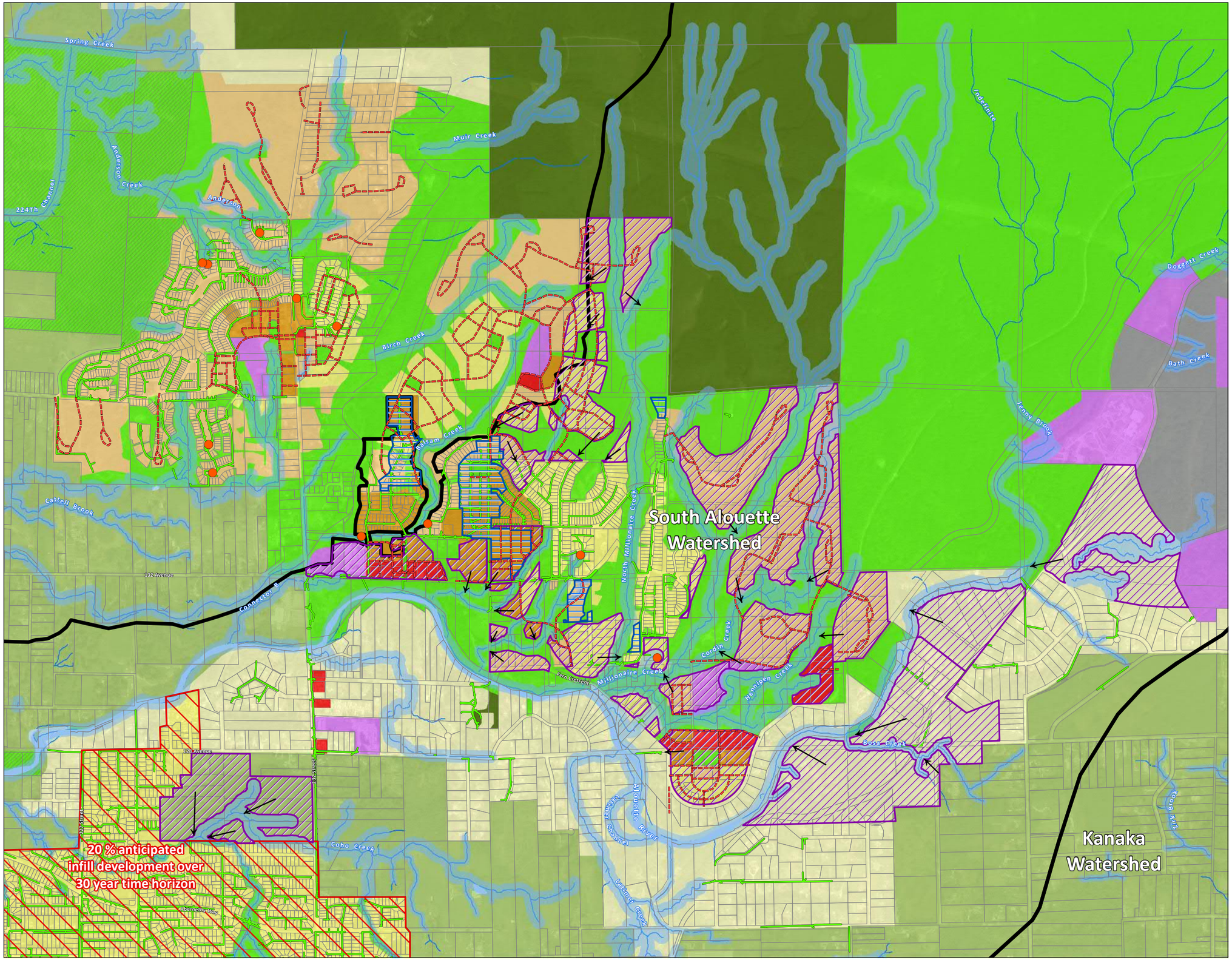
Date:	2017 / 8 / 15

URBAN systems

FIGURE 7.1



MAPLE RIDGE
British Columbia

South Alouette and Kanaka Integrated Stormwater Management Plans

South Alouette Watershed -

Future Land Use Servicing Schematic

- Assumed Future Roadway
- Presumed Drainage Outfall
- Recent Development (2011 - 2016)
- Future Development Densification
- Future Infill Development
- Natural Watershed Boundary

Official Community Plan

- Agriculture
- Forest
- Commercial
- High Density Residential
- Medium Density Residential
- Low Density Residential
- Rural Residential / Suburban Residential
- Industrial
- Parks & Open Space
- Parks within the ALR
- Civic & Institutional
- Creeks
- Drainage Pipes
- Detention Ponds
- Parcel
- Municipal Boundary
- Existing Creek Setbacks

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Coordinate System:
NAD 1983 UTM Zone 10N

Data Sources:
City of Maple Ridge
City of Pitt Meadows
BC MoE
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Author:	BG/LP
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Revision:	N
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FIGURE 7.2

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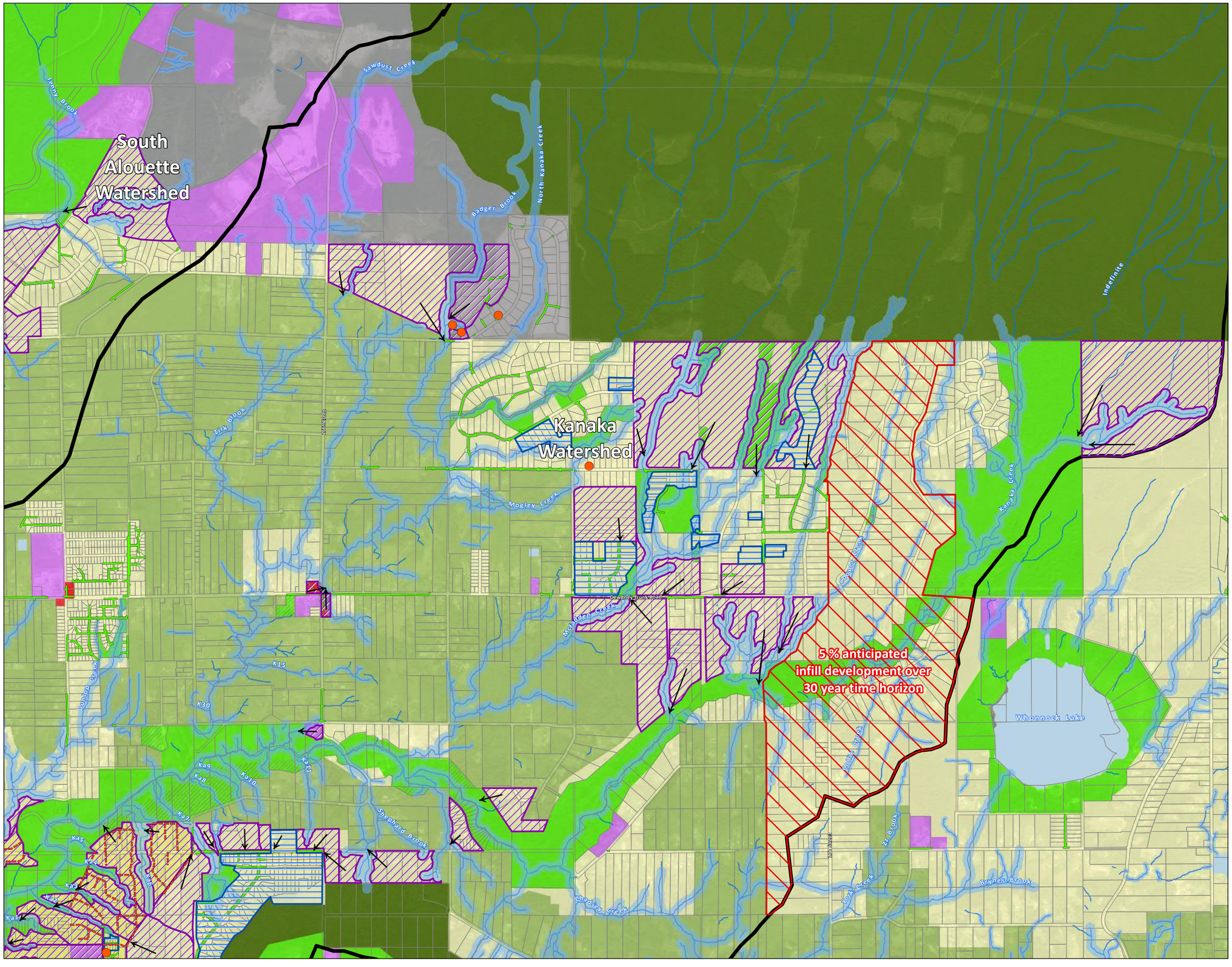

South Alouette and Kanaka Integrated Stormwater Management Plans

Kanaka Creek Watershed -

Future Land Use Servicing Schematic

- Assumed Future Roadway
- Presumed Drainage Outfall
- Recent Development (2011 - 2016)
- Future Development Densification
- Future Infill Development
- Natural Watershed Boundary

Official Community Plan

- Agriculture
- Forest
- Commercial
- Low Density Residential
- Rural Residential / Suburban Residential
- Industrial
- Parks & Open Space
- Parks within the ALR
- Civic & Institutional
- Creeks
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Coordinate System:
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City of Maple Ridge
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NR Canada

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URBAN systems

FIGURE 7.3

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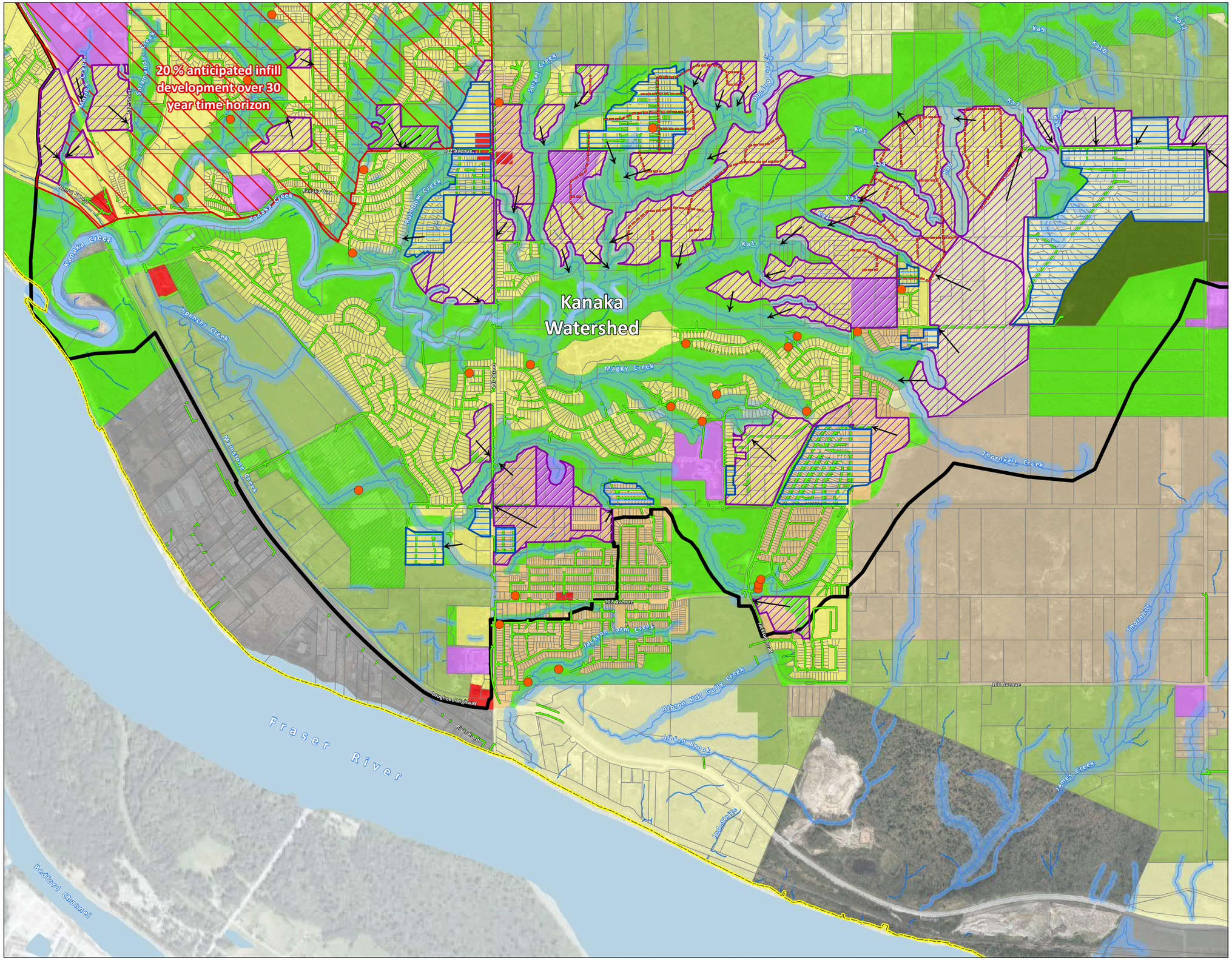

MAPLE RIDGE
British Columbia

South Alouette and Kanaka Integrated Stormwater Management Plans

Kanaka Creek Watershed -

Future Land Use Servicing Schematic

- Assumed Future Roadway
- Presumed Drainage Outfall
- Recent Development (2011 - 2016)
- Future Development Densification
- Future Infill Development
- Natural Watershed Boundary

Official Community Plan

- Urban Reserve
- Agriculture
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- Commercial
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Coordinate System:
NAD 1983 UTM Zone 10N

Data Sources:
City of Maple Ridge
City of Pitt Meadows
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NR Canada

Project #:	1279.0025.01
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Status:	~ DRAFT ~
Revision:	N
Date:	2017 / 8 / 15

URBAN systems

FIGURE 7.4

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Hennipen Creek at Fern Crescent (Urban Systems, 2014)

8 LAND USE PARAMETERS

Within each land use category, there are variations in the intensity of development. For example, using aerial photos of recent developments, it is observed that there is a large range of lot sizes and impervious fractions for single family development. And single-family development dominates both recent and future growth. Therefore, single family residential development is expected to have the most influence on system outcomes. It is understood that in most cased "LD Res" (low density residential) and "MD Res" (medium density residential) are single family lots of various sizes and impervious fractions, but it is recognized that on occasion a multi-family unit may be within the medium density category.

For each land use category applied to future conditions, an estimated total impervious fraction was developed with dialogue with City staff. For modeling purposes, a portion of the impervious fraction which is likely to drain off to a pervious surface was also estimated. These are surfaces such as driveways or walkways, or portions thereof, from which rainwater runoff is not efficiently captured by a piping system. A summary of the applied values is presented in **Table 8.1** below.

Table 8.1 – Impervious Fraction

Land Use Category	Total Impervious Fraction(**)	Impervious Fraction Redirected to Pervious
Rural / Suburban	0.20	0.20
Low Density Residential	0.50	0.10
Medium Density Residential	0.70	0.10
High Density Residential	0.80	0*
Institutional	0.81	0*
Industrial and Commercial	0.90	0*

(*) Retention requirements are represented through LID controls. See Section 7.1 below.

(**) Impervious fractions represent the combination of the private lot and half of the fronting roadway. All roadways were estimated at 90% impervious.

8.1 Rainwater Management Controls and Criteria

The City's Design Criteria Manual (October 2015) specifies three levels of controls are to be applied. Beyond what is stated in the manual, a review with City staff further clarified the application of the criteria and the typical practices to achieve them, as summarized below:

8.1.1 Tier A

Tier A events are small rainfall events that are less than half the size of the Mean Annual Rainfall (MAR) and represent approximately 90% of the annual rainfall. This captured rainfall should be infiltrated, evapotranspired or re-used at the source.

Through a review of precipitation data and dialogue with the City, a precipitation depth of 80 mm was selected to represent the MAR event but scaled for higher elevations in accordance with the Design Criteria Manual. Therefore, Tier A criteria says that the first 40 mm of precipitation is to be retained.

For rural and suburban land uses, the City generally requires a rock pit to be applied. Impervious surfaces are directed to the pervious surface and soils to maximize the opportunity of the land to absorb runoff. The degree of retention is largely driven by the distribution of runoff onto the soils and the infiltration capacity of the soils.

For low density and medium density development, standard practice is that roof leaders be directed to a sump and control orifice, then to an infiltration system and/or detention system, which in turn is plumbed into the municipal storm sewer system. Sumps would need to be perforated to achieve any amount of infiltration. Whether or not the sumps are always perforated and sufficiently sized is unclear.

The sumps and orifice are required to be sized, typically using the modified Rational Method, to achieve Tier B criteria (refer to section below), however with concerns for clogging, the City has stipulated a minimum orifice size of 16.5 mm in diameter.

Lots smaller than 371 m2 in size (R1, R2, R3 zoning) have also been problematic to due a lack of space and need to achieve setback requirements. As such, on site retention is not being applied in most of these cases.

There are also cases, such as along the Fraser River escarpment, where ground recharge / infiltration and features causing ponding are prohibited (Policy 6.23).

As the City has been concerned with the ineffectiveness of infiltration systems in low permeability soils, onsite infiltration has not permitted them in soils with a percolation rate less than 0.5"/hr (12.5 mm/hr).

For a variety of reasons, there are many instances where the Tier A criteria are not achievable. However, there is insufficient information currently available to represent all the exceptions in the hydrologic modeling for this study. As such, only the prescribed criteria have been represented in the technical analysis herein.

While the City does require developers to demonstrate retention of 50% MAR, it does not prescribe how it is to be achieved.

8.1.2 Tier B

Tier B events are larger rainfall events that exceed Tier A up to and including MAR. These events represent approximately 10% of the annual rainfall and result in the majority of the peak flows in downstream watercourses. Source control facilities are required to store the runoff from impervious surfaces resulting from the large rainfall events and release it at a controlled rate of a 1:2 year forested / woodlot flow. Typical source control facilities include detention/retention ponds, oversized storm sewers, and storage tanks (on-lot and off-lot).

Tier B controls are applied to all land use designations, both for infill and Greenfield Development

8.1.3 Tier C

Tier C events are extreme storm events that exceed Tier B rainfall events and may or may not occur in any given year. At a minimum, the 1:10 year event must be detained and released at the 1:2 year predevelopment rate. Where directed by the City, the 1:100 year flow may sometimes be detained to a 1:10 year pre-development rate. However, in discussion with City staff, it is understood that a more stringent criterion of controlling the 100 year to 10 year is done in only few instances. For baseline future condition analysis, only the 10 year post to 2 year pre Tier C criteria has been applied herein.

For Infill development, Tier C controls are not applied to single family residential but are to higher density and ICI land uses.

8.1.4 Topsoil

The City's Design Criteria Manual requires 350 mm of topsoil be applied to boulevards of City streets, but not landscaping of private lots. City staff have indicated that 300 mm of topsoil is sought in development applications.

For analysis within this study, the above criteria have been applied to all new development, whether it be those recently developed between 2011 and 2016, future Greenfield Development or Infill Development. Where no development is anticipated, all land use and modeling parameters remain unchanged from those applied to the Part 1 existing baseline condition.

Table 8.2 on the following page summarizes the predicted land use changes within four sub-watersheds which will be specifically investigated further into this report. The table specifically notes the extent of Low and Medium density development within each sub-watershed.

Table 8.2 – Predicted Sub-Watershed Land Use Change

	South Alouette Watershed		Kanaka Creek Watershed	
	T2 Creek Sub-Watershed	Millionaire Creek Sub-Watershed	Dunlop Creek Sub-Watershed	Spencer Creek Sub-Watershed
Total Sub-Watershed Area	117 ha	452 ha	277 ha	96 ha
Area Expected to Redevelop	23 ha (1)	57 ha	41 ha	34 ha
Percent of Area Represented by Low Density and Medium Density Growth over Baseline Condition reported in Part 1 Report	77% (only occurring through infill)	12%	13%	33%
Future Condition Directly Connected Impervious Area	48%	10%	15%	25%
Future Condition Total Impervious Area	55%	14%	27%	31%

8.1.5 Current Water Quality Treatment in Maple Ridge

The Watercourse Bylaw and design criteria requires that the stormwater management plans include water treatment. It is common that proprietary treatment system (eg. Stormceptor, Vortsentries, Vortechs, oil/water separators, etc.) are proposed, which the City accepts, but the City does not have a fixed list of accepted systems. The Engineering and Operations Dept. review calculations, maintenance requirements, familiarity with, and access concerns, etc. for these systems. The Building Department has a role in ensuring implementation by the developer / builder.

For single family developments in close proximity to an outfall the City typically sees proprietary systems installed within a roadway which become City owned. The City currently has 52 such units in public right-of-way across the entire City.

For multi-family (townhouse, bare land strata and apartment), institutional, industrial, or commercial sites it becomes increasingly important that appropriate type and size units are utilized on site because there is typically a larger amount of impervious surface area on site to support traffic, parking, storage of vehicles, etc. and subsequently water quality concerns associated with hydro-carbons, heavy metals, etc. Length, size, and number of roads/parking areas also comes into consideration. For these sites, usually oil/grit separators are applied, sometimes in combination with other proprietary treatment systems, all remaining on site as private systems.

From an environmental perspective, the City seeks to expand the importance of the Tier A requirements from a landscaping and high-quality topsoil perspective where possible to assist with water quality improvements. There is further discussion regarding water quality treatment and the effectiveness of green infrastructure in Section 13.1.5.

Millionaire Creek, Upstream (Urban systems, 2014)

9 FUTURE CONDITIONS IMPACT ASSESSMENT

9.1 Design Storm Events

To assess the system under future conditions, several design storm events are simulated, including single storm events, single storm events with consideration of climate change, and extended period rainfall for continuous simulations.

9.1.1 Single event storms

A broad set of design storms in accordance with the City criteria, ranging in duration from 1 hour to 24 hours, were modelled to determine the critical event for each system component. In addition to the minor and major event return periods, the Mean Annual Rainfall (MAR) event is modelled. Through assessment and dialogue with the City it was agreed to use 80 mm as the 24-hour MAR value applied across the City, but scaled by 1.4 for elevations above 150 m. The MAR event is used to test against Tier B criteria, and for erosion risk assessment as presented in Section 4.0. Finally, the ARDSA events are modelled to compare performance against that of the existing condition in the agricultural zones.

Table 9.1 summarizes each of the design storms simulated and their purpose.

Table 9.1 – Simulated Design Storm Events

Mean Annual Rainfall (MAR)	**To define and assess Tier A and Tier B controls for future development and infill development**
2-Year, All Durations **(30-min, 1-hr, 2-hr, 6-hr, 12-hr, and 24-hr)**	To define and assess Tier C controls for future development and infill development
10-Year, All Durations **(30-min, 1-hr, 2-hr, 6-hr, 12-hr, and 24-hr)**	To assess the minor system conveyance capacity
100-Year, All Durations **(30-min, 1-hr, 2-hr, 6-hr, 12-hr, and 24-hr)**	To assess the major system conveyance capacity
ARDSA 10-Year 2-Day (Summer)	To assess change of performance in agricultural zones
ARDSA 10-Year 5-Day (Winter)	To assess change of performance in agricultural zones

Table 9.2 summarizes the total rainfall depth for each simulated 2-Year, 10-Year, and 100-Year design storm duration.

Table 9.2 – Design Storm Events

Rain Gauge	Return Period	Total Rainfall (mm)					
		30-min	1-hr	2-hr	6-hr	12-hr	24-hr
Katzie Pump Station (DM44)	2-Year	9.8	14.5	20.3	38.6	56.4	76.2
	10-Year	17.2	26.9	32.0	56.4	93.6	132.9
	100-Year	26.3	42.3	46.7	78.6	140.1	203.7
Maple Ridge Reservoir (DM45)	2-Year	9.1	12.9	18.8	37.0	54.0	75.9
	10-Year	17.1	25.2	31.4	50.2	83.2	118.7
	100-Year	27.2	40.6	47.2	66.8	119.6	172.1
Golden Ears Elementary School (DM62)	2-Year	9.8	14.5	20.3	38.6	56.4	76.2
	10-Year	17.2	26.9	32.0	56.4	93.6	132.9
	100-Year	26.3	42.3	46.7	78.6	140.1	203.7
Haney UBC Research Forest	2-Year	9.4	12.7	19.4	38.4	57.6	86.4
	10-Year	15.2	19.0	25.4	49.2	78.0	122.4
	100-Year	22.5	26.8	32.8	62.4	104.4	168.0

Table 9.3 summarizes the total rainfall depth for each simulated ARDSA design storm event.

Table 9.3 – ARDSA Design Storm Events

Design Storm Event	Total Rainfall (mm)
ARDSA – 10yr 2day	84.0
ARDSA – 10yr 5day	193.1

As a conservative approach, all design storms were simulated under winter conditions when soils are assumed to be saturated.

9.1.2 Climate change

In the absence of study to define the specific climate change specific to Maple Ridge, as agreed with the City, the one-day rainfall depths are scaled by both 10% and 20%. This is to test system sensitivity to a range of potential change. This range spans the 15% increase suggested in the Master Municipal Construction Documents Association (MMCD) *Design Guidelines 2014,* and the 17% increase suggested for Metro Vancouver for the year 2050 as described in the report *Vulnerability of Vancouver Sewerage Area Infrastructure to Climate Change* (March 2008).

The Pacific Climate Impacts Consortium (PCIC) are the predominant climate change modellers for western Canada, who have developed a publicly accessible tool referred to as "Plan2Adapt" where current predictions of climate change can be obtained. Pertinent to Maple Ridge (Greater Vancouver), the Plan2Adapt tool provides the following predictions for the 2050's and 2080's respectively. These result further support consideration for the range of a 10% to 20% increase for winter conditions.

Despite the primary focus here being on the effects of climate change on precipitation, the potential impacts will extend to heat, drought, and wind. Climate change alone may result in diminished groundwater during summer months, which may be compounded by expanded urban development that increases impervious surface in absence of recharge management techniques. Sufficient groundwater to sustain summer base flow in creeks is important to supporting aquatic habitats, including providing thermal refuge for spawning and rearing salmon. This further emphasizes the importance of rainwater recharge into the ground and to maximize the potential for tree canopy within the urban areas as a heat shield.

Summary of Climate Change for Greater Vancouver in the 2050s

Climate Variable	Season	Projected Change from 1961-1990 Baseline	
		Ensemble Median	Range (10th to 90th percentile)
Mean Temperature (°C)	Annual	+1.7 °C	+1.0 °C to +2.5 °C
Precipitation (%)	Annual	+7%	-2% to +11%
	Summer	-15%	-25% to +3%
	Winter	+6%	-4% to +15%
Snowfall* (%)	Winter	-36%	-56% to -19%
	Spring	-56%	-73% to -17%
Growing Degree Days* (degree days)	Annual	+415 degree days	+250 to +609 degree days
Heating Degree Days* (degree days)	Annual	-589 degree days	-853 to -360 degree days
Frost-Free Days* (days)	Annual	+22 days	+14 to +33 days

The table above shows projected changes in average (mean) temperature, precipitation and several derived climate variables from the baseline historical period (1961-1990) to the **2050s** for the **Greater Vancouver** region. The ensemble median is a mid-point value, chosen from a PCIC standard set of Global Climate Model (GCM) projections (see the 'Notes' tab for more information). The range values represent the lowest and highest results within the set. Please note that this summary table does not reflect the 'Season' choice made under the 'Region & Time' tab. However, this setting does affect results obtained under each variable tab.

* These values are derived from temperature and precipitation. Please select the appropriate variable tab for more information.

Summary of Climate Change for Greater Vancouver in the 2080s

Climate Variable	Season	Projected Change from 1961-1990 Baseline	
		Ensemble Median	Range (10th to 90th percentile)
Mean Temperature (°C)	Annual	+2.7 °C	+1.5 °C to +4.1 °C
Precipitation (%)	Annual	+8%	+1% to +18%
	Summer	-14%	-37% to -3%
	Winter	+9%	+1% to +23%
Snowfall* (%)	Winter	-52%	-74% to -26%
	Spring	-75%	-88% to -21%
Growing Degree Days* (degree days)	Annual	+680 degree days	+373 to +1072 degree days
Heating Degree Days* (degree days)	Annual	-919 degree days	-1344 to -520 degree days
Frost-Free Days* (days)	Annual	+33 days	+19 to +47 days

The table above shows projected changes in average (mean) temperature, precipitation and several derived climate variables from the baseline historical period (1961-1990) to the **2080s** for the **Greater Vancouver** region. The ensemble median is a mid-point value, chosen from a PCIC standard set of Global Climate Model (GCM) projections (see the 'Notes' tab for more information). The range values represent the lowest and highest results within the set. Please note that this summary table does not reflect the 'Season' choice made under the 'Region & Time' tab. However, this setting does affect results obtained under each variable tab.

* These values are derived from temperature and precipitation. Please select the appropriate variable tab for more information.

9.1.3 Continuous simulation

Precipitation data recorded during the model calibration simulation period (refer to Part 1 report) of November 21, 2014 to February 21, 2015 was used to compare the flow regime between the existing and future conditions. These outputs are primarily used in the creek erosion risk sensitivity analysis presented in Section 9.0 below.

9.2 Model Representation of Controls

9.2.1 Tier A

Tier A controls were represented using a depression storage parameter. Depression storage values for impervious surfaces were adjusted such that runoff was 50% of the MAR. Losses from pervious areas were determined computationally by the model based on the soil infiltration and ground cover parameters assigned.

9.2.2 Tier B

Tier B controls were represented using Low Impact Development (LID) controls such that the post-development MAR flows are detained and released at the "forested/woodlot" MAR flow rate. LID controls are built-in functions within the InfoSWMM modeling software and are integrated in the subcatchment layer. They are designed to capture surface runoff and allow controls to define a combination of detention, infiltration, and evapotranspiration functions. The software can model up to eight different generic types of LID controls; bio-retention cells, rain gardens, green roofs, infiltration trenches, continuous permeable pavement, rain barrels, rooftop disconnection, and vegetative swales.

For the purposes of detaining flow and releasing at a prescribed flow rate, the "rain barrel" LID function was used as it incorporates a storage layer to define a storage volume and an underdrain layer to define the release flow rate. To determine the required release rate for the Tier B control, it was necessary to simulate flows from the "forested/woodlot" MAR scenario first. The storage requirements for the LIDs were then determined by simulating the future land use MAR scenario and sizing the storage such that they do not overflow. This was done to assess the effects of the established criteria, despite the City minimum orifice size of 16.5 mm in diameter.

9.2.3 Tier C

Tier C controls require the detention of the 10-year post-development flow to be released at the 2-year "predevelopment" flow rate. To simulate these controls, a storage unit with release and overflow conduits were defined for each recent development and future development area sub-catchment. However, given the uncertainty of placement within the Infill development zones, LID controls within InfoSWMM were once again used. Within the software, LID controls are scalable to the catchment size, therefore a scaling factor equivalent to the City specified rate of infill were applied (refer to **Figure 7.1 through Figure 7.4** for rate of infill).

9.3 Performance Assessment Criteria

The drainage system is assessed using the same design criteria presented in the Part 1 baseline condition analysist. The criteria are reiterated below.

Since specific water depth/pipe Diameter (d/D) or peak flow rate/full pipe flow (q/Q) criteria are not provided in the City design criteria manual, simulation results for existing culverts, pipes and creeks were analyzed for their hydraulic performance as measured against criteria commonly used in the Industry.

From commonly accepted hydraulic criteria, model results were queried for peak flow and maximum water surface conditions and the report mapping shows locations where:

- [q/Q] is less than 1.05 and [d/D] > 1.0 for less than 15 minutes, the pipe is shown GREEN. Creeks under this hydraulic condition are shown BLUE.
- [q/Q] is less than 1.05 and [d/D] > 1.0 for and lasts longer than 15 minutes, the pipe is shown ORANGE.
- [q/Q] is more than 1.05 and [d/D] > 1.0 for and lasts longer than 15 minutes, the pipe is shown RED, the node is surcharging.

9.4 Global Assumptions

The following assumptions were applied to the future condition models:

- Soil and groundwater parameters defined in the Part 1 baseline assessment were reapplied in the future condition models.
- An impervious percentage of 5% was used to represent the "Woodlot/Forested" conditions, as permitted in the Design Criteria Manual (Section D5.1).
- Tier A, B, and C controls were configured to suit the baseline future condition scenarios and *not* adjusted for the climate change scenarios. The impacts of climate change were assessed by applying the City's current sizing requirements and precipitation.

9.5 Existing Condition Capacity Analysis

To reflect some minor changes to catchment delineation and to reaffirm the critical flow duration for each component of the management system, the existing condition was re-assessed to re-establish the benchmark to which the future condition will be compared.

System performance for each existing condition scenario are presented in **Figure 9.1 to Figure 9.5** below.

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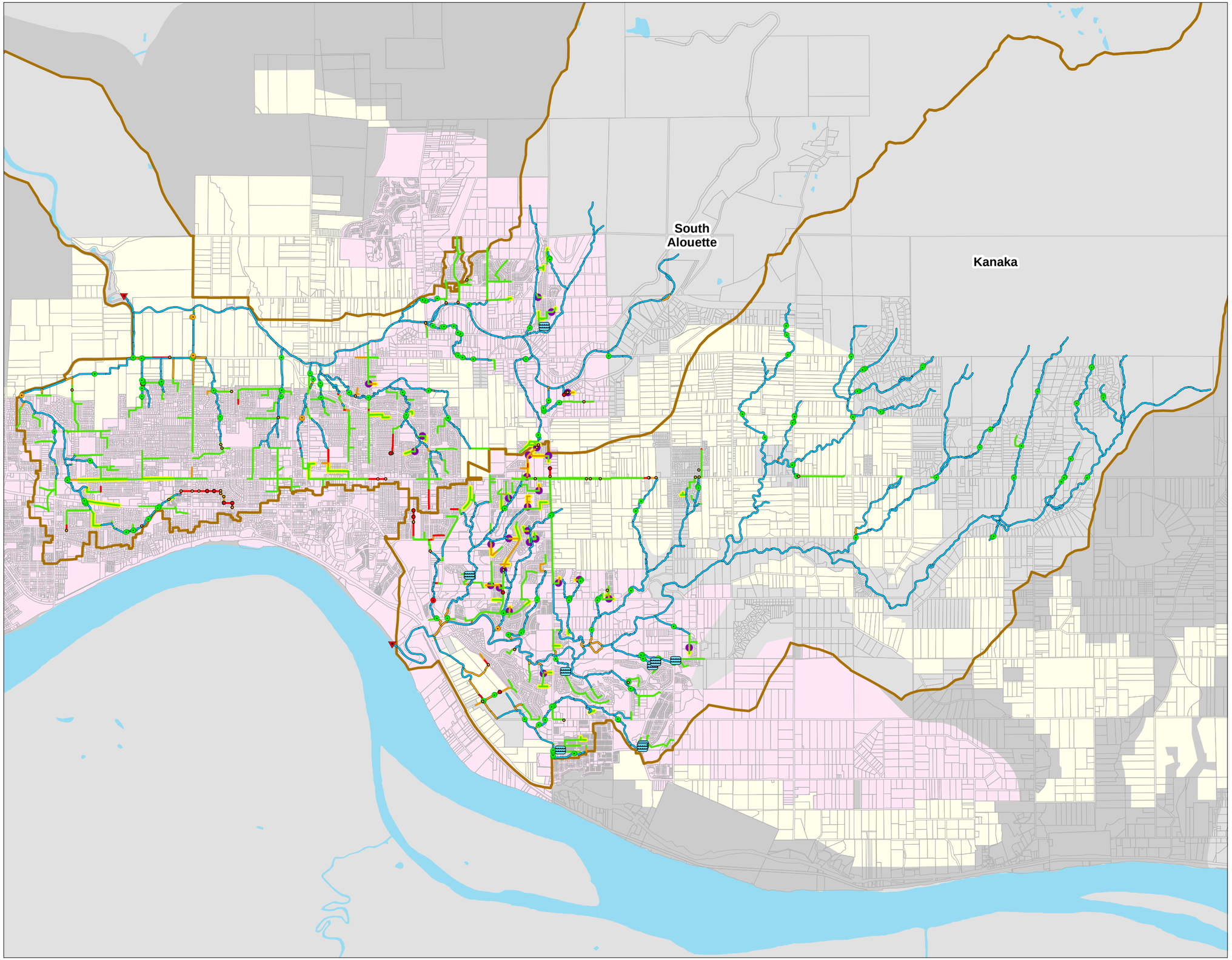

MAPLE RIDGE
British Columbia

South Alouette and Kanaka Integrated Stormwater Management Plans

Mean Annual Rainfall Capacity Analysis (Existing Land Use)

Legend

- Agricultural Land Reserve (11)
- Urban Containment Boundary
- Watershed Boundary
- Parcel
- Detention Pond
- Outfall
- Flow Control Manhole
- Storage

Culvert

Peak Flow / Pipe Full Capacity

- < 1.05 OR Surcharge < 15 min (128)
- < 1.05 AND Surcharge > 15 min (6)
- >= 1.05 AND Surcharge > 15 min (2)

Creek

Peak Flow / Creek Full Capacity

- < 1.05 OR Surcharge < 15 min (1,053)
- < 1.05 AND Surcharge > 15 min (45)
- >= 1.05 AND Surcharge > 15 min (Potential Breach of Creek) (1)

Storm Main

Peak Flow / Pipe Full Capacity

- <1.05 OR Surcharge < 15 min (1,086)
- < 1.05 AND Surcharge > 15 min (135)
- >= 1.05 AND Surcharge > 15 min (55)

Junction

Maximum Water Surface Elevation @ Modeled Junctions

- > Ground (13)
- <= Ground and > Ground - 0.6 m (58)

1,000 500 0 1,000
m

N

Coordinate System:
NAD 1983 UTM Zone 10N

Data Sources:
GeoAdvice
City of Maple Ridge
City of Pitt Meadows
BC MoE
NR Canada

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URBAN systems

FIGURE 9.1

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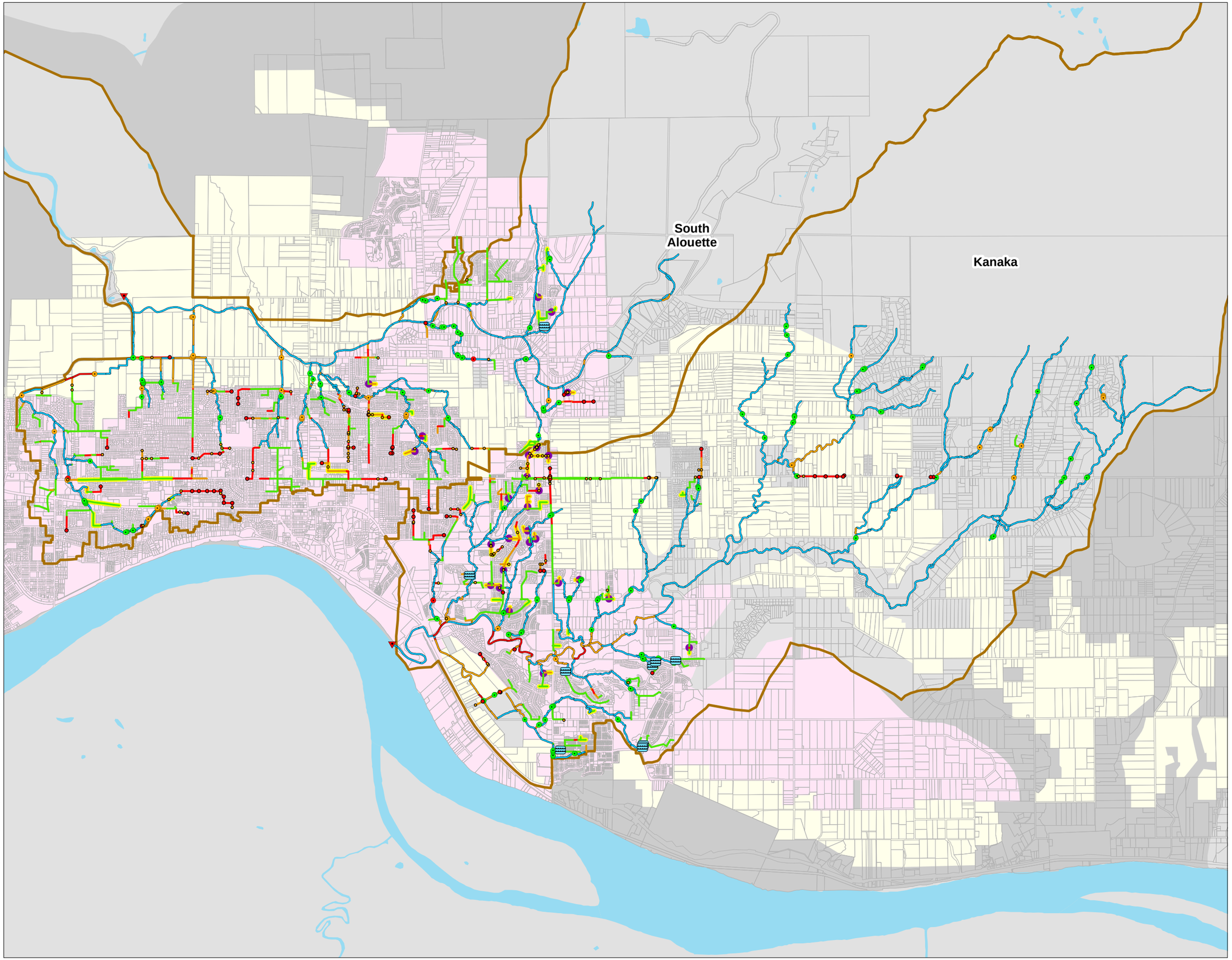

MAPLE RIDGE
British Columbia

South Alouette and Kanaka Integrated Stormwater Management Plans

10-Year, Critical Duration Capacity Analysis (Existing Land Use)

Legend

- Agricultural Land Reserve (11)
- Urban Containment Boundary
- Watershed Boundary
- Parcel
- Detention Pond

Junction

Maximum Water Surface Elevation @ Modeled Junctions

- > Ground
- <= Ground and > Ground - 0.6 m
- Outfall

Culvert

Peak Flow / Pipe Full Capacity

- < 1.05 OR Surcharge < 15 min
- < 1.05 AND Surcharge > 15
- >= 1.05 AND Surcharge > 15

Creek

Peak Flow / Creek Full Capacity

- < 1.05 OR Surcharge < 15 min
- < 1.05 AND Surcharge > 15
- >= 1.05 AND Surcharge > 15 min (Potential Breach of Creek)

Storm Main

Peak Flow / Pipe Full Capacity

- <1.05 OR Surcharge < 15 min
- < 1.05 AND Surcharge > 15
- >= 1.05 AND Surcharge > 15
- Flow Control Manhole
- Storage

Results presented represent the worst case hydraulic condition for each reach and control from all storm durations simulated
(30-min, 1-hr, 2-hr, 6-hr, 12-hr, and 24-hr)

1,000 500 0 1,000
m

N

Coordinate System:
NAD 1983 UTM Zone 10N

Data Sources:
GeoAdvice
City of Maple Ridge
City of Pitt Meadows
BC MoE
NR Canada

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URBAN systems

FIGURE 9.2

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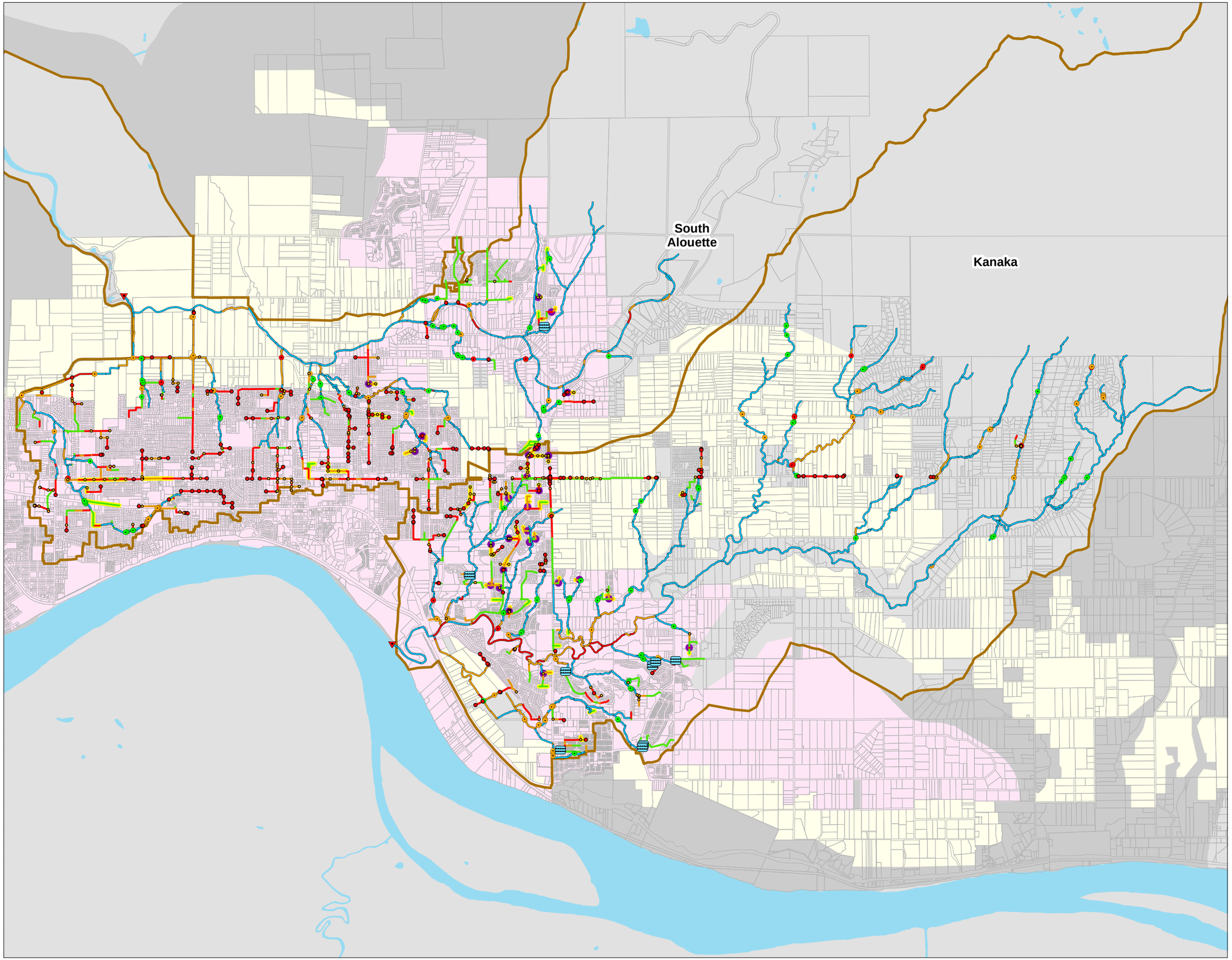

MAPLE RIDGE
British Columbia

South Alouette and Kanaka Integrated Stormwater Management Plans

100-Year, Critical Duration Capacity Analysis (Existing Land Use)

Legend

- Agricultural Land Reserve (11)
- Urban Containment Boundary
- Watershed Boundary
- Parcel
- Detention Pond

Junction

Maximum Water Surface Elevation @ Modeled Junctions

- > Ground
- <= Ground and > Ground - 0.6 m
- Outfall

Culvert

Peak Flow / Pipe Full Capacity

- < 1.05 OR Surcharge < 15 min
- < 1.05 AND Surcharge > 15
- >= 1.05 AND Surcharge > 15

Creek

Peak Flow / Creek Full Capacity

- < 1.05 OR Surcharge < 15 min
- < 1.05 AND Surcharge > 15
- >= 1.05 AND Surcharge > 15 min (Potential Breach of Creek)

Storm Main

Peak Flow / Pipe Full Capacity

- <1.05 OR Surcharge < 15 min
- < 1.05 AND Surcharge > 15
- >= 1.05 AND Surcharge > 15
- Flow Control Manhole
- Storage

Results presented represent the worst case hydraulic condition for each reach and control from all storm durations simulated (30-min, 1-hr, 2-hr, 6-hr, 12-hr, and 24-hr)

1,000 500 0 1,000
m

N

Coordinate System:
NAD 1983 UTM Zone 10N

Data Sources:
GeoAdvice
City of Maple Ridge
City of Pitt Meadows
BC MoE
NR Canada

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URBAN systems

FIGURE 9.3

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South Alouette

Kanaka

Albion Flats agricultural area has been studied separately by the City

MAPLE RIDGE
British Columbia

South Alouette and Kanaka Integrated Stormwater Management Plans

ARDSA 10-Year, 2-Day Capacity Analysis (Existing Land Use)

Legend

- Agricultural Land Reserve (11)
- Albion Flats Area Plan Boundary
- Urban Containment Boundary
- Watershed Boundary
- Parcel
- Detention Pond

Junction

Maximum Water Surface Elevation @ Modeled Junctions

- > Ground (0)
- <= Ground and > Ground - 0.6 m (7)
- Outfall

Culvert

Peak Flow / Pipe Full Capacity

- < 1.05 OR Surcharge < 15 min
- < 1.05 AND Surcharge > 15
- >= 1.05 AND Surcharge > 15

Creek

Peak Flow / Creek Full Capacity

- < 1.05 OR Surcharge < 15 min
- < 1.05 AND Surcharge > 15
- >= 1.05 AND Surcharge > 15 min (Potential Breach of Creek)

Storm Main

Peak Flow / Pipe Full Capacity

- <1.05 OR Surcharge < 15 min
- < 1.05 AND Surcharge > 15
- >= 1.05 AND Surcharge > 15

1,000 500 0 1,000
m

N

Coordinate System:
NAD 1983 UTM Zone 10N

Data Sources:
GeoAdvice
City of Maple Ridge
City of Pitt Meadows
BC MoE
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FIGURE 9.4

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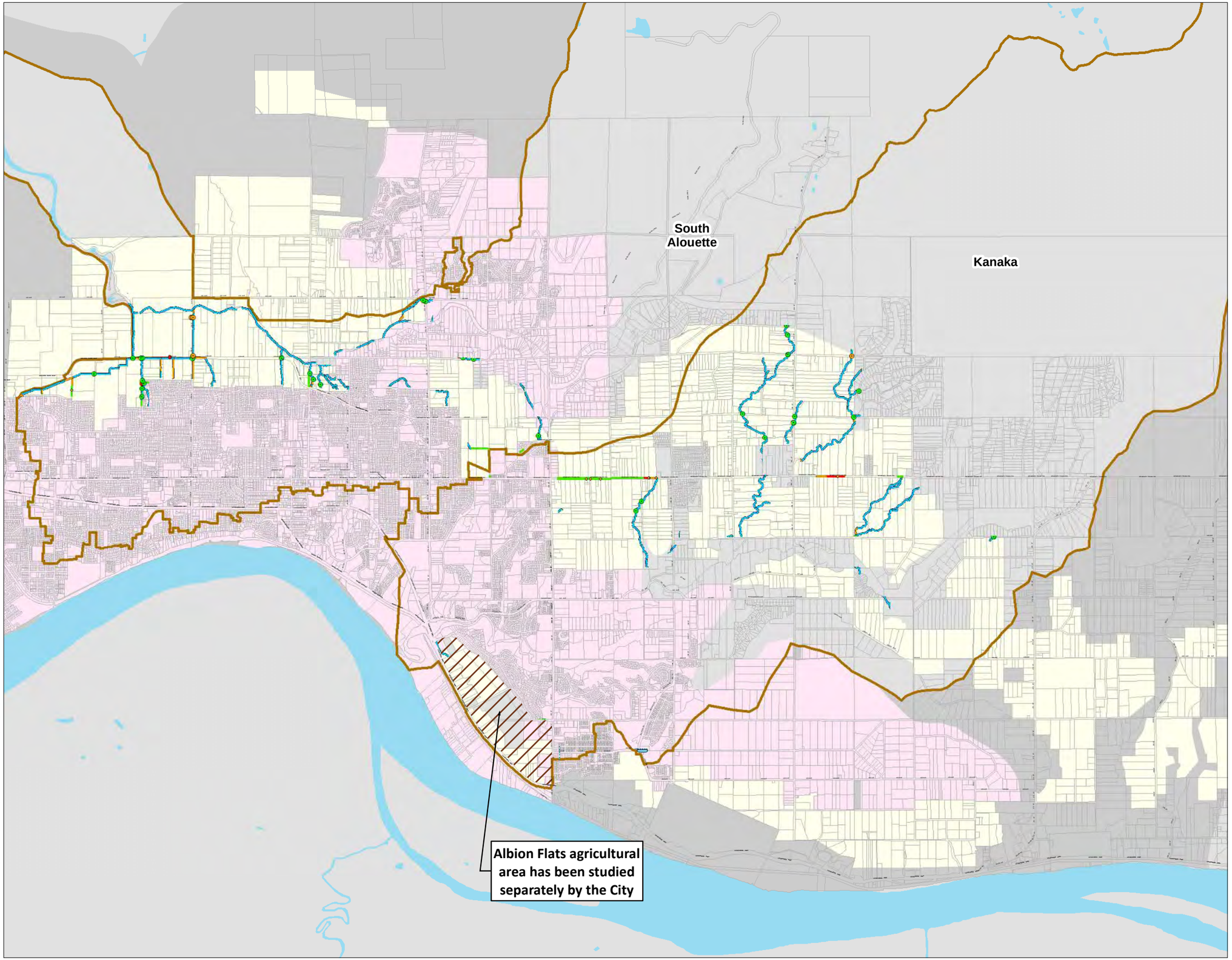

MAPLE RIDGE
British Columbia

South Alouette and Kanaka Integrated Stormwater Management Plans

ARDSA 10-Year, 5-Day Capacity Analysis (Existing Land Use)

Legend

- Agricultural Land Reserve (11)
- Albion Flats Area Plan Boundary (1)
- Urban Containment Boundary
- Watershed Boundary
- Parcel
- Detention Pond

Junction

Maximum Water Surface Elevation @ Modeled Junctions

- > Ground (1)
- <= Ground and > Ground - 0.6 m (12)
- Outfall

Culvert

Peak Flow / Pipe Full Capacity

- < 1.05 OR Surcharge < 15 min
- < 1.05 AND Surcharge > 15
- >= 1.05 AND Surcharge > 15

Creek

Peak Flow / Creek Full Capacity

- < 1.05 OR Surcharge < 15 min
- < 1.05 AND Surcharge > 15
- >= 1.05 AND Surcharge > 15 min (Potential Breach of Creek)

Storm Main

Peak Flow / Pipe Full Capacity

- <1.05 OR Surcharge < 15 min
- < 1.05 AND Surcharge > 15
- >= 1.05 AND Surcharge > 15
- Flow Control Manhole
- Storage

1,000 500 0 1,000
m

N

Coordinate System:
NAD 1983 UTM Zone 10N

Data Sources:
GeoAdvice
City of Maple Ridge
City of Pitt Meadows
BC MoE
NR Canada

GeoADVICE

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Date:	2020 / 2 / 7

URBAN systems

FIGURE 9.5

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9.6 Future Condition Capacity Analysis

What is most helpful to understand about the future condition is how system performance is predicted to change over current condition. Presenting the absolute performance in the future condition is difficult to compare against current, therefore the relative change in performance is presented for ease of interpretation.

Further to aid in the results interpretation, "computational noise" has been dampened by only presenting relative changes in flow of 5% or greater. Changes below 5% are considered insignificant and below the margin of error that are inherent to the modeling process.

Results representing future conditions, measured against existing condition, are presented in **Figure 9.6 through Figure 9.10.**

Results indicated that overall changes are minimal, which signals that for the storm events considered, the City's current stormwater management criteria abate the negative effects of development.

The instances where performance worsens more than 5% is likely caused by a change in peak flow timing between various contributing sub-catchments. As expected, the majority of worsening occurs during the 1:100 year event because the City's baseline criteria does not universally require the 1:100 year flow to be conveyed in a storm main (the 100 year event is typically designed to flow over street surfaces to a receiving waterbody).

9.7 Future Condition with Climate Change

As described above, existing design storms were scaled up by 10% and again by 20% to simulate two different possible impacts due to climate change. The MAR, 10-Year, and 100-Year design storms were reassessed.

Results representing the climate change scenarios are presented in **Figure 9.11 through Figure 9.16.**

Overall future condition system performance worsened under the influence of both climate change assumptions, as compared to the future baseline condition. Once land and drainage systems are saturated, there is a relatively direct relationship between precipitation and runoff. Therefore, not surprisingly, as the precipitation is scaled up, system performance gets incrementally worse.

It is emphasized that this analysis reports the predicted hydraulic performance of each conveyance object within the assessment system, including channels and ditches within the floodplain. Channels and ditches highlighted red demonstrate breach of their main channels, however within the floodplain this does not necessarily constitute failure. The floodplain warrants special consideration. Refer to section 9.9 below for further information about floodplain analysis.

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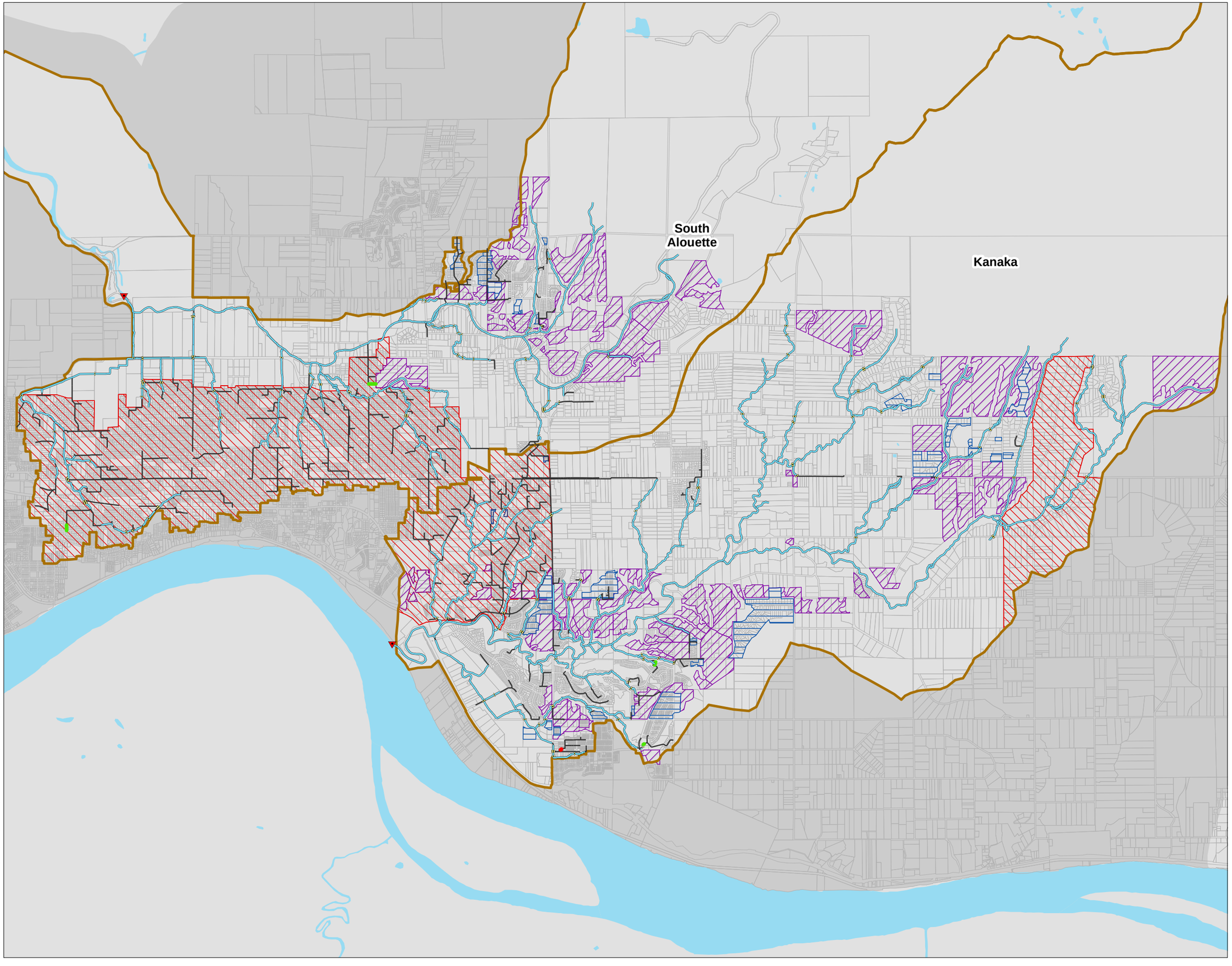

MAPLE RIDGE
British Columbia

South Alouette and Kanaka Integrated Stormwater Management Plans

Mean Annual Rainfall Available Capacity Change (Future Land Use vs Existing Land Use)

Legend

- Recent Development (2011 - 2016) (29)
- Future Development Densification (117)
- Future Infill Development (3)
- Watershed Boundary
- Outfall
- Parcel

Culvert Available Capacity

- Available Capacity Improves (0)
- Available Capacity Worsens (0)
- Culvert

Creek Available Capacity Change

- Available Capacity Improves (0)
- Available Capacity Worsens (0)
- Creek

Storm Main Available Capacity

- Available Capacity Improves (5)
- Available Capacity Worsens (1)
- Storm Main

Tiers A & B controls applied to recent, future and infill development.
Comparative changes of less than 5% are not shown as they are considered insignificant and below the margin of error.

1,000 500 0 1,000
m

N

Coordinate System:
NAD 1983 UTM Zone 10N

Data Sources:
GeoAdvice
City of Maple Ridge
City of Pitt Meadows
BC MoE
NR Canada

GeoAdvice

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URBAN systems

FIGURE 9.6

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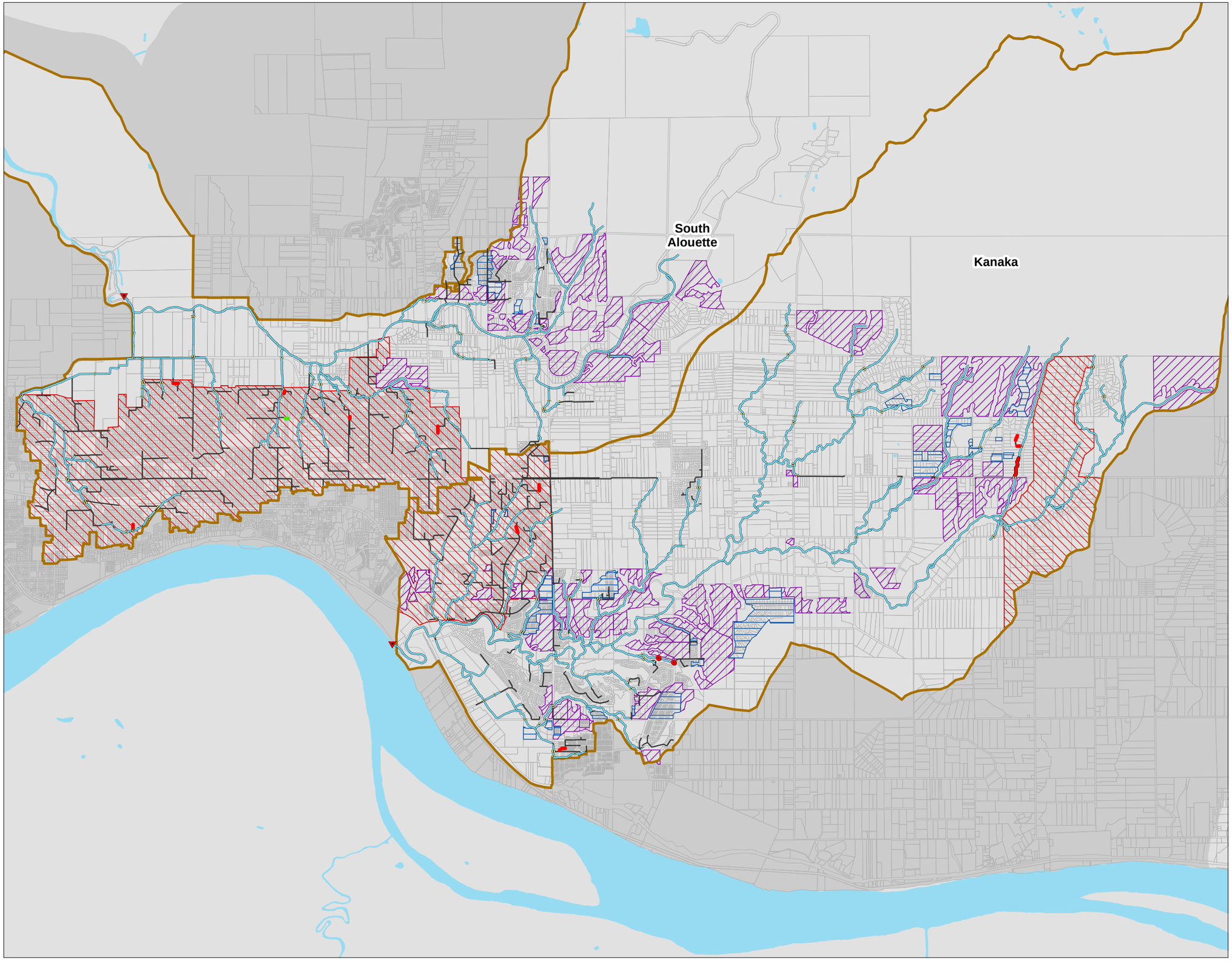

MAPLE RIDGE
British Columbia

South Alouette and Kanaka Integrated Stormwater Management Plans

10-Year, Critical Duration Available Capacity Change (Future Land Use vs Existing Land Use)

Legend

- Recent Development (2011 - 2016) (29)
- Future Development Densification (117)
- Future Infill Development (3)
- Watershed Boundary
- Parcel
- Outfall

Culvert Available Capacity Change

- Available Capacity Improves (0)
- Available Capacity Worsens (2)
- Culvert

Creek Available Capacity Change

- Available Capacity Improves (0)
- Available Capacity Worsens (1)
- Creek

Storm Main Available Capacity

- Available Capacity Improves (1)
- Available Capacity Worsens (11)
- Storm Main

Results presented represent the worst case hydraulic condition for each reach and control from all storm durations simulated
(30-min, 1-hr, 2-hr, 6-hr, 12-hr, and 24-hr)
Tier A, B & C controls applied to recent and future development.
Tier A & C controls applied to infill development.
Comparative changes of less than 5% are not shown as they are considered insignificant and below the margin of error.

1,000 500 0 1,000
m

N

Coordinate System:
NAD 1983 UTM Zone 10N

Data Sources:
GeoAdvice
City of Maple Ridge
City of Pitt Meadows
BC MoE
NR Canada

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Status:	FINAL
Revision:	N
Date:	2020 / 2 / 5

URBAN systems

FIGURE 9.7

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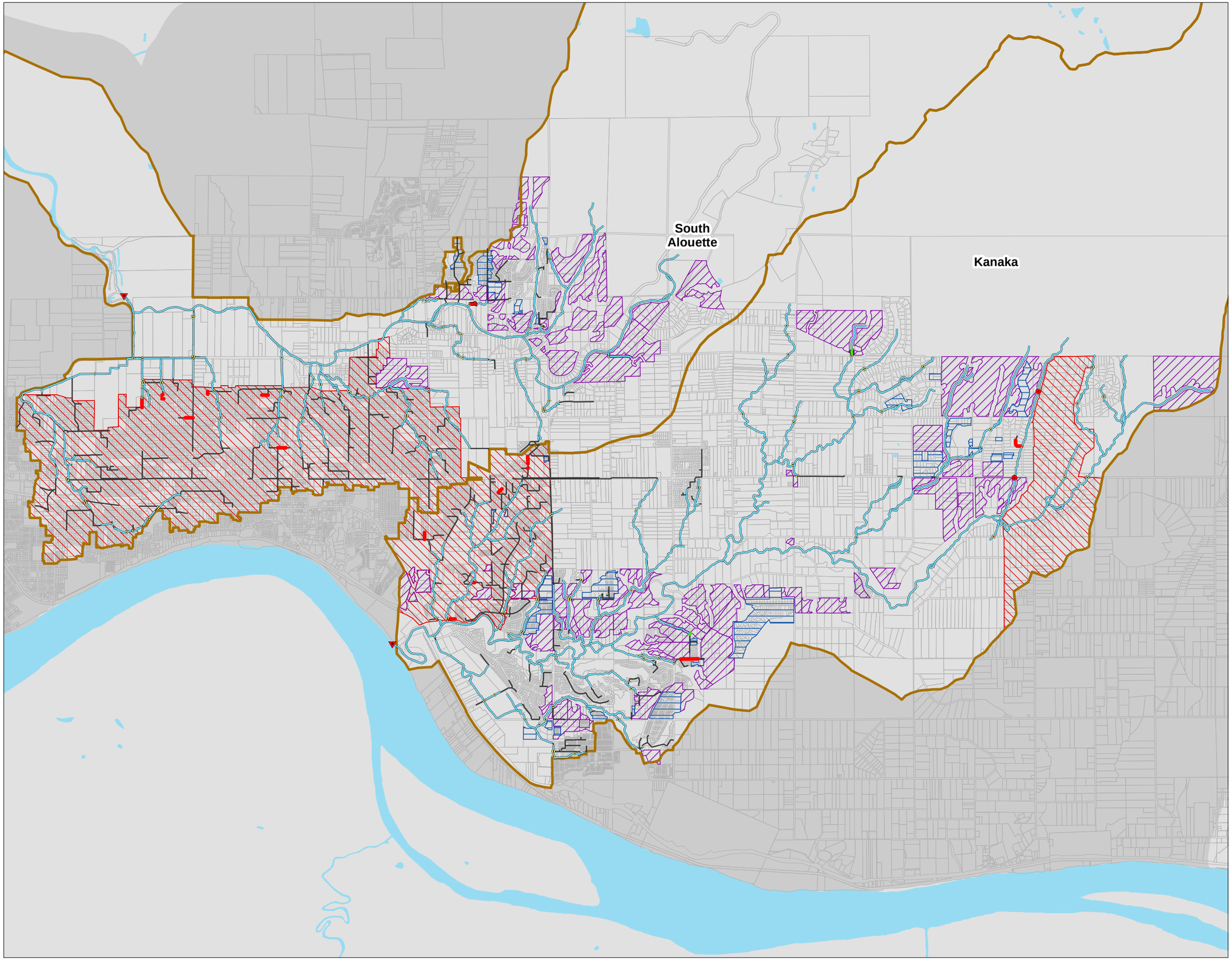

MAPLE RIDGE
British Columbia

South Alouette and Kanaka Integrated Stormwater Management Plans

100-Year, Critical Duration Available Capacity Change (Future Land Use vs Existing Land Use)

Legend

- Recent Development (2011 - 2016) (29)
- Future Development Densification (117)
- Future Infill Development (3)
- Watershed Boundary
- Parcel
- Outfall

Culvert Available Capacity Change

- Available Capacity Improves (0)
- Available Capacity Worsens (2)
- Culvert

Creek Available Capacity Change

- Available Capacity Improves (1)
- Available Capacity Worsens (1)
- Creek

Storm Main Available Capacity

- Available Capacity Improves (1)
- Available Capacity Worsens (23)
- Storm Main

Results presented represent the worst case hydraulic condition for each reach and control from all storm durations simulated
(30-min, 1-hr, 2-hr, 6-hr, 12-hr, and 24-hr)
Tier A, B & C controls applied to recent and future development.
Tier A & C controls applied to infill development.
Comparative changes of less than 5% are not shown as they are considered insignificant and below the margin of error.

1,000 500 0 1,000
m

N

Coordinate System:
NAD 1983 UTM Zone 10N

Data Sources:
GeoAdvice
City of Maple Ridge
City of Pitt Meadows
BC MoE
NR Canada

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Status:	FINAL
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URBAN systems

FIGURE 9.8

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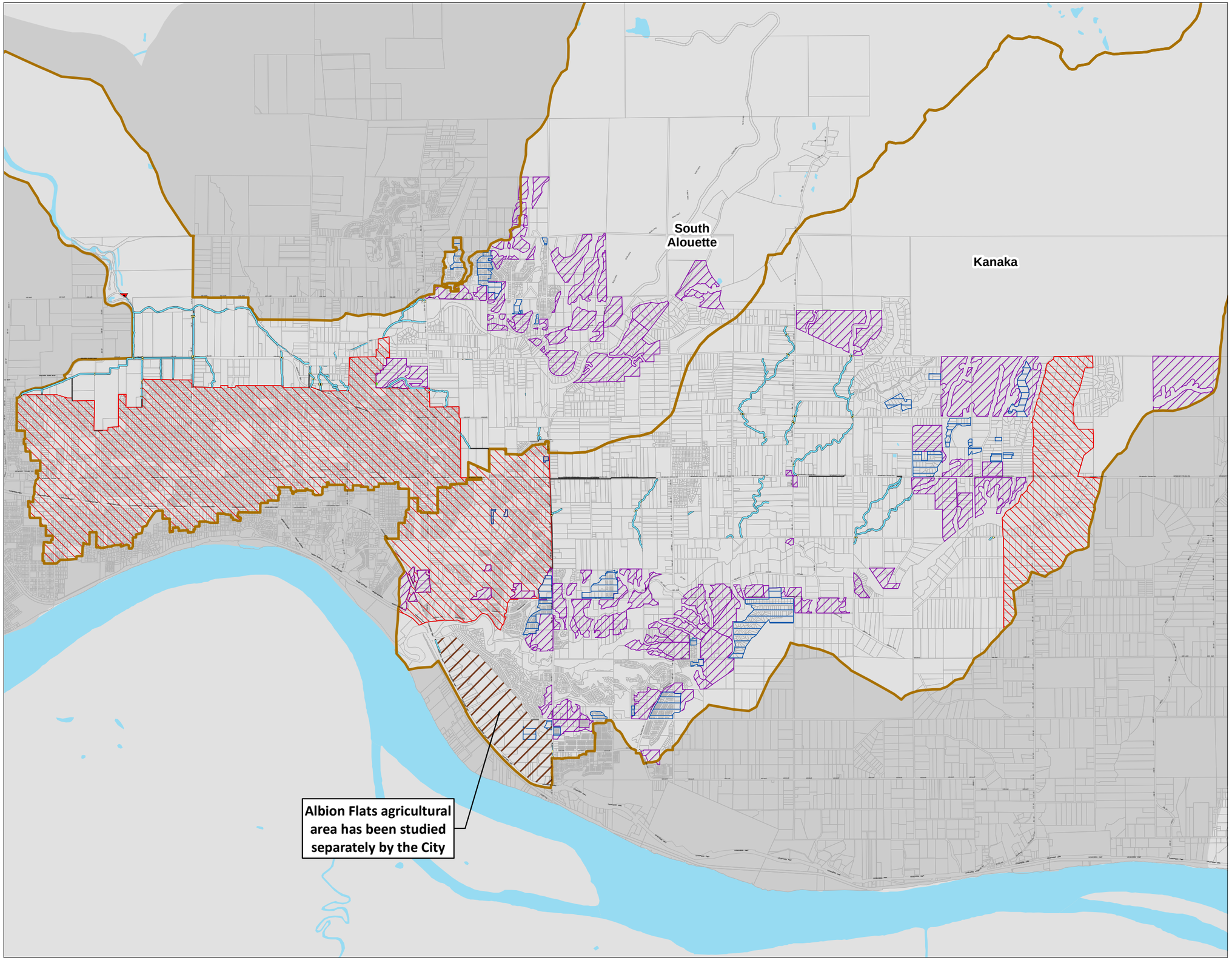

MAPLE RIDGE
British Columbia

South Alouette and Kanaka Integrated Stormwater Management Plans

ARDSA 10-Year, 2-Day Available Capacity Change (Future Land Use vs Existing Land Use)

Legend

- Recent Development (2011 - 2016)
- Future Development Densification
- Future Infill Development
- Albion Flats Area Plan Boundary
- Watershed Boundary
- Parcel
- Outfall

Culvert Available Capacity Change

- Available Capacity Improves
- Available Capacity Worsens
- Culvert

Creek Available Capacity Change

- Available Capacity Improves
- Available Capacity Worsens
- Creek

Storm Main Available Capacity Change

- Available Capacity Improves
- Available Capacity Worsens
- Storm Main

Tier A, B & C controls applied to recent and future development.
Tier A & C controls applied to infill development.
Comparative changes of less than 5% are not shown as they are considered insignificant and below the margin of error.

1,000 500 0 1,000
m

N

Coordinate System:
NAD 1983 UTM Zone 10N

Data Sources:
GeoAdvice
City of Maple Ridge
City of Pitt Meadows
BC MoE
NR Canada

GeoADVICE

Project #:	1279.0025.01
Author:	LP
Checked:	GS
Status:	FINAL
Revision:	N
Date:	2020 / 2 / 7

URBAN systems

FIGURE 9.9

U:\Projects_VAN\1279\0025\01D-Drafting-Design-Analysis\GIS\Projects\MXD\Current\Stage 4 Report Figures_20200130\Figure 9-9 - Maple Ridge ISMP GA Template_RevC.mxd Last updated by lpunt on February 7, 2020 at 11:52:28 AM

South Alouette

Kanaka

Albion Flats agricultural area has been studied separately by the City

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South Alouette and Kanaka Integrated Stormwater Management Plans

ARDSA 10-Year, 5-Day Available Capacity Change (Future Land Use vs Existing Land Use)

Legend

- Recent Development (2011 - 2016)
- Future Development Densification
- Future Infill Development
- Albion Flats Area Plan
- Watershed Boundary
- Parcel
- Outfall

Culvert Available Capacity Change

- Available Capacity Improves
- Available Capacity Worsens
- Culvert

Creek Available Capacity Change

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1,000 500 0 1,000
m

N

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URBAN systems

FIGURE 9.10

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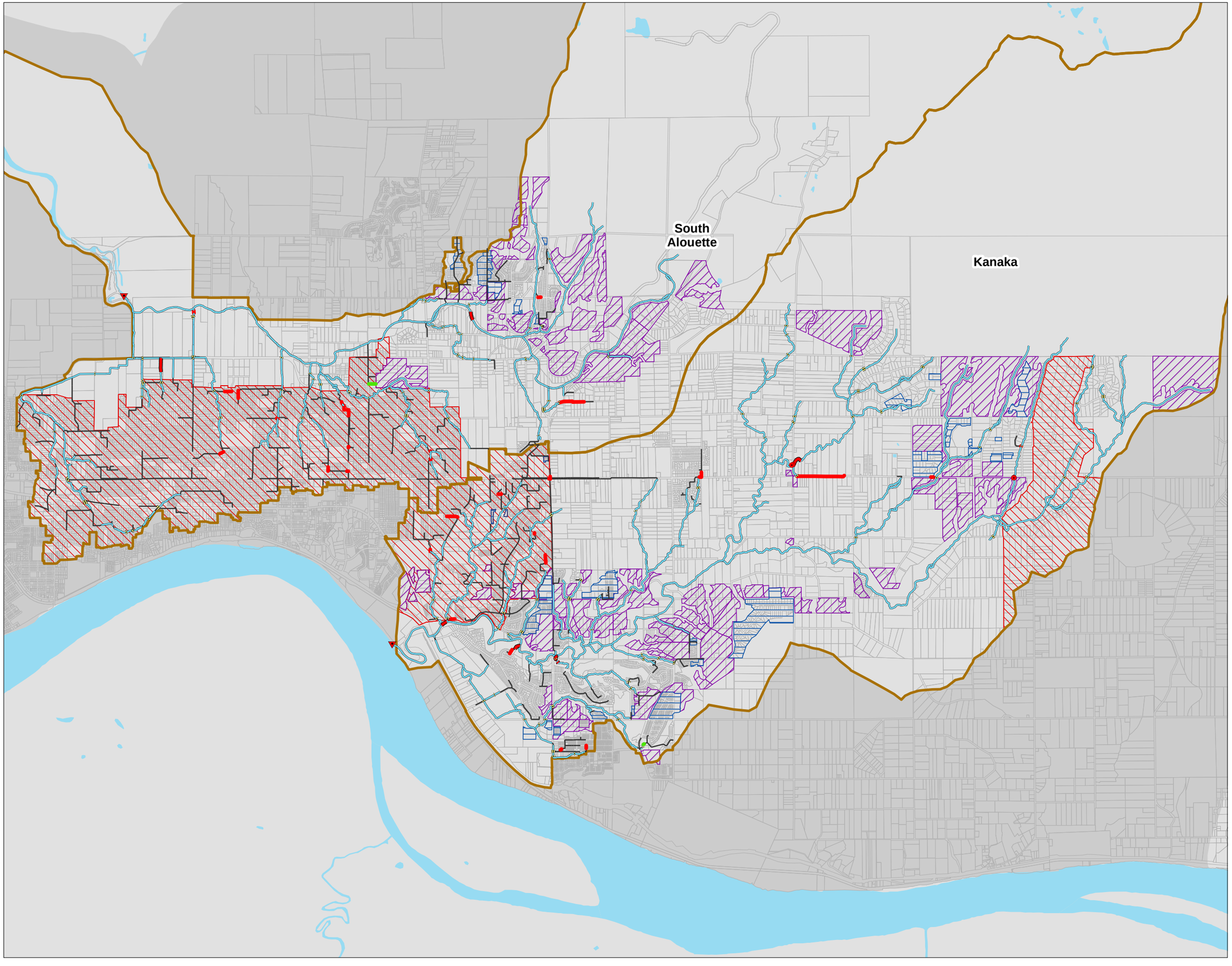

MAPLE RIDGE
British Columbia

South Alouette and Kanaka Integrated Stormwater Management Plans

Mean Annual Rainfall
With 10% Climate Change
Available Capacity Change
(Future Land Use vs
Existing Land Use)

Legend

- Recent Development (2011 - 2016) (29)
- Future Development Densification (117)
- Future Infill Development (3)
- Watershed Boundary
- Parcel
- Outfall

Culvert Available Capacity

- Available Capacity Improves
- Available Capacity Worsens
- Culvert

Creek Available Capacity

- Available Capacity Improves
- Available Capacity Worsens
- Creek

Storm Main Available Capacity

- Available Capacity Improves
- Available Capacity Worsens
- Storm Main

Tier A & B controls applied to recent, future and infill development.
Comparative changes of less than 5% are not shown as they are considered insignificant and below the margin of error.

1,000 500 0 1,000
m

N

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GeoAdvice
City of Maple Ridge
City of Pitt Meadows
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URBAN systems

FIGURE 9.11

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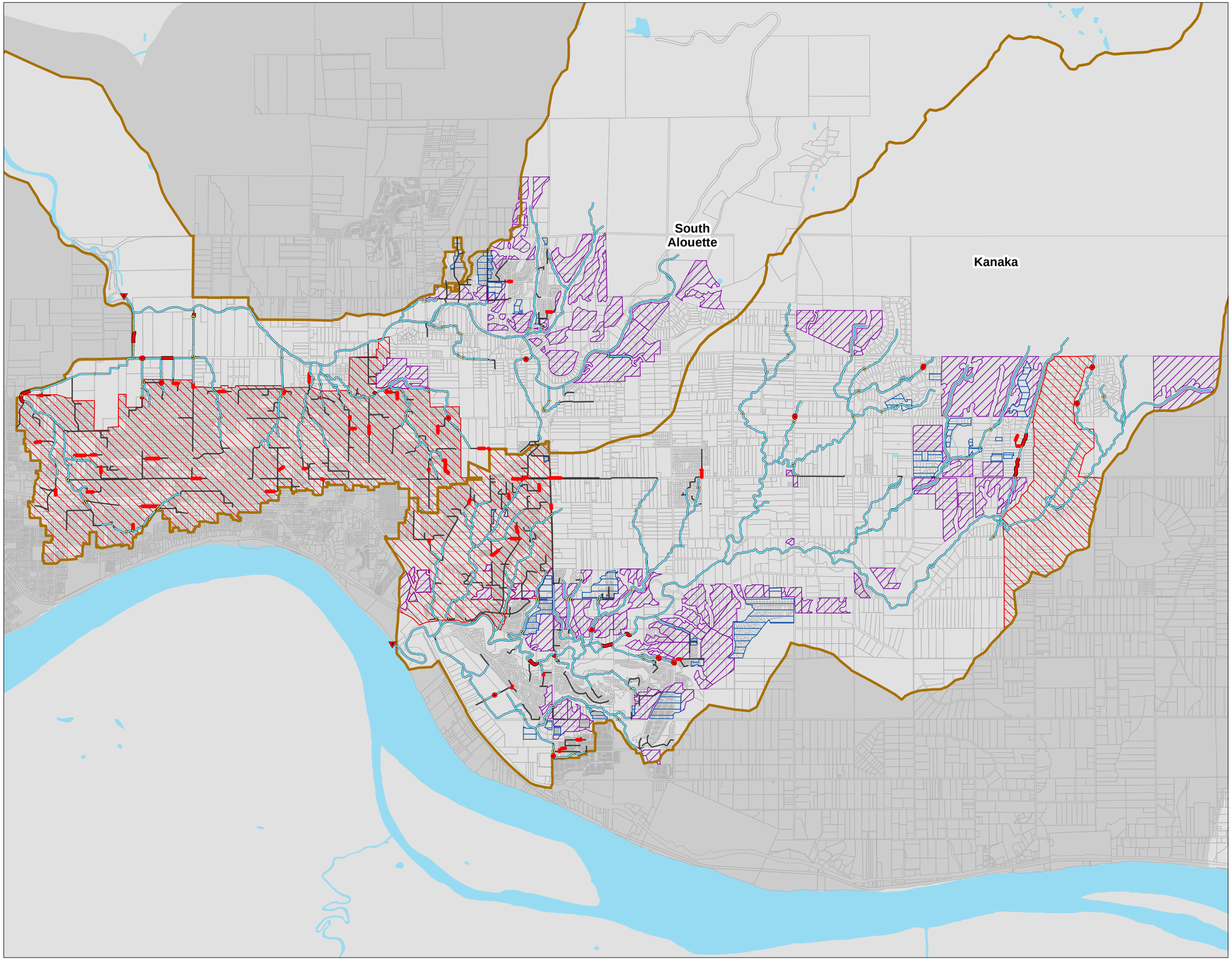

MAPLE RIDGE
British Columbia

South Alouette and Kanaka Integrated Stormwater Management Plans

**10-Year, Critical Duration
With 10% Climate Change
Available Capacity Change
(Future Land Use vs
Existing Land Use)**

Legend

- Recent Development (2011 - 2016) (29)
- Future Development Densification (117)
- Future Infill Development (3)
- Watershed Boundary
- Parcel
- Outfall

Culvert Available Capacity Change

- Available Capacity Improves
- Available Capacity Worsens
- Culvert

Creek Available Capacity Change

- Available Capacity Improves
- Available Capacity Worsens
- Creek

Storm Main Available Capacity

- Available Capacity Improves
- Available Capacity Worsens
- Storm Main

Results presented represent the worst case hydraulic condition for each reach and control from all storm durations simulated
(30-min, 1-hr, 2-hr, 6-hr, 12-hr, and 24-hr)
Tier A, B & C controls applied to recent and future development.
Tier A & C controls applied to infill development.
Comparative changes of less than 5% are not shown as they are considered insignificant and below the margin of error.

1,000 500 0 1,000
m

N

Coordinate System:
NAD 1983 UTM Zone 10N

Data Sources:
GeoAdvice
City of Maple Ridge
City of Pitt Meadows
BC MoE
NR Canada

GeoAdvice

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Date:	2020 / 2 / 5

URBAN systems

FIGURE 9.12

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South Alouette

Kanaka

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British Columbia

South Alouette and Kanaka Integrated Stormwater Management Plans

100-Year, Critical Duration With 10% Climate Change Available Capacity Change (Future Land Use vs Existing Land Use)

Legend

- Recent Development (2011 - 2016) (29)
- Future Development Densification (117)
- Future Infill Development (3)
- Watershed Boundary
- Parcel
- Outfall

Culvert Available Capacity

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- Available Capacity Worsens
- Culvert

Creek Available Capacity

- Available Capacity Improves
- Available Capacity Worsens
- Creek

Storm Main Available Capacity

- Available Capacity Improves
- Available Capacity Worsens
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1,000 500 0 1,000
m

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NR Canada

GeoADVICE

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FIGURE 9.13

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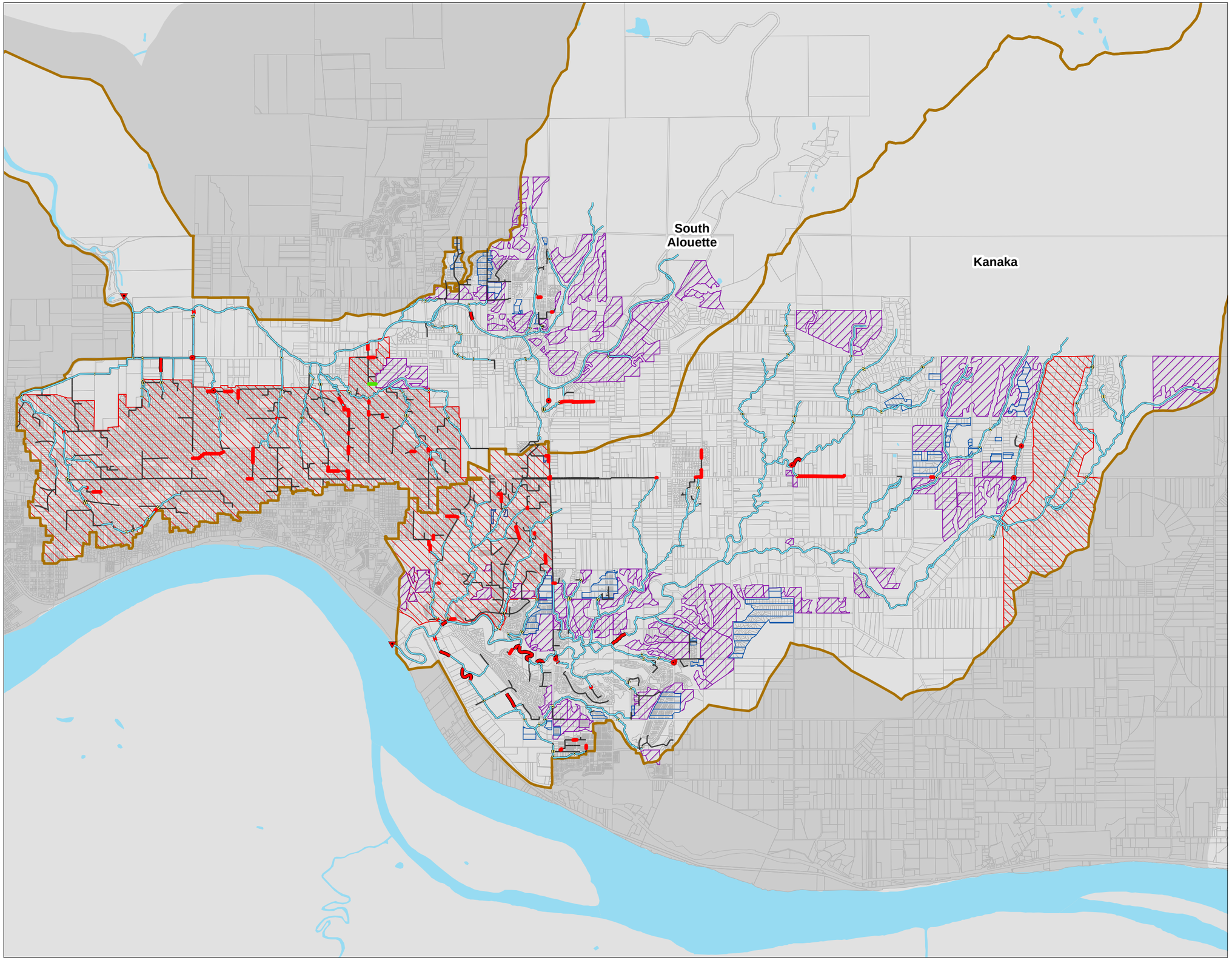

MAPLE RIDGE
British Columbia

South Alouette and Kanaka Integrated Stormwater Management Plans

**Mean Annual Rainfall
With 20% Climate Change
Available Capacity Change
(Future Land Use vs
Existing Land Use)**

Legend

- Recent Development (2011 - 2016) (29)
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- Future Infill Development (3)
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- Parcel
- Outfall

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1,000 500 0 1,000
m

N

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City of Pitt Meadows
BC MoE
NR Canada

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FIGURE 9.14

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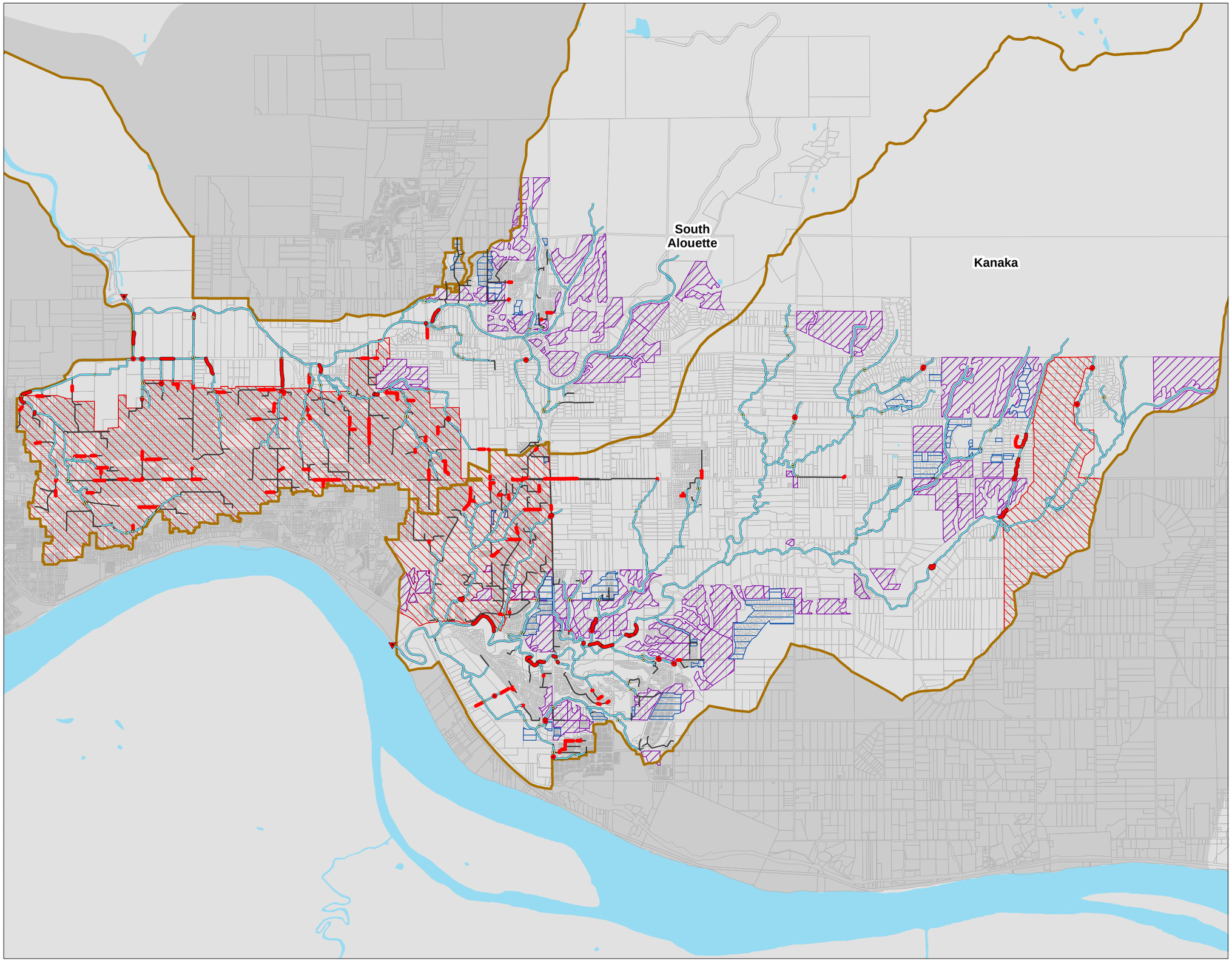

MAPLE RIDGE
British Columbia

South Alouette and Kanaka Integrated Stormwater Management Plans

**10-Year, Critical Duration
With 20% Climate Change
Available Capacity Change
(Future Land Use vs
Existing Land Use)**

Legend

- Recent Development (2011 - 2016) (29)
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(30-min, 1-hr, 2-hr, 6-hr, 12-hr, and 24-hr)
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1,000 500 0 1,000
m

N

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URBAN systems

FIGURE 9.15

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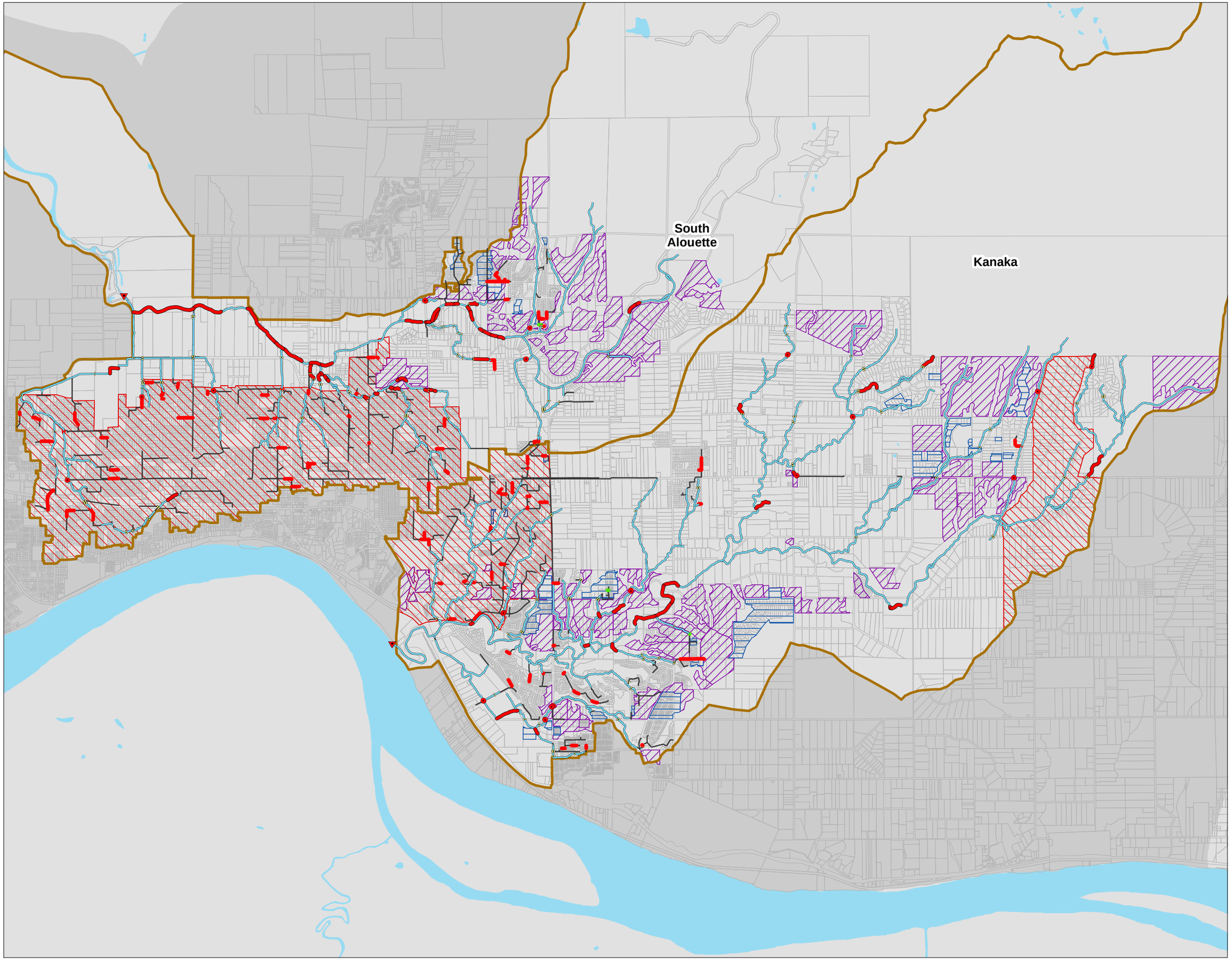

MAPLE RIDGE
British Columbia

South Alouette and Kanaka Integrated Stormwater Management Plans

**100-Year, Critical Duration
With 20% Climate Change
Available Capacity Change
(Future Land Use vs
Existing Land Use)**

Legend

- Recent Development (2011 - 2016) (29)
- Future Development Densification (117)
- Future Infill Development (3)
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- Storm Main

Results presented represent the worst case hydraulic condition for each reach and control from all storm durations simulated
(30-min, 1-hr, 2-hr, 6-hr, 12-hr, and 24-hr)
Tier A, B & C controls applied to recent and future development.
Tier A & C controls applied to infill development.
Comparative changes of less than 5% are not shown as they are considered insignificant and below the margin of error.

1,000 500 0 1,000
m

N

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GeoAdvice

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URBAN systems

FIGURE 9.16

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9.8 Performance of Detention Facilities

The analytical model includes 37 existing communal stormwater detention facilities of various types; open ponds, detention tanks, oversized pipes. They are represented in the model with best available information provided by the City through its GIS inventory or record drawings. It is expected that their performance may also change as a result of climate change. Table 9.4 below presents a summary of predicted peak release rates under a 1:10 year storm event under existing conditions and with the application of a 20% increase in precipitation to account for climate change impacts. The specific criteria originally applied to the design of each facility was not researched, however the table shows that the predicted unit release rate (URR) varies significantly between facilities.

As a point of comparison, sample forested catchments 5 hectares in size and with a slope of 5% were analysed for each of the primary soil groups within the study area since infiltration capacity will have an influence on runoff rates. Theoretical unit release rates from the forested parcels were computed under a 1:2 year design storm since the Tier C criteria seeks for a 1:10 year post to 1:2 pre reduction. A summary of the predicted forested condition URR's are provided in **Table 9.5**.

There are two particular ponds highlighted in yellow which are significant outliers from the rest; and both are for very small catchment areas. Their control structures could be reviewed in further detail to determine if modification is possible to improve their performance.

The information presented in **Table 9.4** is to provide insights into the projected performance of each existing communal detention facility. However, each facility will have been design to a unique set of parameters. While it appears that nearly all of them are releasing water at a rate exceeding a 1:2 year forested condition, it is not possible to state herein whether these facilities are deficient or not. It is not recommended that these facilities be re-explored in detail unless there are observed problems with them, or within the catchments they serve. Rather, this information can serve as a further example of the need for the City to explore actual in-field practices relative to stated criteria.

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Table 9.4 - Summary of Detention Pond Performance

			Existing Scenario				Future CC-20% Scenario			
Node ID	Control Structure Notes	Location (Latitude, Longitude)	Tributary Area (ha)	Peak Release Rate (m3/s)	Corresponding Storm Event	Unit Release Rate (m3/s/ha)	Tributary Area (ha)	Peak Release Rate (m3/s)	Corresponding Storm Event	Unit Release Rate (m3/s/ha)
CT086	Bottom and overflow orifice	Along River between 236 St and 234A St (49.207,-122.571)	3.6	0.054	10-yr 24-hr	0.0150	3.6	0.059	10-yr 24-hr	0.0164
JCT-1082	Bottom and overflow orifice	11187 Creekside Street	0.7	0.082	10-yr 30-min	0.1114	0.7	0.095	10-yr 30-min	0.1293
JCT-1162	Bottom and overflow orifice	12186 232 Street	1.5	0.106	10-yr 24-hr	0.0692	1.5	0.138	10-yr 24-hr	0.0901
JCT-124	Bottom and overflow orifice	23979 118 Avenue	5.6	0.282	10-yr 24-hr	0.0501	5.6	0.290	10-yr 30-min	0.0516
JCT-126	Bottom and overflow orifice	12040 240 Street	2.7	0.162	10-yr 24-hr	0.0590	2.3	0.176	10-yr 24-hr	0.0753
JCT-1592	Bottom and overflow orifice	12061 Blossom Street	6.4	0.397	10-yr 24-hr	0.0622	6.4	0.492	10-yr 24-hr	0.0771
JCT-1680	Bottom and overflow orifice	24160 152 Avenue	4.6	0.133	10-yr 24-hr	0.0288	4.3	0.143	10-yr 24-hr	0.0331
JCT-170	Bottom and overflow orifice	22845 125 A Ave	1.2	0.068	10-yr 24-hr	0.0591	0.5	0.048	10-yr 24-hr	0.0913
JCT-1924	Bottom and overflow orifice	11756 Gilland Loop	1.7	0.090	10-yr 24-hr	0.0518	1.7	0.113	10-yr 24-hr	0.0650
JCT-1942	Bottom and overflow orifice	11786 237 A Street	0.8	0.025	10-yr 24-hr	0.0303	0.8	0.042	10-yr 24-hr	0.0508
JCT-1978	Bottom and overflow orifice	East of 238b Street and 120b Avenue (49.221,-122.56)	5.0	0.309	10-yr 24-hr	0.0623	5.0	0.310	10-yr 24-hr	0.0625
JCT-1988	Bottom and overflow orifice	23880 119A Ave	14.8	0.796	10-yr 24-hr	0.0539	14.8	0.898	10-yr 24-hr	0.0608
JCT-1992	Bottom and overflow orifice	11502 236B Street	7.5	0.347	10-yr 1-hr	0.0460	7.5	0.420	10-yr 24-hr	0.0557
JCT-2012	Bottom and overflow orifice	11508 Creekside Street	10.4	0.223	10-yr 24-hr	0.0214	10.4	0.385	10-yr 1-hr	0.0369
JCT-2058	Bottom and overflow orifice	Along River between Creekside St and 111A St (49.205,-122.565)	3.3	0.213	10-yr 1-hr	0.0638	3.9	0.256	10-yr 24-hr	0.0651
JCT-2166	Bottom and overflow orifice	23933 115 Ave	2.2	0.104	10-yr 24-hr	0.0479	2.2	0.164	10-yr 24-hr	0.0756
JCT-22	Bottom and overflow orifice	10595 240 St	6.0	0.235	10-yr 24-hr	0.0391	5.9	0.325	10-yr 24-hr	0.0555
JCT-278	Orifice at Pond	248414 106B Ave	16.4	0.150	10-yr 24-hr	0.0092	31.6	0.455	10-yr 24-hr	0.0144
JCT-332	Bottom and overflow orifice	11008 237B Street	4.4	0.261	10-yr 1-hr	0.0588	5.0	0.358	10-yr 1-hr	0.0719
JCT-344	Orifice at Pond	10696 Komola Way	19.4	0.082	10-yr 1-hr	0.0042	16.2	0.178	10-yr 24-hr	0.0110
JCT-370	Bottom and overflow orifice	10700 Erskine Street	2.4	0.111	10-yr 24-hr	0.0468	2.1	0.080	10-yr 24-hr	0.0386
JCT-424	Bottom and overflow orifice	North west of 115 A Ave at 239A Street (49.212,-122.56)	3.9	0.237	10-yr 24-hr	0.0609	3.9	0.334	10-yr 30-min	0.0859
JCT-488	Bottom and overflow orifice	130 Ave , east of Mill Street (49.239,-122.555)	2.6	0.128	10-yr 24-hr	0.0493	3.2	0.189	10-yr 24-hr	0.0582
JCT-510	Bottom and overflow orifice	112190 243 St	2.4	0.141	10-yr 24-hr	0.0580	2.3	0.147	10-yr 24-hr	0.0652
JCT-516	Bottom and overflow orifice	24085 112 Ave	2.8	0.158	10-yr 24-hr	0.0561	2.8	0.198	10-yr 24-hr	0.0706
JCT-562	Bottom and overflow orifice	23945 115 Ave	1.7	0.083	10-yr 24-hr	0.0492	1.7	0.130	10-yr 24-hr	0.0771
JCT-572	Bottom and overflow orifice	10130 246A Street	19.4	0.033	10-yr 24-hr	0.0017	17.5	0.052	10-yr 24-hr	0.0030
JCT-5974	Bottom and overflow orifice	Along River between Creekside St and 238 St (49.208,-122.564)	14.0	0.695	10-yr 24-hr	0.0496	14.0	0.820	10-yr 24-hr	0.0585

			Existing Scenario				Future CC-20% Scenario			
Node ID	Control Structure Notes	Location (Latitude, Longitude)	Tributary Area (ha)	Peak Release Rate (m3/s)	Corresponding Storm Event	Unit Release Rate (m3/s/ha)	Tributary Area (ha)	Peak Release Rate (m3/s)	Corresponding Storm Event	Unit Release Rate (m3/s/ha)
JCT-5988	Bottom and overflow orifice	Along River between Creekside St and 238 St (49.209,-122.564)	10.4	0.441	10-yr 1-hr	0.0423	10.4	0.491	10-yr 30-min	0.0471
JCT-656	Bottom and overflow orifice	13091 240 Street	3.5	0.156	10-yr 24-hr	0.0452	3.5	0.238	10-yr 24-hr	0.0690
JCT-70	Bottom and overflow orifice	South of River, north of Cameron Ct (49.204,-122.545)	11.1	0.192	10-yr 24-hr	0.0172	8.6	0.146	10-yr 24-hr	0.0170
JCT-810	Bottom and overflow orifice	12079 240 Street	0.9	0.105	10-yr 24-hr	0.1168	0.9	0.148	10-yr 24-hr	0.1646
POND-00002-2	Orifice at Pond	10130 146A Street	19.4	0.063	10-yr 30-min	0.0033	17.5	0.056	10-yr 30-min	0.0032
POND-00002-3	Orifice at Pond	24684 101 Ave	19.4	0.052	10-yr 30-min	0.0027	17.5	0.052	10-yr 24-hr	0.0030
POND-00003	Orifice at Pond	Between Hawkins Ave and Hill Ave, west of 241 Street (49.186,-122.554)	11.8	0.335	10-yr 24-hr	0.0283	9.5	0.405	10-yr 24-hr	0.0425
POND-00004	Orifice at Pond	24107 McClure Drive	16.5	0.436	10-yr 24-hr	0.0264	16.5	0.567	10-yr 24-hr	0.0343
POND-00008	Weir at headwall, orifice at headwall, emergency spillway	west of 1233 Mill Street, east of 12958 Sheldrake Ct (49.237,-122.557)	12.2	0.120	10-yr 24-hr	0.0098	12.3	0.124	10-yr 24-hr	0.0101

Table 9.5 - Summary of 1:2 year Peak Release Rates for a Forested Parcel (5 hectares, 5% slope)

Soil Group	General Description	Runoff Characteristic	Infiltration Characteristic	Area (ha)	Catchment Width (m)	Slope (%)	Peak Unit Runoff (m3/s/ha)
1	Imperfect to Very Poor. Seasonally high water table, flooding, seepage. Potential discharge; slow recharge, if any.	High runoff	Low infiltration	5	380	5	0.026
2	Moderately Well to Well. Perched water table or observed seepage, indicating a confining low-permeability layer. Variable recharge or discharge, depending on season and location.	Moderate runoff	Moderately low infiltration	5	380	5	0.004
3	Moderately Well to Rapid. Rapid infiltration, no confining layer. Potential recharge.	Low runoff	High infiltration	5	380	5	0.000
4	Moderately Well to Rapid. Relatively thin overburden over bedrock or till confining layer; steep terrain. Mountain block /bedrock recharge.	High runoff	Low infiltration	5	380	5	0.010

n-imp 0.020, n-per 0.300, dstore-imp 1.5 mm, dstore-per 5 mm.

To be clear, the above noted URR's only represent surface runoff and excludes shallow groundwater seepage that is bound to occur.

9.9 Floodplain Analysis

As previously noted in Section 5, Northwest Hydraulic Consultants (NHC) completed a complementary study for the City titled "North Alouette and South Alouette Rivers Additional Floodplain Analysis, Phase 2 – Technical Investigations Completion Final Report". The NHC report presents the updated 200-year floodplain maps for the North and South Alouette River. The 200 year flood limit includes 0.6 m of freeboard and determines the updated flood construction levels (FCLs).

Also included is the 25 year flood levels, with 0.6 m freeboard. Flood estimates incorporate a 10% increase in flows on all unregulated basins for projected climate change impacts to year 2100, which as discussed elsewhere in this ISMP may be on a low side. Downstream boundary conditions were set to a large winter flow on the Fraser River, which includes an allowance for sea level rise.

More information on the report and NHC's recommendations can be obtained on the City website at:

https://www.mapleridge.ca/DocumentCenter/View/8145/North-and-South-Alouette-Rivers- Floodplain-Study?bidId=

http://www.mapleridge.ca/DocumentCenter/View/486/Regulation-of-Earth-Fill-within-Floodplains?bidId=

10 EFFECTS ON WATERSHED HEALTH

Figure 10.1 on the following page depicts the impacts of development and loss of vegetative cover. Environmental health is closely linked to the Mean Annual Flow (MAF). Vegetation and soils absorb and retain significant water, some of which is slowly released as seepage into receiving watercourse. In a natural state where vegetative cover is vast, the MAF is at its lowest and the receiving watercourses establish their geometry based on that flow. As development and removal of vegetation occurs, the lands ability to retain water is reduced, thereby raising the MAF. The receiving watercourse then adjust their geometry to a new MAF, getting wider and deeper through erosion. Low Impact Development, or Green Infrastructure is to integrate water retention features into the development area to compensate for the reduction of natural vegetation and to minimize the change to the MAF.

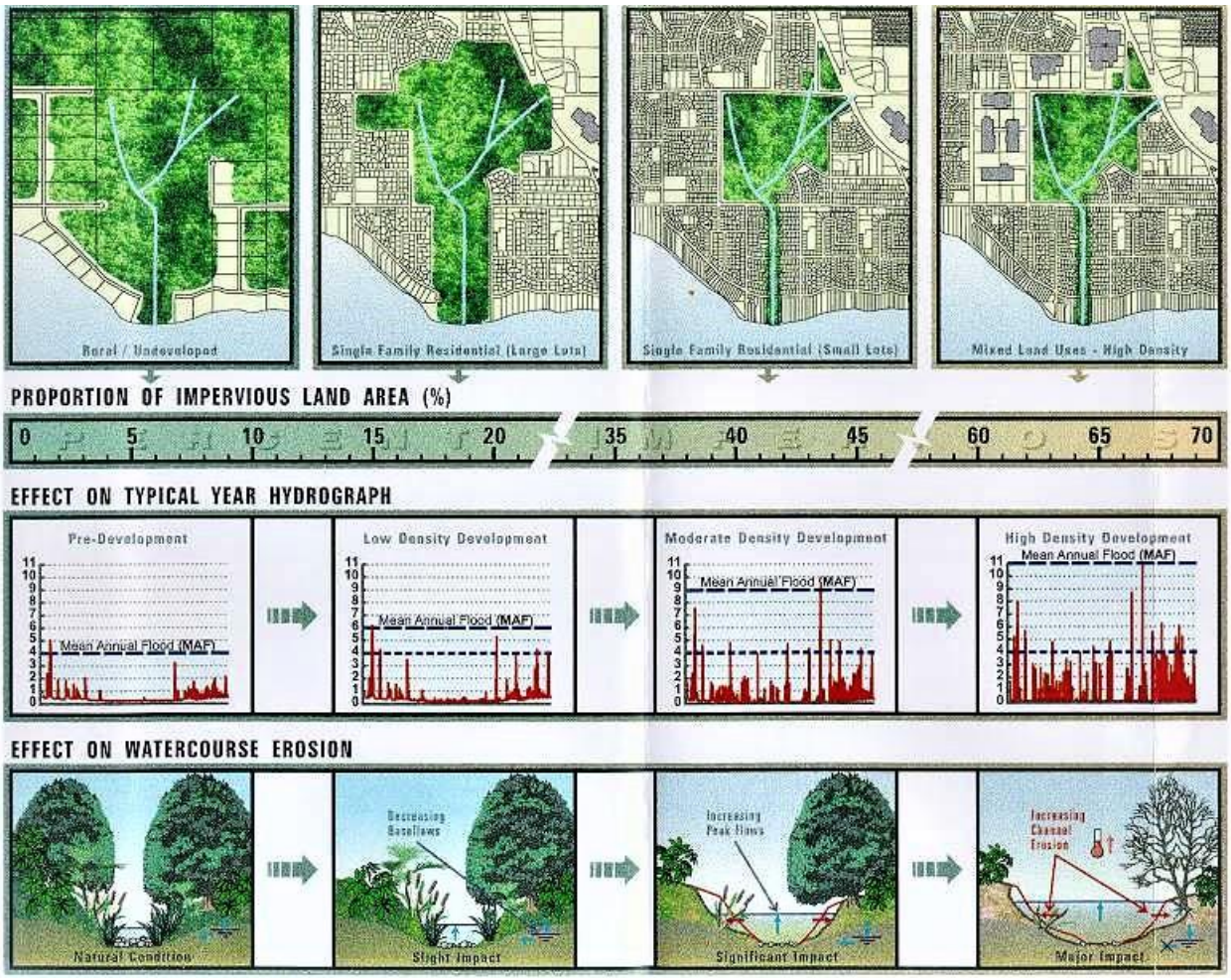

Figure 10.1 - Effects of Land Use on Hydrology and Watercourse Erosion

(Credit to Kerr Wood Leidal)

Five creek locations were selected with watersheds of various sizes and with various anticipated changes to development. These sites were selected as representative samples of how system performance is expected to change at a local scale, and to specifically assess the relative change in erosion potential within the creek system. The summarized characteristics of each creek segment catchment is presented in Table 10.1 on the following page. The creek ID notes is per the City GIS creek database.

The locations of these creek segments and their associated catchments are presented in Error! Reference source not found.**2.**

Table 10.1 – Erosion Potential Catchment Characteristics

Creek Location (creek ID)	Catchment Area (ha)	Anticipated Greenfield Development Area Above Existing Baseline Condition (ha)	Infill Redevelopment Area (ha)	Future Development Land Use Distribution	Existing TIMP[2]	Future TIMP[2]
Millionaire Creek @ Fern Cres (CR46077)	452	57	-	12% - Low Density Res. 80% - Medium Density Res. 1% - High Density Res. 6% - Institutional	6%	14%
McFadden Creek @ 264 St. (CR46556)	467	126	-	100% Suburban	8%	13%
T2 Creek @ 126 Ave (CR47667)	117	-	116 (20% of this area is predicted to redevelop)	60% - Low Density Res. 17% - Medium Density Res. 2% - High Density Res. 6% - Institutional 7% - Industrial	45%	55%
Dunlop Creek Discharge to Kanaka Creek (CR47210)	277	41	-	3% - Suburban 87% - Low Density Res. 10% - Institutional	21%	27%
Kanaka Creek @ the d/s of Dunlop Tributary (CR48546)	4,960	469	-	76% - Suburban 19% - Low Density Res. 2% - Institutional 3% - Industrial	11%	14%

Note 1: Percentages based on the total area

Note 2: TIMP = Total Impervious Area

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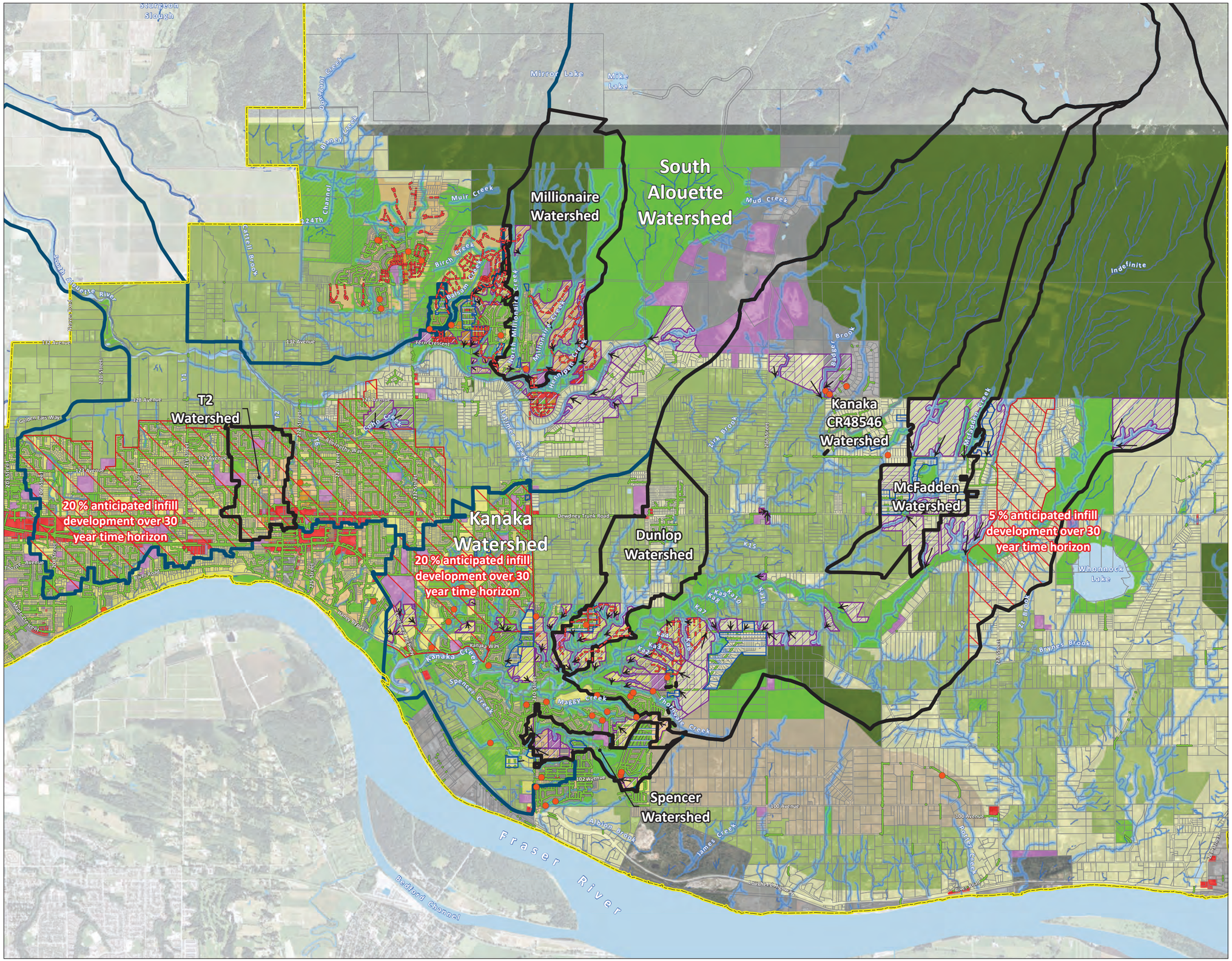


U:\Projects_VAN\1279\0025\01\D-Drafting-Design-Analysis\GIS\Projects\MXD\Current\Stage 4 Report Figures_20200130\Figure 10-2 - Maple Ridge ISMP Template_RevN_Erosion Potential and Watershed Health Assessment Catchments.mxd Last updated by bunt on March 3, 2020 at 2:04:36 PM

MAPLE RIDGE
British Columbia

South Alouette and Kanaka Integrated Stormwater Management Plans

Erosion Potential and Watershed Health Assessment Catchments

- Assumed Future Roadway
- Presumed Drainage Outfall
- Recent Development (2011 - 2016)
- Future Development Densification
- Future Infill Development
- Creek Subcatchment Boundary
- Natural Watershed Boundary

Official Community Plan

- Urban Reserve
- Agriculture
- Forest
- Commercial
- High Density Residential
- Medium Density Residential
- Low Density Residential
- Rural Residential / Suburban Residential
- Industrial
- Parks & Open Space
- Parks within the ALR
- Civic & Institutional
- Creeks
- Drainage Pipes
- Detention Ponds /Facilities
- Parcel
- Municipal Boundary
- Existing Creek Setbacks

500 250 0 500 1,000
m

N

Coordinate System:
NAD 1983 UTM Zone 10N

Data Sources:
City of Maple Ridge
City of Pitt Meadows
BC MoE
NR Canada
GeoAdvice

Project #:	1279.0025.01
Author:	BG/LP
Checked:	GS
Status:	FINAL
Revision:	N
Date:	2020 / 3 / 3

URBAN SYSTEMS

FIGURE 10.2

As a comparison to assess the relative change in peak flow rates between existing and future conditions including climate change, simulated design storm unit peak flow rates were compared at the five creek locations, as summarized in **Table 10.2** below.

Table 10.2 – Unit Peak Flow Rate Comparison

Creek Location	Existing Peak Runoff Flow Rate (L/s/ha)		
	MAR, 24-Hour	10-year Critical Duration	100-year Critical Duration
Millionaire Creek @ Fern Cres (CR46077)	5.0	12.3	26.2
McFadden Creek @ 264 St. (CR46556)	12.8	24.1	38.6
T2 Creek @ 126 Ave (CR47667)	19.6	39.1	56.1
Dunlop Creek Discharge to Kanaka Creek (CR47210)	8.4	18.4	28.8
Kanaka Creek @ the d/s of Dunlop Tributary (CR48546)	6.4	12.9	18.1

Creek Location	Future Peak Runoff Flow Rate (L/s/ha)		
	MAR, 24-Hour	10-year Critical Duration	100-year Critical Duration
Millionaire Creek @ Fern Cres (CR46077)	5.0	11.7	26.7
McFadden Creek @ 264 St. (CR46556)	12.2	20.7	35.6
T2 Creek @ 126 Ave (CR47667)	18.7	39.0	56.3
Dunlop Creek Discharge to Kanaka Creek (CR47210)	8.6	17.5	25.9
Kanaka Creek @ the d/s of Dunlop Tributary (CR48546)	6.6	12.7	18.2

Creek Location	Future with 10% Climate Change Peak Runoff Flow Rate (L/s/ha)		
	MAR, 24-Hour	10-year Critical Duration	100-year Critical Duration
Millionaire Creek @ Fern Cres (CR46077)	5.7	14.6	33.8
McFadden Creek @ 264 St. (CR46556)	13.3	23.3	41.1
T2 Creek @ 126 Ave (CR47667)	22.4	44.1	59.6
Dunlop Creek Discharge to Kanaka Creek (CR47210)	10.5	19.4	27.4
Kanaka Creek @ the d/s of Dunlop Tributary (CR48546)	8.0	13.9	19.7

Creek Location	Future with 20% Climate Change Peak Runoff Flow Rate (L/s/ha)		
	MAR, 24-Hour	10-year Critical Duration	100-year Critical Duration
Millionaire Creek @ Fern Cres (CR46077)	6.7	17.9	40.0
McFadden Creek @ 264 St. (CR46556)	15.2	26.3	46.5
T2 Creek @ 126 Ave (CR47667)	25.5	47.9	60.9
Dunlop Creek Discharge to Kanaka Creek (CR47210)	12.5	21.1	27.9
Kanaka Creek @ the d/s of Dunlop Tributary (CR48546)	9.3	15.2	21.0

Notes:

Results presented under the 10-year and 100-year return periods represent the worst case from all storm durations assessed (30-min, 1-hr, 2-hr, 6-hr, 12-hr, and 24-hr).

The above results demonstrate that current criteria will generally maintain, or reduce the instantaneous peak flow without consideration for climate change, however generally exceed existing conditions when climate change is considered.

10.1 MAR Creek Flow Volumes

Runoff resulting from the Mean Annual Rainfall (MAR) event is sometimes referred to as the "channel forming flow", in that it is the most influential flow that governs the geometry and stability of a watercourse. If the flow regime for events up to the MAR level change, the conditions of the channel are likely to morph. For this reason, the MAR event may be considered the first indicator for creek stability. A comparison of MAR event creek flow for the sample sub-catchments are provided in **Table 10.3.**

It is important to distinguish that the creek flow volume presented in **Table 10.3** represents the combination of direct surface runoff and predicted groundwater seepage, which is related to the infiltration potential and groundwater regime. Within the context and scope of this ISMP, it is a simplistic representation of groundwater flow developed from limited model calibration during the Part 1 modeling process.

Table 10.3 – MAR Creek Flow Volume Comparison

Creek Location	MAR Flow Volume (ML) Surface Runoff and Groundwater Seepage			
	Existing Baseline	Future Baseline	Future Climate Change (10% Increase)	Future Climate Change (20% Increase)
Millionaire Creek @ Fern Cres (CR46077)	425	423 (-1%)	463 (+9%)	503 (+18%)
McFadden Creek @ 264 St. (CR46556)	1,118	1,072 (-4%)	1,146 (+3%)	1,215 (+9%)
T2 Creek @ 126 Ave (CR47667)	80	82 (+2%)	89 (+10%)	97 (+21%)
Dunlop Creek Discharge to Kanaka Creek (CR47210)	223	234 (+5%)	257 (+15%)	280 (+26%)
Kanaka Creek @ the d/s of Dunlop Tributary (CR48546)	4,855	4,807 (-1%)	5,274 (+9%)	5,747 (+18%)

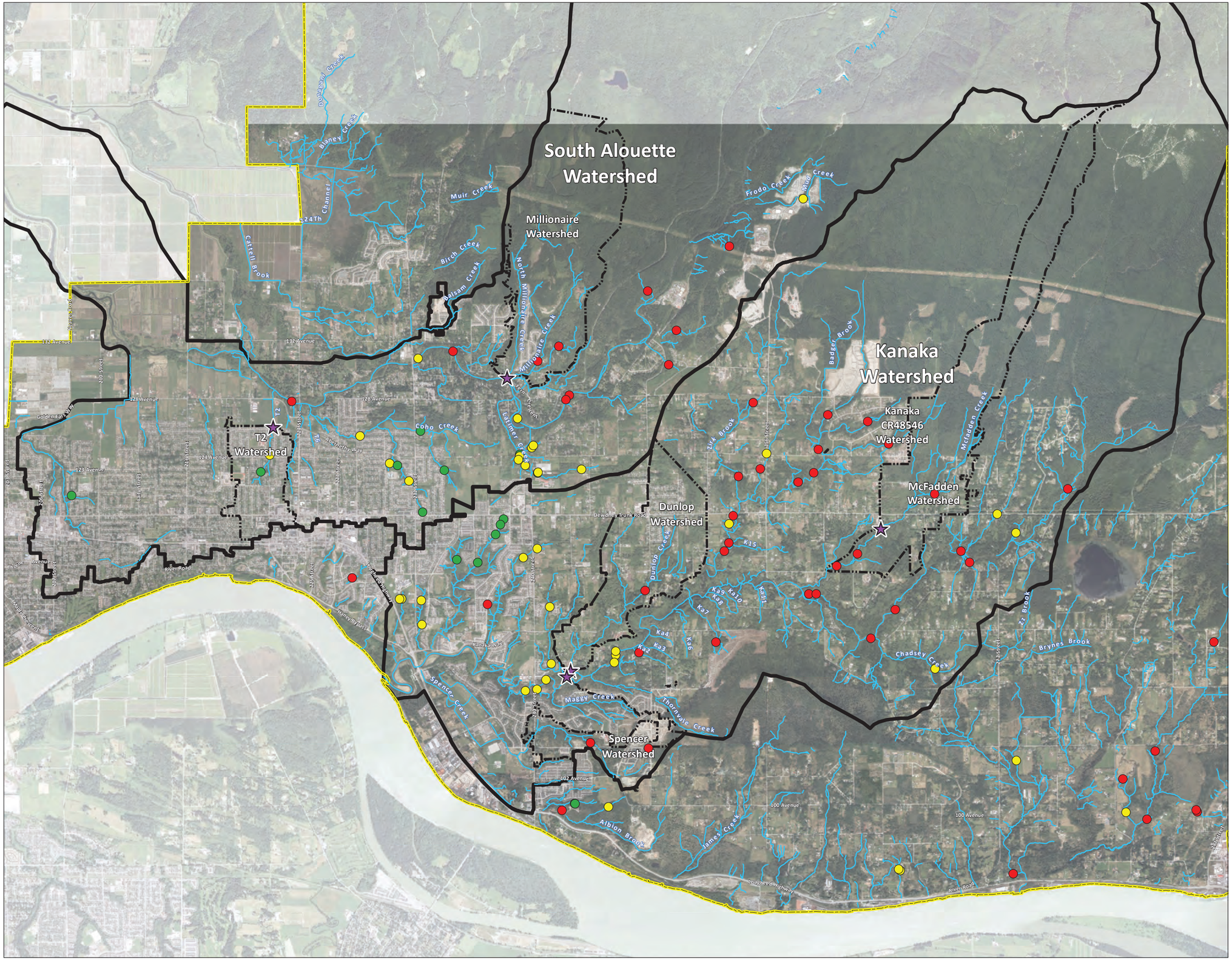
Whether or not the runoff volume increases or decreases is a function of many complex factors, largely attributed to the land use distribution and the controls applied, the degree to which land use will change, and the soils infiltration capacity. Similar to other performance indicators, the predicted change in flow volume is plus or minus 5% of current conditions, which is considered small and within the margin of error of the analysis.

These results suggest that the City's ***criteria*** is sufficient to address future development, however not sufficient to address the increased threat of climate change, particular if future precipitation is to rise 20% above current levels. It re-emphasises the need for the City to change its design criteria to account for climate change. It's recommended that the City adapt a set of

future condition (climate change) IDF curves and design storms that all new facilities would be designed to. It is worth noting that upsizing storm sewer pipe upstream will not address the risk of stream erosion.

10.2 Continuous Simulation

Perhaps the best indicator of the likely effect on watershed health is to consider the continuous flow regime in the watercourses. A review of current creek erosion and instability issues in the Kanaka and Alouette watersheds, based on Maple Ridge's GIS database, shows that 100 sites scattered throughout the City have been identified as exhibiting bank erosion, as depicted in **Figure 9.2**. The data was generally collected in the early 2000's (2000-2003) and presumably before the City's current stormwater management criteria were in force. Of these sites, nearly half (47) were identified as "severe" (i.e., affecting greater than 10 m^2 of bank). It is not known how many additional sites are now experiencing bank erosion. An erosion potential assessment was undertaken to attempt to establish the likelihood and general severity of further erosion happening. The assessment focuses on bed erosion, not bank erosion; however, the two are related, with banks likely to erode when the bed does.



MAPLE RIDGE
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South Alouette and Kanaka Integrated Stormwater Management Plans

Documented Erosion Sites

- Erosion Potential Assessment Site
- Municipal Boundary
- Natural Watershed Boundary
- Creek Subcatchment Boundary
- Creeks

Erosion Severity

- Low
- Moderate
- Severe

200 0 200 400
m

Coordinate System:
NAD 1983 UTM Zone 10N

Data Sources:
City of Maple Ridge
City of Pitt Meadows
BC MoE
NR Canada
GeoAdvice

Project #:	1279.0025.01
Author:	BG
Checked:	GS
Status:	FINAL
Revision:	N
Date:	2020 / 3 / 3

URBAN SYSTEMS

FIGURE 10.3

U:\Projects_VAN\1279\0025\01\D-Drafting-Design-Analysis\GIS\Projects\MXD\Current\Stage 4 Report Figures_20200130\Figure 10-3 - Maple Ridge ISMP Documented Erosion Sites_RevA.mxd Last updated by lpunt on March 3, 2020 at 2:09:14 PM

Erosion occurs in watercourses when the force of the flowing water exceeds the resistance of the bed material to be moved. The longer flowing water exceeds this resistance to movement, the more likely erosion (sometimes called general scour) is to occur. Using a method that compares boundary shear stress (the force of flowing water; designated τ_0) with critical shear stress (bed resistance to movement, based on mass as represented by particle size; designated τ_C) to estimate excess shear stress (designated ε), the erosion potentials at five sites around the Study Area were estimated (Rohrer & Roesner, 2005). For each time step of the continuous hydrologic simulation completed for the ISMP, excess shear stress was computed for a range of particle sizes characterizing each site:

$$\varepsilon = (\tau_0 - \tau_C)^{3/2}$$

Subsequently, an erosion potential index, *EPI*, was computed as a ratio of the sum of these excess shear values of each future conditions scenario to that of existing conditions:

$$EPI = \Sigma\varepsilon_{future} / \Sigma\varepsilon_{existing}$$

An EPI value greater than one (1) means that the future condition is more likely to worsen any current erosion problems as well as likely to yield new erosion problems as over against the existing condition. Conversely, a value less than 1 means the opposite, that is, less likelihood of erosion. A value of 1 means "no change" in erosion is anticipated due to the future condition.

The five test sites were chosen to represent areas likely to experience significant development within the time horizon of this ISMP (30 years). They are shown on Error! Reference source not found. **.** Key site characteristics are listed in **Table 10.4.**

Table 10.4 – Characteristics of Sites for Erosion Potential Assessment

Site ID	Maple Ridge ID	Watercourse Name	Length of Stream Segment (m)	Slope of Watercourse (m/m)	Bed Material Median Size (d_{50}) (mm)	Armouring[11] Bed Material Size (d_{90}) (mm)
CR46077	350	Millionaire Creek	67	0.052	64 (very coarse gravel)	600 (boulder)
CR46556	11215	McFadden Creek	154	0.056	15 (medium gravel)	100 (fine cobble)
CR47667	17003	T2	112	0.011	13.5 (medium gravel)	170 (coarse cobble)
CR47210	2080	Dunlop Creek	48	0.019	0.5 (medium sand)	14 (medium gravel)
CR48546	32354	Kanaka Creek	53	0.004	0.11 (very fine sand)	20 (coarse gravel)

[11] Representative of larger bed material in a watercourse that can form an "armouring" layer that is resistant to erosion.

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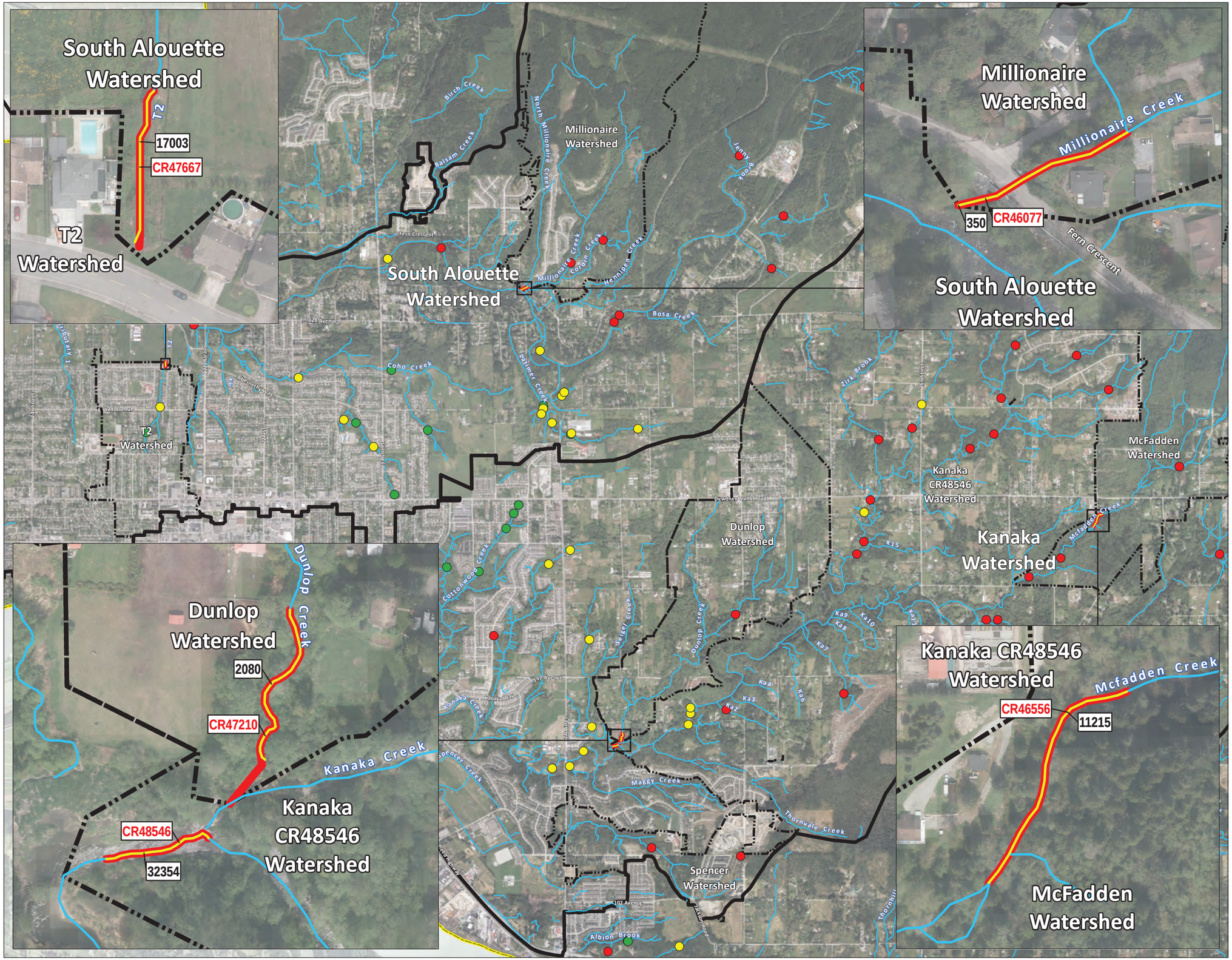


MAPLE RIDGE
British Columbia

South Alouette and Kanaka Integrated Stormwater Management Plans

Erosion Potential Assessment Sites

- Municipal Boundary
- Natural Watershed Boundary
- Creek Subcatchment Boundary
- Maple Ridge Channel Reach (with ID)
- Modeled Channel Reach, for Erosion Potential Assessment (with ID)
- Creeks

Erosion Severity

- Low
- Moderate
- Severe

200 100 0 200 400
m

Coordinate System:
NAD 1983 UTM Zone 10N

Data Sources:
City of Maple Ridge
City of Pitt Meadows
BC MoE
NR Canada
GeoAdvice

Project #:	1279.0025.01
Author:	BG
Checked:	GS
Status:	FINAL
Revision:	N
Date:	2020 / 3 / 3

URBAN SYSTEMS

FIGURE 10.4

U:\Projects_VAN\1279\0025\01\D-Drafting-Design+Analysis\GIS\Projects\MXD\Current\Stage 4 Report Figures_20200130\Figure 10-4 - Maple Ridge ISMP Erosion Potential Assessment Sites_RevA.mxd Last updated by bunt on March 3, 2020 at 2:12:25 PM

The hydraulic parameters necessary for the analysis were obtained from continuous simulation of the hydrologic model for the period November 21, 2014 to February 21, 2015, which represents the governing portion of the annual cycle.

Excess shear values were computed for the range of bed material sizes present at each site, as described in Maple Ridge's GIS inventory of erosion sites, as well as for a representative bed material size at each site (assumed to the median particle size, d50). The results for the composite EPIs are shown in the plots below in **Figure 10.a through 10.5e**, with the existing condition assigned a value of "1". Results for all four scenarios are shown. Additional information about the erosion potential assessment, including plots showing the erosion potential for all bed materials present at each site, are in **Appendix D.**

Briefly, as shown in the EPI plots future conditions, when current City stormwater controls are applied to future development, erosion potentials in the test streams drop slightly from existing conditions, but then rise above existing conditions with increasing seasonal precipitation associated with climate change. This basically indicates that the current controls are sufficient for minimizing erosion potential when considering today's climate patterns but not those of an uncertain future. Increasing storage volume is the expected necessary response.

When viewing and attempting to interpret the EPI results, the following should be taken into consideration:

- As used in this ISMP, each "test site", represents average conditions over a length of creek (48 m to 154 m, depending on the site). Thus, the EPI is not intended as a predictor of erosion problems at specific sites. It is intended to illustrate how future conditions (land use; climate change; application of required BMPs) could impact the overall erosional characteristics of local creeks in the watersheds.
- The City's GIS database contains information about the substrate (creek bed material) within the test sites. However, since they were not fully described in the database, actual particle size distributions for substrate were not available but inferred. This also discourages interpreting results as predictors of specific erosion problems at specific sites.
- The continuous hydrologic simulation as used in the assessment was for a single winter season, which produced 651 mm of precipitation[12]. During the period of record, seasonal precipitation ranged from 360.4 mm to 929 mm, with a median of 605.8 mm. As used for the climate change scenarios, increases of 10% and 20% over the simulation period yield seasonal precipitation depths of 716.1 mm and 781.2 mm, respectively, both of which are well below the period of record maximum.
- While the simulation period included two significant rainfall events, neither was of an extreme nature. The first (January 3-5, 2015) exhibited return periods of less than 2-years for a range of durations (30 minute to 24 hour), while the second (January 22-25, 2015) was less than 2-year except at the longest durations (12 and 24 hour) where it was between a 2 and 5-year return period. See **Appendix D** for details.
- With respect to long-term climate change, it is assumed that the current particle size distributions still apply.
- By assigning an EPI of 1 to existing conditions, it is assumed that the test creek reaches are currently stable.
- EPI is an assessment of probable bed erosion, but it does not account for sediment that may be conveyed into a reach of creek as a result of general stream scour upstream. Put differently, long-term estimates of site-specific erosion and deposition would require a full sediment transport analysis; the EPI simply indicates whether erosion is likely to occur in the subject creek reach.
- Increases in the EPI of 10-20% are probably within the tolerance range for the computations, based as they are average creek conditions that were not fully defined and on a single winter's worth of rainfall. The results should be seen as illustrative of erosion potential.

[12] Representing the 64th percentile winter season over the 21 years of record (1994-2015).

To summarize, the erosion potential assessment illustrates that as land use intensifies and generates more runoff (both total volume and peak), excess shear stress increases and stream bed erosion potential increases. However, the current set of stormwater controls required for new development by the City – where achieved – appear able to offset the land intensification issues, at least for areas that have developed to the level of the catchments feeding the five test sections used in the assessment. Finally, with the threat of climate change, erosion risk increases regardless of the application of controls as currently defined.

Figure 10.5a – Erosion Potential Index for Millionaire Creek

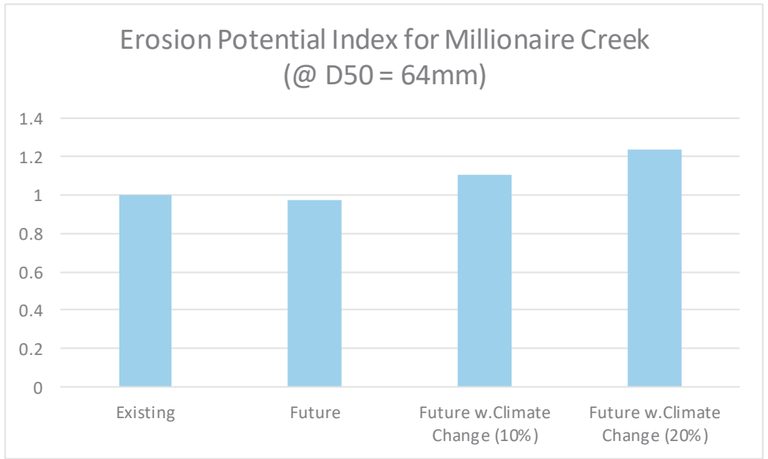


Figure 10.5b – Erosion Potential Index for Dunlop Creek

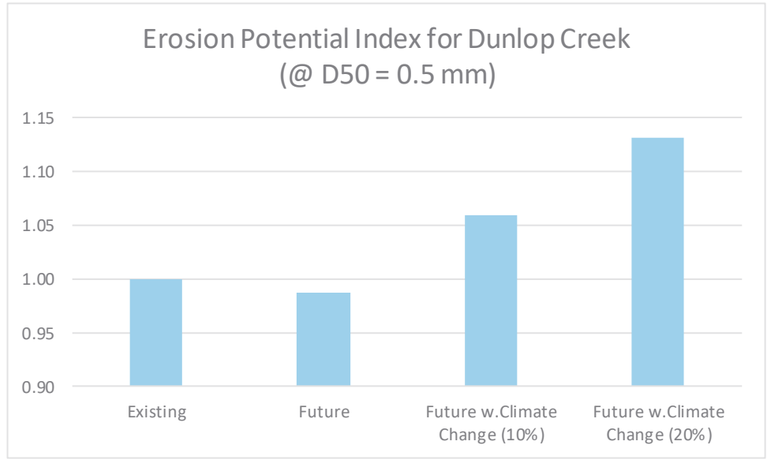


Figure 10.5c – Erosion Potential Index for Kanaka Creek

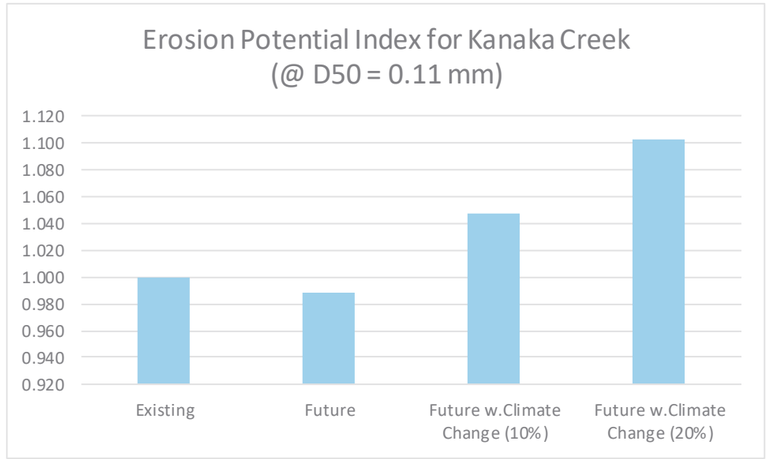


Figure 10.5d – Erosion Potential Index for McFadden Creek

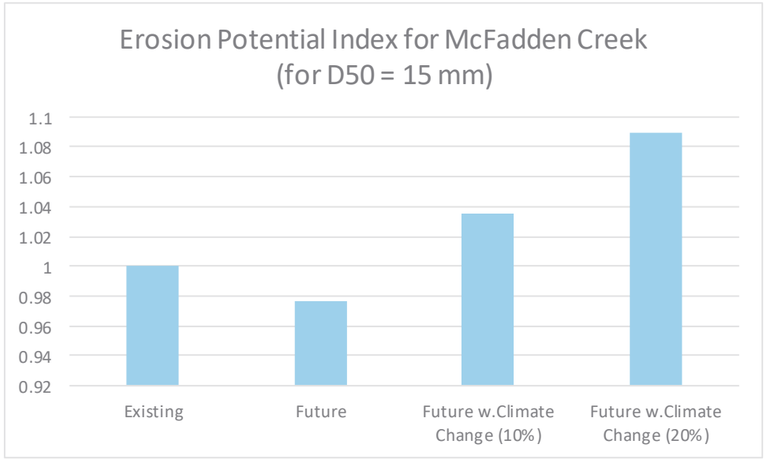
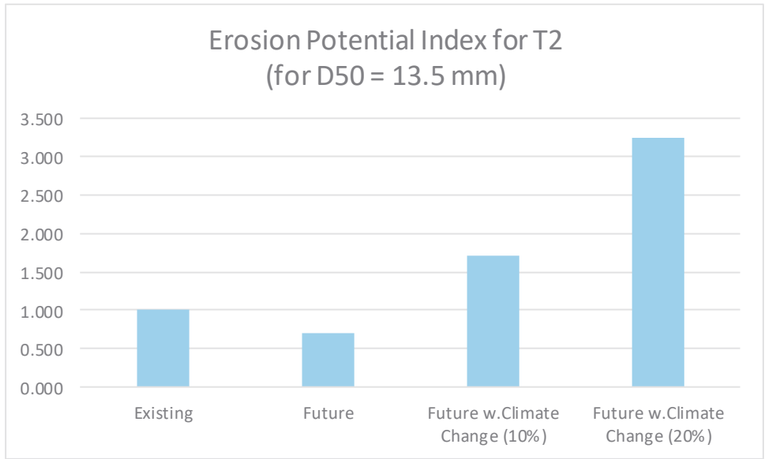


Figure 10.5e – Erosion Potential Index for T2 Creek



10.3 Future Land Use Summary and Conclusions

Based on the OCP, Area Plans, and pattern of infill development, the projected change in land use is predicted. The City completed their Design Criteria Manual in 2015, requiring a multi-tiered approach to stormwater management.

Future condition modeling has been conducted that for a variety of single event storms, including the MAR event, a range of 1:10 year events, a range of 1:100 year events, the defined ARDSA events and a small sample of continuous simulation. System performance was then determined based on a wide range of indicators, including peak flow and maximum hydraulic grades lines in the conveyance system, creek flow volumes, and through computation of an erosion potential index (EPI) for sample creek segments.

Results are summarized as follows:

- For a variety of reasons, current development practices for Low Density and Medium Density developments will not always satisfy the City criteria to retain the first 50% MAR (mean annual rainfall) precipitation (40 mm). In cases where on-lot Tier A is unachievable, consideration should be given to communal facilities in public lands that can attempt to satisfy the Tier A target. This will require dedicated space based on the service area and soil infiltration capacity. While a Tier C pond may contribute to meeting Tier A targets as well, it is anticipated that additional space and facilities will be required to fully satisfy Tier A targets.

  When a Developer can't meet the Tier A criteria by providing the off-site facilities either (escarpment area, geotechnical issues or smaller subdivisions), the City may then consider cash-in lieu to fund the City looking for other compensating benefits within the watershed.

- Low and Medium Density developments are by far the most dominant land use. Not achieving Tier A retention may contribute to diminished creek base flows and it puts stronger emphasis on the need to achieve Tier C criteria (detention of 1:10 year post development flows to 1:2 year woodlot condition flows).

- For conveyance systems, predicted future system performance remains comparable to existing condition for events up to and including the 1:10 year event, based on the assumption that Tier A and Tier B are being achieved. Performance worsens to a modest degree during a 1:100 year event, largely due to the fact that the standard criteria only requires flow attenuation for the 1:10 year event (Tier C). In some circumstances, the City requires attenuation of the 1:100 year event, however it is currently not well defined where that is a requirement. At this time, analysis herein has discounted attenuation of the 1:100 year event.

- Despite the two bullets above, based on stream data collected and provide by the City, sample catchments suggest that the City's current stormwater criteria should, at minimum, abate the impact development may have on stream erosion and watershed health. Under current climate conditions, current practices, and assuming current climatic conditions, are expected to generally maintain, or minorly reduce, the risk of erosion in areas that had been previously developed without the application of controls. However, this is with a caveat that developers are not consistently achieving Tier A / B controls. Where they are not achieved, development impacts are expected.

- It is very difficult to fully replicate nature in a built environment. At best, new developments will near the performance of nature, therefore Greenfield Development will not provide an opportunity to improve watershed

health. The only opportunity to improve watershed health will be in infill development zones, where the application of current criteria can in some cases repair historic impacts.

- The degree to which climate change will affect precipitation is still uncertain, but climate science is showing significant increases in intensity during the wet season for all storm events up to 24 hours. Summers are expected to get drier. Should this occur, and without the adjustment to the design of stormwater controls, impact is expected in both the hydraulic performance of conveyance systems, the erosion potential in receiving streams, and watershed health.
- The City can best adapt to climate change by controlling infrastructure and development moving forward with new criteria that includes a factor for climate change, through gradual infrastructure renewal, implementing green infrastructure that reduces runoff volumes and through flexible criteria and priority-based decisions.
- The City can track the number and severity of watercourse erosion sites as a means to understand the effects of development and climate change on watershed health.

PART 3 - Recommendations & Implementation Strategy

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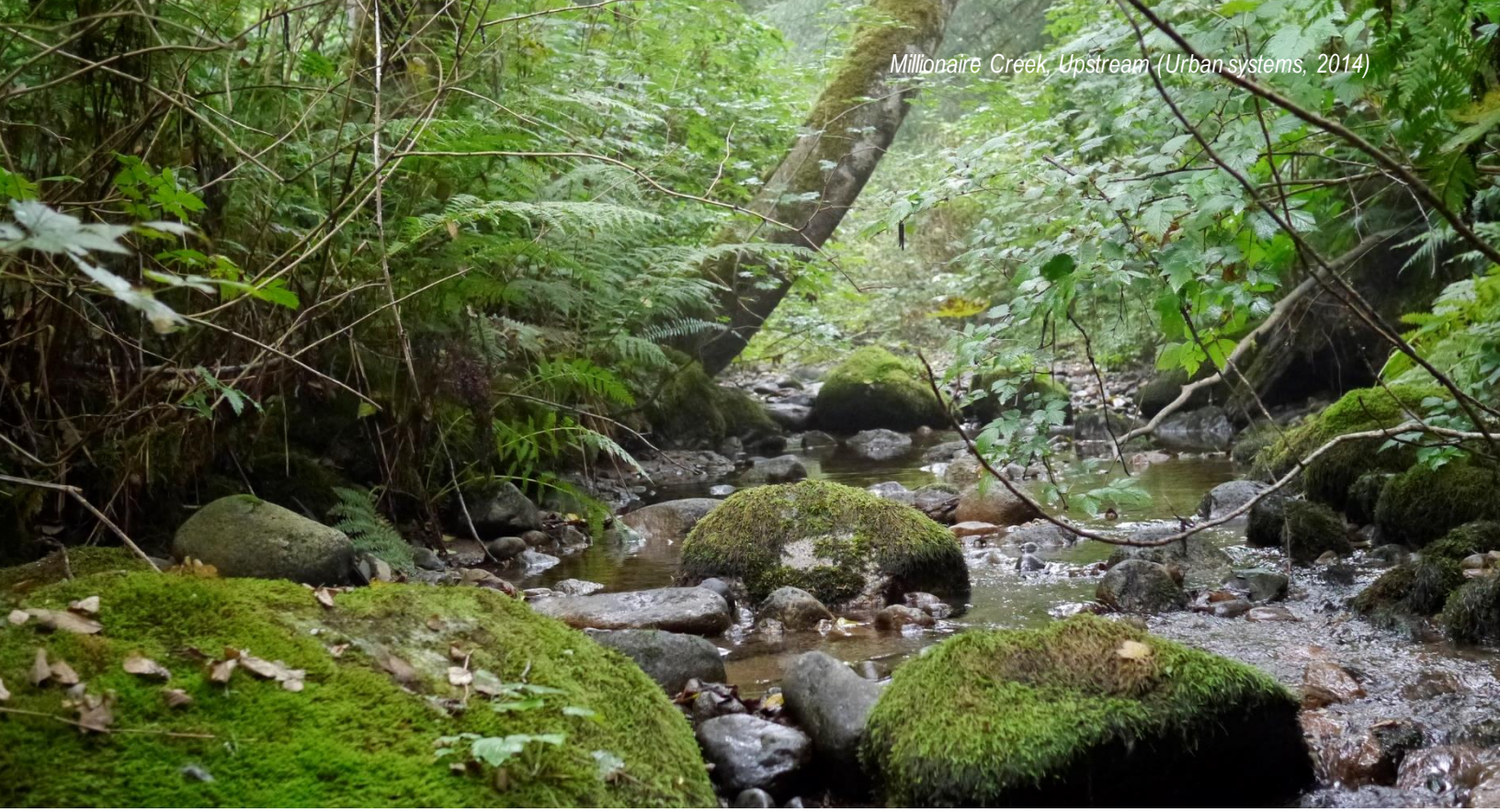

Millionaire Creek, Upstream (Urban systems, 2014)

11 SUMMARY OF KEY ISSUES AND ASSESSMENTS

Findings of Part 1 (existing conditions) and Part 2 (future conditions) to develop the Integrated Stormwater Management Plan (ISMP) for the South Alouette River and Kanaka Creek watersheds are now understood.

The recommendations and implementation plan are informed by the outcomes of the technical analysis and expression of challenges and issues by City staff and stakeholders. A recap of key assessment findings is as follows:

- The City's current stormwater management practices, at a minimum, strive to achieve a no-net-loss in watershed health.
- In some cases, watershed health in urban areas , such as Spencer and T2, are considered poor to very poor. The application of current criteria to infill development in these historic areas provides an opportunity to improve watershed health over time, but only if the current criteria are implemented successfully and outpaces increases in impervious surface rather than simply offset it. The rate of potential improvements would be directly related to the rate of infill development. At the predicted pace of infill development, it is expected to take decades to make significant improvements, but is a worthy effort, nonetheless.
- It is very difficult to fully replicate nature with a built environment. At best, new developments will near the performance of nature, therefore Greenfield Development will not provide an opportunity to improve watershed health. The only opportunity to improve watershed health will be in infill development zones, where the application of new criteria can repair historic impacts.

- The City's criteria to retain the first 50% MAR precipitation (40 mm) is ambitious and requires effective collection and redistribution of impervious surface runoff to an infiltration zone. There are several site characteristic restrictions imposed by the City that restrict that application of techniques to achieve the retention target. As such, actual practices don't always match, and are not reflected in the City's own criteria.
- For conveyance systems, the City's current criteria demonstrates that system performance remains comparable to existing condition for events up to and including the 1:10 year event, based on the assumption that Tier A/B targets are met. Performance worsens to a modest degree during a 1:100-year event, largely since the standard criteria only requires flow attenuation and conveyance of the 1:10 year event. In some circumstances, the City requires conveyance of the 1:100-year event in pipe versus overland, however it is currently not well defined where that in-pipe control becomes a requirement. At this time, analysis has discounted control of the 1:100-year event within the stormwater pipe system. It is noted, however, that storm sewers are only intended to serve the 1:10-year level and that surcharging and overland flow paths are acceptable beyond the 1:10-year level. Locations of where surface major flow paths are needed are identified. The question is whether the worsening of the 1:100-year condition is significant or not. This is not a question that can be answered in the scope of the ISMP, as this requires detailed site information and an assessment of risk. Within the scope of the ISMP, areas of interest are identified for further assessment.
- The municipality has a responsibility to develop design criteria to ensure that drainage in new developments does not breach from public corridors into private lands unless into a natural watercourse protected by the Crown, or where a statutory right of way has been secured. Containing major flow (surface flow) within public corridors can be considerably challenging in older neighbourhoods where roadways lack curb and gutter, and where the elevation of adjacent lots are sometimes lower that the roadway. There are also some rare instances where neighbourhoods historically developed without any piped drainage system or clearly defined ditches.
- Based on stream data collected and provided by the City, assessment of sample catchments suggests that if successfully achieved, the City's current stormwater management criteria should, at minimum, abate the impact development may have on stream erosion and watershed health, satisfying the baseline ISMP goal of "no-net-loss". However, restrictions on the application of infiltration systems due to potential conflicts with Building Code drainage and site stability design rules raise question as to the degree to which retention criteria will in fact be achieved.
- The degree to which climate change will affect precipitation is still uncertain, but climate science is showing significant increases in intensity during the wet season for all storm events up to 24 hours. Summers are expected to get drier. Should this occur, and without the adjustment to the design of stormwater controls, impact is expected in both the hydraulic performance of conveyance systems, the erosion potential in receiving streams, and watershed health.
- A public survey was conducted on-line, with a summary of limited responses (25) being as follows:
    - Based on our survey responses, 60% of respondents (15 out of 25) have been impacted by flooding in their neighbourhood and 88% of respondents (22 of the 25) are aware of the importance of natural features for drainage.

- In regard to the *rural* watershed health, 8 of 25 respondents believe the health of the watershed is poor, and 10 responses specifically mention how development has negatively impacted the watershed.
- When asked about the *suburban* areas, 12 of the 25 respondents believe the health of the watershed to be poor, and 13 of 25 respondents mention the negative impacts of development near the watershed.
- The majority of survey respondents believe the watershed health in *urban* areas to be poor (15 of 25 respondents). Respondents believe the main culprit for this is development that removes natural drainage features and is too close to the waterway. Participants said that old development and infrastructure is seen as not able to address the additional runoff, and new developments are not considering or maintaining the existing natural drainage features.
- Participants overwhelmingly responded that the health of the watershed is important to them, with more than 70% (18 or 25) saying significantly important. When asked about how much investment into drainage improvements they would support, the majority of respondents (19 of 25) would support moderate to significant investment.

Kanaka Creek near Thornvale Creek (Urban Systems, 2014)

12 ISMP GOAL AND OBJECTIVES

As a summary recap, the goal and objectives of the ISMP provide the strategic direction for recommendations in improvements in integrated stormwater management practices and processes.

12.1 Goal

The primary goal of integrated stormwater management in the South Alouette and Kanaka Creek watersheds is to *maintain, and ideally enhance, watershed health*.

12.2 Objectives

Objectives describe what the City strives to achieve in the South Alouette and Kanaka Creek watersheds through effective integrated stormwater management:

Maintain watershed health in areas experiencing greenfield development	Enhance watershed health in areas experiencing infill development	Effectively manage risk to public health and safety	Deliver sustainable services that are adaptive to climate change

Hennipen Creek at Fern Crescent (Urban Systems, 2014)

13 RECOMMENDED PROGRAM AREAS

Recommendations to address issues and opportunities identified, and to make progress on the goal and objectives of the ISMP, are organized into five program areas. Recommendations under each program area, and an implementation action plan, are detailed on the following pages.

1. Regulation and Enforcement
2. Asset Management
3. Environmental Monitoring
4. Collaboration, Education, and Outreach
5. Adaptive Management and Continuous Improvement

13.1 Program Area 1: Regulation and Enforcement

13.1.1 Overview

There is an important relationship between healthy watersheds, healthy streams, and healthy continuous riparian corridors. Managing risk through regulation is the easiest and most important component of the ISMP. It is important that regulations are achievable and are enforced by the municipality. The City can best control infrastructure and development moving forward with new criteria that includes a factor for climate change, through gradual infrastructure renewal, and through flexible criteria and priority-based decisions.

As a municipality, the City has the authority to regulate the following variables in support of the goal and objectives of this ISMP:

- General land use
- Development in hazardous and environmentally sensitive areas
- Development in the Town Centre
- Development adjacent to Kanaka Creek
- Impervious area
- Tree canopy
- Watercourse setbacks
- Stormwater management requirements (on-lot and in streets)
- Source control
- Construction practices

The City has many established programs and regulatory documents to regulate the above, including:

- Official Community Plan – including Land Use Plan, Development Permit Areas, and Area Plans
- Tree Protection & Management Bylaw
- Watercourse Protection Bylaw and the Streamside Protection Regulation (SPR)
- Subdivision and Development Bylaw, including Design Criteria

Strategic studies such as the Green Infrastructure Management Strategy currently in development could lead to additional regulations. Additionally, the City is planning to launch a "Ecological Network Management Strategy" (ENMS) in 2022 that will identify existing / potential municipal ecosystem health and wildlife management priorities for watersheds, green corridors, and major hubs. WildSafe BC representatives have asked for the City of Maple Ridge to have a comprehensive plan for the movement of wildlife within City limits, particular for bears. Such considerations are appropriate for the upcoming ENMS.

13.1.2 Soil Infiltration Rates and Design of On-Site Controls – Discussion

The City's criteria around retention and flow control do not reflect the many challenges and variable site conditions that result in exemptions and exceptions that occur through building and development processes. The discussion below is intended to raise awareness, with the ultimate need being to modify the criteria to reflect the varying conditions across the City, and to inventory where exemptions apply.

Retention, as opposed to detention, is highly governed by depression storage and the recharge potential of the soils. **Figure 13.1 and Figure 13.2** attached show generally the infiltration potential of soils in the study area, categorized by "soil group".

Table 13.1 below describes the implications of soil condition for management practices (which could inform standards) for each soil group. **Table 13.1** presents the distribution of these soil groups across the study area, as derived from the GW Solutions Report (**Appendix B**).

Table 13.1 – Primary Soil Groups and Implications for Stormwater Management Practices/Standards

Primary Soil Group	Description	Anticipated Infiltration Rate (mm/hr)	Implications for Stormwater Management Practices/ Standards
1	Imperfect to very poor drainage. Seasonally high-water table, flooding, seepage. Potential groundwater discharge, slow recharge if any.	< 1	• Not suitable for centralized retention facilities • Maybe suitable for small scaled, distributed practices, but must have under-drains.
2	Moderately well to well draining. Perched water table or observed seepage, indicated a confining low-permeability layer. Variable groundwater recharge and discharge, depending on season and location.	1 to 5	• Generally, not suitable for concentrating runoff from large areas • Suitable for small scaled, distributed practices, but consideration should be given to under-drains
3	Moderately well to rapid drainage. Rapid infiltration rates, no confining layer. Potential groundwater recharge.	>10	• May be suitable for centralized retention facilities
4	Moderately well to rapid drainage. Relatively thin overburden over bedrock or till; steep terrain. Mountain block/bedrock groundwater recharge.	1 to 5	• Generally, not suitable for concentrating runoff from large areas • Suitable for small scaled, distributed practices, but consideration should be given to under-drains

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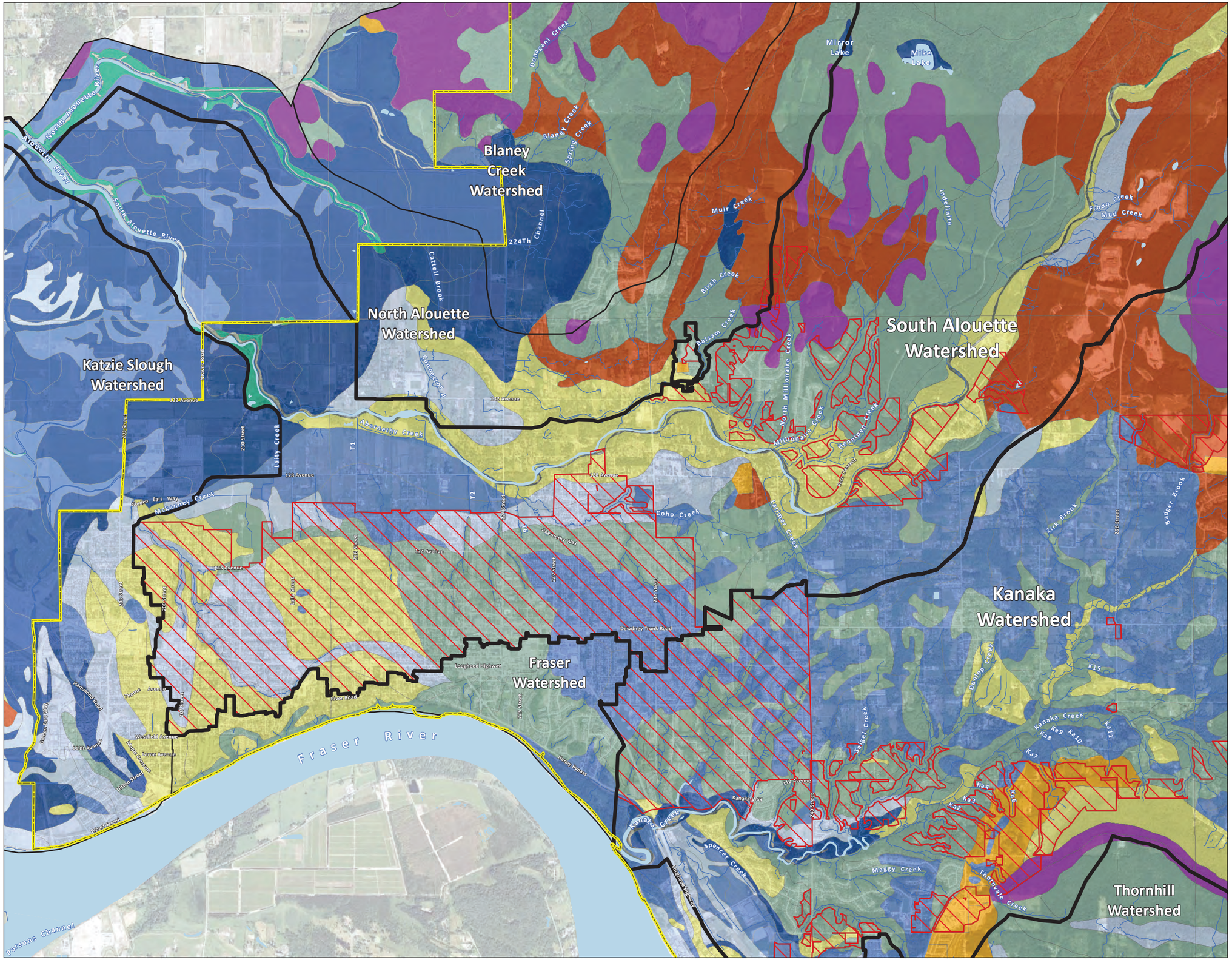

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South Alouette and Kanaka Integrated Stormwater Management Plans

Primary Soil Groups

Soil Drainage and Aquifer Recharge Potential

1. Slow Recharge / Seepage Discharge Areas:
   - Poor to very poor drainage
   - Poor to moderately poor drainage
   - Moderately poor to imperfect drainage
2. Slow Recharge / Seasonal Discharge Areas:
   - Moderately well drained
   - Well to moderately well drained
3. Rapid Recharge / Alluvial Areas:
   - Moderately well to well drained
   - Well drained
   - Well to rapidly drained
4. Mountain Block Recharge Areas:
   - Well to rapidly drained
   - Recent and Future Development or Redevelopment
   - Natural Watershed Boundary
   - Creeks
   - Municipal Boundary

500 250 0 500 1,000
m

N

Coordinate System:
NAD 1983 UTM Zone 10N

Data Sources:
City of Maple Ridge
City of Pitt Meadows
BC MoE
NR Canada

Project #:	1279.0025.01
Author:	BG
Checked:	GS
Status:	FINAL
Revision:	M
Date:	2017 / 8 / 16

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FIGURE 13.1

U:\Projects_VAN\1279\0025\01D-Drafting-Design-Analysis\GIS\Projects\MXD\Current\Phase 2 Report Figures - 20170815\Figure 5-1 - Maple Ridge ISMP Primary Soil Groups_ReVM.mxd Last updated by lpunt on August 16, 2017 at 11:18:46 AM

13.1.3 City's Practices

The City released Bulletin 2012-01 (June 27,2012) On-Site Stormwater Management Systems (Infiltrators), which lists the following siting requirements:

1- "Infiltrators must be setback a minimum 5.0m from building foundations or basements (This distance may be reduced to 3.0m for soils that do not have significant presence of clays). If located upslope from a building, then the distance is increase to 15.0m.
2- The base of all trenches must be set a minimum of 0.6m above the seasonal high ground water table and 1.2m above bedrock.
3- All infiltrators are to be located to ensure gravity flow from the house foundation.
4- Overflow mechanisms are to be installed to ensure surcharging of the system does not get to within 450mm of the low spot of a buildings perimeter drainage system.
5- Infiltrators must be a minimum of 30m from a source of water (well).
6- Infiltrators will not be permitted on soils with a percolation rate less than 0.5"/hr, and
7- Infiltrators are not permitted on slopes greater than 25% due to seepage, saturation and slope failure concerns."

13.1.4 Metro Vancouver Source Control Design Guidelines

As a point of reference, in 2012, Metro Vancouver released a reference document titled "Stormwater Source Control Design Guidelines 2012"[13]. This document addresses design considerations for on-site controls for different soil types as exist in Maple Ridge. Section 1 – Source Control Design Process of the Metro Vancouver document speaks to limitations and precautions to implementing source controls as follows:

- Steep or Unstable Slopes – The implementation of source controls should be prohibited in hazardous areas of potential slope instability.
- Overflows – As with all drainage works, source controls should be designed to ensure that facility overflows drain to the municipal minor / major drainage system or natural drainage path, and do not discharge to or though adjacent sites.
- Groundwater Protection – Infiltration should be separated from drinking water wells, against both surface water intrusion and ground water pollution. Currently, Provincial Health Hazard Regulation requires a minimum of 30m of horizontal separation between a well and potential surface water contamination sources.[14]
- Contaminated Soils and High-Risk Land Uses – Infiltration should be avoided in soils that have contamination, or within land uses that may generate high risk (eg. wrecking yards).
- Seasonably High-Water Table – Infiltration systems should be at least 600 mm above seasonably high-water table.
- Shallow Bedrock – Infiltration systems should be at least 600 mm above monolithic unfractured bedrock. However, many types of bedrock are highly pervious and suitable for infiltration.
- Riparian Areas or Protected Habitat – Infiltration techniques that require excavation are commonly restricted in areas of protected habitat.

[13] http://www.metrovancouver.org/services/liquid-waste/LiquidWastePublications/StormwaterSourceControlDesignGuidelines2012StormwaterSourceControlDesignGuidelines2012.pdf#search="Stormwater%20Source%20Control%20Design%20Guidelines"

[14] Health Hazards Regulation (gov.bc.ca)

The Metro Vancouver source control manual also recognizes the wide variety of soils that guides the application and design of source controls. It offers the following guidelines to address soil infiltration rate.

Table 13.2 - Metro Vancouver Stormwater Source Control Guideline Infiltration Rates

Soil Infiltration Rate tested at the site of proposed infiltration.	*Full Infiltration*	*Full Infiltration with Reservoir*	*Partial Infiltration with Reservoir and Subdrain*	*Partial Infiltration with Flow Restrictor*
>30 mm/hr.	**X**	X		
15–30 mm/hr.	X	**X**	X	
1–15 mm/hr.		X	**X**	X
<1 mm/hr.			X	**X**

Stormwater Source Control Design Guidelines 2012, Table 5-1.

When infiltration rates are greater than 30 mm/hr, the guideline suggests that strictly infiltration should be pursued. For moderate infiltration rates between 15 and 30 mm/hr the addition of a drain rock reservoir under a layer of soil provides temporary storage. In soils with low infiltration rates between 1 and 15 mm/hr the addition of sub-drains at the top of the drain rock reservoir diverts excess water when the reservoir is full. This provides opportunity for infiltration, while minimizing ponding. In soils over very low infiltration rates less than 1 mm/hr, infiltration still occurs (1 mm/hr is 24 mm per day) which still absorbs a significant portion of the annual rainfall. Facilities in these soils must include a reservoir and underdrain and may also be coupled with a discharge control device.

It is recognized that even in a natural system, where there is low infiltration rainwater is held within surface depressions and voids of topsoil, and once saturated will discharge into a nearby watercourse through horizontal seepage.

The above guidelines reinforce variability of conditions and performance, which in turn requires variability in how source controls are designed.

Some of the above noted City restrictions are generally consistent with those in the Metro Vancouver Source Control Guidelines, however the City's decision to restrict infiltrators in soils with a "percolation" (infiltration) rate less than 0.5"/hr (12.5 mm/hr) is not. As suggested by the Metro Vancouver Source Control Guidelines, site controls in soils with an infiltration rate below 12.5 mm/hr should be provided a reservoir layer and consideration for an underdrain but should not be prevented. It is anticipated that very few soils within the study area offer infiltration above 12.5 mm/hr. This restriction is anticipated to significantly limit the application of any source controls within the study area. It's recommended that design standards be developed to suit variable site conditions rather than prohibiting application of facilities in soils with infiltration below 12.5 mm/hr.

In addition to the above, it is understood that infiltrators are not achievable on lots of 371 m^2 or smaller (R1, R2, R3) due to a lack of space. For reference, a map of currently zoned R1, R2, R3 properties is provided in **Figure 13.2** to offer a sense of the magnitude of area serviced by on-lot controls for this reason. At a macro scale within the watersheds the areas are generally insignificant, however a local neighbourhood level the areas are significant and may result in local impacts,

including higher storm sewer discharge more frequently which can contribute to stream erosion, and decrease creek base flows during summer. A failure to achieve Tier A controls puts stronger emphasis on needing to achieve Tier B controls.

Yet, the City has expressed that Tier B are also sometimes not achieved because the size of the orifice in the flow control manhole becomes quite small and is prone to getting blocked. It is understood that the City has specified a minimum orifice size of 16.5mm in diameter, and at that size is unlikely to detain the 2yr post to the required 2yr forested condition rate. For this, the City could consider a design template that includes a pre-treatment strainer ahead of the orifice. There may also not be enough room between the house and garage to accommodate the size of detention tank needed.

As such, for a variety of reasons there are several cases where Tier A on-lot controls are not achievable. In these instances, the best approach will be to enforce minimum amended topsoil requirements of 300 mm for all landscape surfaces with direction of roof leaders to the landscaped surfaces to the degree possible, along with communal facilities in public lands that can achieve the Tier B target. This will require dedicated space based on the service area and soil infiltration capacity. Under most circumstances the land base required to achieve Tier B detention is likely far less than the land base required to meet the Tier A retention target because it is far more dependant on surface area. It is anticipated that additional space and facilities will be required to fully satisfy Tier A targets but is highly governed by the infiltration capacity of the local soils.

When a Developer can't meet the Tier A criteria by providing the off-site facilities either (escarpment area, geotechnical issues or smaller subdivisions), the City may then consider cash-in lieu to fund the City looking for other compensating benefits within the watershed.

And finally, the application of ground disposal methods is prohibited in high risk geotechnical areas such as the area bounded by 207 Street, 124 Avenue, 224 Street and the Fraser River Escarpment (refer to **Appendix E** for policy 6.23).

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South Alouette and Kanaka Integrated Storm Water Management Plans

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Current Zoning

- Natural Watershed Boundary
- Creeks
- Parcel

Current Zoning

- R-1
- R-2
- R-3
- RS-1b
- Municipal Boundary

South Alouette Watershed

Kanaka Watershed

Sturgeon Slough
Blaney Creek
Mirror Lake
Mike Lake
Muir Creek
Mud Creek
Channel
224Th
South Alouette River
Cattell Brook
Birch Creek
Balsam Creek
North Millionaire Creek
Millionaire Creek
Indefinite
Badger Brook
132 Avenue
128 Avenue
126 Avenue
129 Avenue
123 Avenue
Golden Ears Way
Coho Creek
Latimer Creek
Abernethy Way
216 Street
224 Street
232 Street
240 Street
256 Street
Zirk Brook
Dewdney Trunk Road
Dunlop Creek
McFadden Creek
Whonnock Lake
Zz Brook
Brynes Brook
Thorne Avenue
River Road
Lougheed Highway
Kanaka Creek
Spencer Creek
Maggy Creek
Thornvale Creek
102 Avenue
100 Avenue
Albion Brook
James Creek
Potter Creek
Fraser River
Bedford Channel

The accuracy & completeness of information shown on this drawing is not guaranteed. It will be the responsibility of the user of the information shown on this drawing to locate & establish the precise location of all existing information whether shown or not.

200 0 200 400
m

Coordinate System:
NAD 1983 UTM Zone 10N

Data Sources:
City of Maple Ridge
City of Pitt Meadows
BC MoE
NR Canada

Project #:	1279.0025.01
Author:	BG
Checked:	GS
Status:	FINAL
Revision:	N
Date:	2019 / 9 / 24

URBAN systems

FIGURE13.2

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13.1.5 Water Quality Treatment

Tier A criteria emphasis is currently on volumetric retention, with little emphasis on water quality treatment. The criteria and standards should be expanded to be more explicit with regards to bio-filtration and water quality treatment. First is to consider what contaminants may be of most interest or concern.

Typical non-point source (NPS) pollutants that are conveyed in rainwater runoff include suspended sediments; nutrients such as nitrogen and phosphorous; trace metals such as copper, nickel and zinc; bacteria; and hydrocarbons. Many of these are by-products of vehicle use (i.e., automobiles, buses and trucks), but also of such things as the use of chemicals to maintain green lawns, chemicals in roofing and other construction materials, pet and wildlife droppings, and even general littering. **Table 13.3** lists common runoff pollutants and their sources. It is presumed that many, if not all, of the pollutants listed below will be present in rainwater runoff from development in the study area.

Table 13.3: Common Non-Point Source Pollutants and Their Sources

POLLUTANT	COMMON SOURCES
Total Suspended Solids (TSS)	Construction sites; exposed or poorly vegetated lawns and open space; pavement wear; vehicle use, including maintenance; litter breakdown; de-icing (sand); industrial yards; atmospheric deposition
Petroleum Products*	Spills, leaks and blow-by of motor lubricants, antifreeze and hydraulic fluids from vehicles; industrial/commercial development sites; uncovered fueling stations; industrial yards
Nutrients (Nitrogen; Phosphorous)	Fertilizer application on lawns, golf courses and playing fields; open space; atmospheric deposition
Lead	Vehicle use (tire wear; lubricating oil; grease; bearing wear; batteries); paint
Zinc	Vehicle use (tire wear; motor oil stabilizing additive); galvanized pipe; uncoated metal roofs; corroding building surfaces; high use parking lots and driveways; industrial sites; de-icing (salt); wood preservatives; paint; atmospheric deposition
Copper	Vehicle use (metal plating, bearing and bushing wear; moving engine parts; brake lining wear); fungicides, insecticides and algaecides; industrial sites; paint; atmospheric deposition
Cadmium	Vehicle use (tire wear); insecticides
Chromium	Vehicle use (metal plating; moving engine parts; break lining wear); paint
Pathogens**	Livestock, pets and wildlife; lawns and open space; roofs; gutters & storm drains
Polycyclic Aromatic Hydrocarbons (PAHs)	Vehicle use (partially combusted fuels); atmospheric deposition from stationary sources (e.g., partially combusted carbon-based fuels such as wood, coal, diesel, etc.)

**Frequently identified as "oil & grease" in many rainwater management studies, as that has been the standard test method used for many years. However, "petroleum hydrocarbons" is a better descriptor.*
***Frequently identified in rainwater management studies by using either total or fecal coliform bacteria as an indicator.*

Not listed are other "emerging contaminants", such as nano-particles, per- and polyfluoroalkyl substances (PFAS), pharmaceuticals and personal care products (Tran, et al., 2019); the actual extent and implications of the presence of such products is still under investigation. However, the presence of these are more relevant to wastewater streams than rainwater runoff.

The impacts of several common NPS pollutants are briefly noted here. High levels of TSS can damage fish and aquatic invertebrates and degrade in-stream habitat where the material settles onto gravel and cobble substrates. Besides simply producing an unsightly sheen to water, petroleum hydrocarbons can be directly toxic to aquatic life. Copper (Cu) and zinc (Zn) are primary trace metals of concern because of their adverse impacts on fisheries. Copper interferes with fish sensory systems related to predator avoidance, juvenile growth and migratory success. Zinc alters behavior, blood and serum chemistry, impairs reproduction and reduces growth. Presence of pathogens (including viruses, bacteria and parasitic protozoa) can directly cause infections in those cases of contact recreation or other use of contaminated water, and can lead to contamination and closure of shellfish harvesting areas and contamination of wells. PAHs are known for their carcinogenic, mutagenic and teratogenic properties; they show moderate to high acute and chronic toxicity to aquatic life. Nitrogen, in its form as nitrates (NO3), can stimulate harmful algal blooms in ponds and lakes and, in its form as nitrites (NO2), can have serious health effects in fish and in humans. Phosphorus is also well-known for stimulating algal blooms.

Recently, an emerging, highly lethal, contaminant was identified in urban runoff (Tian, *et al*, 2021). This contaminant, 6PPD-quinone, causes high mortality in coho salmon and, as a by-product of the breakdown of rubber tires, is ubiquitous in urban/suburban water course environments. At this time no specific treatment process has been identified to remove 6PPD-quinone from runoff, although bioretention-based systems appear promising (MacIntyre, 2016). Finding a replacement for 6PPD (the chemical used in tire manufacturing) is apparently already being explored (USTMA, 2021). Until such time that an alternative chemical is implemented, reduction of this chemical reaching waterways is likely best addressed through street cleaning (using high efficiency vacuum sweepers) and water quality treatment methods.

One other particularly pernicious emerging pollutant is road salt. The use of road salts has become a significant issue in locales with winter weather conducive to ice formation. Chlorides from the salt are extremely difficult to remove from runoff and, and being dissolved, they readily contaminate groundwater as they percolate into soils. Once stored in local soils, the chlorides can be released to surface watercourses or continue to percolate into deeper aquifers. In surface waters, chlorides are harmful to aquatic life. To the extent possible the City uses brine, which is 23.3% salt, rather than rock salt, which is 100% salt and has a very high scatter when placed.

A frequent question or concern is the quality of runoff from building roofs. In the past it has often been assumed that roof drainage is generally "clean"; however, a number of researchers have noted that rainfall coming in contact with roofs as well as exterior building surfaces may be contaminated with a variety of pollutants (Minton, 2011). As noted in **Table 13.3**, above, wood preservatives, paint, uncoated metals, biocides and pathogens (from animal droppings) can be washed off buildings. Vents on roofs (e.g., oven or grill vents from restaurants) can also deposit oil and grease on roofs then wash during storms. Further, atmospheric deposition of other particulates can find their way on to building surfaces, potentially contaminating runoff. This is not to suggest that all roof runoff is high in pollutants, but at the same time it is fallacy that all roof runoff is clean.

Many of the pollutants listed above, and the ones in greatest quantity in an urban environment, are associated with vehicle and building materials. Municipalities have no jurisdiction to control either. Regarding building materials, Provincial legislation prevents a local government from regulating anything that is already regulated within the building code to a more

restrictive standard. As such, the City relies on the industries themselves to be good stewards and evolve their practices. And it relies on senior level regulators to force the industries to change. The Building Code is modified from time to time by the provincial Building Safety Standards Branch in conjunction with National Research Council Canada (NRC). While not in control of the building materials, the City can advocate for industry change. Regarding the deleterious impact of building materials such as certain roofing products on stormwater runoff[15], the first step may be to monitor international research, collaborate with other local governments to examine the issue and request a review by the NRC.

Key Pollutants

Given the number of potential NPS pollutants that can be picked up and conveyed by rainwater, the following discussion can be simplified somewhat by focusing on just a few "key" pollutants:

- Sediments; as represented by total suspended solids (TSS);
- Trace metals; as represented by total copper (Cu);
- Nutrients; as represented by nitrites-nitrates (NO2-NO3);
- Petroleum hydrocarbons, as represented by total oil and grease (O&G); and
- Pathogens; as represented by fecal coliforms.

In discussing treatment and/or preventive measures for the key pollutants, it might be helpful to first look at what can be expected in the way of levels (or concentrations) for these pollutants in runoff. Some data are available to differentiate among a few select broad land use categories and these are shown in **Figure 13.3**, below (based on Pitt, et al., 2018). "Event mean concentrations" (EMCs) have become the commonly accepted notation for conveying the magnitude of runoff pollutant loads. An EMC is the total mass of pollutant divided by the total volume of runoff for a single rain event. The data presented in **Figure 13.3** is based on between 1,450 and 4,870 individual EMC data points, depending on the pollutant.

Treatment Mechanisms and Methods

There are many physical, chemical and biological processes that are applicable to the treatment of rainwater. These include gravity separation (settling; flotation), filtration, absorption, adsorption, flocculation, chemical reaction and transformation, disinfection, and biological uptake. Many pollutants found in rainwater runoff are to some degree hydrophobic; in other words, they are associated with sediments that can, in turn, be settled or filtered. This suggests that, once entrained in runoff, a basic treatment strategy can focus on removing total suspended solids (TSS), after which increasingly more intensive treatment could be applied to remove very fine sediments, which may not be easily settled, dissolved pollutants or other more difficult to remove contaminants. That said, it is always preferable to keep pollutants out of runoff in the first place, through source controls, street cleaning, adaptive site design and other best practices (see next section below for further discussion).

[15] McIntyre, J.K., N. Winters, L. Rozmyn, T. Haskins, J.D. Stark. 2019. Metals leaching from common residential and commercial roofing materials across four years of weathering and implications for environmental loading. Environmental Pollution. Volume 255, Part 2. 113262, ISSN 0269-7491. https://doi.org/10.1016/j.envpol.2019.113262

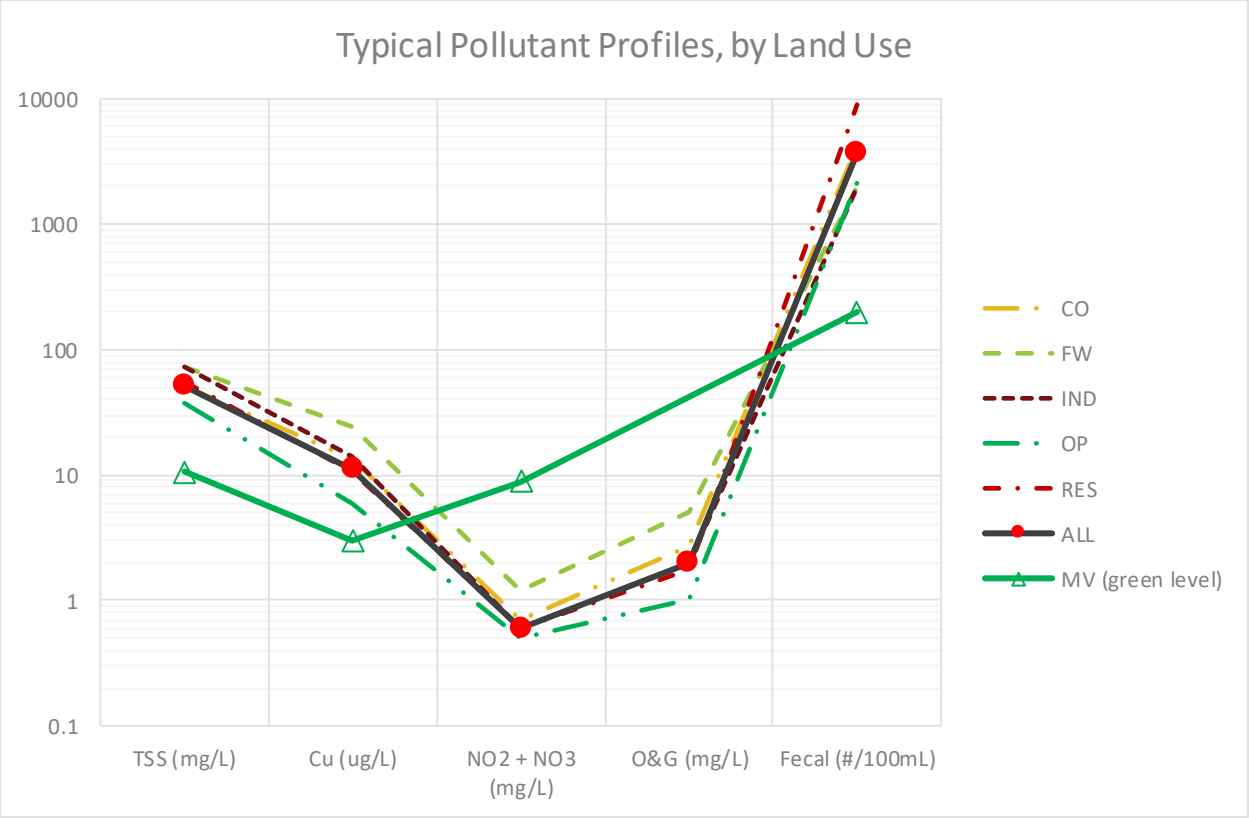

Figure 13.3 - Typical Median EMCs of Key Pollutants in Rainwater, by Land Use Category

Key: **CO** is commercial; **FW** is freeway; **IND** is industrial; **OP** is open space **RES** is residential; and **ALL** is combined data from all land uses. For comparison: **MV (green level)** is "good" WQ level per Metro Vancouver "Adaptive Management Framework". Note: Y-axis scale is logarithmic.

Pathogens, presumed present when an indicator species such as fecal coliform bacteria are detected, are solids themselves and often associated with inorganic sediments (e.g., silts); further, exposure to sunlight and contact with organic soils tends to kill or remove fecal coliform bacteria. Thus, again, focusing on TSS removal as well as emphasizing the use of "naturalized" surface-oriented rainwater management systems will provide a high level of fecal coliform treatment.

Copper is found as both solids and in dissolved form, in varying ratios depending on local conditions. Further, as a solid, it is often associated with very fine particles. Unfortunately, it is the dissolved form that is most troublesome for aquatic life.

PAHs are frequently found in open channels and could have been included in the list of key pollutants. PAHs are lipophilic, i.e., they mix easily with oils rather than water; further they are also commonly associated with soil and sediments (i.e., TSS). Thus, focusing on removal of TSS and oils will also tend to remove PAHs.

In addition, because of their toxicity and carcinogenic potential, pesticides (including herbicides, fungicides and insecticides) could be considered, as well. These are best controlled through strict restrictions or complete bans on their use, rather than by attempting to remove them once entrained in runoff.

Several decades ago, runoff treatment began following the lead of wastewater treatment, first by focusing on removing trash, grit and other coarse materials (sediments) in runoff. Thus, some of the first commercially available runoff treatment devices were oil/grit separators, such as "StormCeptors", manufactured by a Canadian-based company, currently known as Imbrium Industries. With the realization that removing coarse sediments from runoff was not enough to protect receiving waters,

attention began to focus on removal of finer sized solids using various filter media and, in some cases, removing dissolved pollutants through application of various physical, chemical and biological processes (including "green" technologies like rain gardens).

Infiltration of rainwater is an opportunity both to reduce total runoff volume to surface watercourses and to replenish groundwater. However, contaminants not removed directly from the runoff before the infiltration occurs can simply be transported into the groundwater where they may remain for a long time. This is particularly true if the infiltration occurs directly into coarse sand and gravel materials or into highly fractured clay or rock. Other risk factors related to groundwater contamination are depth to groundwater, land use and solubility of contaminants. Pre-treatment prior to infiltration is critical. In this context, percolation through "topsoils" (see next paragraph) can be considered pre-treatment.

Filter media (i.e., "soils" or growing media) form the backbone of the treatment provided in bioretention/biofilter-type facilities (i.e., "low impact development", LID, or "green stormwater infrastructure", GSI) and sufficient depth must be provided to ensure performance. For the key pollutants, this means the following minimum depths, based on Minton (2011) and MPCA (undated; but still current as of October 2018):

- TSS – 50-75mm of bioretention growing media;
- Metals – top 200mm of bioretention growing media;
- Nitrogen – from top to bottom and as much retention time as possible, with minimum 1.0m of bioretention growing media;
- Petroleum hydrocarbons – 75-100mm of mulch and top 25mm of bioretention growing media; and
- Fecal coliforms (and other pathogens) – as much contact as possible, with minimum 600mm of bioretention growing media.

Similarly, for the noted key pollutants, generally hydraulic conductivity in the range 50-150 mm/hr is recommended (MPCA, undated). That said, Minton (2011) notes that concerns have not been raised about higher rates and good performance has been noted for systems with rates up to 1,250-2,500 mm/hr. Lower rates are, however, associated with improved bacteria (pathogen) removal (WEF and ASCE/EWRI, 2012).

The need to consider enhancing the treatment capabilities of bioretention growing media (greater levels of removal; removal of metals, nutrients and emerging pollutants) has led to research in use of various additives to soil. These include compost, zeolite, activated carbon, biochar, iron and more. This same kind of exploration has been occurring with respect to manufactured filter devices as well. Increasingly, it appears possible to remove specific contaminants associated with specific industries or land use activities, though there can be high costs to do so.

A basic picture of how well various best practices can treat runoff is available through an on-line database of stormwater best management practices (BMPs) (Clary, et al., 2017). The database draws on over 700 BMP studies and, along with other resources, provides performance analysis results from those studies. The studies have been all been vetted to meet high quality assurance standards in order to deliver comparable results across many BMP installations.

Based on the BMP database, **Figure 13.4** shows achievable treatment level profiles for some of the eleven (11) BMPs. The figure shows median achievable effluent EMCs for the key pollutants[16]. Results are compared against the target levels for

[16] Note that some of the key pollutants are missing from the database for some BMPs, usually either because they were not included in the testing protocol or because their values were below the detection level. Also note that other parameters, such as the 25 and 75 percentile EMCs and coefficient of variation, are also available from the cited report; these can give a fuller picture of performance.

the key pollutants as listed in the "Adaptive Management Framework" document recommended for use by municipalities in the Lower Mainland (Metro Vancouver, 2014).

Sometimes percentage removal is used as a means of expressing treatment performance capability. However, this is not a good way to evaluate runoff treatment, for several reasons, including:

- For many pollutants, the achievable effluent concentration is a function of the influent concentration (i.e., the greater the influent concentration the greater percent removal that can be achieved).
- For other pollutants, there is a minimum achievable effluent concentration (i.e., the technology being evaluated or applied can not do any better).
- In some cases, the concentrations of a rainwater pollutant are less than the minimum achievable effluent concentration to begin with or are at a level not considered problematic in the first place.
- Finally, using percent removal can lead to erroneous results when evaluating performance of treatment facilities in series, generally overstating performance.

Percentage removal should thus only be used as a preliminary or rough guide to the performance of various BMPs over extended periods. Better to compare the achievable effluent concentration against common water quality guidelines or target levels in a watercourse than worry too much about performance "efficiency" during a single rainfall event.

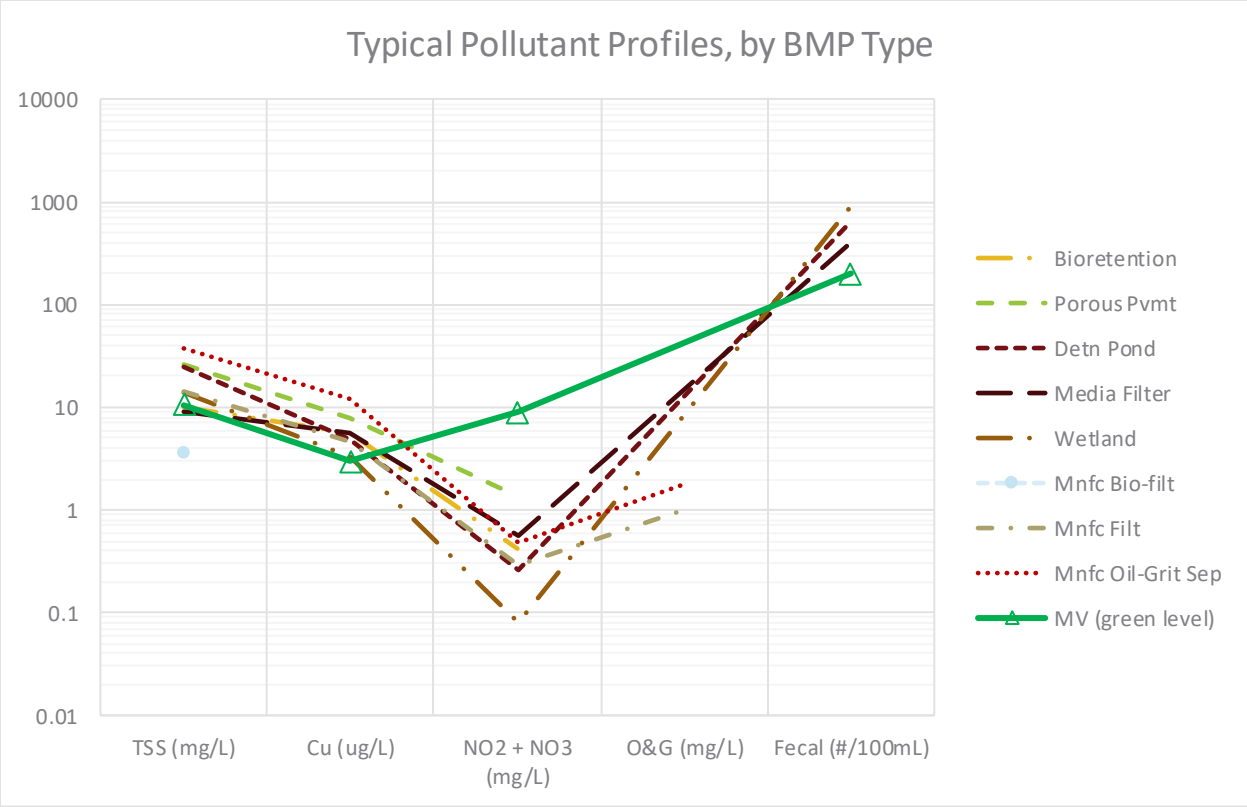

Figure 13.4 - Typical Performance of Some Common Best Management Practices

Key: **Bioretention** includes rain gardens, bioswales and biofilters; **Porous Pvmt** includes asphalt and concrete; **Detn Pond** is a dry detention basin; **Media Filter** is in-ground filters using sand (with or without amendments); **Wetland** is a constructed stormwater wetland; **Mnfc Bio-filt** includes various manufactured biofilter systems with trees or other vegetation; **Mnfc Filt** includes various manufactured, cartridge-style media filters; **Mnfc Oil-Grit Sep** includes various manufactured coarse particle removal devices. For comparison: **MV (green level)** is "good" WQ level per Metro Vancouver "Adaptive Management Framework". Infiltration BMPs (infiltration swales, trenches and galleries; drywells/soakaway manholes and rock pits) don't have "discharges" per se, and thus are not included in this graphic. Note: Y-axis scale is logarithmic.

There are several ways a community could begin to apply these BMPs with an eye to improving runoff quality before it is released to surface watercourses or infiltrated to groundwater.

- Firm performance targets could be set for BMPs, e.g., 90% removal of TSS at any time or 90% removal of the total annual mass of TSS. Or, due to the problematic nature of applying percent removal as a performance measure, specific pollutant concentrations could be set, e.g., maximum discharge of 30 mg/L TSS at any time. These approaches could be difficult to implement as they require either regular (or periodic) self-monitoring and reporting on the part of owners to prove compliance or regular (or periodic) monitoring by the City to do the same.
- Another approach is simply to require the implementation of at least one or more of the BMPs listed above, under the presumption that this will protect water quality. As a variation on this, the City could require use of certain BMPs based on land use or land use activity, again under the presumption that this will protect water quality. The State of Washington uses a combined approach that first acknowledges that different BMPs have different performance characteristics that should be matched with site-specific land uses or activities. Treatment levels have been set for "basic" (for TSS), "enhanced" (for metals), "oil" and/or "nutrient (phosphorus)" treatment, with treatment

performance capabilities for a wide variety of structural controls reviewed and certified through a state protocol. In Washington's view, "basic" treatment means removal of >80% of TSS, a level that generally cannot be achieved with typical manufactured grit removal structures, which are limited to use as pre-treatment prior to discharge to other devices (this would be similar to a sediment forebay in a detention or wet pond).

- Total maximum daily (weekly, monthly, annual) loads for a suite of pollutants could be established and allocated among the various land uses or properties of the area; developers would then formulate and submit their own designs for meeting the targets. This requires a thorough scientific assessment of the receiving waters' current condition and capacity to assimilate rainwater inflow without unacceptable degradation, followed by formulation of allowable discharge loads and subsequent review and approval of proposed treatment plans by developers.

It would seem, that for the City something like the second approach would work best; it is consistent with the two applicable ISMPs and other previous recommendations for the area. Below a range of best practices are briefly reviewed.

Application of Best Practices

For this discussion we group BMPs into four broad categories:

Site adaptive planning includes a variety of site design practices that can be used to reduce the impervious surface coverage on a wide range of land uses. These practices include reducing roadway widths, reducing building footprints, reducing parking standards (number of parking spaces provided per dwelling unit), limiting amount of surface parking, building compact communities and preserving natural features such as wetlands, forests and soils. Tree restoration and urban forestry would also sit in this category.

As already well recognized by the City, ***source controls*** are those practices intended to reduce runoff volume by retaining or enhancing infiltration and evapotranspiration; these practices supplement the site adaptive planning BMP that directly reduce impervious surfaces in a watershed. Source controls are typically applied to an individual building site or property, such as a single house, apartment complex or shopping mall. Some source controls do provide direct water quality benefits. Examples of source controls with water quality benefits include absorbent landscaping (amended soils), surface (e.g., green roofs, rain gardens and vegetative planters). Those with lesser water quality treatment benefits include subsurface (e.g., drywells and soak-away manholes; rock pits) infiltration facilities, pervious paving (pavers; concrete and asphalt paving), pervious decks, rain barrels and disconnected roof leaders. Though not usually listed as "LID", per se, some manufactured facilities can be considered source controls; for example, oil/water separators are often located at gas service stations, but generally only service a small portion of the property in order to limit their size.

Structural controls are perhaps the most well-known type of stormwater treatment practices, generally providing hydrologic and water quality benefits for rainwater catchments larger than a single property or site; sometimes called "end-of-pipe" practices, they needn't actually be situated at the downstream end of a storm sewer system outfall. About 50 years ago, communities across North America began constructing detention ponds to attenuate the affects of peak runoff from developments; a side benefit of their use was removal of TSS from the rainwater. Since then, a number of other structural BMPs have been added to the tool box. Some of these are retention (wet) ponds, constructed wetlands, infiltration (bio)swales, sand filters, and a wide variety of manufactured water quality control facilities for gross solids removal, oil and coarse sediment removal (aka, oil/grit separators or hydrodynamic separators), and advanced treatment (including, media filters, chemical coagulation, disinfection, ion exchange and "treatment trains"). While sharing with source controls a focus on the use of LID concepts, green stormwater infrastructure (GSI) facilities can also be considered structural controls. Among

these are large scale rain gardens and other bioretention (biofilters; bioswales) facilities. They may be used to treat rainwater prior to large scale infiltration or drain directly to a storm sewer system. It should also be noted that there are an increasing number of manufactured water quality control facilities on the market that incorporate green infrastructure-like design components, including trees, wetland vegetation and/or amended soils. In general, these should be viewed as functionally equivalent to GSI facilities. It should also be noted that GSI offers environmental and other co-benefits that many manufactured facilities do not, for example, runoff reduction through evapotranspiration, urban cooling and carbon sequestration.

Media based proprietary treatment system will include a proprietary bioretention media, but for non-proprietary treatment systems (eg. raingarden) the City may consider specifying a media that is easily available locally. Appropriate media would be identified through the City's Green Infrastructure Strategy review process.

Finally, ***non-structural practices*** focus both on maintaining the long-term usefulness of structural BMPs and source controls, as well as reducing the likelihood of stormwater causing problems in the first place. In this category are street cleaning, detection and containment of contaminant spills, maintenance of vegetation in rain gardens and bio-swales, sump cleaning for catch basins and manufactured BMPs, media filter cleaning and replacement for certain "advanced" manufactured BMPs, public education programs, best practices for fertilizer and pesticides, adoption of alternative pest management programs, and best practices for handling and using potential pollutant-generating materials such as salt. This last example of a non-structural BMP is particularly critical at hot spots where commercial (or industrial) activities may expose harmful materials to rainfall for potential pickup in runoff.

The point of this discussion is to suggest that a strong runoff quality program can and should draw on a variety of best practices from each of these four categories. There are numerous guidelines available for planning and design, such as those issued by Metro Vancouver (Lanarc, *et al.*, 2012). As a rule of thumb, for example, one can anticipate bioretention-type facilities to require a *maximum* "impervious area to pervious facility area" (I/P) ratio on the order of 20:1, 30:1 and 50:1 for collector roads, local roads and single-family residential areas, respectively. (For planning purposes, accounting for a healthy contingency would be advised.)

One final note in regards to infiltration within well capture zones; given the pollutant profile of runoff from both residential areas and public roads and given the importance of protecting water source aquifers from unnecessary degradation, all rainwater should be pre-treated prior to infiltration to the aquifer to a level beyond simple removal of grit and other coarse particulates. While this is necessary to minimize clogging of subsoils, additional attention to keeping specific pollutants out of the infiltration zone through use of LID, GSI or advanced water quality treatment devices is advised. This same caution could be applied to direct discharges to surface watercourses as well. The Province of BC has prepared the "Underground Stormwater Infiltration – Best Practices for Protection of Groundwater Resources in British Columbia".[17] This document recommends that to reduce potential pathways between infiltration facilities and water wells, underground infiltration systems should meet a minimum horizontal setback distance from all domestic and municipal drinking water supply wells and irrigation wells. Underground infiltration systems are not appropriate for areas with high potential for contamination. A minimum setback distance of 60 m is recommended between infiltration systems and well heads, consistent with the Municipal Wastewater Regulation. However, a protective setback distance will depend on site-specific conditions including the direction and rate of groundwater flow and the vulnerability of the drinking water wells to contamination. Therefore, greater setback distances may be required to address site-specific hydrogeologic conditions. Capture zone analysis is an alternative

[1717] http://www.env.gov.bc.ca/wsd/plan_protect_sustain/groundwater/library/underground_stormwater_infiltration-2014.pdf

approach for establishing a setback distance. The Province recommends a setback distance based on well-head travel times (e.g., a one-year travel time) be established. Wells that are registered with the Province and a high-level statement on aquifer vulnerability are provided in Section 10 – Hydrogeologic Conditions. A hydrogeologist will need to be engaged as a separate assignment to more succinctly state well capture zones and recommended setbacks.

Based on the above, the following considerations are recommended to address water quality treatment concerns:

- Beyond the Provincial Best Practices for groundwater protection, map respective well capture zones, with a statement on whether they are confined or unconfined from surface water within the urban boundary. This will map the risk of surface water pollutants to potable source waters.
- Update the tiered approach to water quality control that provides:
    - ***Basic treatment*** that focuses on TSS and oil removal at sites with lower potential for runoff contamination; and
    - ***Enhanced treatment*** that additionally focuses on metals and nutrient removal at sites with a higher potential for runoff contamination.
- For single family residential properties, consider ***basic treatment*** to be a sufficient level of rainwater management, which can be met through:
    - Use of amended growing media over the entire lawn area, to a minimum depth of 300mm; and
    - To the extent possible, direct runoff from hard surfaces (roof, patio, sidewalk and driveway) to landscaped areas.
    - Rain gardens, rainwater harvesting, or other site adaptive and source control practices would be encouraged, though still at the discretion of the homeowner.

Municipalities across the Metro Vancouver (MV) have been hesitant to require engineered water management systems on single family residential lots because of the lack of resources for municipalities to enforce proper operation and maintenance by the home owner. A more passive approach to managing single family lots is taken. In 2017, Metro Vancouver released the "Region-wide Baseline for On-site Stormwater Management (For use on Single-lot Residential Development in the Greater Vancouver Sewerage and Drainage District) [18]. Consistent with recommendations above, the MV document promotes drainage of impervious surfaces to permeable ones, to use permeable paving, or to collect and drain runoff through a sump prior to discharge to the storm sewer.

Residential driveways are less risk that the public roadways, but are a pollutant source. Driveway are typically graded down to the roadway, so directing all runoff from a driveway to a landscaped surface is a legitimate challenge. To overcome these challenges, municipalities are gradually transforming roadways to include green infrastructure, and municipalities could make it a requirement for trench drains across the foot of driveway, directing runoff to an infiltration gallery, raingarden, or sump with trash-hood and overflow to the storm sewer.

- For all other properties, consider requiring ***enhanced treatment***, which must be met by:
    - Application of site adaptive and source control practices on the site as possible.
    - Use of amended growing media over landscape areas, to a minimum depth of 300mm for lawn (but perhaps exempt "natural areas" within "Park and Open Space" and "Conservation" areas); and

[18] Region-wideBaselineOnsiteStormwaterManagement-Feb2017.pdf (metrovancouver.org)

- Direction of all runoff from hard surfaces (roofs, sidewalks and parking lots) to appropriate source or structural control BMPs, with a preference for LID practices.
- Application of non-structural controls as possible.
- Subsequent discharge of runoff could be to groundwater (preferred) or to local surface waters.
- Preparation and application of a Site-Specific Rainwater Management Plan as part of the development process.

- For public roads, consider applying ***enhanced treatment***, which must be met by:
  - Application of site adaptive and source control practices within the ROW, as possible.
  - Use of amended growing media for all lawn areas along roads, to a minimum depth of 300 mm;
  - Direction of all runoff from road surfaces to appropriate source or structural control BMPs, with a preference for LID practices. Sole use of devices or features that target coarse sediments[19] for removal should not be considered sufficient to meet this requirement, although they may be used in conjunction with other best practices to provide enhanced treatment.
  - Application of non-structural controls as possible, specifically adoption of environmentally-friendly best de-icing practices (see, for example, EPA, 2010).
  - Subsequent discharge of runoff could be to groundwater (preferred) or to local surface waters.

Please refer to Appendix F for reference material

13.1.6 Alternatives

While diversifying the criteria and standards to maximize retention through on-site infiltration systems, there will remain site limitations that will prevent the application of ground level on-site LID (eg. steep slopes, inappropriate soils, land use limitations, etc.). In unique circumstances the City could identify alternative solutions which may be considered, such as:

- Green Roofs. While not suitable for all land use types, they are being more common in the Metro Vancouver region for large scale buildings with flat, or near flat roof lines. This is particularly the case in the City of Vancouver. It is a proven method for achieving rainwater retention where the landscape space surrounding the building is inadequate. The downside is that Green Roofs add cost to the construction and long-term maintenance of the building.
- Off Site Options. The City may consider the possibility of offsite options for a developer, in special circumstances. This might include possible fiscal compensation scheme that goes into a designated SMP fund for developments that are not able to achieve their 3 tier requirements on site, but somewhere in the near vicinity. In some areas due to soils, densities & lot size, geotechnical, or other reasons, it might make more sense for the City to consider establish community management facilities for detention/retention, bio-filtration, or infiltration purposes, but will require further exploration for where and when these types of solutions can occur.

13.1.7 Rainwater Harvesting (RWH) and Reuse

Some interest has been expressed within Maple Ridge staff and Council as to the potential role that rainwater harvesting (RWH) and reuse may play in the overall management strategy.

[19] Such devices include manufactured treatment facilities such as hydrodynamic separators, oil/grit separators and baffle boxes, as well as features such as sediment forebays and the like at ponds, wetlands and swales.

RWH is the practice of collecting and storing rainwater for future use. At a minimum, RWH are comprised of a catchment area, a storage vessel, and a conveyance system. More elaborate systems can also include a pump, water treatment, and fixtures for the use of water.

Depending on the design and level of water treatment and purification, RWH can be used for outdoor irrigation, domestic purposes, such as toilet flushing and laundry, and even potable uses. However, with each respective use listed are increasing levels of system complexity and regulation. It is important to consider codes, regulations, and standards. But presently, no single set of Provincial or Federal regulations addresses the collection, storage, purification, and disinfection of rainwater.

Some regulations and codes do exist, including:

- B.C. Plumbing Code requirements for hydraulic loads from peak storm events, for piping under driveways, for potable water distribution pipes, and for backflow prevention devices;
- B.C. Building Code requirements for building and roof structures, for maximum flow loads of drainpipes, and for drainage away from structures;
- Electrical codes for wiring and pumps,
- International and Canadian certification for potable water tanks, pipes and water purification and disinfection equipment, and
- Health Canada's Guidelines for Canadian Drinking Water Quality.

One must also consider the objectives and benefits the rainwater harvesting and reuse may provide. The practice does not measurably change winter design flows or flood risk, so will not affect the design and sizing of municipal rainwater management infrastructure. But the practice does respect rainwater as a resource, reducing the demand on other water supply systems, and when used for irrigation, can help recharge groundwater during drier periods of the year (May through September), and to reduce overall runoff volumes to receiving natural waterbodies.

Categories of RWH

The fundamental distinction between RWH systems is whether they provide Non-Potable Water (Outdoor Use), Non-Potable Water (Indoor Use) for flushing toilets, or Potable Water (Human consumption). Each category requires different components, operational requirements, and maintenance responsibilities to supply the quality of water designated for the appropriate use and to prevent cross connections between the harvested rainwater and the water in any drinking water system.

Non-Potable Outdoor Use RWH systems are for non-drinkable uses and have no treatment requirements. Such uses include:

- Garden watering and irrigation use
- Pool/hot tub/pond filling
- Water for animals
- Outdoor cleaning
- Vehicle washing
- Fire protection or emergency water

Building roofs are the primary water source. Most standard roofing types, gutters and downspouts can be used, though for pool filling or irrigation of food crops, water for animals, certain roofing materials, particularly those containing lead or other contaminants, should be avoided.

Non-Potable (Indoor Use) RWH systems are for non-drinking water using within a building; most commonly toilet flushing. Compared to outdoor use RWH systems, indoor use generally:

- Operated year-round
- Requires a dedicated pumping and distribution system within the building
- Requires primary treatment to remove debris, at a minimum
- Without colour control and disinfection, RWH will likely cause discoloration and algae growth within the toilet

Potable RWH is safe to drink and meets Health Canada's Guidelines for Canadian Drinking Water Quality. Water colour, acidity, and removal of pathogens must be addressed. Uses include:

- Drinking water
- Household laundry
- Bathing and showering
- Cooking, and
- Dishwashing

In comparison to Non-Potable systems, potable RWH systems generally:

- Operation year-round
- Are far more costly to design and operate
- Incorporate a higher degree of pre-treatment before water enters the storage tank
- Require thoughtful computations of collection area and storage volume, which will dictate the degree to which the household can meet its water demands
- Require post-storage filtration and disinfection
- Require careful attention to maintenance

Because of the complexities and cost for a potable system, property owners would consider a potable RWH where a communal water service does not exist or is substandard, and where well water is not reasonably accessed.

For a single property, health authority approval is required to construct the RWH system, but there are no further regulatory reporting requirements. Any system servicing more than one property is considered a communal system and requires minimum maintenance and reporting procedures by a certified small water systems operator to meet health authority requirements.

RWH Systems in Maple Ridge

Non-Potable Outdoor Use RWH RWH for non-potable outdoor use is comparably inexpensive and easy to operate and maintain. As noted above in the introduction, its application will not significantly change the sizing or performance of infrastructure such as large pipes meant to convey runoff from major rainfall events but can contribute to reducing runoff volumes through a portion of the year and contribute to groundwater recharge. Also, it promotes rainwater as a resource,

reducing the unnecessary demand on the potable water system. Rain barrels are currently offered in Maple Ridge through the Maple Ridge Recycling Society. https://rmrecycling.org/environmental-programs/rain-barrels.

Non-Potable and Potable (Indoor Use) RWH Property owners may pursue RWH for indoor use in rural and agricultural areas where a municipal water supply connection is not available. Many such homeowners currently depend on groundwater wells. If those wells are shallow, they can go dry in the summertime, and some homeowners will temporarily obtain drinking water during the hottest months at the City's bulk water fill stations.[20]

Sub-urban and urban areas within Maple Ridge have access to the municipal potable water supply system that provides potable water at significantly less expense compared with to individual on-site potable water systems. This makes connecting to the City's water distribution system more attractive for property owners from a cost perspective.

Indoor RWH systems can reduce the demand for drinking water supplied and distributed from Coquitlam Lake, but is expectedly insufficient to alter watershed performance or municipal drainage infrastructure requirements. That said, Metro Vancouver is encouraging RWH as part of the Drinking Water Management Plan. MV is currently working to develop guidelines for RWH and expects to publish these by 2022.

13.1.8 Erosion & Sediment Control

The City currently requires that subdivision and servicing applicants, and large-scale building permit applicants, submit Erosion & Sediment Control (ESC) Plans as part of the approval application package. Such plans are to be "*prepared and designed in accordance with the Guidelines to prevent the discharge of Prohibited Material to the Drainage System*." The "Guidelines" being the "Land Development Guidelines for Protection of Aquatic Habitat". DFO, 1993. While these guidelines remain a very common reference across Metro Vancouver and specify acceptable total suspended solid discharge concentrations, these guidelines offer little direction on the cumulative effects of techniques in meeting discharge specifications. The developers ESC monitor is required to provide regular monitoring reports to the City. This is required until the City deems the site 100% stable, meaning all surfaces are stabilized with permanent treatments (sod, landscaping, etc.) Security is retained until the City is satisfied. City environmental staff carry out routine inspections.

The City's experience has been that ESC plans are being prepared, implemented, and maintained by professionals from different professional disciplines and with varying degrees of training and knowledge of Erosion and Sediment Control and stormwater management. Professionals that prepare ESC plans and oversee and monitor the implementation of ESC plans should be required to have ESC specific training, education, and certification to ensure that the City's resources are protected from ESC related issues associated with development, infrastructure and construction projects.

The release of sediment from construction sites remains an issue for receiving waters and maintenance of traditional storm sewers, but now pose a significant risk to Green Infrastructure. Clogging with sediment is the primary risk to the effectiveness of Green Infrastructure.

The Revised Universal Soil Loss Equation (RUSLE) is a numerical approach to estimating the soil loss rates from construction sites and the incremental benefits of applying cover and erosion control techniques. City staff have expressed support for an update to its ESC requirements requiring ESC specific training, certification and use of RUSLE.

[20] mapleridge.ca/359/Bulk-Water-Fill-Stations

13.1.9 Retaining Natural Features

As part of the stakeholder consultation process, BC MFLNRORD commented that constructed water features to not confer the same habitat functions as natural systems, so it seeks for retention of natural features ahead of constructing compensating features. Some natural features of value may not be subject to either riparian regulations or the water sustainability act, therefore the City is encouraged to continue with policies to protect natural features, including its Development Permit Areas (DP's) for Environment, Watercourse Protection, Natural Features, along with its Watercourse Protection Bylaw, Tree Protection and Management Bylaw and other Environmental / Urban Forestry related initiatives.

13.1.10 Recommendations

As a general statement, Maple Ridge has a solid foundation of policy, goals, objectives, and criteria. While some alterations to these are warranted, supplemental efforts are needed on converting them into reality through enhanced consideration for implementation, funding, and operations.

The following is a collection of management options and recommendations for consideration. They have been specifically identified in response to the above noted assessment findings and implementation challenges expressed by the City. An action plan for implementing them, indicating priority and sequencing, follows this section.

1. **Review and update the Watercourse Protection Bylaw and the stormwater management section of the Servicing Bylaw, to include appropriate on-site and off-site options for meeting 3-tier standards and water quality requirements, with consideration for infiltration, bio-filtration and exfiltration where possible, and how these elements can be coordinated with pervious area requirements and integrated into building and landscape designs. Ensure coordination with the Building Bylaw.**

   Based on the understood restrictions imposed by the City, it is expected that some opportunities for source controls are being unnecessarily missed. Criteria, and management practices to achieve them, currently do not recognize variability in type of development and infiltration potential of soils. The City will increase its likelihood of meeting its Tier A design criteria by describing in the Design Criteria the various practices and designs that are acceptable for different types of development and underlying soil conditions. This may involve testing infiltration rates of various soil types in Maple Ridge and exploring what onsite designs may be acceptable in challenging situations or how offsite infiltration could be achieved. There will also be increased understanding and certainty for all City departments and developer consultants if exemption areas were mapped and reflected in the Design Criteria.

   Through the conduct of this ISMP, it was computed and agree with City staff that 40 mm would represent 50% of the MAR, assuming no increase for climate change. In this case, we suggest that including a climate change factor in the retention criteria is not necessary because 40 mm is already an ambitious target and objectives of watershed health will be largely met by achieving it. We recommend that wording in the City criteria be clarified around the linkage between design events and required controls. One of the items that can be clarified is to specify 40 mm as being the 50% of MAR retention criteria.

   The retention target should refer to the combined volume of surface depression storage, void space in overlying topsoils, infiltration / evaporation losses over a 24 hour period, and void space in any drain rock reservoir layer. It does

not necessarily restrict the release of water from the site which may occur through under-drains. Lexicon should not suggest "infiltration" alone.

Despite the restrictions imposed, the City expects Tier A criteria to be met for all sizes of development; from single family lot infill development, to large scale greenfield developments. While significant developments should continue to be responsible for engineering study and geotechnical testing, it is often a challenging impediment for a small lot single family builder. As other communities have done, we recommend that the City consider preparing "small lot" criteria that recognize soil infiltration variability across the watersheds and provides more prescription direction to the sizing and type of management systems that could be applied to particular zoning or lot type. While the actual infiltration capacity of each lot will vary to some degree, this approach streamlines the application review process for landowners who do not often have the means to conduct engineering study and provides the City with greater certainty with the outcome.

The City may wish to include, as part of its Design Criteria, soil mapping like what is shown in **Figure 13.1** for the purpose of providing direction on the appropriate type and sizing of recharge facilities for each soil group. This could be expanded even further to provide a matrix of retention sizing as a function of land use density and zoning. For example, two parcels of land with the same soils will have the same infiltration potential, but a lot with 80% impervious surface will require a considerably larger facility than a lot with 30% impervious surface (also see discussion on Neighbourhood Plans). Consideration could also be given to optimizing infiltration where Building Code Drainage requirements and parcel size make doing so a challenge.

Further, the City would prepare a map(s) highlighting areas where exemptions or special design consideration apply. This will include mapping of active water source wells, along with capture zones and definition on whether they are confined or unconfined from surface waters within the urban reserve.

The City should consider the pros and cons of having highly prescriptive design standards to meet criteria:

- Highly prescriptive standards are beneficial when there are insufficient resources or knowledge, and/or when the City seeks greater consistency from developers; and they can streamline review and approval processes.
- Flexible, non-prescriptive standards put greater onus on the developers to provide solutions to meet criteria; however, this requires greater resources from the City during review and inspection processes. This requires City staff (reviewers and inspectors) to have more knowledge and experience. Urban Systems is not able to evaluate the state of the City in this regard. Our recommendation is simply for the City to consider its experiences and evaluate whether more prescriptive standards would be beneficial.

In general, the City should re-evaluate appropriate performance targets for volumes, runoff rates, water quality with climate change impacts in mind, being clear on what it will support for each soil group and zoning. This includes exploring alternative solutions such as green roofs for larger buildings, green walls, pocket parks, minimum % of lands set aside for landscaping on site, redesign of infiltration system, disconnection of roof leaders, urban forest plantings, etc.

Higher permit fees could be considered where onsite controls are not achievable, and burden is put off-site. Where engineered management systems are implemented, the City should require one year of monitoring of water quality and runoff rates for larger projects after construction (see section 13.5.1 for additional discussion on post construction

monitoring). The City would also determine what in-lieu contribution is required of Developers if the on-site or off-site stormwater management requirements cannot be met.

However, a caution regarding off-site stormwater management controls: as stated by staff from the Ministry of Forests, Lands, Natural Resource Operations & Rural Development, "constructed water features do not confer the same habitat and infiltration functions as those they replace. In relation to. . .infiltration capacity in the catchment, off site compensation in another part of the watershed is the least reliable method of controlling development related flows. Retaining on site tree cover, wetted features (whether ditches, wetlands or otherwise) is the most cost effective and reliable way to control runoff. Many of these features may not be subject to either the Riparian Areas Protection Regulation or the Water Sustainability Act and as such, the City may want to consider conferring their own protection standards for 'minor' watercourses related to stormwater goals." Recognizing the value of retaining natural areas to maintain habitat, recharge groundwater (to maintain stream flows during increasingly hot/dry summers) and provide storage for runoff from increasingly intense rain events related to climate change, it is recommended that the City seek opportunities within the Watercourse Protection bylaw or other suitable means to further stress and encourage the need for retention of native vegetation, ditches and wetlands.

In redefining retention criteria, linkages should be made to tree canopy targets (see Recommendation #6), as tree canopy provides an important function in rainwater retention. Special consideration should be given to evergreen trees that will retain rainwater more effectively during wet winter months than deciduous trees would.

Finally, add to the Erosion & Sediment Control bylaw a requirement of Plans to be prepared by professionals that have Erosion & Sediment Control specific training, education and certification and that numerical performance evaluation methods such as RUSLE (Revised Universal Soil Loss Equation) are applied.

2. Update the City's Design Criteria to encourage roof leader disconnections and Non-Potable Outdoor RWH.

Related to the above recommendation is that the City currently requires roof leader connections to the municipal storm system for most soil conditions. Subject to current restrictions, this connection may be interrupted by a management feature, such as a sump and orifice, or a recharge gallery. Limitations imposed by the City make roof leader disconnections rare. This approach concentrates roof discharge and forces retention to be achieved through infiltration alone, and within a comparably small footprint, which may not be suitable under all conditions. The water retaining capacity of surface soils and landscaping, particularly if the City adopts tree canopy targets, represents a significant opportunity that is being missed if runoff from impervious surfaces is not directed to them. Other communities, such as the City of Surrey, require downspouts from single family lots to discharge to splash pads. It is understood that discharge to surface requires greater consideration to soil types, groundwater levels, lot grading and provision for inlets prior to leaving the property but is recommended that the City reconsiders roof leader and lot grading criteria with consideration to infiltration potential of soils, recognizing that limitations justifiably apply in risk areas such are the Fraser River escarpment, other steep slopes, etc. Where low permeability soils exist (eg. clay), there is higher reliance on the minimum application of amended topsoil (see Section 7.1.4) to serve as an absorbing layer, along with possible underdrains within on-lot swales.

Linked with roof leader disconnection can be storage for non-potable outdoor rainwater harvesting (RWH). Rain barrels are currently offered in Maple Ridge through the Maple Ridge Recycling Society[21]. The City can continue to promote and educate its residents.

3. **Update the City's Design Criteria to require consideration for climate change impacts in the design of stormwater infrastructure.**

   Increased precipitation due to climate change is expected to have the largest influence on the future performance of existing infrastructure and erosion in natural channels. While the magnitude of long-range climate change is still uncertain, it is recommended that the City integrate a reasonable climate change factor into the design of all future infrastructure. This will require an amendment to the Design Criteria.

   Metro Vancouver first prepared Intensity Duration Frequency (IDF) curves in 2009 for a year 2050 climate change scenario, predicting precipitation intensity increases between 10% and 21%. Climate science has advanced considerably since 2009 and Metro Vancouver recently completed a study to assess the climate change impacts on rainfall.[22] This latest study recognizes that actual outcomes will depend on several factors, but the general findings predict that the increase in IDF parameters for Maple Ridge (zone 3 lower elevations and zone 6 higher elevations) are 26% and 20% respectively for a moderate climate change scenario to year 2050.

   Tools exist to allow the City to update IDF curves to account for climate change with relative ease, provided that a good set of IDF curves currently exist. One such tool is the "IDF_CC Tool 2.0", developed by researchers at the University of Western Ontario. This computerized web-based IDF tool enables users to carry out statistical analysis on historical data, and generate possible future changes based on a combination of climate modeling outputs and locally observed weather data. Metro Vancouver has also recently created one available to member municipalities.

   It is recommended that the City update its IDF curves and account for climate change in its criteria, either by adopting the finding of the Metro Vancouver study, or by conducting their own research and applying available tools. At this time, its recommended that the City adopt criteria for the median 2050 time frame. If agreed by the City, its recommended that the City adopt the increases predicted in the Metro Vancouver study.

4. **Update the City's Design Criteria to clarify the conditions under which detention of the 1:100-year event is required as part of Tier C stormwater control.**

   We recommend that the City clarifies where this higher degree of control is required. This decision could potentially be based on:

   - observed historical performance of the drainage systems,
   - results of the analysis conducted through this ISMP (recognizing that the analysis was conducted on the main piped system for the 1:10-year event, and on culverts and watercourses for the 1:100-year event)
   - the degree and type of expected land use change

[21] https://rmrecycling.org/environmental-programs/rain-barrels.
[22] Study of the Impacts of Climate Change on Precipitation and Stormwater Management, GHD, 2018.

5. **Update the City's Design Criteria to require three-tier stormwater controls within street corridors and other public spaces where space, soil conditions, and other environmental conditions permit. Develop a pilot program to retrofit existing streets upstream of the most sensitive receiving bodies of water.**

Currently, it is unclear whether retention criteria apply to roads and public spaces. The City should consider and clarify whether retention criteria apply to public spaces, including streets. As the City of Maple Ridge has done in Silver Valley, many communities have explored and are seeking to expand the application of bioretention and landscape treatments within street corridors. The City's current Design Criteria roads section is limited to basic sod and tree planting and could be expanded to show vegetated swales within the boulevards.

Example of Roadway Pollution

We recommend that the City revisit its roads standards and develop cross-section templates for the integration of rainwater swales or raingardens. Such practices are not suitable for all roadway corridors, particularly historic, congested roads where no landscaped boulevard currently exists. However, if deemed important by community leaders, roadway reconfiguration can occur to incorporate new functions, but likely at the expense of parking stall, lightly used travel lanes, excessively wide lanes, etc. In the development of cross-section templates, the City should consider the conditions under which standards are required (e.g., road classification, soils conditions, topography, etc.). This is not to say that templates are created for every possible scenario, but a typical section created for each road classification, with principles or guidelines to suit the design variables. In support of this objective, the City would pursue a pilot program for implementation of water quality treatment of road runoff. The program would be coordinated with other ISMP's completed by the City and could incorporate:

- An initial study to identify the most sensitive aquatic habitat areas that currently receive stormwater runoff directly from road surfaces
- Development of pilot projects to remove pollutants from stormwater prior to discharge to the environment at these locations
- Implementation of stormwater quality improvement features through landscaped based green infrastructure or proprietary treatment systems.
- Public outreach and education to explain the intent and benefit and to receive feedback on the proposed design. Communications would demonstrate the as-maintained state of the features, not only the as-new condition
- Before/after testing to validate the environmental benefit of the program
- Pilot project implementations at one location annually over an initial 5 year period
- A review of opportunities to combine implementations with planned roadway upgrades
- Updates to the City's design criteria manual to include designs that have been validated through the pilot program
- Involvement of maintenance staff in the design process
- Assessment of maintenance costs for the green infrastructure and implementation of appropriate increases to the City's maintenance budget
- A small detention component (if feasible) in addition to water quality improvements to help mitigate climate change impacts on runoff quantities

The ultimate goal should be to adapt this program and continue it into the future, to create a long term commitment to improvement in the quality of water entering the watercourses within the City and to the enhancement of the health of the watersheds.

Separately, the City would review its current and future Parks and City-owned lands for opportunities for centralized rainwater management facilities. This would first involve identifying where opportunity may exist, then an evaluation to determine the type and size of facility that could be incorporated, the extent of lands that could be serviced by it, and the benefit derived from it.

This commitment is important for the City to be leaders towards meeting its own stormwater policies and objectives. However, this will also require the City to review and commit its funding towards operation and maintenance of features implemented.

6. **Consider regulating and enforcing tree canopy targets through the Zoning Bylaw.**

It is well documented that the protection of riparian forest integrity and the inclusion of tree canopy throughout urban areas provides significant benefit to watershed health, human health, and improved property values. The City has already taken a significant step towards protecting tree canopy through the adoption of its Watercourse Protection Bylaw and Tree Protection Management Bylaw.

It is understood that currently, the City accepts cash-in lieu of meeting its target of 40 trees per hectare on every site within the Developable Area for every parcel, as it is not always feasible to achieve this target and/or the City experiences push-back from developers. We suggest caution in how extensively cash-in lieu is applied, for two reasons: the City must have an alternate site(s) to which the cash will be applied that results in City-wide targets being met; and it can create an "easy out" for the land owner. The intent is to achieve a dispersed and interconnected canopy, not isolated hubs. For infill or more challenging sites, we suggest tree species and canopy requirements that are realistically achievable on-lot to limit the need for cash in-lieu.

As experienced by the City and other communities, unless the provision is specifically provided in zoning, it is often that canopy targets are not achieved, in turn forcing cash in-lieu and often a decline in city-wide tree canopy. The City should consider enshrining tree canopy targets in the Zoning Bylaw to ensure there is space intentionally allotted for trees and landscaping. This would involve updating setbacks to allow space for trees. Of course, the trade-off is in building footprint. However, we recommend the City reconsiders its approach, as decisions made at time of zoning represent a significant opportunity to achieve the goals of the ISMP.

7. **Formulate acceptable examples and educate developers on how to develop according to the guidelines and ideas in the Town Centre Area Plan.**

The City has experience in preparing Area Plans that soundly establish the goals and objectives for environmental protection and water management, such as the Silver Valley Area Plan and the Town Centre Area Plan.

Greenfield development is markedly different from infill development. And it is one thing to establish goals and objectives, but another to understand and articulate how they can be achieved through implementation. The City of Maple Ridge is not alone in struggling with how best to manage infill development or densification. For the goals and objectives of an Area Plan to be achieved, consideration for the implementation challenges must be considered.

The Town Centre Area Plan has clearly defined Principles, Goals and Objectives that, if implemented, will directly benefit watershed heath and drainage.

8. **Review and improve internal processes to ensure consistent enforcement of regulations.**

   One of the greatest liabilities for a municipality is to have regulations – policies, bylaws, criteria, etc. – that are not enforced or achieved. As part of updating the design criteria (see item 1 above) it is recommended that the City undertake a more comprehensive review of its practices, staff perspectives, and constraints within each department to overcome challenges and to create new criteria and standards that are consistently applied moving forward, and with clear understanding of when and where criteria is being achieved or not.

   In addition to updating criteria and standards, the City would continue to apply other municipal regulatory controls (e.g., covenants for lots with source controls) and servicing agreements that may be appropriate to strengthen the long-term performance of on-lot systems. The City is encouraged to connect with their counterparts in other communities, such as City of Vancouver, City of Surrey, Township of Langley, and City of Coquitlam on lessons learned and how they have interfaced with the development community. The Stormwater Interagency Liaison Group (SILG), in which the City participates, is likely a good forum for this dialogue.

   Developing metrics or a checklist, conducting consistent staff training, and regular communications about regulation changes and challenges is also important.

9. **Work to ensure appropriate watershed networks**

   Habitat system are most valuable where they are networked, rather than in isolated pockets. Land use plans at all levels would consider the types of ecosystems, locations and size, health and distribution of natural hubs and community greenway connections, particularly surrounding waterways. The City is initiating an Ecological Network Management Strategy in 2022.

10. **North and South Alouette River Floodplain Assessment**

    A 2016 Northwest Hydraulic Consultants (NHC) report titled "North Alouette and South Alouette Rivers Additional Floodplain Analysis, Phase 2 – Technical Investigations Completion Final Report" made recommendation for a future "integrated flood management plan" to address the following scope:

    - Development of flood bylaws.
    - Development of an early warning system for severe flooding.
    - Development of an emergency preparedness plan.
    - Development of a flood recovery program.
    - Completion of a vulnerability assessment to identify high risk areas.
    - Development and assessment of different flood mitigation options.

It is recommended that the City implement the recommendations from the study.

13.1.11 Recommended Action Plan

The following sequence of actions are to implement the recommendations described above.

Action	Relative Priority
1. Complete the "Green Infrastructure Management Strategy Policy Review" launched in 2020. Develop a dedicated Green Infrastructure (GI) Strategy document that will provide greater direction on the selection and application of the different GI typologies, linked to the updated criteria, as well as address the Operation & Maintenance and associated funding and resource requirements. This is anticipated to be a significant contributor to the overall funding strategy.	High
2. Review and update the Watercourse Protection Bylaw to include appropriate on-site and off-site options for meeting 3-tier standards and water quality requirements, and how these can be coordinated with pervious area requirements and integrated into building and landscape designs. Update Erosion and Sediment Control Permit requirements for construction sites such that plans are to be prepared by professionals having Erosion and Sediment Control specific training, education and certification and that plans are numerical based performance evaluation system like the Revised Universal Soil Loss Equation. Seek opportunities to further stress within the Watercourse Protection bylaw (and/or other appropriate documents) the need for retention of native vegetation, ditches and wetlands for the purpose of maintaining habitat, recharging groundwater (to maintain stream flows during increasingly hot/dry summers) and providing storage for runoff from increasingly intense rain events.	High
3. Further to the item above, update the Design Criteria and standards to reflect limitations and variable site conditions. Ensure criteria match practices in all departments. Map exemption areas or areas of special design consideration. Map active well capture zones and a statement of whether their aquifers are confined or unconfined from surface water within the urban reserve. In absence of this mapping, apply the Provinces "Underground Stormwater Infiltration – Best Practices for Protection of Groundwater Resources in British Columbia" (B.C. Ministry of Environment, Water Protection and Sustainability Branch, 2014). Also adopt new design precipitation to reflect climate change. Ensure coordination with the Building Bylaw.	High
4. Strengthen the Design Criteria with respect to stormwater quality treatment and associated performance targets, with stronger emphasis on landscape based green infrastructure where possible.	Medium
5. Formulate acceptable examples and educate developers on how to develop according to the guidelines and ideas in the Town Centre Area Plan.	Medium
6. Recognizing that the City recently completed a Zoning update, consider a future update to the Zoning Bylaw to provide provisions achieving tree canopy targets.	Medium

7. Complete pilot projects that provide water quality treatment of roadway runoff that is piped directly into sensitive aquatic habitats. This commitment is important to mitigate the effects of stormwater pollution on the natural environment, understand and optimize maintenance costs and aesthetics associated with different design options, develop preferred designs for inclusion in future design criteria documents, and for the City to be seen as leaders towards meeting its own stormwater policies and objectives.	High
8. Seek to achieve effective watershed habitat networks with City land use plans and educating developers on how to develop according to the guidelines, land use plans, and bylaws. The City is planning to undertake an Ecological Network Management Strategy in 2022.	Medium
9. Consider recommendations by Northwest Hydraulic Consultants (NHC) - "North Alouette and South Alouette Rivers Additional Floodplain Analysis, Phase 2 – Technical Investigations Completion Final Report".	NA – see NHC report

13.2 Program Area 2: Asset Management

13.2.1 Overview

Because many of the recommendations relate to asset management (for example, condition, risk, and funding), we recommend the City approach their implementation through a dedicated asset management program.

The City defines asset management in its Corporate Asset Management Policy No. 9.13 (July 11, 2017) as follows:

Asset Management (AM) is a comprehensive framework to guide the planning, acquisition, operation and maintenance, rehabilitation, disposal and ultimate replacement of municipal infrastructure assets. The objective is to maximise asset service delivery potential, manage related risks and minimize costs of ownership while delivering acceptable levels of service in a sustainable manner that does not compromise the ability of future generations to meet their own needs.

Put another way, using the BC Framework for Asset Management, AM is an integrated process of bringing together the skills, expertise, and activities of people; with information about a community's physical assets and finances; so that informed decisions can be made to support sustainable service delivery. People, information, assets, and finances are considered the core elements of asset management – and it is through this lens that numerous recommendations as part of the ISMP are made.

Strong asset management processes and practices will position the City to make considerable progress on providing sustainable stormwater service delivery, adapting to climate change, and protecting public health and safety. Strong asset management processes and practices mean:

- An asset management strategy and plans are in place and used to inform decisions
- Capital planning and operations decisions are based on level of service and risk
- Quality and quantity of information is adequate for the decision being made

- Funding requirements for long-term stormwater service delivery (including capital construction, O&M, asset renewal, and the practice of asset management) are understood
- Sustainable funding is in place
- Staff and elected officials are aware of the need for asset management and supports its implementation
- There is a culture of interdisciplinary teamwork, informed decision-making, and continuous improvement at the City

Relatively poor or undeveloped asset management elevates the risk of service delivery disruptions, infrastructure failure, funding gaps, and risk to public and environmental health. For these reasons, building capacity at the municipal level to develop and implement strong asset management processes and practices has, over recent years, become a priority for senior levels of government. Various grants are in place to support municipal asset management planning and the implementation of processes and practices from the Federation of Canadian Municipalities (FCM), the Union of BC Municipalities (UBCM), and the Province of BC.

The City recently engaged a consultant to initiate an Asset Management program, so it is recommended that the City continue in its development.

13.2.2 Recommendations

To make progress on the goal and objectives of this ISMP, the following recommendations are made as part of asset management. An action plan for implementing them, indicating priority and sequencing, follows this section.

1. **Continue to develop and implement a City-wide asset management strategy that aligns with the City's Corporate Asset Management Policy and is informed by this (and other) ISMPs.**

   A City-wide asset management strategy typically identifies improvement areas and prioritized actions for strengthening the City's asset management processes and practices. The strategy should be based on a clear understanding of where the City is currently at in terms of its maturity in asset management. A variety of tools are available that the City may use to asses its maturity, including the FCM Readiness Scale, the Asset Smart Assessment Framework, and NAMS Canada.

   The City's Corporate Asset Management Policy sets the framework for developing a City-wide asset management strategy. It is recommended that the City continues to develop and implement a City-wide asset management strategy based on a maturity assessment, to inform priority areas for improvement. The City-wide asset management strategy should indicate where stormwater falls in terms of priority relative to other asset classes (roads, water, sewer, etc.).

2. **Define existing stormwater levels of service.**

   Levels of service (LOS) describe the quality and quantity of service provided. They reflect the unique goals of the municipality and public, and can be measured in a number of ways depending on what is deemed to be important; for example, safety, customer satisfaction, responsiveness, environmental acceptability, and cost. In the case of stormwater, measures for LOS may include (but are not necessarily limited to) depth, frequency, and location of flooding. This LOS relates to nuisance flooding, not events that cause harm, since a fundamental requirement of a major flow path is to protect property and public safety.

   Many communities have found it helpful to define LOS, for a number of reasons:

- They inform (together with an understanding of risk) decisions about stormwater service delivery, such as asset renewal and replacement, upgrades, and ongoing operations and maintenance
- They provide context to current funding levels and gaps, and can be used to identify funding needs
- They provide rationale to public works staff and operators as to why operations and works are required where and when
- They can be used as a tool to evaluate and communicate public expectations regarding service delivery, and to communicate with the public about service delivery

The City's Corporate Asset Policy includes a framework for asset management that includes defining LOS. It is recommended that the City establishes existing and desired LOS for stormwater services. The process to define them should include internal engagement with staff and Council, and external engagement with customers.

3. Consider inventorying and valuating the service provided by natural assets.

A recent trend, with research and pilot projects undertaken by the David Suzuki Foundation and advocating municipalities such as the Town of Gibsons, is Natural Asset Management. Natural asset management is an emerging strategy to manage natural assets such as woodlands, wetlands, and creeks in urban areas as part of an overall approach to sustainable service delivery. Specifically, it involves inventorying, valuating, and accounting for natural assets' contribution identifies, to municipal service delivery – services that would otherwise need to be delivered by engineered assets. These natural assets have capital value and need capital to protect and manage them.

There are many benefits associated with natural assets and green infrastructure:

- It has been shown to help reduce costs to taxpayers if used effectively with grey infrastructure
- The provide socio-economic benefits to the community
- They reduce the need for grey infrastructure (ie. Pipes)
- They meet water quality and environmental protection objectives.

As this is still an emerging area, it is recommended that the City explore the approach and make its own conclusion on how this may fit within its asset management program and funding levels. It important to generate greater awareness about natural assets and to promote the benefits of them. There should be ongoing research into what kinds of cost savings, services and benefits provided by natural assets.

4. Quantify the long-term sustainable funding level for stormwater assets.

It is noted that funding is expected to be deficient for many asset classes. A cross-asset (not only stormwater) risk management framework to rank maintenance improvement initiatives is recommended (see item 5 below). It is critical that the City understands the funding levels required to provide service to the defined LOS, so that funding levels and funding/financing mechanisms are informed by a quantified need. This can be done through the development of a City-wide stormwater Asset Management Investment Plan (AMIP). This can be done at the same time as defining LOS.

There are essentially four different ways to fund stormwater infrastructure:

1. General Property Taxation – stormwater operating, and capital are funded through general property tax, similar to Roads, Parks, Recreation, Emergency Services, etc.

2. Levy on Property Tax Notice – stormwater is funded as a distinct levy on the property tax notice. This is generally done on a flat rate basis, but it could be based on parcel area, frontage, or ad valorem (assessment) basis.
3. User fees – these are dedicated fees collected from users. Fees may be set a variety of ways, depending on what is important to the municipality – for example, if equity is a primary objective, the fees may be reflective of impervious area on each property. Fees may be collected through existing utility bills, such as water or sewer.
4. Stormwater utility – a separate, dedicated, self-funded utility can be created, similar to water and sewer. Utility rates may be set a variety of different ways, similar to user charges. While many communities in the United States have a stormwater utility, only a handful in Canada do and even less in British Columbia. This may be because establishing and operating a utility often requires significant administrative resources.

Development cost charges (DCCs) are another funding mechanism available to municipalities, but they can only be applied to capital projects and must be used to help pay for growth-driven infrastructure (new infrastructure or growth-driven upgrades to existing infrastructure).

The City of Maple Ridge currently collects revenues to apply to stormwater asset management through a levy on property tax and general taxation for operating. It was not within the scope of the ISMP to evaluate whether current funding levels are adequate to fully recover the cost of stormwater service delivery, or if a levy is the optimal funding mechanism. It is recommended that the City quantifies the long-term sustainable funding level for stormwater assets, and if a gap exists, then evaluate funding options and identify the preferred approach.

5. Develop a risk framework to inform and prioritize stormwater asset investment planning, including asset renewal and operations and maintenance.

Many communities find there is a shortfall in funding sustainable service delivery – that is, existing funding levels are insufficient to maintain and renew municipal assets over their service life. Risk is a useful way to prioritize infrastructure investments, so that resources can be allocated to where they are most needed. This is typically done through the development of a risk framework.

In the case of stormwater infrastructure, the risk framework could be informed by the defined LOS (Recommendation 2). It could also be informed by or inform condition of stormwater assets and performance of the system (Recommendation 6 below), and flood risk (Recommendation 7) – they are equally valid approaches.

6. Enhance the City's understanding of stormwater system performance and condition to inform decision-making.

At this time, creating a "laundry list" of capital projects to replace or improve existing infrastructure is not recommended, as it is unclear with existing information whether they are absolutely necessary or can realistically be funded. Information on system performance and condition should be used to assess risk, which in turn should inform the City's decisions regarding operations and maintenance, asset renewal, and upgrades. As noted previously, perhaps the biggest influence on long term performance will be climate change, but it is unrealistic to replace all infrastructure for this anticipated threat. As such, a pragmatic, risk-based program is required, along with evaluating options for other adaptive measures.

Hydraulic modelling conducted in the process to develop the ISMP made best use of available data to formulate projections about how the drainage trunk system is currently performing. The analysis identified some locations of interest.

It is recommended that the City conducts the following to enhance its understanding of stormwater system performance and condition, to inform the business case for capital works:

- **System performance should first be validated** at areas of interest by gathering water level and flow data. These data should be gathered between the months of October and February (at a minimum) to capture wet-weather performance.

  As a starting point, five sites could be monitored in the first year, and the decision on additional monitoring could be made based on the findings. Criteria for site selection are suggested to include: peak flow/pipe capacity is >=1.05 and surcharges > 15min (shown as red on **Figure 13.5**); surrounding land use density or arterial roads; and upstream development potential. Using these criteria, the City could start by focusing on the Town Centre and in the lower reaches of Kanaka Creek, in the vicinity of Lougheed Highway.

- **Continue the City's cross culvert inspection program**, and CCTV inspection program. However, expand the program(s) to include storm sewer mains that were identified in this study as being an area of interest, those that have an observed history of flooding, and those that have reached an age of 30 years or more. Asset age is available in the City's asset inventory database.
- **Carry out Drainage Master Planning at the sub-watershed level** (see Section 13.5.6)

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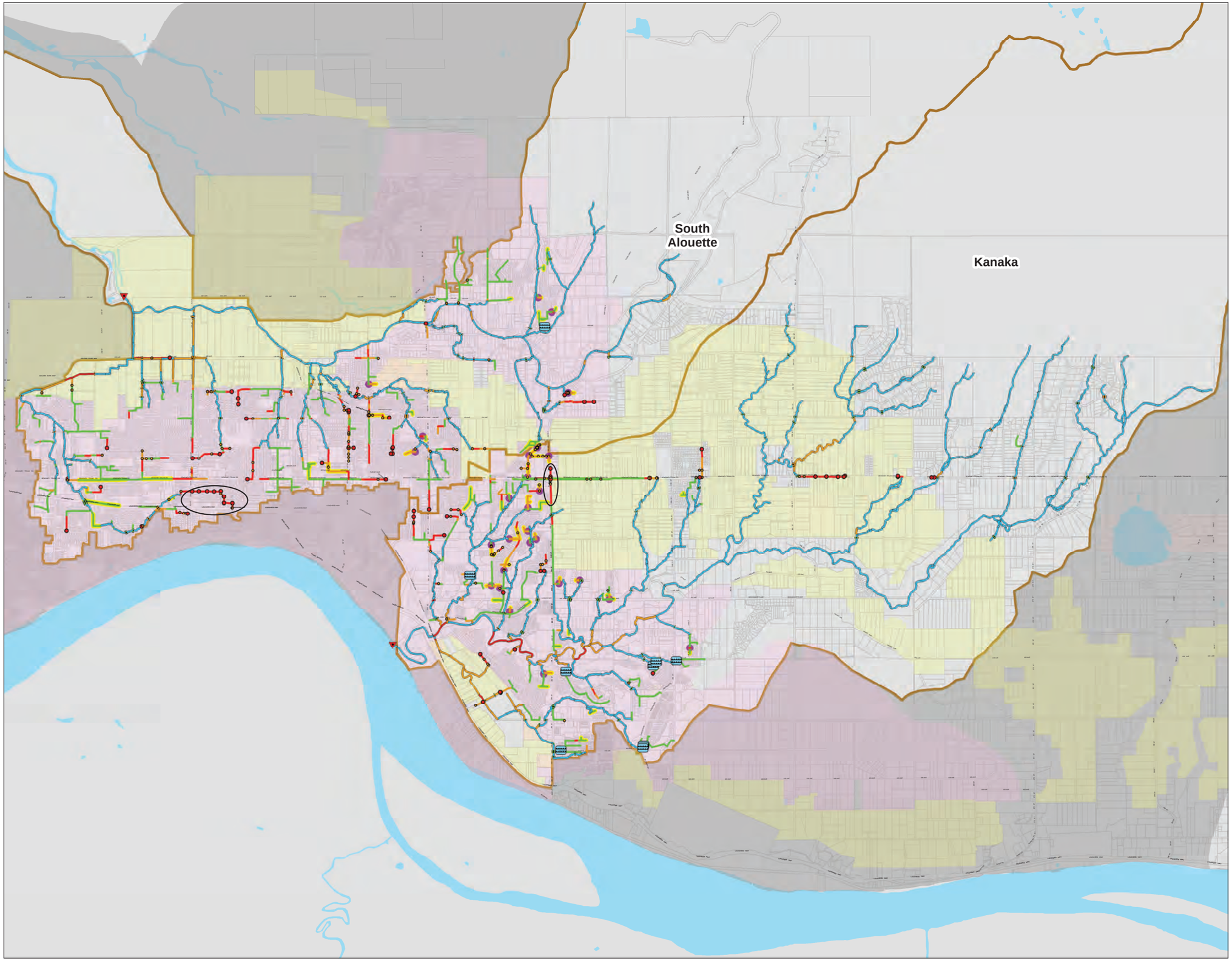


MAPLE RIDGE
British Columbia

South Alouette and Kanaka Integrated Stormwater Management Plans

Priority Hydrometric Monitoring Sites Based on 10-Year, Critical Duration Capacity Analysis (Existing Land Use)

Legend

- Agricultural Land Reserve
- Urban Containment Boundary
- Watershed Boundary
- Parcel
- Detention Pond

Junction

Maximum Water Surface Elevation @ Modeled Junctions

- > Ground (72)
- <= Ground and > Ground - 0.6 m (138)
- Outfall

Culvert

Peak Flow / Pipe Full Capacity

- < 1.05 OR Surcharge < 15 min (103)
- < 1.05 AND Surcharge > 15 min (29)
- >= 1.05 AND Surcharge > 15 min (4)

Creek

Peak Flow / Creek Full Capacity

- < 1.05 OR Surcharge < 15 min (998)
- < 1.05 AND Surcharge > 15 min (90)
- >= 1.05 AND Surcharge > 15 min (Potential Breach of Creek) (11)

Storm Main

Peak Flow / Pipe Full Capacity

- <1.05 OR Surcharge < 15 min (833)
- < 1.05 AND Surcharge > 15 min (232)
- >= 1.05 AND Surcharge > 15 min (211)
- Flow Control Manhole
- Storage
- Priority hydrometric monitoring sites

Results presented represent the worst case hydraulic condition for each reach and control from all storm durations simulated (30-min, 1-hr, 2-hr, 6-hr, 12-hr, and 24-hr)

1,000 500 0 1,000
m

N

Coordinate System:
NAD 1983 UTM Zone 10N

Data Sources:
GeoAdvice
City of Maple Ridge
City of Pitt Meadows
BC MoE
NR Canada

GeoAdvice

Project #:	1279.0025.01
Author:	LP
Checked:	GS
Status:	FINAL
Revision:	N
Date:	2018 / 1 / 31

URBAN systems

FIGURE 13.5

\\USLCA\Projects\Projects_VAN\1279\0025\01\D-Drafting-Design-Analysis\GIS\Projects\MXD\Current\Stage 3 Report Figures_2018-01-29\Fig03_Maple Ridge ISMP_10yr Critical Duration Existing_20180129.mxd Last updated by jwilkes on January 31, 2018 at 8:15:36 AM

7. **Enhance the City's understanding of overland flood paths and risk to inform decision-making.**

The City's current criteria and management practices, both historic and current, allow for surcharging of the conveyance system and overland flow during an event exceeding the minor event (1:10 year). Where there has been a history of flooding, or where significant surface flooding has been predicted by the analysis, it is recommended that a more detailed overland flow risk assessment be conducted. This would involve application of LiDAR data and GIS tools in combination with site reviews as the introductory step. The need for further analytical modeling is not certain and would be informed by the initial review. Areas of priority would first be identified from the findings of Recommendation 6. This review has highest priority where no drainage infrastructure currently exists, where there is no obvious major flow path maintained within public corridors, and where private lots are lower that the fronting roadway.

8. **Develop and implement an O&M program informed by risk and level of service.**

The operation and maintenance (O&M) of infrastructure is important, and yet commonly a deficiency in municipalities, resulting from:

- lack of funding
- lack of knowledge transfer
- lack of synchronized programs

It is recommended that the City review its O&M program to assess whether there are gaps that may cause premature failure of infrastructure or may prevent LOS from being achieved. For example, water quality monitoring indicates higher-than-desired levels of microbial bacteria and metals in more urbanized watercourses. Metals, which are commonly associated with suspended solids, are most commonly sources from paved surfaces (i.e., roadways and parking lots). The simplest ways to manage pollutant load from streets is to vacuum the pavement surface and catch basin sumps.

Landscape-based best management practices that filter runoff from impervious surfaces are also a very effective approach to reducing pollutant loading to receiving watercourses. It is important that landscape maintenance programs are in place.

Whatever the City's O&M program looks like, it is recommended that the City's O&M program be informed by LOS and risk (discussed under Recommendation 2 and 5).

9. **Build an inter-departmental asset management team to lead the development and implementation of asset management initiatives.**

Asset management requires many champions, effective inter-departmental communication and collaboration, and clear roles and responsibilities. Communities approach leadership of asset management in many ways; what is critical is that an inter-disciplinary team is involved in developing and implementing asset management initiatives. It is recommended that if the City does not already have one, such a team is established. To support sustainable stormwater service delivery, the team should have strong staff representation from Engineering and Public Works staff familiar with the service.

10. **Grow awareness among staff, elected officials, and the public of the importance of asset management and the risk of insufficient practices and funding.**

    Communities that have been able to make progress in asset management, including funding, effectively and frequently communicate the value of stormwater services to staff, elected officials, and the public. It is recommended that the City uses engagement opportunities with these various audiences to communicate the need for stormwater asset management and funding – for example, through reports to Council, inter-departmental asset management team meetings, and public communications.

13.2.3 Recommended Action Plan

The following sequence of actions are to implement the recommendations described above.

Action	Relative Priority
1. Build an inter-departmental asset management team to lead the development and implementation of asset management initiatives, with stormwater representation from Engineering and Public Works.	High
2. Grow awareness among staff, elected officials, and the public of the importance of asset management and the risk of insufficient practices and funding.	Low
3. Focus inspections and condition assessments on areas of interest identified from the hydraulic modelling. Use these to inform the risk framework and subsequent decisions about operations, maintenance, and asset renewal/replacement.	Medium
4. Gather data on water level and flow at areas of interest identified from the hydraulic modelling to confirm system performance. Use these to inform the risk framework and subsequent decisions about operations, maintenance, and asset renewal/replacement.	Medium
5. Define stormwater levels of service.	High
6. Inventory and valuate the services provided by natural assets.	High
7. Quantify required stormwater funding levels.	High
8. Develop a risk framework to inform future stormwater asset investment planning.	Medium
9. Develop and implement an O&M program informed by LOS and risk.	High
10. Conduct a review of major overland flood paths using a risk assessment framework.	Medium
11. Build an inter-departmental asset management team to lead the development and implementation of asset management initiatives, with stormwater representation from Engineering and Public Works. (Asset management program has been recently launched by the City)	Medium

13.3 Program Area 3: Environmental Monitoring

13.3.1 Overview

Environmental monitoring is a core component of the ISMP because environmental data tell the City how it is doing in terms of meeting the goal and objectives of the ISMP. The City can then use the data to inform decisions about changes and improvements to its management practices as part of an overall "adaptive management and continuous improvement" process, which is described under Program Area 5.

13.3.2 Potential Monitoring Parameters

A variety of parameters provide an indication of whether the City is making progress on the goal and objectives of the ISMP. Specifically, the following indicate that watershed health is being maintained or improved:

- Increase in tree canopy
- Riparian forest integrity
- Decrease in impervious area
- Increase in water quality
- Decrease in incidences of flooding (in both the piped system and watercourses)
- Increase in summer base flows
- Improvements to B-IBI
- Less erosion and sedimentation

Also, monitoring precipitation is a way to monitor climate change. There is high value in monitoring data, but it requires significant investment to acquire meaningful data. The City's monitoring program should be expanded based on priority and financial commitment. Highest priority should be placed on those watersheds that are under the most pressure for land use change and those watersheds that are not yet understood. Least priority is on watersheds reasonably understood and are not pressured by land use change.

Making environmental monitoring data available to the public is a general trend for the City through its Open Government initiative.

13.3.3 Potential Monitoring Programs

1. Stream Monitoring – Water Quality, Flows, and B-IBI

In 2015, the City implemented an initial round of environmental monitoring in accordance with Metro Vancouver's Monitoring and Adaptive Management Framework (MAMF).[23] The City collected water quality, flow, and benthic invertebrate data from Millionaire Creek and T2 Creek (South Alouette Watershed) and Dunlop Creek and Spencer Creek (Kanaka Creek watershed), at locations SA-1, SA-2, K-1, and K-2 shown on **Figure 13.6**. These streams and locations were selected as their catchments were considered representative of the different types and stages of development across the City. Recommendations below for stream monitoring are based on the 2015 results and other issues and opportunities identified through the ISMP process.

[23] - Monitoring and Adaptive Management Framework Report - September 2014 (metrovancouver.org)

Water Quality

To address findings from the 2015 monitoring, the City should consider undertaking annual water quality sampling for three consecutive years at the aforementioned locations to allow an evaluation of data where there can be a consideration of inter-annual variability. The focus for this sampling could include the broad range of parameters sampled in 2015 under the MAMF, with parameters to be removed or monitoring frequency reduced after the three-year period, when a better determination can be made with respect to importance of the various parameters to water quality concerns identified from the 2015 results.

Due to the ability to easily monitor temperature, dissolved oxygen, pH and turbidity in the field, increased frequency in monitoring for these parameters should be considered. The focus for dissolved oxygen would be the late summer/early fall, when flows are low and water temperatures are elevated. Monitoring of pH will allow direction to be set on potential trends for particulate metals to move into the dissolved form. The monitoring scope could also include consideration of changes during and after storm events.

The MAMF also recommends testing a number of parameters requiring laboratory analysis including nutrients, Ecoli and Fecal coliforms, and several "total" metals. In addition to those recommended by MAMF, the following additional parameters are recommended:

- Hardness may already be completed by the laboratory as part of the metals analysis but may not necessarily be reported by the lab. To ensure that these data are reported by the laboratory, instead of requesting "total iron, total copper, total lead, total zinc, total cadmium" on the lab chain of custody form, requesting "total metals plus hardness" and indicating "analyses are to be done to BC Water Quality Guidelines for the Protection of Aquatic Life" will ensure that all lab data are reported.
- Dissolved Organic Carbon - Water quality guidelines are continually evolving. Since the writing of the 2014 MAMF document, there have been several changes to the guidelines. One of these changes is the approach for copper guidelines (aquatic life), with the guideline now relating to a model which uses several parameters to calculate an aquatic life guideline. Monitoring of dissolved organic carbon is needed for the model. If this parameter is not monitored, the alternative is estimating a possible dissolved organic carbon concentration, which could result in a more stringent guideline concentration. Monitoring of dissolved organic carbon is recommended to allow a more site specific and relevant guideline concentration for copper to be calculated.
- Total AND Dissolved Metals - It is prudent to analyse for both total and dissolved metals to provide direction relating to water quality guidelines. Just analysing for total metals will provide an over estimation of the guideline and may not fully represent the situation or level of risk.

Because of the vastness of the South Alouette and Kanaka Creek systems, the City could expand its monitoring locations to include both downstream (of development or agriculture), upstream (headwaters above development), and intermediate sampling locations to assess trends across the systems. Upstream samples can also serve as a baseline to compare for each sampling period.

Flow

At a minimum, flow monitoring should be conducted for a one-year period, every five years, at the aforementioned locations, in accordance with the MAMF. At key locations, and particularly in those watersheds where significant land use change is to occur, the City is strongly encouraged to implement semi-permanent monitoring.

Historically all flow monitoring emphasis has been placed on high flows during winter, but seasonal transitions and summer base flows are also very important to watershed health. Between climate change and land use change, there is a significant risk of declining base flow during the summer, reinforcing the importance of achieving Tier A water retention and its return to ground, true for both Greenfield, and Brownfield and Infill development areas.

The City already has a water level gauge on Kanaka Creek, and the Province / Pitt Meadows has gauges on the Alouette River's. This data would be used for tracking and analysis of lowland hydraulics at the macro watershed scale.

B-IBI

The Benthic Index of Biological Integrity (B-IBI) is a quantitative method for measuring and comparing the biological health of streams, and involves sampling benthic invertebrates at suitable locations in a stream.

The MAMF requires monitoring every five years; however, it is recommended that benthic invertebrates monitoring be conducted every two to five years to establish a trend in B-IBI scores, and to gather more information on potential long-term reasons (if any) for discrepancies between predicted and actual B-IBI values in the monitored catchments.

Fish Counts

Both DFO and ARMS collect fish count data, so its unlikely that the City would develop its own fish count program. The City should support these programs by others in return for acquiring the data for assessment.

2. Erosion and Bank Stability, and Stream Bed Substrate Monitoring

Historic erosion sites within local streams are shown on Figure 13.6, as well as locations at which erosion potential analysis was conducted as part of the ISMP process. Erosion data used to conduct erosion potential analysis as part of the ISMP were dated to the early 2000's, and we understand the City does not currently have a regular erosion monitoring program. For these reasons, and to be more informed of potential hazard and risks to watershed health and public safety, it is recommended that City's monitoring program includes erosion and bank stability where access is feasible. This inherently includes identifying location of accelerated tree falls, which can increase risk of flooding and debris flows. Mapping and tracking these occurrences will allow them entered into the Natural Asset database for inclusion into the Asset Management Program.

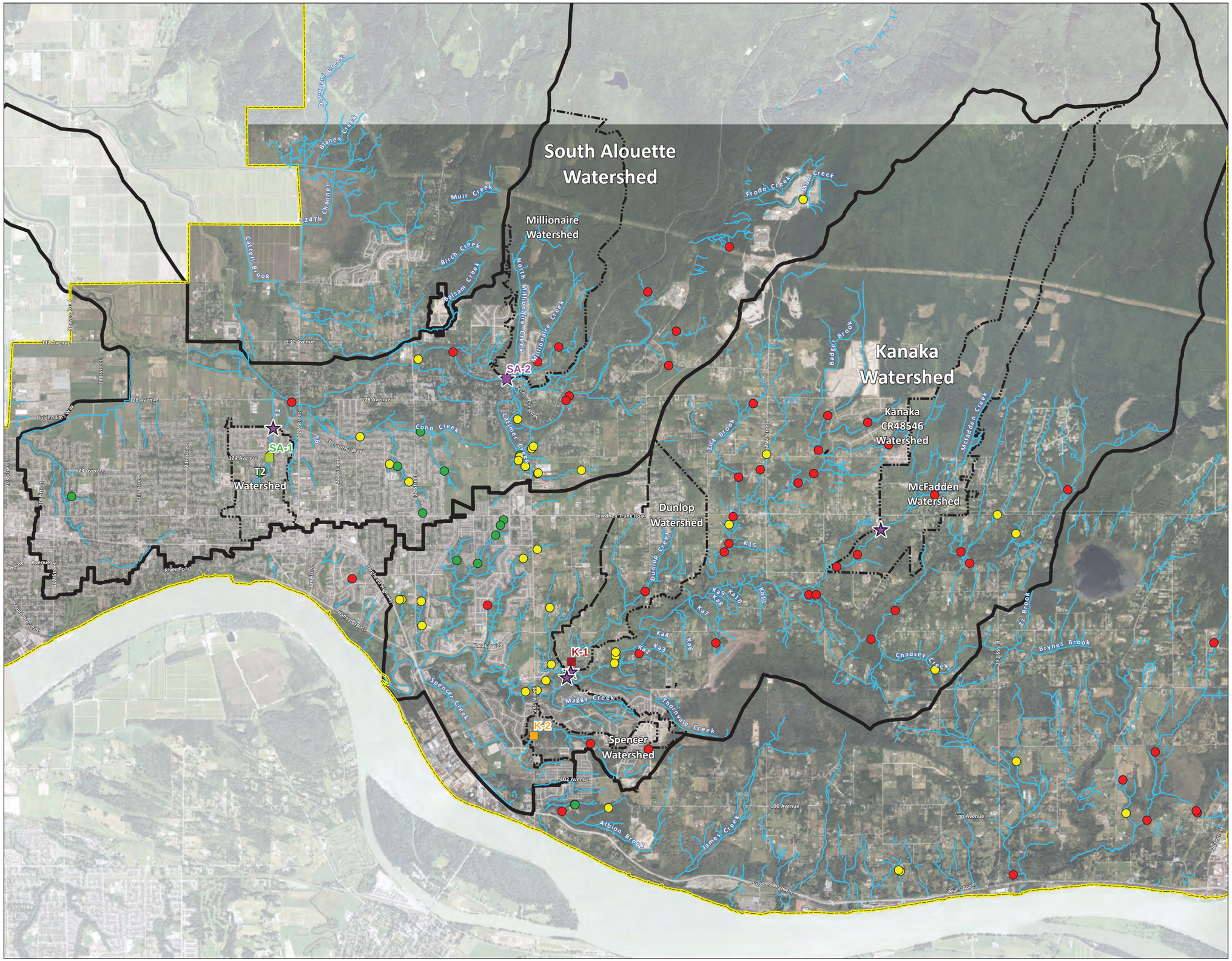
Note the City does not monitor for the formation of log jams on watercourses. The City's current policy is to evaluate and react to concerns reported by residents on a case by case basis. If residents have concerns about fallen trees in the river, they are advised contact the City's Operations Centre at OperationsCentre@mapleridge.ca.

The City should consider implementing an erosion monitoring program with a goal of inspecting 20% of the watershed streams each year (subject to access feasibility), resulting in a five-year cycle. Priority should be placed on watercourses that were previously identified as having "severe" erosion issues (greater than 10m2 of bank erosion), and where upstream development is anticipated that could worsen conditions if unmitigated. Using these criteria, potential starting points include Bosa Creek in the South Alouette watershed, and McFadden Creek in the Kanaka Creek watershed. Jurisdiction, property ownership, natural watercourse erosion processes, climate change and responsibility for any reactive or proactive bank stabilization works should be considered when developing a program.

Coupled with erosion and bank stability monitoring would be stream substrate characterization, identifying reaches of good a poor quality substrate for aquatic habitats. This would help with mapping watershed health, identifying areas

impacted by past activity and those vulnerable to future activity. It would also assist with identifying priority projects for restoration. This is intended to be a visual inspection, not involving sampling and lab work.

Finally, as part of the inspections the City could note obstacles to habitat connectivity, in particular anthropogenic fish barriers. The City identified such fish barriers in 2003-2005. The City's maps could be updated and opportunities for future restoration work identified and prioritized.



South Alouette and Kanaka Integrated Stormwater Management Plans

Documented Erosion Sites & Environmental Monitoring Stations

Monitoring Site Locations

- K-1
- K-2
- SA-1
- SA-2
- Erosion Potential Assessment Site
- Municipal Boundary
- Natural Watershed Boundary
- Creek Subcatchment Boundary
- Creeks

Erosion Severity

- Low
- Moderate
- Severe

200 0 200 400 m

N

Coordinate System:
NAD 1983 UTM Zone 10N

Data Sources:
City of Maple Ridge
City of Pitt Meadows
BC MoE
NR Canada
GeoAdvice

Project #:	1279.0025.01
Author:	BG
Checked:	GS
Status:	FINAL
Revision:	N
Date:	2018 / 1 / 31

URBAN systems

FIGURE 13.6

U:\Projects_VAN\1279\0025\01\D-Drafting-Design-Analysis\GIS\Projects\MXD\Current\Stage 3 Report Figures_2018-01-29\Fig04_Maple Ridge ISMP Erosion Sites and Monitoring Stations_20180129.mxd Last updated by jwilkes on January 31, 2018 at 3:58:37 PM

3. Desktop monitoring of tree canopy, RFI, and impervious area

Tree canopy, RFI, and impervious area are all parameters that can be monitored using GIS analysis. This type of analysis could form part of an overall monitoring program used to evaluate the effectiveness of the ISMP.

To support this, we recommend the City acquire LIDAR data every 5 years. The costs may be highly variable depending on whether the area needs to be custom flown, or is done in concert with other agencies. It is recommended that LiDAR data acquisition be coordinated through SILG / Metro Vancouver.

Action	Relative Priority
1. Conduct stream monitoring - water quality and B-IBI. Start with 3 continuous years to first establish inter-seasonal variability, then conduct on 3 year cycle. Semi-permanent flow monitoring stations are encouraged for key locations in watersheds to experience significant land use change (monitoring only once every five years as per minimum MAMF requirements would mean missing variability from year to year and make it harder to determine if objectives are being met.)	Medium
2. Conduct erosion and bank stability monitoring as well as stream substrate monitoring (where site access is feasible). Pay close attention to erosion in McFadden Creek (enters Kanaka at the fish hatchery), Dunlop Creek (discharges to key spawning area in Kanaka) and other sensitive locations. At the same time, identify obstacles to habitat connectivity, in particular anthropogenic fish barriers. Update 2003-2005 mapping to track restoration opportunities.	Low (5 year cycle)
3. Conduct desktop monitoring of GIS-based parameters, such as riparian forest integrity, urban tree canopy, impervious surface, inventory of green infrastructure, new developments, etc.	Low (5 year cycle)

The first priority for the City would be to meet or exceed the City's Monitoring and Adaptive Management Framework (MAMF) obligations. Staff resources to support additional monitoring programs can be prioritized as part of the ISMP implementation plan and annual Business Plans. ARMS in particular, has expressed interest to work in partnership with the City and other interested groups in a volunteer based monitoring program. Possibilities for this would be explored through the ISMP implementation plan and through collaboration meetings with ARMS.

Refer to Section 13.6 Program Area 5: Adaptive Management and Continuous Improvement for discussion on other forms of monitoring and response planning.

13.4 Program Area 4: Collaboration, Education, and Outreach

13.4.1 Overview

These are vast watersheds that extend well beyond the City's urban boundary and even beyond the jurisdiction of the City. Watershed management programs can be enhanced by collaboration, education and outreach; internally within the City departments, and externally with stewardship groups, stakeholders, and property owners / operators.

Various City departments may collaborate to explore opportunities for siting community detention / retention facilities, or other forms of Green Infrastructure, preferably within Parks (either existing or acquired) where they can provide co-benefits. There is also benefit for all departments involved in the enforcement or implementation of Green Infrastructure to collaborate in the Green Infrastructure Management Strategy Policy Review initiative.

Volunteer stewardship groups make a significant contribution to the environmental wellbeing of a community. The City has well established groups - KEEPS (Kanaka Education and Environmental Partnership Society) and ARMS (Alouette River Management Society). Both do a lot of education activities (www.keeps.org and https://www.alouetteriver.org/), engage in restoration projects and give updates to Council. The City recognizes the excellent work and valued contributions that KEEPS and ARMS make to the community and will continue to support and partner with them.

Within the Kanaka Creek watershed is the Bell-Irving Hatchery and Watershed Stewardship Centre [24], which has been a partnership among KEEPS, Metro Vancouver Regional Parks, and the Department of Fisheries and Oceans since 1983 focussed on education and environmental stewardship. The Stewardship Centre is a community asset, providing education through facilities such as a classroom, stormwater management landscaping and a "roof to creek" demonstration.

The Kanaka and South Alouette watersheds exist within the traditional territories of the Katzie and Kwantlen First Nations. Additional information on the approximate territorial extents and links to the First Nations' websites can be found at the following: https://native-land.ca/maps/territories/kwantlen/ , https://native-land.ca/maps/territories/katzie/

BC Parks plays a major role in managing Golden Ears Park (Golden Ears Park Management Plan[25], BC Parks, 2013). Its vision is centred around being a place where visitors can experience and learn about wilderness and ecosystems, can recreate, and learn to better respect the surroundings. A place where First Nations can practice their culture and a place where visitors can learn about and celebrate First Nation' traditions and history. Volunteerism is a core asset to Golden Ears Park. BC Parks has a relationship with institutions such as the UBC Malcolm Knapp Research Forest and partners with them on projects to improve understanding of the park. Currently, BC Parks is seeking to inventory amphibian species in the park.

Similarly, the Malcolm Knapp Research Forest (MKRF) was established primarily for research and education purposes by UBC. They provide a wide variety of educational opportunities to elementary schools, high schools, post-secondary groups, youth groups, corporate groups and more. They welcome self-guided tour groups throughout the year.

The City of Maple Ridge, in partnership with WildSafe BC and Ridge Meadows Recycling, has offered education and advocacy work to "keep wildlife wild and our communities safe"[26]. The goal is to teach people about how to avoid potential conflicts with wildlife such as bears and cougars, and how to manage attractants, which is the biggest problem the community

[24] Kanaka Creek Watershed Stewardship Centre (metrovancouver.org)
[25] https://bcparks.ca/explore/parkpgs/golden_ears/golden-ears-mp.pdf
[26] WildsafeBC Program (rmrecycling.org)

faces when it comes to the presence of bears. WildSafe BC also has a GIS based database website "WARP" – the Wildlife Alert Reporting Program which provides an inventory of near-term animal sightings[27].

Additionally, the City of Pitt Meadows and Provincial ministries have jurisdiction and vested interests in the watersheds. Continuing to build on established relationships among all grounds is hoped to strengthen the spirit and effectiveness of watershed stewardship and improvement. It's recommended that a Watershed Management Committee be established for Kanaka Creek watershed, and the Alouette (north and south) watershed formed by representatives of the various groups and agencies noted above.

With respect to other members of the public, it is often that people do not respect or support things they do not understand. The development of this ISMP included communication and engagement with stakeholders such as community groups, a local development engineering company and the general public through a survey, however, it is expected that a broader education and outreach program would be beneficial to help the City make progress on meeting the goal and objectives of the ISMP. This education and outreach would be both internal and external.

There is a growing awareness of the importance of integrating the site, with the stream, with the watersheds to establish a viable future with respect to integrated watershed management plans. The City should develop a communication strategy to help convey this message to the general public, to current and future decision makers, and to the development community.

13.4.2 Improving Fish Migration in the South Alouette River

Despite the current trap and truck program that moves returning sockeye into Alouette Lake Reservoir (refer to section 4.5.1), City Councils have expressed interest in evaluating the viability of re-establishing permanent year-round passage for fish into Alouette Lake Reservoir, focussing on salmon species. Since its inception in 1993, ARMS (Alouette River Management Society) has dedicated significant efforts in various forms to improve flows and fish accessibility.

The City engaged a qualified independent consultant to review the existing decision-making frameworks, analytical reports and data generated through the various processes to facilitate dialogue with Council as the basis for the development of a position to the Comptroller of Water Rights. A report was delivered the City October 01, 2020 in considering further direction regarding fish passage and the Alouette ecosystem. The memorandum provides information on initiatives currently underway, salmon species of interest as well as study initiatives supporting re-introduction, fish passage options and hatchery implications.

The October 1, 2020 consultant report summarized its findings as: "*The most significant limitation for the Alouette Reservoir Sockeye re-introduction is likely low marine survival (current mean is =0.5%), which limits the adult returns to the base of the dam. This means that the program likely requires hatchery supplementation to increase Sockeye production and address outstanding uncertainties such as the heritability of anadromy. As the number of anadromous Alouette sockeye increases over time, the marine survival of the population, the numbers of outmigrating smolts and the productive capacity of the reservoir may increase. This will be particularly true if anadromy is heritable and there is a survival advantage of smolts produced from Sockeye versus resident Nerkid parents.*

The Sockeye Research Facility located beside the Allco Fish Hatchery in Maple Ridge could be used to supplement the Alouette (and Coquitlam) Sockeye populations. However, water supply issues need to be resolved and a water license sought as soon as possible."

[27] WARP | WildSafeBC (https://warp.wildsafebc.com/)

Council was presented with the following actions for consideration:

1. Focus on advocating for, and lobbying Hydro to secure a fish ladder across the dam through the Hydro Water Licence and Water Use Plan Order Review processes.
2. Have the City formally participate in the ARSRP process on the feasibility of fish passage through the Framework, seeking a staged process to build the returns into the reservoir as outlined in the Framework while also enhancing habitat below the reservoir with the goal to see the construction of a fish ladder at the Reservoir.
3. Promote the enhancement of the larger, overall Alouette ecosystem, both upstream and downstream of the reservoir by the federal and provincial regulatory agencies. This endeavour would be significant in scale, beyond available City resources, but certainly the City could play a supporting role in an initiative that would be more feasible if driven by higher levels of government. Staff has been directed to work with LGL Limited - Environmental Research Associates to develop a position statement for Council's consideration, to be submitted as part of the BC Hydro License process.

13.4.3 Agriculture Community

To minimize the impact of farming on the environment, the Province has developed the Environmental Farm Plan Program[28] (EFP) to support farm operations to complete agri-environmental risk assessments. The benefits of this program are:

- Improved sustainability of the agricultural industry
- Recognition of efforts to manage land in an environmentally sustainable manner
- Enhanced marketing opportunities and improved relationships with environmental agencies
- Improved response to environmental incidents through contingency planning
- For farmers who have participated in the EFP, the Province offers funding of $70,000 towards the implementation of environmentally beneficial actions, but only to a limited number of farms

The Program is delivered by the BC Agricultural Research & Development Corporation (ARDCorp.)[29]. It is a voluntary and confidential program, but for some industry associations are seeking increased involvement in the EFP program to fulfill the needs of buyers. For example, the dairy sector is developing a proactive campaign to mandate EFP's.[30]

The Salmon-Safe Standards[31] is a third-party certification program that recognizes and rewards responsible, eco-friendly management practices that protect Pacific salmon habitat and enhance water quality on agricultural and urban lands. Salmon-Safe was brought to B.C. by the Pacific Salmon Foundation and Fraser Basin Council, who launched Salmon-Safe B.C. in 2011. To date, more than 40 farms and vineyards across British Columbia have achieved Salmon-Safe certification. In 2018, the Fraser Basin Council became the sole delivery organization of Salmon-Safe BC. Salmon-Safe has a specific Agricultural Site Certification Process.

[28] Environmental Farm Plan Program - Province of British Columbia (gov.bc.ca)
[29] https://ardcorp.ca/programs/environmental-farm-plan/
[30] Comments received from Ministry of Agriculture, Food and Fisheries representatives, June 3, 2021
[31] The Salmon-Safe Standards | Salmon-Safe BC

13.4.4 Recommendations

The following recommendations are made as part of collaboration, education, and outreach:

1. **Collaboration among City departments; effectively and frequently communicate in implementing the ISMP.**

   This is to provide strategic oversights and to evolve the understanding and mindset of staff around new approaches and standards through planning, design, construction, and operation.

   Collaboration amongst departments to develop potential cost sharing opportunities and identify where community facilities would make the most sense from an ISMP perspective in addition to consideration of other green infrastructure or park area requirements that might be needed or desirable in the immediate area. Promote multiple or co-benefits where possible.

2. **Develop a communication strategy and engage external stakeholders and the public to further discuss environmental principles and the implementation of the ISMP.**

   Externally it is to educate the public, and to collaborate with developers and environmental stewardship groups on how they can contribute to successful implementation. It is also to evolve their understanding and mindset around stormwater management and its interplay with watershed. The City should consider the participation of development community representatives in the recommended initiatives to address on-lot controls and infill development.

   External engagement should also be used to communicate findings of the ISMP, and to express the need for cooperation with organizations operating lands upstream of the urban boundary to meet the ISMP goal and objectives.

3. **Remain connected with the Stormwater Interagency Liaison Group (SILG)**

   Connecting with SILG is a way to stay apprised of what other municipalities and governments are doing regarding stormwater regulation, stormwater asset management, environmental monitoring, and education and outreach. It is recommended that the City remains connected to SILG by participating in meetings and discussions and providing input on regional guiding documents and frameworks (such as the Template for ISMPs and the MAMF).

   As previously stated, City staff are encouraged to connect with their counterparts in other communities, such as City of Vancouver, City of Surrey, Township of Langley, and City of Coquitlam to discuss issues and share lessons learned.

4. **Partnerships with neighbouring jurisdictions, agencies, research and stewardship groups**

   There is a wealth of knowledge represented within these watersheds. The South Alouette and Kanaka Creek watersheds involve many other jurisdictions, agencies and groups beyond the City, with predominant ones being the Agricultural Land Commission, BC Hydro, BC Parks, Fisheries & Oceans Canada, Local First Nations, Metro Vancouver, Ministry of Agriculture, Food and Fisheries, Ministry of Forests, Lands & Natural Resource Operations, Ministry of Environment, Pitt Meadows, UBC Malcolm Knapp Research Forest, BC Conservation Foundation (Wildsafe BC Program), and various woodlot operators as outlined in **Figure 13.7**. Continuing to share perspectives and information among these groups and others as well as collaborating to identify and address any specific challenges would serve the watershed well. It is recommended that the City instigate a watershed committee with representation from each jurisdiction, agency, and research group. This group would meet once or twice a year with additional meetings as required to resolve special issues. Given the maturity of stewardship groups in each watershed, it is

recommended that one group be established for each the Kanaka, one for the Alouette (north and south combined) and one for Blaney. A terms of reference for the groups would be confirmed prior to initiation of the committees, along with an assessment of funding and staff time requirements.

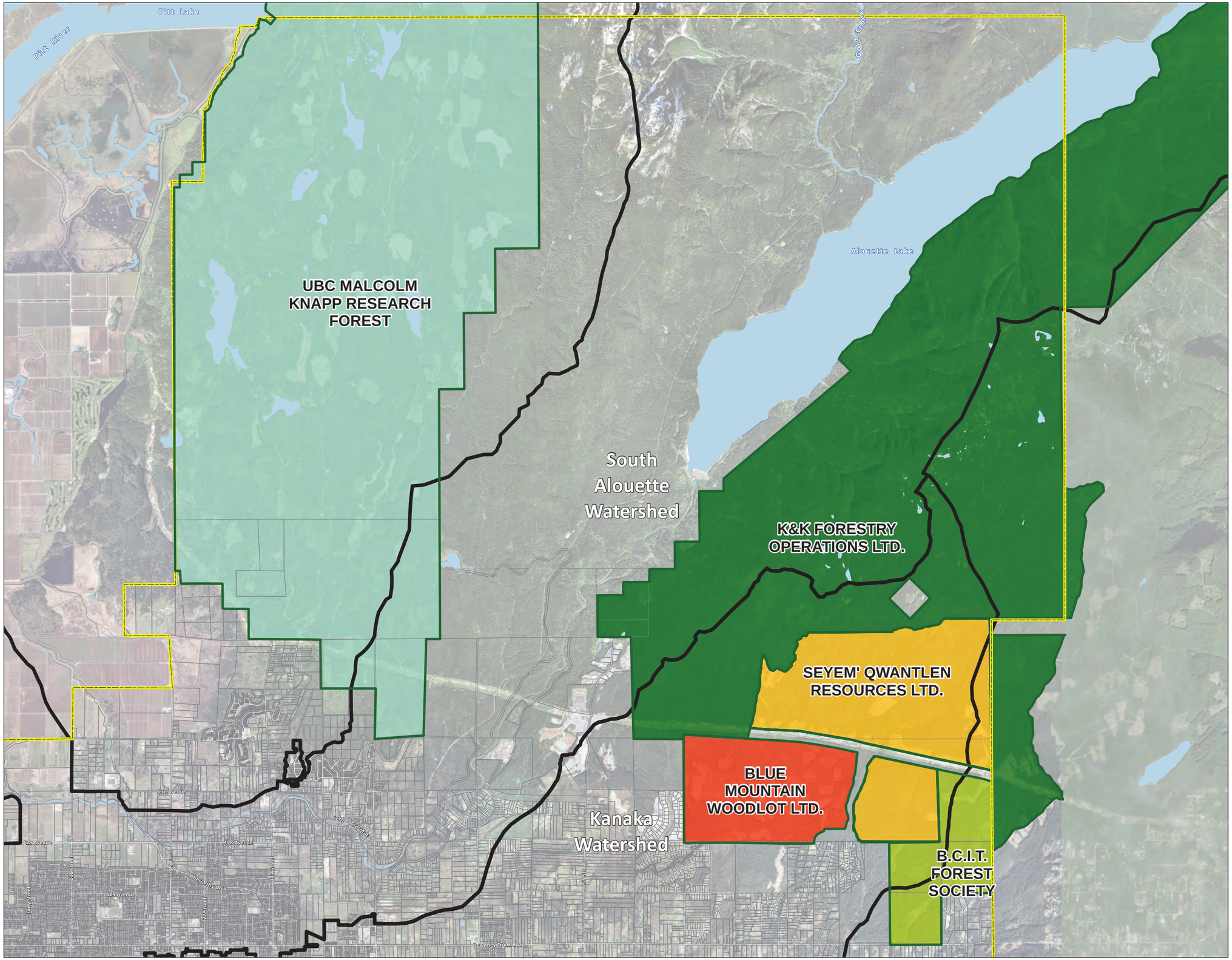
The City could thus cultivate relationships with different stakeholder groups/jurisdictions as a means to invest in responsible water management protection and best management practices in upland areas (e.g. Crown forests outside of municipal jurisdictions).

5. Continue to support KEEPS and ARMS

The City recognizes the excellent work and valuable contribution these groups make to the environmental wellbeing of the City. The City is encouraged to continue to support and partner with them, and it is likely advantageous for them to also participate in the watershed committee noted in item 4 above.

6. Encourage Environmental Farming Practices

The City recommends the farming community capitalize on the Province's Environmental Farm Plan Program support and the Salmon-Safe certification. Through the formation of a watershed committee, connections and collaboration between the City, ARMS, KEEPS, Ministry of Agriculture, Food and Fisheries, Agricultural Land Commission and others could be strengthened. It would be a venue for interested parties to share perspectives on farm monitoring and management practices as well as opportunities for improvement.



South Alouette and Kanaka Integrated Storm Water Management Plans

Woodlot Operators

- UBC - Malcom Knapp Research Forest

CLNTNM

- B.C.I.T. FOREST SOCIETY
- BLUE MOUNTAIN WOODLOT LTD.
- K&K FORESTRY OPERATIONS LTD.
- SEYEM' QWANTLEN RESOURCES LTD.
- Natural Watershed Boundary
- Parcel
- UBC - Malcom Knapp Research Forest
- Municipal Boundary

The accuracy & completeness of information shown on this drawing is not guaranteed. It will be the responsibility of the user of the information shown on this drawing to locate & establish the precise location of all existing information whether shown or not.

200 0 200 400
m

Coordinate System:
NAD 1983 UTM Zone 10N

Data Sources:
City of Maple Ridge
City of Pitt Meadows
BC MoE
NR Canada

Project #:	1279.0025.01
Author:	BG
Checked:	GS
Status:	FINAL
Revision:	O
Date:	2021 / 3 / 10

URBAN SYSTEMS

FIGURE 13.7

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13.4.5 Action Plan

The following sequence of actions are to implement the recommendations described above.

Action	Relative Priority
1. Collaboration among City departments; affectively and frequently communicate in implementing the ISMP.	High
2. Develop a communication strategy and engage external stakeholders and the general public to further explain the importance of environmental principles and actions of the ISMP. Provide educational information to developers and permit applicants.	Low
3. Remain connected with the Stormwater Interagency Liaison Group (SILG).	Medium
4. Instigate watershed committees. A term of reference and mandate statement for their engagement should be prepared along with a review of funding and staff time requirements.	Medium
5. Continue to support and partner with ARMS and KEEPS	High
6. Notify the Provincial Comptroller of Water Rights of Maple Ridge Council's position on possible restoration of lost fish passage incurred as a result of the construction of the Alouette Reservoir.	High
7. Encourage the farming community to capitalize on the Province's Environmental Farm Plan Program support and consideration for Salmon-Safe certification. Identify active farms and those which represent best opportunity for environmental improvements. Work with Ministry of Agriculture, Food and Fisheries, Agricultural Land Commission, FLNRORD, DFO and others to encourage and support environmental enhancements on farms, in achievement of a riparian buffer area adjacent watercourses.	Medium

13.5 Program Area 5: Adaptive Management and Continuous Improvement

Adaptive management is a process of monitoring, reviewing, learning, and adjusting. There is a myriad of things to monitor, requiring significant resources. The recommendations contained herein will help to establish a monitoring framework – the components that should be tracked and assessed. In the early years of the program its expected that coarse level information would be collected across the watersheds of the City to allow determination of priorities and to inform where further monitoring efforts are required. Emphasis in reporting and strategic decisions will look at the trend of outcomes, not on the nuances of site-specific data. For example, is the summer base flow in Creek "x" improving? Is the Watershed Health Tracking Score in Creek "y" improving?

13.5.1 Monitoring

Environmental health and flow monitoring are two important components of an Adaptive Management process, but the program needs to be expanded. Monitoring is broken into several categories, including physical (eg. are the desired flows and quality of water being achieved?), regulatory (eg. are the City's regulatory tools successfully guiding development?), and process (eg. are City staff properly informed and are inter-departmental processes in place to successfully direct the plan's implementation).

Physical Monitoring

Through this ISMP process, baseline water quality and health scores were established. The Monitoring and Adaptive Management Framework developed by Metro Vancouver[32] provides a resource in developing an expanded program. As noted in that document, it is recommended that physical monitoring occur on a 3 year cycle.

As discussed in Section 8, 37 public detention facilities have been reviewed through desktop. Physical monitoring and assessment of all these existing facilities would be resource and time intensive, and not necessarily warranted. It is recommended that monitoring of existing ponds only be done where there are observed cases of watercourse erosion of system flooding in close proximity downstream, or for ponds that are observed to rarely ever store water. Monitoring will help determine whether or not these ponds are performing at their optimum level, and if not, what changes should be made. What defines "optimal" will depend on the circumstance. If a pond contributes to a local stream system that is not exhibiting erosion problems, then its optimal performance is likely to be managing the higher, more extreme precipitation events for flood control. If a pond contributes to a local stream system that does exhibit erosion, then the optimal performance may be to restrict smaller storms and let more extreme events overflow.

However, moving forward the City should consider a post-development monitoring program for new development and associated infrastructure, for at least the one year maintenance period following project completion. The extent of complexity of monitoring will depend on the size and complexity of the development project. It's recommended that the City develop a post-development monitoring framework as part of an ISMP implementation plan. It is possible for monitoring needs to be reduced if the City develops a "pre approved" list of Green Infrastructure designs and criteria, such as the Technology Assessment Protocol – Ecology (TAPE)[33] in Washington State. This monitoring is beneficial but add cost. As part of the framework development the City will need to decide how the program is implemented and funded by development.

The monitoring locations of existing storm sewers should be placed where the theoretical SWMM model indicates storm sewer capacity is inadequate for a 1:10 year flow. The chance of capturing a significant storm event (>1:2 year) within a single winter season is relatively low, but this data will allow model calibration to more confidently predict performance under a design event, in turn providing greater confidence to capital plan priorities. This monitoring of storm sewers is deemed higher priority than monitoring of the existing ponds.

It is recommended that the City require short term monitoring (one winter season) of select stormwater source controls, private and public, to validate that their performance in accordance with design criteria.

Regulatory Monitoring

[32] http://www.metrovancouver.org/services/liquid-waste/LiquidWastePublications/Monitoring_Adaptive_Management_Framework_for_Stormwater.pdf

[33] Emerging stormwater treatment technologies (TAPE) - Washington State Department of Ecology

The most significant regulatory aspect to track is whether source controls are being implemented in accordance with rainwater management design criteria. It is recommended that the City set up appropriate record systems to track that source controls are being implemented through both the Development and Building Permit processes, and if not then the challenges which prevented their successful implementation. As an extension, also track that inspection and maintenance reporting is being done.

And finally, it is recommended that inspection and monitoring occur at occupancy permit that a development / building has not exceeded the permissible site coverage as permitted by the zoning bylaw, and that directly connected impervious surface does not exceed those permitted by design criteria.

Process Monitoring

An important process to monitor is the Development or Building Permit process – are rainwater management goals being subverted to achieve higher site drainage and site stability design considerations? – It's recommended that a "checklist" field be created in the application registry to track whether or not Tier A/B/C controls are successfully implemented and if not, then to what extent and also for what reason are they not being implemented. Only by developing a full understanding of the application or non-application of rainwater management objectives can the City work to creatively overcome challenges to their implementation.

The City would continue to build its map of net habitat gains and Green Infrastructure.

13.5.2 Assessment

It is recommended that an audit of all above monitoring be undertaken on a 3 year cycle. Physical monitoring data would be processed for evaluation by hydrologists and environmental professionals and evaluated against all preceding data. It is recommended that the City implement a central database to record and track data for each monitoring period. The fundamental goal is to see if the hydrologic response to rainfall of the built lands is reducing, and that the water quality and watershed health is improving. This should be tracked in relationship to the changes that have occurred in the contributing catchment. As such, the number and location of development permits, building permits, and capital projects would be inventoried, and the details of their implemented source controls evaluated. The audit would first assess whether or not implementation has been successful, and then secondly assess whether or not the changes have resulted in a positive, neutral, or negative outcome to system performance, water quality, stream stability and health. It is expected that significant catchment changes will be required to result in an obvious positive outcome on the receiving watercourses. Given the anticipated influence of climate change, the assessment will need to consider the severity of precipitation that falls between audits. As such, its valuable that the City maintain permanent rain gauges and that rainfall frequency analysis be undertaken with each audit. The evaluation will be more meaningful if environmental factors can be separated from anthropogenic factors.

13.5.3 Key Performance Targets and Indicators

Specific performance targets are defined in criteria of established bylaw. (eg. retain 50% of MAR, convey the 1:10 year peak flow, remove 90 % of TSS, maximum discharge of 30 mg/L TSS, plant 40 trees per hectare, etc.) and apply largely at the site and neighbourhood level.

At a sub-watershed or watershed scale, cost effective, measurable, and reliable key performance indicators allow the City to determine whether or not the watershed vision is being achieved. Performance indicators need to be selected for things

that can be observed and measured frequently. In the context of South Allouette and Kanaka Creek, recommended key performance indicators are:

- Reduced sediment deposits in streams
- Stability of creek bed and banks
- Fewer annual service complaints due to flooding
- Increase in tree canopy as measured from aerial photos
- A positive differential between the number of trees planted to the number of trees removed
- No reduction in the riparian vegetation as measured from aerial photos
- Improved fish count data
- Successful implementation of source controls with all development and building permits that require them
- Improved water quality
- Improved benthic health
- Successful implementation of the Capital Program.

13.5.4 Responses

The monitoring program is important to assess the specific failure mechanism, should failure occur. Was there a poor design(s)? Has there been a significant change in weather patterns? Were there slope stability or on-site drainage design rules that rainwater management design criteria from being achieved? Was there an infrastructure failure due to insufficient maintenance? Was there insufficient parcel area to achieve rainwater management goals (supplemental off-parcel areas for rainwater management need to be considered early in the land use planning process? There can be many reasons why objectives may not be met. The response(s) need to align with the cause. It is therefore premature to articulate a specific response plan at this time, but some fundamental responses may be as follows:

1. If watercourse erosion and environmental health do not stabilize, or preferably improve, the City may need to accelerate the implementation of communal management infrastructure through its capital program; either with high flow diversions or stormwater detention ponds. Within mature development areas land acquisition and building demolition may be required.
2. If development or building permits are being completed without successful source controls, the City needs to evaluate whether this was a procedural failure or a result of imposed limitations on their application.
3. If service calls occur due to structural or maintenance failure, the City needs to strengthen its Asset Management Program.
4. If maintenance of private source controls is not validated, the City should consider implementing a formal Stormwater Source Control Operating Permit program.
5. If there is increased flooding in the upland urban area not caused by structural or maintenance failure, the City may consider accelerating its pipe replacement program on a priority basis, or explore alternative mitigative measures.
6. If the funding for infrastructure change cannot keep up with demand (ie. worsening conditions) the City needs to revisit its funding stream and look to a program that provides more reliable funding.
7. If the City is not leading by example in implementing and maintaining source controls in public spaces, the City needs to evaluate its interdepartmental collaboration and priorities.

13.5.5 Action Plan

The following sequence of actions are to implement the recommendations described above.

Action	Relative Priority
1. Decide on key performance indicators to be monitored and tracked	High
2. Define staff champions who will lead the Adaptive Management program	High
3. Implement systems to collect and store information	High
4. Assess information and make adapted decisions on no more than a 3 year cycle	Medium (3 year cycle)

13.6 Program Area 6: Capital Planning and Infrastructure Improvements

Hydraulic performance of storm sewer mains and culverts was determined using criteria noted in Section 5.3; coding them as green (under capacity), yellow (at capacity) or red (over capacity). For consideration of potential storm sewer improvement costs the 1:10 year event is applied for storm sewer mains and the 1:100 year event is applied for road crossing culverts. And for both storm sewer mains and culverts a comparison between the "existing condition" and "future condition - community growth with 20% climate change" is applied. Future condition assumes that stormwater controls in accordance with current municipal standards are applied to future development. A summary of performance statistics is presented in Table 7.1 (Storm Sewers) and 7.2 (Culverts) below, and graphically represented in **Figures 14.1** through **Figure 14.5**.

System performance and identification of future deficiencies reflects the combined effects of future development (infill and greenfield), climate change (20% increase in precipitation), and assumes that the City's drainage management criteria is achieved (Tier A, B, C) by future developments.

Table 13.4 - Summary of Existing and Future Storm Sewer Infrastructure Performance (1:10 year)

Storm Sewer Performance Code	Existing Condition 1:10 year Storm		Future Condition with 20% CC 1:10 year Storm	
	Approximate Length of Pipe (m)	Weighted Average Diameter (mm)	Approximate Length of Pipe (m)	Weighted Average Diameter (mm)
Green (under capacity)	41,000	665	34,000	664
Yellow (at capacity)	10,000	729	12,000	733
Red (over capacity)	13,000	517	18,000	525

Table 13.5 - Summary of Existing and Future Culvert Infrastructure Performance (1:100 year)

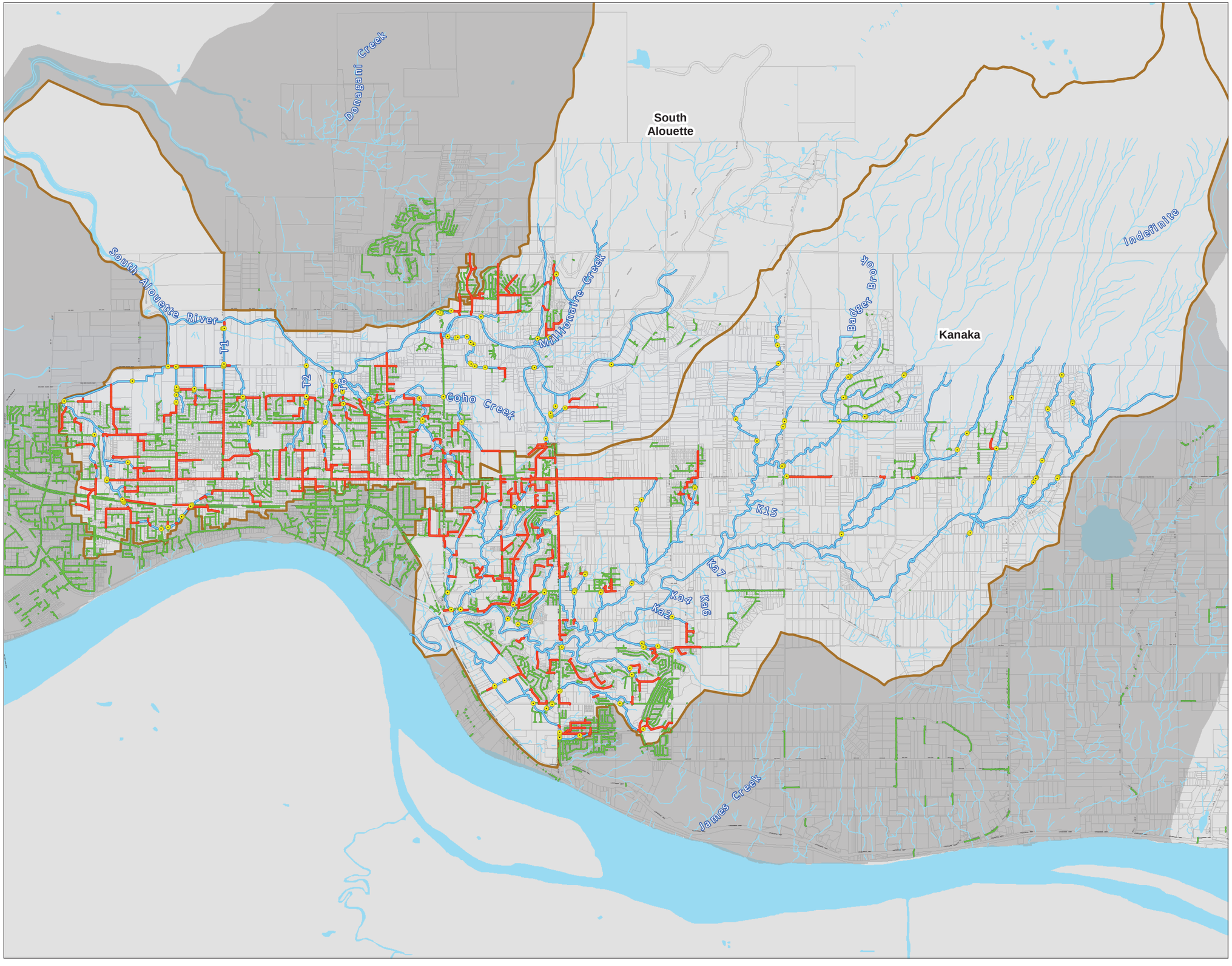
Culvert Performance Code	Existing Condition 1:100 year Storm		Future Condition with 20% CC 1:100 year Storm (includes existing)	
	Approximate Length of Pipe (m)	Weighted Average Diameter (mm)	Approximate Length of Pipe (m)	Weighted Average Diameter (mm)
Green (under capacity)	1,351	1,365	1,196	1,350
Yellow (at capacity)	956	1,264	931	1,305
Red (over capacity)	362 (18 crossings)	879	542 (27 crossings)	997

Green coded pipes are of low interest from a capacity perspective (does not consider pipe condition), yellow coded pipes are of moderate interest and red coded pipes are of high interest. For preliminary planning, only red coded pipes are considered for potential reinvestment (upgrade). As noted in previous sections of the report, it is considered premature to reach a firm conclusion on specifically what pipes must be upgraded and when. Upgrade requirements should be confirmed by observing performance data through monitoring and conducting a risk-based assessment. This would involve local flow / water level monitoring and predictive model calibration, since it is unlikely that a design event will be observed through short term monitoring. A locally calibrated model for the areas of high interest will provide greater confidence in the prediction that this system will flood under a design event. Once requirements for drainage system upgrades are verified, the City must evaluate infrastructure re-investment needs and reconcile this with long range financial planning.

In the existing condition, approximately 13 km of trunk storm sewers modelled (20%) are predicted undersized with respect to target levels of service, increasing to 18 km (28%) in the future (including existing deficiencies) with an assumed 20% increase in precipitation due to climate change.

With consideration for the future condition only, the weighted average pipe diameter is 525 mm. Using a planning level unit cost of $3.00 per mm diameter per meter of length (inclusive of engineering and contingencies), the red coded storm sewer trunk mains have a value of $28M for existing and future deficiencies. The value of existing deficiencies is $20M.

An upgrade associated with McKenney Creek overflowing to a farm field between 203 and 210 Streets was not developed as the issue requires dedicated study. It is recommended the overflow be further evaluated as part of the Master Drainage Plans and the Lowland Agricultural Drainage study recommended in Section 13.6.2.



South Alouette and Kanaka Integrated Stormwater Management Plans

Modelled System

Legend

- Modelled Pipe System
- Modelled Creek System
- Modelled Culvert
- Drainage Pipes
- Watershed Boundary
- Parcel
- Creeks

1,000 500 0
m

N

Coordinate System:
NAD 1983 UTM Zone 10N

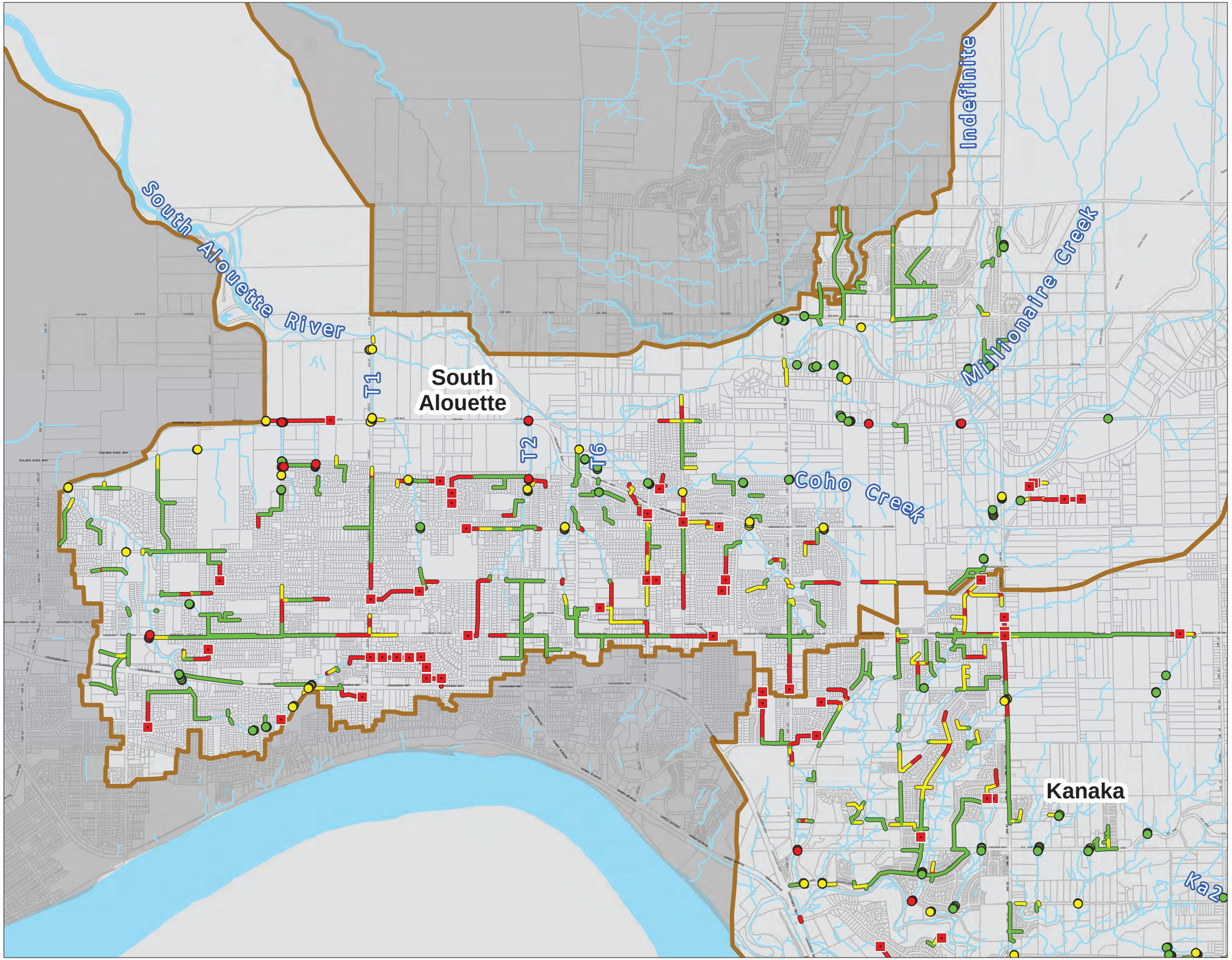
Data Sources:
GeoAdvice
City of Maple Ridge
City of Pitt Meadows
BC MoE
NR Canada

Project #:	1279.0025.01
Author:	LP
Checked:	GS
Status:	FINAL
Revision:	N
Date:	2020 / 2 / 5

URBAN systems

FIGURE 13.8

U:\Projects_VAN\1279\0025\01-D-Drafting-Design-Analysis\GIS\Projects\MXD\Current\Stage 4 Report Figures_20200130\Fig14_1_Maple Ridge ISMP Modelled Pipe System.mxd Last updated by lpunt on February 5, 2020 at 10:31:57 AM



MAPLE RIDGE
British Columbia

South Alouette and Kanaka Integrated Stormwater Management Plans

System Capacity Analysis Existing Conditions

South Alouette

Legend

- Surface Flooding
- Over Capacity Main
- At Capacity Main
- Under Capacity Main
- Over Capacity Culvert
- At Capacity Culvert
- Under Capacity Culvert
- Watershed Boundary
- Parcel
- Creeks

Results presented represent:
- 10 Year Flows for Storm Mains and Manholes
- 100 Year Flows for Culverts

1,000 500 0
m

N

Coordinate System:
NAD 1983 UTM Zone 10N

Data Sources:
GeoAdvice
City of Maple Ridge
City of Pitt Meadows
BC MoE
NR Canada

GeoAdvice

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Author:	LP
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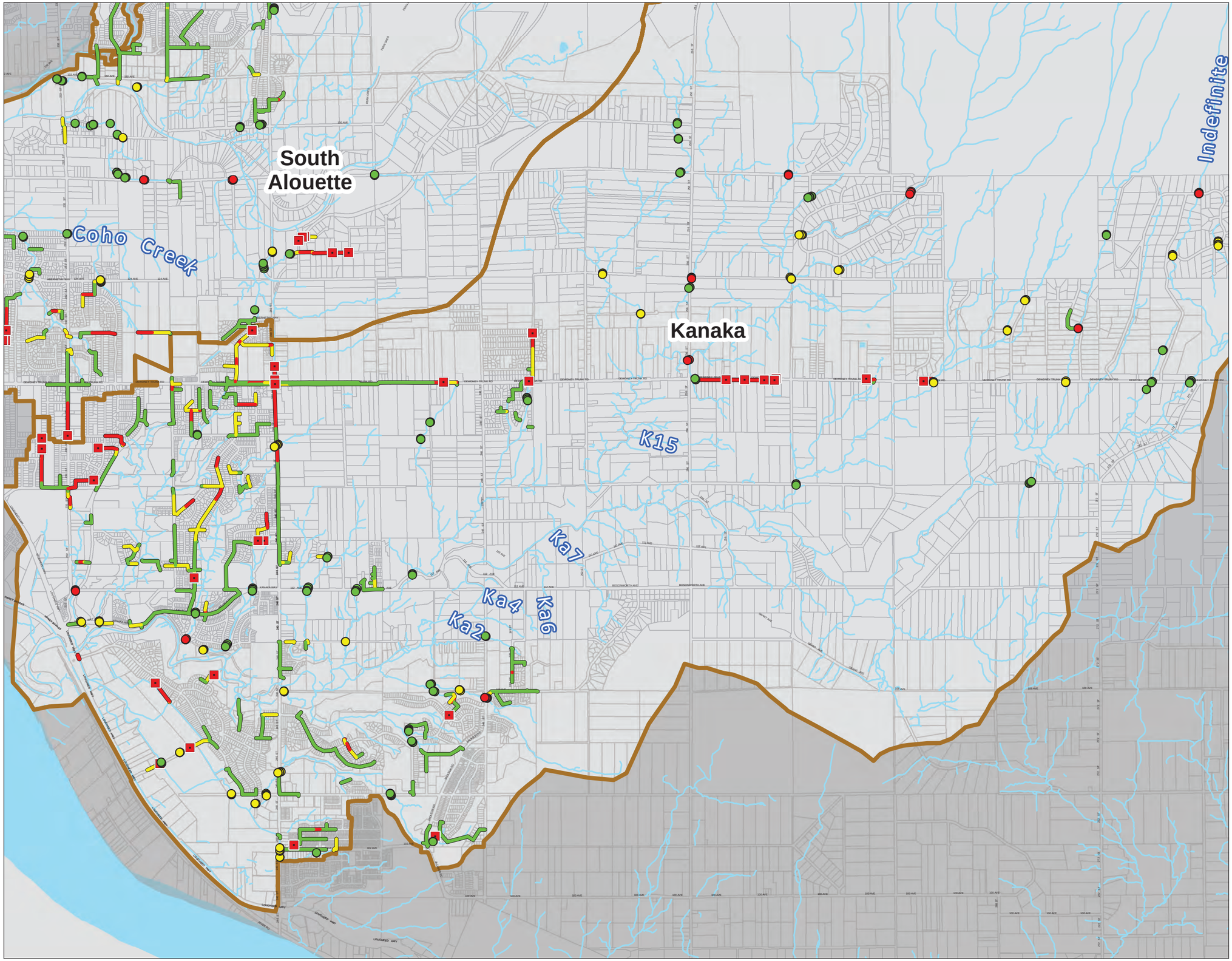
Status:	FINAL
Revision:	N
Date:	2020 / 2 / 26

URBAN SYSTEMS

FIGURE 13.9

U:\Projects_VAN\1279\0025\01D-Drafting-Design-Analysis\GIS\Projects\MXD\Current\Stage 4 Report Figures_20200130\Fig14_2_Maple Ridge ISMP System Capacity Analysis_Existing Conditions_South Alouette.mxd Last updated by lpunt on February 26, 2020 at 10:43:10 AM



South Alouette and Kanaka Integrated Stormwater Management Plans

System Capacity Analysis
Existing Conditions

Kanaka

Legend

- Surface Flooding
- Over Capacity Main
- At Capacity Main
- Under Capacity Main
- Over Capacity Culvert
- At Capacity Culvert
- Under Capacity Culvert
- Watershed Boundary
- Parcel
- Creeks

Results presented represent:
- 10 Year Flows for Storm Mains and Manholes
- 100 Year Flows for Culverts

1,000 500 0
m

N

Coordinate System:
NAD 1983 UTM Zone 10N

Data Sources:
GeoAdvice
City of Maple Ridge
City of Pitt Meadows
BC MoE
NR Canada

Project #:	1279.0025.01
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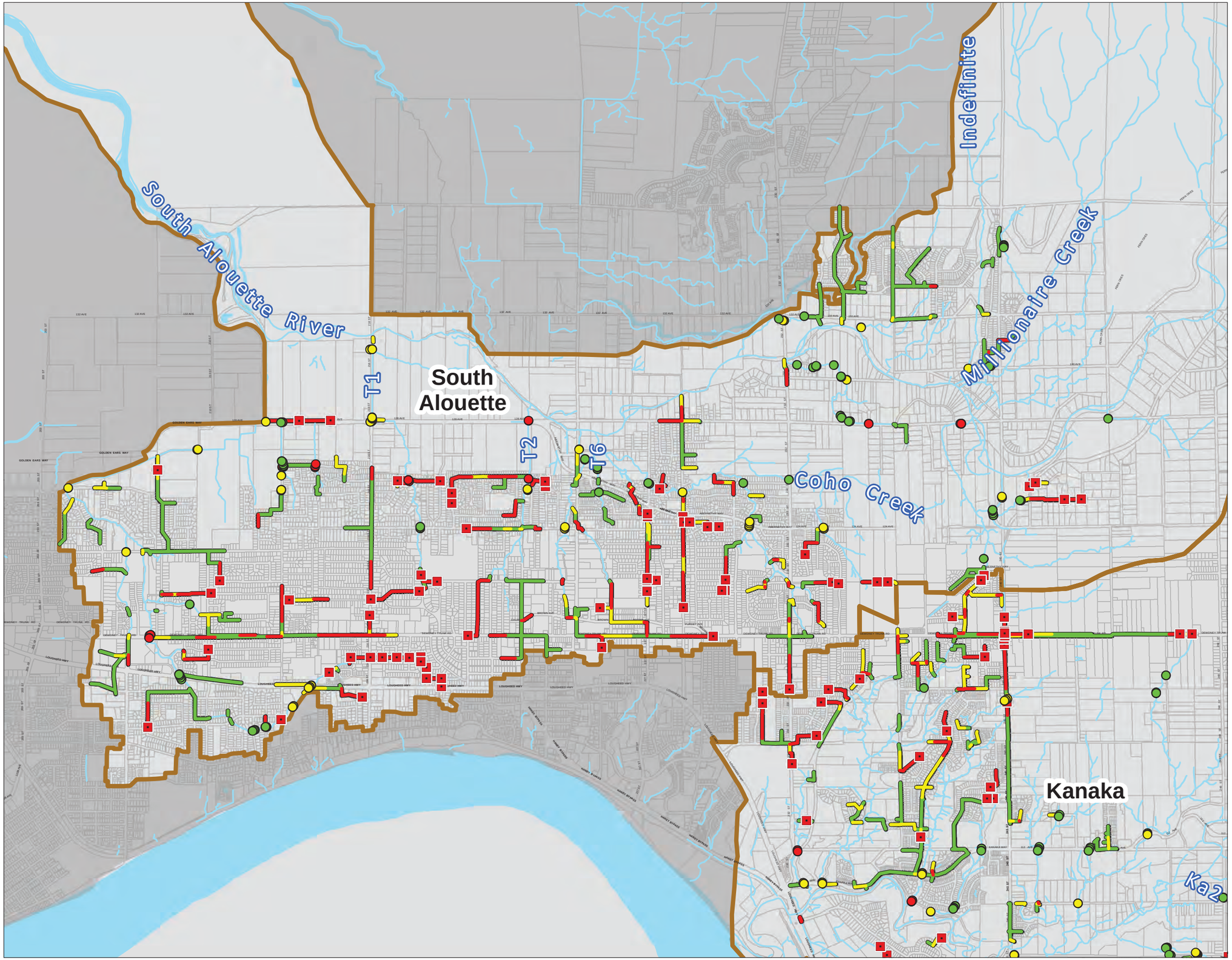
Revision:	N
Date:	2020 / 2 / 26

URBAN SYSTEMS

FIGURE 13.10

U:\Projects_VAN\1279\0025\01\D-Drafting-Design-Analysis\GIS\Projects\MXD\Current\Stage 4 Report Figures_20200130\Fig14_3_Maple Ridge ISMP System Capacity Analysis_Existing Conditions_Kanaka.mxd Last updated by lpunt on February 26, 2020 at 10:42:06 AM



South Alouette and Kanaka Integrated Stormwater Management Plans

System Capacity Analysis
With 20% Climate Change
Future Conditions

South Alouette

Legend

- Surface Flooding
- Over Capacity Main
- At Capacity Main
- Under Capacity Main
- Over Capacity Culvert
- At Capacity Culvert
- Under Capacity Culvert
- Watershed Boundary
- Parcel
- Creeks

Results presented represent:
- 10 Year Flows for Storm Mains and Manholes
- 100 Year Flows for Culverts

1,000 500 0
m

N

Coordinate System:
NAD 1983 UTM Zone 10N

Data Sources:
GeoAdvice
City of Maple Ridge
City of Pitt Meadows
BC MoE
NR Canada

Project #:	1279.0025.01
Author:	LP
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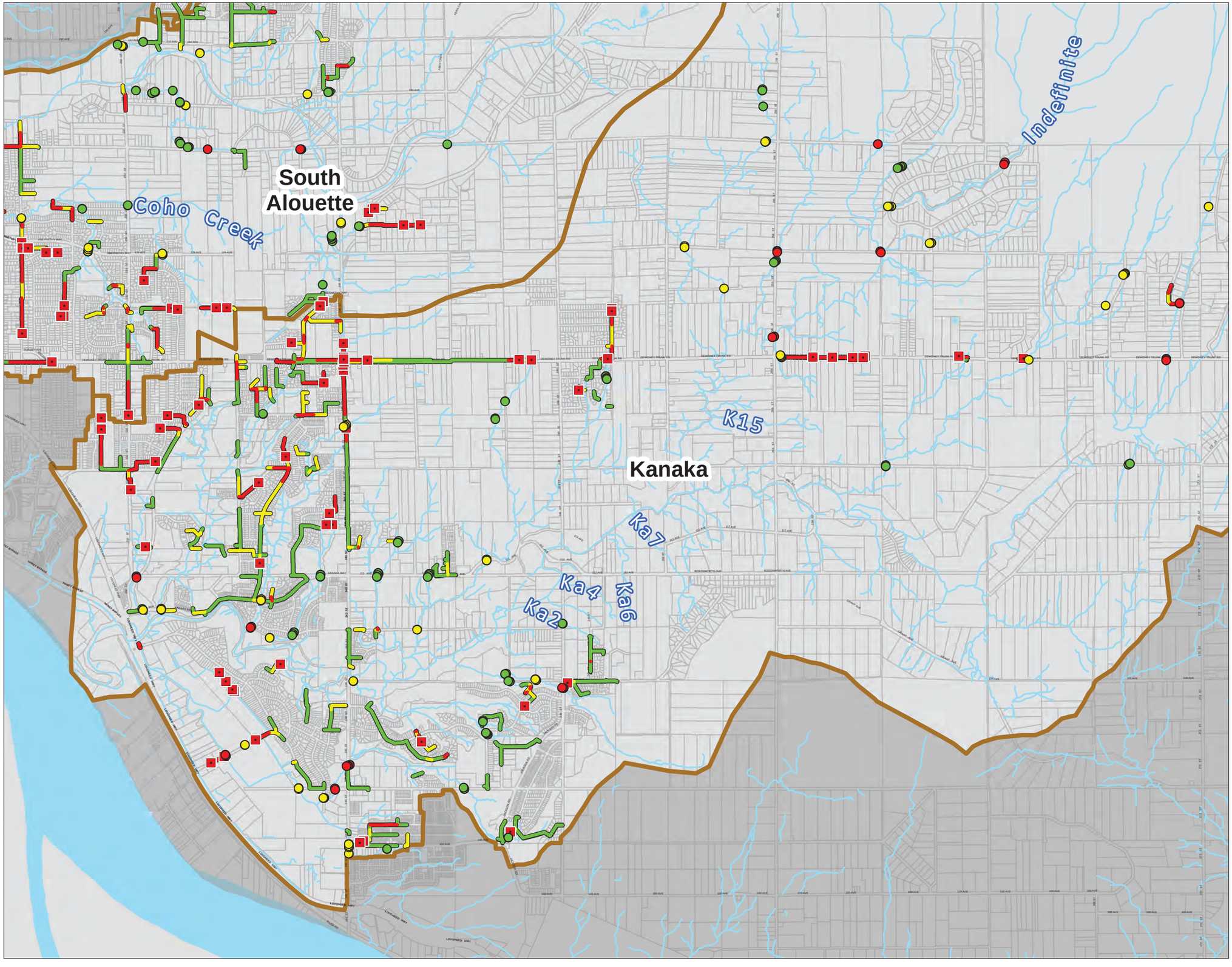
Status:	FINAL
Revision:	N
Date:	2020 / 2 / 25

URBAN SYSTEMS

FIGURE 13.11

U:\Projects_VAN\1279\0025\01\D-Drafting-Design-Analysis\GIS\Projects\MXD\Current\Stage 4 Report Figures_20200130\Fig13_4_Maple Ridge ISMP System Capacity Analysis_Future Conditions_South_Alouette.mxd Last updated by jpurton February 25, 2020 at 12:50:37 PM



MAPLE RIDGE
British Columbia

South Alouette and Kanaka Integrated Stormwater Management Plans

System Capacity Analysis With 20% Climate Change Future Conditions

Kanaka

Legend

- Surface Flooding
- Over Capacity Main
- At Capacity Main
- Under Capacity Main
- Over Capacity Culvert
- At Capacity Culvert
- Under Capacity Culvert
- Watershed Boundary
- Parcel
- Creeks

Results presented represent:
- 10 Year Flows for Storm Mains and Manholes
- 100 Year Flows for Culverts

1,000 500 0
m

N

Coordinate System:
NAD 1983 UTM Zone 10N

Data Sources:
GeoAdvice
City of Maple Ridge
City of Pitt Meadows
BC MoE
NR Canada

GeoAdvice

Project #:	1279.0025.01
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Revision:	N
Date:	2020 / 2 / 25

URBAN SYSTEMS

FIGURE 13.12

U:\Projects_VAN\1279\0025\01\D-Drafting\Design-Analysis\GIS\Projects\MXD\Current\Stage 4 Report\Figures_20200130\Fig14_5_Maple Ridge ISMP System Capacity Analysis_Future Conditions_Kanaka.mxd Last updated by jpunt on February 25, 2020 at 2:07:09 PM

Subject to available resources and priorities, as part of the process of monitoring and recalibrating the systems of interest, the City may wish to expand the modeling to include the smaller local pipes such that all infrastructure (not just trunks) are considering in the capital planning. Inclusion of local pipes in the assessment will likely increase the list of deficiencies and capital replacement costs.

Similarly, for road culverts, red coded pipes in the future (including existing deficiencies) total 542 meters with a weighted average diameter of 997 mm for 27 roadway crossings (18 red coded in existing condition). The unit cost for culverts are very different than storm mains and are highly variable based on a variety of factors. Small culverts on local roads can perhaps be completed for something in the range of $100,000 to $200,000, but larger culverts on busy roads, where dewatering is required and where utilities may conflict, it is common for such culverts to cost in the range of $200,000 to $500,000 each. In absence of conducting design reviews for each crossing, it's suggested that a value of $300,000 per crossing be considered for each of the 27 crossings, for a total of $8M (future plus existing). The estimated value for the existing 18 deficient crossings only is $5.4M.

A recent rainfall and design storm tool developed by Metro Vancouver [34] indicates that a 20 % increase in precipitation will occur by year 2050 for a moderate climate change scenario. This is a general statement as the predicted increase varies depending on the return period and storm duration. It is emphasized that there remains no certainty on the precise change in precipitation. All estimates are based on an ensemble of climate model predictions; each yielding variable results. Rainfall predictions will continue to evolve with climate science research. It is an accepted practice for local governments to make decisions today based on best available information. These decisions are influenced by the municipality's tolerance to risk. It is, however, recommended that regardless of the decision made today, the City commit to tracking climate change projections on a regular cycle (eg. 5 years) and making adaptive management decisions as new information dictates.

13.6.1 Interpreting the Results

While this study has identified $36M in infrastructure replacements for existing plus future growth and climate change, there are many considerations that must still be made before concluding that such replacements must be done, or when they should be done. They include:

- Analytical modeling is not an exact science. Hydrology and hydraulics are very complex processes that ideally are proven with performance monitoring and model calibration. Monitoring and calibration to date has been done at a high level, watershed scale, not at a local level where variability will exist. Areas of deficiency noted are at this point considered "points of interest" and it is recommended that a winter season flow monitoring program be conducted at these locations allow model calibration at a local level.
- The criteria applied in assessing whether a pipe is deficient or not is based on low tolerance to surcharging during its design event; in this case a 1:10 year event for storm sewers, or an event that has a 10% of occurring in any given year. It is quite possible that some of these pipes do surcharge today, but unless they cause damage or obvious surface flooding, this surcharging goes unnoticed and is not a concern.
- Most storm sewers are designed to prevent "nuisance flooding" only, which is referred to as the "minor" system. The City of Maple Ridge has elected to use a 1:10 year event as its minor system, whereas many communities in Canada only apply a 1:5 year event.

[34] Metro Vancouver IDF Curve and Design Storm Spreadsheet, Final 2019.

- By designing a storm sewer system for a 1:10 year event, the storm sewers are inherently designed to surcharge and fail on occasion, thereby activating the "major" system, which are flow paths that protect public safety and property to a 1:100 year level. The influence of climate change is a significant aspect that is changing how frequently storm sewers will surcharge.
- Given the above bullets, overland flow should be expected on occasion. Where this is predicted to occur, there is need to assess the overland flow risk to public safety and property damage and develop options to mitigate the risk (storage, conveyance upgrades, flow redirection, surface flow path improvements). This ISMP highlights potential areas of concern which should be explored in greater detail.

13.6.2 Master Drainage Planning

The City is not yet able to confirm existing/future funding requirements for the drainage system because more refined monitoring and analysis should be undertaken for areas identified herein as "areas of interest". This will include further assessment of storm sewer performance at the local level, a more detailed overland flow path assessment, and an evaluation of risk. This would be done through more refined Master Drainage Plans at a sub-watershed level.

Master Drainage Plans would better recognize the unique conditions, opportunities, constraints in each area, in turn better assessing the need and ability to attain Tier A and B criteria. It would allow the City to integrate and sensitivity test the outcomes of its Green Infrastructure Strategy. Moreover, it would enable the City to sensitivity test different infill development projections and scenarios, including projections for changes to impervious areas versus measures intended to offset this increase. Analytical modeling could be expanded to include additional pipes within the network (this ISMP only analyzed trunk pipes) for a more refined assessment of system flood risk and mitigation strategies, in turn leading to priority-based capital plan decisions. Lastly, the Master Plans could plan for the addition of storm sewers to pockets within the developed urban area where storm sewer servicing does not currently exist.

Funding for Master Drainage Plans can be included in the DCC (development cost charge) program. It is recommended that each study be in the order of 200 – 300 hectares. Priority would be placed on areas of known system failure and areas that are seeing greatest redevelopment pressures, such as the Fraser River Escarpment. The outcome of the more detailed and rigorous Master Drainage Plans can drive updates to the City's Drainage DCC Bylaw.

Similar to the Master Drainage Plans, a lowland agricultural drainage study is recommended for the agricultural lands north of 123 Avenue. The study would assess the drainage of these lands and identify opportunities for improvement with the goal of maintaining the agricultural viability of these areas.

14 SUMMARY ACTIONS, PRIORITIES, AND BUDGETS

A summary table of draft recommended actions, their relative priority, and a suggested budget amount is provided on the following pages in **Table 14.1**. Only those activities that are expected to require external consultants or contractors has been budgeted. Activities internal of City functions are not and are noted as "Internal" in the table.

Actual budget requirements are subject to development of the detailed scope and deliverables. The suggested budgets herein are planning level based on conduct of similar assignments in other jurisdictions. Also, many actions occur repeatedly. **Budget for only a five year window is included in the totals.**

Table 14.1 - Summary of Program Areas, Actions, and Budgets

Program Area	Actions	Relative Priority	Suggested Budget
1. Regulation and Enforcement	Complete the "Green Infrastructure Management Strategy Policy Review" launched in 2020. Develop a dedicated Green Infrastructure (GI) Strategy document that will provide greater direction on the selection and application of the different GI typologies, linked to the updated criteria, as well as address the Operation & Maintenance and associated funding and resource requirements. This is anticipated to be a significant contributor to the overall funding strategy.	High	N/A
	Review and update the Watercourse Protection Bylaw to include appropriate on-site and off-site options for meeting 3-tier standards and water quality requirements, and how these can be coordinated with pervious area requirements and integrated into building and landscape designs. Update Erosion and Sediment Control Permit requirements for construction sites such that plans are to be prepared by professionals that have Erosion & Sediment Control specific training, education and certification using a numerical based performance evaluation system like the Revised Universal Soil Loss Equation. Seek opportunities to further stress within the Watercourse Protection bylaw (and/or other appropriate documents) the need for retention of native vegetation, ditches and wetlands for the purpose of maintaining habitat, recharging groundwater (to maintain stream flows during increasingly hot/dry summers) and providing storage for runoff from increasingly intense rain events.	High	$20,000
	Further to the item above, update the Design Criteria and standards to reflect limitations and variable site conditions. Ensure criteria match practices in all departments. Map exemption areas or areas of special design consideration. Map active well capture zones and a statement of whether their aquifers are confined or unconfined from surface water within the urban reserve. In absence of this mapping, apply the Provinces "Underground Stormwater Infiltration – Best Practices for Protection of Groundwater Resources in British Columbia" (B.C. Ministry of Environment, Water Protection and	High	$50,000 (excluding well capture zone analysis)

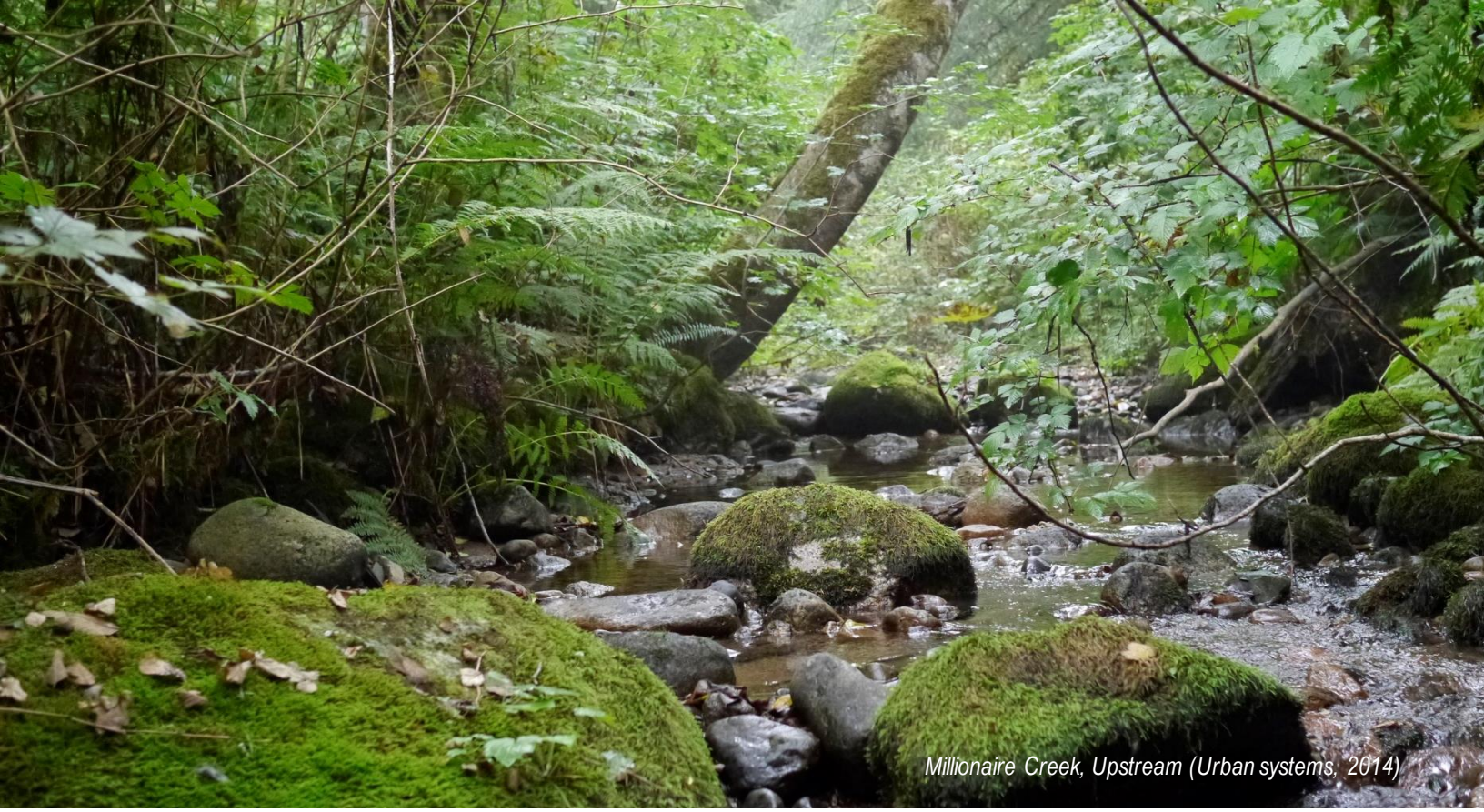
	Sustainability Branch, 2014). Also adopt new design precipitation to reflect climate change. Ensure coordination with the Building Bylaw.		
	Strengthen the Design Criteria with respect to stormwater quality treatment and associated performance targets, with stronger emphasis on landscape based green infrastructure where possible.	High	$10,000
	Formulate acceptable examples and educate developers on how to develop according to the guidelines and ideas in the Town Centre Area Plan.	Medium	Internal
	Recognizing that the City recently completed a Zoning update, consider a future update to the Zoning Bylaw to provide provisions achieving tree canopy targets.	Medium	Internal
	Complete pilot projects that provide water quality treatment of roadway runoff that is piped directly into sensitive aquatic habitats. This commitment is important to mitigate the effects of stormwater pollution on the natural environment, understand and optimize maintenance costs and aesthetics associated with different design options, develop preferred designs for inclusion in future design criteria documents, and for the City to be seen as leaders towards meeting its own stormwater policies and objectives.	High	$100,000 Per year for 5 years plus maintenance costs to be determined
	Seek to achieve effective watershed habitat networks with City land use plans and educating developers on how to develop according to the guidelines, land use plans, and bylaws. The City is planning to undertake an Ecological Network Management Strategy in 2022.	Medium	Internal
	Consider recommendations by Northwest Hydraulic Consultants (NHC) - "North Alouette and South Alouette Rivers Additional Floodplain Analysis, Phase 2 – Technical Investigations Completion Final Report".	Priority not assessed as part of ISMP	Not available without further investigation
2. Asset Management	Build an inter-departmental asset management team to lead the development and implementation of asset management initiatives, with stormwater representation from Engineering and Public Works. (Asset management program has been recently launched by the City)	High	Internal
	Grow awareness among staff, elected officials, and the public of the importance of asset management and the risk of insufficient practices and funding. Budget cost is strictly to develop	Low	$5,000

	communication aids – basic printed material and/or PowerPoint presentation.		
	Focus inspections and condition assessments on areas of interest identified from the hydraulic modelling. Use these to inform the risk framework and subsequent decisions about operations, maintenance, and asset renewal/replacement.	Medium	Internal
	Gather data on water level and flow at areas of interest identified from the hydraulic modelling to confirm system performance. Use these to inform the risk framework and subsequent decisions about operations, maintenance, and asset renewal/replacement. Budget is to establish 5 stations as temporary installations over a 3 to 4 month winter period. This may be repeated over 2 or 3 consecutive years at different locations.	Medium	$50,000 per year for 3 years
	Define stormwater levels of service. Budget is for a consultant to assist City staff through workshop discussions.	High	$5,000
	Inventory and valuate the services provided by natural assets. Budget may be highly variable and significant depending on how many assets are to be reviewed, how they are to be assessed, and what in amount of information is currently available. Budget noted is a reasonable starting point which would be used to help determine need for additional financial commitments based on desired outcomes. A reference for scope consideration is Municipal Natural Assets Initiative at https://mnai.ca/	High	$100,000
	Quantify required stormwater funding levels.	Medium	Internal
	Develop a risk framework to inform future stormwater asset investment planning.	High	$10,000
	Review the City's O&M program, informed by anticipated changes in level of service over time and risk. Budget may be highly variable depending on level of detail and whether document is general to cover all system, or specific and tailored to cover unique difference for each system. Budget provided is for a general document.	Medium	$50,000
	Conduct a review of major overland flood paths using a risk assessment framework. This work is often done in two stages; 1) desktop analysis using digital terrain models and hydraulic modeling output and 2) site reconnaissance for areas of particular interest. **Budget noted here is for stage 1 only.** Budget for stage	High	$25,000

	2 would be informed by stage 1. This budget would be for Kanaka and South Alouette only, but this could be coupled with similar analysis for other watersheds. If so, the budget would be scaled accordingly. This assessment would be using currently available hydraulic model information and therefore at a course level. It is anticipated that a more refined analysis would occur through sub-watershed level Master Drainage Plans (MDP's), however, it is expected that it will take several years for the City to complete all MDP's, so there would be benefit to proceed with a high level assessment near term.		
3. Environmental Monitoring	Conduct stream monitoring - water quality and B-IBI. Start with 3 continuous years to first establish inter-seasonal variability, then conduct on 3 year cycle. Budget is based on monitoring 4 sites as done in 2015, using the Metro Van MAMF protocols, for three continuous years.	Medium	$33,000for 3 years.
	Install semi-permanent flow monitoring stations at key locations in watersheds to experience significant land use change	Medium	$50,000 per year allows for 2 locations
	Conduct erosion and bank stability monitoring as well as stream substrate monitoring. Pay close attention to erosion in McFadden Creek (enters Kanaka at the fish hatchery), Dunlop Creek (discharges to key spawning area in Kanaka) and other sensitive locations. At the same time, identify obstacles to habitat connectivity, in particular anthropogenic fish barriers. Update 2003-2005 mapping to track restoration opportunities. Budget will depend on the extent of the watercourses monitored. Recommend that monitoring occur in fall and winter before vegetation growth to improve visibility. Budget suggested herein is for site reconnaissance and reporting in a single year. The value is based on a unit rate of $1,000 per kilometer of channel as experienced by the City of Surrey which has conducted such studies over several years. Jurisdiction, property ownership, natural watercourse erosion processes, climate change and responsibility for any reactive or proactive bank stabilization works should be considered when developing a program.	Medium (5 year cycle)	$150,000

	Conduct desktop monitoring of GIS-based parameters, such as riparian forest integrity, urban tree canopy, impervious surface, inventory of green infrastructure, new developments, etc. Budget assumes that all required data sets are already available in digital form. Recommend that LiDAR data be acquired every 5 years, requiring additional funding, costs to be determined.	Low (5 year cycle)	$30,000
	Collaboration among City departments; effectively and frequently communicate in implementing the ISMP.	High	Internal
4. Collaboration, Education, and Outreach	Develop a communication strategy and engage external stakeholders and the general public to further explain the importance of environmental principles and actions of the ISMP. Provide educational information to developers and permit applicants.	Medium	$15,000
	Remain connected with the Stormwater Interagency Liaison Group (SILG).	Medium	Internal
	Instigate watershed committees (Kanaka, Alouettes, and Blaney) with other jurisdictions, agencies, stewardship groups and others. A terms of reference, mandate statement for their engagement and a review of potential funding and staff time requirements should be prepared.	Medium	Funding requirement to be reviewed
	Continue to support and partner with ARMS and KEEPS	High	Internal
	Decide on key performance indicators to be monitored and tracked	High	Internal
	Notify the Provincial Comptroller of Water Rights of Maple Ridge Council's position on possible restoration of lost fish passage incurred as a result of the construction of the Alouette Reservoir.	High	Internal
	Encourage the farming community to capitalize on the Province's Environmental Farm Plan Program support and consideration for Salmon-Safe certification. Identify active farms and those which represent best opportunity for environmental improvements. Work with Ministry of Agriculture, Food and Fisheries, Agricultural Land Commission, FLNRORD, DFO and others to encourage and support environmental enhancements on farms, in achievement of a riparian buffer area adjacent watercourses.	Medium	Internal
5. Adaptive Management and	Define staff champions who will lead the Adaptive Management program	High	Internal

Continuous Improvement	Implement systems to collect and store information	High	Internal
	Assess information and make adapted decisions on a 3 year cycle	Medium (3 year cycle)	Internal
6. Capital Planning and Infrastructure Improvements	Placeholder budget for replacement of infrastructure predicted to be under-capacity ($28M existing deficiencies plus $8M additional deficiencies due to growth and climate change). Replacements should be confirmed through Master Drainage Plans (see below), additional monitoring, and risk assessment. This budget is for the South Alouette and Kanaka Watersheds only, and for pipes/culverts 400mm and larger only.	TBD	$36,000,000
	Undertake sub-watershed Master Drainage Plans. Budget assumes that analysis would build upon pre-existing analysis conducted through ISMP's. This budget would not be sufficient to build an analytical model from scratch or resolve significant infrastructure data gaps. It is considered a refinement to the ISMP focusing on conveyance and overland flood routing.	High	$100,000 each (assume 2 within next 5 years)
	Lowland Agricultural Drainage Study for land north of 123 Avenue.	High	$200,000
	Update the City's Drainage Development Cost Charge bylaw based on the outcomes of the sub-watershed Master Drainage Plans and the Agricultural Lowland Drainage Study	High	Internal
		Total Low Priority Budget	$35,000
		Total Medium Priority Budget	$714,000
		Total High Priority Budget	$1,120,000
		Total Infrastructure Replacement Preliminary Budget	$36,000,000



Millionaire Creek, Upstream (Urban systems, 2014)

15 CONCLUSION

Similar to other urban jurisdictions, historic development in the South Alouette and Kanaka Creek watersheds has impacted the health of natural environment systems. But the City of Maple Ridge was an early adopter of policy and criteria that strives to facilitate community growth in a more sustainable manner than it had during early settlement. Two key successes achieved to date have been progressive watercourse setbacks and designation of environmentally sensitive protection areas, and formation of three-tiered rainwater management criteria. While built examples like Silver Valley are beginning to form, the City recognizes the need to further develop its Green Infrastructure implementation strategy, with primary focus on better achieving its Tier A criteria (retaining 50% of the Mean Annual Rainfall). The City is undertaking a Green Infrastructure Management Strategy Policy Review in 2020.

In previously built urban areas, redevelopment poses an opportunity for betterment of conditions. Where there is to be Greenfield development, or conversion of rural lands to urban densities, there is a greater challenge to prevent degradation of watershed health; but certainly achievable.

Climate change poses a threat to the performance of infrastructure moving forward. Planning and infrastructure decisions near term should consider an allowance of increased winter precipitation over current levels. Climate science continues to evolve and so the City should track new information and be prepared for adaptive management. Once again, the City of Maple Ridge is not alone in this challenge.

Storm sewer infrastructure is not intended to prevent flooding in all circumstances but is intended to prevent "nuisance flooding" from moderate sized storms. As such, surcharging of pipes and surface flows should be expected from time to time. It is expected to happen more frequently with the impact of climate change. This study has identified areas where surface flows are most likely to occur and the City should further investigate the potential risk of flooding at these locations and decide what actions are required, if any, to provide a flow path that is safe to public and does not result in property

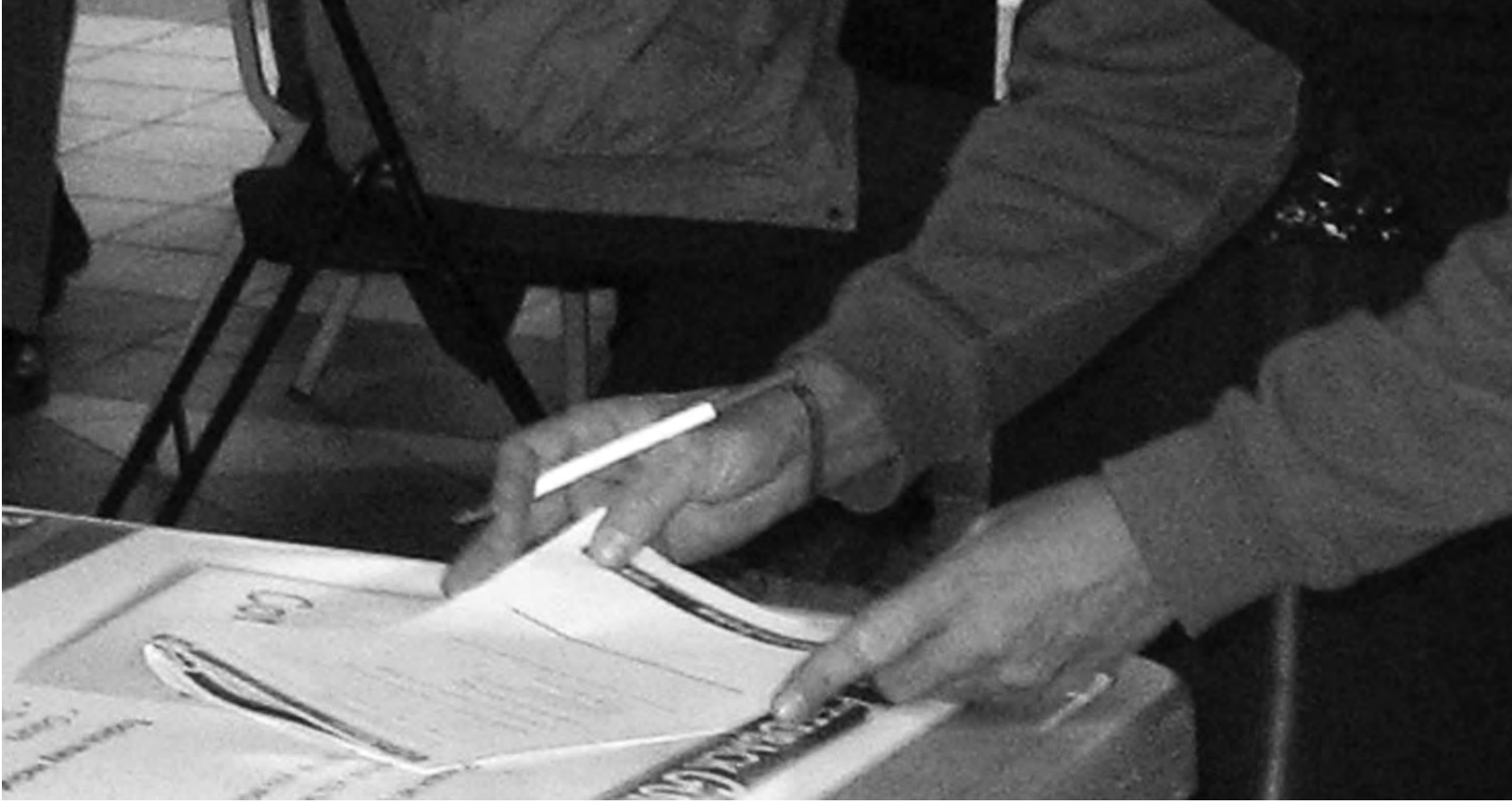
damage. Designated floodplains are a special case that will continue to flood. Within the designated floodplain of a natural watercourse, the municipality has discretion to develop policy on how it wishes to manage flood risk (eg. Build dikes or manage risk through regulation such as a "flood construction level"). The creation of dikes involves several senior government regulations and would create a major commitment in perpetuity for the City as the diking authority.

This study has identified a number of recommendations in six different program areas to assist the City with improving on what it already does. These program areas include:

1. Regulation and Enforcement
2. Asset Management
3. Environmental Monitoring
4. Collaboration, Education, and Outreach
5. Adaptive Management and Continuous Learning
6. Capital Planning and Infrastructure Improvements

For the next 5 year capital planning cycle, action items estimated at $2M in external costs are recommended. This includes pilot projects to remove pollutants from roadway runoff, sub-watershed Master Drainage Plans and an Agricultural Lowland Drainage Study. An additional $36M is recommended for consideration in long range financial planning to address infrastructure improvements over time. These infrastructure improvements consider the effects of existing deficiencies, community growth and climate change. The recommended budget amount of $36M warrants more refined investigation through local monitoring and risk assessment to make conclusive decisions in the expenditure of funds to replace existing infrastructure that has not yet reached the end of its service life.

The importance of environmental values and protecting watershed health has long been recognized by the City. The notion of integration is inherent in the City's value statement on stewardship, which states that the City will "consider the long-term consequences of actions, think broadly across issues, disciplines and boundaries and act accordingly". This ISMP is in strong alignment with this value statement. By taking actions as identified herein, the City will successfully accommodate community growth in a proactive manner that achieves the City's goals towards environment and watershed health while minimizing its system failures and liabilities.



Appendix A: 2014-2015 Water Quality and Benthic Invertebrate Monitoring Report

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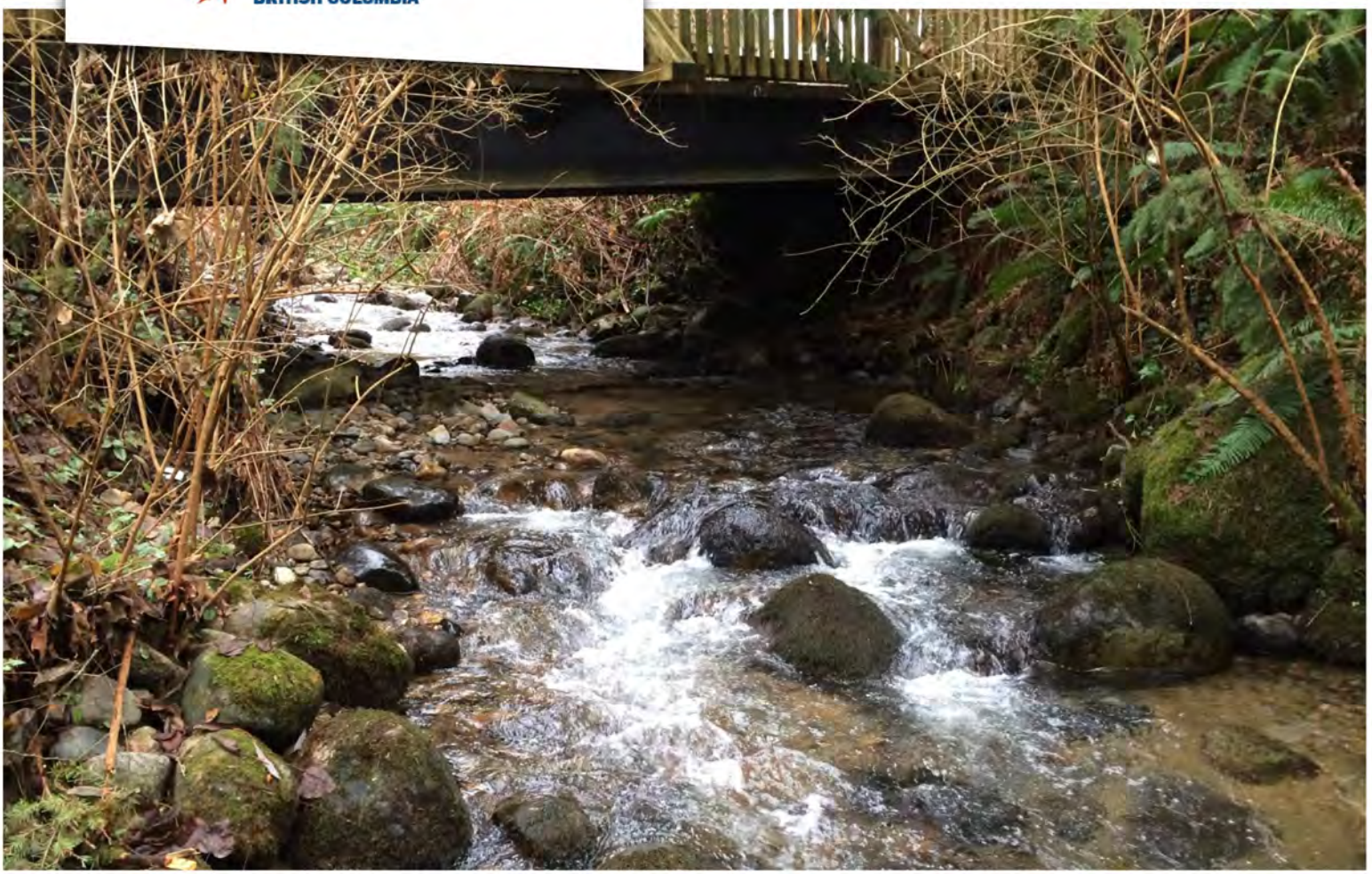
MAPLE RIDGE
BRITISH COLUMBIA



Final Report

Water Quality and Benthic Invertebrate Monitoring in T2, Millionaire, Dunlop and Spencer Creeks, 2014-2015

March 2016
KWL File No. 173.169-300

Submitted by:

KERR WOOD LEIDAL
consulting engineers

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Executive Summary

In 2014 the City of Maple Ridge (the City) initiated hydrometric (flow), water quality, and benthic invertebrate monitoring in support of its Integrated Stormwater Management Planning (ISMP) program. Kerr Wood Leidal Associates Ltd. (KWL) was retained by the City to conduct the water quality and benthic invertebrate portion of the monitoring at four sites in 2014 and 2015, two sites within the South Alouette River watershed and two sites within the Kanaka Creek watershed. The monitoring program follows the direction of Metro Vancouver's Monitoring and Adaptive Management Framework (MAMF) and is aimed at meeting the City's provincial requirements for monitoring under the approval of Metro Vancouver's 2011 Integrated Liquid Waste Resource Management Plan (ILWRMP).

Wet season water quality sampling was conducted from November through December 2014. Dry season water quality sampling was conducted from July through September 2015. Benthic invertebrate sampling was conducted in September 2015. Sampling sites and parameters were determined by the City of Maple Ridge. Results were compared against federal, provincial, and regional water quality guidelines.

All four sites, SA-1, SA-2, K-1, and K-2, had mean water quality parameter values that were either approaching or exceeding guidelines in either the wet or dry season. The parameters approaching or exceeding guidelines during the wet season at each site were as follows:

- SA-1 (T2 Creek at 124 St): turbidity, Escherichia coli (E. coli), fecal coliforms, total copper, total zinc, and conductivity;
- K-1 (Dunlop Creek at 110 Ave): turbidity, fecal coliforms, total iron, total zinc, and conductivity; and
- K-2 (Spencer Creek at 240 St): turbidity, total iron, total copper, total zinc, and conductivity.

Dry season parameters approaching or exceeding guidelines during the dry season were as follows:

- SA-1 (T2 Creek): *E. coli*, fecal coliforms, dissolved oxygen, temperature, and total copper;
- SA-2 (Millionaire Creek): *E. coli,* dissolved oxygen, and temperature;
- K-1 (Dunlop Creek): Dissolved oxygen, *E. coli,* total iron, total zinc, and conductivity; and
- K-2 (Spencer Creek): *E. coli,* turbidity, dissolved oxygen, and temperature.

Total taxa richness of benthic invertebrates was highest in Millionaire Creek (Site SA-2; 40 taxa) and Dunlop Creek (Site K-1; 40 taxa) and lowest in T2 Creek (Site SA-1; 18 taxa). Mean B-IBI scores were highest in Dunlop Creek (Site K-1; 28.0) and lowest in T2 Creek (Site SA-1; 14.0). Based on the biological condition rankings found in the MAMF that correspond to these B-IBI scores, biological conditions were fair in Dunlop Creek and Millionaire Creek, poor in Spencer Creek, and very poor in T2 Creek.

The following priority recommendations are made from the results of the monitoring program:

1. Standardize bacteriological tests to multiple-tube fermentation method for *E. coli* and fecal and total coliforms. The Membrane Filtration (MF) method is not suitable for stormwater samples.
2. Review the Spencer Creek catchment and consider additional investigative sampling to identify potential sources of turbidity within the watershed. The high levels of observed turbidity are atypical for even urban watersheds, and may be originating from a point source.
3. Consider investigative sampling to identify potential sources for *E.coli* and fecal coliforms in the South Alouette watershed. Identify adaptive management actions to address the issue.

4. Use the Watershed Health Tracking System (WHTS) found in the ISMP template to compare measured B-IBI scores with predicted B-IBI scores from the WHTS based on the total impervious area and riparian forest integrity within each sampled subcatchment.
5. Further investigate and identify adaptive management actions to address poor aquatic health in T2 Creek (SA-1). For example, low B-IBI scores are correlated with degraded water quality, changes in flow regime (i.e., increased flashiness), and increases in total impervious area.
6. Investigate opportunities to mitigate low dissolved oxygen levels and high water temperatures measured in all creeks during the dry season. Examples of actions include increasing riparian forest cover, decreasing total impervious area, and encouraging private property riparian area protection and planting through the use of outreach programs.
7. Investigate and manage adaptively for other parameters of concern (needs attention category) or approaching levels of concern (satisfactory category) as part of future Integrated Stormwater Management Planning in these watersheds.
8. Continue to monitor stormwater quality at least every five years at each site using the same set of parameters.

1. Introduction

1.1 Background

In 2014, the City of Maple Ridge (the City) initiated hydrometric (flow), water quality, and benthic invertebrate monitoring in support of its Integrated Stormwater Management Planning (ISMP) program. The data collected will be used to inform the development of ISMPs for watersheds in the City and to establish a baseline on which to assess and report on watershed health and the effectiveness of ISMPs over time.

Kerr Wood Leidal Associates Ltd. (KWL) was retained by the City to conduct the water quality and benthic invertebrate portions of the monitoring at four sites between 2014 and 2015, two sites within the South Alouette River watershed and two sites within the Kanaka Creek watershed. ISMPs for these watersheds are currently under development. They are the first ISMPs to be developed by the City.

1.2 Monitoring and Adaptive Management Framework for Stormwater

Condition 7 of the BC Minister of Environment's approval of Metro Vancouver's 2011 Integrated Liquid Waste Resource Management Plan (ILWRMP) requires that all municipalities, with coordination from Metro Vancouver, monitor stormwater to assess and report on the effectiveness of ISMP implementation. To fulfill this provincial requirement, Metro Vancouver has developed the *Monitoring and Adaptive Management Framework for Stormwater* (MAMF) (Metro Vancouver, 2014). The MAMF takes a weight of evidence approach, using several types of monitoring and indicators to develop an overall assessment of watershed conditions. Through repeated sampling, watershed health and the response to specific watershed protection measures and management actions can be tracked over time.

The MAMF provides direction on the general types of monitoring for higher gradient, lower gradient, and piped systems (Table 1-1), the methods and parameters to be used for monitoring and the reporting required.

Table 1-1: Standard MAMF Monitoring Program Elements Based on Stream Type

Stream Type	Water Quality	Hydrometric	Benthic Invertebrates
Lower Gradient	Yes	Yes (natural channels only)	Yes
Higher Gradient	Yes	Yes	Yes
Piped Systems	Yes	No	No

For water quality monitoring, the MAMF recommends that sampling at selected sites be undertaken five times in a 30-day period in both the dry season (July through August) and the wet season (November through December). Minimum parameters to be monitored include general water quality parameters (dissolved oxygen, pH, water temperature, conductivity, and turbidity), nutrients (nitrate), microbiological parameters (*Escherichia coli* and fecal coliforms) and metals (iron, cadmium, copper, lead, and zinc). Benthic invertebrates should be sampled once in late summer/early fall (August and September). Subsequent monitoring at each site at least every five years will be used to assess ISMP implementation and guide adaptive management.

1.3 Purpose of Report

The purpose of this report is to summarize the results of water quality and benthic invertebrate monitoring conducted by KWL in 2014 and 2015. The monitoring followed the direction of Metro Vancouver's MAMF and is part of the City's program aimed at meeting the City's provincial requirements for monitoring under the approval of Metro Vancouver's 2011 ILWRMP.

2. Assessment Approaches

Water quality monitoring results were assessed using relevant benchmarks developed at the regional, provincial, and national level. Benthic invertebrate results were assessed using a standardized scoring system, the Benthic Index of Biotic Integrity (B-IBI). Both evaluation approaches contribute to the assessment and monitoring of aquatic health over time.

2.1 Water Quality Guidelines

The following guidelines were used to assess the water quality monitoring results:

- *Metro Vancouver: Monitoring and Adaptive Management Framework Water Quality Evaluation System* (MAMF) – Water quality assessment approach to help municipalities quickly identify where water quality conditions are good and where there may be concerns with water quality. The general interpretation of individual categories is the following:
    - Good Priority Indicator = suggests that water quality for this parameter, at least at the current monitoring location, is good. Based on this monitoring, no further monitoring for this parameter is required in the drainage system for five years. No adaptive management is required based on this monitoring.
    - Satisfactory Priority Indicator = suggests that water quality is either closely approaching a level of concern for this parameter or is already in non-attainment with provincial water quality guidelines. The level of the parameter result (relative to water quality guidelines and/or objectives) and the incidence of additional priority indicators of concern should be considered in development of the citywide Adaptive Management Plan. Consideration should be given to supplemental water quality monitoring and/or adaptive management actions.
    - Needs Attention Priority Indicator = suggests that water quality is in non-attainment with provincial water quality guidelines. The level of the parameter result and the incidence of additional priority indicators of concern should be considered as part of the citywide Adaptive Management Plan. Supplemental water quality monitoring and/or adaptive management actions are recommended.

  Under the MAMF, water temperature, dissolved oxygen, and turbidity are considered primary indicators. Conductivity and pH are considered secondary indicators, and provide supporting information for interpretation of priority indicators and for identification of the source of an impact. See Metro Vancouver (2014) for more details.
- *BC Ministry of Environment: Approved and Working Water Quality Guidelines* (BCWQG) – BC water quality guidelines are considered environmental benchmarks, and are safe levels of substances for the protection of a given water use, including drinking water, primary and secondary contact recreation, and agricultural uses, such as irrigation and livestock watering, or the protection of aquatic life. They are developed in order that water quality data can be assessed and site-specific water quality objectives can be prepared.
- *Council of Ministers of the Environment: Canadian Environmental Quality Guidelines – Water Quality Guidelines for the Protection of Aquatic Life* (CEQG) – The Canadian Council of Ministers of the Environment (CCME) is a major intergovernmental forum in Canada for discussion and joint action on environmental issues of national and international concern. It comprises environmental ministers from the federal, provincial and territorial governments. However, each jurisdiction determines the degree to which it will adopt the council's recommendations. Guidelines are available for both protection of aquatic life in both freshwater and marine environments.

Table 2-1 below shows the guideline abbreviations used throughout the report.

Table 2-1: Guideline Abbreviations

Guidelines	Abbreviation
Metro Vancouver: Monitoring and Adaptive Management Framework – Water Quality Evaluation System	MAMF
BC Ministry of Environment: Approved Water Quality Guidelines – based on given water uses	BCWQG
Canadian Council of Ministers of the Environment – Canadian Environmental Quality Guidelines – Water Quality Guidelines for the Protection of Aquatic Life (Freshwater)	CEQG

Based on the expected water uses in the watersheds that were monitored, the most relevant BCWQGs and CEQGs for assessment were those for protection of freshwater aquatic life, with the exception of the guidelines used for the bacteriological parameters, which were those for protection of primary contact recreational use (e.g., swimming). Primary contract recreational use guidelines are typically used for bacteriological parameters in urban stormwater because of the high potential for recreational and domestic pet use of urban streams and to protect from any detrimental impacts of these uses.

2.2 Benthic Index of Biotic Integrity (B-IBI)

The assessment of benthic invertebrate data used a standardized scoring system, the Benthic Index of Biotic Integrity (B-IBI), to compare and rank the biological health of the sampled streams. Two indicators are part of the main reporting for MAMF:

- *Benthic Index of Biotic Integrity (B-IBI)* – B-IBI is a 10-metric index of biotic integrity that is used to evaluate watershed health. The 10 metrics that compose the index summarize information on taxa richness and community composition and structure. Individual metrics are measured, scored, and then combined to give a single, integrated overall B-IBI score that ranges between 10 and 50. B-IBI scores can be associated with five biological condition categories, excellent, good, fair, poor, or very poor, with higher scores indicating better biological condition. Declines in the benthic invertebrate community have been correlated to increases in urban land cover, increased total impervious area, and increased flashiness of streams (Metro Vancouver, 2014).
- *Total Taxa Richness* – Total taxa richness is the total number of taxa sampled in a stream, providing a basic measure of stream biodiversity. It represents the unique taxa identified across all three sub-samples (see Methods) taken at each site. In general, taxa richness declines with increased urbanization and decreases in forest cover (Metro Vancouver, 2014).

Although additional indicators are reported in Appendix H, they are not discussed further in the report.

3. Monitoring Site Locations

Water quality monitoring sites were determined by the City of Maple Ridge and had been previously chosen as part of an ISMP scoping study undertaken for the City (Urban Systems, 2014).

Table 3-1 provides details on the four water quality monitoring locations sampled in late fall 2014 (wet season sampling) and summer 2015 (dry season sampling). All four sites are considered higher gradient systems under the MAMF.

Table 3-1: Water Quality Monitoring Site Locations

Site ID	Site Description	ISMP Study Area	Location Details
SA-1	T2 Creek at 124 Avenue	South Alouette	3 m downstream of culvert at 124 Avenue
SA-2	Millionaire Creek at Fern Crescent	South Alouette	Alongside of 129 Avenue, 40 m upstream of Fern Crescent bridge; at former MOE water quality monitoring station
K-1	Dunlop Creek at 110 Avenue	Kanaka	2 m upstream of twin culverts at 110 Avenue
K-2	Spencer Creek at 240 Street	Kanaka	10 m upstream of culvert at 240 Street

Benthic invertebrate sampling was undertaken on the same creeks, in a reach nearest to the water quality monitoring site location where suitable sampling riffles were present. Distance between the water quality monitoring site and the benthic invertebrate sampling reaches ranged from no distance (Millionaire Creek) to 500 m - 600 m upstream of the water quality monitoring location (Dunlop Creek).

Table 3-2 provides details on the specific benthic invertebrate sampling reach sampled in each creek in late summer/early fall 2015 and its location relative to the water quality monitoring site.

Table 3-2: Benthic Invertebrate Monitoring Site Locations

Site ID	Creek Name	ISMP Study Area	Location of Downstream End of Sampling Reach
SA-1	T2 Creek	South Alouette	Immediately upstream of culvert at 124 Avenue. On other side of road from water quality monitoring site.
SA-2	Millionaire Creek	South Alouette	Alongside of 129 Avenue, 40 m upstream of Fern Crescent bridge; at former MOE water quality monitoring station. At water quality monitoring site.
K-1	Dunlop Creek	Kanaka	ESE of intersection of 112 Avenue and 244 Street. Approximately 500 to 600 m upstream from water quality monitoring site.
K-2	Spencer Creek	Kanaka	Due south of intersection of McClure Drive and Baker Place. Approximately 400 to 500 m upstream from water quality monitoring site.

Figure 3-1 provides an overview of the water quality monitoring and benthic invertebrate sampling site locations. Larger-scale maps showing both the specific water quality monitoring and benthic invertebrate sampling locations for each creek can be found in Appendix A.

Site photographs showing the conditions at each water quality monitoring and benthic invertebrate sampling site can be found in Appendix B.

City of Maple Ridge
Water Quality and Benthic Invertebrate Monitoring

Legend

- Municipal Boundary
- Creeks
- South Alouette Watershed
- Kanaka Watershed
- Benthic Sampling Reach

Monitoring Site Locations

- SA-1 (T2 Creek at 124 Avenue)
- SA-2 (Millionaire Creek at Fern Crescent)
- K-1 (Dunlop Creek at 110 Avenue)
- K-2 (Spencer Creek at 240 Street)

Reference: Background data from the City of Maple Ridge.

KERR WOOD LEIDAL
consulting engineers

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Project No.	Date
173-169	February 2016

Monitoring Site Locations

Figure 3-1

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Author: JLau

4. Methods

Wet season water quality monitoring was conducted in 2014 on November 26, December 5, 9, 16, and 19. Dry season water quality monitoring was conducted in 2015 on July 29, August 5, 11, 19 and 26. Benthic invertebrate sampling was conducted on September 15, 2015. General methods and parameters followed those outlined in the MAMF. Study-specific details of the methods used are provided briefly below. For the water quality monitoring, Table 4-1 summarizes the parameters collected and whether they are core MAMF or additional monitoring parameters.

4.1 Water Quality Monitoring

4.1.1 Field Sampling

It-situ Water Quality Parameters

General in-situ water quality parameters (dissolved oxygen, pH, water temperature, conductivity, turbidity) were measured in the field using a YSI 6920 water quality multiparameter sonde (YSI 6920) rented from Pine Environmental (Burnaby, BC). In addition to the core MAMF parameters, several additional in-situ monitoring parameters (total dissolved solids, salinity, oxygen reduction potential) were collected because they could be easily collected at no additional cost (Table 4-1).

Water Sample Collection

Water samples for laboratory testing were collected using methods as outlined in the Guidelines for Designing and Implementing a Water Quality Monitoring Program in British Columbia (Cavanagh et al., 1998). When necessary, samples were field filtered and preserved (see detailed lab analysis reports in Appendix B for details). All samples were placed in a cooler with ice (approximately 4 °C) for transport and were delivered to the lab within required hold times as per laboratory protocols.

4.1.2 Laboratory Water Quality Testing

Processing and laboratory analysis of water samples was completed by Caro Analytics (Richmond, BC) or their subcontractors using the methods recommended in the MAMF (see next section for exceptions). The detailed lab reports in Appendix C and D contain more details on the particular method references and techniques utilized for the lab analyses.

In addition to the core MAMF lab parameters, the City also requested that dissolved metals be included in the analyses. Alkalinity (speciated) and hardness (as $CaCO_3$) were also tested because they are relatively inexpensive tests and important for comparison to the *Approved BC Water Quality Guidelines* for some parameters, such as metals (Table 4-1).

Table 4-1: Core MAMF and Additional Monitoring Parameters

	Parameter	Units	Core MAMF Parameters	Additional Parameters
General In-situ Parameters	Dissolved Oxygen	mg/L and %	X	
	pH	(relative units)	X	
	Water Temperature	°C	X	
	Conductivity	µs/cm	X	
	Specific Conductivity	µs/cm[C]		X
	Turbidity	NTU	X	
	Total Dissolved Solids	g/L		X
	Salinity	-		X
	Oxygen Reduction Potential (ORP)	-		X
Nutrients	Nitrate (as Nitrogen)	mg/L	X	
Microbiological	*Escherichia coli* (*E. coli*)	MPN/100 mL or CFU/100 mL		
	Fecal Coliforms	MPN/100 mL or CFU/100 mL		
Metals	Total Metals	mg/L	X	X
	Dissolved Metals	mg/L		X
General Lab Parameters	Alkalinity (Speciated)	mg/L		X
	Hardness (as $CaCO_3$)	mg/L		X

4.1.3 Quality Assurance/Quality Control Program

The following Quality Assurance/Quality Control (QA/QC) program was implemented to ensure the consistency of field data collection and to minimize imprecision and bias in the data:

- All field equipment was calibrated less than 24 hours prior to use and calibration values recorded for reference;
- All field data was recorded using standardized methods;
- All data transcribed to electronic files was crosschecked to ensure accurate data recording and entry;
- Field blanks and travel blanks were used during each round of sampling. The travel blank was only tested if the field blank showed any evidence of contamination. Field blanks showed no evidence of contamination of the samples during any of the rounds of sampling; and
- Approximately 10% of the laboratory analyses were conducted for QC. For all types of laboratory QC, results are compared to specified recovery (% Rec) and relative per cent difference (RPD) limits derived from long-term method performance averages and/or prescribed by the reference method. Results of the QC analyses can be found in the detailed laboratory analysis reports (Appendix C and D).

4.1.4 Deviations from MAMF

Two small deviations were made from the prescribed MAMF methods, both relating to the bacteriological tests undertaken during the initial rounds of wet season sampling in 2014:

1. Bacteriological laboratory testing for *Escherichia coli* (*E. coli*) and fecal and total coliforms was inconsistent in the methods used. The multiple-tube fermentation method was used for the November 26, December 16, and December 19 samples and the Membrane Filtration (MF) (fecal and total coliforms) and Enzyme Substrate methods (*E. coli*) were used for the December 5 and 9 samples. While both sets of methods can be used, the MF method, although recommended in the MAMF, is usually less suitable for samples that contain larger amounts of suspended solids, which is typical of wet weather stormwater samples. The multiple-tube fermentation method is preferable for stormwater samples.
2. The bacteriological laboratory tests for the December 9 samples for the *E. coli* parameter were completed using the using the food method (MFHPB-19) instead of the water/wastewater method (SMEWW 9222) which could have caused potential interference with these samples. The basic difference between the two methods is the media used for the test. Use of food sample media may have resulted in less accurate results for samples on these two dates and results on these dates should be interpreted with caution.

Appropriate methods were clarified with the lab and consistent methods were used in subsequent wet season in 2014 and dry season sampling in 2015.

4.2 Benthic Invertebrate Sampling

4.2.1 Field Sampling

Field sampling was conducted on September 15, 2015 as per MAMF protocols. A Surber stream bottom sampler with 250 µm mesh was used to collect samples. Samples were taken by placing the sampler in a random, shallow riffle. Substrate within the 30 cm x 30 cm sampling square was then agitated for three minutes to dislodge benthic invertebrates and allow them to be washed by the streamflow into the sampling net. Samples were then washed from the Surber sampler into a 250 µm mesh sieve and then transferred into leak-proof, pre-labelled plastic sample jars (500 mL or 1 L depending on the volume of material collected).

Each jar consisted of a composite of three Surber sampler placements. At each site, three replicate samples were taken for analysis (three jars per stream). The three replicate samples making up the composite sample at the site, where possible, were collected within a 50 m long sampling reach.

All samples were preserved with 10% buffered formalin. An internal paper label slip was also placed in each jar. Preserved samples were then packed and transported to the lab for taxonomic analysis.

At each sampling station, data on channel dimensions (e.g., wetted width, bankfull width, riffle depth), substrate composition, and embeddedness were also collected.

4.2.2 Laboratory Analysis

Field samples were subsampled, sorted, and identified by Biologica Environmental Services Ltd. (Victoria, BC) according to MAMF protocols. Samples were subsampled using a Caton tray. All samples were identified to the lowest practical taxonomic level according to Plotnikoff and White (1996) which includes Chironomidae to subclass, Oligochaeta to family, Acari to subclass.

4.2.3 Quality Assurance/Quality Control Program

A Quality Assurance/Quality Control (QA/QC) program was followed for the benthic invertebrate monitoring to ensure consistent and accurate taxonomic results. The QA/QC program included the following:

- Field data was recorded using standardized methods;
- All data transcribed to electronic files was cross-checked to ensure accurate data recording and entry;
- Only North American Benthological Society (NABS) certified taxonomists conducted the taxonomic identifications;
- A project-specific reference collection was created by Biologica for ongoing identification comparisons and for potential third party verification; and
- Sample re-sorts and spot checks were performed to evaluate sorting efficiency and identification.

4.2.4 Metric Scoring and B-IBI Calculations

Scores were calculated for ten metrics composing the B-IBI and were added together to determine the total B-IBI score for each site (mean of three replicate samples). Unique taxa for each site were identified and summed to calculate total taxa richness (composite of three replicate samples).

For the B-IBI metrics, all identified taxa were classified according to the benthic taxa attribute information available on the Puget Sound Stream Benthos website (www.pugetsoundstreambenthos.org) (City of Seattle, King County, Pierce County, and Snohomish County, 2016). Metrics for each sample were assigned a value (1, 3 or 5) according to the thresholds given in Page *et al.* (2008). Sample B-IBI scores were calculated as the sum of these values. Mean B-IBI scores were calculated as the average of the three replicate sample B-IBI scores.

Further details on the laboratory methods, QA/QC, and metric scoring calculations can be found in Appendix G.

5. Results

A summary of the results of the 2014 wet season and 2015 dry season water quality monitoring and the 2015 benthic invertebrate sampling are presented below. For the water quality monitoring results, only mean parameter values found to be exceedance of regional (yellow or red categories as per the MAMF colour coding system), provincial, or federal water quality guidelines are discussed below.

Detailed water quality laboratory analysis reports, completed MAMF reporting sheets, and full water quality monitoring results data tables are provided in Appendices C to F.

Full benthic invertebrate sampling results and associated environmental field data can be found in Appendices H to J.

5.1 2014 Wet Season Water Quality Monitoring

For the 2014 wet season monitoring, three of the four sites sampled, SA-1, K-1, and K-2, had mean water quality parameter values that were either approaching or exceeding guidelines. Only SA-2 had no values approaching or exceeding guidelines during the 2014 wet season. SA-1 had the highest number of parameters approaching or exceeding guidelines (6), while SA-2 had the lowest (0). Both K-1 and K-2 had five parameters approaching or exceeding guidelines. In total, seven different parameters across the sites contained parameters of concern. These included turbidity, *E. coli*, fecal coliforms, total copper, total iron, total zinc and conductivity. Turbidity at K-2 was the only parameter in the MAMF's needs attention category during the wet season. Parameters of concern at each of the sites in the wet season are highlighted below.

SA-1 (T2 Creek at 124 Avenue)

At Site SA-1, mean values (five samples in 30 days) of six different water quality parameters were found to be in the MAMF's satisfactory category, indicating these parameters are approaching a level of concern: turbidity, *E. coli*, fecal coliforms, total copper, total zinc, and conductivity. Of those parameters, four, fecal coliforms, total copper, and total zinc, exceeded BC water quality guidelines.

Mean values compared to relevant guidelines are presented in Table 5-1.

Table 5-1: Wet Season Water Quality Parameters Approaching or Exceeding Guidelines at Site SA-1

SA-1 Parameters of Concern			Guidelines*				
Parameter	Mean[1]	Units	MAMF Evaluation System			BCWQG	CEQG
			Good	Satisfactory	Needs Attention		
Turbidity	7.2	NTU	0-5	>5-25	> 25	5 NTU change[2]	-
E. coli[1]	107	MPN/10 0 mL	Geomean ≤ 77	Geomean 78-385	Geomean > 385	Geomean ≤ 77	-
Fecal coliforms[1]	571	MPN/10 0 mL	Geomean ≤ 200	Geomean 201-1000	Geomean > 1000	Geomean ≤ 200	-
Total Copper	3.3	µg/L	< 3[3]	3-11[3]	> 11[3]	2[4]	2[4]
Total Zinc	12	µg/L	< 6[3]	6-40[3]	> 40[3]	7.5[4]	30[4]
Conductivity	135	µS/cm	< 50	50-200	> 200	-	-

[1]All mean values are arithmetic means except for bacteriological results, which are geometric mean of 5 samples in 30 days as per guidelines.
[2]Background turbidity values used for comparison based on dry season sampling.
[3]Guideline assumes hardness of 100 mg/L $CaCO_3$.
[4]Guideline is hardness dependent. Total hardness used for guideline comparison is the mean value based on 5-samples over 30 days. Total hardness is 45.44 mg/L $CaCO_3$.
*Exceeded guideline limit is highlighted.

SA-2 (Millionaire Creek at Fern Crescent)

At Site SA-2, no water quality parameters were found to be of concern or exceeding guidelines.

K-1 (Dunlop Creek at 110 Avenue)

At Site K-1, five different water quality parameters were found to be approaching a level of concern (satisfactory category): turbidity, fecal coliforms, total iron, total zinc, and conductivity. Of these parameters, fecal coliforms exceeded BC water quality guidelines. Total iron exceeded the Canadian Environmental Quality Guidelines for protection of freshwater aquatic life.

Mean values compared to relevant guidelines are presented in Table 5-2.

Table 5-2: Wet Season Water Quality Parameters Approaching or Exceeding Guidelines at Site K-1

K-1 Parameters of Concern			Guidelines*				
Parameter	Mean[1]	Units	MAMF Evaluation System			BCWQG	CEQG
			Good	Satisfactory	Needs Attention		
Turbidity	14.8	NTU	0-5	>5-25	> 25	5 NTU change	
Fecal coliforms[1]	350	MPN/100 mL	Geomean ≤ 200	Geomean 201-1000	Geomean > 1000	Geomean ≤ 200	-
Total Iron	894	µg/L	800	800-5000	> 5000	1000	300
Total Zinc	7	µg/L	< 6[3]	6-40[3]	> 40[3]	7.5[4]	30[4]
Conductivity	78	µS/cm	< 50	50-200	> 200	-	-

[1]All mean values are arithmetic means except for bacteriological results, which are geometric mean of 5 samples in 30 days as per guidelines.
[2]Background turbidity values used for comparison based on dry season sampling.
[3]Guideline assumes hardness of 100 mg/L $CaCO_3$.
[4]Guideline is hardness dependent. Total hardness used for guideline comparison is the mean value based on 5-samples over 30 days. Total hardness is 27.14 mg/L $CaCO_3$.
*Exceeded guideline limit is highlighted.

K-2 (Spencer Creek at 240 Street)

At Site K-2, one water quality parameters was found to be of concern (needs attention category): turbidity. Four other parameters were found to be approaching a level of concern (satisfactory category) in 2014: *E. coli*, fecal coliforms, total copper, total zinc, and conductivity. Of those parameters, total iron, total copper, and total zinc exceeded BC water quality guidelines. Total iron and total copper also exceeded the Canadian Environmental Quality Guidelines for protection of freshwater aquatic life.

Mean values compared to relevant guidelines are presented in Table 5-3.

Table 5-3: Wet Season Water Quality Parameters Approaching or Exceeding Guidelines Site K-2

K-2 Parameters of Concern			Guidelines*				
			MAMF Evaluation System				
Parameter	Mean[1]	Units	Good	Satisfactory	Needs Attention	BCWQG	CEQG
Turbidity	32.4	NTU	0-5	>5-25	> 25	5 NTU change[2]	
Total Iron	2052	µg/L	800	800-5000	> 5000	1000	300
Total Copper	4.8	µg/L	< 3[3]	3-11[3]	> 11[3]	2[4]	2[4]
Total Zinc	9	µg/L	< 6[3]	6-40[3]	> 40[3]	7.5[4]	30[4]
Conductivity	119	µS/cm	< 50	50-200	> 200	-	-

[1]All mean values are arithmetic means except for bacteriological results, which are geometric mean of 5 samples in 30 days as per guidelines.
[2]Background turbidity values used for comparison based on dry season sampling.
[3]Guideline assumes hardness of 100 mg/L $CaCO_3$.
[4]Guideline is hardness dependent. Total hardness used for guideline comparison is the mean value based on 5-samples over 30 days. Total hardness is 50.94 mg/L $CaCO_3$.
*Exceeded guideline limit is highlighted.

5.2 2015 Dry Season Water Quality Monitoring

All four sites had mean water quality values either approaching or exceeding guidelines during the 2015 dry season monitoring period. SA-1 and K-2 each had five parameters approaching or exceeding guidelines, while K-1 and SA-2 had four and three, respectively. A total of nine different parameters were either approaching or exceeding guidelines across all sites, including *E. coli*, fecal coliforms, dissolved oxygen, turbidity, temperature, total copper, total iron, total zinc, and conductivity. Three sites had parameters in the MAMF's needs attention category (*E. coli*, fecal coliforms and dissolved oxygen). Only K-2 had no parameters in the needs attention category. Parameters of concern at each site in the dry season are highlighted below.

SA-1 (T2 Creek at 124 Avenue)

At Site SA-1, mean values of the two bacteriological indicators, *E. coli* and fecal coliforms, were in the needs attention category in the MAMF evaluation system, and also exceeded BC water quality guidelines. Dissolved oxygen, temperature, and total copper were in the MAMF evaluation system's satisfactory category, suggesting that water quality is approaching a level of concern. Levels of total copper also exceeded BC water quality guidelines and Canadian Environmental Quality Guidelines for protection of freshwater aquatic life.

Mean values compared to relevant guidelines are presented in Table 5-4.

Table 5-4: Dry Season Water Quality Parameters Approaching or Exceeding Guidelines at Site SA-1

SA-1 Parameters of Concern			Guidelines*				
			MAMF Evaluation System				
Parameter	Mean[1]	Units	Good	Satisfactory	Needs Attention	BCWQG	CEQG
E. coli[1]	1884	MPN/100 mL	Geomean ≤ 77	Geomean 78-385	Geomean > 385	Geomean ≤ 77	-
Fecal coliforms[1]	1189	MPN/100 mL	Geomean ≤ 200	Geomean 201-1000	Geomean > 1000	Geomean ≤ 200	-
Dissolved Oxygen	9.42	mg/L	≥ 11	6.5-<11	< 6.5	-	-
Temperature	16.90	°C	< 16	16-18	< 18	-	-
Total Copper	3.1	µg/L	< 3[2]	3-11[2]	> 11[2]	2.9[3]	2[3]

[1]All mean values are arithmetic means except for bacteriological results, which are geometric mean of 5 samples in 30 days as per guidelines.
[2]Guideline assumes hardness of 100 mg/L $CaCO_3$.
[3]Guideline is hardness dependent. Total hardness used for guideline comparison is the mean value based on 5-samples over 30 days. Total hardness is 73.54 mg/L $CaCO_3$.
*Exceeded guideline limit is highlighted.

SA-2 (Millionaire Creek at Fern Crescent)

At Site SA-2, mean values of one parameter, *E. coli*, in the MAMF evaluation system's needs attention category. Dissolved oxygen and temperature were approaching levels of concern and were in the MAMF evaluation system's satisfactory category. *E. coli* levels also exceeded BC water quality guidelines.

Mean values compared to relevant guidelines are presented in Table 5-5.

Table 5-5: Dry Season Water Quality Parameters Approaching or Exceeding Guidelines at Site SA-2

SA-2 Parameters of Concern			Guidelines*				
			MAMF Evaluation System				
Parameter	Mean[1]	Units	Good	Satisfactory	Needs Attention	BCWQG	CEQG
E. coli[1]	79	MPN/100 mL	Geomean ≤ 77	Geomean 78-385	Geomean > 385	Geomean ≤ 77	-
Dissolved Oxygen	9.75	mg/L	≥ 11	6.5-<11	< 6.5	-	-
Temperature	16.53	°C	< 16	16-18	< 18	-	-

[1]All mean values are arithmetic means except for bacteriological results, which are geometric mean of 5 samples in 30 days as per guidelines.
*Exceeded guideline limit is highlighted.

K-1 (Dunlop Creek at 110 Avenue)

At Site K-1, dry season sampling found one parameter, dissolved oxygen, to be in the MAMF evaluation system's needs attention category. Four parameters, *E. coli*, total iron, total zinc and conductivity, were in the MAMF evaluation system's satisfactory category, suggesting these parameters are approaching a level of concern. *E. coli*, total iron, and total zinc exceeded BC water quality guidelines, while total iron also exceeded the Canadian Environmental Quality Guidelines for the protection of freshwater aquatic life.

Mean values compared to relevant guidelines are presented in Table 5-6.

Table 5-6: Dry Season Water Quality Parameters Approaching or Exceeding Guidelines at Site K-1

K-1 Parameters of Concern			Guidelines*				
			MAMF Evaluation System				
Parameter	Mean[1]	Units	Good	Satisfactory	Needs Attention	BCWQG	CEQG
Dissolved Oxygen	4.29	mg/L	≥ 11	6.5-<11	< 6.5	-	-
E. coli[1]	115	MPN/100 mL	Geomean ≤ 77	Geomean 78-385	Geomean > 385	Geomean ≥ 77	-
Total Iron	1074	µg/L	< 800	800-5000	> 5000	1000	300
Total Zinc	18	µg/L	< 6[2]	6-40[2]	> 40[2]	7.5[3]	30[3]
Conductivity	135	µS/cm	< 50	50-200	> 200	-	-

[1]All mean values are arithmetic means except for bacteriological results, which are geometric mean of 5 samples in 30 days as per guidelines.
[2]Guideline assumes hardness of 100 mg/L $CaCO_3$.
[3]Guideline is hardness dependent. Total hardness used for guideline comparison is the mean value based on 5-samples over 30 days. Total hardness is 70.16 mg/L $CaCO_3$.
*Exceeded guideline limit is highlighted.

K-2 (Spencer Creek at 240 Street)

At Site K-2, four parameters, *E. coli*, turbidity, dissolved oxygen, and temperature, were in the MAMF evaluation system's satisfactory category, suggesting these parameters are approaching levels of concern. *E. coli* levels also exceeded BC water quality guidelines. No parameters were in the MAMF evaluation system's needs attention category.

Mean values compared to relevant guidelines are presented in Table 5-7.

Table 5-7: Dry Season Water Quality Parameters Approaching or Exceeding Guidelines Site K-2

K-2 Parameters of Concern			Guidelines*				
			MAMF Evaluation System				
Parameter	Mean[1]	Units	Good	Satisfactory	Needs Attention	BCWQG	CEQG
E. coli[1]	157	MPN/100 mL	Geomean ≤ 77	Geomean 78-385	Geomean > 385	Geomean ≤ 77	-
Turbidity	7.2	NTU	0-5	>5-25	> 25	5 NTU change[2]	-
Dissolved Oxygen	8.71	mg/L	≥ 11	6.5-<11	< 6.5	-	-
Temperature	16.71	°C	< 16	16-18	< 18	-	-

[1]All mean values are arithmetic means except for bacteriological results, which are geometric mean of 5 samples in 30 days as per guidelines.
[2]Dry season results represent background levels of turbidity for guideline comparison.
*Exceeded guideline limit is highlighted.

5.3 2015 Benthic Invertebrate Sampling

Total taxa richness (unique taxa across all three samples per site) was highest in Millionaire Creek (Site SA-2; 40 taxa) and Dunlop Creek (Site K-1; 40 taxa) and lowest in T2 Creek (Site SA-1; 18 taxa).

Mean B-IBI scores were highest in Dunlop Creek (Site K-1; 28.0) and lowest in T2 Creek (Site SA-1; 14.0). Based on the biological condition rankings found in the MAMF that correspond to these B-IBI scores, biological conditions were fair in Dunlop Creek and Millionaire Creek, poor in Spencer Creek, and very poor in T2 Creek.

Table 5-8 shows the results for total taxa richness, mean B-IBI and B-IBI rankings for each site.

Table 5-8: Benthic Invertebrate Sampling Results at Four Monitoring Sites

Site ID	Subcatchment	Total Taxa Richness	Mean B-IBI Score	MAMF Biological Condition Rank
SA-1	T2 Creek	18	14.0	Very poor
SA-2	Millionaire Creek	40	26.6	Fair
K-1	Dunlop Creek	40	28.0	Fair
K-2	Spencer Creek	31	23.6	Poor

The observed patterns in total taxa richness and B-IBI results generally correlate with levels of riparian forest integrity and total impervious area observed in each of the subcatchments sampled.

6. Recommendations

Based on the results from this initial round of water quality and benthic invertebrate monitoring in the City of Maple Ridge, the following recommendations are made to guide further monitoring and adaptive management activities under the City's Integrated Stormwater Management Planning program:

1. Standardize bacteriological tests to multiple-tube fermentation method for *E. coli* and fecal and total coliforms. The Membrane Filtration (MF) method is not suitable for stormwater samples.
2. Review the Spencer Creek catchment and consider additional investigative sampling to identify potential sources of turbidity within the watershed. The high levels of observed turbidity are atypical for even urban watersheds, and may be originating from a point source.
3. Consider investigative sampling to identify potential sources for E.coli and fecal coliforms in the South Alouette watershed. Identify adaptive management actions to address the issue.
4. Use the Watershed Health Tracking System (WHTS) found in the ISMP template to compare measured B-IBI scores with predicted B-IBI scores from the WHTS based on the total impervious area and riparian forest integrity within each sampled subcatchment.
5. Further investigate and identify adaptive management actions to address poor aquatic health in T2 Creek (SA-1). For example, low B-IBI scores are correlated with degraded water quality, changes in flow regime (i.e., increased flashiness), and increases in total impervious area.
6. Investigate opportunities to mitigate low dissolved oxygen levels and high water temperatures measured in all creeks during the dry season. Examples of actions include increasing riparian forest cover, decreasing total impervious area, and encouraging private property riparian area protection and planting through the use of outreach programs.
7. Investigate and manage adaptively for other parameters of concern (needs attention category) or approaching levels of concern (satisfactory category) as part of future Integrated Stormwater Management Planning in these watersheds.
8. Continue to monitor stormwater quality at least every five years at each site using the same set of parameters.

7. References

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7.1 Report Submission

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MAR. 22, 2016
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This document is a copy of the sealed and signed hard copy original retained on file. The content of the electronically transmitted document can be confirmed by referring to the filed original.

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Revision History

Revision #	Date	Status	Revision	Author
0	February 16, 2015	Interim	Interim report (wet season sampling only) for client review	PL
1	February 16, 2016	Draft	Draft report for client review	PDK/PL
2	March 22, 2016	Final	Final Report	PDK/PL

OQM | Organizational Quality Management Program

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Appendix A

Site Maps

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City of Maple Ridge
Water Quality and Benthic Invertebrate Monitoring

Project No.	Date
173-169	February 2016

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SA-1 - T2 Creek at 124 Avenue

Figure 1

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Author: JLau

Reference: 2011 Orthophoto and GIS background data from the City of Maple Ridge.
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City of Maple Ridge
Water Quality and Benthic Invertebrate Monitoring

Project No.	Date
173-169	February 2016

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SA-2 - Millionaire Creek at Fern Crescent

Figure 2

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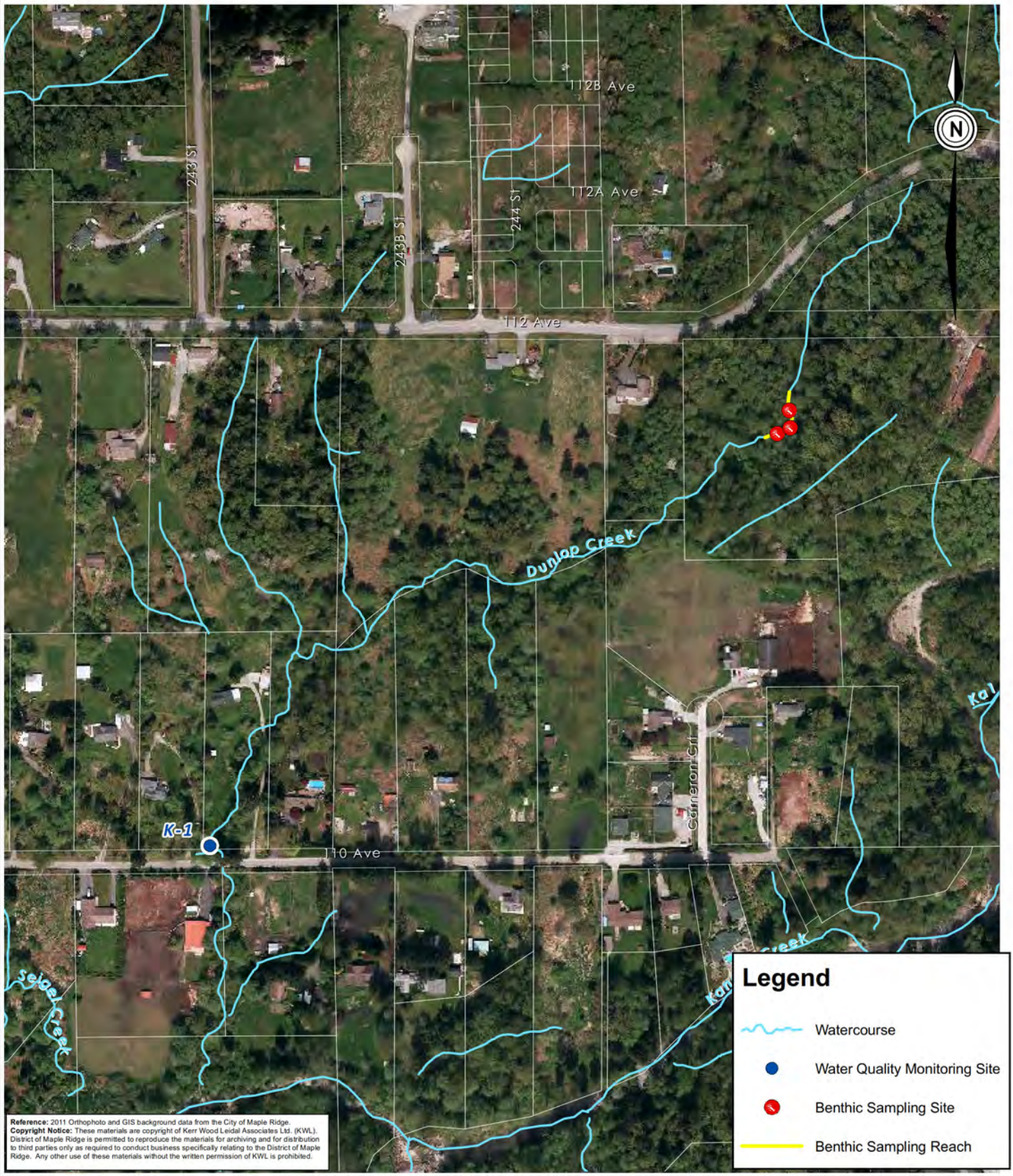
Author: JLau



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City of Maple Ridge
Water Quality and Benthic Invertebrate Monitoring

Project No.	Date
173-169	February 2016

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K-1 - Dunlop Creek at 110 Avenue

Figure 3

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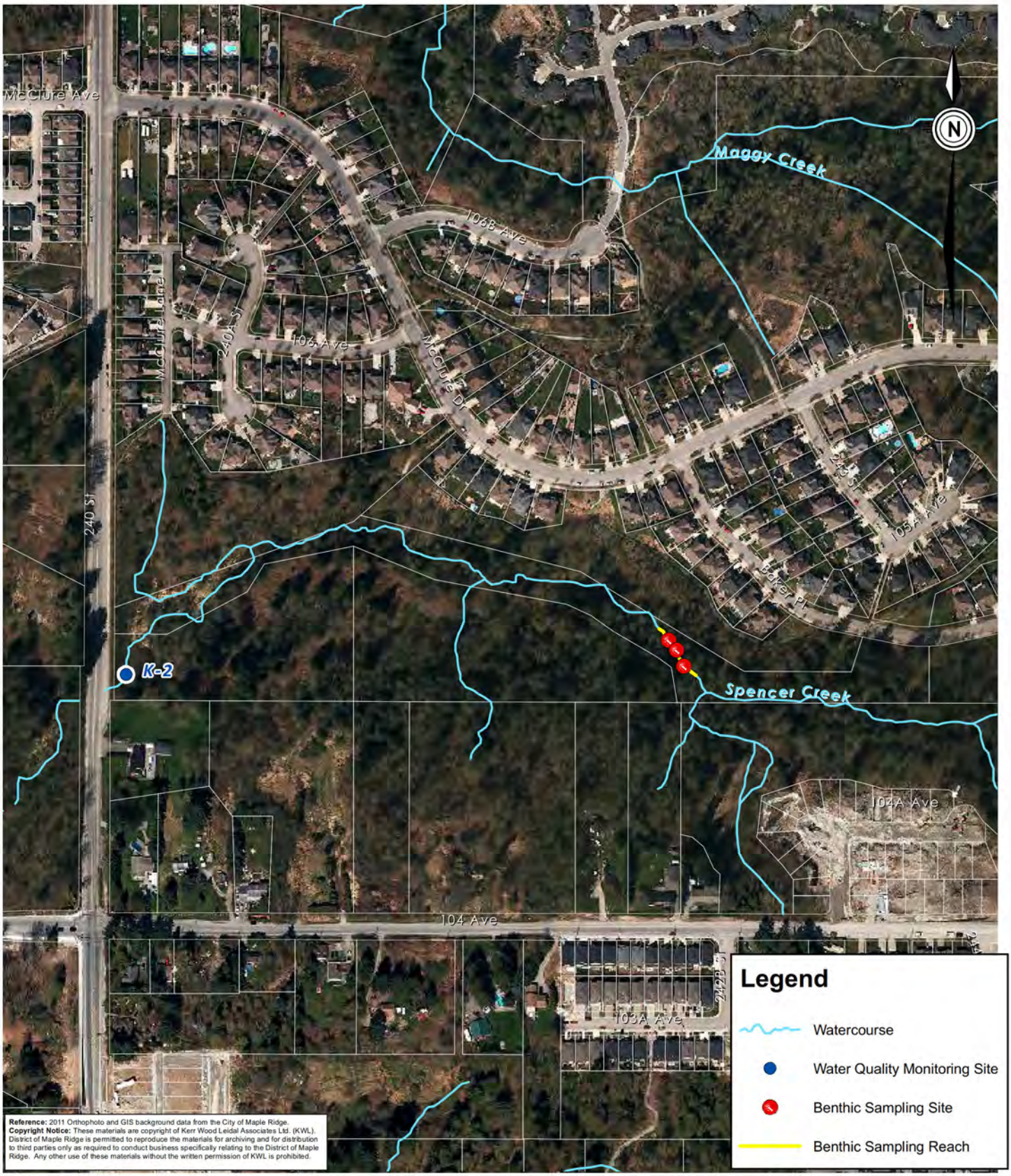

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Water Quality and Benthic Invertebrate Monitoring

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K-2 - Spencer Creek at 240 Street

Figure 4

Path: O:\0100-0199\173-169\430-GIS\MXD-Rp\173169_Fig_K-2.mxd Date Saved: 03/02/2016 2:51:26 PM
Author: JLau

KERR WOOD LEIDAL
consulting engineers

Appendix B

Site Photographs

Appendix B – Photographs

SA-1 (T2 Creek at 124 Avenue)
Water Quality Monitoring Site

Photo B-1: Substrate at Monitoring Site

Photo B-2: Looking Upstream from Site

Photo B-3: Looking Downstream from Site
Photo Date August 11, 2015

Photo B-4: Typical Conditions

Appendix B – Photographs

SA-2 (Millionaire Creek at Fern Crescent)
Water Quality Monitoring Site

Photo B-1: Substrate at Monitoring Site

Photo B-2: Looking Upstream from Site

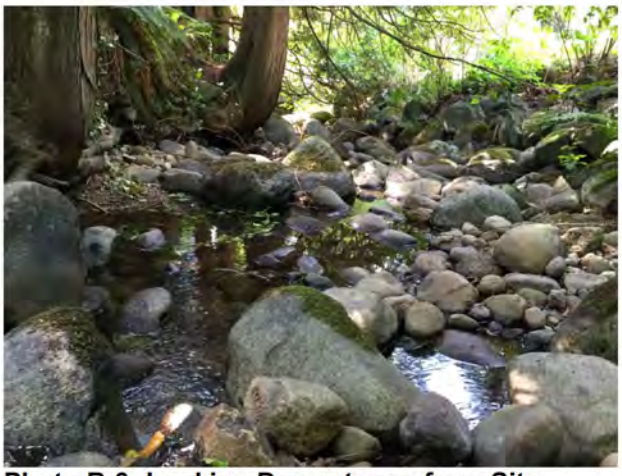

Photo B-3: Looking Downstream from Site
Photo Date August 11, 2015

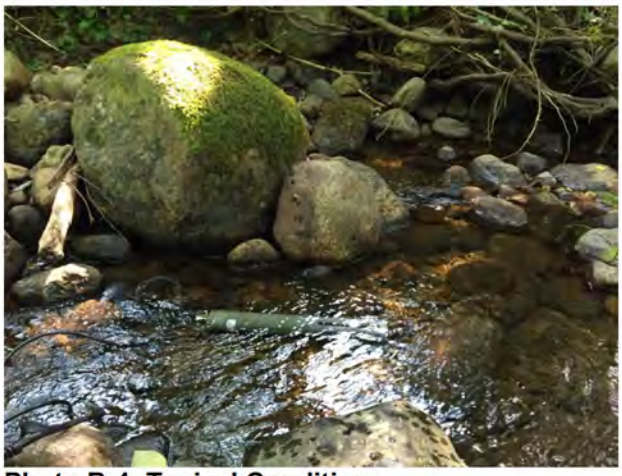

Photo B-4: Typical Conditions

Appendix B – Photographs

K-1 (Dunlop Creek at 110 Avenue)
Water Quality Monitoring Site

Photo B-1: Substrate at Monitoring Site

Photo B-2: Looking Upstream from Site

Photo B-3: Looking Downstream from Site
Photo Date August 11, 2015

Photo B-4: Typical Conditions

Appendix B – Photographs

K-2 (Spencer Creek at 240 Street)
Water Quality Monitoring Site

Photo B-1: Substrate at Monitoring Site

Photo B-2: Looking Upstream from Site

Photo B-3: Looking Downstream from Site
Photo Date August 11, 2015

Photo B-4: Typical Conditions

Appendix B – Photographs

SA-1 (T2 Creek at 124 Avenue)
Benthic Invertebrate Sampling Site

Photo B-1: Substrate at Monitoring Site

Photo B-2: Looking Upstream from Site

Photo B-3: Looking Downstream from Site
Photo Date September 15, 2015

Photo B-4: Typical Conditions

Appendix B – Photographs

SA-2 (Millionaire Creek at Fern Crescent)
Benthic Invertebrate Sampling Site

Photo B-1: Substrate at Monitoring Site

Photo B-2: Looking Upstream from Site

Photo B-3: Looking Downstream from Site
Photo Date September 15, 2015

Photo B-4: Typical Conditions

Appendix B – Photographs

K-1 (Dunlop Creek at 110 Avenue)
Benthic Invertebrate Sampling Site

Photo B-1: Substrate at Monitoring Site

Photo B-2: Looking Upstream from Site

Photo B-3: Looking Downstream from Site
Photo Date September 15, 2015

Photo B-4: Typical Conditions

Appendix B – Photographs

K-2 (Spencer Creek at 240 Street)
Benthic Invertebrate Sampling Site

Photo B-1: Substrate at Monitoring Site

Photo B-2: Looking Upstream from Site

Photo B-3: Looking Downstream from Site
Photo Date September 15, 2015

Photo B-4: Typical Conditions

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KERR WOOD LEIDAL
consulting engineers

Appendix C

2014 Wet Season Detailed Laboratory Analysis Reports

CARO ANALYTICAL SERVICES

CERTIFICATE OF ANALYSIS

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby) 200 - 4185A Still Creek Dr Burnaby, BC V5C 6G9	**TEL** **FAX**	(604) 294-2088 (604) 294-2090
ATTENTION	Patrick Lilley	**WORK ORDER**	4111465
PO NUMBER		**RECEIVED / TEMP**	Nov-27-14 08:00 / 2°C
PROJECT	173.169 Maple Ridge WQ	**REPORTED**	Dec-04-14
PROJECT INFO	Stormwater Monitoring	**COC NUMBER**	No Number

General Comments:

CARO Analytical Services employs methods which are conducted according to procedures accepted by appropriate regulatory agencies, and/or are conducted in accordance with recognized professional standards using accepted testing methodologies and quality control efforts, except where otherwise agreed to by the client.

The results in this report apply to the samples analyzed in accordance with the Chain of Custody or Sample Requisition document. This analytical report must be reproduced in its entirety. CARO is not responsible for any loss or damage resulting directly or indirectly from error or omission in the conduct of testing. Liability is limited to the cost of analysis. Samples will be disposed of 30 days after the test report has been issued unless otherwise agreed to in writing.

Issued By: **Jennifer Shanko, AScT**
Administration Coordinator

Please contact CARO if more information is needed or to provide feedback on our services.

CARO ANALYTICAL SERVICES

ANALYSIS INFORMATION

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4111465
REPORTED Dec-04-14

Analysis Description	Method Reference	Technique	Location
Alkalinity (Speciated)	APHA 2320 B	Titration with H2SO4 to pH 4.5	Kelowna
Anions in Water by IC	APHA 4110 B	Ion Chromatography with Chemical Suppression of Eluent Conductivity	Kelowna
Dissolved Metals	APHA 3030 B / APHA 3125 B	0.45 µm Filtration / Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	Richmond
E. coli (MPN)	APHA 9221	Multiple-Tube Fermentation	Sublet
Fecal Coliforms (MPN)	APHA 9221	Multiple-Tube Fermentation	Sublet
Hardness (as CaCO3)	APHA 2340 B	Calculation	N/A
Total Coliforms (MPN)	APHA 9221	Multiple-Tube Fermentation	Sublet
Total Recoverable Metals	APHA 3030E * / APHA 3125 B	HNO3+HCl Hot Block Digestion / Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	Richmond

Note: An asterisk in the Method Reference indicates that the CARO method has been modified from the reference method

Method Reference Descriptions:

APHA	Standard Methods for the Examination of Water and Wastewater, 22nd Edition, American Public Health Association/American Water Works Association/Water Environment Federation

Glossary of Terms:

MRL	Method Reporting Limit
<	Less than the Reported Detection Limit (RDL) - the RDL may be higher than the MRL due to various factors such as dilutions, limited sample volume, high moisture, or interferences
mg/L	Milligrams per litre
MPN/100 mL	Most Probable Number per 100 millilitres

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4111465
REPORTED Dec-04-14

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SA-1 (4111465-01) [Water] Sampled: Nov-26-14 15:30							F1
Anions							
Nitrogen, Nitrate as N	**1.86**	N/A	0.010	mg/L	N/A	Nov-29-14	
General Parameters							
Alkalinity, Total as CaCO3	**36**	N/A	1	mg/L	N/A	Nov-28-14	
Alkalinity, Phenolphthalein as CaCO3	< 1	N/A	1	mg/L	N/A	Nov-28-14	
Alkalinity, Bicarbonate as CaCO3	**36**	N/A	1	mg/L	N/A	Nov-28-14	
Alkalinity, Carbonate as CaCO3	< 1	N/A	1	mg/L	N/A	Nov-28-14	
Alkalinity, Hydroxide as CaCO3	< 1	N/A	1	mg/L	N/A	Nov-28-14	
Calculated Parameters							
Hardness, Total (Total as CaCO3)	**45.5**	N/A	0.50	mg/L	N/A	N/A	
Hardness, Total (Diss. as CaCO3)	**38.7**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.115**	N/A	0.005	mg/L	N/A	Dec-03-14	
Antimony, dissolved	**0.0003**	N/A	0.0001	mg/L	N/A	Dec-03-14	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-03-14	
Barium, dissolved	**0.013**	N/A	0.005	mg/L	N/A	Dec-03-14	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-03-14	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-03-14	
Boron, dissolved	**0.014**	N/A	0.004	mg/L	N/A	Dec-03-14	
Cadmium, dissolved	**0.00002**	N/A	0.00001	mg/L	N/A	Dec-03-14	
Calcium, dissolved	**10.0**	N/A	0.2	mg/L	N/A	Dec-03-14	
Chromium, dissolved	**0.0008**	N/A	0.0005	mg/L	N/A	Dec-03-14	
Cobalt, dissolved	**0.00008**	N/A	0.00005	mg/L	N/A	Dec-03-14	
Copper, dissolved	**0.0027**	N/A	0.0002	mg/L	N/A	Dec-03-14	
Iron, dissolved	**0.113**	N/A	0.010	mg/L	N/A	Dec-03-14	
Lead, dissolved	**0.0002**	N/A	0.0001	mg/L	N/A	Dec-03-14	
Lithium, dissolved	**0.0005**	N/A	0.0001	mg/L	N/A	Dec-03-14	
Magnesium, dissolved	**3.32**	N/A	0.01	mg/L	N/A	Dec-03-14	
Manganese, dissolved	**0.0121**	N/A	0.0002	mg/L	N/A	Dec-03-14	
Mercury, dissolved	**0.00030**	N/A	0.00002	mg/L	N/A	Nov-28-14	
Molybdenum, dissolved	**0.0009**	N/A	0.0001	mg/L	N/A	Dec-03-14	
Nickel, dissolved	**0.0007**	N/A	0.0002	mg/L	N/A	Dec-03-14	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	Dec-03-14	
Potassium, dissolved	**1.73**	N/A	0.02	mg/L	N/A	Dec-03-14	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-03-14	
Silicon, dissolved	**5.3**	N/A	0.5	mg/L	N/A	Dec-03-14	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	Dec-03-14	
Sodium, dissolved	**6.88**	N/A	0.02	mg/L	N/A	Dec-03-14	
Strontium, dissolved	**0.068**	N/A	0.001	mg/L	N/A	Dec-03-14	
Sulfur, dissolved	< 1	N/A	1	mg/L	N/A	Dec-03-14	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Dec-03-14	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Dec-03-14	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-03-14	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Dec-03-14	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	Dec-03-14	

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4111465
REPORTED Dec-04-14

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SA-1 (4111465-01) [Water] Sampled: Nov-26-14 15:30, Continued							F1
Dissolved Metals, Continued							
Uranium, dissolved	**0.00002**	N/A	0.00002	mg/L	N/A	Dec-03-14	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	Dec-03-14	
Zinc, dissolved	**0.009**	N/A	0.004	mg/L	N/A	Dec-03-14	
Zirconium, dissolved	**0.0006**	N/A	0.0001	mg/L	N/A	Dec-03-14	
Total Recoverable Metals							
Aluminum, total	**0.722**	N/A	0.005	mg/L	Dec-01-14	Dec-02-14	
Antimony, total	**0.0005**	N/A	0.0001	mg/L	Dec-01-14	Dec-02-14	
Arsenic, total	**0.0006**	N/A	0.0005	mg/L	Dec-01-14	Dec-02-14	
Barium, total	**0.017**	N/A	0.005	mg/L	Dec-01-14	Dec-02-14	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	Dec-01-14	Dec-02-14	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	Dec-01-14	Dec-02-14	
Boron, total	**0.022**	N/A	0.004	mg/L	Dec-01-14	Dec-02-14	
Cadmium, total	**0.00002**	N/A	0.00001	mg/L	Dec-01-14	Dec-02-14	
Calcium, total	**11.6**	N/A	0.2	mg/L	Dec-01-14	Dec-02-14	
Chromium, total	**0.0020**	N/A	0.0005	mg/L	Dec-01-14	Dec-02-14	
Cobalt, total	**0.00031**	N/A	0.00005	mg/L	Dec-01-14	Dec-02-14	
Copper, total	**0.0047**	N/A	0.0002	mg/L	Dec-01-14	Dec-02-14	
Iron, total	**0.70**	N/A	0.01	mg/L	Dec-01-14	Dec-02-14	
Lead, total	**0.0007**	N/A	0.0001	mg/L	Dec-01-14	Dec-02-14	
Lithium, total	**0.0008**	N/A	0.0001	mg/L	Dec-01-14	Dec-02-14	
Magnesium, total	**4.03**	N/A	0.01	mg/L	Dec-01-14	Dec-02-14	
Manganese, total	**0.0376**	N/A	0.0002	mg/L	Dec-01-14	Dec-02-14	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	Dec-01-14	Dec-02-14	
Molybdenum, total	**0.0011**	N/A	0.0001	mg/L	Dec-01-14	Dec-02-14	
Nickel, total	**0.0014**	N/A	0.0002	mg/L	Dec-01-14	Dec-02-14	
Phosphorus, total	**0.038**	N/A	0.020	mg/L	Dec-01-14	Dec-02-14	
Potassium, total	**2.17**	N/A	0.02	mg/L	Dec-01-14	Dec-02-14	
Selenium, total	**0.0005**	N/A	0.0005	mg/L	Dec-01-14	Dec-02-14	
Silicon, total	**7.2**	N/A	0.5	mg/L	Dec-01-14	Dec-02-14	
Silver, total	< 0.00005	N/A	0.00005	mg/L	Dec-01-14	Dec-02-14	
Sodium, total	**8.00**	N/A	0.02	mg/L	Dec-01-14	Dec-02-14	
Strontium, total	**0.074**	N/A	0.001	mg/L	Dec-01-14	Dec-02-14	
Sulfur, total	**3**	N/A	1	mg/L	Dec-01-14	Dec-02-14	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	Dec-01-14	Dec-02-14	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	Dec-01-14	Dec-02-14	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	Dec-01-14	Dec-02-14	
Tin, total	< 0.0002	N/A	0.0002	mg/L	Dec-01-14	Dec-02-14	
Titanium, total	**0.029**	N/A	0.005	mg/L	Dec-01-14	Dec-02-14	
Uranium, total	**0.00004**	N/A	0.00002	mg/L	Dec-01-14	Dec-02-14	
Vanadium, total	**0.002**	N/A	0.001	mg/L	Dec-01-14	Dec-02-14	
Zinc, total	**0.016**	N/A	0.004	mg/L	Dec-01-14	Dec-02-14	
Zirconium, total	**0.0008**	N/A	0.0001	mg/L	Dec-01-14	Dec-02-14	
Microbiological Parameters							
Coliforms, Fecal	**1600**	N/A	2	MPN/100 mL	N/A	Nov-27-14	

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4111465
REPORTED Dec-04-14

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SA-1 (4111465-01) [Water] Sampled: Nov-26-14 15:30, Continued							F1
Microbiological Parameters, Continued							
E. coli (MPN)	< 2	N/A	2	MPN/100 mL	N/A	Nov-27-14	
Coliforms, Total	**16000**	N/A	2	MPN/100 mL	N/A	Nov-27-14	
Sample ID: SA-2 (4111465-02) [Water] Sampled: Nov-26-14 16:05							F1
Anions							
Nitrogen, Nitrate as N	**0.487**	N/A	0.010	mg/L	N/A	Nov-29-14	
General Parameters							
Alkalinity, Total as CaCO3	**6**	N/A	1	mg/L	N/A	Nov-28-14	
Alkalinity, Phenolphthalein as CaCO3	< 1	N/A	1	mg/L	N/A	Nov-28-14	
Alkalinity, Bicarbonate as CaCO3	**6**	N/A	1	mg/L	N/A	Nov-28-14	
Alkalinity, Carbonate as CaCO3	< 1	N/A	1	mg/L	N/A	Nov-28-14	
Alkalinity, Hydroxide as CaCO3	< 1	N/A	1	mg/L	N/A	Nov-28-14	
Calculated Parameters							
Hardness, Total (Total as CaCO3)	**8.75**	N/A	0.50	mg/L	N/A	N/A	
Hardness, Total (Diss. as CaCO3)	**7.29**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.084**	N/A	0.005	mg/L	N/A	Dec-03-14	
Antimony, dissolved	**0.0002**	N/A	0.0001	mg/L	N/A	Dec-03-14	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-03-14	
Barium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	Dec-03-14	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-03-14	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-03-14	
Boron, dissolved	< 0.004	N/A	0.004	mg/L	N/A	Dec-03-14	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	Dec-03-14	
Calcium, dissolved	**2.2**	N/A	0.2	mg/L	N/A	Dec-03-14	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-03-14	
Cobalt, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	Dec-03-14	
Copper, dissolved	**0.0005**	N/A	0.0002	mg/L	N/A	Dec-03-14	
Iron, dissolved	**0.038**	N/A	0.010	mg/L	N/A	Dec-03-14	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-03-14	
Lithium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-03-14	
Magnesium, dissolved	**0.44**	N/A	0.01	mg/L	N/A	Dec-03-14	
Manganese, dissolved	**0.0019**	N/A	0.0002	mg/L	N/A	Dec-03-14	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Nov-28-14	
Molybdenum, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-03-14	
Nickel, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Dec-03-14	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	Dec-03-14	
Potassium, dissolved	**0.16**	N/A	0.02	mg/L	N/A	Dec-03-14	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-03-14	
Silicon, dissolved	**3.1**	N/A	0.5	mg/L	N/A	Dec-03-14	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	Dec-03-14	
Sodium, dissolved	**1.65**	N/A	0.02	mg/L	N/A	Dec-03-14	
Strontium, dissolved	**0.017**	N/A	0.001	mg/L	N/A	Dec-03-14	

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4111465
REPORTED Dec-04-14

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SA-2 (4111465-02) [Water] Sampled: Nov-26-14 16:05, Continued							F1
Dissolved Metals, Continued							
Sulfur, dissolved	< 1	N/A	1	mg/L	N/A	Dec-03-14	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Dec-03-14	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Dec-03-14	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-03-14	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Dec-03-14	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	Dec-03-14	
Uranium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Dec-03-14	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	Dec-03-14	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	Dec-03-14	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-03-14	
Total Recoverable Metals							
Aluminum, total	**0.356**	N/A	0.005	mg/L	Dec-01-14	Dec-02-14	
Antimony, total	**0.0001**	N/A	0.0001	mg/L	Dec-01-14	Dec-02-14	
Arsenic, total	< 0.0005	N/A	0.0005	mg/L	Dec-01-14	Dec-02-14	
Barium, total	**0.006**	N/A	0.005	mg/L	Dec-01-14	Dec-02-14	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	Dec-01-14	Dec-02-14	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	Dec-01-14	Dec-02-14	
Boron, total	**0.006**	N/A	0.004	mg/L	Dec-01-14	Dec-02-14	
Cadmium, total	< 0.00001	N/A	0.00001	mg/L	Dec-01-14	Dec-02-14	
Calcium, total	**2.5**	N/A	0.2	mg/L	Dec-01-14	Dec-02-14	
Chromium, total	< 0.0005	N/A	0.0005	mg/L	Dec-01-14	Dec-02-14	
Cobalt, total	**0.00012**	N/A	0.00005	mg/L	Dec-01-14	Dec-02-14	
Copper, total	**0.0008**	N/A	0.0002	mg/L	Dec-01-14	Dec-02-14	
Iron, total	**0.29**	N/A	0.01	mg/L	Dec-01-14	Dec-02-14	
Lead, total	**0.0001**	N/A	0.0001	mg/L	Dec-01-14	Dec-02-14	
Lithium, total	**0.0002**	N/A	0.0001	mg/L	Dec-01-14	Dec-02-14	
Magnesium, total	**0.60**	N/A	0.01	mg/L	Dec-01-14	Dec-02-14	
Manganese, total	**0.0098**	N/A	0.0002	mg/L	Dec-01-14	Dec-02-14	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	Dec-01-14	Dec-02-14	
Molybdenum, total	**0.0002**	N/A	0.0001	mg/L	Dec-01-14	Dec-02-14	
Nickel, total	**0.0004**	N/A	0.0002	mg/L	Dec-01-14	Dec-02-14	
Phosphorus, total	< 0.020	N/A	0.020	mg/L	Dec-01-14	Dec-02-14	
Potassium, total	**0.27**	N/A	0.02	mg/L	Dec-01-14	Dec-02-14	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	Dec-01-14	Dec-02-14	
Silicon, total	**4.1**	N/A	0.5	mg/L	Dec-01-14	Dec-02-14	
Silver, total	< 0.00005	N/A	0.00005	mg/L	Dec-01-14	Dec-02-14	
Sodium, total	**1.91**	N/A	0.02	mg/L	Dec-01-14	Dec-02-14	
Strontium, total	**0.020**	N/A	0.001	mg/L	Dec-01-14	Dec-02-14	
Sulfur, total	< 1	N/A	1	mg/L	Dec-01-14	Dec-02-14	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	Dec-01-14	Dec-02-14	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	Dec-01-14	Dec-02-14	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	Dec-01-14	Dec-02-14	
Tin, total	< 0.0002	N/A	0.0002	mg/L	Dec-01-14	Dec-02-14	
Titanium, total	**0.013**	N/A	0.005	mg/L	Dec-01-14	Dec-02-14	
Uranium, total	< 0.00002	N/A	0.00002	mg/L	Dec-01-14	Dec-02-14	

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4111465
REPORTED Dec-04-14

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SA-2 (4111465-02) [Water] Sampled: Nov-26-14 16:05, Continued							F1
Total Recoverable Metals, Continued							
Vanadium, total	**0.001**	N/A	0.001	mg/L	Dec-01-14	Dec-02-14	
Zinc, total	**0.026**	N/A	0.004	mg/L	Dec-01-14	Dec-02-14	
Zirconium, total	< 0.0001	N/A	0.0001	mg/L	Dec-01-14	Dec-02-14	
Microbiological Parameters							
Coliforms, Fecal	**13**	N/A	2	MPN/100 mL	N/A	Nov-27-14	
E. coli (MPN)	< 2	N/A	2	MPN/100 mL	N/A	Nov-27-14	
Coliforms, Total	**170**	N/A	2	MPN/100 mL	N/A	Nov-27-14	
Sample ID: K-1 (4111465-03) [Water] Sampled: Nov-26-14 17:00							F1
Anions							
Nitrogen, Nitrate as N	**1.54**	N/A	0.010	mg/L	N/A	Nov-29-14	
General Parameters							
Alkalinity, Total as CaCO3	**16**	N/A	1	mg/L	N/A	Nov-28-14	
Alkalinity, Phenolphthalein as CaCO3	< 1	N/A	1	mg/L	N/A	Nov-28-14	
Alkalinity, Bicarbonate as CaCO3	**16**	N/A	1	mg/L	N/A	Nov-28-14	
Alkalinity, Carbonate as CaCO3	< 1	N/A	1	mg/L	N/A	Nov-28-14	
Alkalinity, Hydroxide as CaCO3	< 1	N/A	1	mg/L	N/A	Nov-28-14	
Calculated Parameters							
Hardness, Total (Total as CaCO3)	**26.0**	N/A	0.50	mg/L	N/A	N/A	
Hardness, Total (Diss. as CaCO3)	**21.3**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.337**	N/A	0.005	mg/L	N/A	Dec-03-14	
Antimony, dissolved	**0.0002**	N/A	0.0001	mg/L	N/A	Dec-03-14	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-03-14	
Barium, dissolved	**0.010**	N/A	0.005	mg/L	N/A	Dec-03-14	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-03-14	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-03-14	
Boron, dissolved	**0.010**	N/A	0.004	mg/L	N/A	Dec-03-14	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	Dec-03-14	
Calcium, dissolved	**5.5**	N/A	0.2	mg/L	N/A	Dec-03-14	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-03-14	
Cobalt, dissolved	**0.00012**	N/A	0.00005	mg/L	N/A	Dec-03-14	
Copper, dissolved	**0.0020**	N/A	0.0002	mg/L	N/A	Dec-03-14	
Iron, dissolved	**0.282**	N/A	0.010	mg/L	N/A	Dec-03-14	
Lead, dissolved	**0.0002**	N/A	0.0001	mg/L	N/A	Dec-03-14	
Lithium, dissolved	**0.0003**	N/A	0.0001	mg/L	N/A	Dec-03-14	
Magnesium, dissolved	**1.84**	N/A	0.01	mg/L	N/A	Dec-03-14	
Manganese, dissolved	**0.0067**	N/A	0.0002	mg/L	N/A	Dec-03-14	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Nov-28-14	
Molybdenum, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-03-14	
Nickel, dissolved	**0.0007**	N/A	0.0002	mg/L	N/A	Dec-03-14	
Phosphorus, dissolved	**0.04**	N/A	0.02	mg/L	N/A	Dec-03-14	

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4111465
REPORTED Dec-04-14

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: K-1 (4111465-03) [Water] Sampled: Nov-26-14 17:00, Continued							F1
Dissolved Metals, Continued							
Potassium, dissolved	**1.71**	N/A	0.02	mg/L	N/A	Dec-03-14	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-03-14	
Silicon, dissolved	**4.6**	N/A	0.5	mg/L	N/A	Dec-03-14	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	Dec-03-14	
Sodium, dissolved	**3.22**	N/A	0.02	mg/L	N/A	Dec-03-14	
Strontium, dissolved	**0.042**	N/A	0.001	mg/L	N/A	Dec-03-14	
Sulfur, dissolved	< 1	N/A	1	mg/L	N/A	Dec-03-14	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Dec-03-14	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Dec-03-14	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-03-14	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Dec-03-14	
Titanium, dissolved	**0.013**	N/A	0.005	mg/L	N/A	Dec-03-14	
Uranium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Dec-03-14	
Vanadium, dissolved	**0.001**	N/A	0.001	mg/L	N/A	Dec-03-14	
Zinc, dissolved	**0.005**	N/A	0.004	mg/L	N/A	Dec-03-14	
Zirconium, dissolved	**0.0005**	N/A	0.0001	mg/L	N/A	Dec-03-14	
Total Recoverable Metals							
Aluminum, total	**1.72**	N/A	0.005	mg/L	Dec-01-14	Dec-02-14	
Antimony, total	**0.0002**	N/A	0.0001	mg/L	Dec-01-14	Dec-02-14	
Arsenic, total	**0.0007**	N/A	0.0005	mg/L	Dec-01-14	Dec-02-14	
Barium, total	**0.018**	N/A	0.005	mg/L	Dec-01-14	Dec-02-14	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	Dec-01-14	Dec-02-14	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	Dec-01-14	Dec-02-14	
Boron, total	**0.012**	N/A	0.004	mg/L	Dec-01-14	Dec-02-14	
Cadmium, total	**0.00002**	N/A	0.00001	mg/L	Dec-01-14	Dec-02-14	
Calcium, total	**6.4**	N/A	0.2	mg/L	Dec-01-14	Dec-02-14	
Chromium, total	**0.0021**	N/A	0.0005	mg/L	Dec-01-14	Dec-02-14	
Cobalt, total	**0.00070**	N/A	0.00005	mg/L	Dec-01-14	Dec-02-14	
Copper, total	**0.0041**	N/A	0.0002	mg/L	Dec-01-14	Dec-02-14	
Iron, total	**1.59**	N/A	0.01	mg/L	Dec-01-14	Dec-02-14	
Lead, total	**0.0005**	N/A	0.0001	mg/L	Dec-01-14	Dec-02-14	
Lithium, total	**0.0009**	N/A	0.0001	mg/L	Dec-01-14	Dec-02-14	
Magnesium, total	**2.44**	N/A	0.01	mg/L	Dec-01-14	Dec-02-14	
Manganese, total	**0.0418**	N/A	0.0002	mg/L	Dec-01-14	Dec-02-14	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	Dec-01-14	Dec-02-14	
Molybdenum, total	**0.0002**	N/A	0.0001	mg/L	Dec-01-14	Dec-02-14	
Nickel, total	**0.0024**	N/A	0.0002	mg/L	Dec-01-14	Dec-02-14	
Phosphorus, total	**0.081**	N/A	0.020	mg/L	Dec-01-14	Dec-02-14	
Potassium, total	**2.11**	N/A	0.02	mg/L	Dec-01-14	Dec-02-14	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	Dec-01-14	Dec-02-14	
Silicon, total	**7.1**	N/A	0.5	mg/L	Dec-01-14	Dec-02-14	
Silver, total	< 0.00005	N/A	0.00005	mg/L	Dec-01-14	Dec-02-14	
Sodium, total	**3.58**	N/A	0.02	mg/L	Dec-01-14	Dec-02-14	
Strontium, total	**0.045**	N/A	0.001	mg/L	Dec-01-14	Dec-02-14	
Sulfur, total	< 1	N/A	1	mg/L	Dec-01-14	Dec-02-14	

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4111465
REPORTED Dec-04-14

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: K-1 (4111465-03) [Water] Sampled: Nov-26-14 17:00, Continued							F1
Total Recoverable Metals, Continued							
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	Dec-01-14	Dec-02-14	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	Dec-01-14	Dec-02-14	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	Dec-01-14	Dec-02-14	
Tin, total	< 0.0002	N/A	0.0002	mg/L	Dec-01-14	Dec-02-14	
Titanium, total	**0.076**	N/A	0.005	mg/L	Dec-01-14	Dec-02-14	
Uranium, total	**0.00004**	N/A	0.00002	mg/L	Dec-01-14	Dec-02-14	
Vanadium, total	**0.004**	N/A	0.001	mg/L	Dec-01-14	Dec-02-14	
Zinc, total	**0.011**	N/A	0.004	mg/L	Dec-01-14	Dec-02-14	
Zirconium, total	**0.0006**	N/A	0.0001	mg/L	Dec-01-14	Dec-02-14	
Microbiological Parameters							
Coliforms, Fecal	**1600**	N/A	2	MPN/100 mL	N/A	Nov-27-14	
E. coli (MPN)	< 2	N/A	2	MPN/100 mL	N/A	Nov-27-14	
Coliforms, Total	**5000**	N/A	2	MPN/100 mL	N/A	Nov-27-14	
Sample ID: K-2 (4111465-04) [Water] Sampled: Nov-26-14 16:40							F1
Anions							
Nitrogen, Nitrate as N	**0.873**	N/A	0.010	mg/L	N/A	Nov-29-14	
General Parameters							
Alkalinity, Total as CaCO3	**34**	N/A	1	mg/L	N/A	Nov-28-14	
Alkalinity, Phenolphthalein as CaCO3	< 1	N/A	1	mg/L	N/A	Nov-28-14	
Alkalinity, Bicarbonate as CaCO3	**34**	N/A	1	mg/L	N/A	Nov-28-14	
Alkalinity, Carbonate as CaCO3	< 1	N/A	1	mg/L	N/A	Nov-28-14	
Alkalinity, Hydroxide as CaCO3	< 1	N/A	1	mg/L	N/A	Nov-28-14	
Calculated Parameters							
Hardness, Total (Total as CaCO3)	**44.1**	N/A	0.50	mg/L	N/A	N/A	
Hardness, Total (Diss. as CaCO3)	**36.1**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.272**	N/A	0.005	mg/L	N/A	Dec-03-14	
Antimony, dissolved	**0.0002**	N/A	0.0001	mg/L	N/A	Dec-03-14	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-03-14	
Barium, dissolved	**0.008**	N/A	0.005	mg/L	N/A	Dec-03-14	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-03-14	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-03-14	
Boron, dissolved	**0.009**	N/A	0.004	mg/L	N/A	Dec-03-14	
Cadmium, dissolved	**0.00001**	N/A	0.00001	mg/L	N/A	Dec-03-14	
Calcium, dissolved	**9.7**	N/A	0.2	mg/L	N/A	Dec-03-14	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-03-14	
Cobalt, dissolved	**0.00010**	N/A	0.00005	mg/L	N/A	Dec-03-14	
Copper, dissolved	**0.0023**	N/A	0.0002	mg/L	N/A	Dec-03-14	
Iron, dissolved	**0.235**	N/A	0.010	mg/L	N/A	Dec-03-14	
Lead, dissolved	**0.0004**	N/A	0.0001	mg/L	N/A	Dec-03-14	
Lithium, dissolved	**0.0004**	N/A	0.0001	mg/L	N/A	Dec-03-14	

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4111465
REPORTED Dec-04-14

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: K-2 (4111465-04) [Water] Sampled: Nov-26-14 16:40, Continued							F1
Dissolved Metals, Continued							
Magnesium, dissolved	**2.88**	N/A	0.01	mg/L	N/A	Dec-03-14	
Manganese, dissolved	**0.0062**	N/A	0.0002	mg/L	N/A	Dec-03-14	
Mercury, dissolved	**0.00007**	N/A	0.00002	mg/L	N/A	Nov-28-14	
Molybdenum, dissolved	**0.0004**	N/A	0.0001	mg/L	N/A	Dec-03-14	
Nickel, dissolved	**0.0008**	N/A	0.0002	mg/L	N/A	Dec-03-14	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	Dec-03-14	
Potassium, dissolved	**1.44**	N/A	0.02	mg/L	N/A	Dec-03-14	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-03-14	
Silicon, dissolved	**5.3**	N/A	0.5	mg/L	N/A	Dec-03-14	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	Dec-03-14	
Sodium, dissolved	**4.48**	N/A	0.02	mg/L	N/A	Dec-03-14	
Strontium, dissolved	**0.065**	N/A	0.001	mg/L	N/A	Dec-03-14	
Sulfur, dissolved	< 1	N/A	1	mg/L	N/A	Dec-03-14	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Dec-03-14	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Dec-03-14	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-03-14	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Dec-03-14	
Titanium, dissolved	**0.012**	N/A	0.005	mg/L	N/A	Dec-03-14	
Uranium, dissolved	**0.00003**	N/A	0.00002	mg/L	N/A	Dec-03-14	
Vanadium, dissolved	**0.001**	N/A	0.001	mg/L	N/A	Dec-03-14	
Zinc, dissolved	**0.005**	N/A	0.004	mg/L	N/A	Dec-03-14	
Zirconium, dissolved	**0.0005**	N/A	0.0001	mg/L	N/A	Dec-03-14	
Total Recoverable Metals							
Aluminum, total	**2.59**	N/A	0.005	mg/L	Dec-01-14	Dec-02-14	
Antimony, total	**0.0002**	N/A	0.0001	mg/L	Dec-01-14	Dec-02-14	
Arsenic, total	**0.0009**	N/A	0.0005	mg/L	Dec-01-14	Dec-02-14	
Barium, total	**0.022**	N/A	0.005	mg/L	Dec-01-14	Dec-02-14	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	Dec-01-14	Dec-02-14	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	Dec-01-14	Dec-02-14	
Boron, total	**0.011**	N/A	0.004	mg/L	Dec-01-14	Dec-02-14	
Cadmium, total	**0.00002**	N/A	0.00001	mg/L	Dec-01-14	Dec-02-14	
Calcium, total	**11.1**	N/A	0.2	mg/L	Dec-01-14	Dec-02-14	
Chromium, total	**0.0030**	N/A	0.0005	mg/L	Dec-01-14	Dec-02-14	
Cobalt, total	**0.00101**	N/A	0.00005	mg/L	Dec-01-14	Dec-02-14	
Copper, total	**0.0054**	N/A	0.0002	mg/L	Dec-01-14	Dec-02-14	
Iron, total	**2.36**	N/A	0.01	mg/L	Dec-01-14	Dec-02-14	
Lead, total	**0.0006**	N/A	0.0001	mg/L	Dec-01-14	Dec-02-14	
Lithium, total	**0.0015**	N/A	0.0001	mg/L	Dec-01-14	Dec-02-14	
Magnesium, total	**3.94**	N/A	0.01	mg/L	Dec-01-14	Dec-02-14	
Manganese, total	**0.0607**	N/A	0.0002	mg/L	Dec-01-14	Dec-02-14	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	Dec-01-14	Dec-02-14	
Molybdenum, total	**0.0006**	N/A	0.0001	mg/L	Dec-01-14	Dec-02-14	
Nickel, total	**0.0034**	N/A	0.0002	mg/L	Dec-01-14	Dec-02-14	
Phosphorus, total	**0.063**	N/A	0.020	mg/L	Dec-01-14	Dec-02-14	
Potassium, total	**1.96**	N/A	0.02	mg/L	Dec-01-14	Dec-02-14	

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	4111465
PROJECT	173.169 Maple Ridge WQ	**REPORTED**	Dec-04-14

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: K-2 (4111465-04) [Water] Sampled: Nov-26-14 16:40, Continued							F1
Total Recoverable Metals, Continued							
Selenium, total	< 0.0005	N/A	0.0005	mg/L	Dec-01-14	Dec-02-14	
Silicon, total	**10.3**	N/A	0.5	mg/L	Dec-01-14	Dec-02-14	
Silver, total	< 0.00005	N/A	0.00005	mg/L	Dec-01-14	Dec-02-14	
Sodium, total	**5.30**	N/A	0.02	mg/L	Dec-01-14	Dec-02-14	
Strontium, total	**0.073**	N/A	0.001	mg/L	Dec-01-14	Dec-02-14	
Sulfur, total	< 1	N/A	1	mg/L	Dec-01-14	Dec-02-14	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	Dec-01-14	Dec-02-14	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	Dec-01-14	Dec-02-14	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	Dec-01-14	Dec-02-14	
Tin, total	< 0.0002	N/A	0.0002	mg/L	Dec-01-14	Dec-02-14	
Titanium, total	**0.109**	N/A	0.005	mg/L	Dec-01-14	Dec-02-14	
Uranium, total	**0.00006**	N/A	0.00002	mg/L	Dec-01-14	Dec-02-14	
Vanadium, total	**0.006**	N/A	0.001	mg/L	Dec-01-14	Dec-02-14	
Zinc, total	**0.011**	N/A	0.004	mg/L	Dec-01-14	Dec-02-14	
Zirconium, total	**0.0010**	N/A	0.0001	mg/L	Dec-01-14	Dec-02-14	
Microbiological Parameters							
Coliforms, Fecal	**50**	N/A	2	MPN/100 mL	N/A	Nov-27-14	
E. coli (MPN)	< 2	N/A	2	MPN/100 mL	N/A	Nov-27-14	
Coliforms, Total	**5000**	N/A	2	MPN/100 mL	N/A	Nov-27-14	
Sample ID: Field Blank (4111465-05) [Water] Sampled: Nov-26-14 15:30							F1, F2
Microbiological Parameters							
E. coli (MPN)	< 2	N/A	2	MPN/100 mL	N/A	Nov-27-14	
Coliforms, Total	< 2	N/A	2	MPN/100 mL	N/A	Nov-27-14	

Sample / Analysis Qualifiers:

F1 The sample was not field-filtered and was therefore filtered through a 0.45 µm membrane in the laboratory and preserved with HNO3 prior to analysis for dissolved metals.

F2 The sample was not field-preserved with HNO3 and was therefore preserved in the laboratory and held for at least 16 hours prior to analysis for total metals.

CARO ANALYTICAL SERVICES

QUALITY CONTROL DATA

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	4111465
PROJECT	173.169 Maple Ridge WQ	**REPORTED**	Dec-04-14

The following section displays the quality control (QC) data that is associated with your sample data. Groups of samples are prepared in "batches" and analyzed in conjunction with QC samples that ensure your data is of the highest quality. Common QC types include:

- **Method Blank (Blk)**: Laboratory reagent water is carried through sample preparation and analysis steps. Method Blanks indicate that results are free from contamination, i.e. not biased high from sources such as the sample container or the laboratory environment
- **Duplicate (Dup)**: Preparation and analysis of a replicate aliquot of a sample. Duplicates provide a measure of the analytical method's precision, i.e. how reproducible a result is. Duplicates are only reported if they are associated with your sample data.
- **Blank Spike (BS)**: A known amount of standard is carried through sample preparation and analysis steps. Blank Spikes, also known as laboratory control samples (LCS), are prepared from a different source of standard than used for the calibration. They ensure that the calibration is acceptable (i.e. not biased high or low) and also provide a measure of the analytical method's accuracy (i.e. closeness of the result to a target value).
- **Standard Reference Material (SRM)**: A material of similar matrix to the samples, externally certified for the parameter(s) listed. Standard Reference Materials ensure that the preparation steps in the method are adequate to achieve acceptable recoveries of the parameter(s) tested.

Each QC type is analyzed at a 5-10% frequency, i.e. one blank/duplicate/spike for every 10 samples. For all types of QC, the specified recovery (% Rec) and relative percent difference (RPD) limits are derived from long-term method performance averages and/or prescribed by the reference method.

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	RPD	RPD Limit	Notes
Anions, Batch B4K1295										
Blank (B4K1295-BLK1)				Prepared: Nov-29-14, Analyzed: Nov-29-14						
Nitrogen, Nitrate as N	< 0.010	0.010	mg/L							
LCS (B4K1295-BS1)				Prepared: Nov-29-14, Analyzed: Nov-29-14						
Nitrogen, Nitrate as N	4.33	0.010	mg/L	4.00		108	85-115			
Duplicate (B4K1295-DUP1)		**Source: 4111465-01**		Prepared: Nov-29-14, Analyzed: Nov-29-14						
Nitrogen, Nitrate as N	1.85	0.010	mg/L		1.86			< 1	10	
Dissolved Metals, Batch B4K1240										
Blank (B4K1240-BLK1)				Prepared: Nov-28-14, Analyzed: Nov-28-14						
Mercury, dissolved	< 0.00002	0.00002	mg/L							
Dissolved Metals, Batch B4L0137										
Blank (B4L0137-BLK1)				Prepared: Dec-03-14, Analyzed: Dec-03-14						
Aluminum, dissolved	< 0.005	0.005	mg/L							
Antimony, dissolved	< 0.0001	0.0001	mg/L							
Arsenic, dissolved	< 0.0005	0.0005	mg/L							
Barium, dissolved	< 0.005	0.005	mg/L							
Beryllium, dissolved	< 0.0001	0.0001	mg/L							
Bismuth, dissolved	< 0.0001	0.0001	mg/L							
Boron, dissolved	< 0.004	0.004	mg/L							
Cadmium, dissolved	< 0.00001	0.00001	mg/L							
Calcium, dissolved	< 0.2	0.2	mg/L							
Chromium, dissolved	< 0.0005	0.0005	mg/L							
Cobalt, dissolved	< 0.00005	0.00005	mg/L							
Copper, dissolved	< 0.0002	0.0002	mg/L							
Iron, dissolved	< 0.010	0.010	mg/L							
Lead, dissolved	< 0.0001	0.0001	mg/L							
Lithium, dissolved	< 0.0001	0.0001	mg/L							
Magnesium, dissolved	< 0.01	0.01	mg/L							

CARO ANALYTICAL SERVICES

QUALITY CONTROL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4111465
REPORTED Dec-04-14

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	RPD	RPD Limit	Notes
Dissolved Metals, Batch B4L0137, Continued										
Blank (B4L0137-BLK1), Continued				Prepared: Dec-03-14, Analyzed: Dec-03-14						
Manganese, dissolved	< 0.0002	0.0002	mg/L							
Molybdenum, dissolved	< 0.0001	0.0001	mg/L							
Nickel, dissolved	< 0.0002	0.0002	mg/L							
Phosphorus, dissolved	< 0.02	0.02	mg/L							
Potassium, dissolved	< 0.02	0.02	mg/L							
Selenium, dissolved	< 0.0005	0.0005	mg/L							
Silicon, dissolved	< 0.5	0.5	mg/L							
Silver, dissolved	< 0.00005	0.00005	mg/L							
Sodium, dissolved	< 0.02	0.02	mg/L							
Strontium, dissolved	< 0.001	0.001	mg/L							
Sulfur, dissolved	< 1	1	mg/L							
Tellurium, dissolved	< 0.0002	0.0002	mg/L							
Thallium, dissolved	< 0.00002	0.00002	mg/L							
Thorium, dissolved	< 0.0001	0.0001	mg/L							
Tin, dissolved	< 0.0002	0.0002	mg/L							
Titanium, dissolved	< 0.005	0.005	mg/L							
Uranium, dissolved	< 0.00002	0.00002	mg/L							
Vanadium, dissolved	< 0.001	0.001	mg/L							
Zinc, dissolved	< 0.004	0.004	mg/L							
Zirconium, dissolved	< 0.0001	0.0001	mg/L							
Reference (B4L0137-SRM1)				Prepared: Dec-03-14, Analyzed: Dec-03-14						
Aluminum, dissolved	0.199	0.005	mg/L	0.233		85	58-142			
Antimony, dissolved	0.0503	0.0001	mg/L	0.0430		117	75-125			
Arsenic, dissolved	0.412	0.0005	mg/L	0.438		94	81-119			
Barium, dissolved	3.54	0.005	mg/L	3.35		106	83-117			
Beryllium, dissolved	0.197	0.0001	mg/L	0.213		92	80-120			
Boron, dissolved	1.69	0.004	mg/L	1.74		97	74-117			
Cadmium, dissolved	0.206	0.00001	mg/L	0.224		92	83-117			
Calcium, dissolved	7.7	0.2	mg/L	7.69		100	76-124			
Chromium, dissolved	0.419	0.0005	mg/L	0.437		96	81-119			
Cobalt, dissolved	0.129	0.00005	mg/L	0.128		101	76-124			
Copper, dissolved	0.851	0.0002	mg/L	0.844		101	84-116			
Iron, dissolved	1.24	0.010	mg/L	1.29		96	74-126			
Lead, dissolved	0.113	0.0001	mg/L	0.112		101	72-128			
Lithium, dissolved	0.101	0.0001	mg/L	0.104		98	60-140			
Magnesium, dissolved	6.54	0.01	mg/L	6.92		94	81-119			
Manganese, dissolved	0.337	0.0002	mg/L	0.345		98	84-116			
Molybdenum, dissolved	0.469	0.0001	mg/L	0.426		110	83-117			
Nickel, dissolved	0.837	0.0002	mg/L	0.840		100	74-126			
Phosphorus, dissolved	0.40	0.02	mg/L	0.495		81	68-132			
Potassium, dissolved	2.92	0.02	mg/L	3.19		92	74-126			
Selenium, dissolved	0.0289	0.0005	mg/L	0.0331		87	70-130			
Sodium, dissolved	18.0	0.02	mg/L	19.1		94	72-128			
Strontium, dissolved	0.907	0.001	mg/L	0.916		99	84-113			
Thallium, dissolved	0.0361	0.00002	mg/L	0.0393		92	57-143			
Uranium, dissolved	0.289	0.00002	mg/L	0.266		109	85-115			
Vanadium, dissolved	0.806	0.001	mg/L	0.869		93	87-113			
Zinc, dissolved	0.863	0.004	mg/L	0.881		98	72-128			
General Parameters, Batch B4K1268										
Blank (B4K1268-BLK1)				Prepared: Nov-28-14, Analyzed: Nov-28-14						
Alkalinity, Total as CaCO3	< 1	1	mg/L							
Alkalinity, Phenolphthalein as CaCO3	< 1	1	mg/L							
Alkalinity, Bicarbonate as CaCO3	< 1	1	mg/L							

CARO ANALYTICAL SERVICES

QUALITY CONTROL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4111465
REPORTED Dec-04-14

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	RPD	RPD Limit	Notes
General Parameters, Batch B4K1268, Continued										
Blank (B4K1268-BLK1), Continued				Prepared: Nov-28-14, Analyzed: Nov-28-14						
Alkalinity, Carbonate as CaCO3	< 1	1	mg/L							
Alkalinity, Hydroxide as CaCO3	< 1	1	mg/L							
Blank (B4K1268-BLK2)				Prepared: Nov-28-14, Analyzed: Nov-28-14						
Alkalinity, Total as CaCO3	< 1	1	mg/L							
Alkalinity, Phenolphthalein as CaCO3	< 1	1	mg/L							
Alkalinity, Bicarbonate as CaCO3	< 1	1	mg/L							
Alkalinity, Carbonate as CaCO3	< 1	1	mg/L							
Alkalinity, Hydroxide as CaCO3	< 1	1	mg/L							
LCS (B4K1268-BS1)				Prepared: Nov-28-14, Analyzed: Nov-28-14						
Alkalinity, Total as CaCO3	102	1	mg/L	100		102	96-108			
LCS (B4K1268-BS2)				Prepared: Nov-28-14, Analyzed: Nov-28-14						
Alkalinity, Total as CaCO3	100	1	mg/L	100		100	96-108			
Total Recoverable Metals, Batch B4L0005										
Blank (B4L0005-BLK1)				Prepared: Dec-01-14, Analyzed: Dec-02-14						
Aluminum, total	< 0.005	0.005	mg/L							
Antimony, total	< 0.0001	0.0001	mg/L							
Arsenic, total	< 0.0005	0.0005	mg/L							
Barium, total	< 0.005	0.005	mg/L							
Beryllium, total	< 0.0001	0.0001	mg/L							
Bismuth, total	< 0.0001	0.0001	mg/L							
Boron, total	< 0.004	0.004	mg/L							
Cadmium, total	< 0.00001	0.00001	mg/L							
Calcium, total	< 0.2	0.2	mg/L							
Chromium, total	< 0.0005	0.0005	mg/L							
Cobalt, total	< 0.00005	0.00005	mg/L							
Copper, total	< 0.0002	0.0002	mg/L							
Iron, total	< 0.01	0.01	mg/L							
Lead, total	< 0.0001	0.0001	mg/L							
Lithium, total	< 0.0001	0.0001	mg/L							
Magnesium, total	< 0.01	0.01	mg/L							
Manganese, total	< 0.0002	0.0002	mg/L							
Mercury, total	< 0.00002	0.00002	mg/L							
Molybdenum, total	< 0.0001	0.0001	mg/L							
Nickel, total	< 0.0002	0.0002	mg/L							
Phosphorus, total	< 0.020	0.020	mg/L							
Potassium, total	< 0.02	0.02	mg/L							
Selenium, total	< 0.0005	0.0005	mg/L							
Silicon, total	< 0.5	0.5	mg/L							
Silver, total	< 0.00005	0.00005	mg/L							
Sodium, total	< 0.02	0.02	mg/L							
Strontium, total	< 0.001	0.001	mg/L							
Sulfur, total	< 1	1	mg/L							
Tellurium, total	< 0.0002	0.0002	mg/L							
Thallium, total	< 0.00002	0.00002	mg/L							
Thorium, total	< 0.0001	0.0001	mg/L							
Tin, total	< 0.0002	0.0002	mg/L							
Titanium, total	< 0.005	0.005	mg/L							
Uranium, total	< 0.00002	0.00002	mg/L							
Vanadium, total	< 0.001	0.001	mg/L							
Zinc, total	< 0.004	0.004	mg/L							
Zirconium, total	< 0.0001	0.0001	mg/L							

CARO ANALYTICAL SERVICES

QUALITY CONTROL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4111465
REPORTED Dec-04-14

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	RPD	RPD Limit	Notes
Total Recoverable Metals, Batch B4L0005, Continued										
Duplicate (B4L0005-DUP1)		**Source: 4111465-04**		Prepared: Dec-01-14, Analyzed: Dec-02-14						
Aluminum, total	2.68	0.005	mg/L		2.59			4	29	
Antimony, total	0.0002	0.0001	mg/L		0.0002				31	
Arsenic, total	0.0009	0.0005	mg/L		0.0009				15	
Barium, total	0.022	0.005	mg/L		0.022				9	
Beryllium, total	< 0.0001	0.0001	mg/L		< 0.0001				16	
Bismuth, total	< 0.0001	0.0001	mg/L		< 0.0001				20	
Boron, total	0.010	0.004	mg/L		0.011				29	
Cadmium, total	0.00002	0.00001	mg/L		0.00002				33	
Calcium, total	11.5	0.2	mg/L		11.1			3	12	
Chromium, total	0.0031	0.0005	mg/L		0.0030			1	12	
Cobalt, total	0.00100	0.00005	mg/L		0.00101			1	13	
Copper, total	0.0055	0.0002	mg/L		0.0054			2	37	
Iron, total	2.39	0.01	mg/L		2.36			1	18	
Lead, total	0.0006	0.0001	mg/L		0.0006			< 1	23	
Lithium, total	0.0016	0.0001	mg/L		0.0015			8	19	
Magnesium, total	3.91	0.01	mg/L		3.94			< 1	10	
Manganese, total	0.0607	0.0002	mg/L		0.0607			< 1	13	
Mercury, total	< 0.00002	0.00002	mg/L		< 0.00002				24	
Molybdenum, total	0.0005	0.0001	mg/L		0.0006			18	20	
Nickel, total	0.0034	0.0002	mg/L		0.0034			< 1	28	
Phosphorus, total	0.064	0.020	mg/L		0.063				24	
Potassium, total	1.99	0.02	mg/L		1.96			1	13	
Selenium, total	< 0.0005	0.0005	mg/L		< 0.0005				24	
Silicon, total	10.5	0.5	mg/L		10.3			1	11	
Silver, total	< 0.00005	0.00005	mg/L		< 0.00005				18	
Sodium, total	5.33	0.02	mg/L		5.30			< 1	10	
Strontium, total	0.074	0.001	mg/L		0.073			1	9	
Sulfur, total	2	1	mg/L		1				24	
Tellurium, total	< 0.0002	0.0002	mg/L		< 0.0002				20	
Thallium, total	< 0.00002	0.00002	mg/L		< 0.00002				24	
Thorium, total	< 0.0001	0.0001	mg/L		< 0.0001				18	
Tin, total	< 0.0002	0.0002	mg/L		< 0.0002				18	
Titanium, total	0.110	0.005	mg/L		0.109			1	32	
Uranium, total	0.00006	0.00002	mg/L		0.00006				14	
Vanadium, total	0.006	0.001	mg/L		0.006			4	17	
Zinc, total	0.010	0.004	mg/L		0.011				8	
Zirconium, total	0.0010	0.0001	mg/L		0.0010			< 1	60	
Reference (B4L0005-SRM1)				Prepared: Dec-01-14, Analyzed: Dec-02-14						
Aluminum, total	0.312	0.005	mg/L	0.296		106	81-129			
Antimony, total	0.0505	0.0001	mg/L	0.0505		100	88-114			
Arsenic, total	0.123	0.0005	mg/L	0.122		101	88-114			
Barium, total	0.646	0.005	mg/L	0.777		83	72-104			
Beryllium, total	0.0459	0.0001	mg/L	0.0488		94	76-131			
Boron, total	3.52	0.004	mg/L	3.40		103	75-121			
Cadmium, total	0.0500	0.00001	mg/L	0.0490		102	89-111			
Calcium, total	10.0	0.2	mg/L	10.2		98	86-121			
Chromium, total	0.259	0.0005	mg/L	0.242		107	89-114			
Cobalt, total	0.0386	0.00005	mg/L	0.0366		105	91-113			
Copper, total	0.533	0.0002	mg/L	0.487		110	91-115			
Iron, total	0.52	0.01	mg/L	0.469		110	77-124			
Lead, total	0.198	0.0001	mg/L	0.193		103	92-113			
Lithium, total	0.383	0.0001	mg/L	0.390		98	85-115			
Magnesium, total	3.71	0.01	mg/L	3.31		112	78-120			
Manganese, total	0.114	0.0002	mg/L	0.109		105	90-114			
Mercury, total	0.00422	0.00002	mg/L	0.00456		92	50-150			
Molybdenum, total	0.210	0.0001	mg/L	0.197		107	90-111			

CARO ANALYTICAL SERVICES

QUALITY CONTROL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4111465
REPORTED Dec-04-14

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	RPD	RPD Limit	Notes
Total Recoverable Metals, Batch B4L0005, Continued										
Reference (B4L0005-SRM1), Continued				Prepared: Dec-01-14, Analyzed: Dec-02-14						
Nickel, total	0.246	0.0002	mg/L	0.242		102	90-111			
Phosphorus, total	0.212	0.020	mg/L	0.233		91	85-115			
Potassium, total	6.36	0.02	mg/L	5.93		107	84-113			
Selenium, total	0.122	0.0005	mg/L	0.115		106	85-115			
Sodium, total	8.34	0.02	mg/L	7.64		109	82-123			
Strontium, total	0.381	0.001	mg/L	0.363		105	88-112			
Thallium, total	0.0827	0.00002	mg/L	0.0794		104	91-114			
Uranium, total	0.0194	0.00002	mg/L	0.0192		101	85-120			
Vanadium, total	0.395	0.001	mg/L	0.376		105	86-111			
Zinc, total	2.57	0.004	mg/L	2.42		106	85-111			

CAF ANALYTICAL SERVICES

41111465

TEL: (780) 489-9100 FAX: (480) 489-9700

CHAIN-OF-CUSTODY RECORD COC#

CARO BC COC, Rev 03/13

RELINQUISHED BY: Patrick Lilley	DATE: 27-Nov-14 TIME: 8:00	RECEIVED BY: P/U JT	DATE: 11/27 TIME: 08:00
RELINQUISHED BY:	DATE: TIME:	RECEIVED BY:	DATE: TIME:

REPORT TO:
COMPANY: Kerr Wood Leidal Associates
ADDRESS: 200-4185A Still Creek Drive, Burnaby, BC V5C 6G9
CONTACT: Patrick Lilley
TEL / FAX: 604-293-3121 604-294-2090
EMAIL PDF ☑ EDD ☐ Please email Excel file.
EMAIL 1: plilley@kwl.ca
EMAIL 2:
MAIL HARDCOPY ☐ HOLD FOR P/U ☐ FAX ☐

INVOICE TO: SAME AS REPORT TO ☐
COMPANY: Kerr Wood Leidal Associates
ADDRESS: 200-4185A Still Creek Drive, Burnaby, BC V5C 6G9
CONTACT: Patrick Lilley / Michelle Derer
TEL / FAX: 604-293-3252 604-294-2090
EMAIL PDF ☑
EMAIL 1: plilley@kwl.ca
EMAIL 2: mderer@kwl.ca
MAIL HARDCOPY ☐ HOLD FOR P/U ☑

PROJECT: 173.169 Maple Ridge WQ
PROJECT INFO: Stormwater Monitoring
PO #:
SAMPLED BY: Patrick Lilley
SHIPPING INSTRUCTIONS: RETURN COOLER(S) ☐
SHIP SUPPLIES (PLEASE SPECIFY IN OTHER INSTRUCTIONS SECTION) ☐

TURNAROUND Routine (4-7 days) ☑ Other:
TIME REQUESTED: Rush:* 1 Day ☐ 2 Day ☐ 3 Day ☐ * Contact the lab to confirm, surcharges may apply

ANALYSES REQUESTED:

	CLIENT SAMPLE ID:	MATRIX: DRINKING WATER	OTHER WATER	SOIL	OTHER	# CONTAINERS	SAMPLING: DATE DD-MMM-YY	TIME HH:MM	COMMENTS: CHLORINATED	FILTERED	PRESERVED	(i.e. flow/volume media ID/notes)	BTEX ☐ VPH ☐ MTBE ☐	EPH (not PAH Corrected)	VOC ☐ VPH ☐	L/HEPH (PAH Corrected)	PAH	PHENOLS Chlorinated ☐ Non-Chlor ☐	PCB ☐ GLYCOLS ☐ HAA ☐	METALS - WATER TOTAL (ICPMS - LOW Pkg.)	METALS - WATER DISSOLVED (ICPMS - LOW Pkg.)	Metals - SOIL (SALM) ☐ Inc. pH ☐	pH ☐ EC ☐ Alk ☑	TSS ☐ TDS ☐	BOD ☐ COD ☐	FECAL COLIFORMS ☑ HPC ☐	TOTAL COLIFORMS ☑ E-COL ☑	PESTICIDES ☐ HERBICIDES ☐	SOIL VAPOUR	ASBESTOS	NITRATE-N						HOLD
	SA-1	☐	☑	☐	☐	6	26-Nov-14	15:30	☐	☐	☐	See below	☐	☐	☐	☐	☐	☐	☐	☑	☑	☐	☑	☐	☐	☑	☑	☐	☐	☑							☐
	SA-2	☐	☑	☐	☐	6	26-Nov-14	16:05	☐	☐	☐	See below	☐	☐	☐	☐	☐	☐	☐	☑	☑	☐	☑	☐	☐	☑	☑	☐	☐	☑							☐
	K-1	☐	☑	☐	☐	6	26-Nov-14	17:00	☐	☐	☐	See below	☐	☐	☐	☐	☐	☐	☐	☑	☑	☐	☑	☐	☐	☑	☑	☐	☐	☑							☐
	K-2	☐	☑	☐	☐	6	26-Nov-14	16:40	☐	☐	☐	See below	☐	☐	☐	☐	☐	☐	☐	☑	☑	☐	☑	☐	☐	☑	☑	☐	☐	☑							☐
	Field Blank	☐	☐	☐	☐	1	26-Nov-14	15:30	☐	☐	☐		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐							☐
	Trip Blank	☐	☐	☐	☐	1	26-Nov-14	14:15	☐	☐	☐		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐							☑
		☐	☐	☐	☐				☐	☐	☐		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐							☐
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APPLICABLE REGULATORY LIMITS:
Canadian Drinking Water Quality Guidelines ☐
BC Drinking Water Protection Act/Reg. ☐
BC CSR: AL ☐ RL ☐ CL ☐ IL ☐ AW ☐
CCME ☑ Alberta Tier 1 ☐
OTHER: BC WQ Guidelines for Aquatic Life

SAMPLE RETENTION INSTRUCTIONS (Discarded 30 days after Report unless otherwise specified):
60 Days ☐ 90 Days ☐ Longer Date (Surcharges will apply):

OTHER INSTRUCTIONS:
Total metals, mercury, and bacteriological samples have been preserved. Dissolved metals samples have NOT been filtered or preserved - lab to do upon submission. Metals analysis should be LOW level ICPMS pkg. Add total + dissolved Hg. Alkalinity = TOTAL alkalinity. Use higher dilutions for bacteriological tests

PAYMENT: Cheque ☐ Credit ☐ Debit ☐ Cash ☐ Invoice ☐

SAMPLE RECEIPT TEMP (°C): 1.8
Work Order #:
CUSTODY SEALS INTACT: ☐Y ☐N ☐NA

Required Fields Recommended Fields SHADED AREAS: LAB USE ONLY

CARO ANALYTICAL SERVICES

CERTIFICATE OF ANALYSIS

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby) 200 - 4185A Still Creek Dr Burnaby, BC V5C 6G9	**TEL** **FAX**	(604) 294-2088 (604) 294-2090
ATTENTION	Patrick Lilley	**WORK ORDER**	4120402
PO NUMBER		**RECEIVED / TEMP**	Dec-05-14 13:32 / 3°C
PROJECT	173.169 Maple Ridge WQ	**REPORTED**	Dec-12-14
PROJECT INFO	Stormwater Monitoring	**COC NUMBER**	No#

General Comments:

CARO Analytical Services employs methods which are conducted according to procedures accepted by appropriate regulatory agencies, and/or are conducted in accordance with recognized professional standards using accepted testing methodologies and quality control efforts, except where otherwise agreed to by the client.

The results in this report apply to the samples analyzed in accordance with the Chain of Custody or Sample Requisition document. This analytical report must be reproduced in its entirety. CARO is not responsible for any loss or damage resulting directly or indirectly from error or omission in the conduct of testing. Liability is limited to the cost of analysis. Samples will be disposed of 30 days after the test report has been issued unless otherwise agreed to in writing.

Issued By: **Karin Miyazaki For Jennifer Shanko, AScT**
Administration Coordinator

Please contact CARO if more information is needed or to provide feedback on our services.

Locations:

#110 4011 Viking Way
Richmond, BC V6V 2K9
Tel: 604-279-1499 Fax: 604-279-1599

#102 3677 Highway 97N
Kelowna, BC V1X 5C3
Tel: 250-765-9646 Fax: 250-765-3893

17225 109 Avenue
Edmonton, AB T5S 1H7
Tel: 780-489-9100 Fax: 780-489-9700

www.caro.ca

CARO ANALYTICAL SERVICES

ANALYSIS INFORMATION

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4120402
REPORTED Dec-12-14

Analysis Description	Method Reference	Technique	Location
Alkalinity (Speciated)	APHA 2320 B	Titration with H2SO4 to pH 4.5	Kelowna
Anions in Water by IC	APHA 4110 B	Ion Chromatography with Chemical Suppression of Eluent Conductivity	Kelowna
Dissolved Metals	APHA 3030 B / APHA 3125 B	0.45 µm Filtration / Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	Richmond
E. coli (MF)	APHA 9223 B	Enzyme Substrate	Sublet
Fecal Coliforms (MF)	APHA 9222	Membrane Filtration	Sublet
Hardness (as CaCO3)	APHA 2340 B	Calculation	N/A
Total Coliforms (MF)	APHA 9222	Membrane Filtration	Sublet
Total Recoverable Metals	APHA 3030E * / APHA 3125 B	HNO3+HCl Hot Block Digestion / Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	Richmond

Note: An asterisk in the Method Reference indicates that the CARO method has been modified from the reference method

Method Reference Descriptions:

APHA	Standard Methods for the Examination of Water and Wastewater, 22nd Edition, American Public Health Association/American Water Works Association/Water Environment Federation

Glossary of Terms:

MRL	Method Reporting Limit
<	Less than the Reported Detection Limit (RDL) - the RDL may be higher than the MRL due to various factors such as dilutions, limited sample volume, high moisture, or interferences
CFU/100 mL	Colony Forming Units per 100 millilitres
mg/L	Milligrams per litre

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4120402
REPORTED Dec-12-14

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SA-1 (T2 Creek) (4120402-01) [Water] Sampled: Dec-05-14 10:15							
Anions							
Nitrate as N	**1.08**	N/A	0.010	mg/L	N/A	Dec-09-14	HT
General Parameters							
Alkalinity, Total as CaCO3	**44**	N/A	1	mg/L	N/A	Dec-10-14	
Alkalinity, Phenolphthalein as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-10-14	
Alkalinity, Bicarbonate as CaCO3	**44**	N/A	1	mg/L	N/A	Dec-10-14	
Alkalinity, Carbonate as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-10-14	
Alkalinity, Hydroxide as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-10-14	
Calculated Parameters							
Hardness, Total (Total as CaCO3)	**50.5**	N/A	0.50	mg/L	N/A	N/A	
Hardness, Total (Diss. as CaCO3)	**45.4**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.010**	N/A	0.005	mg/L	N/A	Dec-09-14	
Antimony, dissolved	**0.0003**	N/A	0.0001	mg/L	N/A	Dec-09-14	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-09-14	
Barium, dissolved	**0.013**	N/A	0.005	mg/L	N/A	Dec-09-14	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-09-14	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-09-14	
Boron, dissolved	**0.015**	N/A	0.004	mg/L	N/A	Dec-09-14	
Cadmium, dissolved	**0.00003**	N/A	0.00001	mg/L	N/A	Dec-09-14	
Calcium, dissolved	**10.7**	N/A	0.2	mg/L	N/A	Dec-09-14	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-09-14	
Cobalt, dissolved	**0.00007**	N/A	0.00005	mg/L	N/A	Dec-09-14	
Copper, dissolved	**0.0018**	N/A	0.0002	mg/L	N/A	Dec-09-14	
Iron, dissolved	**0.056**	N/A	0.010	mg/L	N/A	Dec-09-14	
Lead, dissolved	**0.0001**	N/A	0.0001	mg/L	N/A	Dec-09-14	
Lithium, dissolved	**0.0007**	N/A	0.0001	mg/L	N/A	Dec-09-14	
Magnesium, dissolved	**4.55**	N/A	0.01	mg/L	N/A	Dec-09-14	
Manganese, dissolved	**0.0238**	N/A	0.0002	mg/L	N/A	Dec-09-14	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Dec-09-14	
Molybdenum, dissolved	**0.0005**	N/A	0.0001	mg/L	N/A	Dec-09-14	
Nickel, dissolved	**0.0005**	N/A	0.0002	mg/L	N/A	Dec-09-14	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	Dec-09-14	
Potassium, dissolved	**1.75**	N/A	0.02	mg/L	N/A	Dec-09-14	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-09-14	
Silicon, dissolved	**6.9**	N/A	0.5	mg/L	N/A	Dec-09-14	
Silver, dissolved	**0.00061**	N/A	0.00005	mg/L	N/A	Dec-09-14	
Sodium, dissolved	**17.6**	N/A	0.02	mg/L	N/A	Dec-09-14	
Strontium, dissolved	**0.082**	N/A	0.001	mg/L	N/A	Dec-09-14	
Sulfur, dissolved	**2**	N/A	1	mg/L	N/A	Dec-09-14	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Dec-09-14	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Dec-09-14	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-09-14	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Dec-09-14	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	Dec-09-14	

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4120402
REPORTED Dec-12-14

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SA-1 (T2 Creek) (4120402-01) [Water] Sampled: Dec-05-14 10:15, Continued							
Dissolved Metals, Continued							
Uranium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Dec-09-14	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	Dec-09-14	
Zinc, dissolved	**0.008**	N/A	0.004	mg/L	N/A	Dec-09-14	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-09-14	
Total Recoverable Metals							
Aluminum, total	**0.164**	N/A	0.005	mg/L	Dec-08-14	Dec-09-14	
Antimony, total	**0.0004**	N/A	0.0001	mg/L	Dec-08-14	Dec-09-14	
Arsenic, total	< 0.0005	N/A	0.0005	mg/L	Dec-08-14	Dec-09-14	
Barium, total	**0.015**	N/A	0.005	mg/L	Dec-08-14	Dec-09-14	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	Dec-08-14	Dec-09-14	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	Dec-08-14	Dec-09-14	
Boron, total	**0.018**	N/A	0.004	mg/L	Dec-08-14	Dec-09-14	
Cadmium, total	**0.00001**	N/A	0.00001	mg/L	Dec-08-14	Dec-09-14	
Calcium, total	**12.2**	N/A	0.2	mg/L	Dec-08-14	Dec-09-14	
Chromium, total	< 0.0005	N/A	0.0005	mg/L	Dec-08-14	Dec-09-14	
Cobalt, total	**0.00013**	N/A	0.00005	mg/L	Dec-08-14	Dec-09-14	
Copper, total	**0.0024**	N/A	0.0002	mg/L	Dec-08-14	Dec-09-14	
Iron, total	**0.24**	N/A	0.01	mg/L	Dec-08-14	Dec-09-14	
Lead, total	**0.0003**	N/A	0.0001	mg/L	Dec-08-14	Dec-09-14	
Lithium, total	**0.0009**	N/A	0.0001	mg/L	Dec-08-14	Dec-09-14	
Magnesium, total	**4.85**	N/A	0.01	mg/L	Dec-08-14	Dec-09-14	
Manganese, total	**0.0278**	N/A	0.0002	mg/L	Dec-08-14	Dec-09-14	
Mercury, total	**0.00003**	N/A	0.00002	mg/L	Dec-08-14	Dec-09-14	
Molybdenum, total	**0.0005**	N/A	0.0001	mg/L	Dec-08-14	Dec-09-14	
Nickel, total	**0.0007**	N/A	0.0002	mg/L	Dec-08-14	Dec-09-14	
Phosphorus, total	**0.031**	N/A	0.020	mg/L	Dec-08-14	Dec-09-14	
Potassium, total	**1.87**	N/A	0.02	mg/L	Dec-08-14	Dec-09-14	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	Dec-08-14	Dec-09-14	
Silicon, total	**7.5**	N/A	0.5	mg/L	Dec-08-14	Dec-09-14	
Silver, total	**0.00172**	N/A	0.00005	mg/L	Dec-08-14	Dec-09-14	
Sodium, total	**18.5**	N/A	0.02	mg/L	Dec-08-14	Dec-09-14	
Strontium, total	**0.087**	N/A	0.001	mg/L	Dec-08-14	Dec-09-14	
Sulfur, total	**3**	N/A	1	mg/L	Dec-08-14	Dec-09-14	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	Dec-08-14	Dec-09-14	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	Dec-08-14	Dec-09-14	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	Dec-08-14	Dec-09-14	
Tin, total	< 0.0002	N/A	0.0002	mg/L	Dec-08-14	Dec-09-14	
Titanium, total	**0.009**	N/A	0.005	mg/L	Dec-08-14	Dec-09-14	
Uranium, total	**0.00002**	N/A	0.00002	mg/L	Dec-08-14	Dec-09-14	
Vanadium, total	< 0.001	N/A	0.001	mg/L	Dec-08-14	Dec-09-14	
Zinc, total	**0.012**	N/A	0.004	mg/L	Dec-08-14	Dec-09-14	
Zirconium, total	**0.0002**	N/A	0.0001	mg/L	Dec-08-14	Dec-09-14	
Microbiological Parameters							
Coliforms, Fecal	**800**	N/A	1	CFU/100 mL	N/A	Dec-05-14	

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4120402
REPORTED Dec-12-14

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SA-1 (T2 Creek) (4120402-01) [Water] Sampled: Dec-05-14 10:15, Continued							
Microbiological Parameters, Continued							
Coliforms, Total	**850**	N/A	1	CFU/100 mL	N/A	Dec-05-14	
E. coli	**850**	N/A	1	CFU/100 mL	N/A	Dec-05-14	
Sample ID: SA-2 (Millionaire Creek) (4120402-02) [Water] Sampled: Dec-05-14 10:55							
Anions							
Nitrate as N	**0.285**	N/A	0.010	mg/L	N/A	Dec-10-14	HT
General Parameters							
Alkalinity, Total as CaCO3	**10**	N/A	1	mg/L	N/A	Dec-10-14	
Alkalinity, Phenolphthalein as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-10-14	
Alkalinity, Bicarbonate as CaCO3	**10**	N/A	1	mg/L	N/A	Dec-10-14	
Alkalinity, Carbonate as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-10-14	
Alkalinity, Hydroxide as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-10-14	
Calculated Parameters							
Hardness, Total (Total as CaCO3)	**10.6**	N/A	0.50	mg/L	N/A	N/A	
Hardness, Total (Diss. as CaCO3)	**10.1**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.026**	N/A	0.005	mg/L	N/A	Dec-09-14	
Antimony, dissolved	**0.0001**	N/A	0.0001	mg/L	N/A	Dec-09-14	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-09-14	
Barium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	Dec-09-14	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-09-14	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-09-14	
Boron, dissolved	< 0.004	N/A	0.004	mg/L	N/A	Dec-09-14	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	Dec-09-14	
Calcium, dissolved	**3.0**	N/A	0.2	mg/L	N/A	Dec-09-14	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-09-14	
Cobalt, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	Dec-09-14	
Copper, dissolved	**0.0003**	N/A	0.0002	mg/L	N/A	Dec-09-14	
Iron, dissolved	**0.031**	N/A	0.010	mg/L	N/A	Dec-09-14	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-09-14	
Lithium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-09-14	
Magnesium, dissolved	**0.65**	N/A	0.01	mg/L	N/A	Dec-09-14	
Manganese, dissolved	**0.0023**	N/A	0.0002	mg/L	N/A	Dec-09-14	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Dec-09-14	
Molybdenum, dissolved	**0.0003**	N/A	0.0001	mg/L	N/A	Dec-09-14	
Nickel, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Dec-09-14	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	Dec-09-14	
Potassium, dissolved	**0.22**	N/A	0.02	mg/L	N/A	Dec-09-14	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-09-14	
Silicon, dissolved	**3.4**	N/A	0.5	mg/L	N/A	Dec-09-14	
Silver, dissolved	**0.00024**	N/A	0.00005	mg/L	N/A	Dec-09-14	
Sodium, dissolved	**2.94**	N/A	0.02	mg/L	N/A	Dec-09-14	
Strontium, dissolved	**0.025**	N/A	0.001	mg/L	N/A	Dec-09-14	

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4120402
REPORTED Dec-12-14

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SA-2 (Millionaire Creek) (4120402-02) [Water] Sampled: Dec-05-14 10:55, Continued							
Dissolved Metals, Continued							
Sulfur, dissolved	< 1	N/A	1	mg/L	N/A	Dec-09-14	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Dec-09-14	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Dec-09-14	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-09-14	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Dec-09-14	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	Dec-09-14	
Uranium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Dec-09-14	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	Dec-09-14	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	Dec-09-14	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-09-14	
Total Recoverable Metals							
Aluminum, total	**0.082**	N/A	0.005	mg/L	Dec-08-14	Dec-09-14	
Antimony, total	**0.0001**	N/A	0.0001	mg/L	Dec-08-14	Dec-09-14	
Arsenic, total	< 0.0005	N/A	0.0005	mg/L	Dec-08-14	Dec-09-14	
Barium, total	< 0.005	N/A	0.005	mg/L	Dec-08-14	Dec-09-14	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	Dec-08-14	Dec-09-14	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	Dec-08-14	Dec-09-14	
Boron, total	**0.004**	N/A	0.004	mg/L	Dec-08-14	Dec-09-14	
Cadmium, total	< 0.00001	N/A	0.00001	mg/L	Dec-08-14	Dec-09-14	
Calcium, total	**3.2**	N/A	0.2	mg/L	Dec-08-14	Dec-09-14	
Chromium, total	< 0.0005	N/A	0.0005	mg/L	Dec-08-14	Dec-09-14	
Cobalt, total	< 0.00005	N/A	0.00005	mg/L	Dec-08-14	Dec-09-14	
Copper, total	**0.0004**	N/A	0.0002	mg/L	Dec-08-14	Dec-09-14	
Iron, total	**0.09**	N/A	0.01	mg/L	Dec-08-14	Dec-09-14	
Lead, total	< 0.0001	N/A	0.0001	mg/L	Dec-08-14	Dec-09-14	
Lithium, total	**0.0001**	N/A	0.0001	mg/L	Dec-08-14	Dec-09-14	
Magnesium, total	**0.66**	N/A	0.01	mg/L	Dec-08-14	Dec-09-14	
Manganese, total	**0.0037**	N/A	0.0002	mg/L	Dec-08-14	Dec-09-14	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	Dec-08-14	Dec-09-14	
Molybdenum, total	**0.0003**	N/A	0.0001	mg/L	Dec-08-14	Dec-09-14	
Nickel, total	< 0.0002	N/A	0.0002	mg/L	Dec-08-14	Dec-09-14	
Phosphorus, total	< 0.020	N/A	0.020	mg/L	Dec-08-14	Dec-09-14	
Potassium, total	**0.22**	N/A	0.02	mg/L	Dec-08-14	Dec-09-14	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	Dec-08-14	Dec-09-14	
Silicon, total	**3.4**	N/A	0.5	mg/L	Dec-08-14	Dec-09-14	
Silver, total	**0.00164**	N/A	0.00005	mg/L	Dec-08-14	Dec-09-14	
Sodium, total	**2.94**	N/A	0.02	mg/L	Dec-08-14	Dec-09-14	
Strontium, total	**0.024**	N/A	0.001	mg/L	Dec-08-14	Dec-09-14	
Sulfur, total	< 1	N/A	1	mg/L	Dec-08-14	Dec-09-14	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	Dec-08-14	Dec-09-14	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	Dec-08-14	Dec-09-14	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	Dec-08-14	Dec-09-14	
Tin, total	< 0.0002	N/A	0.0002	mg/L	Dec-08-14	Dec-09-14	
Titanium, total	< 0.005	N/A	0.005	mg/L	Dec-08-14	Dec-09-14	
Uranium, total	< 0.00002	N/A	0.00002	mg/L	Dec-08-14	Dec-09-14	

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4120402
REPORTED Dec-12-14

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SA-2 (Millionaire Creek) (4120402-02) [Water] Sampled: Dec-05-14 10:55, Continued							
Total Recoverable Metals, Continued							
Vanadium, total	< 0.001	N/A	0.001	mg/L	Dec-08-14	Dec-09-14	
Zinc, total	< 0.004	N/A	0.004	mg/L	Dec-08-14	Dec-09-14	
Zirconium, total	**0.0001**	N/A	0.0001	mg/L	Dec-08-14	Dec-09-14	
Microbiological Parameters							
Coliforms, Fecal	**4**	N/A	1	CFU/100 mL	N/A	Dec-05-14	
Coliforms, Total	**35**	N/A	1	CFU/100 mL	N/A	Dec-05-14	
E. coli	**10**	N/A	1	CFU/100 mL	N/A	Dec-05-14	
Sample ID: K-1 (Dunlop Creek) (4120402-03) [Water] Sampled: Dec-05-14 12:05							
Anions							
Nitrate as N	**0.712**	N/A	0.010	mg/L	N/A	Dec-10-14	HT
General Parameters							
Alkalinity, Total as CaCO3	**25**	N/A	1	mg/L	N/A	Dec-10-14	
Alkalinity, Phenolphthalein as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-10-14	
Alkalinity, Bicarbonate as CaCO3	**25**	N/A	1	mg/L	N/A	Dec-10-14	
Alkalinity, Carbonate as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-10-14	
Alkalinity, Hydroxide as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-10-14	
Calculated Parameters							
Hardness, Total (Total as CaCO3)	**29.8**	N/A	0.50	mg/L	N/A	N/A	
Hardness, Total (Diss. as CaCO3)	**26.4**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.039**	N/A	0.005	mg/L	N/A	Dec-09-14	
Antimony, dissolved	**0.0002**	N/A	0.0001	mg/L	N/A	Dec-09-14	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-09-14	
Barium, dissolved	**0.008**	N/A	0.005	mg/L	N/A	Dec-09-14	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-09-14	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-09-14	
Boron, dissolved	**0.010**	N/A	0.004	mg/L	N/A	Dec-09-14	
Cadmium, dissolved	**0.00001**	N/A	0.00001	mg/L	N/A	Dec-09-14	
Calcium, dissolved	**6.7**	N/A	0.2	mg/L	N/A	Dec-09-14	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-09-14	
Cobalt, dissolved	**0.00010**	N/A	0.00005	mg/L	N/A	Dec-09-14	
Copper, dissolved	**0.0013**	N/A	0.0002	mg/L	N/A	Dec-09-14	
Iron, dissolved	**0.101**	N/A	0.010	mg/L	N/A	Dec-09-14	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-09-14	
Lithium, dissolved	**0.0001**	N/A	0.0001	mg/L	N/A	Dec-09-14	
Magnesium, dissolved	**2.32**	N/A	0.01	mg/L	N/A	Dec-09-14	
Manganese, dissolved	**0.0137**	N/A	0.0002	mg/L	N/A	Dec-09-14	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Dec-09-14	
Molybdenum, dissolved	**0.0002**	N/A	0.0001	mg/L	N/A	Dec-09-14	
Nickel, dissolved	**0.0004**	N/A	0.0002	mg/L	N/A	Dec-09-14	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	Dec-09-14	

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4120402
REPORTED Dec-12-14

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: K-1 (Dunlop Creek) (4120402-03) [Water] Sampled: Dec-05-14 12:05, Continued							
Dissolved Metals, Continued							
Potassium, dissolved	**1.43**	N/A	0.02	mg/L	N/A	Dec-09-14	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-09-14	
Silicon, dissolved	**4.0**	N/A	0.5	mg/L	N/A	Dec-09-14	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	Dec-09-14	
Sodium, dissolved	**6.50**	N/A	0.02	mg/L	N/A	Dec-09-14	
Strontium, dissolved	**0.053**	N/A	0.001	mg/L	N/A	Dec-09-14	
Sulfur, dissolved	< 1	N/A	1	mg/L	N/A	Dec-09-14	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Dec-09-14	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Dec-09-14	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-09-14	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Dec-09-14	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	Dec-09-14	
Uranium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Dec-09-14	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	Dec-09-14	
Zinc, dissolved	**0.004**	N/A	0.004	mg/L	N/A	Dec-09-14	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-09-14	
Total Recoverable Metals							
Aluminum, total	**0.486**	N/A	0.005	mg/L	Dec-08-14	Dec-09-14	
Antimony, total	**0.0003**	N/A	0.0001	mg/L	Dec-08-14	Dec-09-14	
Arsenic, total	< 0.0005	N/A	0.0005	mg/L	Dec-08-14	Dec-09-14	
Barium, total	**0.012**	N/A	0.005	mg/L	Dec-08-14	Dec-09-14	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	Dec-08-14	Dec-09-14	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	Dec-08-14	Dec-09-14	
Boron, total	**0.012**	N/A	0.004	mg/L	Dec-08-14	Dec-09-14	
Cadmium, total	**0.00001**	N/A	0.00001	mg/L	Dec-08-14	Dec-09-14	
Calcium, total	**7.6**	N/A	0.2	mg/L	Dec-08-14	Dec-09-14	
Chromium, total	**0.0006**	N/A	0.0005	mg/L	Dec-08-14	Dec-09-14	
Cobalt, total	**0.00025**	N/A	0.00005	mg/L	Dec-08-14	Dec-09-14	
Copper, total	**0.0019**	N/A	0.0002	mg/L	Dec-08-14	Dec-09-14	
Iron, total	**0.50**	N/A	0.01	mg/L	Dec-08-14	Dec-09-14	
Lead, total	**0.0002**	N/A	0.0001	mg/L	Dec-08-14	Dec-09-14	
Lithium, total	**0.0004**	N/A	0.0001	mg/L	Dec-08-14	Dec-09-14	
Magnesium, total	**2.59**	N/A	0.01	mg/L	Dec-08-14	Dec-09-14	
Manganese, total	**0.0213**	N/A	0.0002	mg/L	Dec-08-14	Dec-09-14	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	Dec-08-14	Dec-09-14	
Molybdenum, total	**0.0002**	N/A	0.0001	mg/L	Dec-08-14	Dec-09-14	
Nickel, total	**0.0008**	N/A	0.0002	mg/L	Dec-08-14	Dec-09-14	
Phosphorus, total	**0.044**	N/A	0.020	mg/L	Dec-08-14	Dec-09-14	
Potassium, total	**1.61**	N/A	0.02	mg/L	Dec-08-14	Dec-09-14	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	Dec-08-14	Dec-09-14	
Silicon, total	**5.0**	N/A	0.5	mg/L	Dec-08-14	Dec-09-14	
Silver, total	**0.00145**	N/A	0.00005	mg/L	Dec-08-14	Dec-09-14	
Sodium, total	**7.00**	N/A	0.02	mg/L	Dec-08-14	Dec-09-14	
Strontium, total	**0.057**	N/A	0.001	mg/L	Dec-08-14	Dec-09-14	
Sulfur, total	**1**	N/A	1	mg/L	Dec-08-14	Dec-09-14	

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4120402
REPORTED Dec-12-14

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: K-1 (Dunlop Creek) (4120402-03) [Water] Sampled: Dec-05-14 12:05, Continued							
Total Recoverable Metals, Continued							
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	Dec-08-14	Dec-09-14	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	Dec-08-14	Dec-09-14	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	Dec-08-14	Dec-09-14	
Tin, total	< 0.0002	N/A	0.0002	mg/L	Dec-08-14	Dec-09-14	
Titanium, total	**0.020**	N/A	0.005	mg/L	Dec-08-14	Dec-09-14	
Uranium, total	< 0.00002	N/A	0.00002	mg/L	Dec-08-14	Dec-09-14	
Vanadium, total	**0.002**	N/A	0.001	mg/L	Dec-08-14	Dec-09-14	
Zinc, total	**0.005**	N/A	0.004	mg/L	Dec-08-14	Dec-09-14	
Zirconium, total	**0.0003**	N/A	0.0001	mg/L	Dec-08-14	Dec-09-14	
Microbiological Parameters							
Coliforms, Fecal	**150**	N/A	1	CFU/100 mL	N/A	Dec-05-14	
Coliforms, Total	**210**	N/A	1	CFU/100 mL	N/A	Dec-05-14	
E. coli	**180**	N/A	1	CFU/100 mL	N/A	Dec-05-14	
Sample ID: K-2 (Spencer Creek) (4120402-04) [Water] Sampled: Dec-05-14 11:35							
Anions							
Nitrate as N	**0.333**	N/A	0.010	mg/L	N/A	Dec-10-14	HT
General Parameters							
Alkalinity, Total as CaCO3	**53**	N/A	1	mg/L	N/A	Dec-10-14	
Alkalinity, Phenolphthalein as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-10-14	
Alkalinity, Bicarbonate as CaCO3	**53**	N/A	1	mg/L	N/A	Dec-10-14	
Alkalinity, Carbonate as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-10-14	
Alkalinity, Hydroxide as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-10-14	
Calculated Parameters							
Hardness, Total (Total as CaCO3)	**58.2**	N/A	0.50	mg/L	N/A	N/A	
Hardness, Total (Diss. as CaCO3)	**56.3**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.035**	N/A	0.005	mg/L	N/A	Dec-09-14	
Antimony, dissolved	**0.0002**	N/A	0.0001	mg/L	N/A	Dec-09-14	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-09-14	
Barium, dissolved	**0.009**	N/A	0.005	mg/L	N/A	Dec-09-14	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-09-14	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-09-14	
Boron, dissolved	**0.010**	N/A	0.004	mg/L	N/A	Dec-09-14	
Cadmium, dissolved	**0.00001**	N/A	0.00001	mg/L	N/A	Dec-09-14	
Calcium, dissolved	**15.6**	N/A	0.2	mg/L	N/A	Dec-09-14	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-09-14	
Cobalt, dissolved	**0.00015**	N/A	0.00005	mg/L	N/A	Dec-09-14	
Copper, dissolved	**0.0016**	N/A	0.0002	mg/L	N/A	Dec-09-14	
Iron, dissolved	**0.142**	N/A	0.010	mg/L	N/A	Dec-09-14	
Lead, dissolved	**0.0001**	N/A	0.0001	mg/L	N/A	Dec-09-14	
Lithium, dissolved	**0.0003**	N/A	0.0001	mg/L	N/A	Dec-09-14	

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4120402
REPORTED Dec-12-14

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: K-2 (Spencer Creek) (4120402-04) [Water] Sampled: Dec-05-14 11:35, Continued							
Dissolved Metals, Continued							
Magnesium, dissolved	**4.21**	N/A	0.01	mg/L	N/A	Dec-09-14	
Manganese, dissolved	**0.0412**	N/A	0.0002	mg/L	N/A	Dec-09-14	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Dec-09-14	
Molybdenum, dissolved	**0.0004**	N/A	0.0001	mg/L	N/A	Dec-09-14	
Nickel, dissolved	**0.0006**	N/A	0.0002	mg/L	N/A	Dec-09-14	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	Dec-09-14	
Potassium, dissolved	**1.52**	N/A	0.02	mg/L	N/A	Dec-09-14	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-09-14	
Silicon, dissolved	**5.2**	N/A	0.5	mg/L	N/A	Dec-09-14	
Silver, dissolved	**0.00009**	N/A	0.00005	mg/L	N/A	Dec-09-14	
Sodium, dissolved	**19.0**	N/A	0.02	mg/L	N/A	Dec-09-14	
Strontium, dissolved	**0.109**	N/A	0.001	mg/L	N/A	Dec-09-14	
Sulfur, dissolved	**2**	N/A	1	mg/L	N/A	Dec-09-14	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Dec-09-14	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Dec-09-14	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-09-14	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Dec-09-14	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	Dec-09-14	
Uranium, dissolved	**0.00003**	N/A	0.00002	mg/L	N/A	Dec-09-14	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	Dec-09-14	
Zinc, dissolved	**0.008**	N/A	0.004	mg/L	N/A	Dec-09-14	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-09-14	
Total Recoverable Metals							
Aluminum, total	**1.12**	N/A	0.005	mg/L	Dec-08-14	Dec-09-14	
Antimony, total	**0.0002**	N/A	0.0001	mg/L	Dec-08-14	Dec-09-14	
Arsenic, total	**0.0006**	N/A	0.0005	mg/L	Dec-08-14	Dec-09-14	
Barium, total	**0.017**	N/A	0.005	mg/L	Dec-08-14	Dec-09-14	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	Dec-08-14	Dec-09-14	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	Dec-08-14	Dec-09-14	
Boron, total	**0.012**	N/A	0.004	mg/L	Dec-08-14	Dec-09-14	
Cadmium, total	**0.00001**	N/A	0.00001	mg/L	Dec-08-14	Dec-09-14	
Calcium, total	**15.7**	N/A	0.2	mg/L	Dec-08-14	Dec-09-14	
Chromium, total	**0.0012**	N/A	0.0005	mg/L	Dec-08-14	Dec-09-14	
Cobalt, total	**0.00046**	N/A	0.00005	mg/L	Dec-08-14	Dec-09-14	
Copper, total	**0.0028**	N/A	0.0002	mg/L	Dec-08-14	Dec-09-14	
Iron, total	**1.01**	N/A	0.01	mg/L	Dec-08-14	Dec-09-14	
Lead, total	**0.0004**	N/A	0.0001	mg/L	Dec-08-14	Dec-09-14	
Lithium, total	**0.0009**	N/A	0.0001	mg/L	Dec-08-14	Dec-09-14	
Magnesium, total	**4.58**	N/A	0.01	mg/L	Dec-08-14	Dec-09-14	
Manganese, total	**0.0548**	N/A	0.0002	mg/L	Dec-08-14	Dec-09-14	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	Dec-08-14	Dec-09-14	
Molybdenum, total	**0.0004**	N/A	0.0001	mg/L	Dec-08-14	Dec-09-14	
Nickel, total	**0.0016**	N/A	0.0002	mg/L	Dec-08-14	Dec-09-14	
Phosphorus, total	**0.028**	N/A	0.020	mg/L	Dec-08-14	Dec-09-14	
Potassium, total	**1.69**	N/A	0.02	mg/L	Dec-08-14	Dec-09-14	

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4120402
REPORTED Dec-12-14

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: K-2 (Spencer Creek) (4120402-04) [Water] Sampled: Dec-05-14 11:35, Continued							
Total Recoverable Metals, Continued							
Selenium, total	< 0.0005	N/A	0.0005	mg/L	Dec-08-14	Dec-09-14	
Silicon, total	**7.3**	N/A	0.5	mg/L	Dec-08-14	Dec-09-14	
Silver, total	**0.00092**	N/A	0.00005	mg/L	Dec-08-14	Dec-09-14	
Sodium, total	**19.5**	N/A	0.02	mg/L	Dec-08-14	Dec-09-14	
Strontium, total	**0.115**	N/A	0.001	mg/L	Dec-08-14	Dec-09-14	
Sulfur, total	**3**	N/A	1	mg/L	Dec-08-14	Dec-09-14	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	Dec-08-14	Dec-09-14	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	Dec-08-14	Dec-09-14	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	Dec-08-14	Dec-09-14	
Tin, total	< 0.0002	N/A	0.0002	mg/L	Dec-08-14	Dec-09-14	
Titanium, total	**0.057**	N/A	0.005	mg/L	Dec-08-14	Dec-09-14	
Uranium, total	**0.00005**	N/A	0.00002	mg/L	Dec-08-14	Dec-09-14	
Vanadium, total	**0.003**	N/A	0.001	mg/L	Dec-08-14	Dec-09-14	
Zinc, total	**0.010**	N/A	0.004	mg/L	Dec-08-14	Dec-09-14	
Zirconium, total	**0.0007**	N/A	0.0001	mg/L	Dec-08-14	Dec-09-14	
Microbiological Parameters							
Coliforms, Fecal	**400**	N/A	1	CFU/100 mL	N/A	Dec-05-14	
Coliforms, Total	**460**	N/A	1	CFU/100 mL	N/A	Dec-05-14	
E. coli	**400**	N/A	1	CFU/100 mL	N/A	Dec-05-14	
Sample ID: Field Blank (4120402-05) [Water] Sampled: Dec-05-14 10:55							
Anions							
Nitrate as N	< 0.010	N/A	0.010	mg/L	N/A	Dec-10-14	HT

Sample / Analysis Qualifiers:

HT The sample was prepared / analyzed past the recommended holding time.

CARO ANALYTICAL SERVICES

QUALITY CONTROL DATA

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	4120402
PROJECT	173.169 Maple Ridge WQ	**REPORTED**	Dec-12-14

The following section displays the quality control (QC) data that is associated with your sample data. Groups of samples are prepared in "batches" and analyzed in conjunction with QC samples that ensure your data is of the highest quality. Common QC types include:

- **Method Blank (Blk)**: Laboratory reagent water is carried through sample preparation and analysis steps. Method Blanks indicate that results are free from contamination, i.e. not biased high from sources such as the sample container or the laboratory environment
- **Duplicate (Dup)**: Preparation and analysis of a replicate aliquot of a sample. Duplicates provide a measure of the analytical method's precision, i.e. how reproducible a result is. Duplicates are only reported if they are associated with your sample data.
- **Blank Spike (BS)**: A known amount of standard is carried through sample preparation and analysis steps. Blank Spikes, also known as laboratory control samples (LCS), are prepared from a different source of standard than used for the calibration. They ensure that the calibration is acceptable (i.e. not biased high or low) and also provide a measure of the analytical method's accuracy (i.e. closeness of the result to a target value).
- **Standard Reference Material (SRM)**: A material of similar matrix to the samples, externally certified for the parameter(s) listed. Standard Reference Materials ensure that the preparation steps in the method are adequate to achieve acceptable recoveries of the parameter(s) tested.

Each QC type is analyzed at a 5-10% frequency, i.e. one blank/duplicate/spike for every 10 samples. For all types of QC, the specified recovery (% Rec) and relative percent difference (RPD) limits are derived from long-term method performance averages and/or prescribed by the reference method.

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	RPD	RPD Limit	Notes
Anions, Batch B4L0467										
Blank (B4L0467-BLK1)				Prepared: Dec-09-14, Analyzed: Dec-09-14						
Nitrate as N	< 0.010	0.010	mg/L							
LCS (B4L0467-BS1)				Prepared: Dec-09-14, Analyzed: Dec-09-14						
Nitrate as N	3.82	0.010	mg/L	4.00		95	85-115			
Duplicate (B4L0467-DUP1)		**Source: 4120402-01**		Prepared: Dec-09-14, Analyzed: Dec-09-14						
Nitrate as N	1.09	0.010	mg/L		1.08			< 1	10	
Dissolved Metals, Batch B4L0359										
Blank (B4L0359-BLK1)				Prepared: Dec-09-14, Analyzed: Dec-09-14						
Aluminum, dissolved	< 0.005	0.005	mg/L							
Antimony, dissolved	< 0.0001	0.0001	mg/L							
Arsenic, dissolved	< 0.0005	0.0005	mg/L							
Barium, dissolved	< 0.005	0.005	mg/L							
Beryllium, dissolved	< 0.0001	0.0001	mg/L							
Bismuth, dissolved	< 0.0001	0.0001	mg/L							
Boron, dissolved	< 0.004	0.004	mg/L							
Cadmium, dissolved	< 0.00001	0.00001	mg/L							
Calcium, dissolved	< 0.2	0.2	mg/L							
Chromium, dissolved	< 0.0005	0.0005	mg/L							
Cobalt, dissolved	< 0.00005	0.00005	mg/L							
Copper, dissolved	< 0.0002	0.0002	mg/L							
Iron, dissolved	< 0.010	0.010	mg/L							
Lead, dissolved	< 0.0001	0.0001	mg/L							
Lithium, dissolved	< 0.0001	0.0001	mg/L							
Magnesium, dissolved	< 0.01	0.01	mg/L							
Manganese, dissolved	< 0.0002	0.0002	mg/L							
Mercury, dissolved	< 0.00002	0.00002	mg/L							
Molybdenum, dissolved	< 0.0001	0.0001	mg/L							
Nickel, dissolved	< 0.0002	0.0002	mg/L							
Phosphorus, dissolved	< 0.02	0.02	mg/L							

CARO ANALYTICAL SERVICES

QUALITY CONTROL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4120402
REPORTED Dec-12-14

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	RPD	RPD Limit	Notes
Dissolved Metals, Batch B4L0359, Continued										
Blank (B4L0359-BLK1), Continued				Prepared: Dec-09-14, Analyzed: Dec-09-14						
Potassium, dissolved	< 0.02	0.02	mg/L							
Selenium, dissolved	< 0.0005	0.0005	mg/L							
Silicon, dissolved	< 0.5	0.5	mg/L							
Silver, dissolved	< 0.00005	0.00005	mg/L							
Sodium, dissolved	< 0.02	0.02	mg/L							
Strontium, dissolved	< 0.001	0.001	mg/L							
Sulfur, dissolved	< 1	1	mg/L							
Tellurium, dissolved	< 0.0002	0.0002	mg/L							
Thallium, dissolved	< 0.00002	0.00002	mg/L							
Thorium, dissolved	< 0.0001	0.0001	mg/L							
Tin, dissolved	< 0.0002	0.0002	mg/L							
Titanium, dissolved	< 0.005	0.005	mg/L							
Uranium, dissolved	< 0.00002	0.00002	mg/L							
Vanadium, dissolved	< 0.001	0.001	mg/L							
Zinc, dissolved	< 0.004	0.004	mg/L							
Zirconium, dissolved	< 0.0001	0.0001	mg/L							
Matrix Spike (B4L0359-MS1)		**Source: 4120402-01**		Prepared: Dec-09-14, Analyzed: Dec-09-14						
Antimony, dissolved	0.403	0.0001	mg/L	0.400	0.0003	101	76-114			
Arsenic, dissolved	0.168	0.0005	mg/L	0.200	< 0.0005	84	81-115			
Barium, dissolved	0.979	0.005	mg/L	1.00	0.013	97	80-113			
Beryllium, dissolved	0.0940	0.0001	mg/L	0.100	< 0.0001	94	69-109			
Cadmium, dissolved	0.0949	0.00001	mg/L	0.100	0.00003	95	83-110			
Chromium, dissolved	0.355	0.0005	mg/L	0.400	< 0.0005	89	85-115			
Cobalt, dissolved	0.364	0.00005	mg/L	0.400	0.00007	91	86-114			
Copper, dissolved	0.377	0.0002	mg/L	0.400	0.0018	94	82-119			
Iron, dissolved	1.86	0.010	mg/L	2.00	0.056	90	80-116			
Lead, dissolved	0.206	0.0001	mg/L	0.200	0.0001	103	83-112			
Manganese, dissolved	0.389	0.0002	mg/L	0.400	0.0238	91	62-131			
Nickel, dissolved	0.371	0.0002	mg/L	0.400	0.0005	93	81-115			
Selenium, dissolved	0.0889	0.0005	mg/L	0.100	< 0.0005	89	79-115			
Silver, dissolved	0.0981	0.00005	mg/L	0.100	0.00061	97	69-121			
Thallium, dissolved	0.102	0.00002	mg/L	0.100	< 0.00002	102	84-115			
Vanadium, dissolved	0.351	0.001	mg/L	0.400	< 0.001	88	83-113			
Zinc, dissolved	0.909	0.004	mg/L	1.00	0.008	90	82-115			
Reference (B4L0359-SRM1)				Prepared: Dec-09-14, Analyzed: Dec-09-14						
Aluminum, dissolved	0.212	0.005	mg/L	0.233		91	58-142			
Antimony, dissolved	0.0468	0.0001	mg/L	0.0430		109	75-125			
Arsenic, dissolved	0.387	0.0005	mg/L	0.438		88	81-119			
Barium, dissolved	3.33	0.005	mg/L	3.35		99	83-117			
Beryllium, dissolved	0.188	0.0001	mg/L	0.213		88	80-120			
Boron, dissolved	1.81	0.004	mg/L	1.74		104	74-117			
Cadmium, dissolved	0.218	0.00001	mg/L	0.224		97	83-117			
Calcium, dissolved	7.1	0.2	mg/L	7.69		92	76-124			
Chromium, dissolved	0.403	0.0005	mg/L	0.437		92	81-119			
Cobalt, dissolved	0.124	0.00005	mg/L	0.128		96	76-124			
Copper, dissolved	0.811	0.0002	mg/L	0.844		96	84-116			
Iron, dissolved	1.21	0.010	mg/L	1.29		94	74-126			
Lead, dissolved	0.108	0.0001	mg/L	0.112		97	72-128			
Lithium, dissolved	0.0967	0.0001	mg/L	0.104		93	60-140			
Magnesium, dissolved	6.45	0.01	mg/L	6.92		93	81-119			
Manganese, dissolved	0.331	0.0002	mg/L	0.345		96	84-116			
Molybdenum, dissolved	0.449	0.0001	mg/L	0.426		105	83-117			
Nickel, dissolved	0.802	0.0002	mg/L	0.840		95	74-126			
Phosphorus, dissolved	0.44	0.02	mg/L	0.495		89	68-132			
Potassium, dissolved	2.92	0.02	mg/L	3.19		92	74-126			

CARO ANALYTICAL SERVICES

QUALITY CONTROL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4120402
REPORTED Dec-12-14

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	RPD	RPD Limit	Notes
Dissolved Metals, Batch B4L0359, Continued										
Reference (B4L0359-SRM1), Continued				Prepared: Dec-09-14, Analyzed: Dec-09-14						
Selenium, dissolved	0.0300	0.0005	mg/L	0.0331		91	70-130			
Sodium, dissolved	17.8	0.02	mg/L	19.1		93	72-128			
Strontium, dissolved	0.874	0.001	mg/L	0.916		95	84-113			
Thallium, dissolved	0.0383	0.00002	mg/L	0.0393		98	57-143			
Uranium, dissolved	0.261	0.00002	mg/L	0.266		98	85-115			
Vanadium, dissolved	0.787	0.001	mg/L	0.869		91	87-113			
Zinc, dissolved	0.822	0.004	mg/L	0.881		93	72-128			
General Parameters, Batch B4L0478										
Blank (B4L0478-BLK1)				Prepared: Dec-10-14, Analyzed: Dec-10-14						
Alkalinity, Total as CaCO3	< 1	1	mg/L							
Alkalinity, Phenolphthalein as CaCO3	< 1	1	mg/L							
Alkalinity, Bicarbonate as CaCO3	< 1	1	mg/L							
Alkalinity, Carbonate as CaCO3	< 1	1	mg/L							
Alkalinity, Hydroxide as CaCO3	< 1	1	mg/L							
Blank (B4L0478-BLK2)				Prepared: Dec-10-14, Analyzed: Dec-10-14						
Alkalinity, Total as CaCO3	< 1	1	mg/L							
Alkalinity, Phenolphthalein as CaCO3	< 1	1	mg/L							
Alkalinity, Bicarbonate as CaCO3	< 1	1	mg/L							
Alkalinity, Carbonate as CaCO3	< 1	1	mg/L							
Alkalinity, Hydroxide as CaCO3	< 1	1	mg/L							
LCS (B4L0478-BS1)				Prepared: Dec-10-14, Analyzed: Dec-10-14						
Alkalinity, Total as CaCO3	104	1	mg/L	100		104	96-108			
LCS (B4L0478-BS2)				Prepared: Dec-10-14, Analyzed: Dec-10-14						
Alkalinity, Total as CaCO3	102	1	mg/L	100		102	96-108			
Total Recoverable Metals, Batch B4L0362										
Blank (B4L0362-BLK1)				Prepared: Dec-08-14, Analyzed: Dec-09-14						
Aluminum, total	< 0.005	0.005	mg/L							
Antimony, total	< 0.0001	0.0001	mg/L							
Arsenic, total	< 0.0005	0.0005	mg/L							
Barium, total	< 0.005	0.005	mg/L							
Beryllium, total	< 0.0001	0.0001	mg/L							
Bismuth, total	< 0.0001	0.0001	mg/L							
Boron, total	< 0.004	0.004	mg/L							
Cadmium, total	< 0.00001	0.00001	mg/L							
Calcium, total	< 0.2	0.2	mg/L							
Chromium, total	< 0.0005	0.0005	mg/L							
Cobalt, total	< 0.00005	0.00005	mg/L							
Copper, total	< 0.0002	0.0002	mg/L							
Iron, total	< 0.01	0.01	mg/L							
Lead, total	< 0.0001	0.0001	mg/L							
Lithium, total	< 0.0001	0.0001	mg/L							
Magnesium, total	< 0.01	0.01	mg/L							
Manganese, total	< 0.0002	0.0002	mg/L							
Mercury, total	< 0.00002	0.00002	mg/L							
Molybdenum, total	< 0.0001	0.0001	mg/L							
Nickel, total	< 0.0002	0.0002	mg/L							
Phosphorus, total	< 0.020	0.020	mg/L							
Potassium, total	< 0.02	0.02	mg/L							
Selenium, total	< 0.0005	0.0005	mg/L							

CARO ANALYTICAL SERVICES

QUALITY CONTROL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4120402
REPORTED Dec-12-14

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	RPD	RPD Limit	Notes
Total Recoverable Metals, Batch B4L0362, Continued										
Blank (B4L0362-BLK1), Continued				Prepared: Dec-08-14, Analyzed: Dec-09-14						
Silicon, total	< 0.5	0.5	mg/L							
Silver, total	< 0.00005	0.00005	mg/L							
Sodium, total	< 0.02	0.02	mg/L							
Strontium, total	< 0.001	0.001	mg/L							
Sulfur, total	< 1	1	mg/L							
Tellurium, total	< 0.0002	0.0002	mg/L							
Thallium, total	< 0.00002	0.00002	mg/L							
Thorium, total	< 0.0001	0.0001	mg/L							
Tin, total	< 0.0002	0.0002	mg/L							
Titanium, total	< 0.005	0.005	mg/L							
Uranium, total	< 0.00002	0.00002	mg/L							
Vanadium, total	< 0.001	0.001	mg/L							
Zinc, total	< 0.004	0.004	mg/L							
Zirconium, total	< 0.0001	0.0001	mg/L							
Matrix Spike (B4L0362-MS1)		**Source: 4120402-01**		Prepared: Dec-08-14, Analyzed: Dec-09-14						
Antimony, total	0.463	0.0001	mg/L	0.400	0.0004	116	84-125			
Arsenic, total	0.195	0.0005	mg/L	0.200	< 0.0005	97	85-116			
Barium, total	1.05	0.005	mg/L	1.00	0.015	104	87-114			
Beryllium, total	0.0907	0.0001	mg/L	0.100	< 0.0001	91	72-116			
Cadmium, total	0.102	0.00001	mg/L	0.100	0.00001	102	90-112			
Chromium, total	0.380	0.0005	mg/L	0.400	< 0.0005	95	89-120			
Cobalt, total	0.387	0.00005	mg/L	0.400	0.00013	97	88-120			
Copper, total	0.401	0.0002	mg/L	0.400	0.0024	100	88-125			
Iron, total	2.17	0.01	mg/L	2.00	0.24	96	88-119			
Lead, total	0.201	0.0001	mg/L	0.200	0.0003	101	89-118			
Manganese, total	0.420	0.0002	mg/L	0.400	0.0278	98	84-120			
Nickel, total	0.391	0.0002	mg/L	0.400	0.0007	98	87-119			
Selenium, total	0.0954	0.0005	mg/L	0.100	< 0.0005	95	85-113			
Silver, total	0.0374	0.00005	mg/L	0.100	0.00172	36	89-119			SPK1
Thallium, total	0.100	0.00002	mg/L	0.100	< 0.00002	100	92-119			
Vanadium, total	0.374	0.001	mg/L	0.400	< 0.001	93	87-117			
Zinc, total	0.976	0.004	mg/L	1.00	0.012	96	85-116			
Reference (B4L0362-SRM1)				Prepared: Dec-08-14, Analyzed: Dec-09-14						
Aluminum, total	0.270	0.005	mg/L	0.296		91	81-129			
Antimony, total	0.0539	0.0001	mg/L	0.0505		107	88-114			
Arsenic, total	0.117	0.0005	mg/L	0.122		96	88-114			
Barium, total	0.695	0.005	mg/L	0.777		89	72-104			
Beryllium, total	0.0442	0.0001	mg/L	0.0488		90	76-131			
Boron, total	3.62	0.004	mg/L	3.40		106	75-121			
Cadmium, total	0.0471	0.00001	mg/L	0.0490		96	89-111			
Calcium, total	9.3	0.2	mg/L	10.2		91	86-121			
Chromium, total	0.222	0.0005	mg/L	0.242		92	89-114			
Cobalt, total	0.0345	0.00005	mg/L	0.0366		94	91-113			
Copper, total	0.462	0.0002	mg/L	0.487		95	91-115			
Iron, total	0.44	0.01	mg/L	0.469		94	77-124			
Lead, total	0.192	0.0001	mg/L	0.193		100	92-113			
Lithium, total	0.373	0.0001	mg/L	0.390		96	85-115			
Magnesium, total	3.15	0.01	mg/L	3.31		95	78-120			
Manganese, total	0.101	0.0002	mg/L	0.109		92	90-114			
Mercury, total	0.00249	0.00002	mg/L	0.00456		55	50-150			
Molybdenum, total	0.194	0.0001	mg/L	0.197		99	90-111			
Nickel, total	0.223	0.0002	mg/L	0.242		92	90-111			
Phosphorus, total	0.208	0.020	mg/L	0.233		89	85-115			
Potassium, total	5.71	0.02	mg/L	5.93		96	84-113			
Selenium, total	0.106	0.0005	mg/L	0.115		92	85-115			

CARO ANALYTICAL SERVICES

QUALITY CONTROL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4120402
REPORTED Dec-12-14

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	RPD	RPD Limit	Notes
Total Recoverable Metals, Batch B4L0362, Continued										
Reference (B4L0362-SRM1), Continued				Prepared: Dec-08-14, Analyzed: Dec-09-14						
Sodium, total	7.20	0.02	mg/L	7.64		94	82-123			
Strontium, total	0.357	0.001	mg/L	0.363		98	88-112			
Thallium, total	0.0795	0.00002	mg/L	0.0794		100	91-114			
Uranium, total	0.0184	0.00002	mg/L	0.0192		96	85-120			
Vanadium, total	0.338	0.001	mg/L	0.376		90	86-111			
Zinc, total	2.21	0.004	mg/L	2.42		91	85-111			

QC Qualifiers:

SPK1 The recovery of this analyte was outside of established control limits. The data was accepted based on performance of other batch QC.

CARO ANALYTICAL SE

* 4 1 2 0 4 0 2 *

CARO BC COC, Rev 03/13

CHAIN-OF-CUSTODY RECORD COC#

RELINQUISHED BY:	DATE: 5-Dec-14	RECEIVED BY: WI KF	DATE: 12/05
Patrick Lilley	TIME:		TIME: 13:32
RELINQUISHED BY:	DATE:	RECEIVED BY:	DATE:
	TIME:		TIME:

REPORT TO:

COMPANY: Kerr Wood Leidal Associates
ADDRESS: 200-4185A Still Creek Drive, Burnaby, BC V5C 6G9
CONTACT: Patrick Lilley
TEL / FAX: 604-293-3121 604-294-2090
EMAIL PDF ☑ EDD ☐ **Please email Excel file.**
EMAIL 1: plilley@kwl.ca
EMAIL 2:
MAIL HARDCOPY ☐ HOLD FOR P/U ☐ FAX ☐

INVOICE TO: SAME AS REPORT TO ☐

COMPANY: Kerr Wood Leidal Associates
ADDRESS: 200-4185A Still Creek Drive, Burnaby, BC V5C 6G9
CONTACT: Patrick Lilley / Michelle Derer
TEL / FAX: 604-294-2088 604-294-2090
EMAIL PDF ☑
EMAIL 1: plilley@kwl.ca
EMAIL 2: mderer@kwl.ca
MAIL HARDCOPY ☐ HOLD FOR P/U ☐

PROJECT:	PROJECT INFO:	PO #:
173.169 Maple Ridge WQ	Stormwater Monitoring	
SAMPLED BY: Patrick Lilley	SHIPPING INSTRUCTIONS: RETURN COOLER(S) ☐ SHIP SUPPLIES (PLEASE SPECIFY IN OTHER INSTRUCTIONS SECTION) ☐	

TURNAROUND Routine (4-7 days) ☑ Other:
TIME REQUESTED: Rush:* 1 Day ☐ 2 Day ☐ 3 Day ☐ * Contact the lab to confirm, surcharges may apply

ANALYSES REQUESTED:

CLIENT SAMPLE ID:	MATRIX: DRINKING WATER	OTHER WATER	SOIL	OTHER	# CONTAINERS	SAMPLING: DATE DD-MMM-YY	TIME HH:MM	COMMENTS: CHLORINATED	FILTERED	PRESERVED	(i.e. flow/volume media ID/notes)	BTEX ☐ VPH ☐ MTBE ☐	EPH (not PAH Corrected)	VOC ☐ VPH ☐	L/HEPH (PAH Corrected)	PAH	PHENOLS Chlorinated ☐ Non-Chlor ☐	PCB ☐ GLYCOLS ☐ HAA ☐	METALS - WATER TOTAL (ICPMS - LOW Pkg.)	METALS - WATER DISSOLVED (ICPMS - LOW Pkg.)	Metals - SOIL (SALM) ☐ Inc. pH ☐	pH ☐ EC ☐ Alk ☑	TSS ☐ TDS ☐	BOD ☐ COD ☐	FECAL COLIFORMS ☑ HPC ☐	TOTAL COLIFORMS ☑ E-COLI ☑	PESTICIDES ☐ HERBICIDES ☐	SOIL VAPOUR	ASBESTOS	NITRATE-N	HOLD
SA-1 (T2 Creek)	☐	☑	☐	☐	7	5-Dec-14	10:15	☐	☑	☑	See below	☐	☐	☐	☐	☐	☐	☐	☑	☑	☐	☑	☐	☐	☑	☑	☐	☐	☐	☑	☐
SA-2 (Millionaire Creek)	☐	☑	☐	☐	7	5-Dec-14	10:55	☐	☑	☑	See below	☐	☐	☐	☐	☐	☐	☐	☑	☑	☐	☑	☐	☐	☑	☑	☐	☐	☐	☑	☐
K-1 (Dunlop Creek)	☐	☑	☐	☐	7	5-Dec-14	12:05	☐	☑	☑	See below	☐	☐	☐	☐	☐	☐	☐	☑	☑	☐	☑	☐	☐	☑	☑	☐	☐	☐	☑	☐
K-2 (Spencer Creek)	☐	☑	☐	☐	7	5-Dec-14	11:35	☐	☑	☑	See below	☐	☐	☐	☐	☐	☐	☐	☑	☑	☐	☑	☐	☐	☑	☑	☐	☐	☐	☑	☐
Field Blank	☐	☑	☐	☐	1	5-Dec-14	10:55	☐	☐	☑		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐
Trip Blank	☐	☑	☐	☐	1	5-Dec-14	09:15	☐	☐	☑		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑
		☐	☐	☐	☐			☐	☐	☐		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
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APPLICABLE REGULATORY LIMITS:
Canadian Drinking Water Quality Guidelines ☐
BC Drinking Water Protection Act/Reg. ☐
BC CSR: AL ☐ RL ☐ CL ☐ IL ☐ AW ☐
CCME ☑ Alberta Tier 1 ☐
OTHER: BC WQ Guidelines for Aquatic Life

SAMPLE RETENTION INSTRUCTIONS (Discarded 30 days after Report unless otherwise specified):
60 Days ☐ 90 Days ☐ Longer Date (Surcharges will apply):

OTHER INSTRUCTIONS:
Total and dissolved metals, mercury, and bacteriological samples have been preserved. Dissolved metals samples (incl. mercury) have also been filtered. Metals analysis should be LOW level ICPMS pkg. Add total + dissolved Hg. Alkalinity = TOTAL alkalinity. Use higher dilutions for bacteriological tests pls.

PAYMENT: Cheque ☐ Credit ☐ Debit ☐ Cash ☐ Invoice ☐

SAMPLE RECEIPT TEMP (°C): 3.2
Work Order # _____
CUSTODY SEALS INTACT: ☐Y ☐N ☐NA

Required Fields Recommended Fields **SHADED AREAS:** LAB USE ONLY

CARO ANALYTICAL SERVICES

CERTIFICATE OF ANALYSIS

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby) 200 - 4185A Still Creek Dr Burnaby, BC V5C 6G9	**TEL** **FAX**	(604) 294-2088 (604) 294-2090
ATTENTION	Patrick Lilley	**WORK ORDER**	4120569
PO NUMBER		**RECEIVED / TEMP**	Dec-09-14 16:26 / 9°C
PROJECT	173.169 Maple Ridge WQ	**REPORTED**	Dec-17-14
PROJECT INFO	Stormwater Monitoring	**COC NUMBER**	No#

General Comments:

CARO Analytical Services employs methods which are conducted according to procedures accepted by appropriate regulatory agencies, and/or are conducted in accordance with recognized professional standards using accepted testing methodologies and quality control efforts, except where otherwise agreed to by the client.

The results in this report apply to the samples analyzed in accordance with the Chain of Custody or Sample Requisition document. This analytical report must be reproduced in its entirety. CARO is not responsible for any loss or damage resulting directly or indirectly from error or omission in the conduct of testing. Liability is limited to the cost of analysis. Samples will be disposed of 30 days after the test report has been issued unless otherwise agreed to in writing.

Work Order Comments:

Dec.17/14- This is an amended report, please note that the T&D-Hg results for samples -01 to -04 have been added.- JLS

Issued By: **Jennifer Shanko, AScT**
Administration Coordinator

Please contact CARO if more information is needed or to provide feedback on our services.

Locations:

#110 4011 Viking Way
Richmond, BC V6V 2K9
Tel: 604-279-1499 Fax: 604-279-1599

#102 3677 Highway 97N
Kelowna, BC V1X 5C3
Tel: 250-765-9646 Fax: 250-765-3893

17225 109 Avenue
Edmonton, AB T5S 1H7
Tel: 780-489-9100 Fax: 780-489-9700

www.caro.ca

CARO ANALYTICAL SERVICES

ANALYSIS INFORMATION

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4120569
REPORTED Dec-17-14

Analysis Description	Method Reference	Technique	Location
Alkalinity (Speciated)	APHA 2320 B	Titration with H2SO4 to pH 4.5	Kelowna
Anions in Water by IC	APHA 4110 B	Ion Chromatography with Chemical Suppression of Eluent Conductivity	Kelowna
Dissolved Metals	APHA 3030 B / APHA 3125 B	0.45 µm Filtration / Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	Richmond
E. coli (MF)	APHA 9223 B	Enzyme Substrate	Sublet
Fecal Coliforms (MF)	APHA 9222	Membrane Filtration	Sublet
Hardness (as CaCO3)	APHA 2340 B	Calculation	N/A
Total Coliforms (MF)	APHA 9222	Membrane Filtration	Sublet
Total Recoverable Metals	APHA 3030E * / APHA 3125 B	HNO3+HCl Hot Block Digestion / Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	Richmond

Note: An asterisk in the Method Reference indicates that the CARO method has been modified from the reference method

Method Reference Descriptions:

APHA	Standard Methods for the Examination of Water and Wastewater, 22nd Edition, American Public Health Association/American Water Works Association/Water Environment Federation

Glossary of Terms:

MRL	Method Reporting Limit
<	Less than the Reported Detection Limit (RDL) - the RDL may be higher than the MRL due to various factors such as dilutions, limited sample volume, high moisture, or interferences
CFU/100 mL	Colony Forming Units per 100 millilitres
mg/L	Milligrams per litre

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4120569
REPORTED Dec-17-14

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SA-1 (T2 Creek) (4120569-01) [Water] Sampled: Dec-09-14 12:55							
Anions							
Nitrate as N	**0.795**	N/A	0.010	mg/L	N/A	Dec-11-14	
General Parameters							
Alkalinity, Total as CaCO3	**24**	N/A	1	mg/L	N/A	Dec-11-14	
Alkalinity, Phenolphthalein as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-11-14	
Alkalinity, Bicarbonate as CaCO3	**24**	N/A	1	mg/L	N/A	Dec-11-14	
Alkalinity, Carbonate as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-11-14	
Alkalinity, Hydroxide as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-11-14	
Calculated Parameters							
Hardness, Total (Total as CaCO3)	**32.5**	N/A	0.50	mg/L	N/A	N/A	
Hardness, Total (Diss. as CaCO3)	**32.0**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.034**	N/A	0.005	mg/L	N/A	Dec-12-14	
Antimony, dissolved	**0.0002**	N/A	0.0001	mg/L	N/A	Dec-12-14	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-12-14	
Barium, dissolved	**0.008**	N/A	0.005	mg/L	N/A	Dec-12-14	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-12-14	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-12-14	
Boron, dissolved	**0.011**	N/A	0.004	mg/L	N/A	Dec-12-14	
Cadmium, dissolved	**0.00002**	N/A	0.00001	mg/L	N/A	Dec-12-14	
Calcium, dissolved	**8.7**	N/A	0.2	mg/L	N/A	Dec-12-14	
Chromium, dissolved	**0.0007**	N/A	0.0005	mg/L	N/A	Dec-12-14	
Cobalt, dissolved	**0.00008**	N/A	0.00005	mg/L	N/A	Dec-12-14	
Copper, dissolved	**0.0026**	N/A	0.0002	mg/L	N/A	Dec-12-14	
Iron, dissolved	**0.058**	N/A	0.010	mg/L	N/A	Dec-12-14	
Lead, dissolved	**0.0001**	N/A	0.0001	mg/L	N/A	Dec-12-14	
Lithium, dissolved	**0.0004**	N/A	0.0001	mg/L	N/A	Dec-12-14	
Magnesium, dissolved	**2.48**	N/A	0.01	mg/L	N/A	Dec-12-14	
Manganese, dissolved	**0.0165**	N/A	0.0002	mg/L	N/A	Dec-12-14	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Dec-12-14	
Molybdenum, dissolved	**0.0008**	N/A	0.0001	mg/L	N/A	Dec-12-14	
Nickel, dissolved	**0.0006**	N/A	0.0002	mg/L	N/A	Dec-12-14	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	Dec-12-14	
Potassium, dissolved	**1.49**	N/A	0.02	mg/L	N/A	Dec-12-14	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-12-14	
Silicon, dissolved	**3.8**	N/A	0.5	mg/L	N/A	Dec-12-14	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	Dec-12-14	
Sodium, dissolved	**5.78**	N/A	0.02	mg/L	N/A	Dec-12-14	
Strontium, dissolved	**0.051**	N/A	0.001	mg/L	N/A	Dec-12-14	
Sulfur, dissolved	**3**	N/A	1	mg/L	N/A	Dec-12-14	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Dec-12-14	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Dec-12-14	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-12-14	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Dec-12-14	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	Dec-12-14	

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4120569
REPORTED Dec-17-14

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SA-1 (T2 Creek) (4120569-01) [Water] Sampled: Dec-09-14 12:55, Continued							
Dissolved Metals, Continued							
Uranium, dissolved	**0.00005**	N/A	0.00002	mg/L	N/A	Dec-12-14	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	Dec-12-14	
Zinc, dissolved	**0.006**	N/A	0.004	mg/L	N/A	Dec-12-14	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-12-14	
Total Recoverable Metals							
Aluminum, total	**0.839**	N/A	0.005	mg/L	Dec-11-14	Dec-12-14	
Antimony, total	**0.0002**	N/A	0.0001	mg/L	Dec-11-14	Dec-12-14	
Arsenic, total	**0.0007**	N/A	0.0005	mg/L	Dec-11-14	Dec-12-14	
Barium, total	**0.015**	N/A	0.005	mg/L	Dec-11-14	Dec-12-14	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	Dec-11-14	Dec-12-14	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	Dec-11-14	Dec-12-14	
Boron, total	**0.011**	N/A	0.004	mg/L	Dec-11-14	Dec-12-14	
Cadmium, total	**0.00002**	N/A	0.00001	mg/L	Dec-11-14	Dec-12-14	
Calcium, total	**8.6**	N/A	0.2	mg/L	Dec-11-14	Dec-12-14	
Chromium, total	**0.0017**	N/A	0.0005	mg/L	Dec-11-14	Dec-12-14	
Cobalt, total	**0.00035**	N/A	0.00005	mg/L	Dec-11-14	Dec-12-14	
Copper, total	**0.0048**	N/A	0.0002	mg/L	Dec-11-14	Dec-12-14	
Iron, total	**0.77**	N/A	0.01	mg/L	Dec-11-14	Dec-12-14	
Lead, total	**0.0008**	N/A	0.0001	mg/L	Dec-11-14	Dec-12-14	
Lithium, total	**0.0007**	N/A	0.0001	mg/L	Dec-11-14	Dec-12-14	
Magnesium, total	**2.70**	N/A	0.01	mg/L	Dec-11-14	Dec-12-14	
Manganese, total	**0.0295**	N/A	0.0002	mg/L	Dec-11-14	Dec-12-14	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	Dec-11-14	Dec-12-14	
Molybdenum, total	**0.0008**	N/A	0.0001	mg/L	Dec-11-14	Dec-12-14	
Nickel, total	**0.0015**	N/A	0.0002	mg/L	Dec-11-14	Dec-12-14	
Phosphorus, total	**0.033**	N/A	0.020	mg/L	Dec-11-14	Dec-12-14	
Potassium, total	**1.48**	N/A	0.02	mg/L	Dec-11-14	Dec-12-14	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	Dec-11-14	Dec-12-14	
Silicon, total	**4.8**	N/A	0.5	mg/L	Dec-11-14	Dec-12-14	
Silver, total	< 0.00005	N/A	0.00005	mg/L	Dec-11-14	Dec-12-14	
Sodium, total	**5.95**	N/A	0.02	mg/L	Dec-11-14	Dec-12-14	
Strontium, total	**0.053**	N/A	0.001	mg/L	Dec-11-14	Dec-12-14	
Sulfur, total	**2**	N/A	1	mg/L	Dec-11-14	Dec-12-14	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	Dec-11-14	Dec-12-14	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	Dec-11-14	Dec-12-14	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	Dec-11-14	Dec-12-14	
Tin, total	< 0.0002	N/A	0.0002	mg/L	Dec-11-14	Dec-12-14	
Titanium, total	**0.047**	N/A	0.005	mg/L	Dec-11-14	Dec-12-14	
Uranium, total	**0.00005**	N/A	0.00002	mg/L	Dec-11-14	Dec-12-14	
Vanadium, total	**0.002**	N/A	0.001	mg/L	Dec-11-14	Dec-12-14	
Zinc, total	**0.013**	N/A	0.004	mg/L	Dec-11-14	Dec-12-14	
Zirconium, total	**0.0005**	N/A	0.0001	mg/L	Dec-11-14	Dec-12-14	
Microbiological Parameters							
Coliforms, Fecal	**420**	N/A	1	CFU/100 mL	N/A	Dec-09-14	

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4120569
REPORTED Dec-17-14

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SA-1 (T2 Creek) (4120569-01) [Water] Sampled: Dec-09-14 12:55, Continued							
Microbiological Parameters, Continued							
Coliforms, Total	**300**	N/A	1	CFU/100 mL	N/A	Dec-09-14	
E. coli	< 1	N/A	1	CFU/100 mL	N/A	Dec-09-14	
Sample ID: SA-2 (Millionaire Creek) (4120569-02) [Water] Sampled: Dec-09-14 13:30							
Anions							
Nitrate as N	**0.293**	N/A	0.010	mg/L	N/A	Dec-11-14	
General Parameters							
Alkalinity, Total as CaCO3	**7**	N/A	1	mg/L	N/A	Dec-11-14	
Alkalinity, Phenolphthalein as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-11-14	
Alkalinity, Bicarbonate as CaCO3	**7**	N/A	1	mg/L	N/A	Dec-11-14	
Alkalinity, Carbonate as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-11-14	
Alkalinity, Hydroxide as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-11-14	
Calculated Parameters							
Hardness, Total (Total as CaCO3)	**9.50**	N/A	0.50	mg/L	N/A	N/A	
Hardness, Total (Diss. as CaCO3)	**8.45**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.069**	N/A	0.005	mg/L	N/A	Dec-12-14	
Antimony, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-12-14	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-12-14	
Barium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	Dec-12-14	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-12-14	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-12-14	
Boron, dissolved	< 0.004	N/A	0.004	mg/L	N/A	Dec-12-14	
Cadmium, dissolved	**0.00002**	N/A	0.00001	mg/L	N/A	Dec-12-14	
Calcium, dissolved	**2.4**	N/A	0.2	mg/L	N/A	Dec-12-14	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-12-14	
Cobalt, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	Dec-12-14	
Copper, dissolved	**0.0005**	N/A	0.0002	mg/L	N/A	Dec-12-14	
Iron, dissolved	**0.041**	N/A	0.010	mg/L	N/A	Dec-12-14	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-12-14	
Lithium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-12-14	
Magnesium, dissolved	**0.59**	N/A	0.01	mg/L	N/A	Dec-12-14	
Manganese, dissolved	**0.0023**	N/A	0.0002	mg/L	N/A	Dec-12-14	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Dec-12-14	
Molybdenum, dissolved	**0.0002**	N/A	0.0001	mg/L	N/A	Dec-12-14	
Nickel, dissolved	**0.0003**	N/A	0.0002	mg/L	N/A	Dec-12-14	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	Dec-12-14	
Potassium, dissolved	**0.37**	N/A	0.02	mg/L	N/A	Dec-12-14	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-12-14	
Silicon, dissolved	**4.0**	N/A	0.5	mg/L	N/A	Dec-12-14	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	Dec-12-14	
Sodium, dissolved	**2.44**	N/A	0.02	mg/L	N/A	Dec-12-14	
Strontium, dissolved	**0.023**	N/A	0.001	mg/L	N/A	Dec-12-14	

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4120569
REPORTED Dec-17-14

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SA-2 (Millionaire Creek) (4120569-02) [Water] Sampled: Dec-09-14 13:30, Continued							
Dissolved Metals, Continued							
Sulfur, dissolved	**2**	N/A	1	mg/L	N/A	Dec-12-14	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Dec-12-14	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Dec-12-14	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-12-14	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Dec-12-14	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	Dec-12-14	
Uranium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Dec-12-14	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	Dec-12-14	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	Dec-12-14	
Zirconium, dissolved	**0.0001**	N/A	0.0001	mg/L	N/A	Dec-12-14	
Total Recoverable Metals							
Aluminum, total	**0.238**	N/A	0.005	mg/L	Dec-11-14	Dec-12-14	
Antimony, total	**0.0003**	N/A	0.0001	mg/L	Dec-11-14	Dec-12-14	
Arsenic, total	< 0.0005	N/A	0.0005	mg/L	Dec-11-14	Dec-12-14	
Barium, total	**0.005**	N/A	0.005	mg/L	Dec-11-14	Dec-12-14	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	Dec-11-14	Dec-12-14	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	Dec-11-14	Dec-12-14	
Boron, total	< 0.004	N/A	0.004	mg/L	Dec-11-14	Dec-12-14	
Cadmium, total	**0.00004**	N/A	0.00001	mg/L	Dec-11-14	Dec-12-14	
Calcium, total	**2.8**	N/A	0.2	mg/L	Dec-11-14	Dec-12-14	
Chromium, total	< 0.0005	N/A	0.0005	mg/L	Dec-11-14	Dec-12-14	
Cobalt, total	**0.00010**	N/A	0.00005	mg/L	Dec-11-14	Dec-12-14	
Copper, total	**0.0009**	N/A	0.0002	mg/L	Dec-11-14	Dec-12-14	
Iron, total	**0.20**	N/A	0.01	mg/L	Dec-11-14	Dec-12-14	
Lead, total	**0.0001**	N/A	0.0001	mg/L	Dec-11-14	Dec-12-14	
Lithium, total	**0.0001**	N/A	0.0001	mg/L	Dec-11-14	Dec-12-14	
Magnesium, total	**0.61**	N/A	0.01	mg/L	Dec-11-14	Dec-12-14	
Manganese, total	**0.0070**	N/A	0.0002	mg/L	Dec-11-14	Dec-12-14	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	Dec-11-14	Dec-12-14	
Molybdenum, total	**0.0003**	N/A	0.0001	mg/L	Dec-11-14	Dec-12-14	
Nickel, total	**0.0003**	N/A	0.0002	mg/L	Dec-11-14	Dec-12-14	
Phosphorus, total	< 0.020	N/A	0.020	mg/L	Dec-11-14	Dec-12-14	
Potassium, total	**0.32**	N/A	0.02	mg/L	Dec-11-14	Dec-12-14	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	Dec-11-14	Dec-12-14	
Silicon, total	**3.7**	N/A	0.5	mg/L	Dec-11-14	Dec-12-14	
Silver, total	< 0.00005	N/A	0.00005	mg/L	Dec-11-14	Dec-12-14	
Sodium, total	**2.45**	N/A	0.02	mg/L	Dec-11-14	Dec-12-14	
Strontium, total	**0.023**	N/A	0.001	mg/L	Dec-11-14	Dec-12-14	
Sulfur, total	**1**	N/A	1	mg/L	Dec-11-14	Dec-12-14	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	Dec-11-14	Dec-12-14	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	Dec-11-14	Dec-12-14	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	Dec-11-14	Dec-12-14	
Tin, total	< 0.0002	N/A	0.0002	mg/L	Dec-11-14	Dec-12-14	
Titanium, total	**0.008**	N/A	0.005	mg/L	Dec-11-14	Dec-12-14	
Uranium, total	< 0.00002	N/A	0.00002	mg/L	Dec-11-14	Dec-12-14	

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4120569
REPORTED Dec-17-14

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SA-2 (Millionaire Creek) (4120569-02) [Water] Sampled: Dec-09-14 13:30, Continued							
Total Recoverable Metals, Continued							
Vanadium, total	**0.001**	N/A	0.001	mg/L	Dec-11-14	Dec-12-14	
Zinc, total	< 0.004	N/A	0.004	mg/L	Dec-11-14	Dec-12-14	
Zirconium, total	**0.0002**	N/A	0.0001	mg/L	Dec-11-14	Dec-12-14	
Microbiological Parameters							
Coliforms, Fecal	**13**	N/A	1	CFU/100 mL	N/A	Dec-09-14	
Coliforms, Total	**78**	N/A	1	CFU/100 mL	N/A	Dec-09-14	
E. coli	**11**	N/A	1	CFU/100 mL	N/A	Dec-09-14	
Sample ID: K-1 (Dunlop Creek) (4120569-03) [Water] Sampled: Dec-09-14 14:30							
Anions							
Nitrate as N	**0.879**	N/A	0.010	mg/L	N/A	Dec-11-14	
General Parameters							
Alkalinity, Total as CaCO3	**16**	N/A	1	mg/L	N/A	Dec-11-14	
Alkalinity, Phenolphthalein as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-11-14	
Alkalinity, Bicarbonate as CaCO3	**16**	N/A	1	mg/L	N/A	Dec-11-14	
Alkalinity, Carbonate as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-11-14	
Alkalinity, Hydroxide as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-11-14	
Calculated Parameters							
Hardness, Total (Total as CaCO3)	**23.9**	N/A	0.50	mg/L	N/A	N/A	
Hardness, Total (Diss. as CaCO3)	**22.4**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.095**	N/A	0.005	mg/L	N/A	Dec-12-14	
Antimony, dissolved	**0.0001**	N/A	0.0001	mg/L	N/A	Dec-12-14	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-12-14	
Barium, dissolved	**0.007**	N/A	0.005	mg/L	N/A	Dec-12-14	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-12-14	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-12-14	
Boron, dissolved	**0.006**	N/A	0.004	mg/L	N/A	Dec-12-14	
Cadmium, dissolved	**0.00001**	N/A	0.00001	mg/L	N/A	Dec-12-14	
Calcium, dissolved	**5.9**	N/A	0.2	mg/L	N/A	Dec-12-14	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-12-14	
Cobalt, dissolved	**0.00009**	N/A	0.00005	mg/L	N/A	Dec-12-14	
Copper, dissolved	**0.0017**	N/A	0.0002	mg/L	N/A	Dec-12-14	
Iron, dissolved	**0.094**	N/A	0.010	mg/L	N/A	Dec-12-14	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-12-14	
Lithium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-12-14	
Magnesium, dissolved	**1.84**	N/A	0.01	mg/L	N/A	Dec-12-14	
Manganese, dissolved	**0.0078**	N/A	0.0002	mg/L	N/A	Dec-12-14	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Dec-12-14	
Molybdenum, dissolved	**0.0002**	N/A	0.0001	mg/L	N/A	Dec-12-14	
Nickel, dissolved	**0.0006**	N/A	0.0002	mg/L	N/A	Dec-12-14	
Phosphorus, dissolved	**0.02**	N/A	0.02	mg/L	N/A	Dec-12-14	

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4120569
REPORTED Dec-17-14

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: K-1 (Dunlop Creek) (4120569-03) [Water] Sampled: Dec-09-14 14:30, Continued							
Dissolved Metals, Continued							
Potassium, dissolved	**1.93**	N/A	0.02	mg/L	N/A	Dec-12-14	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-12-14	
Silicon, dissolved	**4.3**	N/A	0.5	mg/L	N/A	Dec-12-14	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	Dec-12-14	
Sodium, dissolved	**3.71**	N/A	0.02	mg/L	N/A	Dec-12-14	
Strontium, dissolved	**0.042**	N/A	0.001	mg/L	N/A	Dec-12-14	
Sulfur, dissolved	**2**	N/A	1	mg/L	N/A	Dec-12-14	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Dec-12-14	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Dec-12-14	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-12-14	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Dec-12-14	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	Dec-12-14	
Uranium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Dec-12-14	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	Dec-12-14	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	Dec-12-14	
Zirconium, dissolved	**0.0001**	N/A	0.0001	mg/L	N/A	Dec-12-14	
Total Recoverable Metals							
Aluminum, total	**1.34**	N/A	0.005	mg/L	Dec-11-14	Dec-12-14	
Antimony, total	< 0.0001	N/A	0.0001	mg/L	Dec-11-14	Dec-12-14	
Arsenic, total	**0.0007**	N/A	0.0005	mg/L	Dec-11-14	Dec-12-14	
Barium, total	**0.019**	N/A	0.005	mg/L	Dec-11-14	Dec-12-14	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	Dec-11-14	Dec-12-14	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	Dec-11-14	Dec-12-14	
Boron, total	**0.005**	N/A	0.004	mg/L	Dec-11-14	Dec-12-14	
Cadmium, total	**0.00002**	N/A	0.00001	mg/L	Dec-11-14	Dec-12-14	
Calcium, total	**6.1**	N/A	0.2	mg/L	Dec-11-14	Dec-12-14	
Chromium, total	**0.0021**	N/A	0.0005	mg/L	Dec-11-14	Dec-12-14	
Cobalt, total	**0.00052**	N/A	0.00005	mg/L	Dec-11-14	Dec-12-14	
Copper, total	**0.0034**	N/A	0.0002	mg/L	Dec-11-14	Dec-12-14	
Iron, total	**1.21**	N/A	0.01	mg/L	Dec-11-14	Dec-12-14	
Lead, total	**0.0005**	N/A	0.0001	mg/L	Dec-11-14	Dec-12-14	
Lithium, total	**0.0007**	N/A	0.0001	mg/L	Dec-11-14	Dec-12-14	
Magnesium, total	**2.13**	N/A	0.01	mg/L	Dec-11-14	Dec-12-14	
Manganese, total	**0.0300**	N/A	0.0002	mg/L	Dec-11-14	Dec-12-14	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	Dec-11-14	Dec-12-14	
Molybdenum, total	**0.0001**	N/A	0.0001	mg/L	Dec-11-14	Dec-12-14	
Nickel, total	**0.0018**	N/A	0.0002	mg/L	Dec-11-14	Dec-12-14	
Phosphorus, total	**0.059**	N/A	0.020	mg/L	Dec-11-14	Dec-12-14	
Potassium, total	**1.91**	N/A	0.02	mg/L	Dec-11-14	Dec-12-14	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	Dec-11-14	Dec-12-14	
Silicon, total	**6.0**	N/A	0.5	mg/L	Dec-11-14	Dec-12-14	
Silver, total	< 0.00005	N/A	0.00005	mg/L	Dec-11-14	Dec-12-14	
Sodium, total	**3.69**	N/A	0.02	mg/L	Dec-11-14	Dec-12-14	
Strontium, total	**0.043**	N/A	0.001	mg/L	Dec-11-14	Dec-12-14	
Sulfur, total	**1**	N/A	1	mg/L	Dec-11-14	Dec-12-14	

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4120569
REPORTED Dec-17-14

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: K-1 (Dunlop Creek) (4120569-03) [Water] Sampled: Dec-09-14 14:30, Continued							
Total Recoverable Metals, Continued							
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	Dec-11-14	Dec-12-14	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	Dec-11-14	Dec-12-14	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	Dec-11-14	Dec-12-14	
Tin, total	< 0.0002	N/A	0.0002	mg/L	Dec-11-14	Dec-12-14	
Titanium, total	**0.053**	N/A	0.005	mg/L	Dec-11-14	Dec-12-14	
Uranium, total	**0.00003**	N/A	0.00002	mg/L	Dec-11-14	Dec-12-14	
Vanadium, total	**0.004**	N/A	0.001	mg/L	Dec-11-14	Dec-12-14	
Zinc, total	**0.006**	N/A	0.004	mg/L	Dec-11-14	Dec-12-14	
Zirconium, total	**0.0004**	N/A	0.0001	mg/L	Dec-11-14	Dec-12-14	
Microbiological Parameters							
Coliforms, Fecal	**170**	N/A	1	CFU/100 mL	N/A	Dec-09-14	
Coliforms, Total	**180**	N/A	1	CFU/100 mL	N/A	Dec-09-14	
E. coli	< 1	N/A	1	CFU/100 mL	N/A	Dec-09-14	
Sample ID: K-2 (Spencer Creek) (4120569-04) [Water] Sampled: Dec-09-14 15:00							
Anions							
Nitrate as N	**0.508**	N/A	0.010	mg/L	N/A	Dec-11-14	
General Parameters							
Alkalinity, Total as CaCO3	**37**	N/A	1	mg/L	N/A	Dec-11-14	
Alkalinity, Phenolphthalein as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-11-14	
Alkalinity, Bicarbonate as CaCO3	**37**	N/A	1	mg/L	N/A	Dec-11-14	
Alkalinity, Carbonate as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-11-14	
Alkalinity, Hydroxide as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-11-14	
Calculated Parameters							
Hardness, Total (Total as CaCO3)	**48.9**	N/A	0.50	mg/L	N/A	N/A	
Hardness, Total (Diss. as CaCO3)	**43.9**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.072**	N/A	0.005	mg/L	N/A	Dec-12-14	
Antimony, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-12-14	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-12-14	
Barium, dissolved	**0.006**	N/A	0.005	mg/L	N/A	Dec-12-14	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-12-14	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-12-14	
Boron, dissolved	**0.006**	N/A	0.004	mg/L	N/A	Dec-12-14	
Cadmium, dissolved	**0.00001**	N/A	0.00001	mg/L	N/A	Dec-12-14	
Calcium, dissolved	**12.2**	N/A	0.2	mg/L	N/A	Dec-12-14	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-12-14	
Cobalt, dissolved	**0.00010**	N/A	0.00005	mg/L	N/A	Dec-12-14	
Copper, dissolved	**0.0021**	N/A	0.0002	mg/L	N/A	Dec-12-14	
Iron, dissolved	**0.117**	N/A	0.010	mg/L	N/A	Dec-12-14	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-12-14	
Lithium, dissolved	**0.0003**	N/A	0.0001	mg/L	N/A	Dec-12-14	

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4120569
REPORTED Dec-17-14

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: K-2 (Spencer Creek) (4120569-04) [Water] Sampled: Dec-09-14 15:00, Continued							
Dissolved Metals, Continued							
Magnesium, dissolved	**3.28**	N/A	0.01	mg/L	N/A	Dec-12-14	
Manganese, dissolved	**0.0158**	N/A	0.0002	mg/L	N/A	Dec-12-14	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Dec-12-14	
Molybdenum, dissolved	**0.0004**	N/A	0.0001	mg/L	N/A	Dec-12-14	
Nickel, dissolved	**0.0007**	N/A	0.0002	mg/L	N/A	Dec-12-14	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	Dec-12-14	
Potassium, dissolved	**1.67**	N/A	0.02	mg/L	N/A	Dec-12-14	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-12-14	
Silicon, dissolved	**5.2**	N/A	0.5	mg/L	N/A	Dec-12-14	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	Dec-12-14	
Sodium, dissolved	**5.63**	N/A	0.02	mg/L	N/A	Dec-12-14	
Strontium, dissolved	**0.077**	N/A	0.001	mg/L	N/A	Dec-12-14	
Sulfur, dissolved	**3**	N/A	1	mg/L	N/A	Dec-12-14	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Dec-12-14	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Dec-12-14	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-12-14	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Dec-12-14	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	Dec-12-14	
Uranium, dissolved	**0.00003**	N/A	0.00002	mg/L	N/A	Dec-12-14	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	Dec-12-14	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	Dec-12-14	
Zirconium, dissolved	**0.0001**	N/A	0.0001	mg/L	N/A	Dec-12-14	
Total Recoverable Metals							
Aluminum, total	**2.75**	N/A	0.005	mg/L	Dec-11-14	Dec-12-14	
Antimony, total	**0.0001**	N/A	0.0001	mg/L	Dec-11-14	Dec-12-14	
Arsenic, total	**0.0009**	N/A	0.0005	mg/L	Dec-11-14	Dec-12-14	
Barium, total	**0.026**	N/A	0.005	mg/L	Dec-11-14	Dec-12-14	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	Dec-11-14	Dec-12-14	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	Dec-11-14	Dec-12-14	
Boron, total	**0.006**	N/A	0.004	mg/L	Dec-11-14	Dec-12-14	
Cadmium, total	**0.00002**	N/A	0.00001	mg/L	Dec-11-14	Dec-12-14	
Calcium, total	**12.8**	N/A	0.2	mg/L	Dec-11-14	Dec-12-14	
Chromium, total	**0.0033**	N/A	0.0005	mg/L	Dec-11-14	Dec-12-14	
Cobalt, total	**0.00100**	N/A	0.00005	mg/L	Dec-11-14	Dec-12-14	
Copper, total	**0.0057**	N/A	0.0002	mg/L	Dec-11-14	Dec-12-14	
Iron, total	**2.37**	N/A	0.01	mg/L	Dec-11-14	Dec-12-14	
Lead, total	**0.0007**	N/A	0.0001	mg/L	Dec-11-14	Dec-12-14	
Lithium, total	**0.0015**	N/A	0.0001	mg/L	Dec-11-14	Dec-12-14	
Magnesium, total	**4.10**	N/A	0.01	mg/L	Dec-11-14	Dec-12-14	
Manganese, total	**0.0568**	N/A	0.0002	mg/L	Dec-11-14	Dec-12-14	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	Dec-11-14	Dec-12-14	
Molybdenum, total	**0.0005**	N/A	0.0001	mg/L	Dec-11-14	Dec-12-14	
Nickel, total	**0.0035**	N/A	0.0002	mg/L	Dec-11-14	Dec-12-14	
Phosphorus, total	**0.054**	N/A	0.020	mg/L	Dec-11-14	Dec-12-14	
Potassium, total	**1.98**	N/A	0.02	mg/L	Dec-11-14	Dec-12-14	

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4120569
REPORTED Dec-17-14

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: K-2 (Spencer Creek) (4120569-04) [Water] Sampled: Dec-09-14 15:00, Continued							
Total Recoverable Metals, Continued							
Selenium, total	< 0.0005	N/A	0.0005	mg/L	Dec-11-14	Dec-12-14	
Silicon, total	**9.9**	N/A	0.5	mg/L	Dec-11-14	Dec-12-14	
Silver, total	< 0.00005	N/A	0.00005	mg/L	Dec-11-14	Dec-12-14	
Sodium, total	**6.11**	N/A	0.02	mg/L	Dec-11-14	Dec-12-14	
Strontium, total	**0.087**	N/A	0.001	mg/L	Dec-11-14	Dec-12-14	
Sulfur, total	**2**	N/A	1	mg/L	Dec-11-14	Dec-12-14	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	Dec-11-14	Dec-12-14	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	Dec-11-14	Dec-12-14	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	Dec-11-14	Dec-12-14	
Tin, total	< 0.0002	N/A	0.0002	mg/L	Dec-11-14	Dec-12-14	
Titanium, total	**0.114**	N/A	0.005	mg/L	Dec-11-14	Dec-12-14	
Uranium, total	**0.00007**	N/A	0.00002	mg/L	Dec-11-14	Dec-12-14	
Vanadium, total	**0.006**	N/A	0.001	mg/L	Dec-11-14	Dec-12-14	
Zinc, total	**0.007**	N/A	0.004	mg/L	Dec-11-14	Dec-12-14	
Zirconium, total	**0.0011**	N/A	0.0001	mg/L	Dec-11-14	Dec-12-14	
Microbiological Parameters							
Coliforms, Fecal	**32**	N/A	1	CFU/100 mL	N/A	Dec-09-14	
Coliforms, Total	**260**	N/A	1	CFU/100 mL	N/A	Dec-09-14	
E. coli	< 1	N/A	1	CFU/100 mL	N/A	Dec-09-14	
Sample ID: Field Blank (4120569-05) [Water] Sampled: Dec-09-14 14:30							
Microbiological Parameters							
Coliforms, Fecal	< 1	N/A	1	CFU/100 mL	N/A	Dec-09-14	

CARO ANALYTICAL SERVICES

QUALITY CONTROL DATA

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	4120569
PROJECT	173.169 Maple Ridge WQ	**REPORTED**	Dec-17-14

The following section displays the quality control (QC) data that is associated with your sample data. Groups of samples are prepared in "batches" and analyzed in conjunction with QC samples that ensure your data is of the highest quality. Common QC types include:

- **Method Blank (Blk)**: Laboratory reagent water is carried through sample preparation and analysis steps. Method Blanks indicate that results are free from contamination, i.e. not biased high from sources such as the sample container or the laboratory environment
- **Duplicate (Dup)**: Preparation and analysis of a replicate aliquot of a sample. Duplicates provide a measure of the analytical method's precision, i.e. how reproducible a result is. Duplicates are only reported if they are associated with your sample data.
- **Blank Spike (BS)**: A known amount of standard is carried through sample preparation and analysis steps. Blank Spikes, also known as laboratory control samples (LCS), are prepared from a different source of standard than used for the calibration. They ensure that the calibration is acceptable (i.e. not biased high or low) and also provide a measure of the analytical method's accuracy (i.e. closeness of the result to a target value).
- **Standard Reference Material (SRM)**: A material of similar matrix to the samples, externally certified for the parameter(s) listed. Standard Reference Materials ensure that the preparation steps in the method are adequate to achieve acceptable recoveries of the parameter(s) tested.

Each QC type is analyzed at a 5-10% frequency, i.e. one blank/duplicate/spike for every 10 samples. For all types of QC, the specified recovery (% Rec) and relative percent difference (RPD) limits are derived from long-term method performance averages and/or prescribed by the reference method.

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	RPD	RPD Limit	Notes
Anions, Batch B4L0597										
Blank (B4L0597-BLK1)				Prepared: Dec-11-14, Analyzed: Dec-11-14						
Nitrate as N	< 0.005	0.010	mg/L							
LCS (B4L0597-BS1)				Prepared: Dec-11-14, Analyzed: Dec-11-14						
Nitrate as N	3.97	0.010	mg/L	4.00		99	85-115			
Duplicate (B4L0597-DUP1)		**Source: 4120569-01**		Prepared: Dec-11-14, Analyzed: Dec-11-14						
Nitrate as N	0.817	0.010	mg/L		0.795			3	10	
Dissolved Metals, Batch B4L0549										
Blank (B4L0549-BLK1)				Prepared: Dec-11-14, Analyzed: Dec-11-14						
Aluminum, dissolved	< 0.005	0.005	mg/L							
Antimony, dissolved	< 0.0001	0.0001	mg/L							
Arsenic, dissolved	< 0.0005	0.0005	mg/L							
Barium, dissolved	< 0.005	0.005	mg/L							
Beryllium, dissolved	< 0.0001	0.0001	mg/L							
Bismuth, dissolved	< 0.0001	0.0001	mg/L							
Boron, dissolved	< 0.004	0.004	mg/L							
Cadmium, dissolved	< 0.00001	0.00001	mg/L							
Calcium, dissolved	< 0.2	0.2	mg/L							
Chromium, dissolved	< 0.0005	0.0005	mg/L							
Cobalt, dissolved	< 0.00005	0.00005	mg/L							
Copper, dissolved	< 0.0002	0.0002	mg/L							
Iron, dissolved	< 0.010	0.010	mg/L							
Lead, dissolved	< 0.0001	0.0001	mg/L							
Lithium, dissolved	< 0.0001	0.0001	mg/L							
Magnesium, dissolved	< 0.01	0.01	mg/L							
Manganese, dissolved	< 0.0002	0.0002	mg/L							
Mercury, dissolved	< 0.00002	0.00002	mg/L							
Molybdenum, dissolved	< 0.0001	0.0001	mg/L							
Nickel, dissolved	< 0.0002	0.0002	mg/L							
Phosphorus, dissolved	< 0.02	0.02	mg/L							

CARO ANALYTICAL SERVICES

QUALITY CONTROL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4120569
REPORTED Dec-17-14

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	RPD	RPD Limit	Notes
Dissolved Metals, Batch B4L0549, Continued										
Blank (B4L0549-BLK1), Continued				Prepared: Dec-11-14, Analyzed: Dec-11-14						
Potassium, dissolved	< 0.02	0.02	mg/L							
Selenium, dissolved	< 0.0005	0.0005	mg/L							
Silicon, dissolved	< 0.5	0.5	mg/L							
Silver, dissolved	< 0.00005	0.00005	mg/L							
Sodium, dissolved	< 0.02	0.02	mg/L							
Strontium, dissolved	< 0.001	0.001	mg/L							
Sulfur, dissolved	< 1	1	mg/L							
Tellurium, dissolved	< 0.0002	0.0002	mg/L							
Thallium, dissolved	< 0.00002	0.00002	mg/L							
Thorium, dissolved	< 0.0001	0.0001	mg/L							
Tin, dissolved	< 0.0002	0.0002	mg/L							
Titanium, dissolved	< 0.005	0.005	mg/L							
Uranium, dissolved	< 0.00002	0.00002	mg/L							
Vanadium, dissolved	< 0.001	0.001	mg/L							
Zinc, dissolved	< 0.004	0.004	mg/L							
Zirconium, dissolved	< 0.0001	0.0001	mg/L							
Reference (B4L0549-SRM1)				Prepared: Dec-11-14, Analyzed: Dec-11-14						
Aluminum, dissolved	0.251	0.005	mg/L	0.233		108	58-142			
Antimony, dissolved	0.0484	0.0001	mg/L	0.0430		113	75-125			
Arsenic, dissolved	0.441	0.0005	mg/L	0.438		101	81-119			
Barium, dissolved	3.33	0.005	mg/L	3.35		99	83-117			
Beryllium, dissolved	0.201	0.0001	mg/L	0.213		94	80-120			
Boron, dissolved	1.63	0.004	mg/L	1.74		94	74-117			
Cadmium, dissolved	0.213	0.00001	mg/L	0.224		95	83-117			
Calcium, dissolved	7.9	0.2	mg/L	7.69		103	76-124			
Chromium, dissolved	0.459	0.0005	mg/L	0.437		105	81-119			
Cobalt, dissolved	0.135	0.00005	mg/L	0.128		106	76-124			
Copper, dissolved	0.866	0.0002	mg/L	0.844		103	84-116			
Iron, dissolved	1.35	0.010	mg/L	1.29		105	74-126			
Lead, dissolved	0.107	0.0001	mg/L	0.112		95	72-128			
Lithium, dissolved	0.0990	0.0001	mg/L	0.104		95	60-140			
Magnesium, dissolved	7.35	0.01	mg/L	6.92		106	81-119			
Manganese, dissolved	0.376	0.0002	mg/L	0.345		109	84-116			
Molybdenum, dissolved	0.424	0.0001	mg/L	0.426		100	83-117			
Nickel, dissolved	0.873	0.0002	mg/L	0.840		104	74-126			
Phosphorus, dissolved	0.54	0.02	mg/L	0.495		110	68-132			
Potassium, dissolved	3.74	0.02	mg/L	3.19		117	74-126			
Selenium, dissolved	0.0345	0.0005	mg/L	0.0331		104	70-130			
Sodium, dissolved	20.4	0.02	mg/L	19.1		107	72-128			
Strontium, dissolved	0.967	0.001	mg/L	0.916		106	84-113			
Thallium, dissolved	0.0364	0.00002	mg/L	0.0393		93	57-143			
Uranium, dissolved	0.244	0.00002	mg/L	0.266		92	85-115			
Vanadium, dissolved	0.905	0.001	mg/L	0.869		104	87-113			
Zinc, dissolved	0.892	0.004	mg/L	0.881		101	72-128			
General Parameters, Batch B4L0602										
Blank (B4L0602-BLK1)				Prepared: Dec-11-14, Analyzed: Dec-11-14						
Alkalinity, Total as CaCO3	< 1	1	mg/L							
Alkalinity, Phenolphthalein as CaCO3	< 1	1	mg/L							
Alkalinity, Bicarbonate as CaCO3	< 1	1	mg/L							
Alkalinity, Carbonate as CaCO3	< 1	1	mg/L							
Alkalinity, Hydroxide as CaCO3	< 1	1	mg/L							

CARO ANALYTICAL SERVICES

QUALITY CONTROL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4120569
REPORTED Dec-17-14

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	RPD	RPD Limit	Notes
General Parameters, Batch B4L0602, Continued										
Blank (B4L0602-BLK2)				Prepared: Dec-11-14, Analyzed: Dec-11-14						
Alkalinity, Total as CaCO3	< 1	1	mg/L							
Alkalinity, Phenolphthalein as CaCO3	< 1	1	mg/L							
Alkalinity, Bicarbonate as CaCO3	< 1	1	mg/L							
Alkalinity, Carbonate as CaCO3	< 1	1	mg/L							
Alkalinity, Hydroxide as CaCO3	< 1	1	mg/L							
LCS (B4L0602-BS1)				Prepared: Dec-11-14, Analyzed: Dec-11-14						
Alkalinity, Total as CaCO3	101	1	mg/L	100		101	96-108			
LCS (B4L0602-BS2)				Prepared: Dec-11-14, Analyzed: Dec-11-14						
Alkalinity, Total as CaCO3	103	1	mg/L	100		103	96-108			
Total Recoverable Metals, Batch B4L0551										
Blank (B4L0551-BLK1)				Prepared: Dec-11-14, Analyzed: Dec-12-14						
Aluminum, total	< 0.005	0.005	mg/L							
Antimony, total	< 0.0001	0.0001	mg/L							
Arsenic, total	< 0.0005	0.0005	mg/L							
Barium, total	< 0.005	0.005	mg/L							
Beryllium, total	< 0.0001	0.0001	mg/L							
Bismuth, total	< 0.0001	0.0001	mg/L							
Boron, total	< 0.004	0.004	mg/L							
Cadmium, total	< 0.00001	0.00001	mg/L							
Calcium, total	< 0.2	0.2	mg/L							
Chromium, total	< 0.0005	0.0005	mg/L							
Cobalt, total	< 0.00005	0.00005	mg/L							
Copper, total	< 0.0002	0.0002	mg/L							
Iron, total	< 0.01	0.01	mg/L							
Lead, total	< 0.0001	0.0001	mg/L							
Lithium, total	< 0.0001	0.0001	mg/L							
Magnesium, total	< 0.01	0.01	mg/L							
Manganese, total	< 0.0002	0.0002	mg/L							
Mercury, total	< 0.00002	0.00002	mg/L							
Molybdenum, total	< 0.0001	0.0001	mg/L							
Nickel, total	< 0.0002	0.0002	mg/L							
Phosphorus, total	< 0.020	0.020	mg/L							
Potassium, total	< 0.02	0.02	mg/L							
Selenium, total	< 0.0005	0.0005	mg/L							
Silicon, total	< 0.5	0.5	mg/L							
Silver, total	< 0.00005	0.00005	mg/L							
Sodium, total	< 0.02	0.02	mg/L							
Strontium, total	< 0.001	0.001	mg/L							
Sulfur, total	< 1	1	mg/L							
Tellurium, total	< 0.0002	0.0002	mg/L							
Thallium, total	< 0.00002	0.00002	mg/L							
Thorium, total	< 0.0001	0.0001	mg/L							
Tin, total	< 0.0002	0.0002	mg/L							
Titanium, total	< 0.005	0.005	mg/L							
Uranium, total	< 0.00002	0.00002	mg/L							
Vanadium, total	< 0.001	0.001	mg/L							
Zinc, total	< 0.004	0.004	mg/L							
Zirconium, total	< 0.0001	0.0001	mg/L							
Reference (B4L0551-SRM1)				Prepared: Dec-11-14, Analyzed: Dec-12-14						
Aluminum, total	0.306	0.005	mg/L	0.296		103	81-129			
Antimony, total	0.0500	0.0001	mg/L	0.0505		99	88-114			

CARO ANALYTICAL SERVICES

QUALITY CONTROL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4120569
REPORTED Dec-17-14

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	RPD	RPD Limit	Notes
Total Recoverable Metals, Batch B4L0551, Continued										
Reference (B4L0551-SRM1), Continued				Prepared: Dec-11-14, Analyzed: Dec-12-14						
Arsenic, total	0.122	0.0005	mg/L	0.122		100	88-114			
Barium, total	0.682	0.005	mg/L	0.777		88	72-104			
Beryllium, total	0.0498	0.0001	mg/L	0.0488		102	76-131			
Boron, total	3.55	0.004	mg/L	3.40		104	75-121			
Cadmium, total	0.0487	0.00001	mg/L	0.0490		99	89-111			
Calcium, total	11.4	0.2	mg/L	10.2		111	86-121			
Chromium, total	0.255	0.0005	mg/L	0.242		105	89-114			
Cobalt, total	0.0390	0.00005	mg/L	0.0366		107	91-113			
Copper, total	0.517	0.0002	mg/L	0.487		106	91-115			
Iron, total	0.50	0.01	mg/L	0.469		106	77-124			
Lead, total	0.210	0.0001	mg/L	0.193		109	92-113			
Lithium, total	0.415	0.0001	mg/L	0.390		106	85-115			
Magnesium, total	3.56	0.01	mg/L	3.31		108	78-120			
Manganese, total	0.114	0.0002	mg/L	0.109		104	90-114			
Mercury, total	0.00485	0.00002	mg/L	0.00456		106	50-150			
Molybdenum, total	0.197	0.0001	mg/L	0.197		100	90-111			
Nickel, total	0.251	0.0002	mg/L	0.242		104	90-111			
Phosphorus, total	0.209	0.020	mg/L	0.233		90	85-115			
Potassium, total	6.47	0.02	mg/L	5.93		109	84-113			
Selenium, total	0.109	0.0005	mg/L	0.115		95	85-115			
Sodium, total	8.22	0.02	mg/L	7.64		108	82-123			
Strontium, total	0.396	0.001	mg/L	0.363		109	88-112			
Thallium, total	0.0869	0.00002	mg/L	0.0794		109	91-114			
Uranium, total	0.0202	0.00002	mg/L	0.0192		105	85-120			
Vanadium, total	0.388	0.001	mg/L	0.376		103	86-111			
Zinc, total	2.42	0.004	mg/L	2.42		100	85-111			

CARO ANALYTICAL SER

4120569

CHAIN-OF-CUSTODY RECORD COC#

CARO BC COC, Rev 03/13

Page 1 of 1

RELINQUISHED BY:	DATE: 9-Dec-14	RECEIVED BY: WL KF	DATE: 12/09
Patrick Lilley	TIME: 16:26		TIME: 16:26
RELINQUISHED BY:	DATE:	RECEIVED BY:	DATE:
	TIME:		TIME:

REPORT TO:

COMPANY: Kerr Wood Leidal Associates
ADDRESS: 200-4185A Still Creek Drive
Burnaby, BC V5C 6G9
CONTACT: Patrick Lilley
TEL / FAX: 604-293-3121 604-294-2090
EMAIL PDF ☑ EDD ☐ **Please email Excel file.**
EMAIL 1: plilley@kwl.ca
EMAIL 2:
MAIL HARDCOPY ☐ HOLD FOR P/U ☐ FAX ☐

INVOICE TO: SAME AS REPORT TO ☐

COMPANY: Kerr Wood Leidal Associates
ADDRESS: 200-4185A Still Creek Drive
Burnaby, BC V5C 6G9
CONTACT: Patrick Lilley / Michelle Derer
TEL / FAX: 604-294-2088 604-294-2090
EMAIL PDF ☑
EMAIL 1: plilley@kwl.ca
EMAIL 2: mderer@kwl.ca
MAIL HARDCOPY ☐ HOLD FOR P/U ☐

PROJECT: 173.169 Maple Ridge WQ
PROJECT INFO: Stormwater Monitoring
PO #:
SAMPLED BY: Patrick Lilley
SHIPPING INSTRUCTIONS: RETURN COOLER(S) ☐
SHIP SUPPLIES (PLEASE SPECIFY IN OTHER INSTRUCTIONS SECTION) ☐

TURNAROUND Routine (4-7 days) ☑ Other:
TIME REQUESTED: Rush:* 1 Day ☐ 2 Day ☐ 3 Day ☐ * Contact the lab to confirm, surcharges may apply

ANALYSES REQUESTED:

	CLIENT SAMPLE ID:	MATRIX: DRINKING WATER	OTHER WATER	SOIL	OTHER	# CONTAINERS	SAMPLING: DATE DD-MMM-YY	TIME HH:MM	COMMENTS: CHLORINATED	FILTERED	PRESERVED	(i.e. flow/volume media ID/notes)
01	SA-1 (T2 Creek)	☐	☑	☐	☐	6	9-Dec-14	12:55	☐	☑	☑	See below
02	SA-2 (Millionaire Creek)	☐	☑	☐	☐	6	9-Dec-14	13:30	☐	☑	☑	See below
03	K-1 (Dunlop Creek)	☐	☑	☐	☐	6	9-Dec-14	14:30	☐	☑	☑	See below
04	K-2 (Spencer Creek)	☐	☑	☐	☐	6	9-Dec-14	15:00	☐	☑	☑	See below
05	Field Blank	☐	☑	☐	☐	1	9-Dec-14	14:30	☐	☐	☑	See below
06	Trip Blank	☐	☑	☐	☐	1	9-Dec-14	11:44	☐	☐	☑	-
		☐	☐	☐	☐				☐	☐	☐	
		☐	☐	☐	☐				☐	☐	☐	
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		☐	☐	☐	☐				☐	☐	☐	
		☐	☐	☐	☐				☐	☐	☐	

	BTEX ☐ VPH ☐ MTBE	EPH (not PAH Corrected)	VOC ☐ VPH ☐	L/HEPH (PAH Corrected)	PAH	PHENOLS Chlorinated ☐ Non-Chlor	PCB ☐ GLYCOLS ☐ HAA	METALS - WATER TOTAL (ICPMS - LOW Pkg.)	METALS - WATER DISSOLVED (ICPMS - LOW Pkg.)	Metals - SOIL (SALM) ☐ Inc. pH	pH ☐ EC ☐ Alk	TSS ☐ TDS ☐	BOD ☐ COD ☐	FECAL COLIFORMS ☐ HPC	TOTAL COLIFORMS ☐ E-COLI	PESTICIDES ☐ HERBICIDES	SOIL VAPOUR	ASBESTOS	NITRATE-N						HOLD
01	☐	☐	☐	☐	☐	☐	☐	☑	☑	☐	☑	☐	☐	☑	☑	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐
02	☐	☐	☐	☐	☐	☐	☐	☑	☑	☐	☑	☐	☐	☑	☑	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐
03	☐	☐	☐	☐	☐	☐	☐	☑	☑	☐	☑	☐	☐	☑	☑	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐
04	☐	☐	☐	☐	☐	☐	☐	☑	☑	☐	☑	☐	☐	☑	☑	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐
05	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
06	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑
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APPLICABLE REGULATORY LIMITS:
Canadian Drinking Water Quality Guidelines ☐
BC Drinking Water Protection Act/Reg. ☐
BC CSR: AL ☐ RL ☐ CL ☐ IL ☐ AW ☐
CCME ☑ Alberta Tier 1 ☐
OTHER: BC WQ Guidelines for Aquatic Life

SAMPLE RETENTION INSTRUCTIONS (Discarded 30 days after Report unless otherwise specified):
60 Days ☐ 90 Days ☐ Longer Date (Surcharges will apply):

OTHER INSTRUCTIONS:
Total and dissolved metals, mercury, and bacteriological samples have been preserved. Dissolved metals samples (incl. mercury) have also been filtered. Metals analysis should be LOW level ICPMS pkg. Add total + dissolved Hg. Alkalinity = SPECIATED alkalinity. Use higher dilutions for bacteriological tests pls.

PAYMENT
Cheque ☐
Credit ☐
Debit ☐
Cash ☐
Invoice ☐

SAMPLE RECEIPT TEMP (°C): 8.7
Work Order # _____
CUSTODY SEALS INTACT: ☐Y ☐N ☐NA

Required Fields Recommended Fields **SHADED AREAS:** LAB USE ONLY

CARO ANALYTICAL SERVICES

CERTIFICATE OF ANALYSIS

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby) 200 - 4185A Still Creek Dr Burnaby, BC V5C 6G9	**TEL** **FAX**	(604) 294-2088 (604) 294-2090
ATTENTION	Patrick Lilley	**WORK ORDER**	4120915
PO NUMBER		**RECEIVED / TEMP**	Dec-16-14 14:12 / 7°C
PROJECT	173.169 Maple Ridge WQ	**REPORTED**	Dec-23-14
PROJECT INFO	Stormwater Monitoring		

General Comments:

CARO Analytical Services employs methods which are conducted according to procedures accepted by appropriate regulatory agencies, and/or are conducted in accordance with recognized professional standards using accepted testing methodologies and quality control efforts, except where otherwise agreed to by the client.

The results in this report apply to the samples analyzed in accordance with the Chain of Custody or Sample Requisition document. This analytical report must be reproduced in its entirety. CARO is not responsible for any loss or damage resulting directly or indirectly from error or omission in the conduct of testing. Liability is limited to the cost of analysis. Samples will be disposed of 30 days after the test report has been issued unless otherwise agreed to in writing.

Issued By: **Karin Miyazaki For Jennifer Shanko, AScT**
Administration Coordinator

Please contact CARO if more information is needed or to provide feedback on our services.

Locations:

#110 4011 Viking Way
Richmond, BC V6V 2K9
Tel: 604-279-1499 Fax: 604-279-1599

#102 3677 Highway 97N
Kelowna, BC V1X 5C3
Tel: 250-765-9646 Fax: 250-765-3893

17225 109 Avenue
Edmonton, AB T5S 1H7
Tel: 780-489-9100 Fax: 780-489-9700

www.caro.ca

CARO ANALYTICAL SERVICES

ANALYSIS INFORMATION

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4120915
REPORTED Dec-23-14

Analysis Description	Method Reference	Technique	Location
Alkalinity (Speciated)	APHA 2320 B	Titration with H2SO4 to pH 4.5	Kelowna
Anions in Water by IC	APHA 4110 B	Ion Chromatography with Chemical Suppression of Eluent Conductivity	Kelowna
Dissolved Metals	APHA 3030 B / APHA 3125 B	0.45 µm Filtration / Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	Richmond
E. Coli (MPN)	APHA 9221	Multiple-Tube Fermentation	Kelowna
Fecal Coliforms (MPN)	APHA 9221 E	Multiple-Tube Fermentation	Kelowna
Hardness (as CaCO3)	APHA 2340 B	Calculation	N/A
Total Coliforms (MPN)	APHA 9221 B	Multiple-Tube Fermentation	Kelowna
Total Recoverable Metals	APHA 3030E * / APHA 3125 B	HNO3+HCl Hot Block Digestion / Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	Richmond

Note: An asterisk in the Method Reference indicates that the CARO method has been modified from the reference method

Method Reference Descriptions:

APHA	Standard Methods for the Examination of Water and Wastewater, 22nd Edition, American Public Health Association/American Water Works Association/Water Environment Federation

Glossary of Terms:

MRL	Method Reporting Limit
<	Less than the Reported Detection Limit (RDL) - the RDL may be higher than the MRL due to various factors such as dilutions, limited sample volume, high moisture, or interferences
mg/L	Milligrams per litre
MPN/100 mL	Most Probable Number per 100 millilitres

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4120915
REPORTED Dec-23-14

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SA-1 (T2 Creek) (4120915-01) [Water] Sampled: Dec-16-14 10:45							
Anions							
Nitrate as N	**1.40**	N/A	0.010	mg/L	N/A	Dec-17-14	
General Parameters							
Alkalinity, Total as CaCO3	**48**	N/A	1	mg/L	N/A	Dec-17-14	
Alkalinity, Phenolphthalein as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-17-14	
Alkalinity, Bicarbonate as CaCO3	**48**	N/A	1	mg/L	N/A	Dec-17-14	
Alkalinity, Carbonate as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-17-14	
Alkalinity, Hydroxide as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-17-14	
Calculated Parameters							
Hardness, Total (Total as CaCO3)	**59.6**	N/A	0.50	mg/L	N/A	N/A	
Hardness, Total (Diss. as CaCO3)	**57.6**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.009**	N/A	0.005	mg/L	N/A	Dec-19-14	
Antimony, dissolved	**0.0001**	N/A	0.0001	mg/L	N/A	Dec-19-14	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-19-14	
Barium, dissolved	**0.010**	N/A	0.005	mg/L	N/A	Dec-19-14	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-19-14	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-19-14	
Boron, dissolved	**0.016**	N/A	0.004	mg/L	N/A	Dec-19-14	
Cadmium, dissolved	**0.00001**	N/A	0.00001	mg/L	N/A	Dec-19-14	
Calcium, dissolved	**13.7**	N/A	0.2	mg/L	N/A	Dec-19-14	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-19-14	
Cobalt, dissolved	**0.00007**	N/A	0.00005	mg/L	N/A	Dec-19-14	
Copper, dissolved	**0.0010**	N/A	0.0002	mg/L	N/A	Dec-19-14	
Iron, dissolved	**0.056**	N/A	0.010	mg/L	N/A	Dec-19-14	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-19-14	
Lithium, dissolved	**0.0008**	N/A	0.0001	mg/L	N/A	Dec-19-14	
Magnesium, dissolved	**5.71**	N/A	0.01	mg/L	N/A	Dec-19-14	
Manganese, dissolved	**0.0203**	N/A	0.0002	mg/L	N/A	Dec-19-14	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Dec-19-14	
Molybdenum, dissolved	**0.0006**	N/A	0.0001	mg/L	N/A	Dec-19-14	
Nickel, dissolved	**0.0003**	N/A	0.0002	mg/L	N/A	Dec-19-14	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	Dec-19-14	
Potassium, dissolved	**1.44**	N/A	0.02	mg/L	N/A	Dec-19-14	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-19-14	
Silicon, dissolved	**10.2**	N/A	0.5	mg/L	N/A	Dec-19-14	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	Dec-19-14	
Sodium, dissolved	**11.2**	N/A	0.02	mg/L	N/A	Dec-19-14	
Strontium, dissolved	**0.096**	N/A	0.001	mg/L	N/A	Dec-19-14	
Sulfur, dissolved	< 1	N/A	1	mg/L	N/A	Dec-19-14	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Dec-19-14	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Dec-19-14	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-19-14	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Dec-19-14	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	Dec-19-14	

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4120915
REPORTED Dec-23-14

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SA-1 (T2 Creek) (4120915-01) [Water] Sampled: Dec-16-14 10:45, Continued							
Dissolved Metals, Continued							
Uranium, dissolved	**0.00003**	N/A	0.00002	mg/L	N/A	Dec-19-14	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	Dec-19-14	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	Dec-19-14	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-19-14	
Total Recoverable Metals							
Aluminum, total	**0.132**	N/A	0.005	mg/L	Dec-17-14	Dec-19-14	
Antimony, total	**0.0002**	N/A	0.0001	mg/L	Dec-17-14	Dec-19-14	
Arsenic, total	**0.0005**	N/A	0.0005	mg/L	Dec-17-14	Dec-19-14	
Barium, total	**0.011**	N/A	0.005	mg/L	Dec-17-14	Dec-19-14	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	Dec-17-14	Dec-19-14	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	Dec-17-14	Dec-19-14	
Boron, total	**0.018**	N/A	0.004	mg/L	Dec-17-14	Dec-19-14	
Cadmium, total	**0.00001**	N/A	0.00001	mg/L	Dec-17-14	Dec-19-14	
Calcium, total	**14.0**	N/A	0.2	mg/L	Dec-17-14	Dec-19-14	
Chromium, total	**0.0006**	N/A	0.0005	mg/L	Dec-17-14	Dec-19-14	
Cobalt, total	**0.00011**	N/A	0.00005	mg/L	Dec-17-14	Dec-19-14	
Copper, total	**0.0015**	N/A	0.0002	mg/L	Dec-17-14	Dec-19-14	
Iron, total	**0.22**	N/A	0.01	mg/L	Dec-17-14	Dec-19-14	
Lead, total	**0.0001**	N/A	0.0001	mg/L	Dec-17-14	Dec-19-14	
Lithium, total	**0.0010**	N/A	0.0001	mg/L	Dec-17-14	Dec-19-14	
Magnesium, total	**5.96**	N/A	0.01	mg/L	Dec-17-14	Dec-19-14	
Manganese, total	**0.0240**	N/A	0.0002	mg/L	Dec-17-14	Dec-19-14	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	Dec-17-14	Dec-19-14	
Molybdenum, total	**0.0007**	N/A	0.0001	mg/L	Dec-17-14	Dec-19-14	
Nickel, total	**0.0005**	N/A	0.0002	mg/L	Dec-17-14	Dec-19-14	
Phosphorus, total	**0.026**	N/A	0.020	mg/L	Dec-17-14	Dec-19-14	
Potassium, total	**1.43**	N/A	0.02	mg/L	Dec-17-14	Dec-19-14	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	Dec-17-14	Dec-19-14	
Silicon, total	**10.6**	N/A	0.5	mg/L	Dec-17-14	Dec-19-14	
Silver, total	< 0.00005	N/A	0.00005	mg/L	Dec-17-14	Dec-19-14	
Sodium, total	**11.6**	N/A	0.02	mg/L	Dec-17-14	Dec-19-14	
Strontium, total	**0.102**	N/A	0.001	mg/L	Dec-17-14	Dec-19-14	
Sulfur, total	< 1	N/A	1	mg/L	Dec-17-14	Dec-19-14	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	Dec-17-14	Dec-19-14	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	Dec-17-14	Dec-19-14	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	Dec-17-14	Dec-19-14	
Tin, total	< 0.0002	N/A	0.0002	mg/L	Dec-17-14	Dec-19-14	
Titanium, total	**0.007**	N/A	0.005	mg/L	Dec-17-14	Dec-19-14	
Uranium, total	**0.00004**	N/A	0.00002	mg/L	Dec-17-14	Dec-19-14	
Vanadium, total	**0.002**	N/A	0.001	mg/L	Dec-17-14	Dec-19-14	
Zinc, total	**0.006**	N/A	0.004	mg/L	Dec-17-14	Dec-19-14	
Zirconium, total	**0.0003**	N/A	0.0001	mg/L	Dec-17-14	Dec-19-14	
Microbiological Parameters							
Coliforms, Total (MPN)	**750**	N/A	3.0	MPN/100 mL	Dec-17-14	Dec-18-14	

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4120915
REPORTED Dec-23-14

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SA-1 (T2 Creek) (4120915-01) [Water] Sampled: Dec-16-14 10:45, Continued							
Microbiological Parameters, Continued							
Coliforms, Fecal (MPN)	**91**	N/A	3.0	MPN/100 mL	Dec-17-14	Dec-18-14	
E. coli (MPN)	**91**	N/A	3.0	MPN/100 mL	Dec-17-14	Dec-18-14	
Sample ID: SA-2 (Millionaire Creek) (4120915-02) [Water] Sampled: Dec-16-14 11:20							
Anions							
Nitrate as N	**0.298**	N/A	0.010	mg/L	N/A	Dec-17-14	
General Parameters							
Alkalinity, Total as CaCO3	**8**	N/A	1	mg/L	N/A	Dec-17-14	
Alkalinity, Phenolphthalein as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-17-14	
Alkalinity, Bicarbonate as CaCO3	**8**	N/A	1	mg/L	N/A	Dec-17-14	
Alkalinity, Carbonate as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-17-14	
Alkalinity, Hydroxide as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-17-14	
Calculated Parameters							
Hardness, Total (Total as CaCO3)	**10.3**	N/A	0.50	mg/L	N/A	N/A	
Hardness, Total (Diss. as CaCO3)	**9.17**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.030**	N/A	0.005	mg/L	N/A	Dec-19-14	
Antimony, dissolved	**0.0003**	N/A	0.0001	mg/L	N/A	Dec-19-14	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-19-14	
Barium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	Dec-19-14	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-19-14	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-19-14	
Boron, dissolved	< 0.004	N/A	0.004	mg/L	N/A	Dec-19-14	
Cadmium, dissolved	**0.00001**	N/A	0.00001	mg/L	N/A	Dec-19-14	
Calcium, dissolved	**2.7**	N/A	0.2	mg/L	N/A	Dec-19-14	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-19-14	
Cobalt, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	Dec-19-14	
Copper, dissolved	**0.0003**	N/A	0.0002	mg/L	N/A	Dec-19-14	
Iron, dissolved	**0.033**	N/A	0.010	mg/L	N/A	Dec-19-14	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-19-14	
Lithium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-19-14	
Magnesium, dissolved	**0.59**	N/A	0.01	mg/L	N/A	Dec-19-14	
Manganese, dissolved	**0.0021**	N/A	0.0002	mg/L	N/A	Dec-19-14	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Dec-19-14	
Molybdenum, dissolved	**0.0003**	N/A	0.0001	mg/L	N/A	Dec-19-14	
Nickel, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Dec-19-14	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	Dec-19-14	
Potassium, dissolved	**0.19**	N/A	0.02	mg/L	N/A	Dec-19-14	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-19-14	
Silicon, dissolved	**4.5**	N/A	0.5	mg/L	N/A	Dec-19-14	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	Dec-19-14	
Sodium, dissolved	**2.05**	N/A	0.02	mg/L	N/A	Dec-19-14	
Strontium, dissolved	**0.022**	N/A	0.001	mg/L	N/A	Dec-19-14	

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4120915
REPORTED Dec-23-14

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SA-2 (Millionaire Creek) (4120915-02) [Water] Sampled: Dec-16-14 11:20, Continued							
Dissolved Metals, Continued							
Sulfur, dissolved	< 1	N/A	1	mg/L	N/A	Dec-19-14	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Dec-19-14	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Dec-19-14	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-19-14	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Dec-19-14	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	Dec-19-14	
Uranium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Dec-19-14	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	Dec-19-14	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	Dec-19-14	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-19-14	
Total Recoverable Metals							
Aluminum, total	**0.099**	N/A	0.005	mg/L	Dec-17-14	Dec-19-14	
Antimony, total	**0.0002**	N/A	0.0001	mg/L	Dec-17-14	Dec-19-14	
Arsenic, total	< 0.0005	N/A	0.0005	mg/L	Dec-17-14	Dec-19-14	
Barium, total	< 0.005	N/A	0.005	mg/L	Dec-17-14	Dec-19-14	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	Dec-17-14	Dec-19-14	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	Dec-17-14	Dec-19-14	
Boron, total	**0.005**	N/A	0.004	mg/L	Dec-17-14	Dec-19-14	
Cadmium, total	**0.00002**	N/A	0.00001	mg/L	Dec-17-14	Dec-19-14	
Calcium, total	**3.0**	N/A	0.2	mg/L	Dec-17-14	Dec-19-14	
Chromium, total	< 0.0005	N/A	0.0005	mg/L	Dec-17-14	Dec-19-14	
Cobalt, total	< 0.00005	N/A	0.00005	mg/L	Dec-17-14	Dec-19-14	
Copper, total	**0.0008**	N/A	0.0002	mg/L	Dec-17-14	Dec-19-14	
Iron, total	**0.10**	N/A	0.01	mg/L	Dec-17-14	Dec-19-14	
Lead, total	**0.0001**	N/A	0.0001	mg/L	Dec-17-14	Dec-19-14	
Lithium, total	**0.0002**	N/A	0.0001	mg/L	Dec-17-14	Dec-19-14	
Magnesium, total	**0.66**	N/A	0.01	mg/L	Dec-17-14	Dec-19-14	
Manganese, total	**0.0040**	N/A	0.0002	mg/L	Dec-17-14	Dec-19-14	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	Dec-17-14	Dec-19-14	
Molybdenum, total	**0.0003**	N/A	0.0001	mg/L	Dec-17-14	Dec-19-14	
Nickel, total	< 0.0002	N/A	0.0002	mg/L	Dec-17-14	Dec-19-14	
Phosphorus, total	**0.026**	N/A	0.020	mg/L	Dec-17-14	Dec-19-14	
Potassium, total	**0.20**	N/A	0.02	mg/L	Dec-17-14	Dec-19-14	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	Dec-17-14	Dec-19-14	
Silicon, total	**4.8**	N/A	0.5	mg/L	Dec-17-14	Dec-19-14	
Silver, total	< 0.00005	N/A	0.00005	mg/L	Dec-17-14	Dec-19-14	
Sodium, total	**2.26**	N/A	0.02	mg/L	Dec-17-14	Dec-19-14	
Strontium, total	**0.024**	N/A	0.001	mg/L	Dec-17-14	Dec-19-14	
Sulfur, total	< 1	N/A	1	mg/L	Dec-17-14	Dec-19-14	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	Dec-17-14	Dec-19-14	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	Dec-17-14	Dec-19-14	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	Dec-17-14	Dec-19-14	
Tin, total	< 0.0002	N/A	0.0002	mg/L	Dec-17-14	Dec-19-14	
Titanium, total	< 0.005	N/A	0.005	mg/L	Dec-17-14	Dec-19-14	
Uranium, total	< 0.00002	N/A	0.00002	mg/L	Dec-17-14	Dec-19-14	

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4120915
REPORTED Dec-23-14

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SA-2 (Millionaire Creek) (4120915-02) [Water] Sampled: Dec-16-14 11:20, Continued							
Total Recoverable Metals, Continued							
Vanadium, total	**0.001**	N/A	0.001	mg/L	Dec-17-14	Dec-19-14	
Zinc, total	< 0.004	N/A	0.004	mg/L	Dec-17-14	Dec-19-14	
Zirconium, total	< 0.0001	N/A	0.0001	mg/L	Dec-17-14	Dec-19-14	
Microbiological Parameters							
Coliforms, Total (MPN)	**29**	N/A	3.0	MPN/100 mL	Dec-17-14	Dec-18-14	
Coliforms, Fecal (MPN)	**3.6**	N/A	3.0	MPN/100 mL	Dec-17-14	Dec-18-14	
E. coli (MPN)	**3.6**	N/A	3.0	MPN/100 mL	Dec-17-14	Dec-18-14	
Sample ID: K-1 (Dunlop Creek) (4120915-03) [Water] Sampled: Dec-16-14 11:55							
Anions							
Nitrate as N	**0.928**	N/A	0.010	mg/L	N/A	Dec-17-14	
General Parameters							
Alkalinity, Total as CaCO3	**25**	N/A	1	mg/L	N/A	Dec-17-14	
Alkalinity, Phenolphthalein as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-17-14	
Alkalinity, Bicarbonate as CaCO3	**25**	N/A	1	mg/L	N/A	Dec-17-14	
Alkalinity, Carbonate as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-17-14	
Alkalinity, Hydroxide as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-17-14	
Calculated Parameters							
Hardness, Total (Total as CaCO3)	**33.6**	N/A	0.50	mg/L	N/A	N/A	
Hardness, Total (Diss. as CaCO3)	**28.4**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.040**	N/A	0.005	mg/L	N/A	Dec-19-14	
Antimony, dissolved	**0.0003**	N/A	0.0001	mg/L	N/A	Dec-19-14	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-19-14	
Barium, dissolved	**0.007**	N/A	0.005	mg/L	N/A	Dec-19-14	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-19-14	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-19-14	
Boron, dissolved	**0.011**	N/A	0.004	mg/L	N/A	Dec-19-14	
Cadmium, dissolved	**0.00001**	N/A	0.00001	mg/L	N/A	Dec-19-14	
Calcium, dissolved	**7.6**	N/A	0.2	mg/L	N/A	Dec-19-14	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-19-14	
Cobalt, dissolved	**0.00010**	N/A	0.00005	mg/L	N/A	Dec-19-14	
Copper, dissolved	**0.0011**	N/A	0.0002	mg/L	N/A	Dec-19-14	
Iron, dissolved	**0.091**	N/A	0.010	mg/L	N/A	Dec-19-14	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-19-14	
Lithium, dissolved	**0.0002**	N/A	0.0001	mg/L	N/A	Dec-19-14	
Magnesium, dissolved	**2.28**	N/A	0.01	mg/L	N/A	Dec-19-14	
Manganese, dissolved	**0.0132**	N/A	0.0002	mg/L	N/A	Dec-19-14	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Dec-19-14	
Molybdenum, dissolved	**0.0002**	N/A	0.0001	mg/L	N/A	Dec-19-14	
Nickel, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Dec-19-14	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	Dec-19-14	

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4120915
REPORTED Dec-23-14

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: K-1 (Dunlop Creek) (4120915-03) [Water] Sampled: Dec-16-14 11:55, Continued							
Dissolved Metals, Continued							
Potassium, dissolved	**1.38**	N/A	0.02	mg/L	N/A	Dec-19-14	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-19-14	
Silicon, dissolved	**5.6**	N/A	0.5	mg/L	N/A	Dec-19-14	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	Dec-19-14	
Sodium, dissolved	**4.48**	N/A	0.02	mg/L	N/A	Dec-19-14	
Strontium, dissolved	**0.051**	N/A	0.001	mg/L	N/A	Dec-19-14	
Sulfur, dissolved	< 1	N/A	1	mg/L	N/A	Dec-19-14	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Dec-19-14	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Dec-19-14	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-19-14	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Dec-19-14	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	Dec-19-14	
Uranium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Dec-19-14	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	Dec-19-14	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	Dec-19-14	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-19-14	
Total Recoverable Metals							
Aluminum, total	**0.442**	N/A	0.005	mg/L	Dec-17-14	Dec-19-14	
Antimony, total	**0.0003**	N/A	0.0001	mg/L	Dec-17-14	Dec-19-14	
Arsenic, total	< 0.0005	N/A	0.0005	mg/L	Dec-17-14	Dec-19-14	
Barium, total	**0.011**	N/A	0.005	mg/L	Dec-17-14	Dec-19-14	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	Dec-17-14	Dec-19-14	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	Dec-17-14	Dec-19-14	
Boron, total	**0.015**	N/A	0.004	mg/L	Dec-17-14	Dec-19-14	
Cadmium, total	< 0.00001	N/A	0.00001	mg/L	Dec-17-14	Dec-19-14	
Calcium, total	**9.0**	N/A	0.2	mg/L	Dec-17-14	Dec-19-14	
Chromium, total	**0.0008**	N/A	0.0005	mg/L	Dec-17-14	Dec-19-14	
Cobalt, total	**0.00025**	N/A	0.00005	mg/L	Dec-17-14	Dec-19-14	
Copper, total	**0.0019**	N/A	0.0002	mg/L	Dec-17-14	Dec-19-14	
Iron, total	**0.49**	N/A	0.01	mg/L	Dec-17-14	Dec-19-14	
Lead, total	**0.0002**	N/A	0.0001	mg/L	Dec-17-14	Dec-19-14	
Lithium, total	**0.0005**	N/A	0.0001	mg/L	Dec-17-14	Dec-19-14	
Magnesium, total	**2.67**	N/A	0.01	mg/L	Dec-17-14	Dec-19-14	
Manganese, total	**0.0212**	N/A	0.0002	mg/L	Dec-17-14	Dec-19-14	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	Dec-17-14	Dec-19-14	
Molybdenum, total	**0.0002**	N/A	0.0001	mg/L	Dec-17-14	Dec-19-14	
Nickel, total	**0.0007**	N/A	0.0002	mg/L	Dec-17-14	Dec-19-14	
Phosphorus, total	**0.036**	N/A	0.020	mg/L	Dec-17-14	Dec-19-14	
Potassium, total	**1.52**	N/A	0.02	mg/L	Dec-17-14	Dec-19-14	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	Dec-17-14	Dec-19-14	
Silicon, total	**6.9**	N/A	0.5	mg/L	Dec-17-14	Dec-19-14	
Silver, total	< 0.00005	N/A	0.00005	mg/L	Dec-17-14	Dec-19-14	
Sodium, total	**5.07**	N/A	0.02	mg/L	Dec-17-14	Dec-19-14	
Strontium, total	**0.059**	N/A	0.001	mg/L	Dec-17-14	Dec-19-14	
Sulfur, total	< 1	N/A	1	mg/L	Dec-17-14	Dec-19-14	

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4120915
REPORTED Dec-23-14

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: K-1 (Dunlop Creek) (4120915-03) [Water] Sampled: Dec-16-14 11:55, Continued							
Total Recoverable Metals, Continued							
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	Dec-17-14	Dec-19-14	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	Dec-17-14	Dec-19-14	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	Dec-17-14	Dec-19-14	
Tin, total	< 0.0002	N/A	0.0002	mg/L	Dec-17-14	Dec-19-14	
Titanium, total	**0.020**	N/A	0.005	mg/L	Dec-17-14	Dec-19-14	
Uranium, total	< 0.00002	N/A	0.00002	mg/L	Dec-17-14	Dec-19-14	
Vanadium, total	**0.002**	N/A	0.001	mg/L	Dec-17-14	Dec-19-14	
Zinc, total	**0.007**	N/A	0.004	mg/L	Dec-17-14	Dec-19-14	
Zirconium, total	**0.0003**	N/A	0.0001	mg/L	Dec-17-14	Dec-19-14	
Microbiological Parameters							
Coliforms, Total (MPN)	**430**	N/A	3.0	MPN/100 mL	Dec-17-14	Dec-18-14	
Coliforms, Fecal (MPN)	**36**	N/A	3.0	MPN/100 mL	Dec-17-14	Dec-18-14	
E. coli (MPN)	**36**	N/A	3.0	MPN/100 mL	Dec-17-14	Dec-18-14	
Sample ID: K-2 (Spenser Creek) (4120915-04) [Water] Sampled: Dec-16-14 12:20							
Anions							
Nitrate as N	**0.409**	N/A	0.010	mg/L	N/A	Dec-17-14	
General Parameters							
Alkalinity, Total as CaCO3	**54**	N/A	1	mg/L	N/A	Dec-17-14	
Alkalinity, Phenolphthalein as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-17-14	
Alkalinity, Bicarbonate as CaCO3	**54**	N/A	1	mg/L	N/A	Dec-17-14	
Alkalinity, Carbonate as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-17-14	
Alkalinity, Hydroxide as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-17-14	
Calculated Parameters							
Hardness, Total (Total as CaCO3)	**64.4**	N/A	0.50	mg/L	N/A	N/A	
Hardness, Total (Diss. as CaCO3)	**55.8**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.034**	N/A	0.005	mg/L	N/A	Dec-19-14	
Antimony, dissolved	**0.0003**	N/A	0.0001	mg/L	N/A	Dec-19-14	
Arsenic, dissolved	**0.0005**	N/A	0.0005	mg/L	N/A	Dec-19-14	
Barium, dissolved	**0.007**	N/A	0.005	mg/L	N/A	Dec-19-14	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-19-14	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-19-14	
Boron, dissolved	**0.010**	N/A	0.004	mg/L	N/A	Dec-19-14	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	Dec-19-14	
Calcium, dissolved	**15.1**	N/A	0.2	mg/L	N/A	Dec-19-14	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-19-14	
Cobalt, dissolved	**0.00011**	N/A	0.00005	mg/L	N/A	Dec-19-14	
Copper, dissolved	**0.0012**	N/A	0.0002	mg/L	N/A	Dec-19-14	
Iron, dissolved	**0.122**	N/A	0.010	mg/L	N/A	Dec-19-14	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-19-14	
Lithium, dissolved	**0.0004**	N/A	0.0001	mg/L	N/A	Dec-19-14	

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4120915
REPORTED Dec-23-14

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: K-2 (Spenser Creek) (4120915-04) [Water] Sampled: Dec-16-14 12:20, Continued							
Dissolved Metals, Continued							
Magnesium, dissolved	**4.41**	N/A	0.01	mg/L	N/A	Dec-19-14	
Manganese, dissolved	**0.0255**	N/A	0.0002	mg/L	N/A	Dec-19-14	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Dec-19-14	
Molybdenum, dissolved	**0.0004**	N/A	0.0001	mg/L	N/A	Dec-19-14	
Nickel, dissolved	**0.0004**	N/A	0.0002	mg/L	N/A	Dec-19-14	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	Dec-19-14	
Potassium, dissolved	**1.34**	N/A	0.02	mg/L	N/A	Dec-19-14	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-19-14	
Silicon, dissolved	**7.2**	N/A	0.5	mg/L	N/A	Dec-19-14	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	Dec-19-14	
Sodium, dissolved	**7.96**	N/A	0.02	mg/L	N/A	Dec-19-14	
Strontium, dissolved	**0.108**	N/A	0.001	mg/L	N/A	Dec-19-14	
Sulfur, dissolved	< 1	N/A	1	mg/L	N/A	Dec-19-14	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Dec-19-14	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Dec-19-14	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-19-14	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Dec-19-14	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	Dec-19-14	
Uranium, dissolved	**0.00003**	N/A	0.00002	mg/L	N/A	Dec-19-14	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	Dec-19-14	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	Dec-19-14	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-19-14	
Total Recoverable Metals							
Aluminum, total	**0.826**	N/A	0.005	mg/L	Dec-17-14	Dec-19-14	
Antimony, total	**0.0002**	N/A	0.0001	mg/L	Dec-17-14	Dec-19-14	
Arsenic, total	**0.0007**	N/A	0.0005	mg/L	Dec-17-14	Dec-19-14	
Barium, total	**0.013**	N/A	0.005	mg/L	Dec-17-14	Dec-19-14	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	Dec-17-14	Dec-19-14	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	Dec-17-14	Dec-19-14	
Boron, total	**0.012**	N/A	0.004	mg/L	Dec-17-14	Dec-19-14	
Cadmium, total	**0.00002**	N/A	0.00001	mg/L	Dec-17-14	Dec-19-14	
Calcium, total	**17.7**	N/A	0.2	mg/L	Dec-17-14	Dec-19-14	
Chromium, total	**0.0017**	N/A	0.0005	mg/L	Dec-17-14	Dec-19-14	
Cobalt, total	**0.00038**	N/A	0.00005	mg/L	Dec-17-14	Dec-19-14	
Copper, total	**0.0025**	N/A	0.0002	mg/L	Dec-17-14	Dec-19-14	
Iron, total	**0.85**	N/A	0.01	mg/L	Dec-17-14	Dec-19-14	
Lead, total	**0.0003**	N/A	0.0001	mg/L	Dec-17-14	Dec-19-14	
Lithium, total	**0.0008**	N/A	0.0001	mg/L	Dec-17-14	Dec-19-14	
Magnesium, total	**4.90**	N/A	0.01	mg/L	Dec-17-14	Dec-19-14	
Manganese, total	**0.0384**	N/A	0.0002	mg/L	Dec-17-14	Dec-19-14	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	Dec-17-14	Dec-19-14	
Molybdenum, total	**0.0005**	N/A	0.0001	mg/L	Dec-17-14	Dec-19-14	
Nickel, total	**0.0015**	N/A	0.0002	mg/L	Dec-17-14	Dec-19-14	
Phosphorus, total	**0.036**	N/A	0.020	mg/L	Dec-17-14	Dec-19-14	
Potassium, total	**1.50**	N/A	0.02	mg/L	Dec-17-14	Dec-19-14	

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4120915
REPORTED Dec-23-14

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: K-2 (Spenser Creek) (4120915-04) [Water] Sampled: Dec-16-14 12:20, Continued							
Total Recoverable Metals, Continued							
Selenium, total	< 0.0005	N/A	0.0005	mg/L	Dec-17-14	Dec-19-14	
Silicon, total	**9.0**	N/A	0.5	mg/L	Dec-17-14	Dec-19-14	
Silver, total	< 0.00005	N/A	0.00005	mg/L	Dec-17-14	Dec-19-14	
Sodium, total	**8.57**	N/A	0.02	mg/L	Dec-17-14	Dec-19-14	
Strontium, total	**0.119**	N/A	0.001	mg/L	Dec-17-14	Dec-19-14	
Sulfur, total	< 1	N/A	1	mg/L	Dec-17-14	Dec-19-14	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	Dec-17-14	Dec-19-14	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	Dec-17-14	Dec-19-14	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	Dec-17-14	Dec-19-14	
Tin, total	< 0.0002	N/A	0.0002	mg/L	Dec-17-14	Dec-19-14	
Titanium, total	**0.037**	N/A	0.005	mg/L	Dec-17-14	Dec-19-14	
Uranium, total	**0.00005**	N/A	0.00002	mg/L	Dec-17-14	Dec-19-14	
Vanadium, total	**0.003**	N/A	0.001	mg/L	Dec-17-14	Dec-19-14	
Zinc, total	**0.005**	N/A	0.004	mg/L	Dec-17-14	Dec-19-14	
Zirconium, total	**0.0008**	N/A	0.0001	mg/L	Dec-17-14	Dec-19-14	
Microbiological Parameters							
Coliforms, Total (MPN)	**930**	N/A	3.0	MPN/100 mL	Dec-17-14	Dec-18-14	
Coliforms, Fecal (MPN)	**23**	N/A	3.0	MPN/100 mL	Dec-17-14	Dec-18-14	
E. coli (MPN)	**23**	N/A	3.0	MPN/100 mL	Dec-17-14	Dec-18-14	
Sample ID: Field Blank (4120915-05) [Water] Sampled: Dec-16-14 12:20							
General Parameters							
Alkalinity, Total as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-17-14	
Alkalinity, Phenolphthalein as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-17-14	
Alkalinity, Bicarbonate as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-17-14	
Alkalinity, Carbonate as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-17-14	
Alkalinity, Hydroxide as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-17-14	

CARO ANALYTICAL SERVICES

QUALITY CONTROL DATA

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	4120915
PROJECT	173.169 Maple Ridge WQ	**REPORTED**	Dec-23-14

The following section displays the quality control (QC) data that is associated with your sample data. Groups of samples are prepared in "batches" and analyzed in conjunction with QC samples that ensure your data is of the highest quality. Common QC types include:

- **Method Blank (Blk)**: Laboratory reagent water is carried through sample preparation and analysis steps. Method Blanks indicate that results are free from contamination, i.e. not biased high from sources such as the sample container or the laboratory environment
- **Duplicate (Dup)**: Preparation and analysis of a replicate aliquot of a sample. Duplicates provide a measure of the analytical method's precision, i.e. how reproducible a result is. Duplicates are only reported if they are associated with your sample data.
- **Blank Spike (BS)**: A known amount of standard is carried through sample preparation and analysis steps. Blank Spikes, also known as laboratory control samples (LCS), are prepared from a different source of standard than used for the calibration. They ensure that the calibration is acceptable (i.e. not biased high or low) and also provide a measure of the analytical method's accuracy (i.e. closeness of the result to a target value).
- **Standard Reference Material (SRM)**: A material of similar matrix to the samples, externally certified for the parameter(s) listed. Standard Reference Materials ensure that the preparation steps in the method are adequate to achieve acceptable recoveries of the parameter(s) tested.

Each QC type is analyzed at a 5-10% frequency, i.e. one blank/duplicate/spike for every 10 samples. For all types of QC, the specified recovery (% Rec) and relative percent difference (RPD) limits are derived from long-term method performance averages and/or prescribed by the reference method.

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	RPD	RPD Limit	Notes
Anions, Batch B4L0862										
Blank (B4L0862-BLK1)				Prepared: Dec-17-14, Analyzed: Dec-17-14						
Nitrate as N	< 0.010	0.010	mg/L							
Blank (B4L0862-BLK2)				Prepared: Dec-18-14, Analyzed: Dec-18-14						
Nitrate as N	< 0.010	0.010	mg/L							
LCS (B4L0862-BS1)				Prepared: Dec-17-14, Analyzed: Dec-17-14						
Nitrate as N	3.93	0.010	mg/L	4.00		98	85-115			
LCS (B4L0862-BS2)				Prepared: Dec-17-14, Analyzed: Dec-17-14						
Nitrate as N	3.95	0.010	mg/L	4.00		99	85-115			
Dissolved Metals, Batch B4L0921										
Blank (B4L0921-BLK1)				Prepared: Dec-19-14, Analyzed: Dec-19-14						
Aluminum, dissolved	< 0.005	0.005	mg/L							
Antimony, dissolved	< 0.0001	0.0001	mg/L							
Arsenic, dissolved	< 0.0005	0.0005	mg/L							
Barium, dissolved	< 0.005	0.005	mg/L							
Beryllium, dissolved	< 0.0001	0.0001	mg/L							
Bismuth, dissolved	< 0.0001	0.0001	mg/L							
Boron, dissolved	< 0.004	0.004	mg/L							
Cadmium, dissolved	< 0.00001	0.00001	mg/L							
Calcium, dissolved	< 0.2	0.2	mg/L							
Chromium, dissolved	< 0.0005	0.0005	mg/L							
Cobalt, dissolved	< 0.00005	0.00005	mg/L							
Copper, dissolved	< 0.0002	0.0002	mg/L							
Iron, dissolved	< 0.010	0.010	mg/L							
Lead, dissolved	< 0.0001	0.0001	mg/L							
Lithium, dissolved	< 0.0001	0.0001	mg/L							
Magnesium, dissolved	< 0.01	0.01	mg/L							
Manganese, dissolved	< 0.0002	0.0002	mg/L							
Mercury, dissolved	< 0.00002	0.00002	mg/L							

CARO ANALYTICAL SERVICES

QUALITY CONTROL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4120915
REPORTED Dec-23-14

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	RPD	RPD Limit	Notes
Dissolved Metals, Batch B4L0921, Continued										
Blank (B4L0921-BLK1), Continued				Prepared: Dec-19-14, Analyzed: Dec-19-14						
Molybdenum, dissolved	< 0.0001	0.0001	mg/L							
Nickel, dissolved	< 0.0002	0.0002	mg/L							
Phosphorus, dissolved	< 0.02	0.02	mg/L							
Potassium, dissolved	< 0.02	0.02	mg/L							
Selenium, dissolved	< 0.0005	0.0005	mg/L							
Silicon, dissolved	< 0.5	0.5	mg/L							
Silver, dissolved	< 0.00005	0.00005	mg/L							
Sodium, dissolved	< 0.02	0.02	mg/L							
Strontium, dissolved	< 0.001	0.001	mg/L							
Sulfur, dissolved	< 1	1	mg/L							
Tellurium, dissolved	< 0.0002	0.0002	mg/L							
Thallium, dissolved	< 0.00002	0.00002	mg/L							
Thorium, dissolved	< 0.0001	0.0001	mg/L							
Tin, dissolved	< 0.0002	0.0002	mg/L							
Titanium, dissolved	< 0.005	0.005	mg/L							
Uranium, dissolved	< 0.00002	0.00002	mg/L							
Vanadium, dissolved	< 0.001	0.001	mg/L							
Zinc, dissolved	< 0.004	0.004	mg/L							
Zirconium, dissolved	< 0.0001	0.0001	mg/L							
Duplicate (B4L0921-DUP1)		**Source: 4120915-01**		Prepared: Dec-19-14, Analyzed: Dec-19-14						
Aluminum, dissolved	0.009	0.005	mg/L		0.009				11	
Antimony, dissolved	0.0001	0.0001	mg/L		0.0001				44	
Arsenic, dissolved	< 0.0005	0.0005	mg/L		< 0.0005				8	
Barium, dissolved	0.010	0.005	mg/L		0.010				7	
Beryllium, dissolved	< 0.0001	0.0001	mg/L		< 0.0001				14	
Bismuth, dissolved	< 0.0001	0.0001	mg/L		< 0.0001				20	
Boron, dissolved	0.014	0.004	mg/L		0.016				13	
Cadmium, dissolved	< 0.00001	0.00001	mg/L		0.00001				27	
Calcium, dissolved	13.1	0.2	mg/L		13.7			4	8	
Chromium, dissolved	< 0.0005	0.0005	mg/L		< 0.0005				14	
Cobalt, dissolved	0.00006	0.00005	mg/L		0.00007				10	
Copper, dissolved	0.0009	0.0002	mg/L		0.0010			2	28	
Iron, dissolved	0.056	0.010	mg/L		0.056			1	14	
Lead, dissolved	< 0.0001	0.0001	mg/L		< 0.0001				26	
Lithium, dissolved	0.0008	0.0001	mg/L		0.0008			6	14	
Magnesium, dissolved	5.64	0.01	mg/L		5.71			1	6	
Manganese, dissolved	0.0202	0.0002	mg/L		0.0203			< 1	9	
Mercury, dissolved	< 0.00002	0.00002	mg/L		< 0.00002				19	
Molybdenum, dissolved	0.0005	0.0001	mg/L		0.0006			18	19	
Nickel, dissolved	0.0003	0.0002	mg/L		0.0003				21	
Phosphorus, dissolved	< 0.02	0.02	mg/L		< 0.02				14	
Potassium, dissolved	1.41	0.02	mg/L		1.44			2	8	
Selenium, dissolved	< 0.0005	0.0005	mg/L		< 0.0005				36	
Silicon, dissolved	10.1	0.5	mg/L		10.2			< 1	12	
Silver, dissolved	0.00005	0.00005	mg/L		< 0.00005				20	
Sodium, dissolved	11.0	0.02	mg/L		11.2			1	6	
Strontium, dissolved	0.095	0.001	mg/L		0.096			1	6	
Sulfur, dissolved	< 1	1	mg/L		< 1				26	
Tellurium, dissolved	< 0.0002	0.0002	mg/L		< 0.0002				20	
Thallium, dissolved	< 0.00002	0.00002	mg/L		< 0.00002				13	
Thorium, dissolved	< 0.0001	0.0001	mg/L		< 0.0001				30	
Tin, dissolved	< 0.0002	0.0002	mg/L		< 0.0002				6	
Titanium, dissolved	< 0.005	0.005	mg/L		< 0.005				20	
Uranium, dissolved	0.00003	0.00002	mg/L		0.00003				14	
Vanadium, dissolved	< 0.001	0.001	mg/L		< 0.001				20	
Zinc, dissolved	< 0.004	0.004	mg/L		0.004				11	

CARO ANALYTICAL SERVICES

QUALITY CONTROL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4120915
REPORTED Dec-23-14

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	RPD	RPD Limit	Notes
Dissolved Metals, Batch B4L0921, Continued										
Duplicate (B4L0921-DUP1), Continued		**Source: 4120915-01**		Prepared: Dec-19-14, Analyzed: Dec-19-14						
Zirconium, dissolved	< 0.0001	0.0001	mg/L		< 0.0001				36	
Matrix Spike (B4L0921-MS1)		**Source: 4120915-02**		Prepared: Dec-19-14, Analyzed: Dec-19-14						
Antimony, dissolved	0.381	0.0001	mg/L	0.400	0.0003	95	76-114			
Arsenic, dissolved	0.165	0.0005	mg/L	0.200	< 0.0005	82	81-115			
Barium, dissolved	0.985	0.005	mg/L	1.00	< 0.005	98	80-113			
Beryllium, dissolved	0.0868	0.0001	mg/L	0.100	< 0.0001	87	69-109			
Cadmium, dissolved	0.0918	0.00001	mg/L	0.100	0.00001	92	83-110			
Chromium, dissolved	0.374	0.0005	mg/L	0.400	< 0.0005	94	85-115			
Cobalt, dissolved	0.378	0.00005	mg/L	0.400	< 0.00005	95	86-114			
Copper, dissolved	0.398	0.0002	mg/L	0.400	0.0003	99	82-119			
Iron, dissolved	1.90	0.010	mg/L	2.00	0.033	93	80-116			
Lead, dissolved	0.202	0.0001	mg/L	0.200	< 0.0001	101	83-112			
Manganese, dissolved	0.382	0.0002	mg/L	0.400	0.0021	95	62-131			
Nickel, dissolved	0.381	0.0002	mg/L	0.400	< 0.0002	95	81-115			
Selenium, dissolved	0.0795	0.0005	mg/L	0.100	< 0.0005	79	79-115			
Silver, dissolved	0.0944	0.00005	mg/L	0.100	< 0.00005	94	69-121			
Thallium, dissolved	0.101	0.00002	mg/L	0.100	< 0.00002	101	84-115			
Vanadium, dissolved	0.369	0.001	mg/L	0.400	< 0.001	92	83-113			
Zinc, dissolved	0.935	0.004	mg/L	1.00	< 0.004	93	82-115			
Reference (B4L0921-SRM1)				Prepared: Dec-19-14, Analyzed: Dec-19-14						
Aluminum, dissolved	0.221	0.005	mg/L	0.233		95	58-142			
Antimony, dissolved	0.0446	0.0001	mg/L	0.0430		104	75-125			
Arsenic, dissolved	0.385	0.0005	mg/L	0.438		88	81-119			
Barium, dissolved	3.41	0.005	mg/L	3.35		102	83-117			
Beryllium, dissolved	0.211	0.0001	mg/L	0.213		99	80-120			
Boron, dissolved	1.71	0.004	mg/L	1.74		98	74-117			
Cadmium, dissolved	0.213	0.00001	mg/L	0.224		95	83-117			
Calcium, dissolved	7.8	0.2	mg/L	7.69		101	76-124			
Chromium, dissolved	0.428	0.0005	mg/L	0.437		98	81-119			
Cobalt, dissolved	0.130	0.00005	mg/L	0.128		102	76-124			
Copper, dissolved	0.850	0.0002	mg/L	0.844		101	84-116			
Iron, dissolved	1.27	0.010	mg/L	1.29		98	74-126			
Lead, dissolved	0.117	0.0001	mg/L	0.112		104	72-128			
Lithium, dissolved	0.106	0.0001	mg/L	0.104		102	60-140			
Magnesium, dissolved	6.61	0.01	mg/L	6.92		95	81-119			
Manganese, dissolved	0.346	0.0002	mg/L	0.345		100	84-116			
Molybdenum, dissolved	0.428	0.0001	mg/L	0.426		100	83-117			
Nickel, dissolved	0.843	0.0002	mg/L	0.840		100	74-126			
Phosphorus, dissolved	0.44	0.02	mg/L	0.495		89	68-132			
Potassium, dissolved	3.10	0.02	mg/L	3.19		97	74-126			
Selenium, dissolved	0.0340	0.0005	mg/L	0.0331		103	70-130			
Sodium, dissolved	18.2	0.02	mg/L	19.1		95	72-128			
Strontium, dissolved	0.909	0.001	mg/L	0.916		99	84-113			
Thallium, dissolved	0.0387	0.00002	mg/L	0.0393		98	57-143			
Uranium, dissolved	0.254	0.00002	mg/L	0.266		95	85-115			
Vanadium, dissolved	0.831	0.001	mg/L	0.869		96	87-113			
Zinc, dissolved	0.849	0.004	mg/L	0.881		96	72-128			
General Parameters, Batch B4L0867										
Blank (B4L0867-BLK1)				Prepared: Dec-17-14, Analyzed: Dec-17-14						
Alkalinity, Total as CaCO3	< 1	1	mg/L							
Alkalinity, Phenolphthalein as CaCO3	< 1	1	mg/L							
Alkalinity, Bicarbonate as CaCO3	< 1	1	mg/L							

CARO ANALYTICAL SERVICES

QUALITY CONTROL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4120915
REPORTED Dec-23-14

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	RPD	RPD Limit	Notes
General Parameters, Batch B4L0867, Continued										
Blank (B4L0867-BLK1), Continued				Prepared: Dec-17-14, Analyzed: Dec-17-14						
Alkalinity, Carbonate as CaCO3	< 1	1	mg/L							
Alkalinity, Hydroxide as CaCO3	< 1	1	mg/L							
Blank (B4L0867-BLK2)				Prepared: Dec-17-14, Analyzed: Dec-17-14						
Alkalinity, Total as CaCO3	< 1	1	mg/L							
Alkalinity, Phenolphthalein as CaCO3	< 1	1	mg/L							
Alkalinity, Bicarbonate as CaCO3	< 1	1	mg/L							
Alkalinity, Carbonate as CaCO3	< 1	1	mg/L							
Alkalinity, Hydroxide as CaCO3	< 1	1	mg/L							
LCS (B4L0867-BS1)				Prepared: Dec-17-14, Analyzed: Dec-17-14						
Alkalinity, Total as CaCO3	105	1	mg/L	100		105	96-108			
LCS (B4L0867-BS2)				Prepared: Dec-17-14, Analyzed: Dec-17-14						
Alkalinity, Total as CaCO3	101	1	mg/L	100		101	96-108			
Microbiological Parameters, Batch B4L0836										
Blank (B4L0836-BLK1)				Prepared: Dec-17-14, Analyzed: Dec-18-14						
Coliforms, Total (MPN)	< 3.0	3.0	MPN/100 mL							
Coliforms, Fecal (MPN)	< 3.0	3.0	MPN/100 mL							
E. coli (MPN)	< 3.0	3.0	MPN/100 mL							
Blank (B4L0836-BLK2)				Prepared: Dec-17-14, Analyzed: Dec-18-14						
Coliforms, Total (MPN)	< 2.2	3.0	MPN/100 mL							
Coliforms, Fecal (MPN)	< 2.2	3.0	MPN/100 mL							
E. coli (MPN)	< 2.2	3.0	MPN/100 mL							
Duplicate (B4L0836-DUP2)				**Source: 4120915-01**	Prepared: Dec-17-14, Analyzed: Dec-18-14					
Coliforms, Total (MPN)	2400	3.0	MPN/100 mL		750			105	106	
Coliforms, Fecal (MPN)	91	3.0	MPN/100 mL		91			< 1	88	
E. coli (MPN)	91	3.0	MPN/100 mL		91			< 1	122	
Total Recoverable Metals, Batch B4L0827										
Blank (B4L0827-BLK1)				Prepared: Dec-17-14, Analyzed: Dec-19-14						
Aluminum, total	< 0.005	0.005	mg/L							
Antimony, total	< 0.0001	0.0001	mg/L							
Arsenic, total	< 0.0005	0.0005	mg/L							
Barium, total	< 0.005	0.005	mg/L							
Beryllium, total	< 0.0001	0.0001	mg/L							
Bismuth, total	< 0.0001	0.0001	mg/L							
Boron, total	< 0.004	0.004	mg/L							
Cadmium, total	< 0.00001	0.00001	mg/L							
Calcium, total	< 0.2	0.2	mg/L							
Chromium, total	< 0.0005	0.0005	mg/L							
Cobalt, total	< 0.00005	0.00005	mg/L							
Copper, total	< 0.0002	0.0002	mg/L							
Iron, total	< 0.01	0.01	mg/L							
Lead, total	< 0.0001	0.0001	mg/L							
Lithium, total	< 0.0001	0.0001	mg/L							
Magnesium, total	< 0.01	0.01	mg/L							
Manganese, total	< 0.0002	0.0002	mg/L							
Mercury, total	< 0.00002	0.00002	mg/L							
Molybdenum, total	< 0.0001	0.0001	mg/L							
Nickel, total	< 0.0002	0.0002	mg/L							

CARO ANALYTICAL SERVICES

QUALITY CONTROL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4120915
REPORTED Dec-23-14

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	RPD	RPD Limit	Notes
Total Recoverable Metals, Batch B4L0827, Continued										
Blank (B4L0827-BLK1), Continued				Prepared: Dec-17-14, Analyzed: Dec-19-14						
Phosphorus, total	< 0.020	0.020	mg/L							
Potassium, total	< 0.02	0.02	mg/L							
Selenium, total	< 0.0005	0.0005	mg/L							
Silicon, total	< 0.5	0.5	mg/L							
Silver, total	< 0.00005	0.00005	mg/L							
Sodium, total	< 0.02	0.02	mg/L							
Strontium, total	< 0.001	0.001	mg/L							
Sulfur, total	< 1	1	mg/L							
Tellurium, total	< 0.0002	0.0002	mg/L							
Thallium, total	< 0.00002	0.00002	mg/L							
Thorium, total	< 0.0001	0.0001	mg/L							
Tin, total	< 0.0002	0.0002	mg/L							
Titanium, total	< 0.005	0.005	mg/L							
Uranium, total	< 0.00002	0.00002	mg/L							
Vanadium, total	< 0.001	0.001	mg/L							
Zinc, total	< 0.004	0.004	mg/L							
Zirconium, total	< 0.0001	0.0001	mg/L							
Duplicate (B4L0827-DUP1)		**Source: 4120915-01**		Prepared: Dec-17-14, Analyzed: Dec-19-14						
Aluminum, total	0.121	0.005	mg/L		0.132			9	29	
Antimony, total	0.0002	0.0001	mg/L		0.0002				31	
Arsenic, total	< 0.0005	0.0005	mg/L		0.0005				15	
Barium, total	0.011	0.005	mg/L		0.011				9	
Beryllium, total	< 0.0001	0.0001	mg/L		< 0.0001				16	
Bismuth, total	< 0.0001	0.0001	mg/L		< 0.0001				20	
Boron, total	0.018	0.004	mg/L		0.018				29	
Cadmium, total	< 0.00001	0.00001	mg/L		0.00001				33	
Calcium, total	15.4	0.2	mg/L		14.0			9	12	
Chromium, total	0.0005	0.0005	mg/L		0.0006				12	
Cobalt, total	0.00011	0.00005	mg/L		0.00011				13	
Copper, total	0.0014	0.0002	mg/L		0.0015			5	37	
Iron, total	0.22	0.01	mg/L		0.22			< 1	18	
Lead, total	0.0001	0.0001	mg/L		0.0001				23	
Lithium, total	0.0010	0.0001	mg/L		0.0010			3	19	
Magnesium, total	6.00	0.01	mg/L		5.96			< 1	10	
Manganese, total	0.0242	0.0002	mg/L		0.0240			< 1	13	
Mercury, total	0.00003	0.00002	mg/L		< 0.00002				24	
Molybdenum, total	0.0007	0.0001	mg/L		0.0007			2	20	
Nickel, total	0.0006	0.0002	mg/L		0.0005				28	
Phosphorus, total	0.026	0.020	mg/L		0.026				24	
Potassium, total	1.43	0.02	mg/L		1.43			< 1	13	
Selenium, total	< 0.0005	0.0005	mg/L		< 0.0005				24	
Silicon, total	10.6	0.5	mg/L		10.6			< 1	11	
Silver, total	< 0.00005	0.00005	mg/L		< 0.00005				18	
Sodium, total	11.7	0.02	mg/L		11.6			< 1	10	
Strontium, total	0.103	0.001	mg/L		0.102			< 1	9	
Sulfur, total	< 1	1	mg/L		< 1				24	
Tellurium, total	< 0.0002	0.0002	mg/L		< 0.0002				20	
Thallium, total	< 0.00002	0.00002	mg/L		< 0.00002				24	
Thorium, total	< 0.0001	0.0001	mg/L		< 0.0001				18	
Tin, total	< 0.0002	0.0002	mg/L		< 0.0002				18	
Titanium, total	0.006	0.005	mg/L		0.007				32	
Uranium, total	0.00004	0.00002	mg/L		0.00004				14	
Vanadium, total	0.002	0.001	mg/L		0.002				17	
Zinc, total	0.005	0.004	mg/L		0.006				8	
Zirconium, total	< 0.0001	0.0001	mg/L		0.0003				60	

CARO ANALYTICAL SERVICES

QUALITY CONTROL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4120915
REPORTED Dec-23-14

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	RPD	RPD Limit	Notes
Total Recoverable Metals, Batch B4L0827, Continued										
Matrix Spike (B4L0827-MS1)		**Source: 4120915-02**		Prepared: Dec-17-14, Analyzed: Dec-19-14						
Antimony, total	0.460	0.0001	mg/L	0.400	0.0002	115	84-125			
Arsenic, total	0.178	0.0005	mg/L	0.200	< 0.0005	89	85-116			
Barium, total	1.11	0.005	mg/L	1.00	0.005	110	87-114			
Beryllium, total	0.0997	0.0001	mg/L	0.100	< 0.0001	100	72-116			
Cadmium, total	0.104	0.00001	mg/L	0.100	0.00002	104	90-112			
Chromium, total	0.422	0.0005	mg/L	0.400	< 0.0005	105	89-120			
Cobalt, total	0.429	0.00005	mg/L	0.400	0.00005	107	88-120			
Copper, total	0.452	0.0002	mg/L	0.400	0.0008	113	88-125			
Iron, total	2.22	0.01	mg/L	2.00	0.10	106	88-119			
Lead, total	0.226	0.0001	mg/L	0.200	0.0001	113	89-118			
Manganese, total	0.434	0.0002	mg/L	0.400	0.0040	107	84-120			
Nickel, total	0.438	0.0002	mg/L	0.400	< 0.0002	110	87-119			
Selenium, total	0.0904	0.0005	mg/L	0.100	< 0.0005	90	85-113			
Silver, total	0.109	0.00005	mg/L	0.100	< 0.00005	109	89-119			
Thallium, total	0.118	0.00002	mg/L	0.100	< 0.00002	118	92-119			
Vanadium, total	0.414	0.001	mg/L	0.400	0.001	103	87-117			
Zinc, total	1.06	0.004	mg/L	1.00	0.004	106	85-116			
Reference (B4L0827-SRM1)				Prepared: Dec-17-14, Analyzed: Dec-19-14						
Aluminum, total	0.304	0.005	mg/L	0.296		103	81-129			
Antimony, total	0.0519	0.0001	mg/L	0.0505		103	88-114			
Arsenic, total	0.122	0.0005	mg/L	0.122		100	88-114			
Barium, total	0.730	0.005	mg/L	0.777		94	72-104			
Beryllium, total	0.0467	0.0001	mg/L	0.0488		96	76-131			
Boron, total	3.68	0.004	mg/L	3.40		108	75-121			
Cadmium, total	0.0513	0.00001	mg/L	0.0490		105	89-111			
Calcium, total	10.2	0.2	mg/L	10.2		100	86-121			
Chromium, total	0.258	0.0005	mg/L	0.242		107	89-114			
Cobalt, total	0.0393	0.00005	mg/L	0.0366		107	91-113			
Copper, total	0.542	0.0002	mg/L	0.487		111	91-115			
Iron, total	0.51	0.01	mg/L	0.469		109	77-124			
Lead, total	0.206	0.0001	mg/L	0.193		107	92-113			
Lithium, total	0.390	0.0001	mg/L	0.390		100	85-115			
Magnesium, total	3.54	0.01	mg/L	3.31		107	78-120			
Manganese, total	0.112	0.0002	mg/L	0.109		103	90-114			
Mercury, total	0.00446	0.00002	mg/L	0.00456		98	50-150			
Molybdenum, total	0.214	0.0001	mg/L	0.197		109	90-111			
Nickel, total	0.255	0.0002	mg/L	0.242		105	90-111			
Phosphorus, total	0.217	0.020	mg/L	0.233		93	85-115			
Potassium, total	6.32	0.02	mg/L	5.93		106	84-113			
Selenium, total	0.111	0.0005	mg/L	0.115		97	85-115			
Sodium, total	7.92	0.02	mg/L	7.64		104	82-123			
Strontium, total	0.406	0.001	mg/L	0.363		112	88-112			
Thallium, total	0.0889	0.00002	mg/L	0.0794		112	91-114			
Uranium, total	0.0200	0.00002	mg/L	0.0192		104	85-120			
Vanadium, total	0.391	0.001	mg/L	0.376		104	86-111			
Zinc, total	2.54	0.004	mg/L	2.42		105	85-111			

CAF ANALYTICA

4120915

CHAIN-OF-CUSTODY RECORD

COC#

RELINQUISHED BY: Patrick Lilley	DATE: 16-Dec-14	RECEIVED BY: (W) KF	DATE: 12/16
	TIME: 14:09		TIME: 14:09
RELINQUISHED BY:	DATE:	RECEIVED BY:	DATE:
	TIME:		TIME:

REPORT TO:

COMPANY: Kerr Wood Leidal Associates
ADDRESS: 200-4185A Still Creek Drive, Burnaby, BC V5C 6G9
CONTACT: Patrick Lilley
TEL / FAX: 604-293-3121 604-294-2090
EMAIL PDF ☑ EDD ☐ **Please email Excel file.**
EMAIL 1: plilley@kwl.ca
EMAIL 2:
MAIL HARDCOPY ☐ HOLD FOR P/U ☐ FAX ☐

INVOICE TO: SAME AS REPORT TO ☐

COMPANY: Kerr Wood Leidal Associates
ADDRESS: 200-4185A Still Creek Drive, Burnaby, BC V5C 6G9
CONTACT: Patrick Lilley / Michelle Derer
TEL / FAX: 604-294-2088 604-294-2090
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EMAIL 1: plilley@kwl.ca
EMAIL 2: mderer@kwl.ca
MAIL HARDCOPY ☐ HOLD FOR P/U ☐

PROJECT: 173.169 Maple Ridge WQ	PROJECT INFO: Stormwater Monitoring	PO #:
SAMPLED BY: Patrick Lilley	SHIPPING INSTRUCTIONS: RETURN COOLER(S) ☐	SHIP SUPPLIES (PLEASE SPECIFY IN OTHER INSTRUCTIONS SECTION) ☐

TURNAROUND Routine (4-7 days) ☑ Other:
TIME REQUESTED: Rush:* 1 Day ☐ 2 Day ☐ 3 Day ☐ * Contact the lab to confirm, surcharges may apply

ANALYSES REQUESTED:

	CLIENT SAMPLE ID: (H120915)	MATRIX: DRINKING WATER	OTHER WATER	SOIL	OTHER	# CONTAINERS	SAMPLING: DATE DD-MMM-YY	TIME HH:MM	COMMENTS: CHLORINATED	FILTERED	PRESERVED	(i.e. flow/volume media ID/notes)	BTEX ☐ VPH ☐ MTBE ☐	EPH (not PAH Corrected)	VOC ☐ VPH ☐	L/HEPH (PAH Corrected)	PAH	PHENOLS Chlorinated ☐ Non-Chlor ☐	PCB ☐ GLYCOLS ☐ HAA ☐	METALS - WATER TOTAL (ICPMS - LOW Pkg.)	METALS - WATER DISSOLVED (ICPMS - LOW Pkg.)	Metals - SOIL (SALM) ☐ Inc. pH ☐	pH ☐ EC ☐ Alk ☑	TSS ☐ TDS ☐	BOD ☐ COD ☐	FECAL COLIFORMS ☑ HPC ☐	TOTAL COLIFORMS ☑ E-COLI ☑	PESTICIDES ☐ HERBICIDES ☐	SOIL VAPOUR	ASBESTOS	NITRATE-N	HOLD
	SA-1 (T2 Creek)	☐	☑	☐	☐	6	16-Dec-14	10:45	☐	☑	☑	See below	☐	☐	☐	☐	☐	☐	☐	☑	☑	☐	☑	☐	☐	☑	☑	☐	☐	☐	☑	☐
	SA-2 (Millionaire Creek)	☐	☑	☐	☐	6	16-Dec-14	11:20	☐	☑	☑	See below	☐	☐	☐	☐	☐	☐	☐	☑	☑	☐	☑	☐	☐	☑	☑	☐	☐	☐	☑	☐
	K-1 (Dunlop Creek)	☐	☑	☐	☐	6	16-Dec-14	11:55	☐	☑	☑	See below	☐	☐	☐	☐	☐	☐	☐	☑	☑	☐	☑	☐	☐	☑	☑	☐	☐	☐	☑	☐
	K-2 (Spencer Creek)	☐	☑	☐	☐	6	16-Dec-14	12:20	☐	☑	☑	See below	☐	☐	☐	☐	☐	☐	☐	☑	☑	☐	☑	☐	☐	☑	☑	☐	☐	☐	☑	☐
	Field Blank	☐	☑	☐	☐	1	16-Dec-14	12:20	☐	☐	☑	See below	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐
	Trip Blank	☐	☑	☐	☐	1	16-Dec-14	09:35	☐	☐	☐	-	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑
		☐	☐	☐	☐				☐	☐	☐		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
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		☐	☐	☐	☐				☐	☐	☐		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐				☐	☐	☐		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐				☐	☐	☐		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

APPLICABLE REGULATORY LIMITS:
Canadian Drinking Water Quality Guidelines ☐
BC Drinking Water Protection Act/Reg. ☐
BC CSR: AL ☐ RL ☐ CL ☐ IL ☐ AW ☐
CCME ☑ Alberta Tier 1 ☐
OTHER: BC WQ Guidelines for Aquatic Life

SAMPLE RETENTION INSTRUCTIONS (Discarded 30 days after Report unless otherwise specified):
60 Days ☐ 90 Days ☐ Longer Date (Surcharges will apply):

OTHER INSTRUCTIONS:
Total and dissolved metals, mercury, and bacteriological samples have been preserved. Dissolved metals samples (incl. mercury) have also been filtered. Metals analysis should be LOW level ICPMS pkg. Add total + dissolved Hg. Alkalinity = SPECIATED alkalinity. Use higher dilutions for bacteriological tests pls.

PAYMENT: Cheque ☐ Credit ☐ Debit ☐ Cash ☐ Invoice ☐

SAMPLE RECEIPT TEMP (°C): 6.8
Work Order # _____
CUSTODY SEALS INTACT: ☐Y ☐N ☐NA

Required Fields Recommended Fields **SHADED AREAS:** LAB USE ONLY

CARO ANALYTICAL SERVICES

CERTIFICATE OF ANALYSIS

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby) 200 - 4185A Still Creek Dr Burnaby, BC V5C 6G9	**TEL** **FAX**	(604) 294-2088 (604) 294-2090
ATTENTION	Patrick Lilley	**WORK ORDER**	4121190
PO NUMBER		**RECEIVED / TEMP**	Dec-19-14 13:47 / 8°C
PROJECT	173.169 Maple Ridge WQ	**REPORTED**	Dec-29-14
PROJECT INFO	Stormwater Monitoring	**COC NUMBER**	No#

General Comments:

CARO Analytical Services employs methods which are conducted according to procedures accepted by appropriate regulatory agencies, and/or are conducted in accordance with recognized professional standards using accepted testing methodologies and quality control efforts, except where otherwise agreed to by the client.

The results in this report apply to the samples analyzed in accordance with the Chain of Custody or Sample Requisition document. This analytical report must be reproduced in its entirety. CARO is not responsible for any loss or damage resulting directly or indirectly from error or omission in the conduct of testing. Liability is limited to the cost of analysis. Samples will be disposed of 30 days after the test report has been issued unless otherwise agreed to in writing.

Issued By: **Jennifer Shanko, AScT**
Administration Coordinator

Please contact CARO if more information is needed or to provide feedback on our services.

Locations:

#110 4011 Viking Way
Richmond, BC V6V 2K9
Tel: 604-279-1499 Fax: 604-279-1599

#102 3677 Highway 97N
Kelowna, BC V1X 5C3
Tel: 250-765-9646 Fax: 250-765-3893

17225 109 Avenue
Edmonton, AB T5S 1H7
Tel: 780-489-9100 Fax: 780-489-9700

www.caro.ca

CARO ANALYTICAL SERVICES

ANALYSIS INFORMATION

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4121190
REPORTED Dec-29-14

Analysis Description	Method Reference	Technique	Location
Alkalinity (Speciated)	APHA 2320 B	Titration with H2SO4 to pH 4.5	Kelowna
Anions in Water by IC	APHA 4110 B	Ion Chromatography with Chemical Suppression of Eluent Conductivity	Kelowna
Dissolved Metals	APHA 3030 B / APHA 3125 B	0.45 µm Filtration / Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	Richmond
E. coli (MPN)	APHA 9221	Multiple-Tube Fermentation	Sublet
Fecal Coliforms (MPN)	APHA 9221	Multiple-Tube Fermentation	Sublet
Hardness (as CaCO3)	APHA 2340 B	Calculation	N/A
Total Coliforms (MPN)	APHA 9221	Multiple-Tube Fermentation	Sublet
Total Recoverable Metals	APHA 3030E * / APHA 3125 B	HNO3+HCl Hot Block Digestion / Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	Richmond

Note: An asterisk in the Method Reference indicates that the CARO method has been modified from the reference method

Method Reference Descriptions:

APHA	Standard Methods for the Examination of Water and Wastewater, 22nd Edition, American Public Health Association/American Water Works Association/Water Environment Federation

Glossary of Terms:

MRL	Method Reporting Limit
<	Less than the Reported Detection Limit (RDL) - the RDL may be higher than the MRL due to various factors such as dilutions, limited sample volume, high moisture, or interferences
mg/L	Milligrams per litre
MPN/100 mL	Most Probable Number per 100 millilitres

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4121190
REPORTED Dec-29-14

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SA-1 (T2 Creek) (4121190-01) [Water] Sampled: Dec-19-14 10:40							
Anions							
Nitrate as N	**0.925**	N/A	0.010	mg/L	N/A	Dec-20-14	
General Parameters							
Alkalinity, Total as CaCO3	**33**	N/A	1	mg/L	N/A	Dec-20-14	
Alkalinity, Phenolphthalein as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-20-14	
Alkalinity, Bicarbonate as CaCO3	**33**	N/A	1	mg/L	N/A	Dec-20-14	
Alkalinity, Carbonate as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-20-14	
Alkalinity, Hydroxide as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-20-14	
Calculated Parameters							
Hardness, Total (Total as CaCO3)	**39.1**	N/A	0.50	mg/L	N/A	N/A	
Hardness, Total (Diss. as CaCO3)	**37.5**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.029**	N/A	0.005	mg/L	N/A	Dec-24-14	
Antimony, dissolved	**0.0002**	N/A	0.0001	mg/L	N/A	Dec-24-14	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-24-14	
Barium, dissolved	**0.009**	N/A	0.005	mg/L	N/A	Dec-24-14	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-24-14	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-24-14	
Boron, dissolved	**0.015**	N/A	0.004	mg/L	N/A	Dec-24-14	
Cadmium, dissolved	**0.00002**	N/A	0.00001	mg/L	N/A	Dec-24-14	
Calcium, dissolved	**9.5**	N/A	0.2	mg/L	N/A	Dec-24-14	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-24-14	
Cobalt, dissolved	**0.00008**	N/A	0.00005	mg/L	N/A	Dec-24-14	
Copper, dissolved	**0.0025**	N/A	0.0002	mg/L	N/A	Dec-24-14	
Iron, dissolved	**0.070**	N/A	0.010	mg/L	N/A	Dec-24-14	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-24-14	
Lithium, dissolved	**0.0006**	N/A	0.0001	mg/L	N/A	Dec-24-14	
Magnesium, dissolved	**3.32**	N/A	0.01	mg/L	N/A	Dec-24-14	
Manganese, dissolved	**0.0184**	N/A	0.0002	mg/L	N/A	Dec-24-14	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Dec-24-14	
Molybdenum, dissolved	**0.0008**	N/A	0.0001	mg/L	N/A	Dec-24-14	
Nickel, dissolved	**0.0006**	N/A	0.0002	mg/L	N/A	Dec-24-14	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	Dec-24-14	
Potassium, dissolved	**1.37**	N/A	0.02	mg/L	N/A	Dec-24-14	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-24-14	
Silicon, dissolved	**5.5**	N/A	0.5	mg/L	N/A	Dec-24-14	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	Dec-24-14	
Sodium, dissolved	**7.40**	N/A	0.02	mg/L	N/A	Dec-24-14	
Strontium, dissolved	**0.064**	N/A	0.001	mg/L	N/A	Dec-24-14	
Sulfur, dissolved	< 1	N/A	1	mg/L	N/A	Dec-24-14	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Dec-24-14	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Dec-24-14	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-24-14	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Dec-24-14	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	Dec-24-14	

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4121190
REPORTED Dec-29-14

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SA-1 (T2 Creek) (4121190-01) [Water] Sampled: Dec-19-14 10:40, Continued							
Dissolved Metals, Continued							
Uranium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Dec-24-14	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	Dec-24-14	
Zinc, dissolved	**0.009**	N/A	0.004	mg/L	N/A	Dec-24-14	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-24-14	
Total Recoverable Metals							
Aluminum, total	**0.360**	N/A	0.005	mg/L	Dec-22-14	Dec-23-14	
Antimony, total	**0.0003**	N/A	0.0001	mg/L	Dec-22-14	Dec-23-14	
Arsenic, total	**0.0005**	N/A	0.0005	mg/L	Dec-22-14	Dec-23-14	
Barium, total	**0.013**	N/A	0.005	mg/L	Dec-22-14	Dec-23-14	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	Dec-22-14	Dec-23-14	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	Dec-22-14	Dec-23-14	
Boron, total	**0.015**	N/A	0.004	mg/L	Dec-22-14	Dec-23-14	
Cadmium, total	**0.00002**	N/A	0.00001	mg/L	Dec-22-14	Dec-23-14	
Calcium, total	**10.0**	N/A	0.2	mg/L	Dec-22-14	Dec-23-14	
Chromium, total	**0.0007**	N/A	0.0005	mg/L	Dec-22-14	Dec-23-14	
Cobalt, total	**0.00017**	N/A	0.00005	mg/L	Dec-22-14	Dec-23-14	
Copper, total	**0.0033**	N/A	0.0002	mg/L	Dec-22-14	Dec-23-14	
Iron, total	**0.40**	N/A	0.01	mg/L	Dec-22-14	Dec-23-14	
Lead, total	**0.0004**	N/A	0.0001	mg/L	Dec-22-14	Dec-23-14	
Lithium, total	**0.0007**	N/A	0.0001	mg/L	Dec-22-14	Dec-23-14	
Magnesium, total	**3.41**	N/A	0.01	mg/L	Dec-22-14	Dec-23-14	
Manganese, total	**0.0226**	N/A	0.0002	mg/L	Dec-22-14	Dec-23-14	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	Dec-22-14	Dec-23-14	
Molybdenum, total	**0.0007**	N/A	0.0001	mg/L	Dec-22-14	Dec-23-14	
Nickel, total	**0.0006**	N/A	0.0002	mg/L	Dec-22-14	Dec-23-14	
Phosphorus, total	**0.043**	N/A	0.020	mg/L	Dec-22-14	Dec-23-14	
Potassium, total	**1.37**	N/A	0.02	mg/L	Dec-22-14	Dec-23-14	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	Dec-22-14	Dec-23-14	
Silicon, total	**5.9**	N/A	0.5	mg/L	Dec-22-14	Dec-23-14	
Silver, total	< 0.00005	N/A	0.00005	mg/L	Dec-22-14	Dec-23-14	
Sodium, total	**7.46**	N/A	0.02	mg/L	Dec-22-14	Dec-23-14	
Strontium, total	**0.063**	N/A	0.001	mg/L	Dec-22-14	Dec-23-14	
Sulfur, total	< 1	N/A	1	mg/L	Dec-22-14	Dec-23-14	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	Dec-22-14	Dec-23-14	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	Dec-22-14	Dec-23-14	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	Dec-22-14	Dec-23-14	
Tin, total	< 0.0002	N/A	0.0002	mg/L	Dec-22-14	Dec-23-14	
Titanium, total	**0.016**	N/A	0.005	mg/L	Dec-22-14	Dec-23-14	
Uranium, total	**0.00002**	N/A	0.00002	mg/L	Dec-22-14	Dec-23-14	
Vanadium, total	**0.001**	N/A	0.001	mg/L	Dec-22-14	Dec-23-14	
Zinc, total	**0.012**	N/A	0.004	mg/L	Dec-22-14	Dec-23-14	
Zirconium, total	**0.0003**	N/A	0.0001	mg/L	Dec-22-14	Dec-23-14	
Microbiological Parameters							
Coliforms, Fecal	**150**	N/A	2	MPN/100 mL	N/A	Dec-19-14	

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4121190
REPORTED Dec-29-14

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SA-1 (T2 Creek) (4121190-01) [Water] Sampled: Dec-19-14 10:40, Continued							
Microbiological Parameters, Continued							
E. coli (MPN)	**300**	N/A	2	MPN/100 mL	N/A	Dec-19-14	
Coliforms, Total	**400**	N/A	2	MPN/100 mL	N/A	Dec-19-14	
Sample ID: SA-2 (Millionaire Creek) (4121190-02) [Water] Sampled: Dec-19-14 11:12							
Anions							
Nitrate as N	**0.263**	N/A	0.010	mg/L	N/A	Dec-20-14	
General Parameters							
Alkalinity, Total as CaCO3	**8**	N/A	1	mg/L	N/A	Dec-20-14	
Alkalinity, Phenolphthalein as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-20-14	
Alkalinity, Bicarbonate as CaCO3	**8**	N/A	1	mg/L	N/A	Dec-20-14	
Alkalinity, Carbonate as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-20-14	
Alkalinity, Hydroxide as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-20-14	
Calculated Parameters							
Hardness, Total (Total as CaCO3)	**9.12**	N/A	0.50	mg/L	N/A	N/A	
Hardness, Total (Diss. as CaCO3)	**9.06**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.059**	N/A	0.005	mg/L	N/A	Dec-24-14	
Antimony, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-24-14	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-24-14	
Barium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	Dec-24-14	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-24-14	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-24-14	
Boron, dissolved	< 0.004	N/A	0.004	mg/L	N/A	Dec-24-14	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	Dec-24-14	
Calcium, dissolved	**2.6**	N/A	0.2	mg/L	N/A	Dec-24-14	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-24-14	
Cobalt, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	Dec-24-14	
Copper, dissolved	**0.0004**	N/A	0.0002	mg/L	N/A	Dec-24-14	
Iron, dissolved	**0.052**	N/A	0.010	mg/L	N/A	Dec-24-14	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-24-14	
Lithium, dissolved	**0.0001**	N/A	0.0001	mg/L	N/A	Dec-24-14	
Magnesium, dissolved	**0.60**	N/A	0.01	mg/L	N/A	Dec-24-14	
Manganese, dissolved	**0.0026**	N/A	0.0002	mg/L	N/A	Dec-24-14	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Dec-24-14	
Molybdenum, dissolved	**0.0003**	N/A	0.0001	mg/L	N/A	Dec-24-14	
Nickel, dissolved	**0.0002**	N/A	0.0002	mg/L	N/A	Dec-24-14	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	Dec-24-14	
Potassium, dissolved	**0.24**	N/A	0.02	mg/L	N/A	Dec-24-14	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-24-14	
Silicon, dissolved	**3.9**	N/A	0.5	mg/L	N/A	Dec-24-14	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	Dec-24-14	
Sodium, dissolved	**2.18**	N/A	0.02	mg/L	N/A	Dec-24-14	
Strontium, dissolved	**0.022**	N/A	0.001	mg/L	N/A	Dec-24-14	

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4121190
REPORTED Dec-29-14

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SA-2 (Millionaire Creek) (4121190-02) [Water] Sampled: Dec-19-14 11:12, Continued							
Dissolved Metals, Continued							
Sulfur, dissolved	< 1	N/A	1	mg/L	N/A	Dec-24-14	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Dec-24-14	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Dec-24-14	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-24-14	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Dec-24-14	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	Dec-24-14	
Uranium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Dec-24-14	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	Dec-24-14	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	Dec-24-14	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-24-14	
Total Recoverable Metals							
Aluminum, total	**0.159**	N/A	0.005	mg/L	Dec-22-14	Dec-23-14	
Antimony, total	< 0.0001	N/A	0.0001	mg/L	Dec-22-14	Dec-23-14	
Arsenic, total	< 0.0005	N/A	0.0005	mg/L	Dec-22-14	Dec-23-14	
Barium, total	**0.005**	N/A	0.005	mg/L	Dec-22-14	Dec-23-14	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	Dec-22-14	Dec-23-14	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	Dec-22-14	Dec-23-14	
Boron, total	< 0.004	N/A	0.004	mg/L	Dec-22-14	Dec-23-14	
Cadmium, total	< 0.00001	N/A	0.00001	mg/L	Dec-22-14	Dec-23-14	
Calcium, total	**2.7**	N/A	0.2	mg/L	Dec-22-14	Dec-23-14	
Chromium, total	< 0.0005	N/A	0.0005	mg/L	Dec-22-14	Dec-23-14	
Cobalt, total	**0.00008**	N/A	0.00005	mg/L	Dec-22-14	Dec-23-14	
Copper, total	**0.0005**	N/A	0.0002	mg/L	Dec-22-14	Dec-23-14	
Iron, total	**0.14**	N/A	0.01	mg/L	Dec-22-14	Dec-23-14	
Lead, total	< 0.0001	N/A	0.0001	mg/L	Dec-22-14	Dec-23-14	
Lithium, total	**0.0001**	N/A	0.0001	mg/L	Dec-22-14	Dec-23-14	
Magnesium, total	**0.59**	N/A	0.01	mg/L	Dec-22-14	Dec-23-14	
Manganese, total	**0.0052**	N/A	0.0002	mg/L	Dec-22-14	Dec-23-14	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	Dec-22-14	Dec-23-14	
Molybdenum, total	**0.0003**	N/A	0.0001	mg/L	Dec-22-14	Dec-23-14	
Nickel, total	**0.0002**	N/A	0.0002	mg/L	Dec-22-14	Dec-23-14	
Phosphorus, total	**0.023**	N/A	0.020	mg/L	Dec-22-14	Dec-23-14	
Potassium, total	**0.29**	N/A	0.02	mg/L	Dec-22-14	Dec-23-14	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	Dec-22-14	Dec-23-14	
Silicon, total	**4.0**	N/A	0.5	mg/L	Dec-22-14	Dec-23-14	
Silver, total	< 0.00005	N/A	0.00005	mg/L	Dec-22-14	Dec-23-14	
Sodium, total	**2.20**	N/A	0.02	mg/L	Dec-22-14	Dec-23-14	
Strontium, total	**0.023**	N/A	0.001	mg/L	Dec-22-14	Dec-23-14	
Sulfur, total	< 1	N/A	1	mg/L	Dec-22-14	Dec-23-14	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	Dec-22-14	Dec-23-14	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	Dec-22-14	Dec-23-14	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	Dec-22-14	Dec-23-14	
Tin, total	< 0.0002	N/A	0.0002	mg/L	Dec-22-14	Dec-23-14	
Titanium, total	**0.005**	N/A	0.005	mg/L	Dec-22-14	Dec-23-14	
Uranium, total	< 0.00002	N/A	0.00002	mg/L	Dec-22-14	Dec-23-14	

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4121190
REPORTED Dec-29-14

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SA-2 (Millionaire Creek) (4121190-02) [Water] Sampled: Dec-19-14 11:12, Continued							
Total Recoverable Metals, Continued							
Vanadium, total	< 0.001	N/A	0.001	mg/L	Dec-22-14	Dec-23-14	
Zinc, total	< 0.004	N/A	0.004	mg/L	Dec-22-14	Dec-23-14	
Zirconium, total	**0.0001**	N/A	0.0001	mg/L	Dec-22-14	Dec-23-14	
Microbiological Parameters							
Coliforms, Fecal	**17**	N/A	2	MPN/100 mL	N/A	Dec-19-14	
E. coli (MPN)	**23**	N/A	2	MPN/100 mL	N/A	Dec-19-14	
Coliforms, Total	**46**	N/A	2	MPN/100 mL	N/A	Dec-19-14	
Sample ID: K-1 (Dunlop Creek) (4121190-03) [Water] Sampled: Dec-19-14 11:45							
Anions							
Nitrate as N	**0.707**	N/A	0.010	mg/L	N/A	Dec-20-14	
General Parameters							
Alkalinity, Total as CaCO3	**17**	N/A	1	mg/L	N/A	Dec-20-14	
Alkalinity, Phenolphthalein as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-20-14	
Alkalinity, Bicarbonate as CaCO3	**17**	N/A	1	mg/L	N/A	Dec-20-14	
Alkalinity, Carbonate as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-20-14	
Alkalinity, Hydroxide as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-20-14	
Calculated Parameters							
Hardness, Total (Total as CaCO3)	**22.4**	N/A	0.50	mg/L	N/A	N/A	
Hardness, Total (Diss. as CaCO3)	**21.6**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.097**	N/A	0.005	mg/L	N/A	Dec-24-14	
Antimony, dissolved	**0.0001**	N/A	0.0001	mg/L	N/A	Dec-24-14	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-24-14	
Barium, dissolved	**0.007**	N/A	0.005	mg/L	N/A	Dec-24-14	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-24-14	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-24-14	
Boron, dissolved	**0.011**	N/A	0.004	mg/L	N/A	Dec-24-14	
Cadmium, dissolved	**0.00001**	N/A	0.00001	mg/L	N/A	Dec-24-14	
Calcium, dissolved	**5.6**	N/A	0.2	mg/L	N/A	Dec-24-14	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-24-14	
Cobalt, dissolved	**0.00010**	N/A	0.00005	mg/L	N/A	Dec-24-14	
Copper, dissolved	**0.0018**	N/A	0.0002	mg/L	N/A	Dec-24-14	
Iron, dissolved	**0.109**	N/A	0.010	mg/L	N/A	Dec-24-14	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-24-14	
Lithium, dissolved	**0.0002**	N/A	0.0001	mg/L	N/A	Dec-24-14	
Magnesium, dissolved	**1.84**	N/A	0.01	mg/L	N/A	Dec-24-14	
Manganese, dissolved	**0.0096**	N/A	0.0002	mg/L	N/A	Dec-24-14	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Dec-24-14	
Molybdenum, dissolved	**0.0002**	N/A	0.0001	mg/L	N/A	Dec-24-14	
Nickel, dissolved	**0.0005**	N/A	0.0002	mg/L	N/A	Dec-24-14	
Phosphorus, dissolved	**0.04**	N/A	0.02	mg/L	N/A	Dec-24-14	

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4121190
REPORTED Dec-29-14

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: K-1 (Dunlop Creek) (4121190-03) [Water] Sampled: Dec-19-14 11:45, Continued							
Dissolved Metals, Continued							
Potassium, dissolved	**1.67**	N/A	0.02	mg/L	N/A	Dec-24-14	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-24-14	
Silicon, dissolved	**4.0**	N/A	0.5	mg/L	N/A	Dec-24-14	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	Dec-24-14	
Sodium, dissolved	**3.62**	N/A	0.02	mg/L	N/A	Dec-24-14	
Strontium, dissolved	**0.042**	N/A	0.001	mg/L	N/A	Dec-24-14	
Sulfur, dissolved	< 1	N/A	1	mg/L	N/A	Dec-24-14	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Dec-24-14	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Dec-24-14	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-24-14	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Dec-24-14	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	Dec-24-14	
Uranium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Dec-24-14	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	Dec-24-14	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	Dec-24-14	
Zirconium, dissolved	**0.0001**	N/A	0.0001	mg/L	N/A	Dec-24-14	
Total Recoverable Metals							
Aluminum, total	**1.27**	N/A	0.005	mg/L	Dec-22-14	Dec-23-14	
Antimony, total	**0.0001**	N/A	0.0001	mg/L	Dec-22-14	Dec-23-14	
Arsenic, total	**0.0007**	N/A	0.0005	mg/L	Dec-22-14	Dec-23-14	
Barium, total	**0.017**	N/A	0.005	mg/L	Dec-22-14	Dec-23-14	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	Dec-22-14	Dec-23-14	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	Dec-22-14	Dec-23-14	
Boron, total	**0.010**	N/A	0.004	mg/L	Dec-22-14	Dec-23-14	
Cadmium, total	**0.00002**	N/A	0.00001	mg/L	Dec-22-14	Dec-23-14	
Calcium, total	**5.7**	N/A	0.2	mg/L	Dec-22-14	Dec-23-14	
Chromium, total	**0.0017**	N/A	0.0005	mg/L	Dec-22-14	Dec-23-14	
Cobalt, total	**0.00051**	N/A	0.00005	mg/L	Dec-22-14	Dec-23-14	
Copper, total	**0.0032**	N/A	0.0002	mg/L	Dec-22-14	Dec-23-14	
Iron, total	**1.13**	N/A	0.01	mg/L	Dec-22-14	Dec-23-14	
Lead, total	**0.0004**	N/A	0.0001	mg/L	Dec-22-14	Dec-23-14	
Lithium, total	**0.0007**	N/A	0.0001	mg/L	Dec-22-14	Dec-23-14	
Magnesium, total	**1.94**	N/A	0.01	mg/L	Dec-22-14	Dec-23-14	
Manganese, total	**0.0298**	N/A	0.0002	mg/L	Dec-22-14	Dec-23-14	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	Dec-22-14	Dec-23-14	
Molybdenum, total	**0.0002**	N/A	0.0001	mg/L	Dec-22-14	Dec-23-14	
Nickel, total	**0.0012**	N/A	0.0002	mg/L	Dec-22-14	Dec-23-14	
Phosphorus, total	**0.078**	N/A	0.020	mg/L	Dec-22-14	Dec-23-14	
Potassium, total	**1.69**	N/A	0.02	mg/L	Dec-22-14	Dec-23-14	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	Dec-22-14	Dec-23-14	
Silicon, total	**6.1**	N/A	0.5	mg/L	Dec-22-14	Dec-23-14	
Silver, total	< 0.00005	N/A	0.00005	mg/L	Dec-22-14	Dec-23-14	
Sodium, total	**3.61**	N/A	0.02	mg/L	Dec-22-14	Dec-23-14	
Strontium, total	**0.042**	N/A	0.001	mg/L	Dec-22-14	Dec-23-14	
Sulfur, total	< 1	N/A	1	mg/L	Dec-22-14	Dec-23-14	

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4121190
REPORTED Dec-29-14

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: K-1 (Dunlop Creek) (4121190-03) [Water] Sampled: Dec-19-14 11:45, Continued							
Total Recoverable Metals, Continued							
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	Dec-22-14	Dec-23-14	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	Dec-22-14	Dec-23-14	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	Dec-22-14	Dec-23-14	
Tin, total	< 0.0002	N/A	0.0002	mg/L	Dec-22-14	Dec-23-14	
Titanium, total	**0.068**	N/A	0.005	mg/L	Dec-22-14	Dec-23-14	
Uranium, total	**0.00004**	N/A	0.00002	mg/L	Dec-22-14	Dec-23-14	
Vanadium, total	**0.003**	N/A	0.001	mg/L	Dec-22-14	Dec-23-14	
Zinc, total	**0.007**	N/A	0.004	mg/L	Dec-22-14	Dec-23-14	
Zirconium, total	**0.0008**	N/A	0.0001	mg/L	Dec-22-14	Dec-23-14	
Microbiological Parameters							
Coliforms, Fecal	**300**	N/A	2	MPN/100 mL	N/A	Dec-19-14	
E. coli (MPN)	**300**	N/A	2	MPN/100 mL	N/A	Dec-19-14	
Coliforms, Total	**600**	N/A	2	MPN/100 mL	N/A	Dec-19-14	
Sample ID: K-2 (Spencer Creek) (4121190-04) [Water] Sampled: Dec-19-14 12:10							
Anions							
Nitrate as N	**0.426**	N/A	0.010	mg/L	N/A	Dec-20-14	
General Parameters							
Alkalinity, Total as CaCO3	**32**	N/A	1	mg/L	N/A	Dec-20-14	
Alkalinity, Phenolphthalein as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-20-14	
Alkalinity, Bicarbonate as CaCO3	**32**	N/A	1	mg/L	N/A	Dec-20-14	
Alkalinity, Carbonate as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-20-14	
Alkalinity, Hydroxide as CaCO3	< 1	N/A	1	mg/L	N/A	Dec-20-14	
Calculated Parameters							
Hardness, Total (Total as CaCO3)	**39.1**	N/A	0.50	mg/L	N/A	N/A	
Hardness, Total (Diss. as CaCO3)	**33.7**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.094**	N/A	0.005	mg/L	N/A	Dec-24-14	
Antimony, dissolved	**0.0001**	N/A	0.0001	mg/L	N/A	Dec-24-14	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-24-14	
Barium, dissolved	**0.005**	N/A	0.005	mg/L	N/A	Dec-24-14	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-24-14	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-24-14	
Boron, dissolved	**0.009**	N/A	0.004	mg/L	N/A	Dec-24-14	
Cadmium, dissolved	**0.00001**	N/A	0.00001	mg/L	N/A	Dec-24-14	
Calcium, dissolved	**9.1**	N/A	0.2	mg/L	N/A	Dec-24-14	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-24-14	
Cobalt, dissolved	**0.00011**	N/A	0.00005	mg/L	N/A	Dec-24-14	
Copper, dissolved	**0.0020**	N/A	0.0002	mg/L	N/A	Dec-24-14	
Iron, dissolved	**0.142**	N/A	0.010	mg/L	N/A	Dec-24-14	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-24-14	
Lithium, dissolved	**0.0003**	N/A	0.0001	mg/L	N/A	Dec-24-14	

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4121190
REPORTED Dec-29-14

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: K-2 (Spencer Creek) (4121190-04) [Water] Sampled: Dec-19-14 12:10, Continued							
Dissolved Metals, Continued							
Magnesium, dissolved	**2.69**	N/A	0.01	mg/L	N/A	Dec-24-14	
Manganese, dissolved	**0.0180**	N/A	0.0002	mg/L	N/A	Dec-24-14	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Dec-24-14	
Molybdenum, dissolved	**0.0003**	N/A	0.0001	mg/L	N/A	Dec-24-14	
Nickel, dissolved	**0.0008**	N/A	0.0002	mg/L	N/A	Dec-24-14	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	Dec-24-14	
Potassium, dissolved	**1.19**	N/A	0.02	mg/L	N/A	Dec-24-14	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Dec-24-14	
Silicon, dissolved	**4.4**	N/A	0.5	mg/L	N/A	Dec-24-14	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	Dec-24-14	
Sodium, dissolved	**4.42**	N/A	0.02	mg/L	N/A	Dec-24-14	
Strontium, dissolved	**0.063**	N/A	0.001	mg/L	N/A	Dec-24-14	
Sulfur, dissolved	< 1	N/A	1	mg/L	N/A	Dec-24-14	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Dec-24-14	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Dec-24-14	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Dec-24-14	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Dec-24-14	
Titanium, dissolved	**0.006**	N/A	0.005	mg/L	N/A	Dec-24-14	
Uranium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Dec-24-14	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	Dec-24-14	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	Dec-24-14	
Zirconium, dissolved	**0.0004**	N/A	0.0001	mg/L	N/A	Dec-24-14	
Total Recoverable Metals							
Aluminum, total	**4.25**	N/A	0.005	mg/L	Dec-22-14	Dec-23-14	
Antimony, total	**0.0002**	N/A	0.0001	mg/L	Dec-22-14	Dec-23-14	
Arsenic, total	**0.0011**	N/A	0.0005	mg/L	Dec-22-14	Dec-23-14	
Barium, total	**0.039**	N/A	0.005	mg/L	Dec-22-14	Dec-23-14	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	Dec-22-14	Dec-23-14	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	Dec-22-14	Dec-23-14	
Boron, total	**0.010**	N/A	0.004	mg/L	Dec-22-14	Dec-23-14	
Cadmium, total	**0.00003**	N/A	0.00001	mg/L	Dec-22-14	Dec-23-14	
Calcium, total	**9.7**	N/A	0.2	mg/L	Dec-22-14	Dec-23-14	
Chromium, total	**0.0047**	N/A	0.0005	mg/L	Dec-22-14	Dec-23-14	
Cobalt, total	**0.00152**	N/A	0.00005	mg/L	Dec-22-14	Dec-23-14	
Copper, total	**0.0074**	N/A	0.0002	mg/L	Dec-22-14	Dec-23-14	
Iron, total	**3.67**	N/A	0.01	mg/L	Dec-22-14	Dec-23-14	
Lead, total	**0.0011**	N/A	0.0001	mg/L	Dec-22-14	Dec-23-14	
Lithium, total	**0.0022**	N/A	0.0001	mg/L	Dec-22-14	Dec-23-14	
Magnesium, total	**3.57**	N/A	0.01	mg/L	Dec-22-14	Dec-23-14	
Manganese, total	**0.0824**	N/A	0.0002	mg/L	Dec-22-14	Dec-23-14	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	Dec-22-14	Dec-23-14	
Molybdenum, total	**0.0005**	N/A	0.0001	mg/L	Dec-22-14	Dec-23-14	
Nickel, total	**0.0041**	N/A	0.0002	mg/L	Dec-22-14	Dec-23-14	
Phosphorus, total	**0.103**	N/A	0.020	mg/L	Dec-22-14	Dec-23-14	
Potassium, total	**1.63**	N/A	0.02	mg/L	Dec-22-14	Dec-23-14	

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4121190
REPORTED Dec-29-14

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: K-2 (Spencer Creek) (4121190-04) [Water] Sampled: Dec-19-14 12:10, Continued							
Total Recoverable Metals, Continued							
Selenium, total	< 0.0005	N/A	0.0005	mg/L	Dec-22-14	Dec-23-14	
Silicon, total	**12.9**	N/A	0.5	mg/L	Dec-22-14	Dec-23-14	
Silver, total	**0.00011**	N/A	0.00005	mg/L	Dec-22-14	Dec-23-14	
Sodium, total	**4.48**	N/A	0.02	mg/L	Dec-22-14	Dec-23-14	
Strontium, total	**0.073**	N/A	0.001	mg/L	Dec-22-14	Dec-23-14	
Sulfur, total	< 1	N/A	1	mg/L	Dec-22-14	Dec-23-14	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	Dec-22-14	Dec-23-14	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	Dec-22-14	Dec-23-14	
Thorium, total	**0.0002**	N/A	0.0001	mg/L	Dec-22-14	Dec-23-14	
Tin, total	< 0.0002	N/A	0.0002	mg/L	Dec-22-14	Dec-23-14	
Titanium, total	**0.191**	N/A	0.005	mg/L	Dec-22-14	Dec-23-14	
Uranium, total	**0.00009**	N/A	0.00002	mg/L	Dec-22-14	Dec-23-14	
Vanadium, total	**0.009**	N/A	0.001	mg/L	Dec-22-14	Dec-23-14	
Zinc, total	**0.012**	N/A	0.004	mg/L	Dec-22-14	Dec-23-14	
Zirconium, total	**0.0024**	N/A	0.0001	mg/L	Dec-22-14	Dec-23-14	
Microbiological Parameters							
Coliforms, Fecal	**500**	N/A	2	MPN/100 mL	N/A	Dec-19-14	
E. coli (MPN)	**500**	N/A	2	MPN/100 mL	N/A	Dec-19-14	
Coliforms, Total	**1000**	N/A	2	MPN/100 mL	N/A	Dec-19-14	
Sample ID: Field Blank (4121190-05) [Water] Sampled: Dec-19-14 09:25							
Microbiological Parameters							
E. coli (MPN)	< 2	N/A	2	MPN/100 mL	N/A	Dec-19-14	
Coliforms, Total	< 2	N/A	2	MPN/100 mL	N/A	Dec-19-14	

CARO ANALYTICAL SERVICES

QUALITY CONTROL DATA

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	4121190
PROJECT	173.169 Maple Ridge WQ	**REPORTED**	Dec-29-14

The following section displays the quality control (QC) data that is associated with your sample data. Groups of samples are prepared in "batches" and analyzed in conjunction with QC samples that ensure your data is of the highest quality. Common QC types include:

- **Method Blank (Blk)**: Laboratory reagent water is carried through sample preparation and analysis steps. Method Blanks indicate that results are free from contamination, i.e. not biased high from sources such as the sample container or the laboratory environment
- **Duplicate (Dup)**: Preparation and analysis of a replicate aliquot of a sample. Duplicates provide a measure of the analytical method's precision, i.e. how reproducible a result is. Duplicates are only reported if they are associated with your sample data.
- **Blank Spike (BS)**: A known amount of standard is carried through sample preparation and analysis steps. Blank Spikes, also known as laboratory control samples (LCS), are prepared from a different source of standard than used for the calibration. They ensure that the calibration is acceptable (i.e. not biased high or low) and also provide a measure of the analytical method's accuracy (i.e. closeness of the result to a target value).
- **Standard Reference Material (SRM)**: A material of similar matrix to the samples, externally certified for the parameter(s) listed. Standard Reference Materials ensure that the preparation steps in the method are adequate to achieve acceptable recoveries of the parameter(s) tested.

Each QC type is analyzed at a 5-10% frequency, i.e. one blank/duplicate/spike for every 10 samples. For all types of QC, the specified recovery (% Rec) and relative percent difference (RPD) limits are derived from long-term method performance averages and/or prescribed by the reference method.

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	RPD	RPD Limit	Notes
Anions, Batch B4L1054										
Blank (B4L1054-BLK1)				Prepared: Dec-20-14, Analyzed: Dec-20-14						
Nitrate as N	< 0.010	0.010	mg/L							
Blank (B4L1054-BLK2)				Prepared: Dec-20-14, Analyzed: Dec-20-14						
Nitrate as N	< 0.010	0.010	mg/L							
LCS (B4L1054-BS1)				Prepared: Dec-20-14, Analyzed: Dec-20-14						
Nitrate as N	3.92	0.010	mg/L	4.00		98	85-115			
LCS (B4L1054-BS2)				Prepared: Dec-20-14, Analyzed: Dec-20-14						
Nitrate as N	3.95	0.010	mg/L	4.00		99	85-115			
Dissolved Metals, Batch B4L1072										
Blank (B4L1072-BLK1)				Prepared: Dec-24-14, Analyzed: Dec-24-14						
Aluminum, dissolved	< 0.005	0.005	mg/L							
Antimony, dissolved	< 0.0001	0.0001	mg/L							
Arsenic, dissolved	< 0.0005	0.0005	mg/L							
Barium, dissolved	< 0.005	0.005	mg/L							
Beryllium, dissolved	< 0.0001	0.0001	mg/L							
Bismuth, dissolved	< 0.0001	0.0001	mg/L							
Boron, dissolved	< 0.004	0.004	mg/L							
Cadmium, dissolved	< 0.00001	0.00001	mg/L							
Calcium, dissolved	< 0.2	0.2	mg/L							
Chromium, dissolved	< 0.0005	0.0005	mg/L							
Cobalt, dissolved	< 0.00005	0.00005	mg/L							
Copper, dissolved	< 0.0002	0.0002	mg/L							
Iron, dissolved	< 0.010	0.010	mg/L							
Lead, dissolved	< 0.0001	0.0001	mg/L							
Lithium, dissolved	< 0.0001	0.0001	mg/L							
Magnesium, dissolved	< 0.01	0.01	mg/L							
Manganese, dissolved	< 0.0002	0.0002	mg/L							
Mercury, dissolved	< 0.00002	0.00002	mg/L							

CARO ANALYTICAL SERVICES

QUALITY CONTROL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4121190
REPORTED Dec-29-14

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	RPD	RPD Limit	Notes
Dissolved Metals, Batch B4L1072, Continued										
Blank (B4L1072-BLK1), Continued				Prepared: Dec-24-14, Analyzed: Dec-24-14						
Molybdenum, dissolved	< 0.0001	0.0001	mg/L							
Nickel, dissolved	< 0.0002	0.0002	mg/L							
Phosphorus, dissolved	< 0.02	0.02	mg/L							
Potassium, dissolved	< 0.02	0.02	mg/L							
Selenium, dissolved	< 0.0005	0.0005	mg/L							
Silicon, dissolved	< 0.5	0.5	mg/L							
Silver, dissolved	< 0.00005	0.00005	mg/L							
Sodium, dissolved	< 0.02	0.02	mg/L							
Strontium, dissolved	< 0.001	0.001	mg/L							
Sulfur, dissolved	< 1	1	mg/L							
Tellurium, dissolved	< 0.0002	0.0002	mg/L							
Thallium, dissolved	< 0.00002	0.00002	mg/L							
Thorium, dissolved	< 0.0001	0.0001	mg/L							
Tin, dissolved	< 0.0002	0.0002	mg/L							
Titanium, dissolved	< 0.005	0.005	mg/L							
Uranium, dissolved	< 0.00002	0.00002	mg/L							
Vanadium, dissolved	< 0.001	0.001	mg/L							
Zinc, dissolved	< 0.004	0.004	mg/L							
Zirconium, dissolved	< 0.0001	0.0001	mg/L							
Matrix Spike (B4L1072-MS1)	**Source: 4121190-01**			Prepared: Dec-24-14, Analyzed: Dec-24-14						
Antimony, dissolved	0.362	0.0001	mg/L	0.400	0.0002	91	76-114			
Arsenic, dissolved	0.178	0.0005	mg/L	0.200	< 0.0005	89	81-115			
Barium, dissolved	0.963	0.005	mg/L	1.00	0.009	95	80-113			
Beryllium, dissolved	0.0954	0.0001	mg/L	0.100	< 0.0001	95	69-109			
Cadmium, dissolved	0.0973	0.00001	mg/L	0.100	0.00002	97	83-110			
Chromium, dissolved	0.390	0.0005	mg/L	0.400	< 0.0005	97	85-115			
Cobalt, dissolved	0.398	0.00005	mg/L	0.400	0.00008	100	86-114			
Copper, dissolved	0.416	0.0002	mg/L	0.400	0.0025	103	82-119			
Iron, dissolved	2.00	0.010	mg/L	2.00	0.070	96	80-116			
Lead, dissolved	0.210	0.0001	mg/L	0.200	< 0.0001	105	83-112			
Manganese, dissolved	0.405	0.0002	mg/L	0.400	0.0184	97	62-131			
Nickel, dissolved	0.388	0.0002	mg/L	0.400	0.0006	97	81-115			
Selenium, dissolved	0.0891	0.0005	mg/L	0.100	< 0.0005	89	79-115			
Silver, dissolved	0.0897	0.00005	mg/L	0.100	< 0.00005	90	69-121			
Thallium, dissolved	0.104	0.00002	mg/L	0.100	< 0.00002	104	84-115			
Vanadium, dissolved	0.384	0.001	mg/L	0.400	< 0.001	96	83-113			
Zinc, dissolved	0.948	0.004	mg/L	1.00	0.009	94	82-115			
Reference (B4L1072-SRM1)				Prepared: Dec-24-14, Analyzed: Dec-24-14						
Aluminum, dissolved	0.230	0.005	mg/L	0.233		99	81-129			
Antimony, dissolved	0.0439	0.0001	mg/L	0.0430		102	75-125			
Arsenic, dissolved	0.423	0.0005	mg/L	0.438		97	88-114			
Barium, dissolved	3.33	0.005	mg/L	3.35		99	83-117			
Beryllium, dissolved	0.232	0.0001	mg/L	0.213		109	76-131			
Boron, dissolved	2.11	0.004	mg/L	1.74		121	75-121			
Cadmium, dissolved	0.227	0.00001	mg/L	0.224		101	89-111			
Calcium, dissolved	8.4	0.2	mg/L	7.69		109	86-121			
Chromium, dissolved	0.447	0.0005	mg/L	0.437		102	89-114			
Cobalt, dissolved	0.138	0.00005	mg/L	0.128		108	91-113			
Copper, dissolved	0.901	0.0002	mg/L	0.844		107	91-115			
Iron, dissolved	1.30	0.010	mg/L	1.29		101	77-124			
Lead, dissolved	0.126	0.0001	mg/L	0.112		113	92-113			
Lithium, dissolved	0.116	0.0001	mg/L	0.104		111	85-115			
Magnesium, dissolved	6.95	0.01	mg/L	6.92		101	78-120			
Manganese, dissolved	0.355	0.0002	mg/L	0.345		103	90-114			
Molybdenum, dissolved	0.457	0.0001	mg/L	0.426		107	83-117			

CARO ANALYTICAL SERVICES

QUALITY CONTROL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4121190
REPORTED Dec-29-14

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	RPD	RPD Limit	Notes
Dissolved Metals, Batch B4L1072, Continued										
Reference (B4L1072-SRM1), Continued				Prepared: Dec-24-14, Analyzed: Dec-24-14						
Nickel, dissolved	0.888	0.0002	mg/L	0.840		106	90-111			
Phosphorus, dissolved	0.49	0.02	mg/L	0.495		99	85-115			
Potassium, dissolved	3.16	0.02	mg/L	3.19		99	84-113			
Selenium, dissolved	0.0324	0.0005	mg/L	0.0331		98	85-115			
Sodium, dissolved	19.1	0.02	mg/L	19.1		100	82-123			
Strontium, dissolved	0.923	0.001	mg/L	0.916		101	88-112			
Thallium, dissolved	0.0431	0.00002	mg/L	0.0393		110	91-114			
Uranium, dissolved	0.307	0.00002	mg/L	0.266		115	85-120			
Vanadium, dissolved	0.862	0.001	mg/L	0.869		99	86-111			
Zinc, dissolved	0.865	0.004	mg/L	0.881		98	85-111			
General Parameters, Batch B4L1037										
Blank (B4L1037-BLK1)				Prepared: Dec-20-14, Analyzed: Dec-20-14						
Alkalinity, Total as CaCO3	< 1	1	mg/L							
Alkalinity, Phenolphthalein as CaCO3	< 1	1	mg/L							
Alkalinity, Bicarbonate as CaCO3	< 1	1	mg/L							
Alkalinity, Carbonate as CaCO3	< 1	1	mg/L							
Alkalinity, Hydroxide as CaCO3	< 1	1	mg/L							
Blank (B4L1037-BLK2)				Prepared: Dec-20-14, Analyzed: Dec-20-14						
Alkalinity, Total as CaCO3	< 1	1	mg/L							
Alkalinity, Phenolphthalein as CaCO3	< 1	1	mg/L							
Alkalinity, Bicarbonate as CaCO3	< 1	1	mg/L							
Alkalinity, Carbonate as CaCO3	< 1	1	mg/L							
Alkalinity, Hydroxide as CaCO3	< 1	1	mg/L							
LCS (B4L1037-BS1)				Prepared: Dec-20-14, Analyzed: Dec-20-14						
Alkalinity, Total as CaCO3	103	1	mg/L	100		103	96-108			
LCS (B4L1037-BS2)				Prepared: Dec-20-14, Analyzed: Dec-20-14						
Alkalinity, Total as CaCO3	100	1	mg/L	100		100	96-108			
Total Recoverable Metals, Batch B4L1075										
Blank (B4L1075-BLK1)				Prepared: Dec-22-14, Analyzed: Dec-23-14						
Aluminum, total	< 0.005	0.005	mg/L							
Antimony, total	< 0.0001	0.0001	mg/L							
Arsenic, total	< 0.0005	0.0005	mg/L							
Barium, total	< 0.005	0.005	mg/L							
Beryllium, total	< 0.0001	0.0001	mg/L							
Bismuth, total	< 0.0001	0.0001	mg/L							
Boron, total	< 0.004	0.004	mg/L							
Cadmium, total	< 0.00001	0.00001	mg/L							
Calcium, total	< 0.2	0.2	mg/L							
Chromium, total	< 0.0005	0.0005	mg/L							
Cobalt, total	< 0.00005	0.00005	mg/L							
Copper, total	< 0.0002	0.0002	mg/L							
Iron, total	< 0.01	0.01	mg/L							
Lead, total	< 0.0001	0.0001	mg/L							
Lithium, total	< 0.0001	0.0001	mg/L							
Magnesium, total	< 0.01	0.01	mg/L							
Manganese, total	< 0.0002	0.0002	mg/L							
Mercury, total	< 0.00002	0.00002	mg/L							
Molybdenum, total	< 0.0001	0.0001	mg/L							
Nickel, total	< 0.0002	0.0002	mg/L							

CARO ANALYTICAL SERVICES

QUALITY CONTROL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4121190
REPORTED Dec-29-14

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	RPD	RPD Limit	Notes
Total Recoverable Metals, Batch B4L1075, Continued										
Blank (B4L1075-BLK1), Continued				Prepared: Dec-22-14, Analyzed: Dec-23-14						
Phosphorus, total	< 0.020	0.020	mg/L							
Potassium, total	< 0.02	0.02	mg/L							
Selenium, total	< 0.0005	0.0005	mg/L							
Silicon, total	< 0.5	0.5	mg/L							
Silver, total	< 0.00005	0.00005	mg/L							
Sodium, total	< 0.02	0.02	mg/L							
Strontium, total	< 0.001	0.001	mg/L							
Sulfur, total	< 1	1	mg/L							
Tellurium, total	< 0.0002	0.0002	mg/L							
Thallium, total	< 0.00002	0.00002	mg/L							
Thorium, total	< 0.0001	0.0001	mg/L							
Tin, total	< 0.0002	0.0002	mg/L							
Titanium, total	< 0.005	0.005	mg/L							
Uranium, total	< 0.00002	0.00002	mg/L							
Vanadium, total	< 0.001	0.001	mg/L							
Zinc, total	< 0.004	0.004	mg/L							
Zirconium, total	< 0.0001	0.0001	mg/L							
Matrix Spike (B4L1075-MS1)		**Source: 4121190-01**		Prepared: Dec-22-14, Analyzed: Dec-23-14						
Antimony, total	0.452	0.0001	mg/L	0.400	0.0003	113	84-125			
Arsenic, total	0.186	0.0005	mg/L	0.200	0.0005	93	85-116			
Barium, total	1.13	0.005	mg/L	1.00	0.013	112	87-114			
Beryllium, total	0.0969	0.0001	mg/L	0.100	< 0.0001	97	72-116			
Cadmium, total	0.104	0.00001	mg/L	0.100	0.00002	104	90-112			
Chromium, total	0.402	0.0005	mg/L	0.400	0.0007	100	89-120			
Cobalt, total	0.413	0.00005	mg/L	0.400	0.00017	103	88-120			
Copper, total	0.436	0.0002	mg/L	0.400	0.0033	108	88-125			
Iron, total	2.38	0.01	mg/L	2.00	0.40	99	88-119			
Lead, total	0.208	0.0001	mg/L	0.200	0.0004	104	89-118			
Manganese, total	0.424	0.0002	mg/L	0.400	0.0226	100	84-120			
Nickel, total	0.399	0.0002	mg/L	0.400	0.0006	100	87-119			
Selenium, total	0.0901	0.0005	mg/L	0.100	< 0.0005	90	85-113			
Silver, total	0.0932	0.00005	mg/L	0.100	< 0.00005	93	89-119			
Thallium, total	0.103	0.00002	mg/L	0.100	< 0.00002	103	92-119			
Vanadium, total	0.401	0.001	mg/L	0.400	0.001	100	87-117			
Zinc, total	0.970	0.004	mg/L	1.00	0.012	96	85-116			
Reference (B4L1075-SRM1)				Prepared: Dec-22-14, Analyzed: Dec-23-14						
Aluminum, total	0.277	0.005	mg/L	0.296		94	81-129			
Antimony, total	0.0525	0.0001	mg/L	0.0505		104	88-114			
Arsenic, total	0.118	0.0005	mg/L	0.122		97	88-114			
Barium, total	0.739	0.005	mg/L	0.777		95	72-104			
Beryllium, total	0.0511	0.0001	mg/L	0.0488		105	76-131			
Boron, total	4.01	0.004	mg/L	3.40		118	75-121			
Cadmium, total	0.0507	0.00001	mg/L	0.0490		103	89-111			
Calcium, total	10.9	0.2	mg/L	10.2		107	86-121			
Chromium, total	0.245	0.0005	mg/L	0.242		101	89-114			
Cobalt, total	0.0376	0.00005	mg/L	0.0366		103	91-113			
Copper, total	0.519	0.0002	mg/L	0.487		107	91-115			
Iron, total	0.47	0.01	mg/L	0.469		101	77-124			
Lead, total	0.218	0.0001	mg/L	0.193		113	92-113			
Lithium, total	0.427	0.0001	mg/L	0.390		110	85-115			
Magnesium, total	3.28	0.01	mg/L	3.31		99	78-120			
Manganese, total	0.104	0.0002	mg/L	0.109		96	90-114			
Mercury, total	0.00499	0.00002	mg/L	0.00456		109	50-150			
Molybdenum, total	0.199	0.0001	mg/L	0.197		101	90-111			
Nickel, total	0.242	0.0002	mg/L	0.242		100	90-111			

CARO ANALYTICAL SERVICES

QUALITY CONTROL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 4121190
REPORTED Dec-29-14

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	RPD	RPD Limit	Notes
Total Recoverable Metals, Batch B4L1075, Continued										
Reference (B4L1075-SRM1), Continued				Prepared: Dec-22-14, Analyzed: Dec-23-14						
Phosphorus, total	0.201	0.020	mg/L	0.233		86	85-115			
Potassium, total	5.84	0.02	mg/L	5.93		98	84-113			
Selenium, total	0.107	0.0005	mg/L	0.115		93	85-115			
Sodium, total	7.17	0.02	mg/L	7.64		94	82-123			
Strontium, total	0.385	0.001	mg/L	0.363		106	88-112			
Thallium, total	0.0892	0.00002	mg/L	0.0794		112	91-114			
Uranium, total	0.0229	0.00002	mg/L	0.0192		119	85-120			
Vanadium, total	0.372	0.001	mg/L	0.376		99	86-111			
Zinc, total	2.41	0.004	mg/L	2.42		99	85-111			

CARO BC COC, Rev 03/13

CARO ANALYTICAL SE

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CHAIN-OF-CUSTODY RECORD COC#

RELINQUISHED BY: Patrick Lilley	DATE: 19-Dec-14 TIME:	RECEIVED BY: WI KF	DATE: 12/19 TIME: 13:47
RELINQUISHED BY:	DATE: TIME:	RECEIVED BY:	DATE: TIME:

REPORT TO:
COMPANY: Kerr Wood Leidal Associates
ADDRESS: 200-4185A Still Creek Drive, Burnaby, BC V5C 6G9
CONTACT: Patrick Lilley
TEL / FAX: 604-293-3121 604-294-2090
EMAIL PDF ☑ EDD ☐ **Please email Excel file.**
EMAIL 1: plilley@kwl.ca
EMAIL 2:
MAIL HARDCOPY ☐ HOLD FOR P/U ☐ FAX ☐

INVOICE TO: SAME AS REPORT TO ☐
COMPANY: Kerr Wood Leidal Associates
ADDRESS: 200-4185A Still Creek Drive, Burnaby, BC V5C 6G9
CONTACT: Patrick Lilley / Michelle Derer
TEL / FAX: 604-294-2088 604-294-2090
EMAIL PDF ☑
EMAIL 1: plilley@kwl.ca
EMAIL 2: mderer@kwl.ca
MAIL HARDCOPY ☐ HOLD FOR P/U ☐

PROJECT: 173.169 Maple Ridge WQ	PROJECT INFO: Stormwater Monitoring	PO #:
SAMPLED BY: Patrick Lilley	SHIPPING INSTRUCTIONS: RETURN COOLER(S) ☐ SHIP SUPPLIES (PLEASE SPECIFY IN OTHER INSTRUCTIONS SECTION) ☐	

TURNAROUND Routine (4-7 days) ☑ Other:
TIME REQUESTED: Rush:* 1 Day ☐ 2 Day ☐ 3 Day ☐ * Contact the lab to confirm, surcharges may apply

ANALYSES REQUESTED:

	CLIENT SAMPLE ID:	MATRIX: DRINKING WATER	OTHER WATER	SOIL	OTHER	# CONTAINERS	SAMPLING: DATE DD-MMM-YY	TIME HH:MM	COMMENTS: CHLORINATED	FILTERED	PRESERVED	(i.e. flow/volume media ID/notes)
01	SA-1 (T2 Creek)	☐	☑	☐	☐	6	19-Dec-14	10:40	☐	☑	☑	See below
02	SA-2 (Millionaire Creek)	☐	☑	☐	☐	6	19-Dec-14	11:12	☐	☑	☑	See below
03	K-1 (Dunlop Creek)	☐	☑	☐	☐	6	19-Dec-14	11:45	☐	☑	☑	See below
04	K-2 (Spencer Creek)	☐	☑	☐	☐	6	19-Dec-14	12:10	☐	☑	☑	See below
05	Field Blank	☐	☑	☐	☐	1	19-Dec-14	09:25	☐	☐	☑	See below
06	Trip Blank	☐	☑	☐	☐	1	19-Dec-14	10:40	☐	☐	☐	-

	BTEX ☐ VPH ☐ MTBE ☐	EPH (not PAH Corrected)	VOC ☐ VPH ☐	L/HEPH (PAH Corrected)	PAH	PHENOLS Chlorinated ☐ Non-Chlor ☐	PCB ☐ GLYCOLS ☐ HAA ☐	METALS - WATER TOTAL (ICPMS - LOW Pkg) + Hg	METALS - WATER DISSOLVED (ICPMS - LOW Pkg) + Hg	Metals - SOIL (SALM) ☐ Inc. pH ☐	pH ☐ EC ☐ Alk ☑	TSS ☐ TDS ☐	BOD ☐ COD ☐	FECAL COLIFORMS ☑ HPC ☐	TOTAL COLIFORMS ☑ E-COLI ☑	PESTICIDES ☐ HERBICIDES ☐	SOIL VAPOUR	ASBESTOS	NITRATE-N						HOLD
01	☐	☐	☐	☐	☐	☐	☐	☑	☑	☐	☑	☐	☐	☑	☑	☐	☐	☐	☑	☐	☐	☐	☐	☐
02	☐	☐	☐	☐	☐	☐	☐	☑	☑	☐	☑	☐	☐	☑	☑	☐	☐	☐	☑	☐	☐	☐	☐	☐
03	☐	☐	☐	☐	☐	☐	☐	☑	☑	☐	☑	☐	☐	☑	☑	☐	☐	☐	☑	☐	☐	☐	☐	☐
04	☐	☐	☐	☐	☐	☐	☐	☑	☑	☐	☑	☐	☐	☑	☑	☐	☐	☐	☑	☐	☐	☐	☐	☐
05	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐
06	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑

APPLICABLE REGULATORY LIMITS:
Canadian Drinking Water Quality Guidelines ☐
BC Drinking Water Protection Act/Reg. ☐
BC CSR: AL ☐ RL ☐ CL ☐ IL ☐ AW ☐
CCME ☑ Alberta Tier 1 ☐
OTHER: BC WQ Guidelines for Aquatic Life

SAMPLE RETENTION INSTRUCTIONS (Discarded 30 days after Report unless otherwise specified):
60 Days ☐ 90 Days ☐ Longer Date (Surcharges will apply):

OTHER INSTRUCTIONS:
Total and dissolved metals, mercury, and bacteriological samples have been preserved. Dissolved metals samples (incl. mercury) have also been filtered. Metals analysis should be LOW level ICPMS pkg. Add total + dissolved Hg. Alkalinity = SPECIATED alkalinity. Use higher dilutions for bacteriological tests pls.

PAYMENT: Cheque ☐ Credit ☐ Debit ☐ Cash ☐ Invoice ☐

SAMPLE RECEIPT TEMP (°C): 8.1
Work Order # _____
CUSTODY SEALS INTACT: ☐Y ☐N ☐NA

Required Fields Recommended Fields **SHADED AREAS:** LAB USE ONLY

KERR WOOD LEIDAL
consulting engineers

Appendix D

2015 Dry Season Detailed Laboratory Analysis Reports

CERTIFICATE OF ANALYSIS

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby) 200 - 4185A Still Creek Dr Burnaby, BC V5C 6G9	**TEL** **FAX**	(604) 294-2088 (604) 294-2090
ATTENTION	Patrick Lilley	**WORK ORDER**	5072008
PO NUMBER		**RECEIVED / TEMP**	Jul-29-15 15:00 / 14°C
PROJECT	173.169 Maple Ridge WQ	**REPORTED**	Aug-06-15
PROJECT INFO	Stormwater Monitoring		

General Comments:

CARO Analytical Services employs methods which are conducted according to procedures accepted by appropriate regulatory agencies, and/or are conducted in accordance with recognized professional standards using accepted testing methodologies and quality control efforts, except where otherwise agreed to by the client.

The results in this report apply to the samples analyzed in accordance with the Chain of Custody or Sample Requisition document. This analytical report must be reproduced in its entirety. CARO is not responsible for any loss or damage resulting directly or indirectly from error or omission in the conduct of testing. Liability is limited to the cost of analysis. Samples will be disposed of 30 days after the test report has been issued unless otherwise agreed to in writing.

Authorized By: **Brent Coates, B.Sc.**
Division Manager, Richmond

If you have any questions or concerns, please contact your Account Manager:
Bryan Shaw, Ph.D. (bshaw@caro.ca)

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#102 3677 Highway 97N
Kelowna, BC V1X 5C3
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Edmonton, AB T5S 1H7
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www.caro.ca

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PROJECT	173.169 Maple Ridge WQ	**REPORTED**	Aug-06-15

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Sample Analytical Data Page 4
Test Results, Reporting Limits, Analysis Dates, Sample & Analysis Notes

Quality Control Data Appendix 1
Method Blanks, Duplicates, Spikes, Reference Materials

Analytical Summary Appendix 2
Tabulated data in condensed format to assist with comparisons

Chain of Custody Document Appendix 4
Analysis instructions provided by client

ANALYSIS INFORMATION

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	5072008
PROJECT	173.169 Maple Ridge WQ	**REPORTED**	Aug-06-15

Analysis Description	Method Reference	Technique	Location
Alkalinity in Water (Speciated)	APHA 2320 B*	Titration with H2SO4	Kelowna
Anions in Water by IC	APHA 4110 B	Ion Chromatography with Chemical Suppression of Eluent Conductivity	Kelowna
Dissolved Metals	APHA 3030 B / APHA 3125 B	0.45 µm Filtration / Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	Richmond
E. coli (MPN)	APHA 9221	Multiple-Tube Fermentation	Sublet
Fecal Coliforms (MPN)	APHA 9221	Multiple-Tube Fermentation	Sublet
Hardness (as CaCO3)	APHA 2340 B	Calculation	N/A
Mercury, dissolved by CVAFS	EPA 245.7*	BrCl2 Oxidation / Cold Vapor Atomic Fluorescence Spectrometry (CVAFS)	Richmond
Mercury, total by CVAFS	EPA 245.7*	BrCl2 Oxidation / Cold Vapor Atomic Fluorescence Spectrometry (CVAFS)	Richmond
Total Coliforms (MPN)	APHA 9221	Multiple-Tube Fermentation	Sublet
Total Recoverable Metals	APHA 3030E* / APHA 3125 B	HNO3+HCl Hot Block Digestion / Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	Richmond

Note: An asterisk in the Method Reference indicates that the CARO method has been modified from the reference method

Method Reference Descriptions:

APHA	Standard Methods for the Examination of Water and Wastewater, 22nd Edition, American Public Health Association/American Water Works Association/Water Environment Federation
EPA	United States Environmental Protection Agency Test Methods

Glossary of Terms:

MRL	Method Reporting Limit
<	Less than the Reported Detection Limit (RDL) - the RDL may be higher than the MRL due to various factors such as dilutions, limited sample volume, high moisture, or interferences
mg/L	Milligrams per litre
MPN/100 mL	Most Probable Number per 100 millilitres

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 5072008
REPORTED Aug-06-15

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SA-1 (T2 Creek) (5072008-01) [Water] Sampled: Jul-29-15 11:50							
Anions							
Nitrate as N	**0.665**	N/A	0.010	mg/L	N/A	Jul-31-15	
General Parameters							
Alkalinity, Total as CaCO3	**64**	N/A	1	mg/L	N/A	Jul-31-15	
Alkalinity, Phenolphthalein as CaCO3	< 1	N/A	1	mg/L	N/A	Jul-31-15	
Alkalinity, Bicarbonate as CaCO3	**64**	N/A	1	mg/L	N/A	Jul-31-15	
Alkalinity, Carbonate as CaCO3	< 1	N/A	1	mg/L	N/A	Jul-31-15	
Alkalinity, Hydroxide as CaCO3	< 1	N/A	1	mg/L	N/A	Jul-31-15	
Calculated Parameters							
Hardness, Total (Diss. as CaCO3)	**69.5**	N/A	0.50	mg/L	N/A	N/A	
Hardness, Total (Total as CaCO3)	**69.4**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.012**	N/A	0.005	mg/L	N/A	Aug-04-15	
Antimony, dissolved	**0.0002**	N/A	0.0001	mg/L	N/A	Aug-04-15	
Arsenic, dissolved	**0.0007**	N/A	0.0005	mg/L	N/A	Aug-04-15	
Barium, dissolved	**0.010**	N/A	0.005	mg/L	N/A	Aug-04-15	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-04-15	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-04-15	
Boron, dissolved	**0.023**	N/A	0.004	mg/L	N/A	Aug-04-15	
Cadmium, dissolved	**0.00002**	N/A	0.00001	mg/L	N/A	Aug-04-15	
Calcium, dissolved	**15.9**	N/A	0.2	mg/L	N/A	Aug-04-15	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Aug-04-15	
Cobalt, dissolved	**0.00006**	N/A	0.00005	mg/L	N/A	Aug-04-15	
Copper, dissolved	**0.0031**	N/A	0.0002	mg/L	N/A	Aug-04-15	
Iron, dissolved	**0.110**	N/A	0.010	mg/L	N/A	Aug-04-15	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-04-15	
Lithium, dissolved	**0.0007**	N/A	0.0001	mg/L	N/A	Aug-04-15	
Magnesium, dissolved	**7.22**	N/A	0.01	mg/L	N/A	Aug-04-15	
Manganese, dissolved	**0.0118**	N/A	0.0002	mg/L	N/A	Aug-04-15	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	Aug-04-15	Aug-05-15	
Molybdenum, dissolved	**0.0007**	N/A	0.0001	mg/L	N/A	Aug-04-15	
Nickel, dissolved	**0.0006**	N/A	0.0002	mg/L	N/A	Aug-04-15	
Phosphorus, dissolved	**0.02**	N/A	0.02	mg/L	N/A	Aug-04-15	
Potassium, dissolved	**2.38**	N/A	0.02	mg/L	N/A	Aug-04-15	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Aug-04-15	
Silicon, dissolved	**7.1**	N/A	0.5	mg/L	N/A	Aug-04-15	
Silver, dissolved	**0.00005**	N/A	0.00005	mg/L	N/A	Aug-04-15	
Sodium, dissolved	**18.5**	N/A	0.02	mg/L	N/A	Aug-04-15	
Strontium, dissolved	**0.084**	N/A	0.001	mg/L	N/A	Aug-04-15	
Sulfur, dissolved	**2**	N/A	1	mg/L	N/A	Aug-04-15	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Aug-04-15	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Aug-04-15	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-04-15	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Aug-04-15	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	Aug-04-15	

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 5072008
REPORTED Aug-06-15

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SA-1 (T2 Creek) (5072008-01) [Water] Sampled: Jul-29-15 11:50, Continued							
Dissolved Metals, Continued							
Uranium, dissolved	**0.00004**	N/A	0.00002	mg/L	N/A	Aug-04-15	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	Aug-04-15	
Zinc, dissolved	**0.005**	N/A	0.004	mg/L	N/A	Aug-04-15	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-04-15	
Total Recoverable Metals							
Aluminum, total	**0.143**	N/A	0.005	mg/L	Jul-30-15	Jul-31-15	
Antimony, total	**0.0003**	N/A	0.0001	mg/L	Jul-30-15	Jul-31-15	
Arsenic, total	**0.0007**	N/A	0.0005	mg/L	Jul-30-15	Jul-31-15	
Barium, total	**0.011**	N/A	0.005	mg/L	Jul-30-15	Jul-31-15	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	Jul-30-15	Jul-31-15	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	Jul-30-15	Jul-31-15	
Boron, total	**0.024**	N/A	0.004	mg/L	Jul-30-15	Jul-31-15	
Cadmium, total	**0.00001**	N/A	0.00001	mg/L	Jul-30-15	Jul-31-15	
Calcium, total	**15.8**	N/A	0.2	mg/L	Jul-30-15	Jul-31-15	
Chromium, total	< 0.0005	N/A	0.0005	mg/L	Jul-30-15	Jul-31-15	
Cobalt, total	**0.00010**	N/A	0.00005	mg/L	Jul-30-15	Jul-31-15	
Copper, total	**0.0037**	N/A	0.0002	mg/L	Jul-30-15	Jul-31-15	
Iron, total	**0.31**	N/A	0.01	mg/L	Jul-30-15	Jul-31-15	
Lead, total	**0.0002**	N/A	0.0001	mg/L	Jul-30-15	Jul-31-15	
Lithium, total	**0.0010**	N/A	0.0001	mg/L	Jul-30-15	Jul-31-15	
Magnesium, total	**7.28**	N/A	0.01	mg/L	Jul-30-15	Jul-31-15	
Manganese, total	**0.0168**	N/A	0.0002	mg/L	Jul-30-15	Jul-31-15	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	Aug-04-15	Aug-04-15	
Molybdenum, total	**0.0009**	N/A	0.0001	mg/L	Jul-30-15	Jul-31-15	
Nickel, total	**0.0009**	N/A	0.0002	mg/L	Jul-30-15	Jul-31-15	
Phosphorus, total	**0.06**	N/A	0.02	mg/L	Jul-30-15	Jul-31-15	
Potassium, total	**2.40**	N/A	0.02	mg/L	Jul-30-15	Jul-31-15	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	Jul-30-15	Jul-31-15	
Silicon, total	**7.9**	N/A	0.5	mg/L	Jul-30-15	Jul-31-15	
Silver, total	< 0.00005	N/A	0.00005	mg/L	Jul-30-15	Jul-31-15	
Sodium, total	**18.7**	N/A	0.02	mg/L	Jul-30-15	Jul-31-15	
Strontium, total	**0.090**	N/A	0.001	mg/L	Jul-30-15	Jul-31-15	
Sulfur, total	**1**	N/A	1	mg/L	Jul-30-15	Jul-31-15	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	Jul-30-15	Jul-31-15	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	Jul-30-15	Jul-31-15	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	Jul-30-15	Jul-31-15	
Tin, total	< 0.0002	N/A	0.0002	mg/L	Jul-30-15	Jul-31-15	
Titanium, total	**0.006**	N/A	0.005	mg/L	Jul-30-15	Jul-31-15	
Uranium, total	**0.00005**	N/A	0.00002	mg/L	Jul-30-15	Jul-31-15	
Vanadium, total	**0.002**	N/A	0.001	mg/L	Jul-30-15	Jul-31-15	
Zinc, total	**0.007**	N/A	0.004	mg/L	Jul-30-15	Jul-31-15	
Zirconium, total	< 0.0001	N/A	0.0001	mg/L	Jul-30-15	Jul-31-15	
Microbiological Parameters							
Coliforms, Total	**5000**	N/A	2	MPN/100 mL		Jul-30-15	

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	5072008
PROJECT	173.169 Maple Ridge WQ	**REPORTED**	Aug-06-15

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SA-1 (T2 Creek) (5072008-01) [Water] Sampled: Jul-29-15 11:50, Continued							
Microbiological Parameters, Continued							
Coliforms, Fecal	**1100**	N/A	2	MPN/100 mL		Jul-30-15	
E. coli (MPN)	**1100**	N/A	2	MPN/100 mL		Jul-30-15	
Sample ID: SA-2 (Millionaire Creek) (5072008-02) [Water] Sampled: Jul-29-15 12:25							
Anions							
Nitrate as N	**0.312**	N/A	0.010	mg/L	N/A	Jul-31-15	
General Parameters							
Alkalinity, Total as CaCO3	**26**	N/A	1	mg/L	N/A	Jul-31-15	
Alkalinity, Phenolphthalein as CaCO3	< 1	N/A	1	mg/L	N/A	Jul-31-15	
Alkalinity, Bicarbonate as CaCO3	**26**	N/A	1	mg/L	N/A	Jul-31-15	
Alkalinity, Carbonate as CaCO3	< 1	N/A	1	mg/L	N/A	Jul-31-15	
Alkalinity, Hydroxide as CaCO3	< 1	N/A	1	mg/L	N/A	Jul-31-15	
Calculated Parameters							
Hardness, Total (Diss. as CaCO3)	**23.2**	N/A	0.50	mg/L	N/A	N/A	
Hardness, Total (Total as CaCO3)	**24.1**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.011**	N/A	0.005	mg/L	N/A	Aug-04-15	
Antimony, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-04-15	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Aug-04-15	
Barium, dissolved	**0.007**	N/A	0.005	mg/L	N/A	Aug-04-15	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-04-15	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-04-15	
Boron, dissolved	**0.007**	N/A	0.004	mg/L	N/A	Aug-04-15	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	Aug-04-15	
Calcium, dissolved	**7.0**	N/A	0.2	mg/L	N/A	Aug-04-15	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Aug-04-15	
Cobalt, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	Aug-04-15	
Copper, dissolved	**0.0008**	N/A	0.0002	mg/L	N/A	Aug-04-15	
Iron, dissolved	**0.019**	N/A	0.010	mg/L	N/A	Aug-04-15	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-04-15	
Lithium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-04-15	
Magnesium, dissolved	**1.39**	N/A	0.01	mg/L	N/A	Aug-04-15	
Manganese, dissolved	**0.0018**	N/A	0.0002	mg/L	N/A	Aug-04-15	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	Aug-04-15	Aug-05-15	
Molybdenum, dissolved	**0.0005**	N/A	0.0001	mg/L	N/A	Aug-04-15	
Nickel, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Aug-04-15	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	Aug-04-15	
Potassium, dissolved	**0.60**	N/A	0.02	mg/L	N/A	Aug-04-15	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Aug-04-15	
Silicon, dissolved	**5.2**	N/A	0.5	mg/L	N/A	Aug-04-15	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	Aug-04-15	
Sodium, dissolved	**4.78**	N/A	0.02	mg/L	N/A	Aug-04-15	
Strontium, dissolved	**0.040**	N/A	0.001	mg/L	N/A	Aug-04-15	

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	5072008
PROJECT	173.169 Maple Ridge WQ	**REPORTED**	Aug-06-15

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SA-2 (Millionaire Creek) (5072008-02) [Water] Sampled: Jul-29-15 12:25, Continued							
Dissolved Metals, Continued							
Sulfur, dissolved	< 1	N/A	1	mg/L	N/A	Aug-04-15	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Aug-04-15	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Aug-04-15	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-04-15	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Aug-04-15	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	Aug-04-15	
Uranium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Aug-04-15	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	Aug-04-15	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	Aug-04-15	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-04-15	
Total Recoverable Metals							
Aluminum, total	**0.025**	N/A	0.005	mg/L	Jul-30-15	Jul-31-15	
Antimony, total	**0.0002**	N/A	0.0001	mg/L	Jul-30-15	Jul-31-15	
Arsenic, total	< 0.0005	N/A	0.0005	mg/L	Jul-30-15	Jul-31-15	
Barium, total	**0.008**	N/A	0.005	mg/L	Jul-30-15	Jul-31-15	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	Jul-30-15	Jul-31-15	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	Jul-30-15	Jul-31-15	
Boron, total	**0.009**	N/A	0.004	mg/L	Jul-30-15	Jul-31-15	
Cadmium, total	**0.00003**	N/A	0.00001	mg/L	Jul-30-15	Jul-31-15	
Calcium, total	**7.2**	N/A	0.2	mg/L	Jul-30-15	Jul-31-15	
Chromium, total	< 0.0005	N/A	0.0005	mg/L	Jul-30-15	Jul-31-15	
Cobalt, total	< 0.00005	N/A	0.00005	mg/L	Jul-30-15	Jul-31-15	
Copper, total	**0.0064**	N/A	0.0002	mg/L	Jul-30-15	Jul-31-15	
Iron, total	**0.04**	N/A	0.01	mg/L	Jul-30-15	Jul-31-15	
Lead, total	**0.0002**	N/A	0.0001	mg/L	Jul-30-15	Jul-31-15	
Lithium, total	< 0.0001	N/A	0.0001	mg/L	Jul-30-15	Jul-31-15	
Magnesium, total	**1.48**	N/A	0.01	mg/L	Jul-30-15	Jul-31-15	
Manganese, total	**0.0028**	N/A	0.0002	mg/L	Jul-30-15	Jul-31-15	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	Aug-04-15	Aug-04-15	
Molybdenum, total	**0.0008**	N/A	0.0001	mg/L	Jul-30-15	Jul-31-15	
Nickel, total	< 0.0002	N/A	0.0002	mg/L	Jul-30-15	Jul-31-15	
Phosphorus, total	**0.03**	N/A	0.02	mg/L	Jul-30-15	Jul-31-15	
Potassium, total	**0.69**	N/A	0.02	mg/L	Jul-30-15	Jul-31-15	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	Jul-30-15	Jul-31-15	
Silicon, total	**6.0**	N/A	0.5	mg/L	Jul-30-15	Jul-31-15	
Silver, total	< 0.00005	N/A	0.00005	mg/L	Jul-30-15	Jul-31-15	
Sodium, total	**5.13**	N/A	0.02	mg/L	Jul-30-15	Jul-31-15	
Strontium, total	**0.044**	N/A	0.001	mg/L	Jul-30-15	Jul-31-15	
Sulfur, total	< 1	N/A	1	mg/L	Jul-30-15	Jul-31-15	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	Jul-30-15	Jul-31-15	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	Jul-30-15	Jul-31-15	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	Jul-30-15	Jul-31-15	
Tin, total	< 0.0002	N/A	0.0002	mg/L	Jul-30-15	Jul-31-15	
Titanium, total	< 0.005	N/A	0.005	mg/L	Jul-30-15	Jul-31-15	
Uranium, total	< 0.00002	N/A	0.00002	mg/L	Jul-30-15	Jul-31-15	

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	5072008
PROJECT	173.169 Maple Ridge WQ	**REPORTED**	Aug-06-15

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SA-2 (Millionaire Creek) (5072008-02) [Water] Sampled: Jul-29-15 12:25, Continued							
Total Recoverable Metals, Continued							
Vanadium, total	< 0.001	N/A	0.001	mg/L	Jul-30-15	Jul-31-15	
Zinc, total	**0.005**	N/A	0.004	mg/L	Jul-30-15	Jul-31-15	
Zirconium, total	< 0.0001	N/A	0.0001	mg/L	Jul-30-15	Jul-31-15	
Microbiological Parameters							
Coliforms, Total	**500**	N/A	2	MPN/100 mL		Jul-30-15	
Coliforms, Fecal	**30**	N/A	2	MPN/100 mL		Jul-30-15	
E. coli (MPN)	**23**	N/A	2	MPN/100 mL		Jul-30-15	
Sample ID: K-1 (Dunlop Creek) (5072008-03) [Water] Sampled: Jul-29-15 13:00							
Anions							
Nitrate as N	**0.205**	N/A	0.010	mg/L	N/A	Jul-31-15	
General Parameters							
Alkalinity, Total as CaCO3	**69**	N/A	1	mg/L	N/A	Jul-31-15	
Alkalinity, Phenolphthalein as CaCO3	< 1	N/A	1	mg/L	N/A	Jul-31-15	
Alkalinity, Bicarbonate as CaCO3	**69**	N/A	1	mg/L	N/A	Jul-31-15	
Alkalinity, Carbonate as CaCO3	< 1	N/A	1	mg/L	N/A	Jul-31-15	
Alkalinity, Hydroxide as CaCO3	< 1	N/A	1	mg/L	N/A	Jul-31-15	
Calculated Parameters							
Hardness, Total (Diss. as CaCO3)	**69.5**	N/A	0.50	mg/L	N/A	N/A	
Hardness, Total (Total as CaCO3)	**72.0**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.013**	N/A	0.005	mg/L	N/A	Aug-04-15	
Antimony, dissolved	**0.0001**	N/A	0.0001	mg/L	N/A	Aug-04-15	
Arsenic, dissolved	**0.0008**	N/A	0.0005	mg/L	N/A	Aug-04-15	
Barium, dissolved	**0.013**	N/A	0.005	mg/L	N/A	Aug-04-15	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-04-15	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-04-15	
Boron, dissolved	**0.034**	N/A	0.004	mg/L	N/A	Aug-04-15	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	Aug-04-15	
Calcium, dissolved	**17.8**	N/A	0.2	mg/L	N/A	Aug-04-15	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Aug-04-15	
Cobalt, dissolved	**0.00030**	N/A	0.00005	mg/L	N/A	Aug-04-15	
Copper, dissolved	**0.0015**	N/A	0.0002	mg/L	N/A	Aug-04-15	
Iron, dissolved	**0.540**	N/A	0.010	mg/L	N/A	Aug-04-15	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-04-15	
Lithium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-04-15	
Magnesium, dissolved	**6.11**	N/A	0.01	mg/L	N/A	Aug-04-15	
Manganese, dissolved	**0.123**	N/A	0.0002	mg/L	N/A	Aug-04-15	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	Aug-04-15	Aug-05-15	
Molybdenum, dissolved	**0.0005**	N/A	0.0001	mg/L	N/A	Aug-04-15	
Nickel, dissolved	**0.0006**	N/A	0.0002	mg/L	N/A	Aug-04-15	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	Aug-04-15	

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	5072008
PROJECT	173.169 Maple Ridge WQ	**REPORTED**	Aug-06-15

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: K-1 (Dunlop Creek) (5072008-03) [Water] Sampled: Jul-29-15 13:00, Continued							
Dissolved Metals, Continued							
Potassium, dissolved	**3.64**	N/A	0.02	mg/L	N/A	Aug-04-15	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Aug-04-15	
Silicon, dissolved	**3.9**	N/A	0.5	mg/L	N/A	Aug-04-15	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	Aug-04-15	
Sodium, dissolved	**12.6**	N/A	0.02	mg/L	N/A	Aug-04-15	
Strontium, dissolved	**0.109**	N/A	0.001	mg/L	N/A	Aug-04-15	
Sulfur, dissolved	**3**	N/A	1	mg/L	N/A	Aug-04-15	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Aug-04-15	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Aug-04-15	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-04-15	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Aug-04-15	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	Aug-04-15	
Uranium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Aug-04-15	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	Aug-04-15	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	Aug-04-15	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-04-15	
Total Recoverable Metals							
Aluminum, total	**0.124**	N/A	0.005	mg/L	Jul-30-15	Jul-31-15	
Antimony, total	**0.0002**	N/A	0.0001	mg/L	Jul-30-15	Jul-31-15	
Arsenic, total	**0.0010**	N/A	0.0005	mg/L	Jul-30-15	Jul-31-15	
Barium, total	**0.015**	N/A	0.005	mg/L	Jul-30-15	Jul-31-15	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	Jul-30-15	Jul-31-15	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	Jul-30-15	Jul-31-15	
Boron, total	**0.038**	N/A	0.004	mg/L	Jul-30-15	Jul-31-15	
Cadmium, total	**0.00001**	N/A	0.00001	mg/L	Jul-30-15	Jul-31-15	
Calcium, total	**18.3**	N/A	0.2	mg/L	Jul-30-15	Jul-31-15	
Chromium, total	**0.0005**	N/A	0.0005	mg/L	Jul-30-15	Jul-31-15	
Cobalt, total	**0.00037**	N/A	0.00005	mg/L	Jul-30-15	Jul-31-15	
Copper, total	**0.0021**	N/A	0.0002	mg/L	Jul-30-15	Jul-31-15	
Iron, total	**0.88**	N/A	0.01	mg/L	Jul-30-15	Jul-31-15	
Lead, total	**0.0001**	N/A	0.0001	mg/L	Jul-30-15	Jul-31-15	
Lithium, total	**0.0001**	N/A	0.0001	mg/L	Jul-30-15	Jul-31-15	
Magnesium, total	**6.41**	N/A	0.01	mg/L	Jul-30-15	Jul-31-15	
Manganese, total	**0.148**	N/A	0.0002	mg/L	Jul-30-15	Jul-31-15	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	Aug-04-15	Aug-04-15	
Molybdenum, total	**0.0008**	N/A	0.0001	mg/L	Jul-30-15	Jul-31-15	
Nickel, total	**0.0009**	N/A	0.0002	mg/L	Jul-30-15	Jul-31-15	
Phosphorus, total	**0.07**	N/A	0.02	mg/L	Jul-30-15	Jul-31-15	
Potassium, total	**3.81**	N/A	0.02	mg/L	Jul-30-15	Jul-31-15	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	Jul-30-15	Jul-31-15	
Silicon, total	**4.8**	N/A	0.5	mg/L	Jul-30-15	Jul-31-15	
Silver, total	< 0.00005	N/A	0.00005	mg/L	Jul-30-15	Jul-31-15	
Sodium, total	**13.2**	N/A	0.02	mg/L	Jul-30-15	Jul-31-15	
Strontium, total	**0.121**	N/A	0.001	mg/L	Jul-30-15	Jul-31-15	
Sulfur, total	**5**	N/A	1	mg/L	Jul-30-15	Jul-31-15	

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 5072008
REPORTED Aug-06-15

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: K-1 (Dunlop Creek) (5072008-03) [Water] Sampled: Jul-29-15 13:00, Continued							
Total Recoverable Metals, Continued							
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	Jul-30-15	Jul-31-15	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	Jul-30-15	Jul-31-15	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	Jul-30-15	Jul-31-15	
Tin, total	< 0.0002	N/A	0.0002	mg/L	Jul-30-15	Jul-31-15	
Titanium, total	**0.005**	N/A	0.005	mg/L	Jul-30-15	Jul-31-15	
Uranium, total	< 0.00002	N/A	0.00002	mg/L	Jul-30-15	Jul-31-15	
Vanadium, total	**0.002**	N/A	0.001	mg/L	Jul-30-15	Jul-31-15	
Zinc, total	< 0.004	N/A	0.004	mg/L	Jul-30-15	Jul-31-15	
Zirconium, total	**0.0001**	N/A	0.0001	mg/L	Jul-30-15	Jul-31-15	
Microbiological Parameters							
Coliforms, Total	**3000**	N/A	2	MPN/100 mL		Jul-30-15	
Coliforms, Fecal	**110**	N/A	2	MPN/100 mL		Jul-30-15	
E. coli (MPN)	**110**	N/A	2	MPN/100 mL		Jul-30-15	
Sample ID: K-2 (Spencer Creek) (5072008-04) [Water] Sampled: Jul-29-15 13:30							
Anions							
Nitrate as N	< 0.010	N/A	0.010	mg/L	N/A	Jul-31-15	
General Parameters							
Alkalinity, Total as CaCO3	**87**	N/A	1	mg/L	N/A	Jul-31-15	
Alkalinity, Phenolphthalein as CaCO3	< 1	N/A	1	mg/L	N/A	Jul-31-15	
Alkalinity, Bicarbonate as CaCO3	**87**	N/A	1	mg/L	N/A	Jul-31-15	
Alkalinity, Carbonate as CaCO3	< 1	N/A	1	mg/L	N/A	Jul-31-15	
Alkalinity, Hydroxide as CaCO3	< 1	N/A	1	mg/L	N/A	Jul-31-15	
Calculated Parameters							
Hardness, Total (Diss. as CaCO3)	**89.0**	N/A	0.50	mg/L	N/A	N/A	
Hardness, Total (Total as CaCO3)	**91.3**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.007**	N/A	0.005	mg/L	N/A	Aug-04-15	
Antimony, dissolved	**0.0001**	N/A	0.0001	mg/L	N/A	Aug-04-15	
Arsenic, dissolved	**0.0009**	N/A	0.0005	mg/L	N/A	Aug-04-15	
Barium, dissolved	**0.008**	N/A	0.005	mg/L	N/A	Aug-04-15	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-04-15	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-04-15	
Boron, dissolved	**0.021**	N/A	0.004	mg/L	N/A	Aug-04-15	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	Aug-04-15	
Calcium, dissolved	**24.2**	N/A	0.2	mg/L	N/A	Aug-04-15	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Aug-04-15	
Cobalt, dissolved	**0.00009**	N/A	0.00005	mg/L	N/A	Aug-04-15	
Copper, dissolved	**0.0015**	N/A	0.0002	mg/L	N/A	Aug-04-15	
Iron, dissolved	**0.080**	N/A	0.010	mg/L	N/A	Aug-04-15	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-04-15	
Lithium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-04-15	

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	5072008
PROJECT	173.169 Maple Ridge WQ	**REPORTED**	Aug-06-15

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: K-2 (Spencer Creek) (5072008-04) [Water] Sampled: Jul-29-15 13:30, Continued							
Dissolved Metals, Continued							
Magnesium, dissolved	**6.92**	N/A	0.01	mg/L	N/A	Aug-04-15	
Manganese, dissolved	**0.0361**	N/A	0.0002	mg/L	N/A	Aug-04-15	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	Aug-04-15	Aug-05-15	
Molybdenum, dissolved	**0.0007**	N/A	0.0001	mg/L	N/A	Aug-04-15	
Nickel, dissolved	**0.0006**	N/A	0.0002	mg/L	N/A	Aug-04-15	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	Aug-04-15	
Potassium, dissolved	**2.32**	N/A	0.02	mg/L	N/A	Aug-04-15	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Aug-04-15	
Silicon, dissolved	**5.5**	N/A	0.5	mg/L	N/A	Aug-04-15	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	Aug-04-15	
Sodium, dissolved	**10.8**	N/A	0.02	mg/L	N/A	Aug-04-15	
Strontium, dissolved	**0.143**	N/A	0.001	mg/L	N/A	Aug-04-15	
Sulfur, dissolved	**1**	N/A	1	mg/L	N/A	Aug-04-15	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Aug-04-15	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Aug-04-15	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-04-15	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Aug-04-15	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	Aug-04-15	
Uranium, dissolved	**0.00004**	N/A	0.00002	mg/L	N/A	Aug-04-15	
Vanadium, dissolved	**0.001**	N/A	0.001	mg/L	N/A	Aug-04-15	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	Aug-04-15	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-04-15	
Total Recoverable Metals							
Aluminum, total	**0.511**	N/A	0.005	mg/L	Jul-30-15	Jul-31-15	
Antimony, total	**0.0003**	N/A	0.0001	mg/L	Jul-30-15	Jul-31-15	
Arsenic, total	**0.0012**	N/A	0.0005	mg/L	Jul-30-15	Jul-31-15	
Barium, total	**0.012**	N/A	0.005	mg/L	Jul-30-15	Jul-31-15	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	Jul-30-15	Jul-31-15	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	Jul-30-15	Jul-31-15	
Boron, total	**0.026**	N/A	0.004	mg/L	Jul-30-15	Jul-31-15	
Cadmium, total	**0.00001**	N/A	0.00001	mg/L	Jul-30-15	Jul-31-15	
Calcium, total	**24.3**	N/A	0.2	mg/L	Jul-30-15	Jul-31-15	
Chromium, total	**0.0008**	N/A	0.0005	mg/L	Jul-30-15	Jul-31-15	
Cobalt, total	**0.00034**	N/A	0.00005	mg/L	Jul-30-15	Jul-31-15	
Copper, total	**0.0025**	N/A	0.0002	mg/L	Jul-30-15	Jul-31-15	
Iron, total	**0.70**	N/A	0.01	mg/L	Jul-30-15	Jul-31-15	
Lead, total	**0.0002**	N/A	0.0001	mg/L	Jul-30-15	Jul-31-15	
Lithium, total	**0.0005**	N/A	0.0001	mg/L	Jul-30-15	Jul-31-15	
Magnesium, total	**7.39**	N/A	0.01	mg/L	Jul-30-15	Jul-31-15	
Manganese, total	**0.0670**	N/A	0.0002	mg/L	Jul-30-15	Jul-31-15	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	Aug-04-15	Aug-04-15	
Molybdenum, total	**0.0009**	N/A	0.0001	mg/L	Jul-30-15	Jul-31-15	
Nickel, total	**0.0012**	N/A	0.0002	mg/L	Jul-30-15	Jul-31-15	
Phosphorus, total	**0.06**	N/A	0.02	mg/L	Jul-30-15	Jul-31-15	
Potassium, total	**2.49**	N/A	0.02	mg/L	Jul-30-15	Jul-31-15	

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 5072008
REPORTED Aug-06-15

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: K-2 (Spencer Creek) (5072008-04) [Water] Sampled: Jul-29-15 13:30, Continued							
Total Recoverable Metals, Continued							
Selenium, total	< 0.0005	N/A	0.0005	mg/L	Jul-30-15	Jul-31-15	
Silicon, total	**7.2**	N/A	0.5	mg/L	Jul-30-15	Jul-31-15	
Silver, total	< 0.00005	N/A	0.00005	mg/L	Jul-30-15	Jul-31-15	
Sodium, total	**11.4**	N/A	0.02	mg/L	Jul-30-15	Jul-31-15	
Strontium, total	**0.157**	N/A	0.001	mg/L	Jul-30-15	Jul-31-15	
Sulfur, total	**2**	N/A	1	mg/L	Jul-30-15	Jul-31-15	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	Jul-30-15	Jul-31-15	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	Jul-30-15	Jul-31-15	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	Jul-30-15	Jul-31-15	
Tin, total	< 0.0002	N/A	0.0002	mg/L	Jul-30-15	Jul-31-15	
Titanium, total	**0.020**	N/A	0.005	mg/L	Jul-30-15	Jul-31-15	
Uranium, total	**0.00005**	N/A	0.00002	mg/L	Jul-30-15	Jul-31-15	
Vanadium, total	**0.003**	N/A	0.001	mg/L	Jul-30-15	Jul-31-15	
Zinc, total	**0.005**	N/A	0.004	mg/L	Jul-30-15	Jul-31-15	
Zirconium, total	**0.0002**	N/A	0.0001	mg/L	Jul-30-15	Jul-31-15	
Microbiological Parameters							
Coliforms, Total	**1600**	N/A	2	MPN/100 mL		Jul-30-15	
Coliforms, Fecal	**130**	N/A	2	MPN/100 mL		Jul-30-15	
E. coli (MPN)	**130**	N/A	2	MPN/100 mL		Jul-30-15	
Sample ID: Field Blank (5072008-05) [Water] Sampled: Jul-29-15 11:50							
Microbiological Parameters							
Coliforms, Total	**ND**	N/A	2	MPN/100 mL		Jul-30-15	
E. coli (MPN)	**ND**	N/A	2	MPN/100 mL		Jul-30-15	

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The following section displays the quality control (QC) data that is associated with your sample data. Groups of samples are prepared in "batches" and analyzed in conjunction with QC samples that ensure your data is of the highest quality. Common QC types include:

- **Method Blank (Blk)**: Laboratory reagent water is carried through sample preparation and analysis steps. Method Blanks indicate that results are free from contamination, i.e. not biased high from sources such as the sample container or the laboratory environment
- **Duplicate (Dup)**: Preparation and analysis of a replicate aliquot of a sample. Duplicates provide a measure of the analytical method's precision, i.e. how reproducible a result is. Duplicates are only reported if they are associated with your sample data.
- **Blank Spike (BS)**: A known amount of standard is carried through sample preparation and analysis steps. Blank Spikes, also known as laboratory control samples (LCS), are prepared from a different source of standard than used for the calibration. They ensure that the calibration is acceptable (i.e. not biased high or low) and also provide a measure of the analytical method's accuracy (i.e. closeness of the result to a target value).
- **Standard Reference Material (SRM)**: A material of similar matrix to the samples, externally certified for the parameter(s) listed. Standard Reference Materials ensure that the preparation steps in the method are adequate to achieve acceptable recoveries of the parameter(s) tested.

Each QC type is analyzed at a 5-10% frequency, i.e. one blank/duplicate/spike for every 10 samples. For all types of QC, the specified recovery (% Rec) and relative percent difference (RPD) limits are derived from long-term method performance averages and/or prescribed by the reference method.

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Anions, Batch B5G1705										
Blank (B5G1705-BLK1)				Prepared: Jul-31-15, Analyzed: Jul-31-15						
Nitrate as N	< 0.010	0.010	mg/L							
Blank (B5G1705-BLK2)				Prepared: Jul-31-15, Analyzed: Jul-31-15						
Nitrate as N	< 0.010	0.010	mg/L							
LCS (B5G1705-BS1)				Prepared: Jul-31-15, Analyzed: Jul-31-15						
Nitrate as N	3.96	0.010	mg/L	4.00		99	85-115			
LCS (B5G1705-BS2)				Prepared: Jul-31-15, Analyzed: Jul-31-15						
Nitrate as N	3.98	0.010	mg/L	4.00		99	85-115			
Duplicate (B5G1705-DUP1)		**Source: 5072008-01**		Prepared: Jul-31-15, Analyzed: Jul-31-15						
Nitrate as N	0.671	0.010	mg/L		0.665			1	10	
Matrix Spike (B5G1705-MS1)		**Source: 5072008-01**		Prepared: Jul-31-15, Analyzed: Jul-31-15						
Nitrate as N	3.98	0.010	mg/L	4.00	0.665	83	75-125			
Dissolved Metals, Batch B5H0022										
Blank (B5H0022-BLK1)				Prepared: Aug-04-15, Analyzed: Aug-04-15						
Aluminum, dissolved	< 0.005	0.005	mg/L							
Antimony, dissolved	< 0.0001	0.0001	mg/L							
Arsenic, dissolved	< 0.0005	0.0005	mg/L							
Barium, dissolved	< 0.005	0.005	mg/L							
Beryllium, dissolved	< 0.0001	0.0001	mg/L							
Bismuth, dissolved	< 0.0001	0.0001	mg/L							
Boron, dissolved	< 0.004	0.004	mg/L							
Cadmium, dissolved	< 0.00001	0.00001	mg/L							
Calcium, dissolved	< 0.2	0.2	mg/L							
Chromium, dissolved	< 0.0005	0.0005	mg/L							
Cobalt, dissolved	< 0.00005	0.00005	mg/L							
Copper, dissolved	< 0.0002	0.0002	mg/L							

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Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Dissolved Metals, Batch B5H0022, Continued										
Blank (B5H0022-BLK1), Continued				Prepared: Aug-04-15, Analyzed: Aug-04-15						
Iron, dissolved	< 0.010	0.010	mg/L							
Lead, dissolved	< 0.0001	0.0001	mg/L							
Lithium, dissolved	< 0.0001	0.0001	mg/L							
Magnesium, dissolved	< 0.01	0.01	mg/L							
Manganese, dissolved	< 0.0002	0.0002	mg/L							
Molybdenum, dissolved	< 0.0001	0.0001	mg/L							
Nickel, dissolved	< 0.0002	0.0002	mg/L							
Phosphorus, dissolved	< 0.02	0.02	mg/L							
Potassium, dissolved	< 0.02	0.02	mg/L							
Selenium, dissolved	< 0.0005	0.0005	mg/L							
Silicon, dissolved	< 0.5	0.5	mg/L							
Silver, dissolved	< 0.00005	0.00005	mg/L							
Sodium, dissolved	< 0.02	0.02	mg/L							
Strontium, dissolved	< 0.001	0.001	mg/L							
Sulfur, dissolved	< 1	1	mg/L							
Tellurium, dissolved	< 0.0002	0.0002	mg/L							
Thallium, dissolved	< 0.00002	0.00002	mg/L							
Thorium, dissolved	< 0.0001	0.0001	mg/L							
Tin, dissolved	< 0.0002	0.0002	mg/L							
Titanium, dissolved	< 0.005	0.005	mg/L							
Uranium, dissolved	< 0.00002	0.00002	mg/L							
Vanadium, dissolved	< 0.001	0.001	mg/L							
Zinc, dissolved	< 0.004	0.004	mg/L							
Zirconium, dissolved	< 0.0001	0.0001	mg/L							
Reference (B5H0022-SRM1)				Prepared: Aug-04-15, Analyzed: Aug-04-15						
Aluminum, dissolved	0.222	0.005	mg/L	0.233		95	58-142			
Antimony, dissolved	0.0431	0.0001	mg/L	0.0430		100	75-125			
Arsenic, dissolved	0.424	0.0005	mg/L	0.438		97	81-119			
Barium, dissolved	3.23	0.005	mg/L	3.35		96	83-117			
Beryllium, dissolved	0.195	0.0001	mg/L	0.213		91	80-120			
Boron, dissolved	1.71	0.004	mg/L	1.74		98	74-117			
Cadmium, dissolved	0.212	0.00001	mg/L	0.224		95	83-117			
Calcium, dissolved	8.3	0.2	mg/L	7.69		108	76-124			
Chromium, dissolved	0.461	0.0005	mg/L	0.437		105	81-119			
Cobalt, dissolved	0.133	0.00005	mg/L	0.128		104	76-124			
Copper, dissolved	0.894	0.0002	mg/L	0.844		106	84-116			
Iron, dissolved	1.30	0.010	mg/L	1.29		101	74-126			
Lead, dissolved	0.115	0.0001	mg/L	0.112		102	72-128			
Lithium, dissolved	0.101	0.0001	mg/L	0.104		97	60-140			
Magnesium, dissolved	7.18	0.01	mg/L	6.92		104	81-119			
Manganese, dissolved	0.336	0.0002	mg/L	0.345		97	84-116			
Molybdenum, dissolved	0.421	0.0001	mg/L	0.426		99	83-117			
Nickel, dissolved	0.885	0.0002	mg/L	0.840		105	74-126			
Phosphorus, dissolved	0.46	0.02	mg/L	0.495		92	68-132			
Potassium, dissolved	3.16	0.02	mg/L	3.19		99	74-126			
Selenium, dissolved	0.0364	0.0005	mg/L	0.0331		110	70-130			
Sodium, dissolved	19.8	0.02	mg/L	19.1		104	72-128			
Strontium, dissolved	0.873	0.001	mg/L	0.916		95	84-113			
Thallium, dissolved	0.0387	0.00002	mg/L	0.0393		98	57-143			
Uranium, dissolved	0.274	0.00002	mg/L	0.266		103	85-115			
Vanadium, dissolved	0.868	0.001	mg/L	0.869		100	87-113			
Zinc, dissolved	0.867	0.004	mg/L	0.881		98	72-128			
Dissolved Metals, Batch B5H0043										

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Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Dissolved Metals, Batch B5H0043, Continued										
Blank (B5H0043-BLK1)				Prepared: Aug-04-15, Analyzed: Aug-05-15						
Mercury, dissolved	< 0.00002	0.00002	mg/L							
Blank (B5H0043-BLK2)				Prepared: Aug-04-15, Analyzed: Aug-05-15						
Mercury, dissolved	< 0.00002	0.00002	mg/L							
Duplicate (B5H0043-DUP2)		**Source: 5072008-01**		Prepared: Aug-04-15, Analyzed: Aug-05-15						
Mercury, dissolved	< 0.00002	0.00002	mg/L		< 0.00002				20	
Matrix Spike (B5H0043-MS2)		**Source: 5072008-02**		Prepared: Aug-04-15, Analyzed: Aug-05-15						
Mercury, dissolved	0.00025	0.00002	mg/L	0.000250	< 0.00002	99	70-130			
Reference (B5H0043-SRM1)				Prepared: Aug-04-15, Analyzed: Aug-05-15						
Mercury, dissolved	0.00356	0.00002	mg/L	0.00456		78	50-150			
Reference (B5H0043-SRM2)				Prepared: Aug-04-15, Analyzed: Aug-05-15						
Mercury, dissolved	0.00342	0.00002	mg/L	0.00456		75	50-150			
General Parameters, Batch B5G1734										
Blank (B5G1734-BLK1)				Prepared: Jul-31-15, Analyzed: Jul-31-15						
Alkalinity, Total as CaCO3	< 1	1	mg/L							
Alkalinity, Phenolphthalein as CaCO3	< 1	1	mg/L							
Alkalinity, Bicarbonate as CaCO3	< 1	1	mg/L							
Alkalinity, Carbonate as CaCO3	< 1	1	mg/L							
Alkalinity, Hydroxide as CaCO3	< 1	1	mg/L							
Blank (B5G1734-BLK2)				Prepared: Aug-01-15, Analyzed: Aug-01-15						
Alkalinity, Total as CaCO3	< 1	1	mg/L							
Alkalinity, Phenolphthalein as CaCO3	< 1	1	mg/L							
Alkalinity, Bicarbonate as CaCO3	< 1	1	mg/L							
Alkalinity, Carbonate as CaCO3	< 1	1	mg/L							
Alkalinity, Hydroxide as CaCO3	< 1	1	mg/L							
LCS (B5G1734-BS1)				Prepared: Jul-31-15, Analyzed: Jul-31-15						
Alkalinity, Total as CaCO3	97	1	mg/L	100		97	96-108			
LCS (B5G1734-BS2)				Prepared: Aug-01-15, Analyzed: Aug-01-15						
Alkalinity, Total as CaCO3	96	1	mg/L	100		96	96-108			
Total Recoverable Metals, Batch B5G1596										
Blank (B5G1596-BLK1)				Prepared: Jul-30-15, Analyzed: Jul-31-15						
Aluminum, total	< 0.005	0.005	mg/L							
Antimony, total	< 0.0001	0.0001	mg/L							
Arsenic, total	< 0.0005	0.0005	mg/L							
Barium, total	< 0.005	0.005	mg/L							
Beryllium, total	< 0.0001	0.0001	mg/L							
Bismuth, total	< 0.0001	0.0001	mg/L							
Boron, total	< 0.004	0.004	mg/L							
Cadmium, total	< 0.00001	0.00001	mg/L							
Calcium, total	< 0.2	0.2	mg/L							
Chromium, total	< 0.0005	0.0005	mg/L							
Cobalt, total	< 0.00005	0.00005	mg/L							
Copper, total	< 0.0002	0.0002	mg/L							
Iron, total	< 0.01	0.01	mg/L							
Lead, total	< 0.0001	0.0001	mg/L							

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Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Total Recoverable Metals, Batch B5G1596, Continued										
Blank (B5G1596-BLK1), Continued				Prepared: Jul-30-15, Analyzed: Jul-31-15						
Lithium, total	< 0.0001	0.0001	mg/L							
Magnesium, total	< 0.01	0.01	mg/L							
Manganese, total	< 0.0002	0.0002	mg/L							
Molybdenum, total	< 0.0001	0.0001	mg/L							
Nickel, total	< 0.0002	0.0002	mg/L							
Phosphorus, total	< 0.02	0.02	mg/L							
Potassium, total	< 0.02	0.02	mg/L							
Selenium, total	< 0.0005	0.0005	mg/L							
Silicon, total	< 0.5	0.5	mg/L							
Silver, total	< 0.00005	0.00005	mg/L							
Sodium, total	< 0.02	0.02	mg/L							
Strontium, total	< 0.001	0.001	mg/L							
Sulfur, total	< 1	1	mg/L							
Tellurium, total	< 0.0002	0.0002	mg/L							
Thallium, total	< 0.00002	0.00002	mg/L							
Thorium, total	< 0.0001	0.0001	mg/L							
Tin, total	< 0.0002	0.0002	mg/L							
Titanium, total	< 0.005	0.005	mg/L							
Uranium, total	< 0.00002	0.00002	mg/L							
Vanadium, total	< 0.001	0.001	mg/L							
Zinc, total	< 0.004	0.004	mg/L							
Zirconium, total	< 0.0001	0.0001	mg/L							
Reference (B5G1596-SRM1)				Prepared: Jul-30-15, Analyzed: Jul-31-15						
Aluminum, total	0.302	0.005	mg/L	0.296		102	81-129			
Antimony, total	0.0484	0.0001	mg/L	0.0505		96	88-114			
Arsenic, total	0.121	0.0005	mg/L	0.122		99	88-114			
Barium, total	0.714	0.005	mg/L	0.777		92	72-104			
Beryllium, total	0.0458	0.0001	mg/L	0.0488		94	76-131			
Boron, total	3.44	0.004	mg/L	3.40		101	75-121			
Cadmium, total	0.0489	0.00001	mg/L	0.0490		100	89-111			
Calcium, total	10.5	0.2	mg/L	10.2		103	86-121			
Chromium, total	0.253	0.0005	mg/L	0.242		105	89-114			
Cobalt, total	0.0405	0.00005	mg/L	0.0366		111	91-113			
Copper, total	0.527	0.0002	mg/L	0.487		108	91-115			
Iron, total	0.50	0.01	mg/L	0.469		107	77-124			
Lead, total	0.210	0.0001	mg/L	0.193		109	92-113			
Lithium, total	0.398	0.0001	mg/L	0.390		102	85-115			
Magnesium, total	3.50	0.01	mg/L	3.31		106	78-120			
Manganese, total	0.110	0.0002	mg/L	0.109		101	90-114			
Molybdenum, total	0.200	0.0001	mg/L	0.197		101	90-111			
Nickel, total	0.254	0.0002	mg/L	0.242		105	90-111			
Phosphorus, total	0.20	0.02	mg/L	0.233		86	85-115			
Potassium, total	6.21	0.02	mg/L	5.93		105	84-113			
Selenium, total	0.124	0.0005	mg/L	0.115		107	85-115			
Sodium, total	8.28	0.02	mg/L	7.64		108	82-123			
Strontium, total	0.357	0.001	mg/L	0.363		98	88-112			
Thallium, total	0.0859	0.00002	mg/L	0.0794		108	91-114			
Uranium, total	0.0199	0.00002	mg/L	0.0192		104	85-120			
Vanadium, total	0.379	0.001	mg/L	0.376		101	86-111			
Zinc, total	2.42	0.004	mg/L	2.42		100	85-111			
Total Recoverable Metals, Batch B5H0046										
Blank (B5H0046-BLK1)				Prepared: Aug-04-15, Analyzed: Aug-04-15						
Mercury, total	< 0.00002	0.00002	mg/L							

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Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Total Recoverable Metals, Batch B5H0046, Continued										
Blank (B5H0046-BLK2)				Prepared: Aug-04-15, Analyzed: Aug-04-15						
Mercury, total	< 0.00002	0.00002	mg/L							
Matrix Spike (B5H0046-MS2)		**Source: 5072008-01**		Prepared: Aug-04-15, Analyzed: Aug-04-15						
Mercury, total	0.00022	0.00002	mg/L	0.000250	< 0.00002	87	70-130			
Reference (B5H0046-SRM1)				Prepared: Aug-04-15, Analyzed: Aug-04-15						
Mercury, total	0.00351	0.00002	mg/L	0.00456		77	50-150			
Reference (B5H0046-SRM2)				Prepared: Aug-04-15, Analyzed: Aug-04-15						
Mercury, total	0.00339	0.00002	mg/L	0.00456		74	50-150			

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		5072008-01	5072008-02	5072008-03	5072008-04	5072008-05
		Water	Water	Water	Water	Water
		Jul-29-15	Jul-29-15	Jul-29-15	Jul-29-15	Jul-29-15
		SA-1 (T2 Creek)	SA-2 (Millionaire Creek)	K-1 (Dunlop Creek)	K-2 (Spencer Creek)	Field Blank
Anions	Nitrate as N (mg/L)	0.665	0.312	0.205	< 0.010	
General Parameters	Alkalinity, Total as CaCO3 (mg/L)	64	26	69	87	
	Alkalinity, Phenolphthalein as CaCO3 (mg/L)	< 1	< 1	< 1	< 1	
	Alkalinity, Bicarbonate as CaCO3 (mg/L)	64	26	69	87	
	Alkalinity, Carbonate as CaCO3 (mg/L)	< 1	< 1	< 1	< 1	
	Alkalinity, Hydroxide as CaCO3 (mg/L)	< 1	< 1	< 1	< 1	
Calculated Parameters	Hardness, Total (Diss. as CaCO3) (mg/L)	69.5	23.2	69.5	89.0	
	Hardness, Total (Total as CaCO3) (mg/L)	69.4	24.1	72.0	91.3	
Dissolved Metals	Aluminum, dissolved (mg/L)	0.012	0.011	0.013	0.007	
	Antimony, dissolved (mg/L)	0.0002	< 0.0001	0.0001	0.0001	
	Arsenic, dissolved (mg/L)	0.0007	< 0.0005	0.0008	0.0009	
	Barium, dissolved (mg/L)	0.010	0.007	0.013	0.008	
	Beryllium, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Bismuth, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Boron, dissolved (mg/L)	0.023	0.007	0.034	0.021	
	Cadmium, dissolved (mg/L)	0.00002	< 0.00001	< 0.00001	< 0.00001	
	Calcium, dissolved (mg/L)	15.9	7.0	17.8	24.2	
	Chromium, dissolved (mg/L)	< 0.0005	< 0.0005	< 0.0005	< 0.0005	
	Cobalt, dissolved (mg/L)	0.00006	< 0.00005	0.00030	0.00009	
	Copper, dissolved (mg/L)	0.0031	0.0008	0.0015	0.0015	
	Iron, dissolved (mg/L)	0.110	0.019	0.540	0.080	
	Lead, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Lithium, dissolved (mg/L)	0.0007	< 0.0001	< 0.0001	< 0.0001	
	Magnesium, dissolved (mg/L)	7.22	1.39	6.11	6.92	
	Manganese, dissolved (mg/L)	0.0118	0.0018	0.123	0.0361	
	Mercury, dissolved (mg/L)	< 0.00002	< 0.00002	< 0.00002	< 0.00002	
	Molybdenum, dissolved (mg/L)	0.0007	0.0005	0.0005	0.0007	
	Nickel, dissolved (mg/L)	0.0006	< 0.0002	0.0006	0.0006	
	Phosphorus, dissolved (mg/L)	0.02	< 0.02	< 0.02	< 0.02	
	Potassium, dissolved (mg/L)	2.38	0.60	3.64	2.32	
	Selenium, dissolved (mg/L)	< 0.0005	< 0.0005	< 0.0005	< 0.0005	
	Silicon, dissolved (mg/L)	7.1	5.2	3.9	5.5	
	Silver, dissolved (mg/L)	0.00005	< 0.00005	< 0.00005	< 0.00005	
	Sodium, dissolved (mg/L)	18.5	4.78	12.6	10.8	
	Strontium, dissolved (mg/L)	0.084	0.040	0.109	0.143	
	Sulfur, dissolved (mg/L)	2	< 1	3	1	
	Tellurium, dissolved (mg/L)	< 0.0002	< 0.0002	< 0.0002	< 0.0002	
	Thallium, dissolved (mg/L)	< 0.00002	< 0.00002	< 0.00002	< 0.00002	
	Thorium, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Tin, dissolved (mg/L)	< 0.0002	< 0.0002	< 0.0002	< 0.0002	
	Titanium, dissolved (mg/L)	< 0.005	< 0.005	< 0.005	< 0.005	
	Uranium, dissolved (mg/L)	0.00004	< 0.00002	< 0.00002	0.00004	
	Vanadium, dissolved (mg/L)	< 0.001	< 0.001	< 0.001	0.001	
	Zinc, dissolved (mg/L)	0.005	< 0.004	< 0.004	< 0.004	

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		5072008-01	5072008-02	5072008-03	5072008-04	5072008-05
		Water	Water	Water	Water	Water
		Jul-29-15	Jul-29-15	Jul-29-15	Jul-29-15	Jul-29-15
		SA-1 (T2 Creek)	SA-2 (Millionaire Creek)	K-1 (Dunlop Creek)	K-2 (Spencer Creek)	Field Blank
Dissolved Metals	Zirconium, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
Total Recoverable Metals	Aluminum, total (mg/L)	0.143	0.025	0.124	0.511	
	Antimony, total (mg/L)	0.0003	0.0002	0.0002	0.0003	
	Arsenic, total (mg/L)	0.0007	< 0.0005	0.0010	0.0012	
	Barium, total (mg/L)	0.011	0.008	0.015	0.012	
	Beryllium, total (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Bismuth, total (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Boron, total (mg/L)	0.024	0.009	0.038	0.026	
	Cadmium, total (mg/L)	0.00001	0.00003	0.00001	0.00001	
	Calcium, total (mg/L)	15.8	7.2	18.3	24.3	
	Chromium, total (mg/L)	< 0.0005	< 0.0005	0.0005	0.0008	
	Cobalt, total (mg/L)	0.00010	< 0.00005	0.00037	0.00034	
	Copper, total (mg/L)	0.0037	0.0064	0.0021	0.0025	
	Iron, total (mg/L)	0.31	0.04	0.88	0.70	
	Lead, total (mg/L)	0.0002	0.0002	0.0001	0.0002	
	Lithium, total (mg/L)	0.0010	< 0.0001	0.0001	0.0005	
	Magnesium, total (mg/L)	7.28	1.48	6.41	7.39	
	Manganese, total (mg/L)	0.0168	0.0028	0.148	0.0670	
	Mercury, total (mg/L)	< 0.00002	< 0.00002	< 0.00002	< 0.00002	
	Molybdenum, total (mg/L)	0.0009	0.0008	0.0008	0.0009	
	Nickel, total (mg/L)	0.0009	< 0.0002	0.0009	0.0012	
	Phosphorus, total (mg/L)	0.06	0.03	0.07	0.06	
	Potassium, total (mg/L)	2.40	0.69	3.81	2.49	
	Selenium, total (mg/L)	< 0.0005	< 0.0005	< 0.0005	< 0.0005	
	Silicon, total (mg/L)	7.9	6.0	4.8	7.2	
	Silver, total (mg/L)	< 0.00005	< 0.00005	< 0.00005	< 0.00005	
	Sodium, total (mg/L)	18.7	5.13	13.2	11.4	
	Strontium, total (mg/L)	0.090	0.044	0.121	0.157	
	Sulfur, total (mg/L)	1	< 1	5	2	
	Tellurium, total (mg/L)	< 0.0002	< 0.0002	< 0.0002	< 0.0002	
	Thallium, total (mg/L)	< 0.00002	< 0.00002	< 0.00002	< 0.00002	
	Thorium, total (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Tin, total (mg/L)	< 0.0002	< 0.0002	< 0.0002	< 0.0002	
	Titanium, total (mg/L)	0.006	< 0.005	0.005	0.020	
	Uranium, total (mg/L)	0.00005	< 0.00002	< 0.00002	0.00005	
	Vanadium, total (mg/L)	0.002	< 0.001	0.002	0.003	
	Zinc, total (mg/L)	0.007	0.005	< 0.004	0.005	
	Zirconium, total (mg/L)	< 0.0001	< 0.0001	0.0001	0.0002	
Microbiological Parameters	Coliforms, Total (MPN/100 mL)	5000	500	3000	1600	ND
	Coliforms, Fecal (MPN/100 mL)	1100	30	110	130	
	E. coli (MPN) (MPN/100 mL)	1100	23	110	130	ND

WAY, RICHMOND, BC V6V 2K9
09 FAX: (604) 279-1599
AY 97N, KELOWNA, BC V1X 5C3
16 FAX: (250) 765-3893
UE NW, EDMONTON, AB T5S 1H7
00 FAX: (480) 489-9700

CHAIN-OF-CUSTODY RECORD

COC#

RELINQUISHED BY:	DATE: 29-Jul-15	RECEIVED BY:	DATE: 07/29
Patrick Lilley	TIME: 15:00	WJ BS	TIME: 15:00
RELINQUISHED BY:	DATE:	RECEIVED BY:	DATE:
	TIME:		TIME:

REPORT TO:
COMPANY: Kerr Wood Leidal Associates
ADDRESS: 200-4185A Still Creek Drive, Burnaby, BC V5C 6G9
CONTACT: Patrick Lilley
TEL / FAX: 604-293-3121 604-294-2090
EMAIL PDF ☑ EDD ☐ **Please email Excel file.**
EMAIL 1: plilley@kwl.ca
EMAIL 2: pdekoning@kwl.ca
MAIL HARDCOPY ☐ HOLD FOR P/U ☐ FAX ☐

INVOICE TO: SAME AS REPORT TO ☐
COMPANY: Kerr Wood Leidal Associates
ADDRESS: 200-4185A Still Creek Drive, Burnaby, BC V5C 6G9
CONTACT: Patrick Lilley / Michelle Derer
TEL / FAX: 604-293-3252 604-294-2090
EMAIL PDF ☑
EMAIL 1: plilley@kwl.ca
EMAIL 2: mderer@kwl.ca
MAIL HARDCOPY ☐ HOLD FOR P/U ☑

PROJECT: 173.169 Maple Ridge WQ
PROJECT INFO: Stormwater Monitoring
PO #:
SAMPLED BY: Patrick Lilley
SHIPPING INSTRUCTIONS: RETURN COOLER(S) ☐
SHIP SUPPLIES (PLEASE SPECIFY IN OTHER INSTRUCTIONS SECTION) ☐

TURNAROUND TIME REQUESTED: Routine (4-7 days) ☑ Other: ____
Rush:* 1 Day ☐ 2 Day ☐ 3 Day ☐ * Contact the lab to confirm, surcharges may apply

ANALYSES REQUESTED:

	CLIENT SAMPLE ID:	MATRIX: DRINKING WATER	OTHER WATER	SOIL	OTHER	# CONTAINERS	SAMPLING: DATE DD-MMM-YY	TIME HH:MM	COMMENTS: CHLORINATED	FILTERED	PRESERVED	(i.e. flow/volume media ID/notes)	BTEX ☐ VPH ☐ MTBE ☐	EPH (not PAH Corrected)	VOC ☐ VPH ☐	L/HEPH (PAH Corrected)	PAH	PHENOLS Chlorinated ☐ Non-Chlor ☐	PCB ☐ GLYCOLS ☐ HAA ☐	METALS - WATER TOTAL (ICPMS - LOW Pkg.)	METALS - WATER DISSOLVED (ICPMS - LOW Pkg.)	Metals - SOIL (SALM) ☐ Inc. pH ☐	pH ☐ EC ☐ Alk ☑	TSS ☐ TDS ☐	BOD ☐ COD ☐	FECAL COLIFORMS ☑ HPC ☐	TOTAL COLIFORMS ☑ E-COLI ☑	PESTICIDES ☐ HERBICIDES ☐	SOIL VAPOUR	ASBESTOS	NITRATE-N						HOLD
1	SA-1 (T2 Creek)	☐	☑	☐	☐	6	29-Jul-15	11:50	☐	☐	☐	See below	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☑	☐	☐	☐	☑	☑	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐
2	SA-2 (Millionaire Creek)	☐	☑	☐	☐	6	29-Jul-15	12:25	☐	☐	☐	See below	☐	☐	☐	☐	☐	☐	☐	☑	☑	☐	☑	☐	☐	☐	☑	☑	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐
3	K-1 (Dunlop Creek)	☐	☑	☐	☐	6	29-Jul-15	13:00	☐	☐	☐	See below	☐	☐	☐	☐	☐	☐	☐	☑	☑	☐	☑	☐	☐	☐	☑	☑	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐
4	K-2 (Spencer Creek)	☐	☑	☐	☐	6	29-Jul-15	13:30	☐	☐	☐	See below	☐	☐	☐	☐	☐	☐	☐	☑	☑	☐	☑	☐	☐	☐	☑	☑	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐
5	Field Blank	☐	☐	☐	☐	1	29-Jul-15	11:50	☐	☐	☐		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
6	Trip Blank	☐	☐	☐	☐	1	29-Jul-15	10:05	☐	☐	☐		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑
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APPLICABLE REGULATORY LIMITS:
Canadian Drinking Water Quality Guidelines ☐
BC Drinking Water Protection Act/Reg. ☐
BC CSR: AL ☐ RL ☐ CL ☐ IL ☐ AW ☐
CCME ☑ Alberta Tier 1 ☐
OTHER: BC WQ Guidelines for Aquatic Life

SAMPLE RETENTION INSTRUCTIONS (Discarded 30 days after Report unless otherwise specified):
60 Days ☐ 90 Days ☐ Longer Date (Surcharges will apply):

OTHER INSTRUCTIONS:
Total and dissolved metals, mercury, and bacteriological samples have been preserved. Dissolved metals samples (incl. mercury) have also been filtered. Metals analysis should be LOW level ICPMS pkg. Add total + dissolved Hg. Alkalinity = SPECIATED alkalinity. Use higher dilutions for bacteriological tests pls.

PAYMENT
Cheque ☐
Credit ☐
Debit ☐
Cash ☐
Invoice ☐

SAMPLE RECEIPT TEMP (°C): 14.2
Work Order # ____
CUSTODY SEALS INTACT: ☐Y ☐N ☐NA

Required Fields Recommended Fields **SHADED AREAS:** LAB USE ONLY

CERTIFICATE OF ANALYSIS

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby) 200 - 4185A Still Creek Dr Burnaby, BC V5C 6G9	**TEL** **FAX**	(604) 294-2088 (604) 294-2090
ATTENTION	Patrick Lilley	**WORK ORDER**	5080262
PO NUMBER		**RECEIVED / TEMP**	Aug-05-15 12:33 / 8°C
PROJECT	173.169 Maple Ridge WQ	**REPORTED**	Aug-12-15
PROJECT INFO	Stormwater Monitoring		

General Comments:

CARO Analytical Services employs methods which are conducted according to procedures accepted by appropriate regulatory agencies, and/or are conducted in accordance with recognized professional standards using accepted testing methodologies and quality control efforts, except where otherwise agreed to by the client.

The results in this report apply to the samples analyzed in accordance with the Chain of Custody or Sample Requisition document. This analytical report must be reproduced in its entirety. CARO is not responsible for any loss or damage resulting directly or indirectly from error or omission in the conduct of testing. Liability is limited to the cost of analysis. Samples will be disposed of 30 days after the test report has been issued unless otherwise agreed to in writing.

Authorized By: **Brent Coates, B.Sc.**
Division Manager, Richmond

If you have any questions or concerns, please contact your Account Manager:
Bryan Shaw, Ph.D. (bshaw@caro.ca)

Locations:

#110 4011 Viking Way
Richmond, BC V6V 2K9
Tel: 604-279-1499 Fax: 604-279-1599

#102 3677 Highway 97N
Kelowna, BC V1X 5C3
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17225 109 Avenue
Edmonton, AB T5S 1H7
Tel: 780-489-9100 Fax: 780-489-9700

www.caro.ca

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PROJECT	173.169 Maple Ridge WQ	**REPORTED**	Aug-12-15

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Sample Analytical Data Page 4
Test Results, Reporting Limits, Analysis Dates, Sample & Analysis Notes

Quality Control Data Appendix 1
Method Blanks, Duplicates, Spikes, Reference Materials

Analytical Summary Appendix 2
Tabulated data in condensed format to assist with comparisons

Chain of Custody Document Appendix 4
Analysis instructions provided by client

ANALYSIS INFORMATION

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	5080262
PROJECT	173.169 Maple Ridge WQ	**REPORTED**	Aug-12-15

Analysis Description	Method Reference	Technique	Location
Alkalinity in Water (Speciated)	APHA 2320 B*	Titration with H2SO4	Kelowna
Anions in Water by IC	APHA 4110 B	Ion Chromatography with Chemical Suppression of Eluent Conductivity	Kelowna
Dissolved Metals	APHA 3030 B / APHA 3125 B	0.45 µm Filtration / Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	Richmond
E. coli (MPN)	APHA 9221	Multiple-Tube Fermentation	Sublet
Fecal Coliforms (MPN)	APHA 9221	Multiple-Tube Fermentation	Sublet
Hardness (as CaCO3)	APHA 2340 B	Calculation	N/A
Mercury, dissolved by CVAFS	EPA 245.7*	BrCl2 Oxidation / Cold Vapor Atomic Fluorescence Spectrometry (CVAFS)	Richmond
Mercury, total by CVAFS	EPA 245.7*	BrCl2 Oxidation / Cold Vapor Atomic Fluorescence Spectrometry (CVAFS)	Richmond
Total Coliforms (MPN)	APHA 9221	Multiple-Tube Fermentation	Sublet
Total Recoverable Metals	APHA 3030E* / APHA 3125 B	HNO3+HCl Hot Block Digestion / Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	Richmond

Note: An asterisk in the Method Reference indicates that the CARO method has been modified from the reference method

Method Reference Descriptions:

APHA	Standard Methods for the Examination of Water and Wastewater, 22nd Edition, American Public Health Association/American Water Works Association/Water Environment Federation
EPA	United States Environmental Protection Agency Test Methods

Glossary of Terms:

MRL	Method Reporting Limit
<	Less than the Reported Detection Limit (RDL) - the RDL may be higher than the MRL due to various factors such as dilutions, limited sample volume, high moisture, or interferences
mg/L	Milligrams per litre
MPN/100 mL	Most Probable Number per 100 millilitres

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 5080262
REPORTED Aug-12-15

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SA-1 (T2 Creek) (5080262-01) [Water] Sampled: Aug-05-15 08:00							
Anions							
Nitrate as N	**0.618**	N/A	0.010	mg/L	N/A	Aug-06-15	
General Parameters							
Alkalinity, Total as CaCO3	**76**	N/A	1	mg/L	N/A	Aug-06-15	
Alkalinity, Phenolphthalein as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-06-15	
Alkalinity, Bicarbonate as CaCO3	**76**	N/A	1	mg/L	N/A	Aug-06-15	
Alkalinity, Carbonate as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-06-15	
Alkalinity, Hydroxide as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-06-15	
Calculated Parameters							
Hardness, Total (Diss. as CaCO3)	**89.8**	N/A	0.50	mg/L	N/A	N/A	
Hardness, Total (Total as CaCO3)	**81.6**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.014**	N/A	0.005	mg/L	N/A	Aug-07-15	
Antimony, dissolved	**0.0003**	N/A	0.0001	mg/L	N/A	Aug-07-15	
Arsenic, dissolved	**0.0006**	N/A	0.0005	mg/L	N/A	Aug-07-15	
Barium, dissolved	**0.010**	N/A	0.005	mg/L	N/A	Aug-07-15	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-07-15	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-07-15	
Boron, dissolved	**0.029**	N/A	0.004	mg/L	N/A	Aug-07-15	
Cadmium, dissolved	**0.00003**	N/A	0.00001	mg/L	N/A	Aug-07-15	
Calcium, dissolved	**22.8**	N/A	0.2	mg/L	N/A	Aug-07-15	
Chromium, dissolved	**0.0008**	N/A	0.0005	mg/L	N/A	Aug-07-15	
Cobalt, dissolved	**0.00009**	N/A	0.00005	mg/L	N/A	Aug-07-15	
Copper, dissolved	**0.0023**	N/A	0.0002	mg/L	N/A	Aug-07-15	
Iron, dissolved	**0.109**	N/A	0.010	mg/L	N/A	Aug-07-15	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-07-15	
Lithium, dissolved	**0.0013**	N/A	0.0001	mg/L	N/A	Aug-07-15	
Magnesium, dissolved	**7.97**	N/A	0.01	mg/L	N/A	Aug-07-15	
Manganese, dissolved	**0.0177**	N/A	0.0002	mg/L	N/A	Aug-07-15	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	Aug-10-15	Aug-11-15	
Molybdenum, dissolved	**0.0070**	N/A	0.0001	mg/L	N/A	Aug-07-15	
Nickel, dissolved	**0.0006**	N/A	0.0002	mg/L	N/A	Aug-07-15	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	Aug-07-15	
Potassium, dissolved	**2.84**	N/A	0.02	mg/L	N/A	Aug-07-15	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Aug-07-15	
Silicon, dissolved	**7.6**	N/A	0.5	mg/L	N/A	Aug-07-15	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	Aug-07-15	
Sodium, dissolved	**18.1**	N/A	0.02	mg/L	N/A	Aug-07-15	
Strontium, dissolved	**0.098**	N/A	0.001	mg/L	N/A	Aug-07-15	
Sulfur, dissolved	< 1	N/A	1	mg/L	N/A	Aug-07-15	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Aug-07-15	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Aug-07-15	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-07-15	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Aug-07-15	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	Aug-07-15	

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 5080262
REPORTED Aug-12-15

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SA-1 (T2 Creek) (5080262-01) [Water] Sampled: Aug-05-15 08:00, Continued							
Dissolved Metals, Continued							
Uranium, dissolved	**0.00009**	N/A	0.00002	mg/L	N/A	Aug-07-15	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	Aug-07-15	
Zinc, dissolved	**0.012**	N/A	0.004	mg/L	N/A	Aug-07-15	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-07-15	
Total Recoverable Metals							
Aluminum, total	**0.158**	N/A	0.005	mg/L	Aug-10-15	Aug-11-15	
Antimony, total	**0.0002**	N/A	0.0001	mg/L	Aug-10-15	Aug-11-15	
Arsenic, total	**0.0008**	N/A	0.0005	mg/L	Aug-10-15	Aug-11-15	
Barium, total	**0.011**	N/A	0.005	mg/L	Aug-10-15	Aug-11-15	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	Aug-10-15	Aug-11-15	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	Aug-10-15	Aug-11-15	
Boron, total	**0.029**	N/A	0.004	mg/L	Aug-10-15	Aug-11-15	
Cadmium, total	**0.00002**	N/A	0.00001	mg/L	Aug-10-15	Aug-11-15	
Calcium, total	**18.7**	N/A	0.2	mg/L	Aug-10-15	Aug-11-15	
Chromium, total	**0.0010**	N/A	0.0005	mg/L	Aug-10-15	Aug-11-15	
Cobalt, total	**0.00013**	N/A	0.00005	mg/L	Aug-10-15	Aug-11-15	
Copper, total	**0.0036**	N/A	0.0002	mg/L	Aug-10-15	Aug-11-15	
Iron, total	**0.37**	N/A	0.01	mg/L	Aug-10-15	Aug-11-15	
Lead, total	**0.0003**	N/A	0.0001	mg/L	Aug-10-15	Aug-11-15	
Lithium, total	**0.0013**	N/A	0.0001	mg/L	Aug-10-15	Aug-11-15	
Magnesium, total	**8.44**	N/A	0.01	mg/L	Aug-10-15	Aug-11-15	
Manganese, total	**0.0255**	N/A	0.0002	mg/L	Aug-10-15	Aug-11-15	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	Aug-10-15	Aug-11-15	
Molybdenum, total	**0.0070**	N/A	0.0001	mg/L	Aug-10-15	Aug-11-15	
Nickel, total	**0.0009**	N/A	0.0002	mg/L	Aug-10-15	Aug-11-15	
Phosphorus, total	**0.05**	N/A	0.02	mg/L	Aug-10-15	Aug-11-15	
Potassium, total	**2.94**	N/A	0.02	mg/L	Aug-10-15	Aug-11-15	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	Aug-10-15	Aug-11-15	
Silicon, total	**8.8**	N/A	0.5	mg/L	Aug-10-15	Aug-11-15	
Silver, total	< 0.00005	N/A	0.00005	mg/L	Aug-10-15	Aug-11-15	
Sodium, total	**19.1**	N/A	0.02	mg/L	Aug-10-15	Aug-11-15	
Strontium, total	**0.099**	N/A	0.001	mg/L	Aug-10-15	Aug-11-15	
Sulfur, total	**3**	N/A	1	mg/L	Aug-10-15	Aug-11-15	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	Aug-10-15	Aug-11-15	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	Aug-10-15	Aug-11-15	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	Aug-10-15	Aug-11-15	
Tin, total	< 0.0002	N/A	0.0002	mg/L	Aug-10-15	Aug-11-15	
Titanium, total	**0.007**	N/A	0.005	mg/L	Aug-10-15	Aug-11-15	
Uranium, total	**0.00007**	N/A	0.00002	mg/L	Aug-10-15	Aug-11-15	
Vanadium, total	**0.002**	N/A	0.001	mg/L	Aug-10-15	Aug-11-15	
Zinc, total	**0.006**	N/A	0.004	mg/L	Aug-10-15	Aug-11-15	
Zirconium, total	**0.0009**	N/A	0.0001	mg/L	Aug-10-15	Aug-11-15	
Microbiological Parameters							
Coliforms, Total	**3000**	N/A	2	MPN/100 mL		Aug-06-15	

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 5080262
REPORTED Aug-12-15

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SA-1 (T2 Creek) (5080262-01) [Water] Sampled: Aug-05-15 08:00, Continued							
Microbiological Parameters, Continued							
Coliforms, Fecal	**3000**	N/A	2	MPN/100 mL		Aug-06-15	
E. coli (MPN)	**3000**	N/A	2	MPN/100 mL		Aug-06-15	
Sample ID: SA-2 (Millionaire Creek) (5080262-02) [Water] Sampled: Aug-05-15 08:45							
Anions							
Nitrate as N	**0.458**	N/A	0.010	mg/L	N/A	Aug-07-15	
General Parameters							
Alkalinity, Total as CaCO3	**31**	N/A	1	mg/L	N/A	Aug-06-15	
Alkalinity, Phenolphthalein as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-06-15	
Alkalinity, Bicarbonate as CaCO3	**31**	N/A	1	mg/L	N/A	Aug-06-15	
Alkalinity, Carbonate as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-06-15	
Alkalinity, Hydroxide as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-06-15	
Calculated Parameters							
Hardness, Total (Diss. as CaCO3)	**25.9**	N/A	0.50	mg/L	N/A	N/A	
Hardness, Total (Total as CaCO3)	**29.2**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.012**	N/A	0.005	mg/L	N/A	Aug-07-15	
Antimony, dissolved	**0.0001**	N/A	0.0001	mg/L	N/A	Aug-07-15	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Aug-07-15	
Barium, dissolved	**0.007**	N/A	0.005	mg/L	N/A	Aug-07-15	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-07-15	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-07-15	
Boron, dissolved	**0.008**	N/A	0.004	mg/L	N/A	Aug-07-15	
Cadmium, dissolved	**0.00001**	N/A	0.00001	mg/L	N/A	Aug-07-15	
Calcium, dissolved	**7.8**	N/A	0.2	mg/L	N/A	Aug-07-15	
Chromium, dissolved	**0.0007**	N/A	0.0005	mg/L	N/A	Aug-07-15	
Cobalt, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	Aug-07-15	
Copper, dissolved	**0.0010**	N/A	0.0002	mg/L	N/A	Aug-07-15	
Iron, dissolved	**0.018**	N/A	0.010	mg/L	N/A	Aug-07-15	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-07-15	
Lithium, dissolved	**0.0001**	N/A	0.0001	mg/L	N/A	Aug-07-15	
Magnesium, dissolved	**1.55**	N/A	0.01	mg/L	N/A	Aug-07-15	
Manganese, dissolved	**0.0023**	N/A	0.0002	mg/L	N/A	Aug-07-15	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	Aug-10-15	Aug-11-15	
Molybdenum, dissolved	**0.0007**	N/A	0.0001	mg/L	N/A	Aug-07-15	
Nickel, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Aug-07-15	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	Aug-07-15	
Potassium, dissolved	**0.63**	N/A	0.02	mg/L	N/A	Aug-07-15	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Aug-07-15	
Silicon, dissolved	**5.3**	N/A	0.5	mg/L	N/A	Aug-07-15	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	Aug-07-15	
Sodium, dissolved	**5.27**	N/A	0.02	mg/L	N/A	Aug-07-15	
Strontium, dissolved	**0.046**	N/A	0.001	mg/L	N/A	Aug-07-15	

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 5080262
REPORTED Aug-12-15

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SA-2 (Millionaire Creek) (5080262-02) [Water] Sampled: Aug-05-15 08:45, Continued							
Dissolved Metals, Continued							
Sulfur, dissolved	< 1	N/A	1	mg/L	N/A	Aug-07-15	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Aug-07-15	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Aug-07-15	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-07-15	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Aug-07-15	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	Aug-07-15	
Uranium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Aug-07-15	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	Aug-07-15	
Zinc, dissolved	**0.004**	N/A	0.004	mg/L	N/A	Aug-07-15	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-07-15	
Total Recoverable Metals							
Aluminum, total	**0.025**	N/A	0.005	mg/L	Aug-10-15	Aug-11-15	
Antimony, total	**0.0001**	N/A	0.0001	mg/L	Aug-10-15	Aug-11-15	
Arsenic, total	< 0.0005	N/A	0.0005	mg/L	Aug-10-15	Aug-11-15	
Barium, total	**0.008**	N/A	0.005	mg/L	Aug-10-15	Aug-11-15	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	Aug-10-15	Aug-11-15	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	Aug-10-15	Aug-11-15	
Boron, total	**0.010**	N/A	0.004	mg/L	Aug-10-15	Aug-11-15	
Cadmium, total	< 0.00001	N/A	0.00001	mg/L	Aug-10-15	Aug-11-15	
Calcium, total	**8.8**	N/A	0.2	mg/L	Aug-10-15	Aug-11-15	
Chromium, total	**0.0008**	N/A	0.0005	mg/L	Aug-10-15	Aug-11-15	
Cobalt, total	< 0.00005	N/A	0.00005	mg/L	Aug-10-15	Aug-11-15	
Copper, total	**0.0014**	N/A	0.0002	mg/L	Aug-10-15	Aug-11-15	
Iron, total	**0.04**	N/A	0.01	mg/L	Aug-10-15	Aug-11-15	
Lead, total	< 0.0001	N/A	0.0001	mg/L	Aug-10-15	Aug-11-15	
Lithium, total	**0.0002**	N/A	0.0001	mg/L	Aug-10-15	Aug-11-15	
Magnesium, total	**1.76**	N/A	0.01	mg/L	Aug-10-15	Aug-11-15	
Manganese, total	**0.0026**	N/A	0.0002	mg/L	Aug-10-15	Aug-11-15	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	Aug-10-15	Aug-11-15	
Molybdenum, total	**0.0008**	N/A	0.0001	mg/L	Aug-10-15	Aug-11-15	
Nickel, total	< 0.0002	N/A	0.0002	mg/L	Aug-10-15	Aug-11-15	
Phosphorus, total	< 0.02	N/A	0.02	mg/L	Aug-10-15	Aug-11-15	
Potassium, total	**0.71**	N/A	0.02	mg/L	Aug-10-15	Aug-11-15	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	Aug-10-15	Aug-11-15	
Silicon, total	**6.2**	N/A	0.5	mg/L	Aug-10-15	Aug-11-15	
Silver, total	< 0.00005	N/A	0.00005	mg/L	Aug-10-15	Aug-11-15	
Sodium, total	**5.95**	N/A	0.02	mg/L	Aug-10-15	Aug-11-15	
Strontium, total	**0.048**	N/A	0.001	mg/L	Aug-10-15	Aug-11-15	
Sulfur, total	< 1	N/A	1	mg/L	Aug-10-15	Aug-11-15	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	Aug-10-15	Aug-11-15	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	Aug-10-15	Aug-11-15	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	Aug-10-15	Aug-11-15	
Tin, total	< 0.0002	N/A	0.0002	mg/L	Aug-10-15	Aug-11-15	
Titanium, total	< 0.005	N/A	0.005	mg/L	Aug-10-15	Aug-11-15	
Uranium, total	< 0.00002	N/A	0.00002	mg/L	Aug-10-15	Aug-11-15	

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 5080262
REPORTED Aug-12-15

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SA-2 (Millionaire Creek) (5080262-02) [Water] Sampled: Aug-05-15 08:45, Continued							
Total Recoverable Metals, Continued							
Vanadium, total	< 0.001	N/A	0.001	mg/L	Aug-10-15	Aug-11-15	
Zinc, total	< 0.004	N/A	0.004	mg/L	Aug-10-15	Aug-11-15	
Zirconium, total	< 0.0001	N/A	0.0001	mg/L	Aug-10-15	Aug-11-15	
Microbiological Parameters							
Coliforms, Total	**2400**	N/A	2	MPN/100 mL		Aug-06-15	
Coliforms, Fecal	**2400**	N/A	2	MPN/100 mL		Aug-06-15	
E. coli (MPN)	**2400**	N/A	2	MPN/100 mL		Aug-06-15	
Sample ID: K-1 (Dunlop Creek) (5080262-03) [Water] Sampled: Aug-05-15 09:20							
Anions							
Nitrate as N	**0.035**	N/A	0.010	mg/L	N/A	Aug-07-15	
General Parameters							
Alkalinity, Total as CaCO3	**77**	N/A	1	mg/L	N/A	Aug-06-15	
Alkalinity, Phenolphthalein as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-06-15	
Alkalinity, Bicarbonate as CaCO3	**77**	N/A	1	mg/L	N/A	Aug-06-15	
Alkalinity, Carbonate as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-06-15	
Alkalinity, Hydroxide as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-06-15	
Calculated Parameters							
Hardness, Total (Diss. as CaCO3)	**69.1**	N/A	0.50	mg/L	N/A	N/A	
Hardness, Total (Total as CaCO3)	**72.7**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.016**	N/A	0.005	mg/L	N/A	Aug-07-15	
Antimony, dissolved	**0.0001**	N/A	0.0001	mg/L	N/A	Aug-07-15	
Arsenic, dissolved	**0.0012**	N/A	0.0005	mg/L	N/A	Aug-07-15	
Barium, dissolved	**0.013**	N/A	0.005	mg/L	N/A	Aug-07-15	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-07-15	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-07-15	
Boron, dissolved	**0.033**	N/A	0.004	mg/L	N/A	Aug-07-15	
Cadmium, dissolved	**0.00002**	N/A	0.00001	mg/L	N/A	Aug-07-15	
Calcium, dissolved	**17.8**	N/A	0.2	mg/L	N/A	Aug-07-15	
Chromium, dissolved	**0.0008**	N/A	0.0005	mg/L	N/A	Aug-07-15	
Cobalt, dissolved	**0.00053**	N/A	0.00005	mg/L	N/A	Aug-07-15	
Copper, dissolved	**0.0012**	N/A	0.0002	mg/L	N/A	Aug-07-15	
Iron, dissolved	**0.625**	N/A	0.010	mg/L	N/A	Aug-07-15	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-07-15	
Lithium, dissolved	**0.0001**	N/A	0.0001	mg/L	N/A	Aug-07-15	
Magnesium, dissolved	**6.00**	N/A	0.01	mg/L	N/A	Aug-07-15	
Manganese, dissolved	**0.281**	N/A	0.0002	mg/L	N/A	Aug-07-15	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	Aug-10-15	Aug-11-15	
Molybdenum, dissolved	**0.0007**	N/A	0.0001	mg/L	N/A	Aug-07-15	
Nickel, dissolved	**0.0007**	N/A	0.0002	mg/L	N/A	Aug-07-15	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	Aug-07-15	

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 5080262
REPORTED Aug-12-15

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: K-1 (Dunlop Creek) (5080262-03) [Water] Sampled: Aug-05-15 09:20, Continued							
Dissolved Metals, Continued							
Potassium, dissolved	**3.48**	N/A	0.02	mg/L	N/A	Aug-07-15	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Aug-07-15	
Silicon, dissolved	**4.1**	N/A	0.5	mg/L	N/A	Aug-07-15	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	Aug-07-15	
Sodium, dissolved	**13.0**	N/A	0.02	mg/L	N/A	Aug-07-15	
Strontium, dissolved	**0.115**	N/A	0.001	mg/L	N/A	Aug-07-15	
Sulfur, dissolved	< 1	N/A	1	mg/L	N/A	Aug-07-15	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Aug-07-15	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Aug-07-15	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-07-15	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Aug-07-15	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	Aug-07-15	
Uranium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Aug-07-15	
Vanadium, dissolved	**0.001**	N/A	0.001	mg/L	N/A	Aug-07-15	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	Aug-07-15	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-07-15	
Total Recoverable Metals							
Aluminum, total	**0.177**	N/A	0.005	mg/L	Aug-10-15	Aug-11-15	
Antimony, total	**0.0001**	N/A	0.0001	mg/L	Aug-10-15	Aug-11-15	
Arsenic, total	**0.0014**	N/A	0.0005	mg/L	Aug-10-15	Aug-11-15	
Barium, total	**0.015**	N/A	0.005	mg/L	Aug-10-15	Aug-11-15	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	Aug-10-15	Aug-11-15	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	Aug-10-15	Aug-11-15	
Boron, total	**0.041**	N/A	0.004	mg/L	Aug-10-15	Aug-11-15	
Cadmium, total	**0.00001**	N/A	0.00001	mg/L	Aug-10-15	Aug-11-15	
Calcium, total	**18.8**	N/A	0.2	mg/L	Aug-10-15	Aug-11-15	
Chromium, total	**0.0011**	N/A	0.0005	mg/L	Aug-10-15	Aug-11-15	
Cobalt, total	**0.00069**	N/A	0.00005	mg/L	Aug-10-15	Aug-11-15	
Copper, total	**0.0017**	N/A	0.0002	mg/L	Aug-10-15	Aug-11-15	
Iron, total	**1.19**	N/A	0.01	mg/L	Aug-10-15	Aug-11-15	
Lead, total	**0.0002**	N/A	0.0001	mg/L	Aug-10-15	Aug-11-15	
Lithium, total	**0.0003**	N/A	0.0001	mg/L	Aug-10-15	Aug-11-15	
Magnesium, total	**6.26**	N/A	0.01	mg/L	Aug-10-15	Aug-11-15	
Manganese, total	**0.340**	N/A	0.0002	mg/L	Aug-10-15	Aug-11-15	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	Aug-10-15	Aug-11-15	
Molybdenum, total	**0.0007**	N/A	0.0001	mg/L	Aug-10-15	Aug-11-15	
Nickel, total	**0.0010**	N/A	0.0002	mg/L	Aug-10-15	Aug-11-15	
Phosphorus, total	**0.06**	N/A	0.02	mg/L	Aug-10-15	Aug-11-15	
Potassium, total	**3.54**	N/A	0.02	mg/L	Aug-10-15	Aug-11-15	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	Aug-10-15	Aug-11-15	
Silicon, total	**4.7**	N/A	0.5	mg/L	Aug-10-15	Aug-11-15	
Silver, total	< 0.00005	N/A	0.00005	mg/L	Aug-10-15	Aug-11-15	
Sodium, total	**13.8**	N/A	0.02	mg/L	Aug-10-15	Aug-11-15	
Strontium, total	**0.116**	N/A	0.001	mg/L	Aug-10-15	Aug-11-15	
Sulfur, total	**2**	N/A	1	mg/L	Aug-10-15	Aug-11-15	

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	5080262
PROJECT	173.169 Maple Ridge WQ	**REPORTED**	Aug-12-15

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: K-1 (Dunlop Creek) (5080262-03) [Water] Sampled: Aug-05-15 09:20, Continued							
Total Recoverable Metals, Continued							
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	Aug-10-15	Aug-11-15	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	Aug-10-15	Aug-11-15	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	Aug-10-15	Aug-11-15	
Tin, total	< 0.0002	N/A	0.0002	mg/L	Aug-10-15	Aug-11-15	
Titanium, total	**0.008**	N/A	0.005	mg/L	Aug-10-15	Aug-11-15	
Uranium, total	< 0.00002	N/A	0.00002	mg/L	Aug-10-15	Aug-11-15	
Vanadium, total	**0.002**	N/A	0.001	mg/L	Aug-10-15	Aug-11-15	
Zinc, total	**0.075**	N/A	0.004	mg/L	Aug-10-15	Aug-11-15	
Zirconium, total	**0.0002**	N/A	0.0001	mg/L	Aug-10-15	Aug-11-15	
Microbiological Parameters							
Coliforms, Total	**1600**	N/A	2	MPN/100 mL		Aug-06-15	
Coliforms, Fecal	**90**	N/A	2	MPN/100 mL		Aug-06-15	
E. coli (MPN)	**90**	N/A	2	MPN/100 mL		Aug-06-15	
Sample ID: K-2 (Spencer Creek) (5080262-04) [Water] Sampled: Aug-05-15 09:50							
Anions							
Nitrate as N	**0.166**	N/A	0.010	mg/L	N/A	Aug-07-15	
General Parameters							
Alkalinity, Total as CaCO3	**111**	N/A	1	mg/L	N/A	Aug-06-15	
Alkalinity, Phenolphthalein as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-06-15	
Alkalinity, Bicarbonate as CaCO3	**111**	N/A	1	mg/L	N/A	Aug-06-15	
Alkalinity, Carbonate as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-06-15	
Alkalinity, Hydroxide as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-06-15	
Calculated Parameters							
Hardness, Total (Diss. as CaCO3)	**111**	N/A	0.50	mg/L	N/A	N/A	
Hardness, Total (Total as CaCO3)	**121**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.009**	N/A	0.005	mg/L	N/A	Aug-07-15	
Antimony, dissolved	**0.0002**	N/A	0.0001	mg/L	N/A	Aug-07-15	
Arsenic, dissolved	**0.0012**	N/A	0.0005	mg/L	N/A	Aug-07-15	
Barium, dissolved	**0.008**	N/A	0.005	mg/L	N/A	Aug-07-15	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-07-15	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-07-15	
Boron, dissolved	**0.024**	N/A	0.004	mg/L	N/A	Aug-07-15	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	Aug-07-15	
Calcium, dissolved	**30.0**	N/A	0.2	mg/L	N/A	Aug-07-15	
Chromium, dissolved	**0.0007**	N/A	0.0005	mg/L	N/A	Aug-07-15	
Cobalt, dissolved	**0.00010**	N/A	0.00005	mg/L	N/A	Aug-07-15	
Copper, dissolved	**0.0013**	N/A	0.0002	mg/L	N/A	Aug-07-15	
Iron, dissolved	**0.076**	N/A	0.010	mg/L	N/A	Aug-07-15	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-07-15	
Lithium, dissolved	**0.0003**	N/A	0.0001	mg/L	N/A	Aug-07-15	

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 5080262
REPORTED Aug-12-15

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: K-2 (Spencer Creek) (5080262-04) [Water] Sampled: Aug-05-15 09:50, Continued							
Dissolved Metals, Continued							
Magnesium, dissolved	**8.65**	N/A	0.01	mg/L	N/A	Aug-07-15	
Manganese, dissolved	**0.0543**	N/A	0.0002	mg/L	N/A	Aug-07-15	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	Aug-10-15	Aug-11-15	
Molybdenum, dissolved	**0.0010**	N/A	0.0001	mg/L	N/A	Aug-07-15	
Nickel, dissolved	**0.0007**	N/A	0.0002	mg/L	N/A	Aug-07-15	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	Aug-07-15	
Potassium, dissolved	**2.59**	N/A	0.02	mg/L	N/A	Aug-07-15	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Aug-07-15	
Silicon, dissolved	**6.2**	N/A	0.5	mg/L	N/A	Aug-07-15	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	Aug-07-15	
Sodium, dissolved	**12.8**	N/A	0.02	mg/L	N/A	Aug-07-15	
Strontium, dissolved	**0.184**	N/A	0.001	mg/L	N/A	Aug-07-15	
Sulfur, dissolved	< 1	N/A	1	mg/L	N/A	Aug-07-15	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Aug-07-15	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Aug-07-15	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-07-15	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Aug-07-15	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	Aug-07-15	
Uranium, dissolved	**0.00007**	N/A	0.00002	mg/L	N/A	Aug-07-15	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	Aug-07-15	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	Aug-07-15	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-07-15	
Total Recoverable Metals							
Aluminum, total	**0.411**	N/A	0.005	mg/L	Aug-10-15	Aug-11-15	
Antimony, total	**0.0002**	N/A	0.0001	mg/L	Aug-10-15	Aug-11-15	
Arsenic, total	**0.0014**	N/A	0.0005	mg/L	Aug-10-15	Aug-11-15	
Barium, total	**0.012**	N/A	0.005	mg/L	Aug-10-15	Aug-11-15	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	Aug-10-15	Aug-11-15	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	Aug-10-15	Aug-11-15	
Boron, total	**0.031**	N/A	0.004	mg/L	Aug-10-15	Aug-11-15	
Cadmium, total	**0.00001**	N/A	0.00001	mg/L	Aug-10-15	Aug-11-15	
Calcium, total	**32.2**	N/A	0.2	mg/L	Aug-10-15	Aug-11-15	
Chromium, total	**0.0013**	N/A	0.0005	mg/L	Aug-10-15	Aug-11-15	
Cobalt, total	**0.00036**	N/A	0.00005	mg/L	Aug-10-15	Aug-11-15	
Copper, total	**0.0022**	N/A	0.0002	mg/L	Aug-10-15	Aug-11-15	
Iron, total	**0.71**	N/A	0.01	mg/L	Aug-10-15	Aug-11-15	
Lead, total	**0.0002**	N/A	0.0001	mg/L	Aug-10-15	Aug-11-15	
Lithium, total	**0.0006**	N/A	0.0001	mg/L	Aug-10-15	Aug-11-15	
Magnesium, total	**9.90**	N/A	0.01	mg/L	Aug-10-15	Aug-11-15	
Manganese, total	**0.100**	N/A	0.0002	mg/L	Aug-10-15	Aug-11-15	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	Aug-10-15	Aug-11-15	
Molybdenum, total	**0.0012**	N/A	0.0001	mg/L	Aug-10-15	Aug-11-15	
Nickel, total	**0.0013**	N/A	0.0002	mg/L	Aug-10-15	Aug-11-15	
Phosphorus, total	**0.03**	N/A	0.02	mg/L	Aug-10-15	Aug-11-15	
Potassium, total	**2.90**	N/A	0.02	mg/L	Aug-10-15	Aug-11-15	

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	5080262
PROJECT	173.169 Maple Ridge WQ	**REPORTED**	Aug-12-15

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: K-2 (Spencer Creek) (5080262-04) [Water] Sampled: Aug-05-15 09:50, Continued							
Total Recoverable Metals, Continued							
Selenium, total	< 0.0005	N/A	0.0005	mg/L	Aug-10-15	Aug-11-15	
Silicon, total	**8.5**	N/A	0.5	mg/L	Aug-10-15	Aug-11-15	
Silver, total	< 0.00005	N/A	0.00005	mg/L	Aug-10-15	Aug-11-15	
Sodium, total	**14.5**	N/A	0.02	mg/L	Aug-10-15	Aug-11-15	
Strontium, total	**0.197**	N/A	0.001	mg/L	Aug-10-15	Aug-11-15	
Sulfur, total	**5**	N/A	1	mg/L	Aug-10-15	Aug-11-15	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	Aug-10-15	Aug-11-15	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	Aug-10-15	Aug-11-15	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	Aug-10-15	Aug-11-15	
Tin, total	< 0.0002	N/A	0.0002	mg/L	Aug-10-15	Aug-11-15	
Titanium, total	**0.023**	N/A	0.005	mg/L	Aug-10-15	Aug-11-15	
Uranium, total	**0.00008**	N/A	0.00002	mg/L	Aug-10-15	Aug-11-15	
Vanadium, total	**0.002**	N/A	0.001	mg/L	Aug-10-15	Aug-11-15	
Zinc, total	< 0.004	N/A	0.004	mg/L	Aug-10-15	Aug-11-15	
Zirconium, total	**0.0002**	N/A	0.0001	mg/L	Aug-10-15	Aug-11-15	
Microbiological Parameters							
Coliforms, Total	**900**	N/A	2	MPN/100 mL		Aug-06-15	
Coliforms, Fecal	**80**	N/A	2	MPN/100 mL		Aug-06-15	
E. coli (MPN)	**80**	N/A	2	MPN/100 mL		Aug-06-15	
Sample ID: Field Blank (5080262-05) [Water] Sampled: Aug-05-15 09:00							
Anions							
Nitrate as N	< 0.010	N/A	0.010	mg/L	N/A	Aug-07-15	

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	5080262
PROJECT	173.169 Maple Ridge WQ	**REPORTED**	Aug-12-15

The following section displays the quality control (QC) data that is associated with your sample data. Groups of samples are prepared in "batches" and analyzed in conjunction with QC samples that ensure your data is of the highest quality. Common QC types include:

- **Method Blank (Blk)**: Laboratory reagent water is carried through sample preparation and analysis steps. Method Blanks indicate that results are free from contamination, i.e. not biased high from sources such as the sample container or the laboratory environment
- **Duplicate (Dup)**: Preparation and analysis of a replicate aliquot of a sample. Duplicates provide a measure of the analytical method's precision, i.e. how reproducible a result is. Duplicates are only reported if they are associated with your sample data.
- **Blank Spike (BS)**: A known amount of standard is carried through sample preparation and analysis steps. Blank Spikes, also known as laboratory control samples (LCS), are prepared from a different source of standard than used for the calibration. They ensure that the calibration is acceptable (i.e. not biased high or low) and also provide a measure of the analytical method's accuracy (i.e. closeness of the result to a target value).
- **Standard Reference Material (SRM)**: A material of similar matrix to the samples, externally certified for the parameter(s) listed. Standard Reference Materials ensure that the preparation steps in the method are adequate to achieve acceptable recoveries of the parameter(s) tested.

Each QC type is analyzed at a 5-10% frequency, i.e. one blank/duplicate/spike for every 10 samples. For all types of QC, the specified recovery (% Rec) and relative percent difference (RPD) limits are derived from long-term method performance averages and/or prescribed by the reference method.

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Anions, Batch B5H0208										
Blank (B5H0208-BLK1)				Prepared: Aug-06-15, Analyzed: Aug-06-15						
Nitrate as N	< 0.005	0.010	mg/L							
Blank (B5H0208-BLK2)				Prepared: Aug-07-15, Analyzed: Aug-07-15						
Nitrate as N	< 0.005	0.010	mg/L							
Blank (B5H0208-BLK3)				Prepared: Aug-07-15, Analyzed: Aug-07-15						
Nitrate as N	< 0.005	0.010	mg/L							
LCS (B5H0208-BS1)				Prepared: Aug-06-15, Analyzed: Aug-06-15						
Nitrate as N	3.98	0.010	mg/L	4.00		99	85-115			
LCS (B5H0208-BS2)				Prepared: Aug-07-15, Analyzed: Aug-07-15						
Nitrate as N	3.98	0.010	mg/L	4.00		99	85-115			
LCS (B5H0208-BS3)				Prepared: Aug-07-15, Analyzed: Aug-07-15						
Nitrate as N	3.99	0.010	mg/L	4.00		100	85-115			
Dissolved Metals, Batch B5H0284										
Blank (B5H0284-BLK1)				Prepared: Aug-07-15, Analyzed: Aug-07-15						
Aluminum, dissolved	< 0.005	0.005	mg/L							
Antimony, dissolved	< 0.0001	0.0001	mg/L							
Arsenic, dissolved	< 0.0005	0.0005	mg/L							
Barium, dissolved	< 0.005	0.005	mg/L							
Beryllium, dissolved	< 0.0001	0.0001	mg/L							
Bismuth, dissolved	< 0.0001	0.0001	mg/L							
Boron, dissolved	< 0.004	0.004	mg/L							
Cadmium, dissolved	< 0.00001	0.00001	mg/L							
Calcium, dissolved	< 0.2	0.2	mg/L							
Chromium, dissolved	< 0.0005	0.0005	mg/L							
Cobalt, dissolved	< 0.00005	0.00005	mg/L							
Copper, dissolved	< 0.0002	0.0002	mg/L							

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby) **WORK ORDER** 5080262
PROJECT 173.169 Maple Ridge WQ **REPORTED** Aug-12-15

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Dissolved Metals, Batch B5H0284, Continued										
Blank (B5H0284-BLK1), Continued				Prepared: Aug-07-15, Analyzed: Aug-07-15						
Iron, dissolved	< 0.010	0.010	mg/L							
Lead, dissolved	< 0.0001	0.0001	mg/L							
Lithium, dissolved	< 0.0001	0.0001	mg/L							
Magnesium, dissolved	< 0.01	0.01	mg/L							
Manganese, dissolved	< 0.0002	0.0002	mg/L							
Molybdenum, dissolved	< 0.0001	0.0001	mg/L							
Nickel, dissolved	< 0.0002	0.0002	mg/L							
Phosphorus, dissolved	< 0.02	0.02	mg/L							
Potassium, dissolved	< 0.02	0.02	mg/L							
Selenium, dissolved	< 0.0005	0.0005	mg/L							
Silicon, dissolved	< 0.5	0.5	mg/L							
Silver, dissolved	< 0.00005	0.00005	mg/L							
Sodium, dissolved	< 0.02	0.02	mg/L							
Strontium, dissolved	< 0.001	0.001	mg/L							
Sulfur, dissolved	< 1	1	mg/L							
Tellurium, dissolved	< 0.0002	0.0002	mg/L							
Thallium, dissolved	< 0.00002	0.00002	mg/L							
Thorium, dissolved	< 0.0001	0.0001	mg/L							
Tin, dissolved	< 0.0002	0.0002	mg/L							
Titanium, dissolved	< 0.005	0.005	mg/L							
Uranium, dissolved	< 0.00002	0.00002	mg/L							
Vanadium, dissolved	< 0.001	0.001	mg/L							
Zinc, dissolved	< 0.004	0.004	mg/L							
Zirconium, dissolved	< 0.0001	0.0001	mg/L							
Reference (B5H0284-SRM1)				Prepared: Aug-07-15, Analyzed: Aug-07-15						
Aluminum, dissolved	0.238	0.005	mg/L	0.233		102	58-142			
Antimony, dissolved	0.0465	0.0001	mg/L	0.0430		108	75-125			
Arsenic, dissolved	0.447	0.0005	mg/L	0.438		102	81-119			
Barium, dissolved	3.47	0.005	mg/L	3.35		104	83-117			
Beryllium, dissolved	0.213	0.0001	mg/L	0.213		100	80-120			
Boron, dissolved	1.80	0.004	mg/L	1.74		104	74-117			
Cadmium, dissolved	0.227	0.00001	mg/L	0.224		101	83-117			
Calcium, dissolved	8.4	0.2	mg/L	7.69		109	76-124			
Chromium, dissolved	0.461	0.0005	mg/L	0.437		105	81-119			
Cobalt, dissolved	0.138	0.00005	mg/L	0.128		108	76-124			
Copper, dissolved	0.900	0.0002	mg/L	0.844		107	84-116			
Iron, dissolved	1.34	0.010	mg/L	1.29		104	74-126			
Lead, dissolved	0.119	0.0001	mg/L	0.112		106	72-128			
Lithium, dissolved	0.113	0.0001	mg/L	0.104		108	60-140			
Magnesium, dissolved	7.21	0.01	mg/L	6.92		104	81-119			
Manganese, dissolved	0.355	0.0002	mg/L	0.345		103	84-116			
Molybdenum, dissolved	0.435	0.0001	mg/L	0.426		102	83-117			
Nickel, dissolved	0.886	0.0002	mg/L	0.840		106	74-126			
Phosphorus, dissolved	0.51	0.02	mg/L	0.495		103	68-132			
Potassium, dissolved	3.18	0.02	mg/L	3.19		100	74-126			
Selenium, dissolved	0.0353	0.0005	mg/L	0.0331		107	70-130			
Sodium, dissolved	19.7	0.02	mg/L	19.1		103	72-128			
Strontium, dissolved	0.912	0.001	mg/L	0.916		100	84-113			
Thallium, dissolved	0.0405	0.00002	mg/L	0.0393		103	57-143			
Uranium, dissolved	0.276	0.00002	mg/L	0.266		104	85-115			
Vanadium, dissolved	0.895	0.001	mg/L	0.869		103	87-113			
Zinc, dissolved	0.900	0.004	mg/L	0.881		102	72-128			
Dissolved Metals, Batch B5H0416										

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 5080262
REPORTED Aug-12-15

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Dissolved Metals, Batch B5H0416, Continued										
Blank (B5H0416-BLK1)				Prepared: Aug-10-15, Analyzed: Aug-11-15						
Mercury, dissolved	< 0.00002	0.00002	mg/L							
Blank (B5H0416-BLK2)				Prepared: Aug-10-15, Analyzed: Aug-11-15						
Mercury, dissolved	< 0.00002	0.00002	mg/L							
Duplicate (B5H0416-DUP2)		**Source: 5080262-03**		Prepared: Aug-10-15, Analyzed: Aug-11-15						
Mercury, dissolved	< 0.00002	0.00002	mg/L		< 0.00002				20	
Matrix Spike (B5H0416-MS2)		**Source: 5080262-04**		Prepared: Aug-10-15, Analyzed: Aug-11-15						
Mercury, dissolved	0.00020	0.00002	mg/L	0.000250	< 0.00002	81	70-130			
Reference (B5H0416-SRM1)				Prepared: Aug-10-15, Analyzed: Aug-11-15						
Mercury, dissolved	0.00300	0.00002	mg/L	0.00456		66	50-150			
Reference (B5H0416-SRM2)				Prepared: Aug-10-15, Analyzed: Aug-11-15						
Mercury, dissolved	0.00315	0.00002	mg/L	0.00456		69	50-150			
General Parameters, Batch B5H0227										
Blank (B5H0227-BLK1)				Prepared: Aug-06-15, Analyzed: Aug-06-15						
Alkalinity, Total as CaCO3	< 1	1	mg/L							
Alkalinity, Phenolphthalein as CaCO3	< 1	1	mg/L							
Alkalinity, Bicarbonate as CaCO3	< 1	1	mg/L							
Alkalinity, Carbonate as CaCO3	< 1	1	mg/L							
Alkalinity, Hydroxide as CaCO3	< 1	1	mg/L							
Blank (B5H0227-BLK2)				Prepared: Aug-06-15, Analyzed: Aug-06-15						
Alkalinity, Total as CaCO3	< 1	1	mg/L							
Alkalinity, Phenolphthalein as CaCO3	< 1	1	mg/L							
Alkalinity, Bicarbonate as CaCO3	< 1	1	mg/L							
Alkalinity, Carbonate as CaCO3	< 1	1	mg/L							
Alkalinity, Hydroxide as CaCO3	< 1	1	mg/L							
LCS (B5H0227-BS1)				Prepared: Aug-06-15, Analyzed: Aug-06-15						
Alkalinity, Total as CaCO3	103	1	mg/L	100		103	96-108			
LCS (B5H0227-BS2)				Prepared: Aug-06-15, Analyzed: Aug-06-15						
Alkalinity, Total as CaCO3	102	1	mg/L	100		102	96-108			
Total Recoverable Metals, Batch B5H0379										
Blank (B5H0379-BLK1)				Prepared: Aug-10-15, Analyzed: Aug-11-15						
Aluminum, total	< 0.005	0.005	mg/L							
Antimony, total	< 0.0001	0.0001	mg/L							
Arsenic, total	< 0.0005	0.0005	mg/L							
Barium, total	< 0.005	0.005	mg/L							
Beryllium, total	< 0.0001	0.0001	mg/L							
Bismuth, total	< 0.0001	0.0001	mg/L							
Boron, total	< 0.004	0.004	mg/L							
Cadmium, total	< 0.00001	0.00001	mg/L							
Calcium, total	< 0.2	0.2	mg/L							
Chromium, total	< 0.0005	0.0005	mg/L							
Cobalt, total	< 0.00005	0.00005	mg/L							
Copper, total	< 0.0002	0.0002	mg/L							
Iron, total	< 0.01	0.01	mg/L							
Lead, total	< 0.0001	0.0001	mg/L							

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 5080262
REPORTED Aug-12-15

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Total Recoverable Metals, Batch B5H0379, Continued										
Blank (B5H0379-BLK1), Continued				Prepared: Aug-10-15, Analyzed: Aug-11-15						
Lithium, total	< 0.0001	0.0001	mg/L							
Magnesium, total	< 0.01	0.01	mg/L							
Manganese, total	< 0.0002	0.0002	mg/L							
Molybdenum, total	< 0.0001	0.0001	mg/L							
Nickel, total	< 0.0002	0.0002	mg/L							
Phosphorus, total	< 0.02	0.02	mg/L							
Potassium, total	< 0.02	0.02	mg/L							
Selenium, total	< 0.0005	0.0005	mg/L							
Silicon, total	< 0.5	0.5	mg/L							
Silver, total	< 0.00005	0.00005	mg/L							
Sodium, total	< 0.02	0.02	mg/L							
Strontium, total	< 0.001	0.001	mg/L							
Sulfur, total	< 1	1	mg/L							
Tellurium, total	< 0.0002	0.0002	mg/L							
Thallium, total	< 0.00002	0.00002	mg/L							
Thorium, total	< 0.0001	0.0001	mg/L							
Tin, total	< 0.0002	0.0002	mg/L							
Titanium, total	< 0.005	0.005	mg/L							
Uranium, total	< 0.00002	0.00002	mg/L							
Vanadium, total	< 0.001	0.001	mg/L							
Zinc, total	< 0.004	0.004	mg/L							
Zirconium, total	< 0.0001	0.0001	mg/L							
Matrix Spike (B5H0379-MS1)	**Source: 5080262-01**			Prepared: Aug-10-15, Analyzed: Aug-11-15						
Antimony, total	0.389	0.0001	mg/L	0.400	0.0002	97	84-125			
Arsenic, total	0.188	0.0005	mg/L	0.200	0.0008	94	85-116			
Barium, total	0.925	0.005	mg/L	1.00	0.011	91	87-114			
Beryllium, total	0.0962	0.0001	mg/L	0.100	< 0.0001	96	72-116			
Cadmium, total	0.0969	0.00001	mg/L	0.100	0.00002	97	90-112			
Chromium, total	0.390	0.0005	mg/L	0.400	0.0010	97	89-120			
Cobalt, total	0.399	0.00005	mg/L	0.400	0.00013	100	88-120			
Copper, total	0.409	0.0002	mg/L	0.400	0.0036	101	88-125			
Iron, total	2.37	0.01	mg/L	2.00	0.37	100	88-119			
Lead, total	0.211	0.0001	mg/L	0.200	0.0003	105	89-118			
Manganese, total	0.395	0.0002	mg/L	0.400	0.0255	92	84-120			
Nickel, total	0.391	0.0002	mg/L	0.400	0.0009	98	87-119			
Selenium, total	0.0884	0.0005	mg/L	0.100	< 0.0005	88	85-113			
Silver, total	0.100	0.00005	mg/L	0.100	< 0.00005	100	89-119			
Thallium, total	0.106	0.00002	mg/L	0.100	< 0.00002	106	92-119			
Vanadium, total	0.376	0.001	mg/L	0.400	0.002	93	87-117			
Zinc, total	0.971	0.004	mg/L	1.00	0.006	96	85-116			
Reference (B5H0379-SRM1)				Prepared: Aug-10-15, Analyzed: Aug-11-15						
Aluminum, total	0.294	0.005	mg/L	0.296		99	81-129			
Antimony, total	0.0494	0.0001	mg/L	0.0505		98	88-114			
Arsenic, total	0.126	0.0005	mg/L	0.122		103	88-114			
Barium, total	0.688	0.005	mg/L	0.777		89	72-104			
Beryllium, total	0.0494	0.0001	mg/L	0.0488		101	76-131			
Boron, total	3.84	0.004	mg/L	3.40		113	75-121			
Cadmium, total	0.0476	0.00001	mg/L	0.0490		97	89-111			
Calcium, total	11.1	0.2	mg/L	10.2		108	86-121			
Chromium, total	0.254	0.0005	mg/L	0.242		105	89-114			
Cobalt, total	0.0408	0.00005	mg/L	0.0366		111	91-113			
Copper, total	0.539	0.0002	mg/L	0.487		111	91-115			
Iron, total	0.50	0.01	mg/L	0.469		107	77-124			
Lead, total	0.204	0.0001	mg/L	0.193		106	92-113			
Lithium, total	0.438	0.0001	mg/L	0.390		112	85-115			

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 5080262
REPORTED Aug-12-15

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Total Recoverable Metals, Batch B5H0379, Continued										
Reference (B5H0379-SRM1), Continued				Prepared: Aug-10-15, Analyzed: Aug-11-15						
Magnesium, total	3.54	0.01	mg/L	3.31		107	78-120			
Manganese, total	0.109	0.0002	mg/L	0.109		100	90-114			
Molybdenum, total	0.205	0.0001	mg/L	0.197		104	90-111			
Nickel, total	0.266	0.0002	mg/L	0.242		110	90-111			
Phosphorus, total	0.22	0.02	mg/L	0.233		96	85-115			
Potassium, total	6.29	0.02	mg/L	5.93		106	84-113			
Selenium, total	0.110	0.0005	mg/L	0.115		95	85-115			
Sodium, total	8.27	0.02	mg/L	7.64		108	82-123			
Strontium, total	0.350	0.001	mg/L	0.363		97	88-112			
Thallium, total	0.0832	0.00002	mg/L	0.0794		105	91-114			
Uranium, total	0.0191	0.00002	mg/L	0.0192		100	85-120			
Vanadium, total	0.386	0.001	mg/L	0.376		103	86-111			
Zinc, total	2.44	0.004	mg/L	2.42		101	85-111			
Total Recoverable Metals, Batch B5H0430										
Blank (B5H0430-BLK1)				Prepared: Aug-10-15, Analyzed: Aug-11-15						
Mercury, total	< 0.00002	0.00002	mg/L							
Blank (B5H0430-BLK2)				Prepared: Aug-10-15, Analyzed: Aug-11-15						
Mercury, total	< 0.00002	0.00002	mg/L							
Duplicate (B5H0430-DUP2)		**Source: 5080262-02**		Prepared: Aug-10-15, Analyzed: Aug-11-15						
Mercury, total	< 0.00002	0.00002	mg/L		< 0.00002				20	
Matrix Spike (B5H0430-MS2)		**Source: 5080262-03**		Prepared: Aug-10-15, Analyzed: Aug-11-15						
Mercury, total	0.00023	0.00002	mg/L	0.000250	< 0.00002	89	70-130			
Reference (B5H0430-SRM1)				Prepared: Aug-10-15, Analyzed: Aug-11-15						
Mercury, total	0.00424	0.00002	mg/L	0.00456		93	50-150			
Reference (B5H0430-SRM2)				Prepared: Aug-10-15, Analyzed: Aug-11-15						
Mercury, total	0.00324	0.00002	mg/L	0.00456		71	50-150			

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 5080262
REPORTED Aug-12-15

		5080262-01	5080262-02	5080262-03	5080262-04	5080262-05
		Water	Water	Water	Water	Water
		Aug-05-15	Aug-05-15	Aug-05-15	Aug-05-15	Aug-05-15
		SA-1 (T2 Creek)	SA-2 (Millionaire Creek)	K-1 (Dunlop Creek)	K-2 (Spencer Creek)	Field Blank
Anions	Nitrate as N (mg/L)	0.618	0.458	0.035	0.166	< 0.010
General Parameters	Alkalinity, Total as CaCO3 (mg/L)	76	31	77	111	
	Alkalinity, Phenolphthalein as CaCO3 (mg/L)	< 1	< 1	< 1	< 1	
	Alkalinity, Bicarbonate as CaCO3 (mg/L)	76	31	77	111	
	Alkalinity, Carbonate as CaCO3 (mg/L)	< 1	< 1	< 1	< 1	
	Alkalinity, Hydroxide as CaCO3 (mg/L)	< 1	< 1	< 1	< 1	
Calculated Parameters	Hardness, Total (Diss. as CaCO3) (mg/L)	89.8	25.9	69.1	111	
	Hardness, Total (Total as CaCO3) (mg/L)	81.6	29.2	72.7	121	
Dissolved Metals	Aluminum, dissolved (mg/L)	0.014	0.012	0.016	0.009	
	Antimony, dissolved (mg/L)	0.0003	0.0001	0.0001	0.0002	
	Arsenic, dissolved (mg/L)	0.0006	< 0.0005	0.0012	0.0012	
	Barium, dissolved (mg/L)	0.010	0.007	0.013	0.008	
	Beryllium, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Bismuth, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Boron, dissolved (mg/L)	0.029	0.008	0.033	0.024	
	Cadmium, dissolved (mg/L)	0.00003	0.00001	0.00002	< 0.00001	
	Calcium, dissolved (mg/L)	22.8	7.8	17.8	30.0	
	Chromium, dissolved (mg/L)	0.0008	0.0007	0.0008	0.0007	
	Cobalt, dissolved (mg/L)	0.00009	< 0.00005	0.00053	0.00010	
	Copper, dissolved (mg/L)	0.0023	0.0010	0.0012	0.0013	
	Iron, dissolved (mg/L)	0.109	0.018	0.625	0.076	
	Lead, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Lithium, dissolved (mg/L)	0.0013	0.0001	0.0001	0.0003	
	Magnesium, dissolved (mg/L)	7.97	1.55	6.00	8.65	
	Manganese, dissolved (mg/L)	0.0177	0.0023	0.281	0.0543	
	Mercury, dissolved (mg/L)	< 0.00002	< 0.00002	< 0.00002	< 0.00002	
	Molybdenum, dissolved (mg/L)	0.0070	0.0007	0.0007	0.0010	
	Nickel, dissolved (mg/L)	0.0006	< 0.0002	0.0007	0.0007	
	Phosphorus, dissolved (mg/L)	< 0.02	< 0.02	< 0.02	< 0.02	
	Potassium, dissolved (mg/L)	2.84	0.63	3.48	2.59	
	Selenium, dissolved (mg/L)	< 0.0005	< 0.0005	< 0.0005	< 0.0005	
	Silicon, dissolved (mg/L)	7.6	5.3	4.1	6.2	
	Silver, dissolved (mg/L)	< 0.00005	< 0.00005	< 0.00005	< 0.00005	
	Sodium, dissolved (mg/L)	18.1	5.27	13.0	12.8	
	Strontium, dissolved (mg/L)	0.098	0.046	0.115	0.184	
	Sulfur, dissolved (mg/L)	< 1	< 1	< 1	< 1	
	Tellurium, dissolved (mg/L)	< 0.0002	< 0.0002	< 0.0002	< 0.0002	
	Thallium, dissolved (mg/L)	< 0.00002	< 0.00002	< 0.00002	< 0.00002	
	Thorium, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Tin, dissolved (mg/L)	< 0.0002	< 0.0002	< 0.0002	< 0.0002	
	Titanium, dissolved (mg/L)	< 0.005	< 0.005	< 0.005	< 0.005	
	Uranium, dissolved (mg/L)	0.00009	< 0.00002	< 0.00002	0.00007	
	Vanadium, dissolved (mg/L)	< 0.001	< 0.001	0.001	< 0.001	
	Zinc, dissolved (mg/L)	0.012	0.004	< 0.004	< 0.004	

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 5080262
REPORTED Aug-12-15

		5080262-01	5080262-02	5080262-03	5080262-04	5080262-05
		Water	Water	Water	Water	Water
		Aug-05-15	Aug-05-15	Aug-05-15	Aug-05-15	Aug-05-15
		SA-1 (T2 Creek)	SA-2 (Millionaire Creek)	K-1 (Dunlop Creek)	K-2 (Spencer Creek)	Field Blank
Dissolved Metals	Zirconium, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
Total Recoverable Metals	Aluminum, total (mg/L)	0.158	0.025	0.177	0.411	
	Antimony, total (mg/L)	0.0002	0.0001	0.0001	0.0002	
	Arsenic, total (mg/L)	0.0008	< 0.0005	0.0014	0.0014	
	Barium, total (mg/L)	0.011	0.008	0.015	0.012	
	Beryllium, total (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Bismuth, total (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Boron, total (mg/L)	0.029	0.010	0.041	0.031	
	Cadmium, total (mg/L)	0.00002	< 0.00001	0.00001	0.00001	
	Calcium, total (mg/L)	18.7	8.8	18.8	32.2	
	Chromium, total (mg/L)	0.0010	0.0008	0.0011	0.0013	
	Cobalt, total (mg/L)	0.00013	< 0.00005	0.00069	0.00036	
	Copper, total (mg/L)	0.0036	0.0014	0.0017	0.0022	
	Iron, total (mg/L)	0.37	0.04	1.19	0.71	
	Lead, total (mg/L)	0.0003	< 0.0001	0.0002	0.0002	
	Lithium, total (mg/L)	0.0013	0.0002	0.0003	0.0006	
	Magnesium, total (mg/L)	8.44	1.76	6.26	9.90	
	Manganese, total (mg/L)	0.0255	0.0026	0.340	0.100	
	Mercury, total (mg/L)	< 0.00002	< 0.00002	< 0.00002	< 0.00002	
	Molybdenum, total (mg/L)	0.0070	0.0008	0.0007	0.0012	
	Nickel, total (mg/L)	0.0009	< 0.0002	0.0010	0.0013	
	Phosphorus, total (mg/L)	0.05	< 0.02	0.06	0.03	
	Potassium, total (mg/L)	2.94	0.71	3.54	2.90	
	Selenium, total (mg/L)	< 0.0005	< 0.0005	< 0.0005	< 0.0005	
	Silicon, total (mg/L)	8.8	6.2	4.7	8.5	
	Silver, total (mg/L)	< 0.00005	< 0.00005	< 0.00005	< 0.00005	
	Sodium, total (mg/L)	19.1	5.95	13.8	14.5	
	Strontium, total (mg/L)	0.099	0.048	0.116	0.197	
	Sulfur, total (mg/L)	3	< 1	2	5	
	Tellurium, total (mg/L)	< 0.0002	< 0.0002	< 0.0002	< 0.0002	
	Thallium, total (mg/L)	< 0.00002	< 0.00002	< 0.00002	< 0.00002	
	Thorium, total (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Tin, total (mg/L)	< 0.0002	< 0.0002	< 0.0002	< 0.0002	
	Titanium, total (mg/L)	0.007	< 0.005	0.008	0.023	
	Uranium, total (mg/L)	0.00007	< 0.00002	< 0.00002	0.00008	
	Vanadium, total (mg/L)	0.002	< 0.001	0.002	0.002	
	Zinc, total (mg/L)	0.006	< 0.004	0.075	< 0.004	
	Zirconium, total (mg/L)	0.0009	< 0.0001	0.0002	0.0002	
Microbiological Parameters	Coliforms, Total (MPN/100 mL)	3000	2400	1600	900	
	Coliforms, Fecal (MPN/100 mL)	3000	2400	90	80	
	E. coli (MPN) (MPN/100 mL)	3000	2400	90	80	

ING WAY, RICHMOND, BC V6V 2K9
-1499 FAX: (604) 279-1599

HWAY 97N, KELOWNA, BC V1X 5C3
-9546 FAX: (250) 765-3893

/ENUE NW, EDMONTON, AB T5S 1H7
-9100 FAX: (480) 489-9700

* 5 0 8 0 2 6 2 *

CHAIN-OF-CUSTODY RECORD

COC#

RELINQUISHED BY:	DATE: 5-Aug-15	RECEIVED BY:	DATE: 08/05
Peter deKoning	TIME: 12:30	WL KF	TIME: 12:33
RELINQUISHED BY:	DATE:	RECEIVED BY:	DATE:
	TIME:		TIME:

REPORT TO:		INVOICE TO:	SAME AS REPORT TO ☐
COMPANY:	Kerr Wood Leidal Associates	COMPANY:	Kerr Wood Leidal Associates
ADDRESS:	200-4185A Still Creek Drive	ADDRESS:	200-4185A Still Creek Drive
	Burnaby, BC V5C 6G9		Burnaby, BC V5C 6G9
CONTACT:	Patrick Lilley	CONTACT:	Patrick Lilley / Michelle Derer
TEL / FAX:	604-293-3121 604-294-2090	TEL / FAX:	604-293-3252 604-294-2090
EMAIL PDF ☑	EDD ☐ Please email Excel file.	EMAIL PDF	☑
EMAIL 1:	plilley@kwl.ca	EMAIL 1:	plilley@kwl.ca
EMAIL 2:	pdekoning@kwl.ca	EMAIL 2:	mderer@kwl.ca
MAIL HARDCOPY ☐	HOLD FOR P/U ☐ FAX ☐	MAIL HARDCOPY ☐	HOLD FOR P/U ☑

PROJECT:	PROJECT INFO:	PO #:
173.169 Maple Ridge WQ	Stormwater Monitoring	
SAMPLED BY:	SHIPPING INSTRUCTIONS:	RETURN COOLER(S) ☐
Peter deKoning	SHIP SUPPLIES (PLEASE SPECIFY IN OTHER INSTRUCTIONS SECTION)	☐

TURNAROUND TIME REQUESTED: Routine (4-7 days) ☑ Other: ____
Rush:* 1 Day ☐ 2 Day ☐ 3 Day ☐ * Contact the lab to confirm, surcharges may apply

ANALYSES REQUESTED:

	CLIENT SAMPLE ID:	MATRIX: DRINKING WATER	OTHER WATER	SOIL	OTHER	# CONTAINERS	SAMPLING: DATE DD-MMM-YY	TIME HH:MM	COMMENTS: CHLORINATED	FILTERED	PRESERVED	(i.e. flow/volume media ID/notes)	BTEX ☐ VPH ☐ MTBE ☐	EPH (not PAH Corrected)	VOC ☐ VPH ☐	L/HEPH (PAH Corrected)	PAH	PHENOLS Chlorinated ☐ Non-Chlor. ☐	PCB ☐ GLYCOLS ☐ HAA ☐	METALS - WATER TOTAL (ICPMS - LOW Pkg.)	METALS - WATER DISSOLVED (ICPMS - LOW Pkg.)	Metals - SOIL (SALM) ☐ Inc. pH ☐	pH ☐ EC ☐ Alk ☑	TSS ☐ TDS ☐	BOD ☐ COD ☐	FECAL COLIFORMS ☑ HPC ☐	TOTAL COLIFORMS ☑ E-COLI ☑	PESTICIDES ☐ HERBICIDES ☐	SOIL VAPOUR	ASBESTOS	NITRATE-N					HOLD
	SA-1 (T2 Creek)	☐	☑	☐	☐	6	5-Aug-15	8:00	☐	☐	☐	See below	☐	☐	☐	☐	☐	☐	☐	☑	☑	☐	☑	☐	☐	☑	☑	☐	☐	☐	☑						☐
	SA-2 (Millionaire Creek)	☐	☑	☐	☐	6	5-Aug-15	8:45	☐	☐	☐	See below	☐	☐	☐	☐	☐	☐	☐	☑	☑	☐	☑	☐	☐	☑	☑	☐	☐	☐	☑						☐
	K-1 (Dunlop Creek)	☐	☑	☐	☐	6	5-Aug-15	9:20	☐	☐	☐	See below	☐	☐	☐	☐	☐	☐	☐	☑	☑	☐	☑	☐	☐	☑	☑	☐	☐	☐	☑						☐
	K-2 (Spencer Creek)	☐	☑	☐	☐	6	5-Aug-15	9:50	☐	☐	☐	See below	☐	☐	☐	☐	☐	☐	☐	☑	☑	☐	☑	☐	☐	☑	☑	☐	☐	☐	☑						☐
	Field Blank	☐	☐	☐	☐	1	5-Aug-15	9:00	☐	☐	☐		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑						☐
	Trip Blank	☐	☐	☐	☐	1	4-Aug-15	16:30	☐	☐	☐		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐						☑
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APPLICABLE REGULATORY LIMITS:
Canadian Drinking Water Quality Guidelines ☐
BC Drinking Water Protection Act/Reg. ☐
BC CSR: AL ☐ RL ☐ CL ☐ IL ☐ AW ☐
CCME ☑ Alberta Tier 1 ☐
OTHER: BC WQ Guidelines for Aquatic Life

SAMPLE RETENTION INSTRUCTIONS (Discarded 30 days after Report unless otherwise specified):
60 Days ☐ 90 Days ☐ Longer Date (Surcharges will apply):

OTHER INSTRUCTIONS:
Total and dissolved metals, mercury, and bacteriological samples have been preserved. Dissolved metals samples (incl. mercury) have also been filtered. Metals analysis should be LOW level ICPMS pkg. Add total + dissolved Hg. Alkalinity = SPECIATED alkalinity. Use higher dilutions for bacteriological tests pls.

PAYMENT
Cheque ☐
Credit ☐
Debit ☐
Cash ☐
Invoice ☐

SAMPLE RECEIPT TEMP (°C): 8.3
Work Order # ____
CUSTODY SEALS INTACT: ☐Y ☐N ☐NA

Required Fields Recommended Fields SHADED AREAS: LAB USE ONLY

ING WAY, RICHMOND, BC V6V 2K9
-1499 FAX: (604) 279-1599

IHWAY 97N, KELOWNA, BC V1X 5C3
-9646 FAX: (250) 765-3893

/ENUE NW, EDMONTON, AB T5S 1H7
-9100 FAX: (480) 489-9700

CHAIN-OF-CUSTODY RECORD

COC#

RELINQUISHED BY:	DATE: 5-Aug-15	RECEIVED BY:	DATE: 08/05
Peter deKoning	TIME: 12:30	WL KF	TIME: 12:33
RELINQUISHED BY:	DATE:	RECEIVED BY:	DATE:
	TIME:		TIME:

REPORT TO:
COMPANY: Kerr Wood Leidal Associates
ADDRESS: 200-4185A Still Creek Drive, Burnaby, BC V5C 6G9
CONTACT: Patrick Lilley
TEL / FAX: 604-293-3121 604-294-2090
EMAIL PDF ☑ EDD ☐ Please email Excel file.
EMAIL 1: plilley@kwl.ca
EMAIL 2: pdekoning@kwl.ca
MAIL HARDCOPY ☐ HOLD FOR P/U ☐ FAX ☐

INVOICE TO: SAME AS REPORT TO ☐
COMPANY: Kerr Wood Leidal Associates
ADDRESS: 200-4185A Still Creek Drive, Burnaby, BC V5C 6G9
CONTACT: Patrick Lilley / Michelle Derer
TEL / FAX: 604-293-3252 604-294-2090
EMAIL PDF ☑
EMAIL 1: plilley@kwl.ca
EMAIL 2: mderer@kwl.ca
MAIL HARDCOPY ☐ HOLD FOR P/U ☑

PROJECT:	PROJECT INFO:	PO #:
173.169 Maple Ridge WQ	Stormwater Monitoring	
SAMPLED BY:	SHIPPING INSTRUCTIONS:	RETURN COOLER(S) ☐
Peter deKoning	SHIP SUPPLIES (PLEASE SPECIFY IN OTHER INSTRUCTIONS SECTION)	☐

TURNAROUND Routine (4-7 days) ☑ Other:
TIME REQUESTED: Rush:* 1 Day ☐ 2 Day ☐ 3 Day ☐ * Contact the lab to confirm, surcharges may apply

ANALYSES REQUESTED:

CLIENT SAMPLE ID:	MATRIX: DRINKING WATER	OTHER WATER	SOIL	OTHER	# CONTAINERS	SAMPLING: DATE DD-MMM-YY	TIME HH:MM	COMMENTS: CHLORINATED	FILTERED	PRESERVED	(i.e. flow/volume media ID/notes)	BTEX ☐ VPH ☐ MTBE ☐	EPH (not PAH Corrected)	VOC ☐ VPH ☐	L/HEPH (PAH Corrected)	PAH	PHENOLS Chlorinated ☐ Non-Chlor. ☐	PCB ☐ GLYCOLS ☐ HAA ☐	METALS - WATER TOTAL (ICPMS - LOW Pkg.)	METALS - WATER DISSOLVED (ICPMS - LOW Pkg.)	Metals - SOIL (SALM) ☐ Inc. pH ☐	pH ☐ EC ☐ Alk ☑	TSS ☐ TDS ☐	BOD ☐ COD ☐	FECAL COLIFORMS ☑ HPC ☐	TOTAL COLIFORMS ☑ E-COLI ☑	PESTICIDES ☐ HERBICIDES ☐	SOIL VAPOUR	ASBESTOS	NITRATE-N						HOLD
SA-1 (T2 Creek)	☐	☑	☐	☐	6	5-Aug-15	8:00	☐	☐	☐	See below	☐	☐	☐	☐	☐	☐	☐	☑	☑	☐	☑	☐	☐	☑	☑	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐
SA-2 (Millionaire Creek)	☐	☑	☐	☐	6	5-Aug-15	8:45	☐	☐	☐	See below	☐	☐	☐	☐	☐	☐	☐	☑	☑	☐	☑	☐	☐	☑	☑	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐
K-1 (Dunlop Creek)	☐	☑	☐	☐	6	5-Aug-15	9:20	☐	☐	☐	See below	☐	☐	☐	☐	☐	☐	☐	☑	☑	☐	☑	☐	☐	☑	☑	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐
K-2 (Spencer Creek)	☐	☑	☐	☐	6	5-Aug-15	9:50	☐	☐	☐	See below	☐	☐	☐	☐	☐	☐	☐	☑	☑	☐	☑	☐	☐	☑	☑	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐
Field Blank	☐	☐	☐	☐	1	5-Aug-15	9:00	☐	☐	☐		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐
Trip Blank	☐	☐	☐	☐	1	4-Aug-15	16:30	☐	☐	☐		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑
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APPLICABLE REGULATORY LIMITS:
Canadian Drinking Water Quality Guidelines ☐
BC Drinking Water Protection Act/Reg. ☐
BC CSR: AL ☐ RL ☐ CL ☐ IL ☐ AW ☐
CCME ☑ Alberta Tier 1 ☐
OTHER: BC WQ Guidelines for Aquatic Life

SAMPLE RETENTION INSTRUCTIONS (Discarded 30 days after Report unless otherwise specified):
60 Days ☐ 90 Days ☐ Longer Date (Surcharges will apply):

OTHER INSTRUCTIONS:
Total and dissolved metals, mercury, and bacteriological samples have been preserved. Dissolved metals samples (incl. mercury) have also been filtered. Metals analysis should be LOW level ICPMS pkg. Add total + dissolved Hg. Alkalinity = SPECIATED alkalinity. Use higher dilutions for bacteriological tests pls.

PAYMENT
Cheque ☐
Credit ☐
Debit ☐
Cash ☐
Invoice ☐

SAMPLE RECEIPT TEMP (°C): 8.3
Work Order # _____
CUSTODY SEALS INTACT: ☐Y ☐N ☐NA

Required Fields Recommended Fields SHADED AREAS: LAB USE ONLY

CERTIFICATE OF ANALYSIS

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby) 200 - 4185A Still Creek Dr Burnaby, BC V5C 6G9	**TEL** **FAX**	(604) 294-2088 (604) 294-2090
ATTENTION	Patrick Lilley	**WORK ORDER**	5080727
PO NUMBER		**RECEIVED / TEMP**	Aug-11-15 19:00 / 12°C
PROJECT	173.169 Maple Ridge WQ	**REPORTED**	Aug-19-15
PROJECT INFO	Stormwater Monitoring		

General Comments:

CARO Analytical Services employs methods which are conducted according to procedures accepted by appropriate regulatory agencies, and/or are conducted in accordance with recognized professional standards using accepted testing methodologies and quality control efforts, except where otherwise agreed to by the client.

The results in this report apply to the samples analyzed in accordance with the Chain of Custody or Sample Requisition document. This analytical report must be reproduced in its entirety. CARO is not responsible for any loss or damage resulting directly or indirectly from error or omission in the conduct of testing. Liability is limited to the cost of analysis. Samples will be disposed of 30 days after the test report has been issued unless otherwise agreed to in writing.

Authorized By: **Brent Coates, B.Sc.**
Division Manager, Richmond

If you have any questions or concerns, please contact your Account Manager:
Bryan Shaw, Ph.D. (bshaw@caro.ca)

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PROJECT	173.169 Maple Ridge WQ	**REPORTED**	Aug-19-15

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Method Blanks, Duplicates, Spikes, Reference Materials

Analytical Summary Appendix 2
Tabulated data in condensed format to assist with comparisons

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ANALYSIS INFORMATION

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	5080727
PROJECT	173.169 Maple Ridge WQ	**REPORTED**	Aug-19-15

Analysis Description	Method Reference	Technique	Location
Alkalinity in Water (Speciated)	APHA 2320 B*	Titration with H2SO4	Kelowna
Anions in Water by IC	APHA 4110 B	Ion Chromatography with Chemical Suppression of Eluent Conductivity	Kelowna
Dissolved Metals	APHA 3030 B / APHA 3125 B	0.45 µm Filtration / Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	Richmond
E. coli (MPN)	APHA 9221	Multiple-Tube Fermentation	Sublet
Fecal Coliforms (MPN)	APHA 9221	Multiple-Tube Fermentation	Sublet
Hardness (as CaCO3)	APHA 2340 B	Calculation	N/A
Mercury, dissolved by CVAFS	EPA 245.7*	BrCl2 Oxidation / Cold Vapor Atomic Fluorescence Spectrometry (CVAFS)	Richmond
Mercury, total by CVAFS	EPA 245.7*	BrCl2 Oxidation / Cold Vapor Atomic Fluorescence Spectrometry (CVAFS)	Richmond
Total Coliforms (MPN)	APHA 9221	Multiple-Tube Fermentation	Sublet
Total Recoverable Metals	APHA 3030E* / APHA 3125 B	HNO3+HCl Hot Block Digestion / Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	Richmond

Note: An asterisk in the Method Reference indicates that the CARO method has been modified from the reference method

Method Reference Descriptions:

APHA	Standard Methods for the Examination of Water and Wastewater, 22nd Edition, American Public Health Association/American Water Works Association/Water Environment Federation
EPA	United States Environmental Protection Agency Test Methods

Glossary of Terms:

MRL	Method Reporting Limit
<	Less than the Reported Detection Limit (RDL) - the RDL may be higher than the MRL due to various factors such as dilutions, limited sample volume, high moisture, or interferences
mg/L	Milligrams per litre
MPN/100 mL	Most Probable Number per 100 millilitres

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 5080727
REPORTED Aug-19-15

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SA-1 (T2 Creek) (5080727-01) [Water] Sampled: Aug-11-15 13:50							
Anions							
Nitrate as N	**0.485**	N/A	0.010	mg/L	N/A	Aug-13-15	
General Parameters							
Alkalinity, Total as CaCO3	**70**	N/A	1	mg/L	N/A	Aug-13-15	
Alkalinity, Phenolphthalein as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-13-15	
Alkalinity, Bicarbonate as CaCO3	**70**	N/A	1	mg/L	N/A	Aug-13-15	
Alkalinity, Carbonate as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-13-15	
Alkalinity, Hydroxide as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-13-15	
Calculated Parameters							
Hardness, Total (Diss. as CaCO3)	**70.5**	N/A	0.50	mg/L	N/A	N/A	
Hardness, Total (Total as CaCO3)	**78.1**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.011**	N/A	0.005	mg/L	N/A	Aug-14-15	
Antimony, dissolved	**0.0001**	N/A	0.0001	mg/L	N/A	Aug-14-15	
Arsenic, dissolved	**0.0007**	N/A	0.0005	mg/L	N/A	Aug-14-15	
Barium, dissolved	**0.010**	N/A	0.005	mg/L	N/A	Aug-14-15	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-14-15	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-14-15	
Boron, dissolved	**0.026**	N/A	0.004	mg/L	N/A	Aug-14-15	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	Aug-14-15	
Calcium, dissolved	**16.2**	N/A	0.2	mg/L	N/A	Aug-14-15	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Aug-14-15	
Cobalt, dissolved	**0.00007**	N/A	0.00005	mg/L	N/A	Aug-14-15	
Copper, dissolved	**0.0024**	N/A	0.0002	mg/L	N/A	Aug-14-15	
Iron, dissolved	**0.115**	N/A	0.010	mg/L	N/A	Aug-14-15	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-14-15	
Lithium, dissolved	**0.0011**	N/A	0.0001	mg/L	N/A	Aug-14-15	
Magnesium, dissolved	**7.26**	N/A	0.01	mg/L	N/A	Aug-14-15	
Manganese, dissolved	**0.0127**	N/A	0.0002	mg/L	N/A	Aug-14-15	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	Aug-17-15	Aug-17-15	
Molybdenum, dissolved	**0.0020**	N/A	0.0001	mg/L	N/A	Aug-14-15	
Nickel, dissolved	**0.0005**	N/A	0.0002	mg/L	N/A	Aug-14-15	
Phosphorus, dissolved	**0.04**	N/A	0.02	mg/L	N/A	Aug-14-15	
Potassium, dissolved	**3.14**	N/A	0.02	mg/L	N/A	Aug-14-15	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Aug-14-15	
Silicon, dissolved	**8.0**	N/A	0.5	mg/L	N/A	Aug-14-15	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	Aug-14-15	
Sodium, dissolved	**16.2**	N/A	0.02	mg/L	N/A	Aug-14-15	
Strontium, dissolved	**0.093**	N/A	0.001	mg/L	N/A	Aug-14-15	
Sulfur, dissolved	**3**	N/A	1	mg/L	N/A	Aug-14-15	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Aug-14-15	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Aug-14-15	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-14-15	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Aug-14-15	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	Aug-14-15	

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 5080727
REPORTED Aug-19-15

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SA-1 (T2 Creek) (5080727-01) [Water] Sampled: Aug-11-15 13:50, Continued							
Dissolved Metals, Continued							
Uranium, dissolved	**0.00006**	N/A	0.00002	mg/L	N/A	Aug-14-15	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	Aug-14-15	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	Aug-14-15	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-14-15	
Total Recoverable Metals							
Aluminum, total	**0.199**	N/A	0.005	mg/L	Aug-13-15	Aug-14-15	
Antimony, total	**0.0001**	N/A	0.0001	mg/L	Aug-13-15	Aug-14-15	
Arsenic, total	**0.0008**	N/A	0.0005	mg/L	Aug-13-15	Aug-14-15	
Barium, total	**0.011**	N/A	0.005	mg/L	Aug-13-15	Aug-14-15	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	Aug-13-15	Aug-14-15	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	Aug-13-15	Aug-14-15	
Boron, total	**0.029**	N/A	0.004	mg/L	Aug-13-15	Aug-14-15	
Cadmium, total	**0.00002**	N/A	0.00001	mg/L	Aug-13-15	Aug-14-15	
Calcium, total	**17.7**	N/A	0.2	mg/L	Aug-13-15	Aug-14-15	
Chromium, total	**0.0005**	N/A	0.0005	mg/L	Aug-13-15	Aug-14-15	
Cobalt, total	**0.00014**	N/A	0.00005	mg/L	Aug-13-15	Aug-14-15	
Copper, total	**0.0034**	N/A	0.0002	mg/L	Aug-13-15	Aug-14-15	
Iron, total	**0.40**	N/A	0.01	mg/L	Aug-13-15	Aug-14-15	
Lead, total	**0.0002**	N/A	0.0001	mg/L	Aug-13-15	Aug-14-15	
Lithium, total	**0.0010**	N/A	0.0001	mg/L	Aug-13-15	Aug-14-15	
Magnesium, total	**8.24**	N/A	0.01	mg/L	Aug-13-15	Aug-14-15	
Manganese, total	**0.0209**	N/A	0.0002	mg/L	Aug-13-15	Aug-14-15	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	Aug-17-15	Aug-17-15	
Molybdenum, total	**0.0024**	N/A	0.0001	mg/L	Aug-13-15	Aug-14-15	
Nickel, total	**0.0009**	N/A	0.0002	mg/L	Aug-13-15	Aug-14-15	
Phosphorus, total	**0.08**	N/A	0.02	mg/L	Aug-13-15	Aug-14-15	
Potassium, total	**3.44**	N/A	0.02	mg/L	Aug-13-15	Aug-14-15	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	Aug-13-15	Aug-14-15	
Silicon, total	**9.3**	N/A	0.5	mg/L	Aug-13-15	Aug-14-15	
Silver, total	< 0.00005	N/A	0.00005	mg/L	Aug-13-15	Aug-14-15	
Sodium, total	**18.3**	N/A	0.02	mg/L	Aug-13-15	Aug-14-15	
Strontium, total	**0.101**	N/A	0.001	mg/L	Aug-13-15	Aug-14-15	
Sulfur, total	**5**	N/A	1	mg/L	Aug-13-15	Aug-14-15	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	Aug-13-15	Aug-14-15	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	Aug-13-15	Aug-14-15	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	Aug-13-15	Aug-14-15	
Tin, total	< 0.0002	N/A	0.0002	mg/L	Aug-13-15	Aug-14-15	
Titanium, total	**0.009**	N/A	0.005	mg/L	Aug-13-15	Aug-14-15	
Uranium, total	**0.00007**	N/A	0.00002	mg/L	Aug-13-15	Aug-14-15	
Vanadium, total	**0.002**	N/A	0.001	mg/L	Aug-13-15	Aug-14-15	
Zinc, total	**0.007**	N/A	0.004	mg/L	Aug-13-15	Aug-14-15	
Zirconium, total	**0.0001**	N/A	0.0001	mg/L	Aug-13-15	Aug-14-15	
Microbiological Parameters							
Coliforms, Total	**7000**	N/A	2	MPN/100 mL		Aug-12-15	

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 5080727
REPORTED Aug-19-15

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SA-1 (T2 Creek) (5080727-01) [Water] Sampled: Aug-11-15 13:50, Continued							
Microbiological Parameters, Continued							
Coliforms, Fecal	**900**	N/A	2	MPN/100 mL		Aug-12-15	
E. coli (MPN)	**900**	N/A	2	MPN/100 mL		Aug-12-15	
Sample ID: SA-2 (Millionaire Creek) (5080727-02) [Water] Sampled: Aug-11-15 14:30							
Anions							
Nitrate as N	**0.360**	N/A	0.010	mg/L	N/A	Aug-13-15	
General Parameters							
Alkalinity, Total as CaCO3	**28**	N/A	1	mg/L	N/A	Aug-13-15	
Alkalinity, Phenolphthalein as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-13-15	
Alkalinity, Bicarbonate as CaCO3	**28**	N/A	1	mg/L	N/A	Aug-13-15	
Alkalinity, Carbonate as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-13-15	
Alkalinity, Hydroxide as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-13-15	
Calculated Parameters							
Hardness, Total (Diss. as CaCO3)	**24.1**	N/A	0.50	mg/L	N/A	N/A	
Hardness, Total (Total as CaCO3)	**25.7**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.012**	N/A	0.005	mg/L	N/A	Aug-14-15	
Antimony, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-14-15	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Aug-14-15	
Barium, dissolved	**0.007**	N/A	0.005	mg/L	N/A	Aug-14-15	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-14-15	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-14-15	
Boron, dissolved	**0.009**	N/A	0.004	mg/L	N/A	Aug-14-15	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	Aug-14-15	
Calcium, dissolved	**7.2**	N/A	0.2	mg/L	N/A	Aug-14-15	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Aug-14-15	
Cobalt, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	Aug-14-15	
Copper, dissolved	**0.0009**	N/A	0.0002	mg/L	N/A	Aug-14-15	
Iron, dissolved	**0.019**	N/A	0.010	mg/L	N/A	Aug-14-15	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-14-15	
Lithium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-14-15	
Magnesium, dissolved	**1.47**	N/A	0.01	mg/L	N/A	Aug-14-15	
Manganese, dissolved	**0.0016**	N/A	0.0002	mg/L	N/A	Aug-14-15	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	Aug-17-15	Aug-17-15	
Molybdenum, dissolved	**0.0008**	N/A	0.0001	mg/L	N/A	Aug-14-15	
Nickel, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Aug-14-15	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	Aug-14-15	
Potassium, dissolved	**0.67**	N/A	0.02	mg/L	N/A	Aug-14-15	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Aug-14-15	
Silicon, dissolved	**6.2**	N/A	0.5	mg/L	N/A	Aug-14-15	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	Aug-14-15	
Sodium, dissolved	**5.12**	N/A	0.02	mg/L	N/A	Aug-14-15	
Strontium, dissolved	**0.044**	N/A	0.001	mg/L	N/A	Aug-14-15	

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 5080727
REPORTED Aug-19-15

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SA-2 (Millionaire Creek) (5080727-02) [Water] Sampled: Aug-11-15 14:30, Continued							
Dissolved Metals, Continued							
Sulfur, dissolved	< 1	N/A	1	mg/L	N/A	Aug-14-15	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Aug-14-15	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Aug-14-15	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-14-15	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Aug-14-15	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	Aug-14-15	
Uranium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Aug-14-15	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	Aug-14-15	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	Aug-14-15	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-14-15	
Total Recoverable Metals							
Aluminum, total	**0.023**	N/A	0.005	mg/L	Aug-13-15	Aug-14-15	
Antimony, total	< 0.0001	N/A	0.0001	mg/L	Aug-13-15	Aug-14-15	
Arsenic, total	< 0.0005	N/A	0.0005	mg/L	Aug-13-15	Aug-14-15	
Barium, total	**0.007**	N/A	0.005	mg/L	Aug-13-15	Aug-14-15	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	Aug-13-15	Aug-14-15	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	Aug-13-15	Aug-14-15	
Boron, total	**0.009**	N/A	0.004	mg/L	Aug-13-15	Aug-14-15	
Cadmium, total	< 0.00001	N/A	0.00001	mg/L	Aug-13-15	Aug-14-15	
Calcium, total	**7.6**	N/A	0.2	mg/L	Aug-13-15	Aug-14-15	
Chromium, total	< 0.0005	N/A	0.0005	mg/L	Aug-13-15	Aug-14-15	
Cobalt, total	< 0.00005	N/A	0.00005	mg/L	Aug-13-15	Aug-14-15	
Copper, total	**0.0009**	N/A	0.0002	mg/L	Aug-13-15	Aug-14-15	
Iron, total	**0.03**	N/A	0.01	mg/L	Aug-13-15	Aug-14-15	
Lead, total	< 0.0001	N/A	0.0001	mg/L	Aug-13-15	Aug-14-15	
Lithium, total	< 0.0001	N/A	0.0001	mg/L	Aug-13-15	Aug-14-15	
Magnesium, total	**1.62**	N/A	0.01	mg/L	Aug-13-15	Aug-14-15	
Manganese, total	**0.0025**	N/A	0.0002	mg/L	Aug-13-15	Aug-14-15	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	Aug-17-15	Aug-17-15	
Molybdenum, total	**0.0007**	N/A	0.0001	mg/L	Aug-13-15	Aug-14-15	
Nickel, total	< 0.0002	N/A	0.0002	mg/L	Aug-13-15	Aug-14-15	
Phosphorus, total	< 0.02	N/A	0.02	mg/L	Aug-13-15	Aug-14-15	
Potassium, total	**0.71**	N/A	0.02	mg/L	Aug-13-15	Aug-14-15	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	Aug-13-15	Aug-14-15	
Silicon, total	**6.7**	N/A	0.5	mg/L	Aug-13-15	Aug-14-15	
Silver, total	< 0.00005	N/A	0.00005	mg/L	Aug-13-15	Aug-14-15	
Sodium, total	**5.61**	N/A	0.02	mg/L	Aug-13-15	Aug-14-15	
Strontium, total	**0.047**	N/A	0.001	mg/L	Aug-13-15	Aug-14-15	
Sulfur, total	< 1	N/A	1	mg/L	Aug-13-15	Aug-14-15	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	Aug-13-15	Aug-14-15	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	Aug-13-15	Aug-14-15	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	Aug-13-15	Aug-14-15	
Tin, total	< 0.0002	N/A	0.0002	mg/L	Aug-13-15	Aug-14-15	
Titanium, total	< 0.005	N/A	0.005	mg/L	Aug-13-15	Aug-14-15	
Uranium, total	< 0.00002	N/A	0.00002	mg/L	Aug-13-15	Aug-14-15	

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 5080727
REPORTED Aug-19-15

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SA-2 (Millionaire Creek) (5080727-02) [Water] Sampled: Aug-11-15 14:30, Continued							
Total Recoverable Metals, Continued							
Vanadium, total	**0.001**	N/A	0.001	mg/L	Aug-13-15	Aug-14-15	
Zinc, total	< 0.004	N/A	0.004	mg/L	Aug-13-15	Aug-14-15	
Zirconium, total	< 0.0001	N/A	0.0001	mg/L	Aug-13-15	Aug-14-15	
Microbiological Parameters							
Coliforms, Total	**2400**	N/A	2	MPN/100 mL		Aug-12-15	
Coliforms, Fecal	**23**	N/A	2	MPN/100 mL		Aug-12-15	
E. coli (MPN)	**23**	N/A	2	MPN/100 mL		Aug-12-15	
Sample ID: K-1 (Dunlop Creek) (5080727-03) [Water] Sampled: Aug-11-15 15:00							
Anions							
Nitrate as N	**0.031**	N/A	0.010	mg/L	N/A	Aug-13-15	
General Parameters							
Alkalinity, Total as CaCO3	**76**	N/A	1	mg/L	N/A	Aug-13-15	
Alkalinity, Phenolphthalein as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-13-15	
Alkalinity, Bicarbonate as CaCO3	**76**	N/A	1	mg/L	N/A	Aug-13-15	
Alkalinity, Carbonate as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-13-15	
Alkalinity, Hydroxide as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-13-15	
Calculated Parameters							
Hardness, Total (Diss. as CaCO3)	**64.2**	N/A	0.50	mg/L	N/A	N/A	
Hardness, Total (Total as CaCO3)	**70.8**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.014**	N/A	0.005	mg/L	N/A	Aug-14-15	
Antimony, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-14-15	
Arsenic, dissolved	**0.0010**	N/A	0.0005	mg/L	N/A	Aug-14-15	
Barium, dissolved	**0.011**	N/A	0.005	mg/L	N/A	Aug-14-15	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-14-15	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-14-15	
Boron, dissolved	**0.034**	N/A	0.004	mg/L	N/A	Aug-14-15	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	Aug-14-15	
Calcium, dissolved	**16.4**	N/A	0.2	mg/L	N/A	Aug-14-15	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Aug-14-15	
Cobalt, dissolved	**0.00034**	N/A	0.00005	mg/L	N/A	Aug-14-15	
Copper, dissolved	**0.0011**	N/A	0.0002	mg/L	N/A	Aug-14-15	
Iron, dissolved	**0.635**	N/A	0.010	mg/L	N/A	Aug-14-15	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-14-15	
Lithium, dissolved	**0.0001**	N/A	0.0001	mg/L	N/A	Aug-14-15	
Magnesium, dissolved	**5.67**	N/A	0.01	mg/L	N/A	Aug-14-15	
Manganese, dissolved	**0.144**	N/A	0.0002	mg/L	N/A	Aug-14-15	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	Aug-17-15	Aug-17-15	
Molybdenum, dissolved	**0.0007**	N/A	0.0001	mg/L	N/A	Aug-14-15	
Nickel, dissolved	**0.0005**	N/A	0.0002	mg/L	N/A	Aug-14-15	
Phosphorus, dissolved	**0.03**	N/A	0.02	mg/L	N/A	Aug-14-15	

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 5080727
REPORTED Aug-19-15

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: K-1 (Dunlop Creek) (5080727-03) [Water] Sampled: Aug-11-15 15:00, Continued							
Dissolved Metals, Continued							
Potassium, dissolved	**3.48**	N/A	0.02	mg/L	N/A	Aug-14-15	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Aug-14-15	
Silicon, dissolved	**4.5**	N/A	0.5	mg/L	N/A	Aug-14-15	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	Aug-14-15	
Sodium, dissolved	**13.1**	N/A	0.02	mg/L	N/A	Aug-14-15	
Strontium, dissolved	**0.112**	N/A	0.001	mg/L	N/A	Aug-14-15	
Sulfur, dissolved	**3**	N/A	1	mg/L	N/A	Aug-14-15	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Aug-14-15	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Aug-14-15	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-14-15	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Aug-14-15	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	Aug-14-15	
Uranium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Aug-14-15	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	Aug-14-15	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	Aug-14-15	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-14-15	
Total Recoverable Metals							
Aluminum, total	**0.108**	N/A	0.005	mg/L	Aug-13-15	Aug-14-15	
Antimony, total	< 0.0001	N/A	0.0001	mg/L	Aug-13-15	Aug-14-15	
Arsenic, total	**0.0012**	N/A	0.0005	mg/L	Aug-13-15	Aug-14-15	
Barium, total	**0.012**	N/A	0.005	mg/L	Aug-13-15	Aug-14-15	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	Aug-13-15	Aug-14-15	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	Aug-13-15	Aug-14-15	
Boron, total	**0.038**	N/A	0.004	mg/L	Aug-13-15	Aug-14-15	
Cadmium, total	**0.00001**	N/A	0.00001	mg/L	Aug-13-15	Aug-14-15	
Calcium, total	**17.8**	N/A	0.2	mg/L	Aug-13-15	Aug-14-15	
Chromium, total	< 0.0005	N/A	0.0005	mg/L	Aug-13-15	Aug-14-15	
Cobalt, total	**0.00045**	N/A	0.00005	mg/L	Aug-13-15	Aug-14-15	
Copper, total	**0.0015**	N/A	0.0002	mg/L	Aug-13-15	Aug-14-15	
Iron, total	**1.12**	N/A	0.01	mg/L	Aug-13-15	Aug-14-15	
Lead, total	< 0.0001	N/A	0.0001	mg/L	Aug-13-15	Aug-14-15	
Lithium, total	**0.0001**	N/A	0.0001	mg/L	Aug-13-15	Aug-14-15	
Magnesium, total	**6.40**	N/A	0.01	mg/L	Aug-13-15	Aug-14-15	
Manganese, total	**0.202**	N/A	0.0002	mg/L	Aug-13-15	Aug-14-15	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	Aug-17-15	Aug-17-15	
Molybdenum, total	**0.0007**	N/A	0.0001	mg/L	Aug-13-15	Aug-14-15	
Nickel, total	**0.0009**	N/A	0.0002	mg/L	Aug-13-15	Aug-14-15	
Phosphorus, total	**0.06**	N/A	0.02	mg/L	Aug-13-15	Aug-14-15	
Potassium, total	**3.67**	N/A	0.02	mg/L	Aug-13-15	Aug-14-15	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	Aug-13-15	Aug-14-15	
Silicon, total	**5.0**	N/A	0.5	mg/L	Aug-13-15	Aug-14-15	
Silver, total	< 0.00005	N/A	0.00005	mg/L	Aug-13-15	Aug-14-15	
Sodium, total	**14.6**	N/A	0.02	mg/L	Aug-13-15	Aug-14-15	
Strontium, total	**0.118**	N/A	0.001	mg/L	Aug-13-15	Aug-14-15	
Sulfur, total	**3**	N/A	1	mg/L	Aug-13-15	Aug-14-15	

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	5080727
PROJECT	173.169 Maple Ridge WQ	**REPORTED**	Aug-19-15

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: K-1 (Dunlop Creek) (5080727-03) [Water] Sampled: Aug-11-15 15:00, Continued							
Total Recoverable Metals, Continued							
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	Aug-13-15	Aug-14-15	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	Aug-13-15	Aug-14-15	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	Aug-13-15	Aug-14-15	
Tin, total	**0.0002**	N/A	0.0002	mg/L	Aug-13-15	Aug-14-15	
Titanium, total	< 0.005	N/A	0.005	mg/L	Aug-13-15	Aug-14-15	
Uranium, total	< 0.00002	N/A	0.00002	mg/L	Aug-13-15	Aug-14-15	
Vanadium, total	**0.002**	N/A	0.001	mg/L	Aug-13-15	Aug-14-15	
Zinc, total	< 0.004	N/A	0.004	mg/L	Aug-13-15	Aug-14-15	
Zirconium, total	< 0.0001	N/A	0.0001	mg/L	Aug-13-15	Aug-14-15	
Microbiological Parameters							
Coliforms, Total	**2400**	N/A	2	MPN/100 mL		Aug-12-15	
Coliforms, Fecal	**130**	N/A	2	MPN/100 mL		Aug-12-15	
E. coli (MPN)	**130**	N/A	2	MPN/100 mL		Aug-12-15	
Sample ID: K-2 (Spencer Creek) (5080727-04) [Water] Sampled: Aug-11-15 15:25							
Anions							
Nitrate as N	**0.100**	N/A	0.010	mg/L	N/A	Aug-13-15	
General Parameters							
Alkalinity, Total as CaCO3	**108**	N/A	1	mg/L	N/A	Aug-13-15	
Alkalinity, Phenolphthalein as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-13-15	
Alkalinity, Bicarbonate as CaCO3	**108**	N/A	1	mg/L	N/A	Aug-13-15	
Alkalinity, Carbonate as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-13-15	
Alkalinity, Hydroxide as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-13-15	
Calculated Parameters							
Hardness, Total (Diss. as CaCO3)	**105**	N/A	0.50	mg/L	N/A	N/A	
Hardness, Total (Total as CaCO3)	**113**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.008**	N/A	0.005	mg/L	N/A	Aug-14-15	
Antimony, dissolved	**0.0002**	N/A	0.0001	mg/L	N/A	Aug-14-15	
Arsenic, dissolved	**0.0013**	N/A	0.0005	mg/L	N/A	Aug-14-15	
Barium, dissolved	**0.009**	N/A	0.005	mg/L	N/A	Aug-14-15	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-14-15	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-14-15	
Boron, dissolved	**0.023**	N/A	0.004	mg/L	N/A	Aug-14-15	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	Aug-14-15	
Calcium, dissolved	**28.2**	N/A	0.2	mg/L	N/A	Aug-14-15	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Aug-14-15	
Cobalt, dissolved	**0.00011**	N/A	0.00005	mg/L	N/A	Aug-14-15	
Copper, dissolved	**0.0012**	N/A	0.0002	mg/L	N/A	Aug-14-15	
Iron, dissolved	**0.068**	N/A	0.010	mg/L	N/A	Aug-14-15	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-14-15	
Lithium, dissolved	**0.0003**	N/A	0.0001	mg/L	N/A	Aug-14-15	

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 5080727
REPORTED Aug-19-15

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: K-2 (Spencer Creek) (5080727-04) [Water] Sampled: Aug-11-15 15:25, Continued							
Dissolved Metals, Continued							
Magnesium, dissolved	**8.35**	N/A	0.01	mg/L	N/A	Aug-14-15	
Manganese, dissolved	**0.0526**	N/A	0.0002	mg/L	N/A	Aug-14-15	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	Aug-17-15	Aug-17-15	
Molybdenum, dissolved	**0.0011**	N/A	0.0001	mg/L	N/A	Aug-14-15	
Nickel, dissolved	**0.0007**	N/A	0.0002	mg/L	N/A	Aug-14-15	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	Aug-14-15	
Potassium, dissolved	**2.66**	N/A	0.02	mg/L	N/A	Aug-14-15	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Aug-14-15	
Silicon, dissolved	**7.1**	N/A	0.5	mg/L	N/A	Aug-14-15	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	Aug-14-15	
Sodium, dissolved	**12.5**	N/A	0.02	mg/L	N/A	Aug-14-15	
Strontium, dissolved	**0.182**	N/A	0.001	mg/L	N/A	Aug-14-15	
Sulfur, dissolved	**4**	N/A	1	mg/L	N/A	Aug-14-15	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Aug-14-15	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Aug-14-15	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-14-15	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Aug-14-15	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	Aug-14-15	
Uranium, dissolved	**0.00006**	N/A	0.00002	mg/L	N/A	Aug-14-15	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	Aug-14-15	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	Aug-14-15	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-14-15	
Total Recoverable Metals							
Aluminum, total	**0.415**	N/A	0.005	mg/L	Aug-13-15	Aug-14-15	
Antimony, total	< 0.0001	N/A	0.0001	mg/L	Aug-13-15	Aug-14-15	
Arsenic, total	**0.0016**	N/A	0.0005	mg/L	Aug-13-15	Aug-14-15	
Barium, total	**0.010**	N/A	0.005	mg/L	Aug-13-15	Aug-14-15	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	Aug-13-15	Aug-14-15	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	Aug-13-15	Aug-14-15	
Boron, total	**0.027**	N/A	0.004	mg/L	Aug-13-15	Aug-14-15	
Cadmium, total	< 0.00001	N/A	0.00001	mg/L	Aug-13-15	Aug-14-15	
Calcium, total	**29.7**	N/A	0.2	mg/L	Aug-13-15	Aug-14-15	
Chromium, total	**0.0006**	N/A	0.0005	mg/L	Aug-13-15	Aug-14-15	
Cobalt, total	**0.00028**	N/A	0.00005	mg/L	Aug-13-15	Aug-14-15	
Copper, total	**0.0017**	N/A	0.0002	mg/L	Aug-13-15	Aug-14-15	
Iron, total	**0.66**	N/A	0.01	mg/L	Aug-13-15	Aug-14-15	
Lead, total	**0.0001**	N/A	0.0001	mg/L	Aug-13-15	Aug-14-15	
Lithium, total	**0.0004**	N/A	0.0001	mg/L	Aug-13-15	Aug-14-15	
Magnesium, total	**9.34**	N/A	0.01	mg/L	Aug-13-15	Aug-14-15	
Manganese, total	**0.0787**	N/A	0.0002	mg/L	Aug-13-15	Aug-14-15	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	Aug-17-15	Aug-17-15	
Molybdenum, total	**0.0011**	N/A	0.0001	mg/L	Aug-13-15	Aug-14-15	
Nickel, total	**0.0011**	N/A	0.0002	mg/L	Aug-13-15	Aug-14-15	
Phosphorus, total	**0.05**	N/A	0.02	mg/L	Aug-13-15	Aug-14-15	
Potassium, total	**2.80**	N/A	0.02	mg/L	Aug-13-15	Aug-14-15	

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 5080727
REPORTED Aug-19-15

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: K-2 (Spencer Creek) (5080727-04) [Water] Sampled: Aug-11-15 15:25, Continued							
Total Recoverable Metals, Continued							
Selenium, total	< 0.0005	N/A	0.0005	mg/L	Aug-13-15	Aug-14-15	
Silicon, total	**8.3**	N/A	0.5	mg/L	Aug-13-15	Aug-14-15	
Silver, total	< 0.00005	N/A	0.00005	mg/L	Aug-13-15	Aug-14-15	
Sodium, total	**13.8**	N/A	0.02	mg/L	Aug-13-15	Aug-14-15	
Strontium, total	**0.190**	N/A	0.001	mg/L	Aug-13-15	Aug-14-15	
Sulfur, total	**4**	N/A	1	mg/L	Aug-13-15	Aug-14-15	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	Aug-13-15	Aug-14-15	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	Aug-13-15	Aug-14-15	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	Aug-13-15	Aug-14-15	
Tin, total	< 0.0002	N/A	0.0002	mg/L	Aug-13-15	Aug-14-15	
Titanium, total	**0.015**	N/A	0.005	mg/L	Aug-13-15	Aug-14-15	
Uranium, total	**0.00006**	N/A	0.00002	mg/L	Aug-13-15	Aug-14-15	
Vanadium, total	**0.003**	N/A	0.001	mg/L	Aug-13-15	Aug-14-15	
Zinc, total	< 0.004	N/A	0.004	mg/L	Aug-13-15	Aug-14-15	
Zirconium, total	**0.0001**	N/A	0.0001	mg/L	Aug-13-15	Aug-14-15	
Microbiological Parameters							
Coliforms, Total	**1600**	N/A	2	MPN/100 mL		Aug-12-15	
Coliforms, Fecal	**130**	N/A	2	MPN/100 mL		Aug-12-15	
E. coli (MPN)	**130**	N/A	2	MPN/100 mL		Aug-12-15	
Sample ID: Field Blank (5080727-05) [Water] Sampled: Aug-11-15 15:40							
Microbiological Parameters							
Coliforms, Fecal	**ND**	N/A	2	MPN/100 mL		Aug-12-15	

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The following section displays the quality control (QC) data that is associated with your sample data. Groups of samples are prepared in "batches" and analyzed in conjunction with QC samples that ensure your data is of the highest quality. Common QC types include:

- **Method Blank (Blk)**: Laboratory reagent water is carried through sample preparation and analysis steps. Method Blanks indicate that results are free from contamination, i.e. not biased high from sources such as the sample container or the laboratory environment
- **Duplicate (Dup)**: Preparation and analysis of a replicate aliquot of a sample. Duplicates provide a measure of the analytical method's precision, i.e. how reproducible a result is. Duplicates are only reported if they are associated with your sample data.
- **Blank Spike (BS)**: A known amount of standard is carried through sample preparation and analysis steps. Blank Spikes, also known as laboratory control samples (LCS), are prepared from a different source of standard than used for the calibration. They ensure that the calibration is acceptable (i.e. not biased high or low) and also provide a measure of the analytical method's accuracy (i.e. closeness of the result to a target value).
- **Standard Reference Material (SRM)**: A material of similar matrix to the samples, externally certified for the parameter(s) listed. Standard Reference Materials ensure that the preparation steps in the method are adequate to achieve acceptable recoveries of the parameter(s) tested.

Each QC type is analyzed at a 5-10% frequency, i.e. one blank/duplicate/spike for every 10 samples. For all types of QC, the specified recovery (% Rec) and relative percent difference (RPD) limits are derived from long-term method performance averages and/or prescribed by the reference method.

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Anions, Batch B5H0635										
Blank (B5H0635-BLK1)				Prepared: Aug-13-15, Analyzed: Aug-13-15						
Nitrate as N	< 0.010	0.010	mg/L							
Blank (B5H0635-BLK2)				Prepared: Aug-13-15, Analyzed: Aug-13-15						
Nitrate as N	< 0.010	0.010	mg/L							
LCS (B5H0635-BS1)				Prepared: Aug-13-15, Analyzed: Aug-13-15						
Nitrate as N	3.97	0.010	mg/L	4.00		99	85-115			
LCS (B5H0635-BS2)				Prepared: Aug-13-15, Analyzed: Aug-13-15						
Nitrate as N	3.98	0.010	mg/L	4.00		99	85-115			
Duplicate (B5H0635-DUP1)		**Source: 5080727-01**		Prepared: Aug-13-15, Analyzed: Aug-13-15						
Nitrate as N	0.450	0.010	mg/L		0.485			7	10	
Matrix Spike (B5H0635-MS1)		**Source: 5080727-01**		Prepared: Aug-13-15, Analyzed: Aug-13-15						
Nitrate as N	4.50	0.010	mg/L	4.00	0.485	100	75-125			
Dissolved Metals, Batch B5H0596										
Blank (B5H0596-BLK1)				Prepared: Aug-14-15, Analyzed: Aug-14-15						
Aluminum, dissolved	< 0.005	0.005	mg/L							
Antimony, dissolved	< 0.0001	0.0001	mg/L							
Arsenic, dissolved	< 0.0005	0.0005	mg/L							
Barium, dissolved	< 0.005	0.005	mg/L							
Beryllium, dissolved	< 0.0001	0.0001	mg/L							
Bismuth, dissolved	< 0.0001	0.0001	mg/L							
Boron, dissolved	< 0.004	0.004	mg/L							
Cadmium, dissolved	< 0.00001	0.00001	mg/L							
Calcium, dissolved	< 0.2	0.2	mg/L							
Chromium, dissolved	< 0.0005	0.0005	mg/L							
Cobalt, dissolved	< 0.00005	0.00005	mg/L							
Copper, dissolved	< 0.0002	0.0002	mg/L							

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Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Dissolved Metals, Batch B5H0596, Continued										
Blank (B5H0596-BLK1), Continued				Prepared: Aug-14-15, Analyzed: Aug-14-15						
Iron, dissolved	< 0.010	0.010	mg/L							
Lead, dissolved	< 0.0001	0.0001	mg/L							
Lithium, dissolved	< 0.0001	0.0001	mg/L							
Magnesium, dissolved	< 0.01	0.01	mg/L							
Manganese, dissolved	< 0.0002	0.0002	mg/L							
Molybdenum, dissolved	< 0.0001	0.0001	mg/L							
Nickel, dissolved	< 0.0002	0.0002	mg/L							
Phosphorus, dissolved	< 0.02	0.02	mg/L							
Potassium, dissolved	< 0.02	0.02	mg/L							
Selenium, dissolved	< 0.0005	0.0005	mg/L							
Silicon, dissolved	< 0.5	0.5	mg/L							
Silver, dissolved	< 0.00005	0.00005	mg/L							
Sodium, dissolved	< 0.02	0.02	mg/L							
Strontium, dissolved	< 0.001	0.001	mg/L							
Sulfur, dissolved	< 1	1	mg/L							
Tellurium, dissolved	< 0.0002	0.0002	mg/L							
Thallium, dissolved	< 0.00002	0.00002	mg/L							
Thorium, dissolved	< 0.0001	0.0001	mg/L							
Tin, dissolved	< 0.0002	0.0002	mg/L							
Titanium, dissolved	< 0.005	0.005	mg/L							
Uranium, dissolved	< 0.00002	0.00002	mg/L							
Vanadium, dissolved	< 0.001	0.001	mg/L							
Zinc, dissolved	< 0.004	0.004	mg/L							
Zirconium, dissolved	< 0.0001	0.0001	mg/L							
Matrix Spike (B5H0596-MS1)		**Source: 5080727-01**		Prepared: Aug-14-15, Analyzed: Aug-14-15						
Antimony, dissolved	0.364	0.0001	mg/L	0.400	0.0001	91	76-114			
Arsenic, dissolved	0.193	0.0005	mg/L	0.200	0.0007	96	81-115			
Barium, dissolved	0.925	0.005	mg/L	1.00	0.010	91	80-113			
Beryllium, dissolved	0.0923	0.0001	mg/L	0.100	< 0.0001	92	69-109			
Cadmium, dissolved	0.0960	0.00001	mg/L	0.100	< 0.00001	96	83-110			
Chromium, dissolved	0.388	0.0005	mg/L	0.400	< 0.0005	97	85-115			
Cobalt, dissolved	0.397	0.00005	mg/L	0.400	0.00007	99	86-114			
Copper, dissolved	0.413	0.0002	mg/L	0.400	0.0024	103	82-119			
Iron, dissolved	2.11	0.010	mg/L	2.00	0.115	100	80-116			
Lead, dissolved	0.203	0.0001	mg/L	0.200	< 0.0001	101	83-112			
Manganese, dissolved	0.391	0.0002	mg/L	0.400	0.0127	95	62-131			
Nickel, dissolved	0.387	0.0002	mg/L	0.400	0.0005	97	81-115			
Selenium, dissolved	0.101	0.0005	mg/L	0.100	< 0.0005	101	79-115			
Silver, dissolved	0.0986	0.00005	mg/L	0.100	< 0.00005	99	69-121			
Thallium, dissolved	0.103	0.00002	mg/L	0.100	< 0.00002	103	84-115			
Vanadium, dissolved	0.376	0.001	mg/L	0.400	0.001	94	83-113			
Zinc, dissolved	0.969	0.004	mg/L	1.00	< 0.004	97	82-115			
Reference (B5H0596-SRM1)				Prepared: Aug-14-15, Analyzed: Aug-14-15						
Aluminum, dissolved	0.234	0.005	mg/L	0.233		100	58-142			
Antimony, dissolved	0.0461	0.0001	mg/L	0.0430		107	75-125			
Arsenic, dissolved	0.448	0.0005	mg/L	0.438		102	81-119			
Barium, dissolved	3.28	0.005	mg/L	3.35		98	83-117			
Beryllium, dissolved	0.214	0.0001	mg/L	0.213		101	80-120			
Boron, dissolved	1.79	0.004	mg/L	1.74		103	74-117			
Cadmium, dissolved	0.226	0.00001	mg/L	0.224		101	83-117			
Calcium, dissolved	8.3	0.2	mg/L	7.69		108	76-124			
Chromium, dissolved	0.453	0.0005	mg/L	0.437		104	81-119			
Cobalt, dissolved	0.137	0.00005	mg/L	0.128		107	76-124			
Copper, dissolved	0.917	0.0002	mg/L	0.844		109	84-116			
Iron, dissolved	1.34	0.010	mg/L	1.29		104	74-126			

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Dissolved Metals, Batch B5H0596, Continued										
Reference (B5H0596-SRM1), Continued				Prepared: Aug-14-15, Analyzed: Aug-14-15						
Lead, dissolved	0.119	0.0001	mg/L	0.112		106	72-128			
Lithium, dissolved	0.111	0.0001	mg/L	0.104		107	60-140			
Magnesium, dissolved	7.14	0.01	mg/L	6.92		103	81-119			
Manganese, dissolved	0.350	0.0002	mg/L	0.345		101	84-116			
Molybdenum, dissolved	0.451	0.0001	mg/L	0.426		106	83-117			
Nickel, dissolved	0.902	0.0002	mg/L	0.840		107	74-126			
Phosphorus, dissolved	0.48	0.02	mg/L	0.495		97	68-132			
Potassium, dissolved	3.28	0.02	mg/L	3.19		103	74-126			
Selenium, dissolved	0.0359	0.0005	mg/L	0.0331		109	70-130			
Sodium, dissolved	19.4	0.02	mg/L	19.1		102	72-128			
Strontium, dissolved	0.885	0.001	mg/L	0.916		97	84-113			
Thallium, dissolved	0.0407	0.00002	mg/L	0.0393		103	57-143			
Uranium, dissolved	0.269	0.00002	mg/L	0.266		101	85-115			
Vanadium, dissolved	0.883	0.001	mg/L	0.869		102	87-113			
Zinc, dissolved	0.897	0.004	mg/L	0.881		102	72-128			
Dissolved Metals, Batch B5H0786										
Blank (B5H0786-BLK1)				Prepared: Aug-17-15, Analyzed: Aug-17-15						
Mercury, dissolved	< 0.00002	0.00002	mg/L							
Duplicate (B5H0786-DUP1)			**Source: 5080727-02**	Prepared: Aug-17-15, Analyzed: Aug-17-15						
Mercury, dissolved	< 0.00002	0.00002	mg/L		< 0.00002				20	
Matrix Spike (B5H0786-MS1)			**Source: 5080727-03**	Prepared: Aug-17-15, Analyzed: Aug-17-15						
Mercury, dissolved	0.00022	0.00002	mg/L	0.000250	< 0.00002	87	70-130			
Reference (B5H0786-SRM1)				Prepared: Aug-17-15, Analyzed: Aug-17-15						
Mercury, dissolved	0.00319	0.00002	mg/L	0.00456		70	50-150			
General Parameters, Batch B5H0656										
Blank (B5H0656-BLK1)				Prepared: Aug-13-15, Analyzed: Aug-13-15						
Alkalinity, Total as CaCO3	< 1	1	mg/L							BLK
Alkalinity, Phenolphthalein as CaCO3	< 1	1	mg/L							
Alkalinity, Bicarbonate as CaCO3	< 1	1	mg/L							BLK
Alkalinity, Carbonate as CaCO3	< 1	1	mg/L							
Alkalinity, Hydroxide as CaCO3	< 1	1	mg/L							
Blank (B5H0656-BLK2)				Prepared: Aug-13-15, Analyzed: Aug-13-15						
Alkalinity, Total as CaCO3	< 1	1	mg/L							BLK
Alkalinity, Phenolphthalein as CaCO3	< 1	1	mg/L							
Alkalinity, Bicarbonate as CaCO3	< 1	1	mg/L							BLK
Alkalinity, Carbonate as CaCO3	< 1	1	mg/L							
Alkalinity, Hydroxide as CaCO3	< 1	1	mg/L							
LCS (B5H0656-BS1)				Prepared: Aug-13-15, Analyzed: Aug-13-15						
Alkalinity, Total as CaCO3	102	1	mg/L	100		102	96-108			
LCS (B5H0656-BS2)				Prepared: Aug-13-15, Analyzed: Aug-13-15						
Alkalinity, Total as CaCO3	102	1	mg/L	100		102	96-108			
Total Recoverable Metals, Batch B5H0605										
Blank (B5H0605-BLK1)				Prepared: Aug-13-15, Analyzed: Aug-14-15						
Aluminum, total	< 0.005	0.005	mg/L							

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Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Total Recoverable Metals, Batch B5H0605, Continued										
Blank (B5H0605-BLK1), Continued				Prepared: Aug-13-15, Analyzed: Aug-14-15						
Antimony, total	< 0.0001	0.0001	mg/L							
Arsenic, total	< 0.0005	0.0005	mg/L							
Barium, total	< 0.005	0.005	mg/L							
Beryllium, total	< 0.0001	0.0001	mg/L							
Bismuth, total	< 0.0001	0.0001	mg/L							
Boron, total	< 0.004	0.004	mg/L							
Cadmium, total	< 0.00001	0.00001	mg/L							
Calcium, total	< 0.2	0.2	mg/L							
Chromium, total	< 0.0005	0.0005	mg/L							
Cobalt, total	< 0.00005	0.00005	mg/L							
Copper, total	< 0.0002	0.0002	mg/L							
Iron, total	< 0.01	0.01	mg/L							
Lead, total	< 0.0001	0.0001	mg/L							
Lithium, total	< 0.0001	0.0001	mg/L							
Magnesium, total	< 0.01	0.01	mg/L							
Manganese, total	< 0.0002	0.0002	mg/L							
Molybdenum, total	< 0.0001	0.0001	mg/L							
Nickel, total	< 0.0002	0.0002	mg/L							
Phosphorus, total	< 0.02	0.02	mg/L							
Potassium, total	< 0.02	0.02	mg/L							
Selenium, total	< 0.0005	0.0005	mg/L							
Silicon, total	< 0.5	0.5	mg/L							
Silver, total	< 0.00005	0.00005	mg/L							
Sodium, total	< 0.02	0.02	mg/L							
Strontium, total	< 0.001	0.001	mg/L							
Sulfur, total	< 1	1	mg/L							
Tellurium, total	< 0.0002	0.0002	mg/L							
Thallium, total	< 0.00002	0.00002	mg/L							
Thorium, total	< 0.0001	0.0001	mg/L							
Tin, total	< 0.0002	0.0002	mg/L							
Titanium, total	< 0.005	0.005	mg/L							
Uranium, total	< 0.00002	0.00002	mg/L							
Vanadium, total	< 0.001	0.001	mg/L							
Zinc, total	< 0.004	0.004	mg/L							
Zirconium, total	< 0.0001	0.0001	mg/L							
Reference (B5H0605-SRM1)				Prepared: Aug-13-15, Analyzed: Aug-14-15						
Aluminum, total	0.318	0.005	mg/L	0.296		107	81-129			
Antimony, total	0.0508	0.0001	mg/L	0.0505		101	88-114			
Arsenic, total	0.129	0.0005	mg/L	0.122		106	88-114			
Barium, total	0.698	0.005	mg/L	0.777		90	72-104			
Beryllium, total	0.0469	0.0001	mg/L	0.0488		96	76-131			
Boron, total	3.69	0.004	mg/L	3.40		109	75-121			
Cadmium, total	0.0494	0.00001	mg/L	0.0490		101	89-111			
Calcium, total	11.2	0.2	mg/L	10.2		110	86-121			
Chromium, total	0.262	0.0005	mg/L	0.242		108	89-114			
Cobalt, total	0.0413	0.00005	mg/L	0.0366		113	91-113			
Copper, total	0.554	0.0002	mg/L	0.487		114	91-115			
Iron, total	0.54	0.01	mg/L	0.469		114	77-124			
Lead, total	0.203	0.0001	mg/L	0.193		105	92-113			
Lithium, total	0.353	0.0001	mg/L	0.390		91	85-115			
Magnesium, total	3.76	0.01	mg/L	3.31		113	78-120			
Manganese, total	0.118	0.0002	mg/L	0.109		108	90-114			
Molybdenum, total	0.203	0.0001	mg/L	0.197		103	90-111			
Nickel, total	0.264	0.0002	mg/L	0.242		109	90-111			
Phosphorus, total	0.24	0.02	mg/L	0.233		104	85-115			
Potassium, total	6.66	0.02	mg/L	5.93		112	84-113			

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Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Total Recoverable Metals, Batch B5H0605, Continued										
Reference (B5H0605-SRM1), Continued				Prepared: Aug-13-15, Analyzed: Aug-14-15						
Selenium, total	0.122	0.0005	mg/L	0.115		107	85-115			
Sodium, total	8.63	0.02	mg/L	7.64		113	82-123			
Strontium, total	0.382	0.001	mg/L	0.363		105	88-112			
Thallium, total	0.0819	0.00002	mg/L	0.0794		103	91-114			
Uranium, total	0.0186	0.00002	mg/L	0.0192		97	85-120			
Vanadium, total	0.402	0.001	mg/L	0.376		107	86-111			
Zinc, total	2.57	0.004	mg/L	2.42		106	85-111			
Total Recoverable Metals, Batch B5H0787										
Blank (B5H0787-BLK1)				Prepared: Aug-17-15, Analyzed: Aug-17-15						
Mercury, total	< 0.00002	0.00002	mg/L							
Blank (B5H0787-BLK2)				Prepared: Aug-17-15, Analyzed: Aug-17-15						
Mercury, total	< 0.00002	0.00002	mg/L							
Duplicate (B5H0787-DUP1)			**Source: 5080727-01**	Prepared: Aug-17-15, Analyzed: Aug-17-15						
Mercury, total	< 0.00002	0.00002	mg/L		< 0.00002				20	
Matrix Spike (B5H0787-MS1)			**Source: 5080727-02**	Prepared: Aug-17-15, Analyzed: Aug-17-15						
Mercury, total	0.00019	0.00002	mg/L	0.000250	< 0.00002	75	70-130			

QC Qualifiers:

BLK Analyte concentration in the Method Blank is above the Method Reporting Limit (MRL).

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		5080727-01	5080727-02	5080727-03	5080727-04	5080727-05
		Water	Water	Water	Water	Water
		Aug-11-15	Aug-11-15	Aug-11-15	Aug-11-15	Aug-11-15
		SA-1 (T2 Creek)	SA-2 (Millionaire Creek)	K-1 (Dunlop Creek)	K-2 (Spencer Creek)	Field Blank
Anions	Nitrate as N (mg/L)	0.485	0.360	0.031	0.100	
General Parameters	Alkalinity, Total as CaCO3 (mg/L)	70	28	76	108	
	Alkalinity, Phenolphthalein as CaCO3 (mg/L)	< 1	< 1	< 1	< 1	
	Alkalinity, Bicarbonate as CaCO3 (mg/L)	70	28	76	108	
	Alkalinity, Carbonate as CaCO3 (mg/L)	< 1	< 1	< 1	< 1	
	Alkalinity, Hydroxide as CaCO3 (mg/L)	< 1	< 1	< 1	< 1	
Calculated Parameters	Hardness, Total (Diss. as CaCO3) (mg/L)	70.5	24.1	64.2	105	
	Hardness, Total (Total as CaCO3) (mg/L)	78.1	25.7	70.8	113	
Dissolved Metals	Aluminum, dissolved (mg/L)	0.011	0.012	0.014	0.008	
	Antimony, dissolved (mg/L)	0.0001	< 0.0001	< 0.0001	0.0002	
	Arsenic, dissolved (mg/L)	0.0007	< 0.0005	0.0010	0.0013	
	Barium, dissolved (mg/L)	0.010	0.007	0.011	0.009	
	Beryllium, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Bismuth, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Boron, dissolved (mg/L)	0.026	0.009	0.034	0.023	
	Cadmium, dissolved (mg/L)	< 0.00001	< 0.00001	< 0.00001	< 0.00001	
	Calcium, dissolved (mg/L)	16.2	7.2	16.4	28.2	
	Chromium, dissolved (mg/L)	< 0.0005	< 0.0005	< 0.0005	< 0.0005	
	Cobalt, dissolved (mg/L)	0.00007	< 0.00005	0.00034	0.00011	
	Copper, dissolved (mg/L)	0.0024	0.0009	0.0011	0.0012	
	Iron, dissolved (mg/L)	0.115	0.019	0.635	0.068	
	Lead, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Lithium, dissolved (mg/L)	0.0011	< 0.0001	0.0001	0.0003	
	Magnesium, dissolved (mg/L)	7.26	1.47	5.67	8.35	
	Manganese, dissolved (mg/L)	0.0127	0.0016	0.144	0.0526	
	Mercury, dissolved (mg/L)	< 0.00002	< 0.00002	< 0.00002	< 0.00002	
	Molybdenum, dissolved (mg/L)	0.0020	0.0008	0.0007	0.0011	
	Nickel, dissolved (mg/L)	0.0005	< 0.0002	0.0005	0.0007	
	Phosphorus, dissolved (mg/L)	0.04	< 0.02	0.03	< 0.02	
	Potassium, dissolved (mg/L)	3.14	0.67	3.48	2.66	
	Selenium, dissolved (mg/L)	< 0.0005	< 0.0005	< 0.0005	< 0.0005	
	Silicon, dissolved (mg/L)	8.0	6.2	4.5	7.1	
	Silver, dissolved (mg/L)	< 0.00005	< 0.00005	< 0.00005	< 0.00005	
	Sodium, dissolved (mg/L)	16.2	5.12	13.1	12.5	
	Strontium, dissolved (mg/L)	0.093	0.044	0.112	0.182	
	Sulfur, dissolved (mg/L)	3	< 1	3	4	
	Tellurium, dissolved (mg/L)	< 0.0002	< 0.0002	< 0.0002	< 0.0002	
	Thallium, dissolved (mg/L)	< 0.00002	< 0.00002	< 0.00002	< 0.00002	
	Thorium, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Tin, dissolved (mg/L)	< 0.0002	< 0.0002	< 0.0002	< 0.0002	
	Titanium, dissolved (mg/L)	< 0.005	< 0.005	< 0.005	< 0.005	
	Uranium, dissolved (mg/L)	0.00006	< 0.00002	< 0.00002	0.00006	
	Vanadium, dissolved (mg/L)	< 0.001	< 0.001	< 0.001	< 0.001	
	Zinc, dissolved (mg/L)	< 0.004	< 0.004	< 0.004	< 0.004	

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 5080727
REPORTED Aug-19-15

		5080727-01	5080727-02	5080727-03	5080727-04	5080727-05
		Water	Water	Water	Water	Water
		Aug-11-15	Aug-11-15	Aug-11-15	Aug-11-15	Aug-11-15
		SA-1 (T2 Creek)	SA-2 (Millionaire Creek)	K-1 (Dunlop Creek)	K-2 (Spencer Creek)	Field Blank
Dissolved Metals	Zirconium, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
Total Recoverable Metals	Aluminum, total (mg/L)	0.199	0.023	0.108	0.415	
	Antimony, total (mg/L)	0.0001	< 0.0001	< 0.0001	< 0.0001	
	Arsenic, total (mg/L)	0.0008	< 0.0005	0.0012	0.0016	
	Barium, total (mg/L)	0.011	0.007	0.012	0.010	
	Beryllium, total (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Bismuth, total (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Boron, total (mg/L)	0.029	0.009	0.038	0.027	
	Cadmium, total (mg/L)	0.00002	< 0.00001	0.00001	< 0.00001	
	Calcium, total (mg/L)	17.7	7.6	17.8	29.7	
	Chromium, total (mg/L)	0.0005	< 0.0005	< 0.0005	0.0006	
	Cobalt, total (mg/L)	0.00014	< 0.00005	0.00045	0.00028	
	Copper, total (mg/L)	0.0034	0.0009	0.0015	0.0017	
	Iron, total (mg/L)	0.40	0.03	1.12	0.66	
	Lead, total (mg/L)	0.0002	< 0.0001	< 0.0001	0.0001	
	Lithium, total (mg/L)	0.0010	< 0.0001	0.0001	0.0004	
	Magnesium, total (mg/L)	8.24	1.62	6.40	9.34	
	Manganese, total (mg/L)	0.0209	0.0025	0.202	0.0787	
	Mercury, total (mg/L)	< 0.00002	< 0.00002	< 0.00002	< 0.00002	
	Molybdenum, total (mg/L)	0.0024	0.0007	0.0007	0.0011	
	Nickel, total (mg/L)	0.0009	< 0.0002	0.0009	0.0011	
	Phosphorus, total (mg/L)	0.08	< 0.02	0.06	0.05	
	Potassium, total (mg/L)	3.44	0.71	3.67	2.80	
	Selenium, total (mg/L)	< 0.0005	< 0.0005	< 0.0005	< 0.0005	
	Silicon, total (mg/L)	9.3	6.7	5.0	8.3	
	Silver, total (mg/L)	< 0.00005	< 0.00005	< 0.00005	< 0.00005	
	Sodium, total (mg/L)	18.3	5.61	14.6	13.8	
	Strontium, total (mg/L)	0.101	0.047	0.118	0.190	
	Sulfur, total (mg/L)	5	< 1	3	4	
	Tellurium, total (mg/L)	< 0.0002	< 0.0002	< 0.0002	< 0.0002	
	Thallium, total (mg/L)	< 0.00002	< 0.00002	< 0.00002	< 0.00002	
	Thorium, total (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Tin, total (mg/L)	< 0.0002	< 0.0002	0.0002	< 0.0002	
	Titanium, total (mg/L)	0.009	< 0.005	< 0.005	0.015	
	Uranium, total (mg/L)	0.00007	< 0.00002	< 0.00002	0.00006	
	Vanadium, total (mg/L)	0.002	0.001	0.002	0.003	
	Zinc, total (mg/L)	0.007	< 0.004	< 0.004	< 0.004	
	Zirconium, total (mg/L)	0.0001	< 0.0001	< 0.0001	0.0001	
Microbiological Parameters	Coliforms, Total (MPN/100 mL)	7000	2400	2400	1600	
	Coliforms, Fecal (MPN/100 mL)	900	23	130	130	ND
	E. coli (MPN) (MPN/100 mL)	900	23	130	130	

CA

ANA

5080727

D, BC V6V 2K9
-1599

NA, BC V1X 5C3
-3893

ON, AB T6S 1H7
)-9700

CHAIN-OF-CUSTODY RECORD

COC#

CARO BC COC, Rev 03/13

RELINQUISHED BY:	DATE: 11-Aug-15	RECEIVED BY:	DATE: 08/11
Peter deKoning	TIME: 19:00	WL BS	TIME: 19:00
RELINQUISHED BY:	DATE:	RECEIVED BY:	DATE:
	TIME:		TIME:

REPORT TO:

COMPANY: Kerr Wood Leidal Associates
ADDRESS: 200-4185A Still Creek Drive
Burnaby, BC V5C 6G9
CONTACT: Patrick Lilley
TEL / FAX: 604-293-3121 604-294-2090
EMAIL PDF ☑ EDD ☐ **Please email Excel file.**
EMAIL 1: plilley@kwl.ca
EMAIL 2: pdekoning@kwl.ca
MAIL HARDCOPY ☐ HOLD FOR P/U ☐ FAX ☐

INVOICE TO: SAME AS REPORT TO ☐

COMPANY: Kerr Wood Leidal Associates
ADDRESS: 200-4185A Still Creek Drive
Burnaby, BC V5C 6G9
CONTACT: Patrick Lilley / Michelle Derer
TEL / FAX: 604-293-3252 604-294-2090
EMAIL PDF ☑
EMAIL 1: plilley@kwl.ca
EMAIL 2: mderer@kwl.ca
MAIL HARDCOPY ☐ HOLD FOR P/U ☑

PROJECT:	PROJECT INFO:	PO #:
173.169 Maple Ridge WQ	Stormwater Monitoring	
SAMPLED BY:	SHIPPING INSTRUCTIONS:	RETURN COOLER(S) ☐
Peter deKoning	SHIP SUPPLIES (PLEASE SPECIFY IN OTHER INSTRUCTIONS SECTION)	☐

TURNAROUND Routine (4-7 days) ☑ Other:
TIME REQUESTED: Rush:* 1 Day ☐ 2 Day ☐ 3 Day ☐ * Contact the lab to confirm, surcharges may apply

ANALYSES REQUESTED:

CLIENT SAMPLE ID:	MATRIX: DRINKING WATER	OTHER WATER	SOIL	OTHER	# CONTAINERS	SAMPLING: DATE DD-MMM-YY	TIME HH:MM	COMMENTS: CHLORINATED	FILTERED	PRESERVED	(i.e. flow/volume media ID/notes)	BTEX ☐ VPH ☐ MTBE ☐	EPH (not PAH Corrected)	VOC ☐ VPH ☐	L/HEPH (PAH Corrected)	PAH	PHENOLS Chlorinated ☐ Non-Chlor. ☐	PCB ☐ GLYCOLS ☐ HAA ☐	METALS - WATER TOTAL (ICPMS - LOW Pkg.)	METALS - WATER DISSOLVED (ICPMS - LOW Pkg.)	Metals - SOIL (SALM) ☐ Inc. pH ☐	pH ☐ EC ☐ Alk ☑	TSS ☐ TDS ☐	BOD ☐ COD ☐	FECAL COLIFORMS ☑ HPC ☐	TOTAL COLIFORMS ☑ E-COLI ☑	PESTICIDES ☐ HERBICIDES ☐	SOIL VAPOUR	ASBESTOS	NITRATE-N	HOLD
SA-1 (T2 Creek)	☐	☑	☐	☐	6	11-Aug-15	13:50	☐	☐	☐	See below	☐	☐	☐	☐	☐	☐	☐	☑	☑	☐	☑	☐	☐	☑	☑	☐	☐	☐	☑	☐
SA-2 (Millionaire Creek)	☐	☑	☐	☐	6	11-Aug-15	14:30	☐	☐	☐	See below	☐	☐	☐	☐	☐	☐	☐	☑	☑	☐	☑	☐	☐	☑	☑	☐	☐	☐	☑	☐
K-1 (Dunlop Creek)	☐	☑	☐	☐	6	11-Aug-15	15:00	☐	☐	☐	See below	☐	☐	☐	☐	☐	☐	☐	☑	☑	☐	☑	☐	☐	☑	☑	☐	☐	☐	☑	☐
K-2 (Spencer Creek)	☐	☑	☐	☐	6	11-Aug-15	15:25	☐	☐	☐	See below	☐	☐	☐	☐	☐	☐	☐	☑	☑	☐	☑	☐	☐	☑	☑	☐	☐	☐	☑	☐
Field Blank	☐	☐	☐	☐	1	11-Aug-15	15:40	☐	☐	☐		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐
Trip Blank	☐	☐	☐	☐	1	11-Aug-15	13:00	☐	☐	☐		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑
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APPLICABLE REGULATORY LIMITS:
Canadian Drinking Water Quality Guidelines ☐
BC Drinking Water Protection Act/Reg. ☐
BC CSR: AL ☐ RL ☐ CL ☐ IL ☐ AW ☐
CCME ☑ Alberta Tier 1 ☐
OTHER: BC WQ Guidelines for Aquatic Life

SAMPLE RETENTION INSTRUCTIONS (Discarded 30 days after Report unless otherwise specified):
60 Days ☐ 90 Days ☐ Longer Date (Surcharges will apply):

OTHER INSTRUCTIONS:
Total and dissolved metals, mercury, and bacteriological samples have been preserved. Dissolved metals samples (incl. mercury) have also been filtered. Metals analysis should be LOW level ICPMS pkg. Add total + dissolved Hg. Alkalinity = SPECIATED alkalinity. Use higher dilutions for bacteriological tests pls.

PAYMENT
Cheque ☐
Credit ☐
Debit ☐
Cash ☐
Invoice ☐

SAMPLE RECEIPT TEMP (°C): 11.8
Work Order # _____
CUSTODY SEALS INTACT: ☐Y ☐N ☐NA

Required Fields Recommended Fields SHADED AREAS: LAB USE ONLY

CERTIFICATE OF ANALYSIS

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby) 200 - 4185A Still Creek Dr Burnaby, BC V5C 6G9	**TEL** **FAX**	(604) 294-2088 (604) 294-2090
ATTENTION	Patrick Lilley	**WORK ORDER**	5081297
PO NUMBER		**RECEIVED / TEMP**	Aug-19-15 17:00 / 8°C
PROJECT	173.169 Maple Ridge WQ	**REPORTED**	Aug-27-15
PROJECT INFO	Stormwater Monitoring		

General Comments:

CARO Analytical Services employs methods which are conducted according to procedures accepted by appropriate regulatory agencies, and/or are conducted in accordance with recognized professional standards using accepted testing methodologies and quality control efforts, except where otherwise agreed to by the client.

The results in this report apply to the samples analyzed in accordance with the Chain of Custody or Sample Requisition document. This analytical report must be reproduced in its entirety. CARO is not responsible for any loss or damage resulting directly or indirectly from error or omission in the conduct of testing. Liability is limited to the cost of analysis. Samples will be disposed of 30 days after the test report has been issued unless otherwise agreed to in writing.

Authorized By: **Brent Coates, B.Sc.**
Division Manager, Richmond

If you have any questions or concerns, please contact your Account Manager:
Bryan Shaw, Ph.D. (bshaw@caro.ca)

Locations:

#110 4011 Viking Way
Richmond, BC V6V 2K9
Tel: 604-279-1499 Fax: 604-279-1599

#102 3677 Highway 97N
Kelowna, BC V1X 5C3
Tel: 250-765-9646 Fax: 250-765-3893

17225 109 Avenue
Edmonton, AB T5S 1H7
Tel: 780-489-9100 Fax: 780-489-9700

www.caro.ca

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PROJECT	173.169 Maple Ridge WQ	**REPORTED**	Aug-27-15

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Analysis Descriptions, Method References, Glossary of Terms

Sample Analytical Data Page 4
Test Results, Reporting Limits, Analysis Dates, Sample & Analysis Notes

Quality Control Data Appendix 1
Method Blanks, Duplicates, Spikes, Reference Materials

Analytical Summary Appendix 2
Tabulated data in condensed format to assist with comparisons

Chain of Custody Document Appendix 4
Analysis instructions provided by client

ANALYSIS INFORMATION

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	5081297
PROJECT	173.169 Maple Ridge WQ	**REPORTED**	Aug-27-15

Analysis Description	Method Reference	Technique	Location
Alkalinity in Water (Speciated)	APHA 2320 B*	Titration with H2SO4	Kelowna
Anions in Water by IC	APHA 4110 B	Ion Chromatography with Chemical Suppression of Eluent Conductivity	Kelowna
Dissolved Metals	APHA 3030 B / APHA 3125 B	0.45 µm Filtration / Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	Richmond
E. coli (MPN)	APHA 9221	Multiple-Tube Fermentation	Sublet
Fecal Coliforms (MPN)	APHA 9221	Multiple-Tube Fermentation	Sublet
Hardness (as CaCO3)	APHA 2340 B	Calculation	N/A
Mercury, dissolved by CVAFS	EPA 245.7*	BrCl2 Oxidation / Cold Vapor Atomic Fluorescence Spectrometry (CVAFS)	Richmond
Mercury, total by CVAFS	EPA 245.7*	BrCl2 Oxidation / Cold Vapor Atomic Fluorescence Spectrometry (CVAFS)	Richmond
Total Coliforms (MPN)	APHA 9221	Multiple-Tube Fermentation	Sublet
Total Recoverable Metals	APHA 3030E* / APHA 3125 B	HNO3+HCl Hot Block Digestion / Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	Richmond

Note: An asterisk in the Method Reference indicates that the CARO method has been modified from the reference method

Method Reference Descriptions:

APHA	Standard Methods for the Examination of Water and Wastewater, 22nd Edition, American Public Health Association/American Water Works Association/Water Environment Federation
EPA	United States Environmental Protection Agency Test Methods

Glossary of Terms:

MRL	Method Reporting Limit
<	Less than the Reported Detection Limit (RDL) - the RDL may be higher than the MRL due to various factors such as dilutions, limited sample volume, high moisture, or interferences
mg/L	Milligrams per litre
MPN/100 mL	Most Probable Number per 100 millilitres

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 5081297
REPORTED Aug-27-15

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SA-1 (T2 Creek) (5081297-01) [Water] Sampled: Aug-19-15 11:25							
Anions							
Nitrate as N	**0.406**	N/A	0.010	mg/L	N/A	Aug-21-15	
General Parameters							
Alkalinity, Total as CaCO3	**72**	N/A	1	mg/L	N/A	Aug-22-15	
Alkalinity, Phenolphthalein as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-22-15	
Alkalinity, Bicarbonate as CaCO3	**72**	N/A	1	mg/L	N/A	Aug-22-15	
Alkalinity, Carbonate as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-22-15	
Alkalinity, Hydroxide as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-22-15	
Calculated Parameters							
Hardness, Total (Diss. as CaCO3)	**71.6**	N/A	0.50	mg/L	N/A	N/A	
Hardness, Total (Total as CaCO3)	**74.7**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.010**	N/A	0.005	mg/L	N/A	Aug-26-15	
Antimony, dissolved	**0.0002**	N/A	0.0001	mg/L	N/A	Aug-26-15	
Arsenic, dissolved	**0.0005**	N/A	0.0005	mg/L	N/A	Aug-26-15	
Barium, dissolved	**0.010**	N/A	0.005	mg/L	N/A	Aug-26-15	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-26-15	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-26-15	
Boron, dissolved	**0.041**	N/A	0.004	mg/L	N/A	Aug-26-15	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	Aug-26-15	
Calcium, dissolved	**16.4**	N/A	0.2	mg/L	N/A	Aug-26-15	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Aug-26-15	
Cobalt, dissolved	**0.00008**	N/A	0.00005	mg/L	N/A	Aug-26-15	
Copper, dissolved	**0.0020**	N/A	0.0002	mg/L	N/A	Aug-26-15	
Iron, dissolved	**0.131**	N/A	0.010	mg/L	N/A	Aug-26-15	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-26-15	
Lithium, dissolved	**0.0010**	N/A	0.0001	mg/L	N/A	Aug-26-15	
Magnesium, dissolved	**7.45**	N/A	0.01	mg/L	N/A	Aug-26-15	
Manganese, dissolved	**0.0167**	N/A	0.0002	mg/L	N/A	Aug-26-15	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	Aug-25-15	Aug-26-15	
Molybdenum, dissolved	**0.0018**	N/A	0.0001	mg/L	N/A	Aug-26-15	
Nickel, dissolved	**0.0004**	N/A	0.0002	mg/L	N/A	Aug-26-15	
Phosphorus, dissolved	**0.06**	N/A	0.02	mg/L	N/A	Aug-26-15	
Potassium, dissolved	**2.45**	N/A	0.02	mg/L	N/A	Aug-26-15	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Aug-26-15	
Silicon, dissolved	**8.8**	N/A	0.5	mg/L	N/A	Aug-26-15	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	Aug-26-15	
Sodium, dissolved	**17.6**	N/A	0.02	mg/L	N/A	Aug-26-15	
Strontium, dissolved	**0.102**	N/A	0.001	mg/L	N/A	Aug-26-15	
Sulfur, dissolved	**1**	N/A	1	mg/L	N/A	Aug-26-15	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Aug-26-15	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Aug-26-15	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-26-15	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Aug-26-15	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	Aug-26-15	

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 5081297
REPORTED Aug-27-15

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SA-1 (T2 Creek) (5081297-01) [Water] Sampled: Aug-19-15 11:25, Continued							
Dissolved Metals, Continued							
Uranium, dissolved	**0.00004**	N/A	0.00002	mg/L	N/A	Aug-26-15	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	Aug-26-15	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	Aug-26-15	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-26-15	
Total Recoverable Metals							
Aluminum, total	**0.140**	N/A	0.005	mg/L	Aug-26-15	Aug-26-15	
Antimony, total	**0.0002**	N/A	0.0001	mg/L	Aug-26-15	Aug-26-15	
Arsenic, total	**0.0007**	N/A	0.0005	mg/L	Aug-26-15	Aug-26-15	
Barium, total	**0.012**	N/A	0.005	mg/L	Aug-26-15	Aug-26-15	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	Aug-26-15	Aug-26-15	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	Aug-26-15	Aug-26-15	
Boron, total	**0.044**	N/A	0.004	mg/L	Aug-26-15	Aug-26-15	
Cadmium, total	**0.00001**	N/A	0.00001	mg/L	Aug-26-15	Aug-26-15	
Calcium, total	**16.9**	N/A	0.2	mg/L	Aug-26-15	Aug-26-15	
Chromium, total	**0.0005**	N/A	0.0005	mg/L	Aug-26-15	Aug-26-15	
Cobalt, total	**0.00013**	N/A	0.00005	mg/L	Aug-26-15	Aug-26-15	
Copper, total	**0.0025**	N/A	0.0002	mg/L	Aug-26-15	Aug-26-15	
Iron, total	**0.35**	N/A	0.01	mg/L	Aug-26-15	Aug-26-15	
Lead, total	**0.0002**	N/A	0.0001	mg/L	Aug-26-15	Aug-26-15	
Lithium, total	**0.0012**	N/A	0.0001	mg/L	Aug-26-15	Aug-26-15	
Magnesium, total	**7.91**	N/A	0.01	mg/L	Aug-26-15	Aug-26-15	
Manganese, total	**0.0227**	N/A	0.0002	mg/L	Aug-26-15	Aug-26-15	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	Aug-25-15	Aug-26-15	
Molybdenum, total	**0.0022**	N/A	0.0001	mg/L	Aug-26-15	Aug-26-15	
Nickel, total	**0.0009**	N/A	0.0002	mg/L	Aug-26-15	Aug-26-15	
Phosphorus, total	**0.09**	N/A	0.02	mg/L	Aug-26-15	Aug-26-15	
Potassium, total	**2.61**	N/A	0.02	mg/L	Aug-26-15	Aug-26-15	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	Aug-26-15	Aug-26-15	
Silicon, total	**9.7**	N/A	0.5	mg/L	Aug-26-15	Aug-26-15	
Silver, total	< 0.00005	N/A	0.00005	mg/L	Aug-26-15	Aug-26-15	
Sodium, total	**17.8**	N/A	0.02	mg/L	Aug-26-15	Aug-26-15	
Strontium, total	**0.106**	N/A	0.001	mg/L	Aug-26-15	Aug-26-15	
Sulfur, total	**4**	N/A	1	mg/L	Aug-26-15	Aug-26-15	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	Aug-26-15	Aug-26-15	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	Aug-26-15	Aug-26-15	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	Aug-26-15	Aug-26-15	
Tin, total	< 0.0002	N/A	0.0002	mg/L	Aug-26-15	Aug-26-15	
Titanium, total	**0.009**	N/A	0.005	mg/L	Aug-26-15	Aug-26-15	
Uranium, total	**0.00005**	N/A	0.00002	mg/L	Aug-26-15	Aug-26-15	
Vanadium, total	**0.001**	N/A	0.001	mg/L	Aug-26-15	Aug-26-15	
Zinc, total	**0.005**	N/A	0.004	mg/L	Aug-26-15	Aug-26-15	
Zirconium, total	**0.0001**	N/A	0.0001	mg/L	Aug-26-15	Aug-26-15	
Microbiological Parameters							
Coliforms, Total	**1600**	N/A	2	MPN/100 mL		Aug-20-15	

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 5081297
REPORTED Aug-27-15

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SA-1 (T2 Creek) (5081297-01) [Water] Sampled: Aug-19-15 11:25, Continued							
Microbiological Parameters, Continued							
Coliforms, Fecal	**1600**	N/A	2	MPN/100 mL		Aug-20-15	
E. coli (MPN)	**1600**	N/A	2	MPN/100 mL		Aug-20-15	
Sample ID: SA-2 (Millionaire Creek) (5081297-02) [Water] Sampled: Aug-19-15 12:00							
Anions							
Nitrate as N	**0.423**	N/A	0.010	mg/L	N/A	Aug-21-15	
General Parameters							
Alkalinity, Total as CaCO3	**29**	N/A	1	mg/L	N/A	Aug-22-15	
Alkalinity, Phenolphthalein as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-22-15	
Alkalinity, Bicarbonate as CaCO3	**29**	N/A	1	mg/L	N/A	Aug-22-15	
Alkalinity, Carbonate as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-22-15	
Alkalinity, Hydroxide as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-22-15	
Calculated Parameters							
Hardness, Total (Diss. as CaCO3)	**24.5**	N/A	0.50	mg/L	N/A	N/A	
Hardness, Total (Total as CaCO3)	**25.5**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.012**	N/A	0.005	mg/L	N/A	Aug-26-15	
Antimony, dissolved	**0.0001**	N/A	0.0001	mg/L	N/A	Aug-26-15	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Aug-26-15	
Barium, dissolved	**0.008**	N/A	0.005	mg/L	N/A	Aug-26-15	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-26-15	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-26-15	
Boron, dissolved	**0.007**	N/A	0.004	mg/L	N/A	Aug-26-15	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	Aug-26-15	
Calcium, dissolved	**7.4**	N/A	0.2	mg/L	N/A	Aug-26-15	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Aug-26-15	
Cobalt, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	Aug-26-15	
Copper, dissolved	**0.0009**	N/A	0.0002	mg/L	N/A	Aug-26-15	
Iron, dissolved	**0.020**	N/A	0.010	mg/L	N/A	Aug-26-15	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-26-15	
Lithium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-26-15	
Magnesium, dissolved	**1.47**	N/A	0.01	mg/L	N/A	Aug-26-15	
Manganese, dissolved	**0.0018**	N/A	0.0002	mg/L	N/A	Aug-26-15	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	Aug-25-15	Aug-26-15	
Molybdenum, dissolved	**0.0007**	N/A	0.0001	mg/L	N/A	Aug-26-15	
Nickel, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Aug-26-15	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	Aug-26-15	
Potassium, dissolved	**0.64**	N/A	0.02	mg/L	N/A	Aug-26-15	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Aug-26-15	
Silicon, dissolved	**5.9**	N/A	0.5	mg/L	N/A	Aug-26-15	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	Aug-26-15	
Sodium, dissolved	**4.99**	N/A	0.02	mg/L	N/A	Aug-26-15	
Strontium, dissolved	**0.047**	N/A	0.001	mg/L	N/A	Aug-26-15	

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 5081297
REPORTED Aug-27-15

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SA-2 (Millionaire Creek) (5081297-02) [Water] Sampled: Aug-19-15 12:00, Continued							
Dissolved Metals, Continued							
Sulfur, dissolved	< 1	N/A	1	mg/L	N/A	Aug-26-15	
Tellurium, dissolved	**0.0002**	N/A	0.0002	mg/L	N/A	Aug-26-15	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Aug-26-15	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-26-15	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Aug-26-15	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	Aug-26-15	
Uranium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Aug-26-15	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	Aug-26-15	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	Aug-26-15	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-26-15	
Total Recoverable Metals							
Aluminum, total	**0.025**	N/A	0.005	mg/L	Aug-26-15	Aug-26-15	
Antimony, total	< 0.0001	N/A	0.0001	mg/L	Aug-26-15	Aug-26-15	
Arsenic, total	< 0.0005	N/A	0.0005	mg/L	Aug-26-15	Aug-26-15	
Barium, total	**0.008**	N/A	0.005	mg/L	Aug-26-15	Aug-26-15	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	Aug-26-15	Aug-26-15	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	Aug-26-15	Aug-26-15	
Boron, total	**0.019**	N/A	0.004	mg/L	Aug-26-15	Aug-26-15	
Cadmium, total	< 0.00001	N/A	0.00001	mg/L	Aug-26-15	Aug-26-15	
Calcium, total	**7.6**	N/A	0.2	mg/L	Aug-26-15	Aug-26-15	
Chromium, total	< 0.0005	N/A	0.0005	mg/L	Aug-26-15	Aug-26-15	
Cobalt, total	< 0.00005	N/A	0.00005	mg/L	Aug-26-15	Aug-26-15	
Copper, total	**0.0012**	N/A	0.0002	mg/L	Aug-26-15	Aug-26-15	
Iron, total	**0.04**	N/A	0.01	mg/L	Aug-26-15	Aug-26-15	
Lead, total	< 0.0001	N/A	0.0001	mg/L	Aug-26-15	Aug-26-15	
Lithium, total	**0.0003**	N/A	0.0001	mg/L	Aug-26-15	Aug-26-15	
Magnesium, total	**1.54**	N/A	0.01	mg/L	Aug-26-15	Aug-26-15	
Manganese, total	**0.0024**	N/A	0.0002	mg/L	Aug-26-15	Aug-26-15	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	Aug-25-15	Aug-26-15	
Molybdenum, total	**0.0007**	N/A	0.0001	mg/L	Aug-26-15	Aug-26-15	
Nickel, total	< 0.0002	N/A	0.0002	mg/L	Aug-26-15	Aug-26-15	
Phosphorus, total	< 0.02	N/A	0.02	mg/L	Aug-26-15	Aug-26-15	
Potassium, total	**0.69**	N/A	0.02	mg/L	Aug-26-15	Aug-26-15	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	Aug-26-15	Aug-26-15	
Silicon, total	**6.6**	N/A	0.5	mg/L	Aug-26-15	Aug-26-15	
Silver, total	< 0.00005	N/A	0.00005	mg/L	Aug-26-15	Aug-26-15	
Sodium, total	**5.39**	N/A	0.02	mg/L	Aug-26-15	Aug-26-15	
Strontium, total	**0.048**	N/A	0.001	mg/L	Aug-26-15	Aug-26-15	
Sulfur, total	< 1	N/A	1	mg/L	Aug-26-15	Aug-26-15	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	Aug-26-15	Aug-26-15	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	Aug-26-15	Aug-26-15	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	Aug-26-15	Aug-26-15	
Tin, total	< 0.0002	N/A	0.0002	mg/L	Aug-26-15	Aug-26-15	
Titanium, total	< 0.005	N/A	0.005	mg/L	Aug-26-15	Aug-26-15	
Uranium, total	< 0.00002	N/A	0.00002	mg/L	Aug-26-15	Aug-26-15	

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 5081297
REPORTED Aug-27-15

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SA-2 (Millionaire Creek) (5081297-02) [Water] Sampled: Aug-19-15 12:00, Continued							
Total Recoverable Metals, Continued							
Vanadium, total	< 0.001	N/A	0.001	mg/L	Aug-26-15	Aug-26-15	
Zinc, total	< 0.004	N/A	0.004	mg/L	Aug-26-15	Aug-26-15	
Zirconium, total	< 0.0001	N/A	0.0001	mg/L	Aug-26-15	Aug-26-15	
Microbiological Parameters							
Coliforms, Total	**1600**	N/A	2	MPN/100 mL		Aug-20-15	
Coliforms, Fecal	**80**	N/A	2	MPN/100 mL		Aug-20-15	
E. coli (MPN)	**80**	N/A	2	MPN/100 mL		Aug-20-15	
Sample ID: K-1 (Dunlop Creek) (5081297-03) [Water] Sampled: Aug-19-15 12:45							
Anions							
Nitrate as N	**0.028**	N/A	0.010	mg/L	N/A	Aug-21-15	
General Parameters							
Alkalinity, Total as CaCO3	**76**	N/A	1	mg/L	N/A	Aug-22-15	
Alkalinity, Phenolphthalein as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-22-15	
Alkalinity, Bicarbonate as CaCO3	**76**	N/A	1	mg/L	N/A	Aug-22-15	
Alkalinity, Carbonate as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-22-15	
Alkalinity, Hydroxide as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-22-15	
Calculated Parameters							
Hardness, Total (Diss. as CaCO3)	**64.5**	N/A	0.50	mg/L	N/A	N/A	
Hardness, Total (Total as CaCO3)	**66.9**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.013**	N/A	0.005	mg/L	N/A	Aug-26-15	
Antimony, dissolved	**0.0002**	N/A	0.0001	mg/L	N/A	Aug-26-15	
Arsenic, dissolved	**0.0010**	N/A	0.0005	mg/L	N/A	Aug-26-15	
Barium, dissolved	**0.012**	N/A	0.005	mg/L	N/A	Aug-26-15	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-26-15	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-26-15	
Boron, dissolved	**0.033**	N/A	0.004	mg/L	N/A	Aug-26-15	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	Aug-26-15	
Calcium, dissolved	**16.6**	N/A	0.2	mg/L	N/A	Aug-26-15	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Aug-26-15	
Cobalt, dissolved	**0.00044**	N/A	0.00005	mg/L	N/A	Aug-26-15	
Copper, dissolved	**0.0009**	N/A	0.0002	mg/L	N/A	Aug-26-15	
Iron, dissolved	**0.592**	N/A	0.010	mg/L	N/A	Aug-26-15	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-26-15	
Lithium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-26-15	
Magnesium, dissolved	**5.60**	N/A	0.01	mg/L	N/A	Aug-26-15	
Manganese, dissolved	**0.274**	N/A	0.0002	mg/L	N/A	Aug-26-15	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	Aug-25-15	Aug-26-15	
Molybdenum, dissolved	**0.0008**	N/A	0.0001	mg/L	N/A	Aug-26-15	
Nickel, dissolved	**0.0005**	N/A	0.0002	mg/L	N/A	Aug-26-15	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	Aug-26-15	

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 5081297
REPORTED Aug-27-15

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: K-1 (Dunlop Creek) (5081297-03) [Water] Sampled: Aug-19-15 12:45, Continued							
Dissolved Metals, Continued							
Potassium, dissolved	**3.34**	N/A	0.02	mg/L	N/A	Aug-26-15	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Aug-26-15	
Silicon, dissolved	**4.6**	N/A	0.5	mg/L	N/A	Aug-26-15	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	Aug-26-15	
Sodium, dissolved	**13.0**	N/A	0.02	mg/L	N/A	Aug-26-15	
Strontium, dissolved	**0.123**	N/A	0.001	mg/L	N/A	Aug-26-15	
Sulfur, dissolved	< 1	N/A	1	mg/L	N/A	Aug-26-15	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Aug-26-15	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Aug-26-15	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-26-15	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Aug-26-15	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	Aug-26-15	
Uranium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Aug-26-15	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	Aug-26-15	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	Aug-26-15	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-26-15	
Total Recoverable Metals							
Aluminum, total	**0.095**	N/A	0.005	mg/L	Aug-26-15	Aug-26-15	
Antimony, total	**0.0001**	N/A	0.0001	mg/L	Aug-26-15	Aug-26-15	
Arsenic, total	**0.0014**	N/A	0.0005	mg/L	Aug-26-15	Aug-26-15	
Barium, total	**0.013**	N/A	0.005	mg/L	Aug-26-15	Aug-26-15	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	Aug-26-15	Aug-26-15	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	Aug-26-15	Aug-26-15	
Boron, total	**0.043**	N/A	0.004	mg/L	Aug-26-15	Aug-26-15	
Cadmium, total	< 0.00001	N/A	0.00001	mg/L	Aug-26-15	Aug-26-15	
Calcium, total	**17.1**	N/A	0.2	mg/L	Aug-26-15	Aug-26-15	
Chromium, total	< 0.0005	N/A	0.0005	mg/L	Aug-26-15	Aug-26-15	
Cobalt, total	**0.00051**	N/A	0.00005	mg/L	Aug-26-15	Aug-26-15	
Copper, total	**0.0011**	N/A	0.0002	mg/L	Aug-26-15	Aug-26-15	
Iron, total	**1.06**	N/A	0.01	mg/L	Aug-26-15	Aug-26-15	
Lead, total	**0.0001**	N/A	0.0001	mg/L	Aug-26-15	Aug-26-15	
Lithium, total	**0.0003**	N/A	0.0001	mg/L	Aug-26-15	Aug-26-15	
Magnesium, total	**5.85**	N/A	0.01	mg/L	Aug-26-15	Aug-26-15	
Manganese, total	**0.298**	N/A	0.0002	mg/L	Aug-26-15	Aug-26-15	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	Aug-25-15	Aug-26-15	
Molybdenum, total	**0.0007**	N/A	0.0001	mg/L	Aug-26-15	Aug-26-15	
Nickel, total	**0.0008**	N/A	0.0002	mg/L	Aug-26-15	Aug-26-15	
Phosphorus, total	**0.05**	N/A	0.02	mg/L	Aug-26-15	Aug-26-15	
Potassium, total	**3.45**	N/A	0.02	mg/L	Aug-26-15	Aug-26-15	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	Aug-26-15	Aug-26-15	
Silicon, total	**4.9**	N/A	0.5	mg/L	Aug-26-15	Aug-26-15	
Silver, total	< 0.00005	N/A	0.00005	mg/L	Aug-26-15	Aug-26-15	
Sodium, total	**13.3**	N/A	0.02	mg/L	Aug-26-15	Aug-26-15	
Strontium, total	**0.123**	N/A	0.001	mg/L	Aug-26-15	Aug-26-15	
Sulfur, total	**2**	N/A	1	mg/L	Aug-26-15	Aug-26-15	

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	5081297
PROJECT	173.169 Maple Ridge WQ	**REPORTED**	Aug-27-15

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: K-1 (Dunlop Creek) (5081297-03) [Water] Sampled: Aug-19-15 12:45, Continued							
Total Recoverable Metals, Continued							
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	Aug-26-15	Aug-26-15	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	Aug-26-15	Aug-26-15	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	Aug-26-15	Aug-26-15	
Tin, total	< 0.0002	N/A	0.0002	mg/L	Aug-26-15	Aug-26-15	
Titanium, total	< 0.005	N/A	0.005	mg/L	Aug-26-15	Aug-26-15	
Uranium, total	< 0.00002	N/A	0.00002	mg/L	Aug-26-15	Aug-26-15	
Vanadium, total	**0.001**	N/A	0.001	mg/L	Aug-26-15	Aug-26-15	
Zinc, total	< 0.004	N/A	0.004	mg/L	Aug-26-15	Aug-26-15	
Zirconium, total	< 0.0001	N/A	0.0001	mg/L	Aug-26-15	Aug-26-15	
Microbiological Parameters							
Coliforms, Total	**1600**	N/A	2	MPN/100 mL		Aug-20-15	
Coliforms, Fecal	**900**	N/A	2	MPN/100 mL		Aug-20-15	
E. coli (MPN)	**900**	N/A	2	MPN/100 mL		Aug-20-15	
Sample ID: K-2 (Spencer Creek) (5081297-04) [Water] Sampled: Aug-19-15 13:15							
Anions							
Nitrate as N	**0.159**	N/A	0.010	mg/L	N/A	Aug-21-15	
General Parameters							
Alkalinity, Total as CaCO3	**108**	N/A	1	mg/L	N/A	Aug-22-15	
Alkalinity, Phenolphthalein as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-22-15	
Alkalinity, Bicarbonate as CaCO3	**108**	N/A	1	mg/L	N/A	Aug-22-15	
Alkalinity, Carbonate as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-22-15	
Alkalinity, Hydroxide as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-22-15	
Calculated Parameters							
Hardness, Total (Diss. as CaCO3)	**104**	N/A	0.50	mg/L	N/A	N/A	
Hardness, Total (Total as CaCO3)	**106**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.008**	N/A	0.005	mg/L	N/A	Aug-26-15	
Antimony, dissolved	**0.0002**	N/A	0.0001	mg/L	N/A	Aug-26-15	
Arsenic, dissolved	**0.0012**	N/A	0.0005	mg/L	N/A	Aug-26-15	
Barium, dissolved	**0.009**	N/A	0.005	mg/L	N/A	Aug-26-15	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-26-15	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-26-15	
Boron, dissolved	**0.022**	N/A	0.004	mg/L	N/A	Aug-26-15	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	Aug-26-15	
Calcium, dissolved	**28.0**	N/A	0.2	mg/L	N/A	Aug-26-15	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Aug-26-15	
Cobalt, dissolved	**0.00009**	N/A	0.00005	mg/L	N/A	Aug-26-15	
Copper, dissolved	**0.0011**	N/A	0.0002	mg/L	N/A	Aug-26-15	
Iron, dissolved	**0.100**	N/A	0.010	mg/L	N/A	Aug-26-15	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-26-15	
Lithium, dissolved	**0.0002**	N/A	0.0001	mg/L	N/A	Aug-26-15	

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	5081297
PROJECT	173.169 Maple Ridge WQ	**REPORTED**	Aug-27-15

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: K-2 (Spencer Creek) (5081297-04) [Water] Sampled: Aug-19-15 13:15, Continued							
Dissolved Metals, Continued							
Magnesium, dissolved	**8.22**	N/A	0.01	mg/L	N/A	Aug-26-15	
Manganese, dissolved	**0.0756**	N/A	0.0002	mg/L	N/A	Aug-26-15	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	Aug-25-15	Aug-26-15	
Molybdenum, dissolved	**0.0012**	N/A	0.0001	mg/L	N/A	Aug-26-15	
Nickel, dissolved	**0.0004**	N/A	0.0002	mg/L	N/A	Aug-26-15	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	Aug-26-15	
Potassium, dissolved	**2.57**	N/A	0.02	mg/L	N/A	Aug-26-15	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Aug-26-15	
Silicon, dissolved	**7.6**	N/A	0.5	mg/L	N/A	Aug-26-15	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	Aug-26-15	
Sodium, dissolved	**12.1**	N/A	0.02	mg/L	N/A	Aug-26-15	
Strontium, dissolved	**0.195**	N/A	0.001	mg/L	N/A	Aug-26-15	
Sulfur, dissolved	< 1	N/A	1	mg/L	N/A	Aug-26-15	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Aug-26-15	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Aug-26-15	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-26-15	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Aug-26-15	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	Aug-26-15	
Uranium, dissolved	**0.00006**	N/A	0.00002	mg/L	N/A	Aug-26-15	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	Aug-26-15	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	Aug-26-15	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-26-15	
Total Recoverable Metals							
Aluminum, total	**0.224**	N/A	0.005	mg/L	Aug-26-15	Aug-26-15	
Antimony, total	**0.0002**	N/A	0.0001	mg/L	Aug-26-15	Aug-26-15	
Arsenic, total	**0.0015**	N/A	0.0005	mg/L	Aug-26-15	Aug-26-15	
Barium, total	**0.011**	N/A	0.005	mg/L	Aug-26-15	Aug-26-15	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	Aug-26-15	Aug-26-15	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	Aug-26-15	Aug-26-15	
Boron, total	**0.032**	N/A	0.004	mg/L	Aug-26-15	Aug-26-15	
Cadmium, total	< 0.00001	N/A	0.00001	mg/L	Aug-26-15	Aug-26-15	
Calcium, total	**28.3**	N/A	0.2	mg/L	Aug-26-15	Aug-26-15	
Chromium, total	**0.0005**	N/A	0.0005	mg/L	Aug-26-15	Aug-26-15	
Cobalt, total	**0.00020**	N/A	0.00005	mg/L	Aug-26-15	Aug-26-15	
Copper, total	**0.0017**	N/A	0.0002	mg/L	Aug-26-15	Aug-26-15	
Iron, total	**0.49**	N/A	0.01	mg/L	Aug-26-15	Aug-26-15	
Lead, total	**0.0001**	N/A	0.0001	mg/L	Aug-26-15	Aug-26-15	
Lithium, total	**0.0005**	N/A	0.0001	mg/L	Aug-26-15	Aug-26-15	
Magnesium, total	**8.54**	N/A	0.01	mg/L	Aug-26-15	Aug-26-15	
Manganese, total	**0.0868**	N/A	0.0002	mg/L	Aug-26-15	Aug-26-15	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	Aug-25-15	Aug-26-15	
Molybdenum, total	**0.0012**	N/A	0.0001	mg/L	Aug-26-15	Aug-26-15	
Nickel, total	**0.0010**	N/A	0.0002	mg/L	Aug-26-15	Aug-26-15	
Phosphorus, total	< 0.02	N/A	0.02	mg/L	Aug-26-15	Aug-26-15	
Potassium, total	**2.61**	N/A	0.02	mg/L	Aug-26-15	Aug-26-15	

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 5081297
REPORTED Aug-27-15

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: K-2 (Spencer Creek) (5081297-04) [Water] Sampled: Aug-19-15 13:15, Continued							
Total Recoverable Metals, Continued							
Selenium, total	< 0.0005	N/A	0.0005	mg/L	Aug-26-15	Aug-26-15	
Silicon, total	**8.3**	N/A	0.5	mg/L	Aug-26-15	Aug-26-15	
Silver, total	< 0.00005	N/A	0.00005	mg/L	Aug-26-15	Aug-26-15	
Sodium, total	**12.2**	N/A	0.02	mg/L	Aug-26-15	Aug-26-15	
Strontium, total	**0.194**	N/A	0.001	mg/L	Aug-26-15	Aug-26-15	
Sulfur, total	**2**	N/A	1	mg/L	Aug-26-15	Aug-26-15	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	Aug-26-15	Aug-26-15	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	Aug-26-15	Aug-26-15	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	Aug-26-15	Aug-26-15	
Tin, total	< 0.0002	N/A	0.0002	mg/L	Aug-26-15	Aug-26-15	
Titanium, total	**0.009**	N/A	0.005	mg/L	Aug-26-15	Aug-26-15	
Uranium, total	**0.00007**	N/A	0.00002	mg/L	Aug-26-15	Aug-26-15	
Vanadium, total	**0.002**	N/A	0.001	mg/L	Aug-26-15	Aug-26-15	
Zinc, total	< 0.004	N/A	0.004	mg/L	Aug-26-15	Aug-26-15	
Zirconium, total	**0.0001**	N/A	0.0001	mg/L	Aug-26-15	Aug-26-15	
Microbiological Parameters							
Coliforms, Total	**900**	N/A	2	MPN/100 mL		Aug-20-15	
Coliforms, Fecal	**500**	N/A	2	MPN/100 mL		Aug-20-15	
E. coli (MPN)	**500**	N/A	2	MPN/100 mL		Aug-20-15	
Sample ID: Field Blank (5081297-05) [Water] Sampled: Aug-19-15 13:00							
General Parameters							
Alkalinity, Total as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-22-15	
Alkalinity, Phenolphthalein as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-22-15	
Alkalinity, Bicarbonate as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-22-15	
Alkalinity, Carbonate as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-22-15	
Alkalinity, Hydroxide as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-22-15	

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	5081297
PROJECT	173.169 Maple Ridge WQ	**REPORTED**	Aug-27-15

The following section displays the quality control (QC) data that is associated with your sample data. Groups of samples are prepared in "batches" and analyzed in conjunction with QC samples that ensure your data is of the highest quality. Common QC types include:

- **Method Blank (Blk)**: Laboratory reagent water is carried through sample preparation and analysis steps. Method Blanks indicate that results are free from contamination, i.e. not biased high from sources such as the sample container or the laboratory environment
- **Duplicate (Dup)**: Preparation and analysis of a replicate aliquot of a sample. Duplicates provide a measure of the analytical method's precision, i.e. how reproducible a result is. Duplicates are only reported if they are associated with your sample data.
- **Blank Spike (BS)**: A known amount of standard is carried through sample preparation and analysis steps. Blank Spikes, also known as laboratory control samples (LCS), are prepared from a different source of standard than used for the calibration. They ensure that the calibration is acceptable (i.e. not biased high or low) and also provide a measure of the analytical method's accuracy (i.e. closeness of the result to a target value).
- **Standard Reference Material (SRM)**: A material of similar matrix to the samples, externally certified for the parameter(s) listed. Standard Reference Materials ensure that the preparation steps in the method are adequate to achieve acceptable recoveries of the parameter(s) tested.

Each QC type is analyzed at a 5-10% frequency, i.e. one blank/duplicate/spike for every 10 samples. For all types of QC, the specified recovery (% Rec) and relative percent difference (RPD) limits are derived from long-term method performance averages and/or prescribed by the reference method.

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Anions, Batch B5H1197										
Blank (B5H1197-BLK1)				Prepared: Aug-24-15, Analyzed: Aug-24-15						
Nitrate as N	< 0.010	0.010	mg/L							
Blank (B5H1197-BLK2)				Prepared: Aug-24-15, Analyzed: Aug-24-15						
Nitrate as N	< 0.010	0.010	mg/L							
Blank (B5H1197-BLK3)				Prepared: Aug-25-15, Analyzed: Aug-25-15						
Nitrate as N	< 0.010	0.010	mg/L							
LCS (B5H1197-BS1)				Prepared: Aug-24-15, Analyzed: Aug-24-15						
Nitrate as N	4.03	0.010	mg/L	4.00		101	85-115			
LCS (B5H1197-BS2)				Prepared: Aug-24-15, Analyzed: Aug-24-15						
Nitrate as N	4.04	0.010	mg/L	4.00		101	85-115			
LCS (B5H1197-BS3)				Prepared: Aug-25-15, Analyzed: Aug-25-15						
Nitrate as N	4.00	0.010	mg/L	4.00		100	85-115			
Dissolved Metals, Batch B5H1273										
Blank (B5H1273-BLK1)				Prepared: Aug-25-15, Analyzed: Aug-26-15						
Mercury, dissolved	< 0.00002	0.00002	mg/L							
Blank (B5H1273-BLK2)				Prepared: Aug-25-15, Analyzed: Aug-26-15						
Mercury, dissolved	< 0.00002	0.00002	mg/L							
Duplicate (B5H1273-DUP1)			**Source: 5081297-02**	Prepared: Aug-25-15, Analyzed: Aug-26-15						
Mercury, dissolved	< 0.00002	0.00002	mg/L		< 0.00002				20	
Matrix Spike (B5H1273-MS1)			**Source: 5081297-03**	Prepared: Aug-25-15, Analyzed: Aug-26-15						
Mercury, dissolved	0.00025	0.00002	mg/L	0.000250	< 0.00002	101	70-130			
Reference (B5H1273-SRM1)				Prepared: Aug-25-15, Analyzed: Aug-26-15						
Mercury, dissolved	0.00358	0.00002	mg/L	0.00456		79	50-150			

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Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Dissolved Metals, Batch B5H1273, Continued										
Reference (B5H1273-SRM2)				Prepared: Aug-25-15, Analyzed: Aug-26-15						
Mercury, dissolved	0.00337	0.00002	mg/L	0.00456		74	50-150			
Dissolved Metals, Batch B5H1364										
Blank (B5H1364-BLK1)				Prepared: Aug-26-15, Analyzed: Aug-26-15						
Aluminum, dissolved	< 0.005	0.005	mg/L							
Antimony, dissolved	< 0.0001	0.0001	mg/L							
Arsenic, dissolved	< 0.0005	0.0005	mg/L							
Barium, dissolved	< 0.005	0.005	mg/L							
Beryllium, dissolved	< 0.0001	0.0001	mg/L							
Bismuth, dissolved	< 0.0001	0.0001	mg/L							
Boron, dissolved	< 0.004	0.004	mg/L							
Cadmium, dissolved	< 0.00001	0.00001	mg/L							
Calcium, dissolved	< 0.2	0.2	mg/L							
Chromium, dissolved	< 0.0005	0.0005	mg/L							
Cobalt, dissolved	< 0.00005	0.00005	mg/L							
Copper, dissolved	< 0.0002	0.0002	mg/L							
Iron, dissolved	< 0.010	0.010	mg/L							
Lead, dissolved	< 0.0001	0.0001	mg/L							
Lithium, dissolved	< 0.0001	0.0001	mg/L							
Magnesium, dissolved	< 0.01	0.01	mg/L							
Manganese, dissolved	< 0.0002	0.0002	mg/L							
Molybdenum, dissolved	< 0.0001	0.0001	mg/L							
Nickel, dissolved	< 0.0002	0.0002	mg/L							
Phosphorus, dissolved	< 0.02	0.02	mg/L							
Potassium, dissolved	< 0.02	0.02	mg/L							
Selenium, dissolved	< 0.0005	0.0005	mg/L							
Silicon, dissolved	< 0.5	0.5	mg/L							
Silver, dissolved	< 0.00005	0.00005	mg/L							
Sodium, dissolved	< 0.02	0.02	mg/L							
Strontium, dissolved	< 0.001	0.001	mg/L							
Sulfur, dissolved	< 1	1	mg/L							
Tellurium, dissolved	< 0.0002	0.0002	mg/L							
Thallium, dissolved	< 0.00002	0.00002	mg/L							
Thorium, dissolved	< 0.0001	0.0001	mg/L							
Tin, dissolved	< 0.0002	0.0002	mg/L							
Titanium, dissolved	< 0.005	0.005	mg/L							
Uranium, dissolved	< 0.00002	0.00002	mg/L							
Vanadium, dissolved	< 0.001	0.001	mg/L							
Zinc, dissolved	< 0.004	0.004	mg/L							
Zirconium, dissolved	< 0.0001	0.0001	mg/L							
Duplicate (B5H1364-DUP1)		**Source: 5081297-03**		Prepared: Aug-26-15, Analyzed: Aug-26-15						
Aluminum, dissolved	0.015	0.005	mg/L		0.013				11	
Antimony, dissolved	< 0.0001	0.0001	mg/L		0.0002				44	
Arsenic, dissolved	0.0012	0.0005	mg/L		0.0010				8	
Barium, dissolved	0.013	0.005	mg/L		0.012				7	
Beryllium, dissolved	< 0.0001	0.0001	mg/L		< 0.0001				14	
Bismuth, dissolved	< 0.0001	0.0001	mg/L		< 0.0001				20	
Boron, dissolved	0.034	0.004	mg/L		0.033			5	13	
Cadmium, dissolved	< 0.00001	0.00001	mg/L		< 0.00001				27	
Calcium, dissolved	16.8	0.2	mg/L		16.6			2	8	
Chromium, dissolved	0.0005	0.0005	mg/L		< 0.0005				14	
Cobalt, dissolved	0.00049	0.00005	mg/L		0.00044			11	10	RPD
Copper, dissolved	0.0011	0.0002	mg/L		0.0009			16	28	
Iron, dissolved	0.618	0.010	mg/L		0.592			4	14	

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

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REPORTED Aug-27-15

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Dissolved Metals, Batch B5H1364, Continued										
Duplicate (B5H1364-DUP1), Continued		**Source: 5081297-03**		Prepared: Aug-26-15, Analyzed: Aug-26-15						
Lead, dissolved	< 0.0001	0.0001	mg/L		< 0.0001				26	
Lithium, dissolved	< 0.0001	0.0001	mg/L		< 0.0001				14	
Magnesium, dissolved	5.84	0.01	mg/L		5.60			4	6	
Manganese, dissolved	0.285	0.0002	mg/L		0.274			4	9	
Molybdenum, dissolved	0.0009	0.0001	mg/L		0.0008			12	19	
Nickel, dissolved	0.0004	0.0002	mg/L		0.0005				21	
Phosphorus, dissolved	< 0.02	0.02	mg/L		< 0.02				14	
Potassium, dissolved	3.49	0.02	mg/L		3.34			4	8	
Selenium, dissolved	< 0.0005	0.0005	mg/L		< 0.0005				36	
Silicon, dissolved	4.7	0.5	mg/L		4.6			2	12	
Silver, dissolved	< 0.00005	0.00005	mg/L		< 0.00005				20	
Sodium, dissolved	13.3	0.02	mg/L		13.0			2	6	
Strontium, dissolved	0.129	0.001	mg/L		0.123			4	6	
Sulfur, dissolved	< 1	1	mg/L		< 1				26	
Tellurium, dissolved	< 0.0002	0.0002	mg/L		0.0002				20	
Thallium, dissolved	< 0.00002	0.00002	mg/L		< 0.00002				13	
Thorium, dissolved	< 0.0001	0.0001	mg/L		< 0.0001				30	
Tin, dissolved	< 0.0002	0.0002	mg/L		< 0.0002				6	
Titanium, dissolved	< 0.005	0.005	mg/L		< 0.005				20	
Uranium, dissolved	< 0.00002	0.00002	mg/L		< 0.00002				14	
Vanadium, dissolved	0.001	0.001	mg/L		< 0.001				20	
Zinc, dissolved	< 0.004	0.004	mg/L		< 0.004				11	
Zirconium, dissolved	< 0.0001	0.0001	mg/L		< 0.0001				36	
Reference (B5H1364-SRM1)				Prepared: Aug-26-15, Analyzed: Aug-26-15						
Aluminum, dissolved	0.301	0.005	mg/L	0.296		102	81-129			
Antimony, dissolved	0.0504	0.0001	mg/L	0.0505		100	88-114			
Arsenic, dissolved	0.123	0.0005	mg/L	0.122		101	88-114			
Barium, dissolved	0.731	0.005	mg/L	0.777		94	72-104			
Beryllium, dissolved	0.0478	0.0001	mg/L	0.0488		98	76-131			
Boron, dissolved	3.55	0.004	mg/L	3.40		105	75-121			
Cadmium, dissolved	0.0483	0.00001	mg/L	0.0490		99	89-111			
Calcium, dissolved	10.1	0.2	mg/L	10.2		99	86-121			
Chromium, dissolved	0.242	0.0005	mg/L	0.242		100	89-114			
Cobalt, dissolved	0.0378	0.00005	mg/L	0.0366		103	91-113			
Copper, dissolved	0.499	0.0002	mg/L	0.487		103	91-115			
Iron, dissolved	0.491	0.010	mg/L	0.469		105	77-124			
Lead, dissolved	0.196	0.0001	mg/L	0.193		102	92-113			
Lithium, dissolved	0.397	0.0001	mg/L	0.390		102	85-115			
Magnesium, dissolved	3.30	0.01	mg/L	3.31		100	78-120			
Manganese, dissolved	0.111	0.0002	mg/L	0.109		102	90-114			
Molybdenum, dissolved	0.201	0.0001	mg/L	0.197		102	90-111			
Nickel, dissolved	0.244	0.0002	mg/L	0.242		101	90-111			
Phosphorus, dissolved	0.23	0.02	mg/L	0.233		99	85-115			
Potassium, dissolved	5.90	0.02	mg/L	5.93		100	84-113			
Selenium, dissolved	0.117	0.0005	mg/L	0.115		102	85-115			
Sodium, dissolved	7.79	0.02	mg/L	7.64		102	82-123			
Strontium, dissolved	0.376	0.001	mg/L	0.363		104	88-112			
Thallium, dissolved	0.0808	0.00002	mg/L	0.0794		102	91-114			
Uranium, dissolved	0.0190	0.00002	mg/L	0.0192		99	85-120			
Vanadium, dissolved	0.369	0.001	mg/L	0.376		98	86-111			
Zinc, dissolved	2.37	0.004	mg/L	2.42		98	85-111			
General Parameters, Batch B5H1124										

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

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REPORTED Aug-27-15

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
General Parameters, Batch B5H1124, Continued										
Blank (B5H1124-BLK1)				Prepared: Aug-21-15, Analyzed: Aug-21-15						
Alkalinity, Total as CaCO3	< 1	1	mg/L							
Alkalinity, Phenolphthalein as CaCO3	< 1	1	mg/L							
Alkalinity, Bicarbonate as CaCO3	< 1	1	mg/L							
Alkalinity, Carbonate as CaCO3	< 1	1	mg/L							
Alkalinity, Hydroxide as CaCO3	< 1	1	mg/L							
Blank (B5H1124-BLK2)				Prepared: Aug-22-15, Analyzed: Aug-22-15						
Alkalinity, Total as CaCO3	< 1	1	mg/L							
Alkalinity, Phenolphthalein as CaCO3	< 1	1	mg/L							
Alkalinity, Bicarbonate as CaCO3	< 1	1	mg/L							
Alkalinity, Carbonate as CaCO3	< 1	1	mg/L							
Alkalinity, Hydroxide as CaCO3	< 1	1	mg/L							
Blank (B5H1124-BLK3)				Prepared: Aug-22-15, Analyzed: Aug-22-15						
Alkalinity, Total as CaCO3	< 1	1	mg/L							
Alkalinity, Phenolphthalein as CaCO3	< 1	1	mg/L							
Alkalinity, Bicarbonate as CaCO3	< 1	1	mg/L							
Alkalinity, Carbonate as CaCO3	< 1	1	mg/L							
Alkalinity, Hydroxide as CaCO3	< 1	1	mg/L							
LCS (B5H1124-BS1)				Prepared: Aug-21-15, Analyzed: Aug-21-15						
Alkalinity, Total as CaCO3	101	1	mg/L	100		101	96-108			
LCS (B5H1124-BS2)				Prepared: Aug-22-15, Analyzed: Aug-22-15						
Alkalinity, Total as CaCO3	101	1	mg/L	100		101	96-108			
LCS (B5H1124-BS3)				Prepared: Aug-22-15, Analyzed: Aug-22-15						
Alkalinity, Total as CaCO3	101	1	mg/L	100		101	96-108			
Total Recoverable Metals, Batch B5H1313										
Blank (B5H1313-BLK1)				Prepared: Aug-25-15, Analyzed: Aug-26-15						
Mercury, total	< 0.00002	0.00002	mg/L							
Blank (B5H1313-BLK2)				Prepared: Aug-25-15, Analyzed: Aug-26-15						
Mercury, total	< 0.00002	0.00002	mg/L							
Duplicate (B5H1313-DUP1)			**Source: 5081297-03**	Prepared: Aug-25-15, Analyzed: Aug-26-15						
Mercury, total	< 0.00002	0.00002	mg/L		< 0.00002				20	
Matrix Spike (B5H1313-MS1)			**Source: 5081297-04**	Prepared: Aug-25-15, Analyzed: Aug-26-15						
Mercury, total	0.00022	0.00002	mg/L	0.000250	< 0.00002	86	70-130			
Reference (B5H1313-SRM1)				Prepared: Aug-25-15, Analyzed: Aug-26-15						
Mercury, total	0.00305	0.00002	mg/L	0.00456		67	50-150			
Reference (B5H1313-SRM2)				Prepared: Aug-25-15, Analyzed: Aug-26-15						
Mercury, total	0.00278	0.00002	mg/L	0.00456		61	50-150			
Total Recoverable Metals, Batch B5H1365										
Blank (B5H1365-BLK1)				Prepared: Aug-26-15, Analyzed: Aug-26-15						
Aluminum, total	< 0.005	0.005	mg/L							
Antimony, total	< 0.0001	0.0001	mg/L							
Arsenic, total	< 0.0005	0.0005	mg/L							
Barium, total	< 0.005	0.005	mg/L							
Beryllium, total	< 0.0001	0.0001	mg/L							

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 5081297
REPORTED Aug-27-15

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Total Recoverable Metals, Batch B5H1365, Continued										
Blank (B5H1365-BLK1), Continued				Prepared: Aug-26-15, Analyzed: Aug-26-15						
Bismuth, total	< 0.0001	0.0001	mg/L							
Boron, total	< 0.004	0.004	mg/L							
Cadmium, total	< 0.00001	0.00001	mg/L							
Calcium, total	< 0.2	0.2	mg/L							
Chromium, total	< 0.0005	0.0005	mg/L							
Cobalt, total	< 0.00005	0.00005	mg/L							
Copper, total	< 0.0002	0.0002	mg/L							
Iron, total	< 0.01	0.01	mg/L							
Lead, total	< 0.0001	0.0001	mg/L							
Lithium, total	< 0.0001	0.0001	mg/L							
Magnesium, total	< 0.01	0.01	mg/L							
Manganese, total	< 0.0002	0.0002	mg/L							
Molybdenum, total	< 0.0001	0.0001	mg/L							
Nickel, total	< 0.0002	0.0002	mg/L							
Phosphorus, total	< 0.02	0.02	mg/L							
Potassium, total	< 0.02	0.02	mg/L							
Selenium, total	< 0.0005	0.0005	mg/L							
Silicon, total	< 0.5	0.5	mg/L							
Silver, total	< 0.00005	0.00005	mg/L							
Sodium, total	< 0.02	0.02	mg/L							
Strontium, total	< 0.001	0.001	mg/L							
Sulfur, total	< 1	1	mg/L							
Tellurium, total	< 0.0002	0.0002	mg/L							
Thallium, total	< 0.00002	0.00002	mg/L							
Thorium, total	< 0.0001	0.0001	mg/L							
Tin, total	< 0.0002	0.0002	mg/L							
Titanium, total	< 0.005	0.005	mg/L							
Uranium, total	< 0.00002	0.00002	mg/L							
Vanadium, total	< 0.001	0.001	mg/L							
Zinc, total	< 0.004	0.004	mg/L							
Zirconium, total	< 0.0001	0.0001	mg/L							
Blank (B5H1365-BLK2)				Prepared: Aug-26-15, Analyzed: Aug-27-15						
Aluminum, total	< 0.005	0.005	mg/L							
Antimony, total	< 0.0001	0.0001	mg/L							
Arsenic, total	< 0.0005	0.0005	mg/L							
Barium, total	< 0.005	0.005	mg/L							
Beryllium, total	< 0.0001	0.0001	mg/L							
Bismuth, total	< 0.0001	0.0001	mg/L							
Boron, total	< 0.004	0.004	mg/L							
Cadmium, total	< 0.00001	0.00001	mg/L							
Calcium, total	< 0.2	0.2	mg/L							
Chromium, total	< 0.0005	0.0005	mg/L							
Cobalt, total	< 0.00005	0.00005	mg/L							
Copper, total	< 0.0002	0.0002	mg/L							
Iron, total	< 0.01	0.01	mg/L							
Lead, total	< 0.0001	0.0001	mg/L							
Lithium, total	< 0.0001	0.0001	mg/L							
Magnesium, total	< 0.01	0.01	mg/L							
Manganese, total	< 0.0002	0.0002	mg/L							
Molybdenum, total	< 0.0001	0.0001	mg/L							
Nickel, total	< 0.0002	0.0002	mg/L							
Phosphorus, total	< 0.02	0.02	mg/L							
Potassium, total	< 0.02	0.02	mg/L							
Selenium, total	< 0.0005	0.0005	mg/L							
Silicon, total	< 0.5	0.5	mg/L							
Silver, total	< 0.00005	0.00005	mg/L							

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 5081297
REPORTED Aug-27-15

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Total Recoverable Metals, Batch B5H1365, Continued										
Blank (B5H1365-BLK2), Continued				Prepared: Aug-26-15, Analyzed: Aug-27-15						
Sodium, total	< 0.02	0.02	mg/L							
Strontium, total	< 0.001	0.001	mg/L							
Sulfur, total	< 1	1	mg/L							
Tellurium, total	< 0.0002	0.0002	mg/L							
Thallium, total	< 0.00002	0.00002	mg/L							
Thorium, total	< 0.0001	0.0001	mg/L							
Tin, total	< 0.0002	0.0002	mg/L							
Titanium, total	< 0.005	0.005	mg/L							
Uranium, total	< 0.00002	0.00002	mg/L							
Vanadium, total	< 0.001	0.001	mg/L							
Zinc, total	< 0.004	0.004	mg/L							
Zirconium, total	< 0.0001	0.0001	mg/L							
Duplicate (B5H1365-DUP1)		**Source: 5081297-04**		Prepared: Aug-26-15, Analyzed: Aug-27-15						
Aluminum, total	0.218	0.005	mg/L		0.224			3	29	
Antimony, total	0.0001	0.0001	mg/L		0.0002				31	
Arsenic, total	0.0015	0.0005	mg/L		0.0015				15	
Barium, total	0.010	0.005	mg/L		0.011				9	
Beryllium, total	< 0.0001	0.0001	mg/L		< 0.0001				16	
Bismuth, total	< 0.0001	0.0001	mg/L		< 0.0001				20	
Boron, total	0.025	0.004	mg/L		0.032			23	29	
Cadmium, total	< 0.00001	0.00001	mg/L		< 0.00001				33	
Calcium, total	27.2	0.2	mg/L		28.3			4	12	
Chromium, total	0.0005	0.0005	mg/L		0.0005				12	
Cobalt, total	0.00019	0.00005	mg/L		0.00020				13	
Copper, total	0.0015	0.0002	mg/L		0.0017			13	37	
Iron, total	0.48	0.01	mg/L		0.49			1	18	
Lead, total	0.0001	0.0001	mg/L		0.0001				23	
Lithium, total	0.0005	0.0001	mg/L		0.0005			1	19	
Magnesium, total	8.34	0.01	mg/L		8.54			2	10	
Manganese, total	0.0844	0.0002	mg/L		0.0868			3	13	
Molybdenum, total	0.0011	0.0001	mg/L		0.0012			2	20	
Nickel, total	0.0011	0.0002	mg/L		0.0010			9	28	
Phosphorus, total	< 0.02	0.02	mg/L		< 0.02				24	
Potassium, total	2.52	0.02	mg/L		2.61			4	13	
Selenium, total	< 0.0005	0.0005	mg/L		< 0.0005				24	
Silicon, total	8.0	0.5	mg/L		8.3			4	11	
Silver, total	< 0.00005	0.00005	mg/L		< 0.00005				18	
Sodium, total	12.0	0.02	mg/L		12.2			2	10	
Strontium, total	0.190	0.001	mg/L		0.194			2	9	
Sulfur, total	2	1	mg/L		2				24	
Tellurium, total	< 0.0002	0.0002	mg/L		< 0.0002				20	
Thallium, total	< 0.00002	0.00002	mg/L		< 0.00002				24	
Thorium, total	< 0.0001	0.0001	mg/L		< 0.0001				18	
Tin, total	0.0002	0.0002	mg/L		0.0002				18	
Titanium, total	0.008	0.005	mg/L		0.009				32	
Uranium, total	0.00006	0.00002	mg/L		0.00007				14	
Vanadium, total	0.002	0.001	mg/L		0.002				17	
Zinc, total	< 0.004	0.004	mg/L		< 0.004				8	
Zirconium, total	0.0001	0.0001	mg/L		0.0001				60	
Reference (B5H1365-SRM1)				Prepared: Aug-26-15, Analyzed: Aug-26-15						
Aluminum, total	0.299	0.005	mg/L	0.296		101	81-129			
Antimony, total	0.0524	0.0001	mg/L	0.0505		104	88-114			
Arsenic, total	0.128	0.0005	mg/L	0.122		105	88-114			
Barium, total	0.754	0.005	mg/L	0.777		97	72-104			
Beryllium, total	0.0477	0.0001	mg/L	0.0488		98	76-131			

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby) **WORK ORDER** 5081297
PROJECT 173.169 Maple Ridge WQ **REPORTED** Aug-27-15

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Total Recoverable Metals, Batch B5H1365, Continued										
Reference (B5H1365-SRM1), Continued				Prepared: Aug-26-15, Analyzed: Aug-26-15						
Boron, total	3.54	0.004	mg/L	3.40		104	75-121			
Cadmium, total	0.0493	0.00001	mg/L	0.0490		101	89-111			
Calcium, total	10.7	0.2	mg/L	10.2		105	86-121			
Chromium, total	0.246	0.0005	mg/L	0.242		102	89-114			
Cobalt, total	0.0389	0.00005	mg/L	0.0366		106	91-113			
Copper, total	0.512	0.0002	mg/L	0.487		105	91-115			
Iron, total	0.50	0.01	mg/L	0.469		106	77-124			
Lead, total	0.206	0.0001	mg/L	0.193		107	92-113			
Lithium, total	0.387	0.0001	mg/L	0.390		99	85-115			
Magnesium, total	3.38	0.01	mg/L	3.31		102	78-120			
Manganese, total	0.112	0.0002	mg/L	0.109		103	90-114			
Molybdenum, total	0.207	0.0001	mg/L	0.197		105	90-111			
Nickel, total	0.251	0.0002	mg/L	0.242		104	90-111			
Phosphorus, total	0.25	0.02	mg/L	0.233		108	85-115			
Potassium, total	6.17	0.02	mg/L	5.93		104	84-113			
Selenium, total	0.129	0.0005	mg/L	0.115		112	85-115			
Sodium, total	7.72	0.02	mg/L	7.64		101	82-123			
Strontium, total	0.381	0.001	mg/L	0.363		105	88-112			
Thallium, total	0.0852	0.00002	mg/L	0.0794		107	91-114			
Uranium, total	0.0203	0.00002	mg/L	0.0192		106	85-120			
Vanadium, total	0.374	0.001	mg/L	0.376		99	86-111			
Zinc, total	2.41	0.004	mg/L	2.42		100	85-111			
Reference (B5H1365-SRM2)				Prepared: Aug-26-15, Analyzed: Aug-27-15						
Aluminum, total	0.292	0.005	mg/L	0.296		99	81-129			
Antimony, total	0.0522	0.0001	mg/L	0.0505		103	88-114			
Arsenic, total	0.127	0.0005	mg/L	0.122		104	88-114			
Barium, total	0.762	0.005	mg/L	0.777		98	72-104			
Beryllium, total	0.0445	0.0001	mg/L	0.0488		91	76-131			
Boron, total	3.28	0.004	mg/L	3.40		97	75-121			
Cadmium, total	0.0505	0.00001	mg/L	0.0490		103	89-111			
Calcium, total	9.9	0.2	mg/L	10.2		97	86-121			
Chromium, total	0.242	0.0005	mg/L	0.242		100	89-114			
Cobalt, total	0.0387	0.00005	mg/L	0.0366		106	91-113			
Copper, total	0.508	0.0002	mg/L	0.487		104	91-115			
Iron, total	0.49	0.01	mg/L	0.469		105	77-124			
Lead, total	0.203	0.0001	mg/L	0.193		105	92-113			
Lithium, total	0.360	0.0001	mg/L	0.390		92	85-115			
Magnesium, total	3.32	0.01	mg/L	3.31		100	78-120			
Manganese, total	0.110	0.0002	mg/L	0.109		101	90-114			
Molybdenum, total	0.206	0.0001	mg/L	0.197		104	90-111			
Nickel, total	0.248	0.0002	mg/L	0.242		103	90-111			
Phosphorus, total	0.21	0.02	mg/L	0.233		91	85-115			
Potassium, total	5.92	0.02	mg/L	5.93		100	84-113			
Selenium, total	0.125	0.0005	mg/L	0.115		109	85-115			
Sodium, total	7.50	0.02	mg/L	7.64		98	82-123			
Strontium, total	0.379	0.001	mg/L	0.363		104	88-112			
Thallium, total	0.0834	0.00002	mg/L	0.0794		105	91-114			
Uranium, total	0.0199	0.00002	mg/L	0.0192		104	85-120			
Vanadium, total	0.368	0.001	mg/L	0.376		98	86-111			
Zinc, total	2.41	0.004	mg/L	2.42		100	85-111			

QC Qualifiers:

RPD Relative percent difference (RPD) of duplicate analysis are outside of control limits for unknown reason(s).

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 5081297
REPORTED Aug-27-15

		5081297-01	5081297-02	5081297-03	5081297-04	5081297-05
		Water	Water	Water	Water	Water
		Aug-19-15	Aug-19-15	Aug-19-15	Aug-19-15	Aug-19-15
		SA-1 (T2 Creek)	SA-2 (Millionaire Creek)	K-1 (Dunlop Creek)	K-2 (Spencer Creek)	Field Blank
Anions	Nitrate as N (mg/L)	0.406	0.423	0.028	0.159	
General Parameters	Alkalinity, Total as CaCO3 (mg/L)	72	29	76	108	< 1
	Alkalinity, Phenolphthalein as CaCO3 (mg/L)	< 1	< 1	< 1	< 1	< 1
	Alkalinity, Bicarbonate as CaCO3 (mg/L)	72	29	76	108	< 1
	Alkalinity, Carbonate as CaCO3 (mg/L)	< 1	< 1	< 1	< 1	< 1
	Alkalinity, Hydroxide as CaCO3 (mg/L)	< 1	< 1	< 1	< 1	< 1
Calculated Parameters	Hardness, Total (Diss. as CaCO3) (mg/L)	71.6	24.5	64.5	104	
	Hardness, Total (Total as CaCO3) (mg/L)	74.7	25.5	66.9	106	
Dissolved Metals	Aluminum, dissolved (mg/L)	0.010	0.012	0.013	0.008	
	Antimony, dissolved (mg/L)	0.0002	0.0001	0.0002	0.0002	
	Arsenic, dissolved (mg/L)	0.0005	< 0.0005	0.0010	0.0012	
	Barium, dissolved (mg/L)	0.010	0.008	0.012	0.009	
	Beryllium, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Bismuth, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Boron, dissolved (mg/L)	0.041	0.007	0.033	0.022	
	Cadmium, dissolved (mg/L)	< 0.00001	< 0.00001	< 0.00001	< 0.00001	
	Calcium, dissolved (mg/L)	16.4	7.4	16.6	28.0	
	Chromium, dissolved (mg/L)	< 0.0005	< 0.0005	< 0.0005	< 0.0005	
	Cobalt, dissolved (mg/L)	0.00008	< 0.00005	0.00044	0.00009	
	Copper, dissolved (mg/L)	0.0020	0.0009	0.0009	0.0011	
	Iron, dissolved (mg/L)	0.131	0.020	0.592	0.100	
	Lead, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Lithium, dissolved (mg/L)	0.0010	< 0.0001	< 0.0001	0.0002	
	Magnesium, dissolved (mg/L)	7.45	1.47	5.60	8.22	
	Manganese, dissolved (mg/L)	0.0167	0.0018	0.274	0.0756	
	Mercury, dissolved (mg/L)	< 0.00002	< 0.00002	< 0.00002	< 0.00002	
	Molybdenum, dissolved (mg/L)	0.0018	0.0007	0.0008	0.0012	
	Nickel, dissolved (mg/L)	0.0004	< 0.0002	0.0005	0.0004	
	Phosphorus, dissolved (mg/L)	0.06	< 0.02	< 0.02	< 0.02	
	Potassium, dissolved (mg/L)	2.45	0.64	3.34	2.57	
	Selenium, dissolved (mg/L)	< 0.0005	< 0.0005	< 0.0005	< 0.0005	
	Silicon, dissolved (mg/L)	8.8	5.9	4.6	7.6	
	Silver, dissolved (mg/L)	< 0.00005	< 0.00005	< 0.00005	< 0.00005	
	Sodium, dissolved (mg/L)	17.6	4.99	13.0	12.1	
	Strontium, dissolved (mg/L)	0.102	0.047	0.123	0.195	
	Sulfur, dissolved (mg/L)	1	< 1	< 1	< 1	
	Tellurium, dissolved (mg/L)	< 0.0002	0.0002	< 0.0002	< 0.0002	
	Thallium, dissolved (mg/L)	< 0.00002	< 0.00002	< 0.00002	< 0.00002	
	Thorium, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Tin, dissolved (mg/L)	< 0.0002	< 0.0002	< 0.0002	< 0.0002	
	Titanium, dissolved (mg/L)	< 0.005	< 0.005	< 0.005	< 0.005	
	Uranium, dissolved (mg/L)	0.00004	< 0.00002	< 0.00002	0.00006	
	Vanadium, dissolved (mg/L)	< 0.001	< 0.001	< 0.001	< 0.001	
	Zinc, dissolved (mg/L)	< 0.004	< 0.004	< 0.004	< 0.004	

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 5081297
REPORTED Aug-27-15

		5081297-01	5081297-02	5081297-03	5081297-04	5081297-05
		Water	Water	Water	Water	Water
		Aug-19-15	Aug-19-15	Aug-19-15	Aug-19-15	Aug-19-15
		SA-1 (T2 Creek)	SA-2 (Millionaire Creek)	K-1 (Dunlop Creek)	K-2 (Spencer Creek)	Field Blank
Dissolved Metals	Zirconium, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
Total Recoverable Metals	Aluminum, total (mg/L)	0.140	0.025	0.095	0.224	
	Antimony, total (mg/L)	0.0002	< 0.0001	0.0001	0.0002	
	Arsenic, total (mg/L)	0.0007	< 0.0005	0.0014	0.0015	
	Barium, total (mg/L)	0.012	0.008	0.013	0.011	
	Beryllium, total (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Bismuth, total (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Boron, total (mg/L)	0.044	0.019	0.043	0.032	
	Cadmium, total (mg/L)	0.00001	< 0.00001	< 0.00001	< 0.00001	
	Calcium, total (mg/L)	16.9	7.6	17.1	28.3	
	Chromium, total (mg/L)	0.0005	< 0.0005	< 0.0005	0.0005	
	Cobalt, total (mg/L)	0.00013	< 0.00005	0.00051	0.00020	
	Copper, total (mg/L)	0.0025	0.0012	0.0011	0.0017	
	Iron, total (mg/L)	0.35	0.04	1.06	0.49	
	Lead, total (mg/L)	0.0002	< 0.0001	0.0001	0.0001	
	Lithium, total (mg/L)	0.0012	0.0003	0.0003	0.0005	
	Magnesium, total (mg/L)	7.91	1.54	5.85	8.54	
	Manganese, total (mg/L)	0.0227	0.0024	0.298	0.0868	
	Mercury, total (mg/L)	< 0.00002	< 0.00002	< 0.00002	< 0.00002	
	Molybdenum, total (mg/L)	0.0022	0.0007	0.0007	0.0012	
	Nickel, total (mg/L)	0.0009	< 0.0002	0.0008	0.0010	
	Phosphorus, total (mg/L)	0.09	< 0.02	0.05	< 0.02	
	Potassium, total (mg/L)	2.61	0.69	3.45	2.61	
	Selenium, total (mg/L)	< 0.0005	< 0.0005	< 0.0005	< 0.0005	
	Silicon, total (mg/L)	9.7	6.6	4.9	8.3	
	Silver, total (mg/L)	< 0.00005	< 0.00005	< 0.00005	< 0.00005	
	Sodium, total (mg/L)	17.8	5.39	13.3	12.2	
	Strontium, total (mg/L)	0.106	0.048	0.123	0.194	
	Sulfur, total (mg/L)	4	< 1	2	2	
	Tellurium, total (mg/L)	< 0.0002	< 0.0002	< 0.0002	< 0.0002	
	Thallium, total (mg/L)	< 0.00002	< 0.00002	< 0.00002	< 0.00002	
	Thorium, total (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Tin, total (mg/L)	< 0.0002	< 0.0002	< 0.0002	< 0.0002	
	Titanium, total (mg/L)	0.009	< 0.005	< 0.005	0.009	
	Uranium, total (mg/L)	0.00005	< 0.00002	< 0.00002	0.00007	
	Vanadium, total (mg/L)	0.001	< 0.001	0.001	0.002	
	Zinc, total (mg/L)	0.005	< 0.004	< 0.004	< 0.004	
	Zirconium, total (mg/L)	0.0001	< 0.0001	< 0.0001	0.0001	
Microbiological Parameters	Coliforms, Total (MPN/100 mL)	1600	1600	1600	900	
	Coliforms, Fecal (MPN/100 mL)	1600	80	900	500	
	E. coli (MPN) (MPN/100 mL)	1600	80	900	500	

AY, RICHMOND, BC V6V 2K9
FAX: (604) 279-1599

97N, KELOWNA, BC V1X 5C3
FAX: (250) 765-3893

NW, EDMONTON, AB T5S 1H7
FAX: (480) 489-9700

CHAIN-OF-CUSTODY RECORD

COC#

RELINQUISHED BY:	DATE: 19-Aug-15	RECEIVED BY:	DATE: 08/19
Peter deKoning	TIME: 17:00	WI BS	TIME: 17:00
RELINQUISHED BY:	DATE:	RECEIVED BY:	DATE:
	TIME:		TIME:

REPORT TO:		INVOICE TO:	SAME AS REPORT TO ☐
COMPANY:	Kerr Wood Leidal Associates	COMPANY:	Kerr Wood Leidal Associates
ADDRESS:	200-4185A Still Creek Drive	ADDRESS:	200-4185A Still Creek Drive
	Burnaby, BC V5C 6G9		Burnaby, BC V5C 6G9
CONTACT:	Patrick Lilley	CONTACT:	Patrick Lilley / Michelle Derer
TEL / FAX:	604-293-3121 604-294-2090	TEL / FAX:	604-293-3252 604-294-2090
EMAIL PDF ☑	EDD ☐ Please email Excel file.	EMAIL PDF ☑	
EMAIL 1:	plilley@kwl.ca	EMAIL 1:	plilley@kwl.ca
EMAIL 2:	pdekoning@kwl.ca	EMAIL 2:	mderer@kwl.ca
MAIL HARDCOPY ☐	HOLD FOR P/U ☐ FAX ☐	MAIL HARDCOPY ☐	HOLD FOR P/U ☑

PROJECT:	PROJECT INFO:	PO #:
173.169 Maple Ridge WQ	Stormwater Monitoring	
SAMPLED BY:	SHIPPING INSTRUCTIONS:	RETURN COOLER(S) ☐
Peter deKoning	SHIP SUPPLIES (PLEASE SPECIFY IN OTHER INSTRUCTIONS SECTION)	☐

TURNAROUND Routine (4-7 days) ☑ Other:

TIME REQUESTED: Rush:* 1 Day ☐ 2 Day ☐ 3 Day ☐ * Contact the lab to confirm, surcharges may apply

ANALYSES REQUESTED:

	CLIENT SAMPLE ID:	MATRIX: DRINKING WATER	OTHER WATER	SOIL	OTHER	# CONTAINERS	SAMPLING: DATE DD-MMM-YY	TIME HH:MM	COMMENTS: CHLORINATED	FILTERED	PRESERVED	(i.e. flow/volume media ID/notes)
	SA-1 (T2 Creek)	☐	☑	☐	☐	6	19-Aug-15	11:25	☐	☐	☐	See below
	SA-2 (Millionaire Creek)	☐	☑	☐	☐	6	19-Aug-15	12:00	☐	☐	☐	See below
	K-1 (Dunlop Creek)	☐	☑	☐	☐	6	19-Aug-15	12:45	☐	☐	☐	See below
	K-2 (Spencer Creek)	☐	☑	☐	☐	6	19-Aug-15	13:15	☐	☐	☐	See below
	Field Blank	☐	☐	☐	☐	1	19-Aug-15	13:00	☐	☐	☐	
	Trip Blank	☐	☐	☐	☐	1	19-Aug-15	10:30	☐	☐	☐	
		☐	☐	☐	☐				☐	☐	☐	
		☐	☐	☐	☐				☐	☐	☐	
		☐	☐	☐	☐				☐	☐	☐	
		☐	☐	☐	☐				☐	☐	☐	
		☐	☐	☐	☐				☐	☐	☐	
		☐	☐	☐	☐				☐	☐	☐	

ANALYSES REQUESTED:	BTEX ☐ VPH ☐ MTBE ☐	EPH (not PAH Corrected) ☐	VOC ☐ VPH ☐	L/HEPH (PAH Corrected) ☐	PAH ☐	PHENOLS Chlorinated ☐ Non-Chlor. ☐	PCB ☐ GLYCOLS ☐ HAA ☐	METALS - WATER TOTAL (ICPMS - LOW Pkg.) ☑	METALS - WATER DISSOLVED (ICPMS - LOW Pkg.) ☑	Metals - SOIL (SALM) ☐ Inc. pH ☐	pH ☐ EC ☐ Alk ☑	TSS ☐ TDS ☐	BOD ☐ COD ☐	FECAL COLIFORMS ☑ HPC ☐	TOTAL COLIFORMS ☑ E-COLI ☑	PESTICIDES ☐ HERBICIDES ☐	SOIL VAPOUR ☐	ASBESTOS ☐	NITRATE-N ☑	HOLD
SA-1 (T2 Creek)	☐	☐	☐	☐	☐	☐	☐	☑	☑	☐	☑	☐	☐	☑	☑	☐	☐	☐	☐
SA-2 (Millionaire Creek)	☐	☐	☐	☐	☐	☐	☐	☑	☑	☐	☑	☐	☐	☑	☑	☐	☐	☐	☐
K-1 (Dunlop Creek)	☐	☐	☐	☐	☐	☐	☐	☑	☑	☐	☑	☐	☐	☑	☑	☐	☐	☐	☐
K-2 (Spencer Creek)	☐	☐	☐	☐	☐	☐	☐	☑	☑	☐	☑	☐	☐	☑	☑	☐	☐	☐	☐
Field Blank	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐
Trip Blank	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑

APPLICABLE REGULATORY LIMITS:
Canadian Drinking Water Quality Guidelines ☐
BC Drinking Water Protection Act/Reg. ☐
BC CSR: AL ☐ RL ☐ CL ☐ IL ☐ AW ☐
CCME ☑ Alberta Tier 1 ☐
OTHER: BC WQ Guidelines for Aquatic Life

SAMPLE RETENTION INSTRUCTIONS (Discarded 30 days after Report unless otherwise specified):
60 Days ☐ 90 Days ☐ Longer Date (Surcharges will apply):

OTHER INSTRUCTIONS:
Total and dissolved metals, mercury, and bacteriological samples have been preserved. Dissolved metals samples (incl. mercury) have also been filtered. Metals analysis should be LOW level ICPMS pkg. Add total + dissolved Hg. Alkalinity = SPECIATED alkalinity. Use higher dilutions for bacteriological tests pls.

PAYMENT
Cheque ☐
Credit ☐
Debit ☐
Cash ☐
Invoice ☐

SAMPLE RECEIPT TEMP (°C): 8.2

Work Order # _____

CUSTODY SEALS INTACT: ☐Y ☐N ☐NA

Required Fields Recommended Fields SHADED AREAS: LAB USE ONLY

CERTIFICATE OF ANALYSIS

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby) 200 - 4185A Still Creek Dr Burnaby, BC V5C 6G9	**TEL** **FAX**	(604) 294-2088 (604) 294-2090
ATTENTION	Patrick Lilley	**WORK ORDER**	5081724
PO NUMBER		**RECEIVED / TEMP**	Aug-26-15 14:54 / 9°C
PROJECT	173.169 Maple Ridge WQ	**REPORTED**	Sep-03-15
PROJECT INFO	Stormwater Monitoring		

General Comments:

CARO Analytical Services employs methods which are conducted according to procedures accepted by appropriate regulatory agencies, and/or are conducted in accordance with recognized professional standards using accepted testing methodologies and quality control efforts, except where otherwise agreed to by the client.

The results in this report apply to the samples analyzed in accordance with the Chain of Custody or Sample Requisition document. This analytical report must be reproduced in its entirety. CARO is not responsible for any loss or damage resulting directly or indirectly from error or omission in the conduct of testing. Liability is limited to the cost of analysis. Samples will be disposed of 30 days after the test report has been issued unless otherwise agreed to in writing.

Authorized By: **Brent Coates, B.Sc.**
Division Manager, Richmond

If you have any questions or concerns, please contact your Account Manager:
Bryan Shaw, Ph.D. (bshaw@caro.ca)

Locations:

#110 4011 Viking Way
Richmond, BC V6V 2K9
Tel: 604-279-1499 Fax: 604-279-1599

#102 3677 Highway 97N
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17225 109 Avenue
Edmonton, AB T5S 1H7
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www.caro.ca

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PROJECT	173.169 Maple Ridge WQ	**REPORTED**	Sep-03-15

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Method Blanks, Duplicates, Spikes, Reference Materials

Analytical Summary Appendix 2
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Chain of Custody Document Appendix 4
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ANALYSIS INFORMATION

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	5081724
PROJECT	173.169 Maple Ridge WQ	**REPORTED**	Sep-03-15

Analysis Description	Method Reference	Technique	Location
Alkalinity in Water (Speciated)	APHA 2320 B*	Titration with H2SO4	Kelowna
Anions in Water by IC	APHA 4110 B	Ion Chromatography with Chemical Suppression of Eluent Conductivity	Kelowna
Dissolved Metals	APHA 3030 B / APHA 3125 B	0.45 µm Filtration / Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	Richmond
E. coli (MPN)	APHA 9221	Multiple-Tube Fermentation	Sublet
Fecal Coliforms (MPN)	APHA 9221	Multiple-Tube Fermentation	Sublet
Hardness (as CaCO3)	APHA 2340 B	Calculation	N/A
Mercury, dissolved by CVAFS	EPA 245.7*	BrCl2 Oxidation / Cold Vapor Atomic Fluorescence Spectrometry (CVAFS)	Richmond
Mercury, total by CVAFS	EPA 245.7*	BrCl2 Oxidation / Cold Vapor Atomic Fluorescence Spectrometry (CVAFS)	Richmond
Total Coliforms (MPN)	APHA 9221	Multiple-Tube Fermentation	Sublet
Total Recoverable Metals	APHA 3030E* / APHA 3125 B	HNO3+HCl Hot Block Digestion / Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	Richmond

Note: An asterisk in the Method Reference indicates that the CARO method has been modified from the reference method

Method Reference Descriptions:

APHA	Standard Methods for the Examination of Water and Wastewater, 22nd Edition, American Public Health Association/American Water Works Association/Water Environment Federation
EPA	United States Environmental Protection Agency Test Methods

Glossary of Terms:

MRL	Method Reporting Limit
<	Less than the Reported Detection Limit (RDL) - the RDL may be higher than the MRL due to various factors such as dilutions, limited sample volume, high moisture, or interferences
mg/L	Milligrams per litre
MPN/100 mL	Most Probable Number per 100 millilitres

CARO ANALYTICAL SERVICES

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 5081724
REPORTED Sep-03-15

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SA-1 (T2 Creek) (5081724-01) [Water] Sampled: Aug-26-15 11:30							
Anions							
Nitrate as N	**0.333**	N/A	0.010	mg/L	N/A	Aug-28-15	
General Parameters							
Alkalinity, Total as CaCO3	**63**	N/A	1	mg/L	N/A	Aug-28-15	
Alkalinity, Phenolphthalein as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-28-15	
Alkalinity, Bicarbonate as CaCO3	**63**	N/A	1	mg/L	N/A	Aug-28-15	
Alkalinity, Carbonate as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-28-15	
Alkalinity, Hydroxide as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-28-15	
Calculated Parameters							
Hardness, Total (Diss. as CaCO3)	**63.1**	N/A	0.50	mg/L	N/A	N/A	
Hardness, Total (Total as CaCO3)	**63.9**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.012**	N/A	0.005	mg/L	N/A	Aug-28-15	
Antimony, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-28-15	
Arsenic, dissolved	**0.0006**	N/A	0.0005	mg/L	N/A	Aug-28-15	
Barium, dissolved	**0.009**	N/A	0.005	mg/L	N/A	Aug-28-15	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-28-15	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-28-15	
Boron, dissolved	**0.022**	N/A	0.004	mg/L	N/A	Aug-28-15	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	Aug-28-15	
Calcium, dissolved	**14.0**	N/A	0.2	mg/L	N/A	Aug-28-15	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Aug-28-15	
Cobalt, dissolved	**0.00007**	N/A	0.00005	mg/L	N/A	Aug-28-15	
Copper, dissolved	**0.0018**	N/A	0.0002	mg/L	N/A	Aug-28-15	
Iron, dissolved	**0.111**	N/A	0.010	mg/L	N/A	Aug-28-15	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-28-15	
Lithium, dissolved	**0.0006**	N/A	0.0001	mg/L	N/A	Aug-28-15	
Magnesium, dissolved	**6.85**	N/A	0.01	mg/L	N/A	Aug-28-15	
Manganese, dissolved	**0.0165**	N/A	0.0002	mg/L	N/A	Aug-28-15	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	Aug-30-15	Aug-31-15	
Molybdenum, dissolved	**0.0011**	N/A	0.0001	mg/L	N/A	Aug-28-15	
Nickel, dissolved	**0.0002**	N/A	0.0002	mg/L	N/A	Aug-28-15	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	Aug-28-15	
Potassium, dissolved	**2.29**	N/A	0.02	mg/L	N/A	Aug-28-15	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Aug-28-15	
Silicon, dissolved	**7.2**	N/A	0.5	mg/L	N/A	Aug-28-15	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	Aug-28-15	
Sodium, dissolved	**16.6**	N/A	0.02	mg/L	N/A	Aug-28-15	
Strontium, dissolved	**0.083**	N/A	0.001	mg/L	N/A	Aug-28-15	
Sulfur, dissolved	**7**	N/A	1	mg/L	N/A	Aug-28-15	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Aug-28-15	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Aug-28-15	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-28-15	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Aug-28-15	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	Aug-28-15	

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 5081724
REPORTED Sep-03-15

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SA-1 (T2 Creek) (5081724-01) [Water] Sampled: Aug-26-15 11:30, Continued							
Dissolved Metals, Continued							
Uranium, dissolved	**0.00004**	N/A	0.00002	mg/L	N/A	Aug-28-15	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	Aug-28-15	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	Aug-28-15	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-28-15	
Total Recoverable Metals							
Aluminum, total	**0.102**	N/A	0.005	mg/L	Aug-31-15	Sep-01-15	
Antimony, total	**0.0001**	N/A	0.0001	mg/L	Aug-31-15	Sep-01-15	
Arsenic, total	**0.0008**	N/A	0.0005	mg/L	Aug-31-15	Sep-01-15	
Barium, total	**0.009**	N/A	0.005	mg/L	Aug-31-15	Sep-01-15	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	Aug-31-15	Sep-01-15	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	Aug-31-15	Sep-01-15	
Boron, total	**0.028**	N/A	0.004	mg/L	Aug-31-15	Sep-01-15	
Cadmium, total	< 0.00001	N/A	0.00001	mg/L	Aug-31-15	Sep-01-15	
Calcium, total	**14.4**	N/A	0.2	mg/L	Aug-31-15	Sep-01-15	
Chromium, total	**0.0005**	N/A	0.0005	mg/L	Aug-31-15	Sep-01-15	
Cobalt, total	**0.00010**	N/A	0.00005	mg/L	Aug-31-15	Sep-01-15	
Copper, total	**0.0021**	N/A	0.0002	mg/L	Aug-31-15	Sep-01-15	
Iron, total	**0.29**	N/A	0.01	mg/L	Aug-31-15	Sep-01-15	
Lead, total	**0.0001**	N/A	0.0001	mg/L	Aug-31-15	Sep-01-15	
Lithium, total	**0.0009**	N/A	0.0001	mg/L	Aug-31-15	Sep-01-15	
Magnesium, total	**6.74**	N/A	0.01	mg/L	Aug-31-15	Sep-01-15	
Manganese, total	**0.0200**	N/A	0.0002	mg/L	Aug-31-15	Sep-01-15	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	Aug-30-15	Aug-31-15	
Molybdenum, total	**0.0011**	N/A	0.0001	mg/L	Aug-31-15	Sep-01-15	
Nickel, total	**0.0010**	N/A	0.0002	mg/L	Aug-31-15	Sep-01-15	
Phosphorus, total	**0.04**	N/A	0.02	mg/L	Aug-31-15	Sep-01-15	
Potassium, total	**2.29**	N/A	0.02	mg/L	Aug-31-15	Sep-01-15	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	Aug-31-15	Sep-01-15	
Silicon, total	**7.6**	N/A	0.5	mg/L	Aug-31-15	Sep-01-15	
Silver, total	**0.00121**	N/A	0.00005	mg/L	Aug-31-15	Sep-01-15	
Sodium, total	**16.4**	N/A	0.02	mg/L	Aug-31-15	Sep-01-15	
Strontium, total	**0.084**	N/A	0.001	mg/L	Aug-31-15	Sep-01-15	
Sulfur, total	**7**	N/A	1	mg/L	Aug-31-15	Sep-01-15	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	Aug-31-15	Sep-01-15	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	Aug-31-15	Sep-01-15	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	Aug-31-15	Sep-01-15	
Tin, total	< 0.0002	N/A	0.0002	mg/L	Aug-31-15	Sep-01-15	
Titanium, total	< 0.005	N/A	0.005	mg/L	Aug-31-15	Sep-01-15	
Uranium, total	**0.00003**	N/A	0.00002	mg/L	Aug-31-15	Sep-01-15	
Vanadium, total	**0.001**	N/A	0.001	mg/L	Aug-31-15	Sep-01-15	
Zinc, total	**0.005**	N/A	0.004	mg/L	Aug-31-15	Sep-01-15	
Zirconium, total	< 0.0001	N/A	0.0001	mg/L	Aug-31-15	Sep-01-15	
Microbiological Parameters							
Coliforms, Total	**9000**	N/A	2	MPN/100 mL		Aug-27-15	

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	5081724
PROJECT	173.169 Maple Ridge WQ	**REPORTED**	Sep-03-15

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SA-1 (T2 Creek) (5081724-01) [Water] Sampled: Aug-26-15 11:30, Continued							
Microbiological Parameters, Continued							
Coliforms, Fecal	**5000**	N/A	2	MPN/100 mL		Aug-27-15	
E. coli (MPN)	**5000**	N/A	2	MPN/100 mL		Aug-27-15	
Sample ID: SA-2 (Millionaire Creek) (5081724-02) [Water] Sampled: Aug-26-15 12:00							
Anions							
Nitrate as N	**0.390**	N/A	0.010	mg/L	N/A	Aug-28-15	
General Parameters							
Alkalinity, Total as CaCO3	**28**	N/A	1	mg/L	N/A	Aug-28-15	
Alkalinity, Phenolphthalein as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-28-15	
Alkalinity, Bicarbonate as CaCO3	**28**	N/A	1	mg/L	N/A	Aug-28-15	
Alkalinity, Carbonate as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-28-15	
Alkalinity, Hydroxide as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-28-15	
Calculated Parameters							
Hardness, Total (Diss. as CaCO3)	**23.9**	N/A	0.50	mg/L	N/A	N/A	
Hardness, Total (Total as CaCO3)	**24.8**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.012**	N/A	0.005	mg/L	N/A	Aug-28-15	
Antimony, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-28-15	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Aug-28-15	
Barium, dissolved	**0.007**	N/A	0.005	mg/L	N/A	Aug-28-15	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-28-15	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-28-15	
Boron, dissolved	**0.008**	N/A	0.004	mg/L	N/A	Aug-28-15	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	Aug-28-15	
Calcium, dissolved	**7.1**	N/A	0.2	mg/L	N/A	Aug-28-15	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Aug-28-15	
Cobalt, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	Aug-28-15	
Copper, dissolved	**0.0010**	N/A	0.0002	mg/L	N/A	Aug-28-15	
Iron, dissolved	**0.018**	N/A	0.010	mg/L	N/A	Aug-28-15	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-28-15	
Lithium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-28-15	
Magnesium, dissolved	**1.48**	N/A	0.01	mg/L	N/A	Aug-28-15	
Manganese, dissolved	**0.0017**	N/A	0.0002	mg/L	N/A	Aug-28-15	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	Aug-30-15	Aug-31-15	
Molybdenum, dissolved	**0.0006**	N/A	0.0001	mg/L	N/A	Aug-28-15	
Nickel, dissolved	**0.0002**	N/A	0.0002	mg/L	N/A	Aug-28-15	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	Aug-28-15	
Potassium, dissolved	**0.66**	N/A	0.02	mg/L	N/A	Aug-28-15	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Aug-28-15	
Silicon, dissolved	**5.2**	N/A	0.5	mg/L	N/A	Aug-28-15	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	Aug-28-15	
Sodium, dissolved	**6.17**	N/A	0.02	mg/L	N/A	Aug-28-15	
Strontium, dissolved	**0.043**	N/A	0.001	mg/L	N/A	Aug-28-15	

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 5081724
REPORTED Sep-03-15

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SA-2 (Millionaire Creek) (5081724-02) [Water] Sampled: Aug-26-15 12:00, Continued							
Dissolved Metals, Continued							
Sulfur, dissolved	**8**	N/A	1	mg/L	N/A	Aug-28-15	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Aug-28-15	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Aug-28-15	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-28-15	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Aug-28-15	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	Aug-28-15	
Uranium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Aug-28-15	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	Aug-28-15	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	Aug-28-15	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-28-15	
Total Recoverable Metals							
Aluminum, total	**0.030**	N/A	0.005	mg/L	Aug-31-15	Sep-01-15	
Antimony, total	**0.0003**	N/A	0.0001	mg/L	Aug-31-15	Sep-01-15	
Arsenic, total	< 0.0005	N/A	0.0005	mg/L	Aug-31-15	Sep-01-15	
Barium, total	**0.008**	N/A	0.005	mg/L	Aug-31-15	Sep-01-15	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	Aug-31-15	Sep-01-15	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	Aug-31-15	Sep-01-15	
Boron, total	**0.009**	N/A	0.004	mg/L	Aug-31-15	Sep-01-15	
Cadmium, total	< 0.00001	N/A	0.00001	mg/L	Aug-31-15	Sep-01-15	
Calcium, total	**7.4**	N/A	0.2	mg/L	Aug-31-15	Sep-01-15	
Chromium, total	< 0.0005	N/A	0.0005	mg/L	Aug-31-15	Sep-01-15	
Cobalt, total	< 0.00005	N/A	0.00005	mg/L	Aug-31-15	Sep-01-15	
Copper, total	**0.0015**	N/A	0.0002	mg/L	Aug-31-15	Sep-01-15	
Iron, total	**0.04**	N/A	0.01	mg/L	Aug-31-15	Sep-01-15	
Lead, total	< 0.0001	N/A	0.0001	mg/L	Aug-31-15	Sep-01-15	
Lithium, total	< 0.0001	N/A	0.0001	mg/L	Aug-31-15	Sep-01-15	
Magnesium, total	**1.55**	N/A	0.01	mg/L	Aug-31-15	Sep-01-15	
Manganese, total	**0.0029**	N/A	0.0002	mg/L	Aug-31-15	Sep-01-15	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	Aug-30-15	Aug-31-15	
Molybdenum, total	**0.0007**	N/A	0.0001	mg/L	Aug-31-15	Sep-01-15	
Nickel, total	**0.0004**	N/A	0.0002	mg/L	Aug-31-15	Sep-01-15	
Phosphorus, total	< 0.02	N/A	0.02	mg/L	Aug-31-15	Sep-01-15	
Potassium, total	**0.71**	N/A	0.02	mg/L	Aug-31-15	Sep-01-15	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	Aug-31-15	Sep-01-15	
Silicon, total	**5.8**	N/A	0.5	mg/L	Aug-31-15	Sep-01-15	
Silver, total	**0.00119**	N/A	0.00005	mg/L	Aug-31-15	Sep-01-15	
Sodium, total	**6.39**	N/A	0.02	mg/L	Aug-31-15	Sep-01-15	
Strontium, total	**0.048**	N/A	0.001	mg/L	Aug-31-15	Sep-01-15	
Sulfur, total	**6**	N/A	1	mg/L	Aug-31-15	Sep-01-15	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	Aug-31-15	Sep-01-15	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	Aug-31-15	Sep-01-15	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	Aug-31-15	Sep-01-15	
Tin, total	< 0.0002	N/A	0.0002	mg/L	Aug-31-15	Sep-01-15	
Titanium, total	< 0.005	N/A	0.005	mg/L	Aug-31-15	Sep-01-15	
Uranium, total	< 0.00002	N/A	0.00002	mg/L	Aug-31-15	Sep-01-15	

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	5081724
PROJECT	173.169 Maple Ridge WQ	**REPORTED**	Sep-03-15

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: SA-2 (Millionaire Creek) (5081724-02) [Water] Sampled: Aug-26-15 12:00, Continued							
Total Recoverable Metals, Continued							
Vanadium, total	< 0.001	N/A	0.001	mg/L	Aug-31-15	Sep-01-15	
Zinc, total	< 0.004	N/A	0.004	mg/L	Aug-31-15	Sep-01-15	
Zirconium, total	< 0.0001	N/A	0.0001	mg/L	Aug-31-15	Sep-01-15	
Microbiological Parameters							
Coliforms, Total	**3000**	N/A	2	MPN/100 mL		Aug-27-15	
Coliforms, Fecal	**30**	N/A	2	MPN/100 mL		Aug-27-15	
E. coli (MPN)	**30**	N/A	2	MPN/100 mL		Aug-27-15	
Sample ID: K-1 (Dunlop Creek) (5081724-03) [Water] Sampled: Aug-26-15 12:35							
Anions							
Nitrate as N	**0.019**	N/A	0.010	mg/L	N/A	Aug-28-15	
General Parameters							
Alkalinity, Total as CaCO3	**79**	N/A	1	mg/L	N/A	Aug-28-15	
Alkalinity, Phenolphthalein as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-28-15	
Alkalinity, Bicarbonate as CaCO3	**79**	N/A	1	mg/L	N/A	Aug-28-15	
Alkalinity, Carbonate as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-28-15	
Alkalinity, Hydroxide as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-28-15	
Calculated Parameters							
Hardness, Total (Diss. as CaCO3)	**65.7**	N/A	0.50	mg/L	N/A	N/A	
Hardness, Total (Total as CaCO3)	**68.4**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.016**	N/A	0.005	mg/L	N/A	Aug-28-15	
Antimony, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-28-15	
Arsenic, dissolved	**0.0010**	N/A	0.0005	mg/L	N/A	Aug-28-15	
Barium, dissolved	**0.012**	N/A	0.005	mg/L	N/A	Aug-28-15	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-28-15	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-28-15	
Boron, dissolved	**0.029**	N/A	0.004	mg/L	N/A	Aug-28-15	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	Aug-28-15	
Calcium, dissolved	**16.6**	N/A	0.2	mg/L	N/A	Aug-28-15	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Aug-28-15	
Cobalt, dissolved	**0.00041**	N/A	0.00005	mg/L	N/A	Aug-28-15	
Copper, dissolved	**0.0009**	N/A	0.0002	mg/L	N/A	Aug-28-15	
Iron, dissolved	**0.574**	N/A	0.010	mg/L	N/A	Aug-28-15	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-28-15	
Lithium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-28-15	
Magnesium, dissolved	**5.90**	N/A	0.01	mg/L	N/A	Aug-28-15	
Manganese, dissolved	**0.205**	N/A	0.0002	mg/L	N/A	Aug-28-15	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	Aug-30-15	Aug-31-15	
Molybdenum, dissolved	**0.0007**	N/A	0.0001	mg/L	N/A	Aug-28-15	
Nickel, dissolved	**0.0007**	N/A	0.0002	mg/L	N/A	Aug-28-15	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	Aug-28-15	

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	5081724
PROJECT	173.169 Maple Ridge WQ	**REPORTED**	Sep-03-15

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: K-1 (Dunlop Creek) (5081724-03) [Water] Sampled: Aug-26-15 12:35, Continued							
Dissolved Metals, Continued							
Potassium, dissolved	**3.25**	N/A	0.02	mg/L	N/A	Aug-28-15	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Aug-28-15	
Silicon, dissolved	**4.1**	N/A	0.5	mg/L	N/A	Aug-28-15	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	Aug-28-15	
Sodium, dissolved	**14.3**	N/A	0.02	mg/L	N/A	Aug-28-15	
Strontium, dissolved	**0.111**	N/A	0.001	mg/L	N/A	Aug-28-15	
Sulfur, dissolved	**9**	N/A	1	mg/L	N/A	Aug-28-15	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Aug-28-15	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Aug-28-15	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-28-15	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Aug-28-15	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	Aug-28-15	
Uranium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Aug-28-15	
Vanadium, dissolved	**0.001**	N/A	0.001	mg/L	N/A	Aug-28-15	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	Aug-28-15	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-28-15	
Total Recoverable Metals							
Aluminum, total	**0.172**	N/A	0.005	mg/L	Aug-31-15	Sep-01-15	
Antimony, total	**0.0001**	N/A	0.0001	mg/L	Aug-31-15	Sep-01-15	
Arsenic, total	**0.0015**	N/A	0.0005	mg/L	Aug-31-15	Sep-01-15	
Barium, total	**0.015**	N/A	0.005	mg/L	Aug-31-15	Sep-01-15	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	Aug-31-15	Sep-01-15	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	Aug-31-15	Sep-01-15	
Boron, total	**0.035**	N/A	0.004	mg/L	Aug-31-15	Sep-01-15	
Cadmium, total	< 0.00001	N/A	0.00001	mg/L	Aug-31-15	Sep-01-15	
Calcium, total	**17.3**	N/A	0.2	mg/L	Aug-31-15	Sep-01-15	
Chromium, total	**0.0006**	N/A	0.0005	mg/L	Aug-31-15	Sep-01-15	
Cobalt, total	**0.00056**	N/A	0.00005	mg/L	Aug-31-15	Sep-01-15	
Copper, total	**0.0013**	N/A	0.0002	mg/L	Aug-31-15	Sep-01-15	
Iron, total	**1.12**	N/A	0.01	mg/L	Aug-31-15	Sep-01-15	
Lead, total	**0.0001**	N/A	0.0001	mg/L	Aug-31-15	Sep-01-15	
Lithium, total	**0.0002**	N/A	0.0001	mg/L	Aug-31-15	Sep-01-15	
Magnesium, total	**6.10**	N/A	0.01	mg/L	Aug-31-15	Sep-01-15	
Manganese, total	**0.264**	N/A	0.0002	mg/L	Aug-31-15	Sep-01-15	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	Aug-30-15	Aug-31-15	
Molybdenum, total	**0.0007**	N/A	0.0001	mg/L	Aug-31-15	Sep-01-15	
Nickel, total	**0.0014**	N/A	0.0002	mg/L	Aug-31-15	Sep-01-15	
Phosphorus, total	**0.06**	N/A	0.02	mg/L	Aug-31-15	Sep-01-15	
Potassium, total	**3.78**	N/A	0.02	mg/L	Aug-31-15	Sep-01-15	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	Aug-31-15	Sep-01-15	
Silicon, total	**5.0**	N/A	0.5	mg/L	Aug-31-15	Sep-01-15	
Silver, total	**0.00111**	N/A	0.00005	mg/L	Aug-31-15	Sep-01-15	
Sodium, total	**14.2**	N/A	0.02	mg/L	Aug-31-15	Sep-01-15	
Strontium, total	**0.126**	N/A	0.001	mg/L	Aug-31-15	Sep-01-15	
Sulfur, total	**7**	N/A	1	mg/L	Aug-31-15	Sep-01-15	

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 5081724
REPORTED Sep-03-15

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: K-1 (Dunlop Creek) (5081724-03) [Water] Sampled: Aug-26-15 12:35, Continued							
Total Recoverable Metals, Continued							
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	Aug-31-15	Sep-01-15	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	Aug-31-15	Sep-01-15	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	Aug-31-15	Sep-01-15	
Tin, total	< 0.0002	N/A	0.0002	mg/L	Aug-31-15	Sep-01-15	
Titanium, total	**0.008**	N/A	0.005	mg/L	Aug-31-15	Sep-01-15	
Uranium, total	< 0.00002	N/A	0.00002	mg/L	Aug-31-15	Sep-01-15	
Vanadium, total	**0.002**	N/A	0.001	mg/L	Aug-31-15	Sep-01-15	
Zinc, total	< 0.004	N/A	0.004	mg/L	Aug-31-15	Sep-01-15	
Zirconium, total	**0.0001**	N/A	0.0001	mg/L	Aug-31-15	Sep-01-15	
Microbiological Parameters							
Coliforms, Total	**170**	N/A	2	MPN/100 mL		Aug-27-15	
Coliforms, Fecal	**17**	N/A	2	MPN/100 mL		Aug-27-15	
E. coli (MPN)	**17**	N/A	2	MPN/100 mL		Aug-27-15	
Sample ID: K-2 (Spencer Creek) (5081724-04) [Water] Sampled: Aug-26-15 13:05							
Anions							
Nitrate as N	**0.121**	N/A	0.010	mg/L	N/A	Aug-28-15	
General Parameters							
Alkalinity, Total as CaCO3	**105**	N/A	1	mg/L	N/A	Aug-28-15	
Alkalinity, Phenolphthalein as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-28-15	
Alkalinity, Bicarbonate as CaCO3	**105**	N/A	1	mg/L	N/A	Aug-28-15	
Alkalinity, Carbonate as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-28-15	
Alkalinity, Hydroxide as CaCO3	< 1	N/A	1	mg/L	N/A	Aug-28-15	
Calculated Parameters							
Hardness, Total (Diss. as CaCO3)	**106**	N/A	0.50	mg/L	N/A	N/A	
Hardness, Total (Total as CaCO3)	**109**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.008**	N/A	0.005	mg/L	N/A	Aug-28-15	
Antimony, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-28-15	
Arsenic, dissolved	**0.0011**	N/A	0.0005	mg/L	N/A	Aug-28-15	
Barium, dissolved	**0.008**	N/A	0.005	mg/L	N/A	Aug-28-15	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-28-15	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-28-15	
Boron, dissolved	**0.020**	N/A	0.004	mg/L	N/A	Aug-28-15	
Cadmium, dissolved	**0.00001**	N/A	0.00001	mg/L	N/A	Aug-28-15	
Calcium, dissolved	**28.0**	N/A	0.2	mg/L	N/A	Aug-28-15	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Aug-28-15	
Cobalt, dissolved	**0.00010**	N/A	0.00005	mg/L	N/A	Aug-28-15	
Copper, dissolved	**0.0011**	N/A	0.0002	mg/L	N/A	Aug-28-15	
Iron, dissolved	**0.091**	N/A	0.010	mg/L	N/A	Aug-28-15	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-28-15	
Lithium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-28-15	

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	5081724
PROJECT	173.169 Maple Ridge WQ	**REPORTED**	Sep-03-15

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: K-2 (Spencer Creek) (5081724-04) [Water] Sampled: Aug-26-15 13:05, Continued							
Dissolved Metals, Continued							
Magnesium, dissolved	**8.64**	N/A	0.01	mg/L	N/A	Aug-28-15	
Manganese, dissolved	**0.0772**	N/A	0.0002	mg/L	N/A	Aug-28-15	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	Aug-30-15	Aug-31-15	
Molybdenum, dissolved	**0.0010**	N/A	0.0001	mg/L	N/A	Aug-28-15	
Nickel, dissolved	**0.0006**	N/A	0.0002	mg/L	N/A	Aug-28-15	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	Aug-28-15	
Potassium, dissolved	**2.43**	N/A	0.02	mg/L	N/A	Aug-28-15	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	Aug-28-15	
Silicon, dissolved	**6.3**	N/A	0.5	mg/L	N/A	Aug-28-15	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	Aug-28-15	
Sodium, dissolved	**13.3**	N/A	0.02	mg/L	N/A	Aug-28-15	
Strontium, dissolved	**0.178**	N/A	0.001	mg/L	N/A	Aug-28-15	
Sulfur, dissolved	**10**	N/A	1	mg/L	N/A	Aug-28-15	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Aug-28-15	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	Aug-28-15	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-28-15	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	Aug-28-15	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	Aug-28-15	
Uranium, dissolved	**0.00007**	N/A	0.00002	mg/L	N/A	Aug-28-15	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	Aug-28-15	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	Aug-28-15	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	Aug-28-15	
Total Recoverable Metals							
Aluminum, total	**0.482**	N/A	0.005	mg/L	Aug-31-15	Sep-01-15	
Antimony, total	**0.0001**	N/A	0.0001	mg/L	Aug-31-15	Sep-01-15	
Arsenic, total	**0.0017**	N/A	0.0005	mg/L	Aug-31-15	Sep-01-15	
Barium, total	**0.012**	N/A	0.005	mg/L	Aug-31-15	Sep-01-15	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	Aug-31-15	Sep-01-15	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	Aug-31-15	Sep-01-15	
Boron, total	**0.023**	N/A	0.004	mg/L	Aug-31-15	Sep-01-15	
Cadmium, total	< 0.00001	N/A	0.00001	mg/L	Aug-31-15	Sep-01-15	
Calcium, total	**30.1**	N/A	0.2	mg/L	Aug-31-15	Sep-01-15	
Chromium, total	**0.0008**	N/A	0.0005	mg/L	Aug-31-15	Sep-01-15	
Cobalt, total	**0.00035**	N/A	0.00005	mg/L	Aug-31-15	Sep-01-15	
Copper, total	**0.0018**	N/A	0.0002	mg/L	Aug-31-15	Sep-01-15	
Iron, total	**0.83**	N/A	0.01	mg/L	Aug-31-15	Sep-01-15	
Lead, total	**0.0002**	N/A	0.0001	mg/L	Aug-31-15	Sep-01-15	
Lithium, total	**0.0005**	N/A	0.0001	mg/L	Aug-31-15	Sep-01-15	
Magnesium, total	**8.26**	N/A	0.01	mg/L	Aug-31-15	Sep-01-15	
Manganese, total	**0.130**	N/A	0.0002	mg/L	Aug-31-15	Sep-01-15	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	Aug-30-15	Aug-31-15	
Molybdenum, total	**0.0010**	N/A	0.0001	mg/L	Aug-31-15	Sep-01-15	
Nickel, total	**0.0014**	N/A	0.0002	mg/L	Aug-31-15	Sep-01-15	
Phosphorus, total	**0.07**	N/A	0.02	mg/L	Aug-31-15	Sep-01-15	
Potassium, total	**2.61**	N/A	0.02	mg/L	Aug-31-15	Sep-01-15	

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Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: K-2 (Spencer Creek) (5081724-04) [Water] Sampled: Aug-26-15 13:05, Continued							
Total Recoverable Metals, Continued							
Selenium, total	< 0.0005	N/A	0.0005	mg/L	Aug-31-15	Sep-01-15	
Silicon, total	**7.8**	N/A	0.5	mg/L	Aug-31-15	Sep-01-15	
Silver, total	**0.00087**	N/A	0.00005	mg/L	Aug-31-15	Sep-01-15	
Sodium, total	**13.4**	N/A	0.02	mg/L	Aug-31-15	Sep-01-15	
Strontium, total	**0.187**	N/A	0.001	mg/L	Aug-31-15	Sep-01-15	
Sulfur, total	**8**	N/A	1	mg/L	Aug-31-15	Sep-01-15	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	Aug-31-15	Sep-01-15	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	Aug-31-15	Sep-01-15	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	Aug-31-15	Sep-01-15	
Tin, total	< 0.0002	N/A	0.0002	mg/L	Aug-31-15	Sep-01-15	
Titanium, total	**0.019**	N/A	0.005	mg/L	Aug-31-15	Sep-01-15	
Uranium, total	**0.00007**	N/A	0.00002	mg/L	Aug-31-15	Sep-01-15	
Vanadium, total	**0.003**	N/A	0.001	mg/L	Aug-31-15	Sep-01-15	
Zinc, total	< 0.004	N/A	0.004	mg/L	Aug-31-15	Sep-01-15	
Zirconium, total	**0.0002**	N/A	0.0001	mg/L	Aug-31-15	Sep-01-15	
Microbiological Parameters							
Coliforms, Total	**5000**	N/A	2	MPN/100 mL		Aug-27-15	
Coliforms, Fecal	**140**	N/A	2	MPN/100 mL		Aug-27-15	
E. coli (MPN)	**140**	N/A	2	MPN/100 mL		Aug-27-15	
Sample ID: Field Blank (5081724-05) [Water] Sampled: Aug-26-15 11:30							
Microbiological Parameters							
E. coli (MPN)	**ND**	N/A	2	MPN/100 mL		Aug-27-15	

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The following section displays the quality control (QC) data that is associated with your sample data. Groups of samples are prepared in "batches" and analyzed in conjunction with QC samples that ensure your data is of the highest quality. Common QC types include:

- **Method Blank (Blk)**: Laboratory reagent water is carried through sample preparation and analysis steps. Method Blanks indicate that results are free from contamination, i.e. not biased high from sources such as the sample container or the laboratory environment
- **Duplicate (Dup)**: Preparation and analysis of a replicate aliquot of a sample. Duplicates provide a measure of the analytical method's precision, i.e. how reproducible a result is. Duplicates are only reported if they are associated with your sample data.
- **Blank Spike (BS)**: A known amount of standard is carried through sample preparation and analysis steps. Blank Spikes, also known as laboratory control samples (LCS), are prepared from a different source of standard than used for the calibration. They ensure that the calibration is acceptable (i.e. not biased high or low) and also provide a measure of the analytical method's accuracy (i.e. closeness of the result to a target value).
- **Standard Reference Material (SRM)**: A material of similar matrix to the samples, externally certified for the parameter(s) listed. Standard Reference Materials ensure that the preparation steps in the method are adequate to achieve acceptable recoveries of the parameter(s) tested.

Each QC type is analyzed at a 5-10% frequency, i.e. one blank/duplicate/spike for every 10 samples. For all types of QC, the specified recovery (% Rec) and relative percent difference (RPD) limits are derived from long-term method performance averages and/or prescribed by the reference method.

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Anions, Batch B5H1494										
Blank (B5H1494-BLK1)				Prepared: Aug-26-15, Analyzed: Aug-26-15						
Nitrate as N	< 0.010	0.010	mg/L							
Blank (B5H1494-BLK2)				Prepared: Aug-28-15, Analyzed: Aug-28-15						
Nitrate as N	< 0.010	0.010	mg/L							
Blank (B5H1494-BLK3)				Prepared: Aug-28-15, Analyzed: Aug-28-15						
Nitrate as N	< 0.010	0.010	mg/L							
LCS (B5H1494-BS1)				Prepared: Aug-26-15, Analyzed: Aug-26-15						
Nitrate as N	4.03	0.010	mg/L	4.00		101	85-115			
LCS (B5H1494-BS2)				Prepared: Aug-28-15, Analyzed: Aug-28-15						
Nitrate as N	4.00	0.010	mg/L	4.00		100	85-115			
LCS (B5H1494-BS3)				Prepared: Aug-28-15, Analyzed: Aug-28-15						
Nitrate as N	4.02	0.010	mg/L	4.00		101	85-115			
Dissolved Metals, Batch B5H1476										
Blank (B5H1476-BLK1)				Prepared: Aug-28-15, Analyzed: Aug-28-15						
Aluminum, dissolved	< 0.005	0.005	mg/L							
Antimony, dissolved	< 0.0001	0.0001	mg/L							
Arsenic, dissolved	< 0.0005	0.0005	mg/L							
Barium, dissolved	< 0.005	0.005	mg/L							
Beryllium, dissolved	< 0.0001	0.0001	mg/L							
Bismuth, dissolved	< 0.0001	0.0001	mg/L							
Boron, dissolved	< 0.004	0.004	mg/L							
Cadmium, dissolved	< 0.00001	0.00001	mg/L							
Calcium, dissolved	< 0.2	0.2	mg/L							
Chromium, dissolved	< 0.0005	0.0005	mg/L							
Cobalt, dissolved	< 0.00005	0.00005	mg/L							
Copper, dissolved	< 0.0002	0.0002	mg/L							

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Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Dissolved Metals, Batch B5H1476, Continued										
Blank (B5H1476-BLK1), Continued				Prepared: Aug-28-15, Analyzed: Aug-28-15						
Iron, dissolved	< 0.010	0.010	mg/L							
Lead, dissolved	< 0.0001	0.0001	mg/L							
Lithium, dissolved	< 0.0001	0.0001	mg/L							
Magnesium, dissolved	< 0.01	0.01	mg/L							
Manganese, dissolved	< 0.0002	0.0002	mg/L							
Molybdenum, dissolved	< 0.0001	0.0001	mg/L							
Nickel, dissolved	< 0.0002	0.0002	mg/L							
Phosphorus, dissolved	< 0.02	0.02	mg/L							
Potassium, dissolved	< 0.02	0.02	mg/L							
Selenium, dissolved	< 0.0005	0.0005	mg/L							
Silicon, dissolved	< 0.5	0.5	mg/L							
Silver, dissolved	< 0.00005	0.00005	mg/L							
Sodium, dissolved	< 0.02	0.02	mg/L							
Strontium, dissolved	< 0.001	0.001	mg/L							
Sulfur, dissolved	< 1	1	mg/L							
Tellurium, dissolved	< 0.0002	0.0002	mg/L							
Thallium, dissolved	< 0.00002	0.00002	mg/L							
Thorium, dissolved	< 0.0001	0.0001	mg/L							
Tin, dissolved	< 0.0002	0.0002	mg/L							
Titanium, dissolved	< 0.005	0.005	mg/L							
Uranium, dissolved	< 0.00002	0.00002	mg/L							
Vanadium, dissolved	< 0.001	0.001	mg/L							
Zinc, dissolved	< 0.004	0.004	mg/L							
Zirconium, dissolved	< 0.0001	0.0001	mg/L							
Matrix Spike (B5H1476-MS1)	**Source: 5081724-01**			Prepared: Aug-28-15, Analyzed: Aug-28-15						
Antimony, dissolved	0.374	0.0001	mg/L	0.400	< 0.0001	93	76-114			
Arsenic, dissolved	0.175	0.0005	mg/L	0.200	0.0006	87	81-115			
Barium, dissolved	1.00	0.005	mg/L	1.00	0.009	99	80-113			
Beryllium, dissolved	0.0748	0.0001	mg/L	0.100	< 0.0001	75	69-109			
Cadmium, dissolved	0.0957	0.00001	mg/L	0.100	< 0.00001	96	83-110			
Chromium, dissolved	0.402	0.0005	mg/L	0.400	< 0.0005	100	85-115			
Cobalt, dissolved	0.396	0.00005	mg/L	0.400	0.00007	99	86-114			
Copper, dissolved	0.403	0.0002	mg/L	0.400	0.0018	100	82-119			
Iron, dissolved	2.08	0.010	mg/L	2.00	0.111	98	80-116			
Lead, dissolved	0.205	0.0001	mg/L	0.200	0.0001	103	83-112			
Manganese, dissolved	0.386	0.0002	mg/L	0.400	0.0165	92	62-131			
Nickel, dissolved	0.370	0.0002	mg/L	0.400	0.0002	92	81-115			
Selenium, dissolved	0.103	0.0005	mg/L	0.100	< 0.0005	102	79-115			
Silver, dissolved	0.0147	0.00005	mg/L	0.100	< 0.00005	15	69-121			SPK1
Thallium, dissolved	0.113	0.00002	mg/L	0.100	< 0.00002	113	84-115			
Vanadium, dissolved	0.367	0.001	mg/L	0.400	< 0.001	92	83-113			
Zinc, dissolved	0.883	0.004	mg/L	1.00	< 0.004	88	82-115			
Reference (B5H1476-SRM1)				Prepared: Aug-28-15, Analyzed: Aug-28-15						
Aluminum, dissolved	0.228	0.005	mg/L	0.233		98	58-142			
Antimony, dissolved	0.0469	0.0001	mg/L	0.0430		109	75-125			
Arsenic, dissolved	0.433	0.0005	mg/L	0.438		99	81-119			
Barium, dissolved	3.61	0.005	mg/L	3.35		108	83-117			
Beryllium, dissolved	0.198	0.0001	mg/L	0.213		93	80-120			
Boron, dissolved	1.76	0.004	mg/L	1.74		101	74-117			
Cadmium, dissolved	0.220	0.00001	mg/L	0.224		98	83-117			
Calcium, dissolved	8.4	0.2	mg/L	7.69		109	76-124			
Chromium, dissolved	0.472	0.0005	mg/L	0.437		108	81-119			
Cobalt, dissolved	0.135	0.00005	mg/L	0.128		106	76-124			
Copper, dissolved	0.910	0.0002	mg/L	0.844		108	84-116			
Iron, dissolved	1.33	0.010	mg/L	1.29		103	74-126			

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Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Dissolved Metals, Batch B5H1476, Continued										
Reference (B5H1476-SRM1), Continued				Prepared: Aug-28-15, Analyzed: Aug-28-15						
Lead, dissolved	0.113	0.0001	mg/L	0.112		101	72-128			
Lithium, dissolved	0.109	0.0001	mg/L	0.104		104	60-140			
Magnesium, dissolved	7.15	0.01	mg/L	6.92		103	81-119			
Manganese, dissolved	0.341	0.0002	mg/L	0.345		99	84-116			
Molybdenum, dissolved	0.439	0.0001	mg/L	0.426		103	83-117			
Nickel, dissolved	0.906	0.0002	mg/L	0.840		108	74-126			
Phosphorus, dissolved	0.40	0.02	mg/L	0.495		82	68-132			
Potassium, dissolved	3.11	0.02	mg/L	3.19		97	74-126			
Selenium, dissolved	0.0348	0.0005	mg/L	0.0331		105	70-130			
Sodium, dissolved	20.0	0.02	mg/L	19.1		104	72-128			
Strontium, dissolved	0.933	0.001	mg/L	0.916		102	84-113			
Thallium, dissolved	0.0415	0.00002	mg/L	0.0393		106	57-143			
Uranium, dissolved	0.297	0.00002	mg/L	0.266		112	85-115			
Vanadium, dissolved	0.910	0.001	mg/L	0.869		105	87-113			
Zinc, dissolved	0.853	0.004	mg/L	0.881		97	72-128			
Dissolved Metals, Batch B5H1638										
Blank (B5H1638-BLK1)				Prepared: Aug-30-15, Analyzed: Aug-31-15						
Mercury, dissolved	< 0.00002	0.00002	mg/L							
Blank (B5H1638-BLK2)				Prepared: Aug-30-15, Analyzed: Aug-31-15						
Mercury, dissolved	< 0.00002	0.00002	mg/L							
Duplicate (B5H1638-DUP2)			**Source: 5081724-02**	Prepared: Aug-30-15, Analyzed: Aug-31-15						
Mercury, dissolved	< 0.00002	0.00002	mg/L		< 0.00002				20	
Matrix Spike (B5H1638-MS2)			**Source: 5081724-03**	Prepared: Aug-30-15, Analyzed: Aug-31-15						
Mercury, dissolved	0.00021	0.00002	mg/L	0.000250	< 0.00002	83	70-130			
Reference (B5H1638-SRM1)				Prepared: Aug-30-15, Analyzed: Aug-31-15						
Mercury, dissolved	0.00315	0.00002	mg/L	0.00456		69	50-150			
Reference (B5H1638-SRM2)				Prepared: Aug-30-15, Analyzed: Aug-31-15						
Mercury, dissolved	0.00295	0.00002	mg/L	0.00456		65	50-150			
General Parameters, Batch B5H1608										
Blank (B5H1608-BLK1)				Prepared: Aug-28-15, Analyzed: Aug-28-15						
Alkalinity, Total as CaCO3	< 1	1	mg/L							
Alkalinity, Phenolphthalein as CaCO3	< 1	1	mg/L							
Alkalinity, Bicarbonate as CaCO3	< 1	1	mg/L							
Alkalinity, Carbonate as CaCO3	< 1	1	mg/L							
Alkalinity, Hydroxide as CaCO3	< 1	1	mg/L							
Blank (B5H1608-BLK2)				Prepared: Aug-28-15, Analyzed: Aug-28-15						
Alkalinity, Total as CaCO3	< 1	1	mg/L							
Alkalinity, Phenolphthalein as CaCO3	< 1	1	mg/L							
Alkalinity, Bicarbonate as CaCO3	< 1	1	mg/L							
Alkalinity, Carbonate as CaCO3	< 1	1	mg/L							
Alkalinity, Hydroxide as CaCO3	< 1	1	mg/L							
Blank (B5H1608-BLK3)				Prepared: Aug-29-15, Analyzed: Aug-29-15						
Alkalinity, Total as CaCO3	< 1	1	mg/L							
Alkalinity, Phenolphthalein as CaCO3	< 1	1	mg/L							
Alkalinity, Bicarbonate as CaCO3	< 1	1	mg/L							

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Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
General Parameters, Batch B5H1608, Continued										
Blank (B5H1608-BLK3), Continued				Prepared: Aug-29-15, Analyzed: Aug-29-15						
Alkalinity, Carbonate as CaCO3	< 1	1	mg/L							
Alkalinity, Hydroxide as CaCO3	< 1	1	mg/L							
LCS (B5H1608-BS1)				Prepared: Aug-28-15, Analyzed: Aug-28-15						
Alkalinity, Total as CaCO3	101	1	mg/L	100		101	96-108			
LCS (B5H1608-BS2)				Prepared: Aug-28-15, Analyzed: Aug-28-15						
Alkalinity, Total as CaCO3	100	1	mg/L	100		100	96-108			
LCS (B5H1608-BS3)				Prepared: Aug-29-15, Analyzed: Aug-29-15						
Alkalinity, Total as CaCO3	102	1	mg/L	100		102	96-108			
Total Recoverable Metals, Batch B5H1639										
Blank (B5H1639-BLK1)				Prepared: Aug-30-15, Analyzed: Aug-31-15						
Mercury, total	< 0.00002	0.00002	mg/L							
Blank (B5H1639-BLK2)				Prepared: Aug-30-15, Analyzed: Aug-31-15						
Mercury, total	< 0.00002	0.00002	mg/L							
Duplicate (B5H1639-DUP2)			**Source: 5081724-01**	Prepared: Aug-30-15, Analyzed: Aug-31-15						
Mercury, total	< 0.00002	0.00002	mg/L		< 0.00002				20	
Matrix Spike (B5H1639-MS2)			**Source: 5081724-02**	Prepared: Aug-30-15, Analyzed: Aug-31-15						
Mercury, total	0.00026	0.00002	mg/L	0.000250	< 0.00002	103	70-130			
Reference (B5H1639-SRM1)				Prepared: Aug-30-15, Analyzed: Aug-31-15						
Mercury, total	0.00351	0.00002	mg/L	0.00456		77	50-150			
Reference (B5H1639-SRM2)				Prepared: Aug-30-15, Analyzed: Aug-31-15						
Mercury, total	0.00333	0.00002	mg/L	0.00456		73	50-150			
Total Recoverable Metals, Batch B5H1696										
Blank (B5H1696-BLK1)				Prepared: Aug-31-15, Analyzed: Sep-01-15						
Aluminum, total	< 0.005	0.005	mg/L							
Antimony, total	< 0.0001	0.0001	mg/L							
Arsenic, total	< 0.0005	0.0005	mg/L							
Barium, total	< 0.005	0.005	mg/L							
Beryllium, total	< 0.0001	0.0001	mg/L							
Bismuth, total	< 0.0001	0.0001	mg/L							
Boron, total	< 0.004	0.004	mg/L							
Cadmium, total	< 0.00001	0.00001	mg/L							
Calcium, total	< 0.2	0.2	mg/L							
Chromium, total	< 0.0005	0.0005	mg/L							
Cobalt, total	< 0.00005	0.00005	mg/L							
Copper, total	< 0.0002	0.0002	mg/L							
Iron, total	< 0.01	0.01	mg/L							
Lead, total	< 0.0001	0.0001	mg/L							
Lithium, total	< 0.0001	0.0001	mg/L							
Magnesium, total	< 0.01	0.01	mg/L							
Manganese, total	< 0.0002	0.0002	mg/L							
Molybdenum, total	< 0.0001	0.0001	mg/L							
Nickel, total	< 0.0002	0.0002	mg/L							
Phosphorus, total	< 0.02	0.02	mg/L							
Potassium, total	< 0.02	0.02	mg/L							

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Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Total Recoverable Metals, Batch B5H1696, Continued										
Blank (B5H1696-BLK1), Continued				Prepared: Aug-31-15, Analyzed: Sep-01-15						
Selenium, total	< 0.0005	0.0005	mg/L							
Silicon, total	< 0.5	0.5	mg/L							
Silver, total	< 0.00005	0.00005	mg/L							
Sodium, total	< 0.02	0.02	mg/L							
Strontium, total	< 0.001	0.001	mg/L							
Sulfur, total	< 1	1	mg/L							
Tellurium, total	< 0.0002	0.0002	mg/L							
Thallium, total	< 0.00002	0.00002	mg/L							
Thorium, total	< 0.0001	0.0001	mg/L							
Tin, total	< 0.0002	0.0002	mg/L							
Titanium, total	< 0.005	0.005	mg/L							
Uranium, total	< 0.00002	0.00002	mg/L							
Vanadium, total	< 0.001	0.001	mg/L							
Zinc, total	< 0.004	0.004	mg/L							
Zirconium, total	< 0.0001	0.0001	mg/L							
Matrix Spike (B5H1696-MS1)		**Source: 5081724-01**		Prepared: Aug-31-15, Analyzed: Sep-01-15						
Antimony, total	0.461	0.0001	mg/L	0.400	0.0001	115	84-125			
Arsenic, total	0.236	0.0005	mg/L	0.200	0.0008	118	85-116			
Barium, total	1.09	0.005	mg/L	1.00	0.009	108	87-114			
Beryllium, total	0.105	0.0001	mg/L	0.100	< 0.0001	105	72-116			
Cadmium, total	0.106	0.00001	mg/L	0.100	< 0.00001	106	90-112			
Chromium, total	0.430	0.0005	mg/L	0.400	0.0005	107	89-120			
Cobalt, total	0.427	0.00005	mg/L	0.400	0.00010	107	88-120			
Copper, total	0.438	0.0002	mg/L	0.400	0.0021	109	88-125			
Iron, total	2.49	0.01	mg/L	2.00	0.29	110	88-119			
Lead, total	0.224	0.0001	mg/L	0.200	0.0001	112	89-118			
Manganese, total	0.448	0.0002	mg/L	0.400	0.0200	107	84-120			
Nickel, total	0.409	0.0002	mg/L	0.400	0.0010	102	87-119			
Selenium, total	0.105	0.0005	mg/L	0.100	< 0.0005	105	85-113			
Silver, total	0.0904	0.00005	mg/L	0.100	0.00121	89	89-119			
Thallium, total	0.111	0.00002	mg/L	0.100	< 0.00002	111	92-119			
Vanadium, total	0.426	0.001	mg/L	0.400	0.001	106	87-117			
Zinc, total	1.10	0.004	mg/L	1.00	0.005	109	85-116			
Reference (B5H1696-SRM1)				Prepared: Aug-31-15, Analyzed: Sep-01-15						
Aluminum, total	0.293	0.005	mg/L	0.296		99	81-129			
Antimony, total	0.0534	0.0001	mg/L	0.0505		106	88-114			
Arsenic, total	0.135	0.0005	mg/L	0.122		111	88-114			
Barium, total	0.752	0.005	mg/L	0.777		97	72-104			
Beryllium, total	0.0482	0.0001	mg/L	0.0488		99	76-131			
Boron, total	3.38	0.004	mg/L	3.40		100	75-121			
Cadmium, total	0.0495	0.00001	mg/L	0.0490		101	89-111			
Calcium, total	11.0	0.2	mg/L	10.2		107	86-121			
Chromium, total	0.254	0.0005	mg/L	0.242		105	89-114			
Cobalt, total	0.0399	0.00005	mg/L	0.0366		109	91-113			
Copper, total	0.518	0.0002	mg/L	0.487		106	91-115			
Iron, total	0.50	0.01	mg/L	0.469		107	77-124			
Lead, total	0.215	0.0001	mg/L	0.193		112	92-113			
Lithium, total	0.380	0.0001	mg/L	0.390		97	85-115			
Magnesium, total	3.39	0.01	mg/L	3.31		103	78-120			
Manganese, total	0.113	0.0002	mg/L	0.109		103	90-114			
Molybdenum, total	0.203	0.0001	mg/L	0.197		103	90-111			
Nickel, total	0.251	0.0002	mg/L	0.242		104	90-111			
Phosphorus, total	0.20	0.02	mg/L	0.233		85	85-115			
Potassium, total	6.49	0.02	mg/L	5.93		109	84-113			
Selenium, total	0.127	0.0005	mg/L	0.115		111	85-115			

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	5081724
PROJECT	173.169 Maple Ridge WQ	**REPORTED**	Sep-03-15

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Total Recoverable Metals, Batch B5H1696, Continued										
Reference (B5H1696-SRM1), Continued				Prepared: Aug-31-15, Analyzed: Sep-01-15						
Sodium, total	7.76	0.02	mg/L	7.64		102	82-123			
Strontium, total	0.382	0.001	mg/L	0.363		105	88-112			
Thallium, total	0.0871	0.00002	mg/L	0.0794		110	91-114			
Uranium, total	0.0205	0.00002	mg/L	0.0192		107	85-120			
Vanadium, total	0.387	0.001	mg/L	0.376		103	86-111			
Zinc, total	2.52	0.004	mg/L	2.42		104	85-111			

QC Qualifiers:

SPK1 The recovery of this analyte was outside of established control limits. The data was accepted based on performance of other batch QC.

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 5081724
REPORTED Sep-03-15

		5081724-01	5081724-02	5081724-03	5081724-04	5081724-05
		Water	Water	Water	Water	Water
		Aug-26-15	Aug-26-15	Aug-26-15	Aug-26-15	Aug-26-15
		SA-1 (T2 Creek)	SA-2 (Millionaire Creek)	K-1 (Dunlop Creek)	K-2 (Spencer Creek)	Field Blank
Anions	Nitrate as N (mg/L)	0.333	0.390	0.019	0.121	
General Parameters	Alkalinity, Total as CaCO3 (mg/L)	63	28	79	105	
	Alkalinity, Phenolphthalein as CaCO3 (mg/L)	< 1	< 1	< 1	< 1	
	Alkalinity, Bicarbonate as CaCO3 (mg/L)	63	28	79	105	
	Alkalinity, Carbonate as CaCO3 (mg/L)	< 1	< 1	< 1	< 1	
	Alkalinity, Hydroxide as CaCO3 (mg/L)	< 1	< 1	< 1	< 1	
Calculated Parameters	Hardness, Total (Diss. as CaCO3) (mg/L)	63.1	23.9	65.7	106	
	Hardness, Total (Total as CaCO3) (mg/L)	63.9	24.8	68.4	109	
Dissolved Metals	Aluminum, dissolved (mg/L)	0.012	0.012	0.016	0.008	
	Antimony, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Arsenic, dissolved (mg/L)	0.0006	< 0.0005	0.0010	0.0011	
	Barium, dissolved (mg/L)	0.009	0.007	0.012	0.008	
	Beryllium, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Bismuth, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Boron, dissolved (mg/L)	0.022	0.008	0.029	0.020	
	Cadmium, dissolved (mg/L)	< 0.00001	< 0.00001	< 0.00001	0.00001	
	Calcium, dissolved (mg/L)	14.0	7.1	16.6	28.0	
	Chromium, dissolved (mg/L)	< 0.0005	< 0.0005	< 0.0005	< 0.0005	
	Cobalt, dissolved (mg/L)	0.00007	< 0.00005	0.00041	0.00010	
	Copper, dissolved (mg/L)	0.0018	0.0010	0.0009	0.0011	
	Iron, dissolved (mg/L)	0.111	0.018	0.574	0.091	
	Lead, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Lithium, dissolved (mg/L)	0.0006	< 0.0001	< 0.0001	< 0.0001	
	Magnesium, dissolved (mg/L)	6.85	1.48	5.90	8.64	
	Manganese, dissolved (mg/L)	0.0165	0.0017	0.205	0.0772	
	Mercury, dissolved (mg/L)	< 0.00002	< 0.00002	< 0.00002	< 0.00002	
	Molybdenum, dissolved (mg/L)	0.0011	0.0006	0.0007	0.0010	
	Nickel, dissolved (mg/L)	0.0002	0.0002	0.0007	0.0006	
	Phosphorus, dissolved (mg/L)	< 0.02	< 0.02	< 0.02	< 0.02	
	Potassium, dissolved (mg/L)	2.29	0.66	3.25	2.43	
	Selenium, dissolved (mg/L)	< 0.0005	< 0.0005	< 0.0005	< 0.0005	
	Silicon, dissolved (mg/L)	7.2	5.2	4.1	6.3	
	Silver, dissolved (mg/L)	< 0.00005	< 0.00005	< 0.00005	< 0.00005	
	Sodium, dissolved (mg/L)	16.6	6.17	14.3	13.3	
	Strontium, dissolved (mg/L)	0.083	0.043	0.111	0.178	
	Sulfur, dissolved (mg/L)	7	8	9	10	
	Tellurium, dissolved (mg/L)	< 0.0002	< 0.0002	< 0.0002	< 0.0002	
	Thallium, dissolved (mg/L)	< 0.00002	< 0.00002	< 0.00002	< 0.00002	
	Thorium, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Tin, dissolved (mg/L)	< 0.0002	< 0.0002	< 0.0002	< 0.0002	
	Titanium, dissolved (mg/L)	< 0.005	< 0.005	< 0.005	< 0.005	
	Uranium, dissolved (mg/L)	0.00004	< 0.00002	< 0.00002	0.00007	
	Vanadium, dissolved (mg/L)	< 0.001	< 0.001	0.001	< 0.001	
	Zinc, dissolved (mg/L)	< 0.004	< 0.004	< 0.004	< 0.004	

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.169 Maple Ridge WQ

WORK ORDER 5081724
REPORTED Sep-03-15

		5081724-01	5081724-02	5081724-03	5081724-04	5081724-05
		Water	Water	Water	Water	Water
		Aug-26-15	Aug-26-15	Aug-26-15	Aug-26-15	Aug-26-15
		SA-1 (T2 Creek)	SA-2 (Millionaire Creek)	K-1 (Dunlop Creek)	K-2 (Spencer Creek)	Field Blank
Dissolved Metals	Zirconium, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
Total Recoverable Metals	Aluminum, total (mg/L)	0.102	0.030	0.172	0.482	
	Antimony, total (mg/L)	0.0001	0.0003	0.0001	0.0001	
	Arsenic, total (mg/L)	0.0008	< 0.0005	0.0015	0.0017	
	Barium, total (mg/L)	0.009	0.008	0.015	0.012	
	Beryllium, total (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Bismuth, total (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Boron, total (mg/L)	0.028	0.009	0.035	0.023	
	Cadmium, total (mg/L)	< 0.00001	< 0.00001	< 0.00001	< 0.00001	
	Calcium, total (mg/L)	14.4	7.4	17.3	30.1	
	Chromium, total (mg/L)	0.0005	< 0.0005	0.0006	0.0008	
	Cobalt, total (mg/L)	0.00010	< 0.00005	0.00056	0.00035	
	Copper, total (mg/L)	0.0021	0.0015	0.0013	0.0018	
	Iron, total (mg/L)	0.29	0.04	1.12	0.83	
	Lead, total (mg/L)	0.0001	< 0.0001	0.0001	0.0002	
	Lithium, total (mg/L)	0.0009	< 0.0001	0.0002	0.0005	
	Magnesium, total (mg/L)	6.74	1.55	6.10	8.26	
	Manganese, total (mg/L)	0.0200	0.0029	0.264	0.130	
	Mercury, total (mg/L)	< 0.00002	< 0.00002	< 0.00002	< 0.00002	
	Molybdenum, total (mg/L)	0.0011	0.0007	0.0007	0.0010	
	Nickel, total (mg/L)	0.0010	0.0004	0.0014	0.0014	
	Phosphorus, total (mg/L)	0.04	< 0.02	0.06	0.07	
	Potassium, total (mg/L)	2.29	0.71	3.78	2.61	
	Selenium, total (mg/L)	< 0.0005	< 0.0005	< 0.0005	< 0.0005	
	Silicon, total (mg/L)	7.6	5.8	5.0	7.8	
	Silver, total (mg/L)	0.00121	0.00119	0.00111	0.00087	
	Sodium, total (mg/L)	16.4	6.39	14.2	13.4	
	Strontium, total (mg/L)	0.084	0.048	0.126	0.187	
	Sulfur, total (mg/L)	7	6	7	8	
	Tellurium, total (mg/L)	< 0.0002	< 0.0002	< 0.0002	< 0.0002	
	Thallium, total (mg/L)	< 0.00002	< 0.00002	< 0.00002	< 0.00002	
	Thorium, total (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Tin, total (mg/L)	< 0.0002	< 0.0002	< 0.0002	< 0.0002	
	Titanium, total (mg/L)	< 0.005	< 0.005	0.008	0.019	
	Uranium, total (mg/L)	0.00003	< 0.00002	< 0.00002	0.00007	
	Vanadium, total (mg/L)	0.001	< 0.001	0.002	0.003	
	Zinc, total (mg/L)	0.005	< 0.004	< 0.004	< 0.004	
	Zirconium, total (mg/L)	< 0.0001	< 0.0001	0.0001	0.0002	
Microbiological Parameters	Coliforms, Total (MPN/100 mL)	9000	3000	170	5000	
	Coliforms, Fecal (MPN/100 mL)	5000	30	17	140	
	E. coli (MPN) (MPN/100 mL)	5000	30	17	140	ND

CA
ANA

5081724

ND, BC V6V 2K9
9-1599

/NA, BC V1X 5C3
5-3893

TON, AB T5S 1H7
9-9700

CHAIN-OF-CUSTODY RECORD

COC#

CARO BC COC, Rev 03/13

RELINQUISHED BY:	DATE: 26-Aug-15	RECEIVED BY:	DATE: 8/26
Peter deKoning	TIME: 14:50	WI TL	TIME: 14:54
RELINQUISHED BY:	DATE:	RECEIVED BY:	DATE:
	TIME:		TIME:

REPORT TO:		INVOICE TO:	SAME AS REPORT TO ☐
COMPANY:	Kerr Wood Leidal Associates	COMPANY:	Kerr Wood Leidal Associates
ADDRESS:	200-4185A Still Creek Drive	ADDRESS:	200-4185A Still Creek Drive
	Burnaby, BC V5C 6G9		Burnaby, BC V5C 6G9
CONTACT:	Patrick Lilley	CONTACT:	Patrick Lilley / Michelle Derer
TEL / FAX:	604-293-3121 604-294-2090	TEL / FAX:	604-293-3252 604-294-2090
EMAIL PDF ☑ EDD ☐	Please email Excel file.	EMAIL PDF	☑
EMAIL 1:	plilley@kwl.ca	EMAIL 1:	plilley@kwl.ca
EMAIL 2:	pdekoning@kwl.ca	EMAIL 2:	mderer@kwl.ca
MAIL HARDCOPY ☐ HOLD FOR P/U ☐ FAX ☐		MAIL HARDCOPY ☐ HOLD FOR P/U	☑

PROJECT:	PROJECT INFO:	PO #:
173.169 Maple Ridge WQ	Stormwater Monitoring	
SAMPLED BY:	SHIPPING INSTRUCTIONS:	RETURN COOLER(S) ☐
Peter deKoning	SHIP SUPPLIES (PLEASE SPECIFY IN OTHER INSTRUCTIONS SECTION)	☐

TURNAROUND Routine (4-7 days) ☑ Other:

TIME REQUESTED: Rush:* 1 Day ☐ 2 Day ☐ 3 Day ☐ * Contact the lab to confirm, surcharges may apply

ANALYSES REQUESTED:

CLIENT SAMPLE ID:	MATRIX: DRINKING WATER	OTHER WATER	SOIL	OTHER	# CONTAINERS	SAMPLING: DATE DD-MMM-YY	TIME HH:MM	COMMENTS: CHLORINATED	FILTERED	PRESERVED	(i.e. flow/volume media ID/notes)
SA-1 (T2 Creek)	☐	☑	☐	☐	6	26-Aug-15	11:30	☐	☐	☐	See below
SA-2 (Millionaire Creek)	☐	☑	☐	☐	6	26-Aug-15	12:00	☐	☐	☐	See below
K-1 (Dunlop Creek)	☐	☑	☐	☐	6	26-Aug-15	12:35	☐	☐	☐	See below
K-2 (Spencer Creek)	☐	☑	☐	☐	6	26-Aug-15	13:05	☐	☐	☐	See below
Field Blank	☐	☐	☐	☐	1	26-Aug-15	11:30	☐	☐	☐	
Trip Blank	☐	☐	☐	☐	1	26-Aug-15	10:35	☐	☐	☐	

ANALYSES REQUESTED (columns):

BTEX ☐ VPH ☐ MTBE ☐ | EPH (not PAH Corrected) ☐ | VOC ☐ VPH ☐ | L/HEPH (PAH Corrected) ☐ | PAH ☐ | PHENOLS Chlorinated ☐ Non-Chlor. ☐ | PCB ☐ GLYCOLS ☐ HAA ☐ | METALS - WATER TOTAL (ICPMS - LOW Pkg.) ☐ | METALS - WATER DISSOLVED (ICPMS - LOW Pkg.) ☐ | Metals - SOIL (SALIM) ☐ Inc. pH ☐ | pH ☐ EC ☐ Alk ☑ | TSS ☐ TDS ☐ | BOD ☐ COD ☐ | FECAL COLIFORMS ☑ HPC ☐ | TOTAL COLIFORMS ☑ E-COLI ☑ | PESTICIDES ☐ HERBICIDES ☐ | SOIL VAPOUR ☐ | ASBESTOS ☐ | NITRATE-N ☑ | E-COLI ONLY | | | | | HOLD

CLIENT SAMPLE ID:	BTEX	EPH	VOC	L/HEPH	PAH	PHENOLS	PCB	METALS - WATER TOTAL	METALS - WATER DISSOLVED	Metals - SOIL (SALIM)	pH	TSS	BOD	FECAL COLIFORMS	TOTAL COLIFORMS	PESTICIDES	SOIL VAPOUR	ASBESTOS	NITRATE-N	E-COLI ONLY					HOLD
SA-1 (T2 Creek)	☐	☐	☐	☐	☐	☐	☐	☑	☑	☐	☑	☐	☐	☑	☑	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐
SA-2 (Millionaire Creek)	☐	☐	☐	☐	☐	☐	☐	☑	☑	☐	☑	☐	☐	☑	☑	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐
K-1 (Dunlop Creek)	☐	☐	☐	☐	☐	☐	☐	☑	☑	☐	☑	☐	☐	☑	☑	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐
K-2 (Spencer Creek)	☐	☐	☐	☐	☐	☐	☐	☑	☑	☐	☑	☐	☐	☑	☑	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐
Field Blank	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☒	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐
Trip Blank	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑

APPLICABLE REGULATORY LIMITS:
Canadian Drinking Water Quality Guidelines ☐
BC Drinking Water Protection Act/Reg. ☐
BC CSR: AL ☐ RL ☐ CL ☐ IL ☐ AW ☐
CCME ☑ Alberta Tier 1 ☐
OTHER: BC WQ Guidelines for Aquatic Life

SAMPLE RETENTION INSTRUCTIONS (Discarded 30 days after Report unless otherwise specified):
60 Days ☐ 90 Days ☐ Longer Date (Surcharges will apply):

OTHER INSTRUCTIONS:
Total and dissolved metals, mercury, and bacteriological samples have been preserved. Dissolved metals samples (incl. mercury) have also been filtered. Metals analysis should be LOW level ICPMS pkg. Add total + dissolved Hg. Alkalinity = SPECIATED alkalinity. Use higher dilutions for bacteriological tests pls.

PAYMENT
Cheque ☐
Credit ☐
Debit ☐
Cash ☐
Invoice ☐

SAMPLE RECEIPT TEMP (°C): 9.4

Work Order # _____

CUSTODY SEALS INTACT: ☐Y ☐N ☐NA

Required Fields Recommended Fields SHADED AREAS: LAB USE ONLY

KERR WOOD LEIDAL
consulting engineers

Appendix E

MAMF Monitoring Results Report Sheets

MONITORING RESULTS REPORT SHEET - HIGHER GRADIENT DRAINAGE

Drainage Name: South Alouette Watershed **Municipality:** City of Maple Ridge

WATER QUALITY MONITORING RESULTS

Site Location and Site Number:	SA-1 (T2 Creek at 124 Ave)					
Water Quality Site UTM Zone:	10N	**Easting:**	674164	**Northing:**	5453351	
Wet Season	**Monitoring Date:**	2014-11-26	2014-12-05	2014-12-09	2014-12-16	2014-12-19
	AVERAGE	**1**	**2**	**3**	**4**	**5**
Priority Indicators: Temperature (°C)	10.04	10.69	9.05	10.97	9.79	9.68
Dissolved Oxygen (mg/L)	11.26	10.91	10.87	11.60	11.20	11.72
Turbidity (NTU)	7.2	10.6	3.8	12.6	2.6	6.2
E. coli (MPN/100ml)[1]	107	2	850	300	91	300
Fecal Coliforms (MPN/100ml)[1]	571	1600	800	420	750	150
Nitrate (as Nitrogen, mg/L)	1.21	1.86	1.08	0.80	1.40	0.93
Total Iron (µg/L)	466	700	240	770	220	400
Total Cadmium (µg/L)*	0.02	0.02	0.01	0.02	0.01	0.02
Total Copper (µg/L)*	3.3	4.7	2.4	4.8	1.5	3.3
Total Lead (µg/L)*	0.5	0.7	0.3	0.8	0.1	0.4
Total Zinc (µg/L)*	12	16	12	13	6	12
Secondary: Conductivity (µS/cm)	135	85	143	217	147	82
pH (rel. units)	7.09	6.30	6.83	7.45	7.47	7.41
Dry Season	**Monitoring Date:**	2015-07-29	2015-08-05	2015-08-11	2015-08-19	2015-08-26
	AVERAGE	**1**	**2**	**3**	**4**	**5**
Priority Indicators: Temperature (°C)	16.90	17.04	16.24	17.76	17.76	15.68
Dissolved Oxygen (mg/L)	9.42	9.52	9.54	9.32	9.32	9.40
Turbidity (NTU)	2.9	2.1	4.1	3.6	3.6	1.2
E. coli (MPN/100ml)[1]	1884	1100	3000	900	1600	5000
Fecal Coliforms (MPN/100ml)[1]	1189	1100	300	900	1600	5000
Nitrate (as Nitrogen, mg/L)	0.50	0.67	0.62	0.49	0.41	0.33
Total Iron (µg/L)	344	310	370	400	350	290
Total Cadmium (µg/L)*	0.01	0.01	0.02	0.02	0.01	0.01
Total Copper (µg/L)*	3.1	3.7	3.6	3.4	2.5	2.1
Total Lead (µg/L)*	0.2	0.2	0.3	0.2	0.2	0.1
Total Zinc (µg/L)*	5	7	6	4	5	5
Secondary: Conductivity (µS/cm)	184	189	208	203	203	116
pH (rel. units)	7.48	7.48	7.69	7.50	7.50	7.25

FLOW MONITORING RESULTS

Hydrometric Site UTM Zone:		**Easting:**		**Northing:**	
Monitoring Period					
	Value	**Trend** Stable, Increasing, Decreasing (S, D, I)*			**Target***
MAD (L/s)					
TQ Mean					S or I
Low Pulse Count					S or D
Low Pulse Duration (Days)					S or I
Summer Baseflow (L/s)					S
Winter Baseflow (L/s)					S or I
High Pulse count					S or D
High Pulse Suration (Days)					S or I

BIOMONITORING RESULTS

Biomonitoring Site UTM Zone:	10N	**Easting:**	528613	**Northing:**	5452832
Monitoring Date:					2015-09-15
	SCORE	**Pre-Dvpt Value or Trend (S, D or I)***			**Trend Target ***
B-IBI Score	14.0				S or I
Total Taxa Richness	18				S or I

Notes: For flow assessment see Table 5 Hydrologic Response to Land Development; *For metals rank value assumes hardness approximating 100mg/L CaCO3

MONITORING RESULTS REPORT SHEET - HIGHER GRADIENT DRAINAGE

Drainage Name: South Alouette Watershed **Municipality:** City of Maple Ridge

WATER QUALITY MONITORING RESULTS

Site Location and Site Number:	SA-2 (Millionaire Creek at Fern Cres)						
Water Quality Site UTM Zone:	10N	**Easting:**	531916	**Northing:**	5453947		
Wet Season	**Monitoring Date:**	2014-11-26	2014-12-05	2014-12-09	2014-12-16	2014-12-19	
	AVERAGE	**1**	**2**	**3**	**4**	**5**	
Priority Indicators	Temperature (°C)	7.44	9.07	4.76	9.09	6.35	7.95
	Dissolved Oxygen (mg/L)	12.11	11.58	12.23	12.20	12.17	12.35
	Turbidity (NTU)	2.4	6.3	0.8	2.6	0.9	1.6
	E. coli (MPN/100ml)[1]	14	2	35	78	4	23
	Fecal Coliforms (MPN/100ml)[1]	13	13	4	13	29	17
	Nitrate (as Nitrogen, mg/L)	0.33	0.49	0.29	0.29	0.30	0.26
	Total Iron (µg/L)	164	290	90	200	100	140
	Total Cadmium (µg/L)*	0.04	0.01	0.10	0.04	0.02	0.01
	Total Copper (µg/L)*	0.7	0.8	0.4	0.9	0.8	0.5
	Total Lead (µg/L)*	0.1	0.1	0.1	0.1	0.1	0.1
	Total Zinc (µg/L)*	8	26	4	4	4	4
Secondary	Conductivity (µS/cm)	49	18	27	145	32	21
	pH (rel. units)	6.95	6.17	6.78	6.91	7.46	7.41
Dry Season	**Monitoring Date:**	2015-07-29	2015-08-05	2015-08-11	2015-08-19	2015-08-26	
	AVERAGE	**1**	**2**	**3**	**4**	**5**	
Priority Indicators	Temperature (°C)	16.53	16.57	15.12	18.06	17.50	15.42
	Dissolved Oxygen (mg/L)	9.75	9.97	10.05	9.38	9.59	9.74
	Turbidity (NTU)	0.0	0.0	0.0	0.0	0.0	0.0
	E. coli (MPN/100ml)[1]	79	23	2400	23	80	30
	Fecal Coliforms (MPN/100ml)[1]	83	30	2400	23	80	30
	Nitrate (as Nitrogen, mg/L)	0.39	0.31	0.46	0.36	0.42	0.39
	Total Iron (µg/L)	38	40	40	30	40	40
	Total Cadmium (µg/L)*	0.01	0.03	0.01	0.01	0.01	0.01
	Total Copper (µg/L)*	2.3	6.4	1.4	0.9	1.2	1.5
	Total Lead (µg/L)*	0.1	0.2	0.1	0.1	0.1	0.1
	Total Zinc (µg/L)*	4	5	4	4	4	4
Secondary	Conductivity (µS/cm)	63	61	67	61	66	62
	pH (rel. units)	7.35	7.45	7.15	7.70	7.39	7.04

FLOW MONITORING RESULTS

Hydrometric Site UTM Zone:		**Easting:**		**Northing:**	
Monitoring Period					

	Value	Trend Stable, Increasing, Decreasing (S, D, I)*	Target*
MAD (L/s)			
TQ Mean			S or I
Low Pulse Count			S or D
Low Pulse Duration (Days)			S or I
Summer Baseflow (L/s)			S
Winter Baseflow (L/s)			S or I
High Pulse count			S or D
High Pulse Suration (Days)			S or I

BIOMONITORING RESULTS

Biomonitoring Site UTM Zone:	10N	**Easting:**	531930	**Northing:**	5453955
Monitoring Date:					2015-09-15

	SCORE	Pre-Dvpt Value or Trend (S, D or I)*	Trend Target *
B-IBI Score	26.6		S or I
Total Taxa Richness	40		S or I

Notes: For flow assessment see Table 5 Hydrologic Response to Land Development; *For metals rank value assumes hardness approximating 100mg/L CaCO3

MONITORING RESULTS REPORT SHEET - HIGHER GRADIENT DRAINAGE

Drainage Name: Kanaka Watershed **Municipality:** City of Maple Ridge

WATER QUALITY MONITORING RESULTS

	Site Location and Site Number:	K-1 (Dunlop Creek at 110 Ave)					
	Water Quality Site UTM Zone:	10N	**Easting:**	532821	**Northing:**	5450037	
	Wet Season	**Monitoring Date:**	2014-11-26	2014-12-05	2014-12-09	2014-12-16	2014-12-19
		AVERAGE	**1**	**2**	**3**	**4**	**5**
Priority Indicators	Temperature (°C)	6.96	8.72	4.20	8.96	5.14	7.77
	Dissolved Oxygen (mg/L)	11.94	11.36	12.00	11.90	12.27	12.17
	Turbidity (NTU)	14.8	25.1	7.7	18.5	6.0	16.8
	E. coli (MPN/100ml)[1]	61	2	210	180	36	300
	Fecal Coliforms (MPN/100ml)[1]	350	1600	150	170	430	300
	Nitrate (as Nitrogen, mg/L)	0.95	1.54	0.71	0.88	0.93	0.71
	Total Iron (µg/L)	984	1590	500	1210	490	1130
	Total Cadmium (µg/L)*	0.02	0.02	0.01	0.02	0.01	0.02
	Total Copper (µg/L)*	2.9	4.1	1.9	3.4	1.9	3.2
	Total Lead (µg/L)*	0.4	0.5	0.2	0.5	0.2	0.4
	Total Zinc (µg/L)*	7	11	5	6	7	7
Secondary	Conductivity (µS/cm)	78	45	62	178	66	40
	pH (rel. units)	6.90	6.57	6.90	6.72	7.08	7.25
	Dry Season	**Monitoring Date:**	2015-07-29	2015-08-05	2015-08-11	2015-08-19	2015-08-26
		AVERAGE	**1**	**2**	**3**	**4**	**5**
Priority Indicators	Temperature (°C)	15.78	16.42	15.25	16.91	16.37	13.95
	Dissolved Oxygen (mg/L)	4.29	6.09	4.54	4.76	2.90	3.18
	Turbidity (NTU)	3.0	2.1	4.3	2.7	2.6	3.1
	E. coli (MPN/100ml)[1]	249	110	90	130	900	17
	Fecal Coliforms (MPN/100ml)[1]	249	110	90	130	900	17
	Nitrate (as Nitrogen, mg/L)	0.06	0.21	0.04	0.03	0.03	0.02
	Total Iron (µg/L)	1074	880	1190	1120	1060	1120
	Total Cadmium (µg/L)*	0.01	0.01	0.01	0.01	0.01	0.01
	Total Copper (µg/L)*	1.5	2.1	1.7	1.5	1.1	1.3
	Total Lead (µg/L)*	0.1	0.1	0.2	0.1	0.1	0.1
	Total Zinc (µg/L)*	18	4	75	4	4	4
Secondary	Conductivity (µS/cm)	152	168	162	115	165	151
	pH (rel. units)	7.14	7.36	6.93	7.26	7.03	7.13

FLOW MONITORING RESULTS

Hydrometric Site UTM Zone:		**Easting:**		**Northing:**	
Monitoring Period					

	Value	**Trend** Stable, Increasing, Decreasing (S, D, I)*	**Target***
MAD (L/s)			
TQ Mean			S or I
Low Pulse Count			S or D
Low Pulse Duration (Days)			S or I
Summer Baseflow (L/s)			S
Winter Baseflow (L/s)			S or I
High Pulse count			S or D
High Pulse Suration (Days)			S or I

BIOMONITORING RESULTS

Biomonitoring Site UTM Zone:	10N	**Easting:**	533232	**Northing:**	5450357
Monitoring Date:					2015-09-15

	SCORE	**Pre-Dvpt Value or Trend (S, D or I)***	**Trend Target ***
B-IBI Score	28.0		S or I
Total Taxa Richness	40		S or I

Notes: For flow assessment see Table 5 Hydrologic Response to Land Development; *For metals rank value assumes hardness approximating 100mg/L CaCO3

MONITORING RESULTS REPORT SHEET - HIGHER GRADIENT DRAINAGE

Drainage Name: Kanaka Watershed **Municipality:** City of Maple Ridge

WATER QUALITY MONITORING RESULTS

	Site Location and Site Number:	K-2 (Spencer Creek at 240 St)					
	Water Quality Site UTM Zone:	10N	**Easting:**	532303	**Northing:**	5449033	
	Wet Season	**Monitoring Date:**	2014-11-26	2014-12-05	2014-12-09	2014-12-16	2014-12-19
		AVERAGE	**1**	**2**	**3**	**4**	**5**
Priority Indicators	Temperature (°C)	7.26	8.96	4.12	9.56	5.67	8.00
	Dissolved Oxygen (mg/L)	11.67	11.00	11.83	11.63	11.97	11.92
	Turbidity (NTU)	32.4	35.8	16.2	37.3	13.7	59.1
	E. coli (MPN/100ml)[1]	77	2	460	260	23	500
	Fecal Coliforms (MPN/100ml)[1]	197	50	400	32	930	500
	Nitrate (as Nitrogen, mg/L)	0.51	0.87	0.33	0.51	0.41	0.43
	Total Iron (µg/L)	2052	2360	1010	2370	850	3670
	Total Cadmium (µg/L)*	0.02	0.02	0.01	0.02	0.02	0.03
	Total Copper (µg/L)*	4.8	5.4	2.8	5.7	2.5	7.4
	Total Lead (µg/L)*	0.6	0.6	0.4	0.7	0.3	1.1
	Total Zinc (µg/L)*	9	11	10	7	5	12
Secondary	Conductivity (µS/cm)	119	68	136	217	116	60
	pH (rel. units)	7.00	6.46	6.78	6.91	7.46	7.41
	Dry Season	**Monitoring Date:**	2015-07-29	2015-08-05	2015-08-11	2015-08-19	2015-08-26
		AVERAGE	**1**	**2**	**3**	**4**	**5**
Priority Indicators	Temperature (°C)	16.71	16.97	15.12	18.36	17.86	15.26
	Dissolved Oxygen (mg/L)	8.71	8.81	9.08	8.34	8.52	8.82
	Turbidity (NTU)	7.2	7.1	7.9	7.6	5.7	7.9
	E. coli (MPN/100ml)[1]	196	130	80	130	500	140
	Fecal Coliforms (MPN/100ml)[1]	196	130	80	130	500	140
	Nitrate (as Nitrogen, mg/L)	0.11	0.01	0.17	0.10	0.16	0.12
	Total Iron (µg/L)	678	700	710	660	490	830
	Total Cadmium (µg/L)*	0.01	0.01	0.01	0.01	0.01	0.01
	Total Copper (µg/L)*	2.0	2.5	2.2	1.7	1.7	1.8
	Total Lead (µg/L)*	0.2	0.2	0.2	0.1	0.1	0.2
	Total Zinc (µg/L)*	4	5	4	4	4	4
Secondary	Conductivity (µS/cm)	0	98	215	143	224	209
	pH (rel. units)	7.55	7.61	7.30	7.64	7.47	7.75

FLOW MONITORING RESULTS

Hydrometric Site UTM Zone:		**Easting:**		**Northing:**	
Monitoring Period					

	Value	Trend Stable, Increasing, Decreasing (S, D, I)*	Target*
MAD (L/s)			
TQ Mean			S or I
Low Pulse Count			S or D
Low Pulse Duration (Days)			S or I
Summer Baseflow (L/s)			S
Winter Baseflow (L/s)			S or I
High Pulse count			S or D
High Pulse Suration (Days)			S or I

BIOMONITORING RESULTS

Biomonitoring Site UTM Zone:	10N	**Easting:**	532727	**Northing:**	5449040
Monitoring Date:					2015-09-15

	SCORE	Pre-Dvpt Value or Trend (S, D or I)*	Trend Target *
B-IBI Score	23.6		S or I
Total Taxa Richness	31		S or I

Notes: For flow assessment see Table 5 Hydrologic Response to Land Development; *For metals rank value assumes hardness approximating 100mg/L CaCO3

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Appendix F

Full Water Quality Monitoring Results Data Tables

Appendix F: Full Monitoring Results Data Table

City of Maple Ridge

Water Quality and Benthic Invertebrate Monitoring in T2, Millionaire, Dunlop, and Spencer Creeks, 2014-2015
March 2016

Parameter	Units	Detection Limit	Guidelines: CCME- CEQG, WQG for the Protection of Aquatic Life - Freshwater	Guidelines: BC Approved (A) and Working (W) Water Quality Guidelines for the Protection of Freshwater Aquatic Life	Metro Vancouver Monitoring and Adaptive Mangement Framework - Water Quality Levels: Green Level	Yellow Level	Red Level	Monitoring Location: SA-1 (T2 Creek at 124 Ave)				
Sampling Date								2015-07-29	2015-08-05	2015-08-11	2015-08-19	2015-08-26
Sampling Time								11:50	8:00	13:50	11:25	11:30
It-situ Parameters												
Dissolved Oxygen	mg/L				11 or greater	<11 to 6.5	<6.5	9.52	9.54	9.2	9.32	9.4
Dissolved Oxygen	%							98.7	97.2	98.1	98.1	94.6
pH	rel. units				6.5 to 9.0	<6.5 to 6.0 or >9.0 to 9.5	<6 or >9.5	7.48	7.69	7.44	7.5	7.25
Water Temperature	°C							17.04	16.24	18.44	17.76	15.68
Conductivity	mS/cm				<0.050	0.050-0.200	>0.200	0.189	0.208	0.128	0.203	0.116
Specific Conductivity	mS/cm[C]							0.223	0.25	0.147	0.235	0.142
Turbidity	NTU				0 to 5	5 to 25 (not including 5)	>25	2.1	4.1	3.8	3.6	1.2
Total Dissolved Solids (TDS)	g/L							0.145	0.162	0.095	0.153	0.117
Salinity								0.11	0.12	0.07	0.11	0.07
Oxygen Reduction Pctential (ORP)								83.5	144.9	167.6	120	158.4
Anions												
Nitrogen, Nitrate as N	mg/L	0.01	Short: 550 Long: 13	(A) **acute**: 32.8; **chronic**: 3.0	<2	2-5	>5	0.665	0.618	0.485	0.406	0.333
Microbiological Parameters												
E. coli (MPN)	MPN/100 mL	2		Geomean <=77	Geomean <=77	Geomean 78-385	Geomean >385	1100	3000	900	1600	5000
Coliforms, Fecal (MPN)	MPN/100 mL	2		Geomean <=200	Geomean <=200	Geomean 201-1000	Geomean >1000	1100	3000	900	1600	5000
Coliforms, Total (MPN)	MPN/100 mL	2						5000	3000	7000	1600	9000
General Lab Parameters												
Alkalinity, Total as $CaCO_3$	mg/L	1		(W) <10 highly sensitive to acidic inputs 10-20 moderately sensitive to acidic inputs, refer to calcium the more restrictive of calcium or alkalinity applies				64	76	70	72	63
Alkalinity, Phenolphthalein as CaCO3	mg/L	1						<1	<1	<1	<1	<1
Alkalinity, Bicarbonate as CaCO3	mg/L	1						64	76	70	72	63
Alkalinity, Carbonate as CaCO3	mg/L	1						<1	<1	<1	<1	<1
Alkalinity, Hydroxide as CaCO3	mg/L	1						<1	<1	<1	<1	<1
Calculated Lab Parameters												
Hardness, Total (Total as CaCO3)	mg/L	0.5						69.4	81.6	78.1	74.7	63.9
Hardness, Total (Diss. as CaCO3)	mg/L	0.5						69.5	89.8	70.5	71.6	63.1
Total Recoverable Metals												
Aluminum, total	mg/L	0.005	If pH< 6.5, 0.005 If pH >= 6.5, 0.1					0.143	0.158	0.199	0.14	0.102
Antimony, total	mg/L	0.0001		(W) 0.02 (proposed Ontario guideline)				0.0003	0.0002	0.0001	0.0002	0.0001
Arsenic, total	mg/L	0.0005	Long Term: 0.005	(A) 0.005				0.0007	0.0008	0.0008	0.0007	0.0008
Barium, total	mg/L	0.005		(W) max: 5; 30 day avg: 1				0.011	0.011	0.011	0.012	0.009
Beryllium, total	mg/L	0.0001		(W) chronic: 0.0053				<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Bismuth, total	mg/L	0.0001						<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Boron, total	mg/L	0.004	Short: 29 Long: 1.5	(A) 1.2				0.024	0.029	0.029	0.044	0.028
Cadmium, total	mg/L	0.00001	Hardness dependent[2] Short: 0.00011 - 0.0077 Long: 0.00004-0.00037	(W) 0.00001 at 30mg/L CaCO3 0.00002 at 60mg/L CaCO3 Cd (µg/L) = $10^{(0.86[\log(\text{hardness})]-3.2)}$	<0.00006 [5]	0.00006-0.00034 [5]	>0.00034 [5]	0.00001	0.00002	0.00002	0.00001	<0.00001
Calcium, total	mg/L	0.2						15.8	18.7	17.7	16.9	14.4
Chromium, total	mg/L	0.0005	Long: 0.001 Cr(VI); 0.0089 Cr(III)	(W) 0.001 Cr(VI); 0.0089 Cr(III)				<0.0005	0.001	0.0005	0.0005	0.0005
Cobalt, total	mg/L	0.00005		(A) **max**: 0.11; **30 day avg**: 0.004				0.0001	0.00013	0.00014	0.00013	0.0001
Copper, total	mg/L	0.0002	Hardness Dependent[3]; Long: 0.002-0.004	(A) CaCO3<= 50mg/L: **30 day avg** 0.002; **max** (µg/L) = 0.094(hardness(mg/L))+2 CaCO3>50mg/L: **30 day avg** (µg/L) = 0.04(mean hardness); **max** (µg/L) = 0.094(hardness(mg/L))+2	<0.003 [5]	0.003-0.011 [5]	<0.011 [5]	0.0037	0.0036	0.0034	0.0025	0.0021
Iron, total	mg/L	0.01	Long: 0.3	(A) max: 1	<0.8 [5]	0.8-5 [5]	>5 [5]	0.31	0.37	0.4	0.35	0.29
Lead, total	mg/L	0.0001	Hardness dependent[4] Long: 0.001-0.007	CaCO3<= 8mg/L: **max** 0.003 CaCO3> 8mg/L: **max**(µg/L)=$e^{(1.273\ln(\text{hardness})-1.460)}$ 30 day avg (µg/L)= 3.31 + $e^{(1.273\ln(\text{mean hardness})-4.704)}$	<0.005 [5]	0.005-0.03 [5]	>0.03 [5]	0.0002	0.0003	0.0002	0.0002	0.0001
Lithium, total	mg/L	0.0001		(W) **max**: 0.87; **chronic**: 0.014 or 0.096				0.001	0.0013	0.001	0.0012	0.0009
Magnesium, total	mg/L	0.01		NA				7.28	8.44	8.24	7.91	6.74
Manganese, total	mg/L	0.0002		(A) **max** =0.01102hardness+0.54 **Chronic** =0.0044hardness+0.605				0.0168	0.0255	0.0209	0.0227	0.02
Mercury, total	mg/L	0.00002	Long: 0.000026	(A) 0.00000125-0.00002 depending on the amount of Methyl Mercury				<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
Molybdenum, total	mg/L	0.0001	Long: 0.073	(A) **max**: 2; **30 day avg**: 1				0.0009	0.007	0.0024	0.0022	0.0011
Nickel, total	mg/L	0.0002	CaCO3< 60mg/L: 0.025 60mg/L<=CaCO3=<180mg/L: Ni (µg/L)= $e^{(0.76[\ln(\text{hardness})]+1.06)}$	(W) CaCO3<60mg/L: 0.025; CaCO3 60-120mg/L: 0.065; CaCO3 120-180mg/L: 0.11. CaCO3> 180mg/L: 0.15				0.0009	0.0009	0.0009	0.0009	0.001
Phosphorus, total	mg/L	0.02						0.06	0.05	0.08	0.09	0.04
Potassium, total	mg/L	0.02		(W) 373-432				2.4	2.94	3.44	2.61	2.29
Selenium, total	mg/L	0.0005	Long: 0.001	(A) alert at 0.001 guideline is 0.002				<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Silicon, total	mg/L	0.5						7.9	8.8	9.3	9.7	7.6
Silver, total	mg/L	0.00005	Long: 0.0001	(A) CaCO3<100mg/L: **max** 0.0001; **30 day avg** 0.00005 CaCO3>100mg/L: **max** 0.003; **30 day avg** 0.0015				<0.00005	<0.00005	<0.00005	<0.00005	0.00121
Sodium, total	mg/L	0.02						18.7	19.1	18.3	17.8	16.4
Strontium, total	mg/L	0.001						0.09	0.099	0.101	0.106	0.084
Sulfur, total	mg/L	1						1	3	5	4	7
Tellurium, total	mg/L	0.0002						<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Thallium, total	mg/L	0.00002	Long: 0.0008	(W) 0.0003 water quality objective for Ontario				<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
Thorium, total	mg/L	0.0001						<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

Parameter	Monitoring Location: SA-2 (Millionaire Creek at Fern Cres)					Monitoring Location: K-1 (Dunlop Creek at 110 Ave)					Monitoring Location: K-2 (Spencer Creek at 240 St)				
Sampling Date	2015-07-29	2015-08-05	2015-08-11	2015-08-19	2015-08-26	2015-07-29	2015-08-05	2015-08-11	2015-08-19	2015-08-26	2015-07-29	2015-08-05	2015-08-11	2015-08-19	2015-08-26
Sampling Time	12:25	8:45	14:30	12:00	12:00	13:00	10:07	15:00	12:45	12:35	13:30	9:50	15:25	13:15	13:05
It-situ Parameters															
Dissolved Oxygen	9.97	10.05	9.38	9.59	9.74	6.09	4.54	4.76	2.9	3.18	8.81	9.08	8.34	8.52	8.93
Dissolved Oxygen	102.2	100	99.2	100.3	97.5	62.2	45.4	49.4	30.6	31	91.1	90.6	88.8	89.9	88.9
pH	7.45	7.15	7.7	7.39	7.04	7.36	6.93	7.26	7.03	7.13	7.61	7.3	7.64	7.47	7.66
Water Temperature	16.57	15.12	18.06	17.5	15.42	16.42	15.25	16.91	16.37	13.95	16.97	15.12	18.36	17.86	15.17
Conductivity	0.061	0.067	0.061	0.066	0.062	0.168	0.162	0.115	0.165	0.151	0.098	0.215	0.143	0.224	0.209
Specific Conductivity	0.072	0.083	0.07	0.077	0.076	0.201	0.199	0.136	0.197	0.191	0.116	0.265	0.163	0.26	0.257
Turbidity	0	0	0	0	0	2.1	4.3	2.7	2.6	3.1	7.1	7.9	7.6	5.7	7.9
Total Dissolved Solids (TDS)	0.047	0.054	0.046	0.05	0.05	0.131	0.13	0.089	0.128	0.124	0.075	0.172	0.106	0.169	0.167
Salinity	0.03	0.04	0.03	0.04	0.04	0.1	0.09	0.06	0.09	0.09	0.05	0.13	0.08	0.12	0.12
Oxygen Reduction Pctential (ORP)	175.9	183.2	207.3	111.6	234.2	180.7	214	162.5	98.4	227	169.6	223.6	167.3	83.4	177.7
Anions															
Nitrogen, Nitrate as N	0.312	0.458	0.36	0.423	0.39	0.205	0.035	0.031	0.028	0.019	<0.010	0.166	0.1	0.159	0.121
Microbiological Parameters															
E. coli (MPN)	23	2400	23	80	30	110	90	130	900	17	130	80	130	500	140
Coliforms, Fecal (MPN)	30	2400	23	80	30	110	90	130	900	17	130	80	130	500	140
Coliforms, Total (MPN)	500	2400	2400	1600	3000	3000	1600	2400	1600	170	1600	900	1600	900	5000
General Lab Parameters															
Alkalinity, Total as $CaCO_3$	26	31	28	29	28	69	77	76	76	79	87	111	108	108	105
Alkalinity, Phenolphthalein as CaCO3	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Alkalinity, Bicarbonate as CaCO3	26	31	28	29	28	69	77	76	76	79	87	111	108	108	105
Alkalinity, Carbonate as CaCO3	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Alkalinity, Hydroxide as CaCO3	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Calculated Lab Parameters															
Hardness, Total (Total as CaCO3)	24.1	29.2	25.7	25.5	24.8	72	72.7	70.8	66.9	68.4	91.3	121	113	106	109
Hardness, Total (Diss. as CaCO3)	23.2	25.9	24.1	24.5	23.9	69.5	69.1	64.2	64.5	65.7	89	111	105	104	106
Total Recoverable Metals															
Aluminum, total	0.025	0.025	0.023	0.025	0.03	0.124	0.177	0.108	0.095	0.172	0.511	0.411	0.415	0.224	0.482
Antimony, total	0.0002	0.0001	<0.0001	<0.0001	0.0003	0.0002	0.0001	<0.0001	0.0001	0.0001	0.0003	0.0002	<0.0001	0.0002	0.0001
Arsenic, total	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.001	0.0014	0.0012	0.0014	0.0015	0.0012	0.0014	0.0016	0.0015	0.0017
Barium, total	0.008	0.008	0.007	0.008	0.008	0.015	0.015	0.012	0.013	0.015	0.012	0.012	0.01	0.011	0.012
Beryllium, total	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Bismuth, total	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Boron, total	0.009	0.01	0.009	0.019	0.009	0.038	0.041	0.038	0.043	0.035	0.026	0.031	0.027	0.032	0.023
Cadmium, total	0.00003	<0.00001	<0.00001	<0.00001	<0.00001	0.00001	0.00001	0.00001	<0.00001	<0.00001	0.00001	0.00001	<0.00001	<0.00001	<0.00001
Calcium, total	7.2	8.8	7.6	7.6	7.4	18.3	18.8	17.8	17.1	17.3	24.3	32.2	29.7	28.3	30.1
Chromium, total	<0.0005	0.0008	<0.0005	<0.0005	<0.0005	0.0005	0.0011	<0.0005	<0.0005	0.0006	0.0008	0.0013	0.0006	0.0005	0.0008
Cobalt, total	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	0.00037	0.00069	0.00045	0.00051	0.00056	0.00034	0.00036	0.00028	0.0002	0.00035
Copper, total	0.0037	0.0064	0.0014	0.0009	0.0012	0.0015	0.0021	0.0017	0.0015	0.0011	0.0013	0.0025	0.0022	0.0017	0.0017	0.0018
Iron, total	0.03	0.04	0.04	0.03	0.04	0.04	0.88	1.19	1.12	1.06	1.12	0.7	0.71	0.66	0.49	0.83
Lead, total	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	0.0002	<0.0001	0.0001	0.0001	0.0002	0.0002	0.0001	0.0001	0.0002
Lithium, total	0.0002	<0.0001	0.0003	<0.0001	0.0001	0.0003	0.0001	0.0003	0.0002	0.0005	0.0006	0.0004	0.0005	0.0005	
Magnesium, total	1.76	1.62	1.54	1.55	6.41	6.26	6.4	5.85	6.1	7.39	9.9	9.34	8.54	8.26	
Manganese, total	0.0026	0.0025	0.0024	0.0029	0.148	0.34	0.202	0.298	0.264	0.067	0.1	0.0787	0.0868	0.13	
Mercury, total	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
Molybdenum, total	0.0008	0.0007	0.0007	0.0007	0.0008	0.0007	0.0007	0.0007	0.0007	0.0009	0.0012	0.0011	0.0012	0.001	
Nickel, total	0.0008	<0.0002	<0.0002	<0.0002	0.0004	0.0009	0.001	0.0009	0.0008	0.0014	0.0012	0.0013	0.0011	0.001	0.0014
Phosphorus, total	0.03	<0.02	<0.02	<0.02	<0.02	0.07	0.06	0.06	0.05	0.06	0.06	0.03	0.05	<0.02	0.07
Potassium, total	0.69	0.71	0.71	0.69	0.71	3.81	3.54	3.67	3.45	3.78	2.49	2.9	2.8	2.61	2.61
Selenium, total	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Silicon, total	6	6.2	6.7	6.6	5.8	4.8	4.7	5	4.9	5	7.2	8.5	8.3	8.3	7.8
Silver, total	<0.00005	<0.00005	<0.00005	<0.00005	0.00119	<0.00005	<0.00005	<0.00005	<0.00005	0.00111	<0.00005	<0.00005	<0.00005	<0.00005	0.00087
Sodium, total	5.13	5.95	5.61	5.39	6.39	13.2	13.8	14.6	13.3	14.2	11.4	14.5	13.8	12.2	13.4
Strontium, total	0.044	0.048	0.047	0.048	0.048	0.121	0.116	0.118	0.123	0.126	0.157	0.197	0.19	0.194	0.187
Sulfur, total	<1	<1	<1	<1	6	5	2	3	2	7	2	5	4	2	8
Tellurium, total	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Thallium, total	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
Thorium, total	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

Parameter	Units	Detection Limit	Guidelines: CCME- CEQG, WQG for the Protection of Aquatic Life - Freshwater	Guidelines: BC Approved (A) and Working (W) Water Quality Guidelines for the Protection of Freshwater Aquatic Life	Metro Vancouver Monitoring and Adaptive Mangement Framework - Water Quality Levels			Monitoring Location	SA-1 (T2 Creek at 124 Ave)					SA-2 (Millionaire Creek at Fern Cres)					K-1 (Dunlop Creek at 110 Ave)					K-2 (Spencer Creek at 240 St)				
								Sampling Date	2015-07-29	2015-08-05	2015-08-11	2015-08-19	2015-08-26	2015-07-29	2015-08-05	2015-08-11	2015-08-19	2015-08-26	2015-07-29	2015-08-05	2015-08-11	2015-08-19	2015-08-26	2015-07-29	2015-08-05	2015-08-11	2015-08-19	2015-08-26
									11:50	8:00	13:50	11:25	11:30	12:25	8:45	14:30	12:00	12:00	13:00	10:07	15:00	12:45	12:35	13:30	9:50	15:25	13:15	13:05
Tin, total	mg/L	0.0002							<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Titanium, total	mg/L	0.005		(W) **max** 0.00024					0.006	0.007	0.009	0.009	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.005	0.008	<0.005	<0.005	0.008	0.02	0.023	0.015	0.009	0.019
Uranium, total	mg/L	0.00002	Short: 0.033 Long: 0.015	(W) **max**: 0.3; 0.5 Ontario's water quality objective					0.00005	0.00007	0.00007	0.00005	0.00003	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	0.00005	0.00008	0.00006	0.00007	0.00007
Vanadium, total	mg/L	0.001		(W) 0.006 Ontarios Water Quality objective; 0.02 secondary value					0.002	0.002	0.002	0.001	0.001	<0.001	<0.001	0.001	<0.001	<0.001	0.002	0.002	0.002	0.001	0.002	0.003	0.002	0.003	0.002	0.003
Zinc, total	mg/L	0.004	Long: 0.03	(A) CaCO3<30mg/L: 0.033. Guideline (ug/L) = 33+0.75(hardness (mg/L)-90)	<0.006 [5]	0.006-0.04 [5]	>0.04 [5]		0.007	0.006	0.007	0.005	0.005	0.005	<0.004	<0.004	<0.004	<0.004	<0.004	0.075	<0.004	<0.004	<0.004	0.005	<0.004	<0.004	<0.004	<0.004
Zirconium, total	mg/L	0.0001							<0.0001	0.0009	0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	0.0002	<0.0001	<0.0001	0.0001	0.0002	0.0002	0.0001	0.0001	0.0002
Dissolved Metals																												
Aluminum, dissolved	mg/L	0.005		(A) ph>= 6.5: **acute** 0.2 pH<6.5: **acute** $Al=e^{1.209 - 2.426 (pH) + 0.286 K)}$ where K = $(pH)^2$ **30-day avg.** $Al= e^{1.5 - 3.327 (median pH) + 0.402 K)}$ where K = $(median\ pH)^2$					0.012	0.014	0.011	0.01	0.012	0.011	0.012	0.012	0.012	0.012	0.013	0.016	0.014	0.013	0.016	0.007	0.009	0.008	0.008	0.008
Antimony, dissolved	mg/L	0.0001							0.0002	0.0003	0.0001	0.0002	<0.0001	<0.0001	0.0001	<0.0001	0.0001	<0.0001	0.0001	0.0001	<0.0001	0.0002	<0.0001	0.0001	0.0002	0.0002	0.0002	<0.0001
Arsenic, dissolved	mg/L	0.0005							0.0007	0.0006	0.0007	0.0005	0.0006	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0008	0.0012	0.001	0.001	0.001	0.0009	0.0012	0.0013	0.0012	0.0011
Barium, dissolved	mg/L	0.005							0.01	0.01	0.01	0.01	0.009	0.007	0.007	0.007	0.008	0.007	0.013	0.013	0.011	0.012	0.012	0.008	0.008	0.009	0.009	0.008
Beryllium, dissolved	mg/L	0.0001							<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Bismuth, dissolved	mg/L	0.0001							<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Boron, dissolved	mg/L	0.004							0.023	0.029	0.026	0.041	0.022	0.007	0.008	0.009	0.007	0.008	0.034	0.033	0.034	0.033	0.029	0.021	0.024	0.023	0.022	0.02
Cadmium, dissolved	mg/L	1.00E-05							0.00002	0.00003	<0.00001	<0.00001	<0.00001	<0.00001	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00002	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00001
Calcium, dissolved	mg/L	0.2		(W) <4 highly sensitive to acidic inputs 4-8 moderately sensitive to acidic inputs. refer to alkalinity the more restrictive of calcium or alkalinity applies					15.9	22.8	16.2	16.4	14	7	7.8	7.2	7.4	7.1	17.8	17.8	16.4	16.6	16.6	24.2	30	28.2	28	28
Chromium, dissolved	mg/L	0.0005							<0.0005	0.0008	<0.0005	<0.0005	<0.0005	<0.0005	0.0007	<0.0005	<0.0005	<0.0005	<0.0005	0.0008	<0.0005	<0.0005	<0.0005	<0.0005	0.0007	<0.0005	<0.0005	<0.0005
Cobalt, dissolved	mg/L	5.00E-05							0.00006	0.00009	0.00007	0.00008	0.00007	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	0.0003	0.00053	0.00034	0.00044	0.00041	0.00009	0.0001	0.00011	0.00009	0.0001
Copper, dissolved	mg/L	0.0002							0.0031	0.0023	0.0024	0.002	0.0018	0.0008	0.001	0.0009	0.0009	0.001	0.0015	0.0012	0.0011	0.0009	0.0009	0.0015	0.0013	0.0012	0.0011	0.0011
Iron, dissolved	mg/L	0.01		(A) max: 0.35					0.11	0.109	0.115	0.131	0.111	0.019	0.018	0.019	0.02	0.018	0.54	0.625	0.635	0.592	0.574	0.08	0.076	0.068	0.1	0.091
Lead, dissolved	mg/L	0.0001							<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Lithium, dissolved	mg/L	0.0001							0.0007	0.0013	0.0011	0.001	0.0006	<0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	0.0001	<0.0001	<0.0001	<0.0001	0.0003	0.0003	0.0002	<0.0001
Magnesium, dissolved	mg/L	0.01							7.22	7.97	7.26	7.45	6.85	1.39	1.55	1.47	1.47	1.48	6.11	6	5.67	5.6	5.9	8.92	8.65	8.35	8.22	8.64
Manganese, dissolved	mg/L	0.0002							0.0118	0.0177	0.0127	0.0167	0.0165	0.0018	0.0023	0.0016	0.0018	0.0017	0.123	0.281	0.144	0.274	0.205	0.0361	0.0543	0.0526	0.0756	0.0772
Mercury, dissolved	mg/L	2.00E-05							<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
Molybdenum, dissolved	mg/L	0.0001							0.0007	0.007	0.002	0.0018	0.0011	0.0005	0.0007	0.0008	0.0007	0.0006	0.0005	0.0007	0.0007	0.0008	0.0007	0.0007	0.001	0.0011	0.0012	0.001
Nickel, dissolved	mg/L	0.0002							0.0006	0.0006	0.0005	0.0004	0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0002	0.0006	0.0007	0.0005	0.0005	0.0007	0.0006	0.0007	0.0007	0.0004	0.0006
Phosphorus, dissolved	mg/L	0.02							0.02	<0.02	0.04	0.06	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.03	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Potassium, dissolved	mg/L	0.02							2.38	2.84	3.14	2.45	2.29	0.6	0.63	0.67	0.64	0.66	3.64	3.48	3.48	3.34	3.25	2.32	2.59	2.66	2.57	2.43
Selenium, dissolved	mg/L	0.0005							<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Silicon, dissolved	mg/L	0.5							7.1	7.6	8	8.8	7.2	5.2	5.3	6.2	5.9	5.2	3.9	4.1	4.5	4.6	4.1	5.5	6.2	7.1	7.6	6.3
Silver, dissolved	mg/L	5.00E-05							0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Sodium, dissolved	mg/L	0.02							18.5	18.1	16.2	17.6	16.6	4.78	5.27	5.12	4.99	6.17	12.6	13	13.1	13	14.3	10.8	12.8	12.5	12.1	13.3
Strontium, dissolved	mg/L	0.001							0.084	0.098	0.093	0.102	0.083	0.04	0.046	0.044	0.047	0.043	0.109	0.115	0.112	0.123	0.111	0.143	0.184	0.182	0.195	0.178
Sulfur, dissolved	mg/L	1							2	<1	3	1	7	<1	<1	<1	<1	8	3	<1	3	<1	9	1	<1	4	<1	10
Tellurium, dissolved	mg/L	0.0002							<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Thallium, dissolved	mg/L	2.00E-05							<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
Thorium, dissolved	mg/L	0.0001							<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Tin, dissolved	mg/L	0.0002							<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Titanium, dissolved	mg/L	0.005							<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Uranium, dissolved	mg/L	2.00E-05							0.00004	0.00009	0.00006	0.00004	0.00004	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	0.00004	0.00007	0.00006	0.00006	0.00007
Vanadium, dissolved	mg/L	0.001							<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc, dissolved	mg/L	0.004							0.005	0.012	<0.004	<0.004	<0.004	<0.004	0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Zirconium, dissolved	mg/L	0.0001							<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

http://st-ts.ccme.ca/

http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html

Notes:
If guidelines had no specific value for a parameter, it was indicated as 'na'; if parameter was not on the guideline list, cell was left blank.
For CCME WQG, Short indicates short term and Long indicates long term.
Fill indicates which guideline is exceeded, if only one guideline exceeded. If two guidelines exceeded, combination of font and fill colour indicate which guidelines are exceeded.
If three guidelines are exceeded, fill matches Metro Vancouver colours and font is brown.

Footnotes:
1. Clear Flow:
short term: max increase 25 mg/L from background
long term: max increase of 5 mg/L from background
High Flow:
background between 25-250 mg/L: max increase of 25mg/L from background
background >= 250mg/L: should not increase more than 10% of background
2. Short Term:
If CaCO3 < 5.3mg/L, guideline is 0.00011 mg/L
If 5.3mg/L<=CaCO3=<360mg/L, use equation: (µg/L)=10^{1.016(log[hardness]) – 1.71 }
If CaCO3> 360mg/L, guideline is 0.0077 mg/L
Long Term:
If CaCO3 < 17mg/L, guideline is 0.00004 mg/L
If 17mg/L<=CaCO3=<280mg/L, use equation: (µg/L)=10^{0.83(log[hardness]) – 2.46 }
If CaCO3> 280mg/L, guideline is 0.00037 mg/L
3. Long Term:
If CaCO3 < 82mg/L, guideline is 0.002 mg/L
If 82mg/L<=CaCO3=<180mg/L, use equation: (µg/L)=0.2 * e^{0.8545[ln(hardness)]-1.465}
If CaCO3> 180mg/L, guideline is 0.004 mg/L
4. Long Term:
If CaCO3 < 60mg/L, guideline is 0.001 mg/L
If 60mg/L<=CaCO3=<180mg/L, use equation: (µg/L)=e^{1.273[ln(hardness)]-4.705}
If CaCO3> 180mg/L, guideline is 0.007 mg/L
5. Assume hardness approximating 100 mg/L CaCO3

Appendix F: Full Monitoring Results Data Table

City of Maple Ridge

Water Quality and Benthic Invertebrate Monitoring in T2, Millionaire, Dunlop, and Spencer Creeks, 2014-2015
March 2016

Parameter	Units	Detection Limit	Guidelines: CCME- CEQG, WQG for the Protection of Aquatic Life - Freshwater	Guidelines: BC Approved (A) and Working (W) Water Quality Guidelines for the Protection of Freshwater Aquatic Life	Guidelines: Metro Vancouver Monitoring and Adaptive Mangement Framework - Water Quality Levels			SA-1 (T2 Creek at 124 Ave)					SA-2 (Millionaire Creek at Fern Cres)					K-1 (Dunlop Creek at 110 Ave)					K-2 (Spencer Creek at 240 St)				
Monitoring Location								SA-1	SA-1	SA-1	SA-1	SA-1	SA-2	SA-2	SA-2	SA-2	SA-2	K-1	K-1	K-1	K-1	K-1	K-2	K-2	K-2	K-2	K-2
Sampling Date								2014-11-26	2014-12-05	2014-12-09	2014-12-16	2014-12-19	2014-11-26	2014-12-05	2014-12-09	2014-12-16	2014-12-19	2014-11-26	2014-12-05	2014-12-09	2014-12-16	2014-12-19	2014-11-26	2014-12-05	2014-12-09	2014-12-16	2014-12-19
								15:44	10:30	13:06	10:52	10:51	16:10	11:08	13:39	11:25	11:21	17:00	12:17	14:38	12:01	11:53	16:44	11:48	15:08	12:25	12:20
It-situ Parameters					Green Level	Yellow Level	Red Level																				
Dissolved Oxygen	mg/L				11 or greater	<11 to 6.5	<6.5	10.91	10.87	11.6	11.2	11.72	11.58	12.23	12.2	12.17	12.35	11.36	12	11.9	12.27	12.17	11	11.83	11.63	11.97	11.92
Dissolved Oxygen	%							98.2	94.2	105.2	98.7	103.1	100.2	95.2	105.8	98.6	104.1	97.6	92	102.9	96.5	102.2	95.1	90.5	102	95.4	100.6
pH	rel. units				6.5 to 9.0	<6.5 to 6.0 or >9.0 to 9.5	<6 or >9.5	6.3	6.83	7.45	7.47	7.41	6.17	6.78	6.91	7.46	7.41	6.57	6.9	6.72	7.08	7.25	6.46	6.8	6.97	7.22	7.13
Water Temperature	°C							10.69	9.05	10.97	9.79	9.68	9.07	4.76	9.09	6.35	7.95	8.72	4.2	8.96	5.14	7.77	8.96	4.12	9.56	5.67	8
Conductivity	mS/cm				<0.050	0.050-0.200	>0.200	0.085	0.143	0.217	0.147	0.082	0.018	0.027	0.145	0.032	0.021	0.045	0.062	0.178	0.066	0.04	0.068	0.136	0.217	0.116	0.06
Specific Conductivity	mS/cm[C]							0.117	0.206	0.296	0.207	0.116	0.025	0.044	0.209	0.05	0.03	0.065	0.103	0.257	0.107	0.06	0.097	0.226	0.307	0.184	0.088
Turbidity	NTU				0 to 5	5 to 25 (not including 5)	>25	10.6	3.8	12.6	2.6	6.2	6.3	0.8	2.6	0.9	1.6	25.1	7.7	18.5	6	16.8	35.8	16.2	37.3	13.7	59.1
Total Dissolved Solids (TDS)	g/L							0.076	0.134	0.193	0.135	0.075	0.016	0.029	0.136	0.033	0.02	0.042	0.067	0.167	0.069	0.039	0.063	0.147	0.2	0.12	0.057
Salinity								0.06	0.1	0.14	0.1	0.05	0.01	0.02	0.1	0.02	0.01	0.03	0.05	0.12	0.05	0.03	0.05	0.11	0.15	0.09	0.04
Oxygen Reduction Potential (ORP)								134.1	69.4	68.7	77.6	103	165.1	79	156	101.7	226.2	203.1	75.4	159.9	136	254.2	192.6	71.3	139	114.3	174.5
Anions																											
Nitrogen, Nitrate as N	mg/L	0.01	Short: 550 Long: 13	(A) **acute**: 32.8; **chronic**: 3.0	<2	2-5	>5	1.86	1.08	0.795	1.4	0.925	0.487	0.285	0.293	0.298	0.263	1.54	0.712	0.879	0.928	0.707	0.873	0.333	0.508	0.409	0.426
Microbiological Parameters																											
E. coli (MPN)	MPN/100 mL	2		Geomean <=77	Geomean <=77	Geomean 78-385	Geomean >385	<2	850	300	91	300	<2	10	11	3.6	23	<2	180	<1	36	300	<2	400	<1	23	500
Coliforms, Fecal (MPN)	MPN/100 mL	2		Geomean <=200	Geomean <=200	Geomean 201-1000	Geomean >1000	1600	800	420	750	150	13	4	13	3.6	17	1600	150	170	36	300	50	400	32	23	500
Coliforms, Total (MPN)	MPN/100 mL	2						16000	850	<1	91	400	170	35	78	29	46	5000	210	180	430	600	5000	460	260	930	1000
General Lab Parameters																											
Alkalinity, Total as CaCO3	mg/L	1		(W) <10 highly sensitive to acidic inputs 10-20 moderately sensitive to acidic inputs, refer to calcium the more restrictive of calcium or alkalinity applies				36	44	24	48	33	6	10	7	8	8	16	25	16	25	17	34	53	37	54	32
Alkalinity, Phenolphthalein as CaCO3	mg/L	1						<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Alkalinity, Bicarbonate as CaCO3	mg/L	1						36	44	24	48	33	6	10	7	8	8	16	25	16	25	17	34	53	37	54	32
Alkalinity, Carbonate as CaCO3	mg/L	1						<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Alkalinity, Hydroxide as CaCO3	mg/L	1						<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Calculated Lab Parameters																											
Hardness, Total (Total as CaCO3)	mg/L	0.5						45.5	50.5	32.5	59.6	39.1	8.75	10.6	9.5	10.3	9.12	26	29.8	23.9	33.6	22.4	44.1	58.2	48.9	64.4	39.1
Hardness, Total (Diss. as CaCO3)	mg/L	0.5						38.7	45.4	32	57.6	37.5	7.29	10.1	8.45	9.17	9.06	21.3	26.4	22.4	28.4	21.6	36.1	56.3	43.9	55.8	33.7
Total Recoverable Metals																											
Aluminum, total	mg/L	0.005	If pH< 6.5, 0.005 If pH >= 6.5, 0.1					0.005	0.164	0.839	0.132	0.36	0.356	0.082	0.238	0.099	0.159	1.72	0.486	1.34	0.442	1.27	2.59	1.12	2.75	0.826	4.25
Antimony, total	mg/L	0.0001		(W) 0.02 (proposed Ontario guideline)				0.0001	0.0004	0.0002	0.0002	0.0003	0.0001	0.0001	0.0003	0.0002	<0.0001	0.0002	0.0003	<0.0001	0.0003	0.0001	0.0002	0.0002	0.0001	0.0002	0.0002
Arsenic, total	mg/L	0.0005	Long Term: 0.005	(A) 0.005				0.0005	<0.0005	0.0007	0.0005	0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0007	<0.0005	0.0007	<0.0005	0.0007	0.0009	0.0006	0.0009	0.0007	0.0011
Barium, total	mg/L	0.005		(W) max: 5; 30 day avg: 1				0.005	0.015	0.015	0.011	0.013	0.006	<0.005	0.005	<0.005	0.005	0.018	0.012	0.019	0.011	0.017	0.022	0.017	0.026	0.013	0.039
Beryllium, total	mg/L	0.0001		(W) chronic: 0.0053				0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Bismuth, total	mg/L	0.0001						0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Boron, total	mg/L	0.004	Short: 29 Long: 1.5	(A) 1.2				0.004	0.018	0.011	0.018	0.015	0.006	0.004	<0.004	0.005	<0.004	0.012	0.012	0.005	0.015	0.01	0.011	0.012	0.006	0.012	0.01
Cadmium, total	mg/L	0.00001	Hardness dependent[2] Short: 0.00011 - 0.0077 Long: 0.00004-0.00037	(W) 0.00001 at 30mg/L CaCO3 0.00002 at 60mg/L CaCO3 Cd (µg/L) = $10^{0.86[log(hardness)]-3.2)}$	<0.00006 [5]	0.00006-0.00034 [5]	>0.00034 [5]	0.00001	0.00001	0.00002	0.00001	0.00002	<0.00001	<0.00001	0.00004	0.00002	<0.00001	0.00002	0.00001	0.00002	<0.00001	0.00002	0.00002	0.00001	0.00002	0.00002	0.00003
Calcium, total	mg/L	0.2						0.2	12.2	8.6	14	10	2.5	3.2	2.8	3	2.7	6.4	7.6	6.1	9	5.7	11.1	15.7	12.8	17.7	9.7
Chromium, total	mg/L	0.0005	Long: 0.001 Cr(VI): 0.0089 Cr(III)	(W) 0.001 Cr(VI): 0.0089 Cr(III)				0.0005	<0.0005	0.0017	0.0006	0.0007	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0021	0.0006	0.0021	0.0008	0.0017	0.003	0.0012	0.0033	0.0017	0.0047
Cobalt, total	mg/L	0.00005		(A) **max**: 0.11; **30 day avg**: 0.004				0.00005	0.00013	0.00035	0.00011	0.00017	0.00012	<0.00005	0.0001	<0.00005	0.00008	0.0007	0.00025	0.00052	0.00025	0.00051	0.00101	0.00046	0.001	0.00038	0.00152
Copper, total	mg/L	0.0002	Hardness Dependent[3]: Long: 0.002-0.004	(A) CaCO3<= 50mg/L: **30 day avg** 0.002; **max** (µg/L) = 0.094(hardness(mg/L))+2 CaCO3>50mg/L: **30 day avg** (µg/L) = 0.04(mean hardness): **max** (µg/L) = 0.094(hardness(mg/L))+2	<0.003 [5]	0.003-0.011 [5]	<0.011 [5]	0.0002	0.0024	0.0048	0.0015	0.0033	0.0008	0.0004	0.0009	0.0008	0.0005	0.0041	0.0019	0.0034	0.0019	0.0032	0.0054	0.0028	0.0057	0.0025	0.0074
Iron, total	mg/L	0.01	Long: 0.3	(A) max: 1	<0.8 [5]	0.8-5 [5]	>5 [5]	0.01	0.24	0.77	0.22	0.4	0.29	0.09	0.2	0.1	0.14	1.59	0.5	1.21	0.49	1.13	2.36	1.01	2.37	0.85	3.67
Lead, total	mg/L	0.0001	Hardness dependent[4] Long: 0.001-0.007	CaCO3<= 8mg/L: **max** 0.003 CaCO3> 8mg/L: **max**(µg/L)=$e^{1.273 \ln(\text{hardness}) - 1.460)}$ 30 day avg (µg/L)= 3.31 + $e^{1.273 \ln(\text{mean hardness}) - 4.704)}$	<0.005 [5]	0.005-0.03 [5]	>0.03 [5]	0.0001	0.0003	0.0008	0.0001	0.0004	0.0001	<0.0001	0.0001	0.0001	<0.0001	0.0005	0.0002	0.0005	0.0002	0.0004	0.0006	0.0004	0.0007	0.0003	0.0011
Lithium, total	mg/L	0.0001		(W) **max**: 0.87; **chronic**: 0.014 or 0.096				0.0001	0.0009	0.0007	0.001	0.0007	0.0002	0.0001	0.0001	0.0002	0.0001	0.0009	0.0004	0.0007	0.0005	0.0007	0.0015	0.0009	0.0015	0.0008	0.0022
Magnesium, total	mg/L	0.01		NA				0.01	4.85	2.7	5.96	3.41	0.6	0.66	0.61	0.66	0.59	2.44	2.59	2.13	2.67	1.94	3.94	4.58	4.1	4.9	3.57
Manganese, total	mg/L	0.0002		(A) **max** =0.01102hardness+0.54 **Chronic** =0.0044hardness+0.605				0.0002	0.0278	0.0295	0.024	0.0226	0.0098	0.0037	0.007	0.004	0.0052	0.0418	0.0213	0.03	0.0212	0.0298	0.0607	0.0548	0.0568	0.0384	0.0824
Mercury, total	mg/L	0.00002	Long: 0.000026	(A) 0.00000125-0.00002 depending on the amount of Methyl Mercury				0.00002	0.00003	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
Molybdenum, total	mg/L	0.0001	Long: 0.073	(A) **max**: 2; **30 day avg**: 1				0.0001	0.0005	0.0008	0.0007	0.0007	0.0002	0.0003	0.0003	0.0003	0.0003	0.0002	0.0002	0.0001	0.0002	0.0002	0.0006	0.0004	0.0005	0.0005	0.0005
Nickel, total	mg/L	0.0002	CaCO3< 60mg/L: 0.025 60mg/L<=CaCO3=<180mg/L: Ni (µg/L)= $e^{[0.76[\ln(\text{hardness})]+1.06]}$	(W) CaCO3<60mg/L: 0.025; CaCO3 60-120mg/L: 0.065; CaCO3 120-180mg/L: 0.11, CaCO3> 180mg/L: 0.15				0.0002	0.0007	0.0015	0.0005	0.0006	0.0004	<0.0002	0.0003	<0.0002	0.0002	0.0024	0.0008	0.0018	0.0007	0.0012	0.0034	0.0016	0.0035	0.0015	0.0041
Phosphorus, total	mg/L	0.02						0.02	0.031	0.033	0.026	0.043	<0.020	<0.020	<0.020	0.026	0.023	0.081	0.044	0.059	0.036	0.078	0.063	0.028	0.054	0.036	0.103
Potassium, total	mg/L	0.02		(W) 373-432				0.02	1.87	1.48	1.43	1.37	0.27	0.22	0.32	0.2	0.29	2.11	1.61	1.91	1.52	1.69	1.96	1.69	1.98	1.5	1.63
Selenium, total	mg/L	0.0005	Long: 0.001	(A) alert at 0.001 guideline is 0.002				0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Silicon, total	mg/L	0.5						0.5	7.5	4.8	10.6	5.9	4.1	3.4	3.7	4.8	4	7.1	5	6	6.9	6.1	10.3	7.3	9.9	9	12.9
Silver, total	mg/L	0.00005	Long: 0.0001	(A) CaCO3<100mg/L: **max** 0.0001; **30 day avg** 0.00005 CaCO3>100mg/L: **max** 0.003; **30 day avg** 0.0015				0.00005	0.00172	<0.00005	<0.00005	<0.00005	<0.00005	0.00164	<0.00005	<0.00005	<0.00005	<0.00005	0.00145	<0.00005	<0.00005	<0.00005	<0.00005	0.00092	<0.00005	<0.00005	0.00011
Sodium, total	mg/L	0.02						0.02	18.5	5.95	11.6	7.46	1.91	2.94	2.45	2.26	2.2	3.58	7	3.69	5.07	3.61	5.3	19.5	6.11	8.57	4.48
Strontium, total	mg/L	0.001						0.001	0.087	0.053	0.102	0.063	0.02	0.024	0.023	0.024	0.023	0.045	0.057	0.043	0.059	0.042	0.073	0.115	0.087	0.119	0.073
Sulfur, total	mg/L	1						1	3	2	<1	<1	<1	<1	1	<1	<1	<1	1	1	<1	<1	<1	3	2	<1	<1
Tellurium, total	mg/L	0.0002						0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Thallium, total	mg/L	0.00002	Long: 0.0008	(W) 0.0003 water quality objective for Ontario				0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002

Appendix F: Full Monitoring Results Data Table

City of Maple Ridge

Water Quality and Benthic Invertebrate Monitoring in T2, Millionaire, Dunlop, and Spencer Creeks, 2014-2015
March 2016

Parameter	Units	Detection Limit	Guidelines: CCME- CEQG, WQG for the Protection of Aquatic Life - Freshwater	Guidelines: BC Approved (A) and Working (W) Water Quality Guidelines for the Protection of Freshwater Aquatic Life	Guidelines: Metro Vancouver Monitoring and Adaptive Mangement Framework - Water Quality Levels			Monitoring Location	SA-1 (T2 Creek at 124 Ave)					SA-2 (Millionaire Creek at Fern Cres)					K-1 (Dunlop Creek at 110 Ave)					K-2 (Spencer Creek at 240 St)				
								Sampling Date	2014-11-26 15:44	2014-12-05 10:30	2014-12-09 13:06	2014-12-16 10:52	2014-12-19 10:51	2014-11-26 16:10	2014-12-05 11:08	2014-12-09 13:39	2014-12-16 11:25	2014-12-19 11:21	2014-11-26 17:00	2014-12-05 12:17	2014-12-09 14:38	2014-12-16 12:01	2014-12-19 11:53	2014-11-26 16:44	2014-12-05 11:48	2014-12-09 15:08	2014-12-16 12:25	2014-12-19 12:20
Thorium, total	mg/L	0.0001							0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0002
Tin, total	mg/L	0.0002							0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Titanium, total	mg/L	0.005		(W) **max** 0.00024					0.005	0.009	0.047	0.007	0.016	0.013	<0.005	0.008	<0.005	0.005	0.076	0.02	0.053	0.02	0.068	0.109	0.057	0.114	0.037	0.191
Uranium, total	mg/L	0.00002	Short: 0.033 Long: 0.015	(W) **max**: 0.3; 0.5 Ontario's water quality objective					0.00002	0.00002	0.00005	0.00004	0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	0.00004	<0.00002	0.00003	<0.00002	0.00004	0.00006	0.00005	0.00007	0.00005	0.00009
Vanadium, total	mg/L	0.001		(W) 0.006 Ontarios Water Quality objective; 0.02 secondary value					0.001	<0.001	0.002	0.002	0.001	0.001	<0.001	0.001	0.001	<0.001	0.004	0.002	0.004	0.002	0.003	0.006	0.003	0.006	0.003	0.009
Zinc, total	mg/L	0.004	Long: 0.03	(A) CaCO3<30mg/L: 0.033. Guideline (ug/L) = 33+0.75(hardness (mg/L)-90)	<0.006 [3]	0.006-0.04 [5]	>0.04 [5]		0.004	0.012	0.013	0.006	0.012	0.026	<0.004	<0.004	<0.004	<0.004	0.011	0.005	0.006	0.007	0.007	0.011	0.01	0.007	0.005	0.012
Zirconium, total	mg/L	0.0001							0.0001	0.0002	0.0005	0.0003	0.0003	<0.0001	0.0001	0.0002	<0.0001	0.0001	0.0006	0.0003	0.0004	0.0003	0.0008	0.001	0.0007	0.0011	0.0008	0.0024
Dissolved Metals																											
Aluminum, dissolved	mg/L	0.005		(A) ph>= 6.5: **acute** 0.2 pH<6.5: **acute** Al=$e^{(1.209 - 2.426\,(pH) + 0.286\,K)}$ where K = $(pH)^2$ **30-day avg**. Al= $e^{(1.6 - 3.327\,(median\ pH) + 0.402\,K)}$ where K = $(median\ pH)^2$					0.005	0.01	0.034	0.009	0.029	0.084	0.026	0.069	0.03	0.059	0.337	0.039	0.095	0.04	0.097	0.272	0.035	0.072	0.034	0.094
Antimony, dissolved	mg/L	0.0001							0.0001	0.0003	0.0002	0.0001	0.0002	0.0002	0.0001	<0.0001	0.0003	<0.0001	0.0002	0.0002	0.0001	0.0003	0.0001	0.0002	0.0002	<0.0001	0.0003	0.0001
Arsenic, dissolved	mg/L	0.0005							0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0005	<0.0005
Barium, dissolved	mg/L	0.005							0.005	0.013	0.008	0.01	0.009	<0.005	<0.005	<0.005	<0.005	<0.005	0.01	0.008	0.007	0.007	0.007	0.008	0.009	0.006	0.007	0.005
Beryllium, dissolved	mg/L	0.0001							0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Bismuth, dissolved	mg/L	0.0001							0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Boron, dissolved	mg/L	0.004							0.004	0.015	0.011	0.016	0.015	<0.004	<0.004	<0.004	<0.004	<0.004	0.01	0.01	0.006	0.011	0.011	0.009	0.01	0.006	0.01	0.009
Cadmium, dissolved	mg/L	1.00E-05							0.00001	0.00003	0.00002	0.00001	0.00002	<0.00001	<0.00001	0.00002	0.00001	<0.00001	<0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	<0.00001	0.00001
Calcium, dissolved	mg/L	0.2		(W) <4 highly sensitive to acidic inputs 4-8 moderately sensitive to acidic inputs. refer to alkalinity the more restrictive of calcium or alkalinity applies					0.2	10.7	8.7	13.7	9.5	2.2	3	2.4	2.7	2.6	5.5	6.7	5.9	7.6	5.6	9.7	15.6	12.2	15.1	9.1
Chromium, dissolved	mg/L	0.0005							0.0005	<0.0005	0.0007	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Cobalt, dissolved	mg/L	5.00E-05							0.00005	0.00007	0.00008	0.00007	0.00008	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	0.00012	0.0001	0.00009	0.0001	0.0001	0.0001	0.00015	0.0001	0.00011	0.00011
Copper, dissolved	mg/L	0.0002							0.0002	0.0018	0.0026	0.001	0.0025	0.0005	0.0003	0.0005	0.0003	0.0004	0.002	0.0013	0.0017	0.0011	0.0018	0.0023	0.0016	0.0021	0.0012	0.002
Iron, dissolved	mg/L	0.01		(A) max: 0.35					0.01	0.056	0.058	0.056	0.07	0.038	0.031	0.041	0.033	0.052	0.282	0.101	0.094	0.091	0.109	0.235	0.142	0.117	0.122	0.142
Lead, dissolved	mg/L	0.0001							0.0001	0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	0.0004	0.0001	<0.0001	<0.0001	<0.0001
Lithium, dissolved	mg/L	0.0001							0.0001	0.0007	0.0004	0.0008	0.0006	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	0.0003	0.0001	<0.0001	0.0002	0.0002	0.0004	0.0003	0.0003	0.0004	0.0003
Magnesium, dissolved	mg/L	0.01							0.01	4.55	2.48	5.71	3.32	0.44	0.65	0.59	0.59	0.6	1.84	2.32	1.84	2.28	1.84	2.88	4.21	3.28	4.41	2.69
Manganese, dissolved	mg/L	0.0002							0.0002	0.0238	0.0165	0.0203	0.0184	0.0019	0.0023	0.0023	0.0021	0.0026	0.0067	0.0137	0.0078	0.0132	0.0096	0.0062	0.0412	0.0158	0.0255	0.018
Mercury, dissolved	mg/L	2.00E-05							0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	0.00007	<0.00002	<0.00002	<0.00002	<0.00002
Molybdenum, dissolved	mg/L	0.0001							0.0001	0.0005	0.0008	0.0006	0.0008	<0.0001	0.0003	0.0002	0.0003	0.0003	<0.0001	0.0002	0.0002	0.0002	0.0002	0.0004	0.0004	0.0004	0.0004	0.0003
Nickel, dissolved	mg/L	0.0002							0.0002	0.0005	0.0006	0.0003	0.0006	<0.0002	<0.0002	0.0003	<0.0002	0.0002	0.0007	0.0004	0.0006	<0.0002	0.0005	0.0008	0.0006	0.0007	0.0004	0.0008
Phosphorus, dissolved	mg/L	0.02							0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.04	<0.02	0.02	<0.02	0.04	<0.02	<0.02	<0.02	<0.02	<0.02
Potassium, dissolved	mg/L	0.02							0.02	1.75	1.49	1.44	1.37	0.16	0.22	0.37	0.19	0.24	1.71	1.43	1.93	1.38	1.67	1.44	1.52	1.67	1.34	1.19
Selenium, dissolved	mg/L	0.0005							0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Silicon, dissolved	mg/L	0.5							0.5	6.9	3.8	10.2	5.5	3.1	3.4	4	4.5	3.9	4.6	4	4.3	5.6	4	5.3	5.2	5.2	7.2	4.4
Silver, dissolved	mg/L	5.00E-05							0.00005	0.00061	<0.00005	<0.00005	<0.00005	<0.00005	0.00024	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	0.00009	<0.00005	<0.00005	<0.00005
Sodium, dissolved	mg/L	0.02							0.02	17.6	5.78	11.2	7.4	1.65	2.94	2.44	2.05	2.18	3.22	6.5	3.71	4.48	3.62	4.48	19	5.63	7.96	4.42
Strontium, dissolved	mg/L	0.001							0.001	0.082	0.051	0.096	0.064	0.017	0.025	0.023	0.022	0.022	0.042	0.053	0.042	0.051	0.042	0.065	0.109	0.077	0.108	0.063
Sulfur, dissolved	mg/L	1							1	2	3	<1	<1	<1	<1	2	<1	<1	<1	<1	2	<1	<1	<1	2	3	<1	<1
Tellurium, dissolved	mg/L	0.0002							0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Thallium, dissolved	mg/L	2.00E-05							0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
Thorium, dissolved	mg/L	0.0001							0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Tin, dissolved	mg/L	0.0002							0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Titanium, dissolved	mg/L	0.005							0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.013	<0.005	<0.005	<0.005	<0.005	0.012	<0.005	<0.005	<0.005	0.006
Uranium, dissolved	mg/L	2.00E-05							0.00002	<0.00002	0.00005	0.00003	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	0.00003	0.00003	0.00003	0.00003	<0.00002
Vanadium, dissolved	mg/L	0.001							0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001
Zinc, dissolved	mg/L	0.004							0.004	0.008	0.006	<0.004	0.009	<0.004	<0.004	<0.004	<0.004	<0.004	0.005	0.004	<0.004	<0.004	<0.004	0.005	0.008	<0.004	<0.004	<0.004
Zirconium, dissolved	mg/L	0.0001							0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	0.0005	<0.0001	0.0001	<0.0001	0.0001	0.0005	<0.0001	0.0001	<0.0001	0.0004

http://st-ts.ccme.ca/

http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html

Notes:
If guidelines had no specific value for a parameter, it was indicated as 'na'; if parameter was not on the guideline list, cell was left blank.
For CCME WQG, Short indicates short term and Long indicates long term.
Fill indicates which guideline is exceeded, if only one guideline exceeded. If two guidelines exceeded, combination of font and fill colour indicate which guidelines are exceeded.
If three guidelines are exceeded, fill matches Metro Vancouver colours and font is brown.

Footnotes:
1. Clear Flow:
short term: max increase 25 mg/L from background
long term: max increase of 5 mg/L from background
High Flow:
background between 25-250 mg/L: max increase of 25mg/L from background
background >= 250mg/L: should not increase more than 10% of background
2. Short Term:
If CaCO3 < 5.3mg/L, guideline is 0.00011 mg/L
If 5.3mg/L<= CaCO3=<360mg/L, use equation: (µg/L)=10^(1.016(log[hardness]) – 1.71)
If CaCO3> 360mg/L, guideline is 0.0077 mg/L
Long Term:
If CaCO3 < 17mg/L, guideline is 0.00004 mg/L
If 17mg/L<=CaCO3=<280mg/L, use equation: (µg/L)=10^(0.83(log[hardness]) – 2.46)
If CaCO3> 280mg/L, guideline is 0.00037 mg/L
3. Long Term:
If CaCO3 < 82mg/L, guideline is 0.002 mg/L
If 82mg/L<=CaCO3=<180mg/L, use equation: (µg/L)=0.2 * e^(0.8545[ln(hardness)]-1.465]
If CaCO3> 180mg/L, guideline is 0.004 mg/L
4. Long Term:
If CaCO3 < 60mg/L, guideline is 0.001 mg/L
If 60mg/L<=CaCO3=<180mg/L, use equation: (µg/L)=e^(1.273[ln(hardness)]-4.705)
If CaCO3> 180mg/L, guideline is 0.007 mg/L
5. Assume hardness approximating 100 mg/L CaCO3

#N/A

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Appendix G

Benthic Invertebrate Laboratory Analysis Detailed Methods

Biologica
Environmental Services Ltd
Marine & Fresh Water Taxonomy

Methods - Freshwater Benthos
Project: Maple Ridge
Client: Kerr Wood Leidal
Protocol: B-IBI (Metro Vancouver Adaptive Management Framework)

Stream samples (Hess/Surber) arrived at Biologica on October 13, 2015, and chain of custody documents were checked and approved. Samples were transferred from formalin into 70% ethanol using a 0.25mm screen and assigned a unique identifier. Samples were stained with Rose Bengal to aid in sorting.

Sample debris was spread on an appropriately-sized Caton Tray (either 6, 12 or 24 quadrat; Caton et al. 1991) and sorted to a minimum count of 400 organisms. If present, large organisms (>1.0cm) were removed and recorded before splitting.

All samples were sorted using a Meiji EMZ dissecting microscope at 10-40x magnification by trained personnel. All debris in the sample was checked microscopically, including leaves, twigs, moss, elutriated gravel, and other large debris. This method assures 'clinger taxa' are recovered consistently from the samples. To minimize potential sorter bias, samples were distributed among technicians such that no person sorted all the replicates of a given sample.

To ensure the sorting efficiency was >95%, whole and/or partial subsamples were re-sorted. Sorting efficiency was calculated using the following equation:

$$\text{Sorting efficiency} = \frac{[\text{Total count} - (\text{organisms recovered in spot check and/or re-sort})] \times 100\%}{\text{Total count}}$$

During quality control checks (QC spotchecks), approximately 25% of the debris was re-sorted for 4 of the 12 samples. The estimated efficiency was 97.87%. No samples fell below 95% sorting efficiency, thus no additional sorting was required. wFor quality assurance, 4 samples (10% of total) were randomly selected and re-sorted in their entirety. The sorting efficiency estimated from QA re-sorts was 98.23%.

All organisms were identified using a combination of dissecting (10-40x) and compound microscopes (100-1000X) and standard taxonomic keys (See Taxonomic References) to the lowest practicable level as specified by Plotnikoff and White (1996). Any taxa new to the reference collection were placed in individual archived vials and added to the project reference collection. For quality assurance, 10% of samples (one sample) was randomly selected and re-

identified by a second trained taxonomist. The %Bray –Curtis Similarity was 98.6%. All specimens were archived in air-tight glass vials with glycerin and 70% ethanol for long-term storage.

Data were compiled in an excel spreadsheet. Incidental organisms (e.g., pupae, Collembola, terrestrial insects) were reported separately. These data were entered into an excel spreadsheet and completely double-checked against bench sheets for entry errors.

The multi-metric benthic index of biological integrity (B-IBI) was calculated based on the following metrics after Karr and Chu (1999), Morely (2000) and Page et al. (2008):

- Total number of unique taxa
- Total number of unique mayfly (Ephemeroptera) taxa
- Total number of unique stonefly (Plecoptera) taxa
- Total number of unique caddisfly (Trichoptera) taxa
- Number of long lived taxa (organisms living a minimum of 2-3 years in the immature state)
- Number of intolerant taxa
- Percent of predatory individuals
- Number of clinger taxa
- Percent dominance: the percent of individuals in the three most dominant taxa.

Long-lived, predatory, clinger, and tolerant/intolerant taxa were defined consistently with available species list attributes at pugetsoundstreambenthos.org (files constructed by R.W. Wisseman and L. Fore).

Each metric in each sample was assigned a value (1, 3 or 5) according to the thresholds reported at pugetsoundstreambenthos.org and Page et al. (2008). The sum of these values gave the sample B-IBI.

Data were delivered to the client electronically.

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Appendix H

Benthic Invertebrate Taxonomic Identification Results (digital file only)

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Appendix I

B-IBI Metric Scoring and Overall B-IBI Calculation Results

Appendix I: B-IBI Metric Scoring and Overall B-IBI Calculation Results

Creek	T2 Creek						Millionaire Creek						Dunlop Creek						Spencer Creek					
Site	SA1-1		SA1-2		SA1-3		SA2-1		SA2-2		SA2-3		K1-1		K1-2		K1-3		K2-1		K2-2		K2-3	
Metric	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score
Taxon richness	10	1	12	1	11	1	23	3	28	3	23	3	22	3	23	3	26	3	22	3	19	3	19	3
E richness	0	1	0	1	0	1	6	3	5	3	5	3	2	1	5	3	5	3	5	3	5	3	4	1
P richness	0	1	0	1	0	1	3	1	6	3	3	1	4	3	4	3	3	1	4	3	3	1	2	1
T richness	0	1	1	1	0	1	3	1	3	1	3	1	4	1	2	1	2	1	3	1	2	1	3	1
Intolerant richness	0	1	0	1	0	1	0	1	1	1	0	1	0	1	0	1	0	1	1	1	1	1	0	1
Clinger richness	0	1	1	1	3	1	9	3	13	3	13	3	9	3	9	3	10	3	8	1	8	1	9	3
Long-lived richness	1	1	2	1	2	1	4	3	7	5	5	5	5	5	5	5	6	5	6	5	3	3	4	3
% tolerant	1.9	5	2.8	5	0.7	5	0.5	5	0.2	5	0.0	5	0.6	5	2.8	5	1.2	5	0.5	5	0.2	5	1.2	5
% predator	0.4	1	0.6	1	0.9	1	3.2	1	6.2	1	2.8	1	3.7	1	3.3	1	7.1	1	5.2	1	2.9	1	4.1	1
% dominance (3)	89.7	1	86.1	1	94.2	1	54.1	5	60.1	3	65.1	3	56.8	5	61.5	3	38.6	5	65.4	3	78.0	3	71.4	3
Sample B-IBI Score	-	**14**	-	**14**		**14**	-	**26**	-	**28**	-	**26**	-	**28**	-	**28**	-	**28**	-	**26**	-	**22**	-	**22**
B-IBI Site Score	**14**						**27**						**28**						**23**					
MAMF Biological Condition Rank	**Very Poor**						**Fair**						**Fair**						**Poor**					

Sampling site	UTM-E	UTM-N	Location description
SA1-1	528613	5452832	5 m upstream of 110 Ave. culvert, adjacent to rip-rap on left bank
SA1-2	528611	5452826	15 m upstream of 110 Ave. culvert, at northeast corner of house adjacent to creek
SA1-3	528614	542811	27 m upstream of 110 Ave. culvert, at southeast corner of house adjacent to creek
SA2-1	531930	5453955	5 m downstream of Ministry of Environment water quality monitoring station and City of Maple Ridge water quality site
SA2-2	531942	5453954	5 m upstream of Ministry of Environment water quality station, 5 m downstream of driveway bridge
SA2-3	531940	5453968	At upstream edge of driveway bridge
K1-1	533232	5450347	At downstream end of flagging tape
K1-2	-	-	10 m upstream of K1-1
K1-3	533248	5450361	15 m upstream of K1-2
K2-1	532727	5449040	At downstream end of flagging tape
K2-2	532755	5449047	10 m upstream of K2-1
K2-3	532745	5449034	15 m upstream of K2-2

KERR WOOD LEIDAL
consulting engineers

Appendix J

Benthic Invertebrate Sampling Environmental Data Table

Appendix J: Benthic Invertebrate Sampling Environmental Data Table

Site	Wetted Width (m)	Bankfull Width (m)	Riffle Depth (cm)	% Boulder	% Cobble	% Large gravel	% Small gravel	% Fines	% Embeddedness
T2 Creek (SA1)									
SA1-1	1.0	1.3	5	5	10	0	65	20	30
SA1-2	0.5	1.8	3	0	2.5	5	80	12.5	30
SA1-3	2.0	2.5	3	2.5	5	10	40	42.5	30
Millionaire Creek (SA2)									
SA2-1	4.1	5.5	12	20	40	30	7.5	2.5	10
SA2-2	2.5	5.0	11	20	40	30	7.5	2.5	15
SA2-3	2.7	5.0	13	30	35	12.5	10	2.5	15
Dunlop Creek (K1)									
K1-1	1.3	3.5	3	0	0	35	50	15	25
K1-2	1.5	3.2	5	0	0	35	50	15	25
K1-3	1.2	5.5	4	0	0	40	55	5	25
Spencer Creek (K2)									
K2-1	0.8	1.5	3	0	0	10	50	40	30
K2-2	1.2	2.0	3	0	0	10	50	40	30
K2-3	0.7	4.0	4	0	0	50	50	45	30

Appendix B: Report on Baseline Hydrogeological Conditions

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November 4, 2015

Urban Systems
1090 Homer Street
Vancouver BC V6B 2W9

Attention: Glen Shkurhan, P.Eng., Senior Engineer, Partner

Re: **INTEGRATED STORMWATER MANAGEMENT PLANNING FOR THE CITY OF MAPLE RIDGE**

1. Introduction

GW Solutions has completed this study as part of a multidisciplinary team lead by Urban Systems. GW Solutions understands that the objective of its involvement was to provide an understanding of the subsurface, particularly about its capacity to receive and transmit water originating from surface.

2. Approach

GW Solutions has developed a 3D conceptual groundwater model that characterizes groundwater conditions within the Integrated Stormwater Management Planning (ISMP) area. The model delineates the fundamental hydrogeological building blocks of aquifers and aquitards within the ISMP, and can be used to investigate spatial patterns in hydraulic gradient, overburden thickness, and aquifer recharge/discharge.

Through our approach, we have aimed to:

- Establish high-permeability versus low-permeability units in the subsurface and relate these, where possible, to surficial geology and soils mapping;
- Group water well lithologies according to hydrogeologic behavior, thereby defining aquifers and aquitards in the model;
- Delineate local hydraulic gradients, highlighting areas likely to play a role in aquifer recharge (where water infiltrates into the subsurface) or discharge to surface water, and the surface water and groundwater interaction;
- Assess areas of potential aquifer vulnerability and/or stormwater retention/release.

Based on this newly acquired knowledge, we aim to enable decision makers to answer such questions as:

- What potential risk is there to underlying aquifers or water supplies if development were to occur?
- What development management techniques are appropriate to protect natural systems and water supplies?
- Do the near surface soils lend themselves to recharge methods, such as infiltration basins, perforated pipes, rain gardens, etc.?
- What are the potential effects, if any, on the agricultural areas downstream?

Background

Stormwater management is a critical issue in fall and winter, when large Pacific storms bear down on the Fraser Valley, water demand is low, and vegetation can't use the excess water for evapotranspiration. Maple Ridge receives about 1.9 m of precipitation every year, mostly in the form of rain. It is well known that this can lead to a rapid hydrologic response in creeks, rivers and drainage systems, but what role does groundwater play? This report focuses on the shallow infiltration, recharge and groundwater flow components of the hydrologic cycle (Figure 1.).

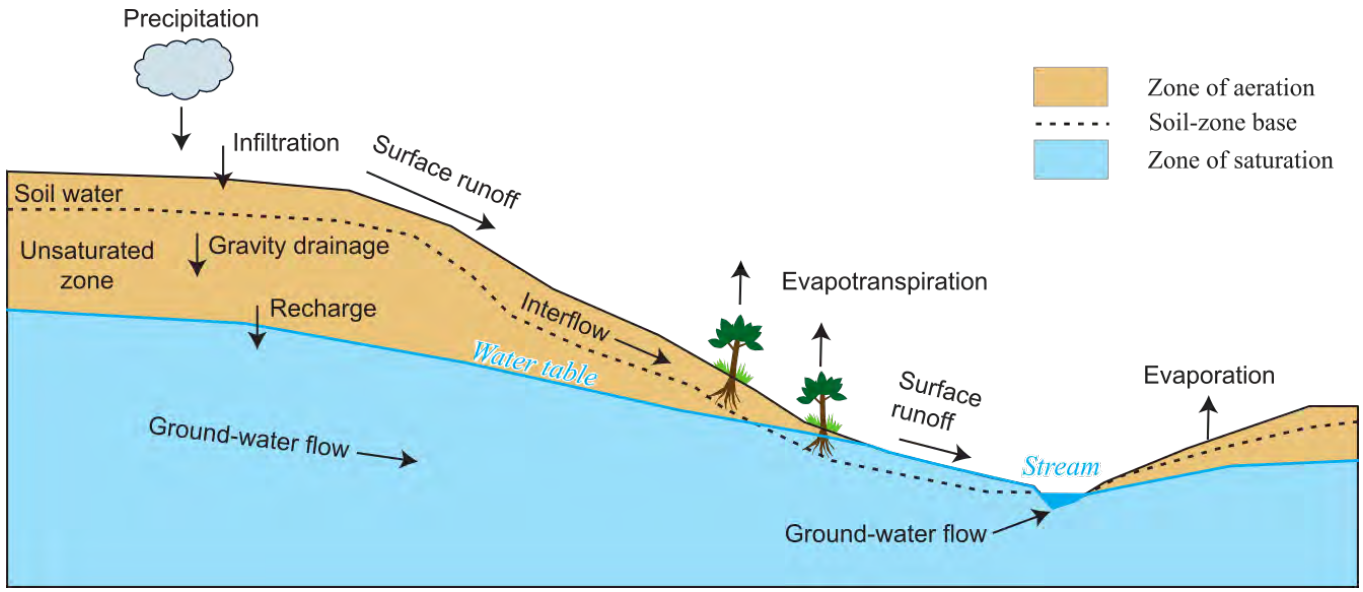


Figure 1: Conceptual diagram of the main components of the Natural hydrologic cycle. This report focuses on the shallow infiltration, recharge and groundwater flow components of the hydrologic cycle. (Source: USGS)

Soils and Shallow Infiltration

The relative ability of soils to transmit water is extremely variable with respect to soil type and texture. Soil mapping by the Province and Agriculture Canada was used to derive a GIS-based soil type and drainage map for Maple Ridge. Soil attributes and descriptions were compiled from the scanned reports available from Agriculture Canada. The soil descriptions were joined to the digital soil polygons (GIS data), available for download from the Agriculture Canada website, using the soil label as a key column. The resulting GIS dataset can be queried or symbolized on the drainage class, shallow water table characteristics, or parent materials (subsoils) present in each soil polygon.

Soil drainage characteristics are presented in Figures 2 to 3. The full explanation of the soil map labels is available in Appendix 1. The majority of urban area within Maple Ridge comprises moderately well to well-drained soils, resulting from the development in the upper 1-2m of a relatively higher infiltration capacity horizon. However, it is important to stress that vertical infiltration may be restricted due to underlying geological layers with low hydraulic conductivities (e.g., glacial tills). The deeper infiltration component is strongly impacted by the hydraulic conductivity and thickness of the deeper sub-soils, which in turn are related to the glacial history of Maple Ridge.

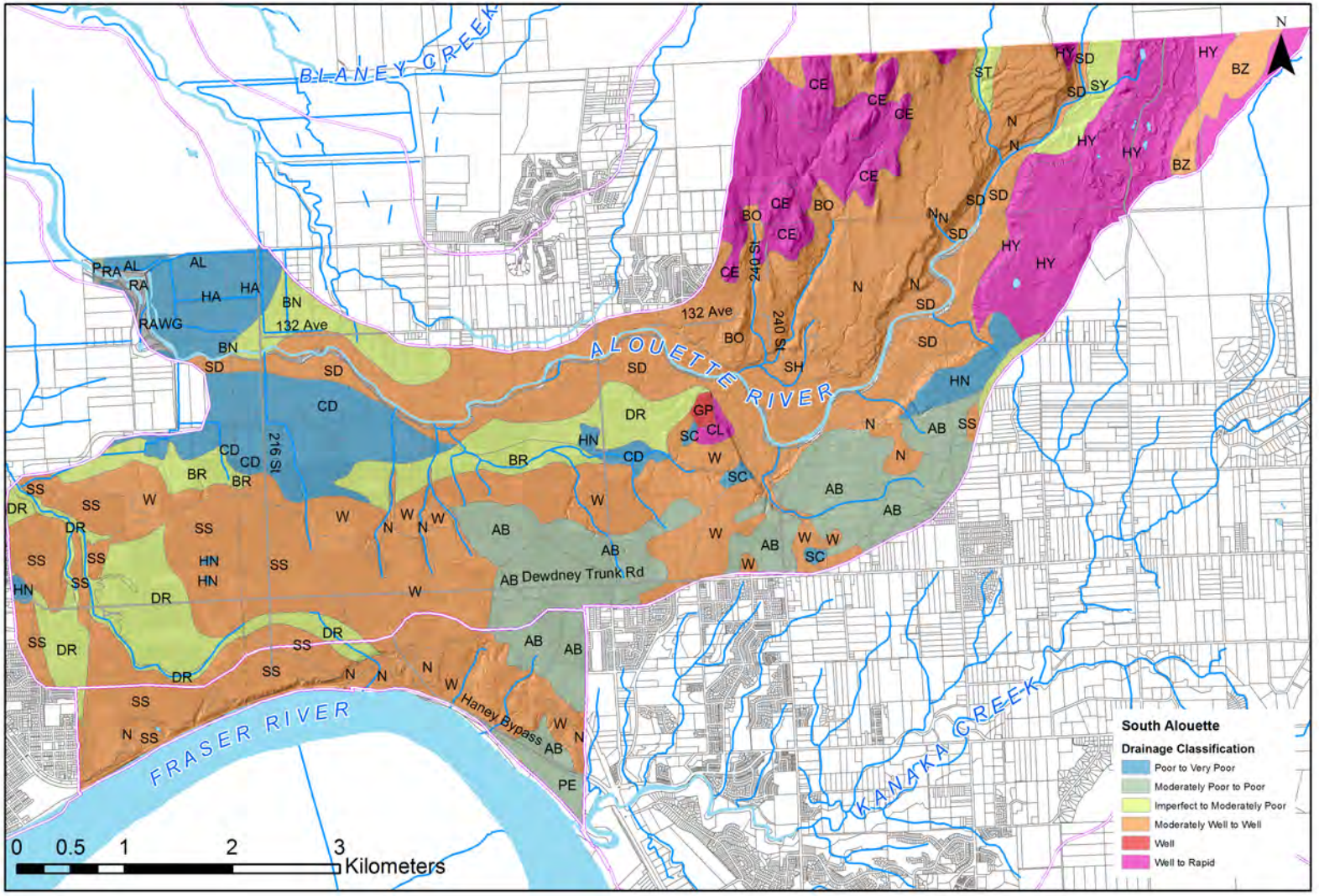


Figure 2: Soil drainage characteristics of the South Alouette River watershed, representing shallow infiltration capacity of the uppermost layer in the hydrogeological cycle. For an explanation of Soil Map label, see Appendix 1.

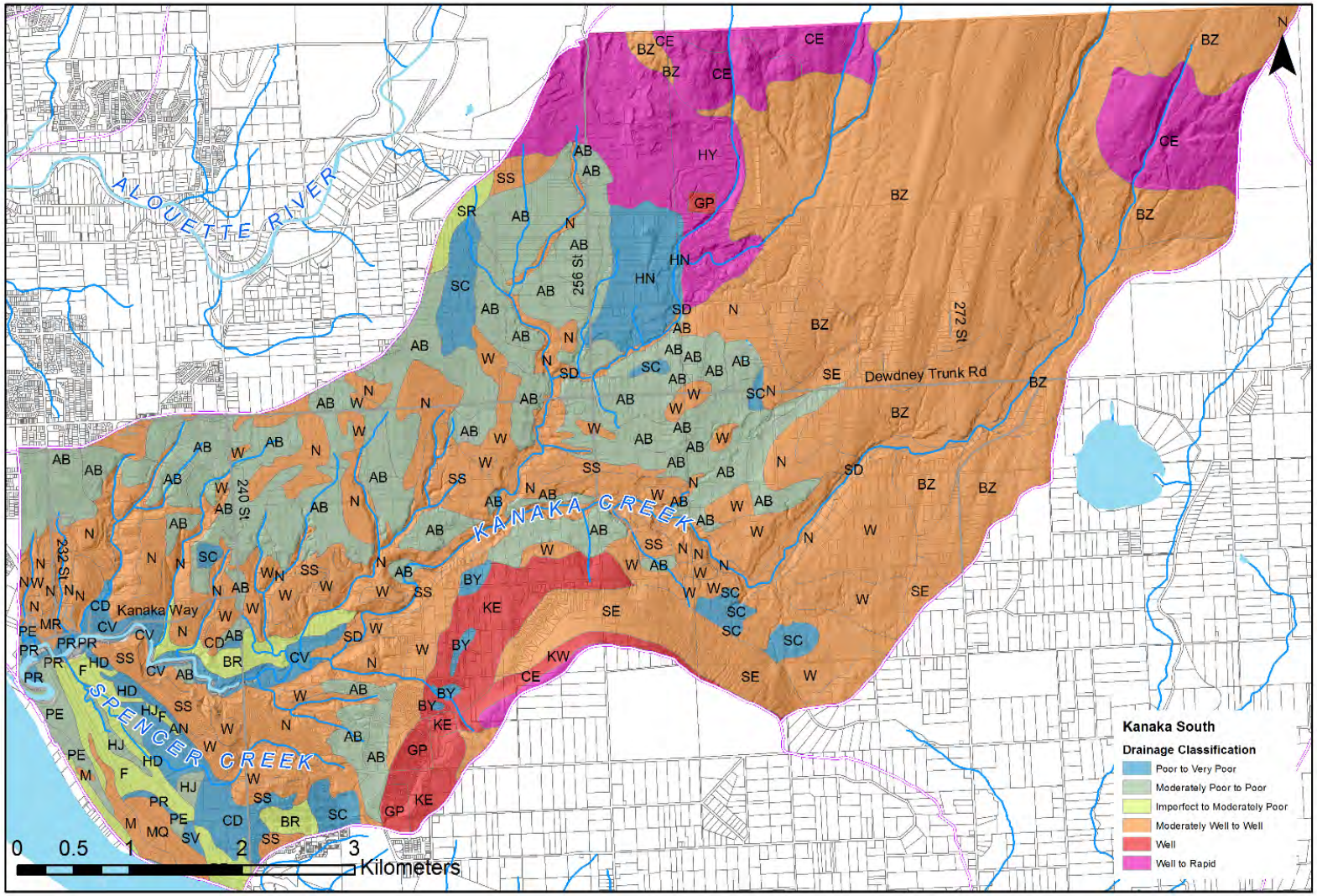


Figure 3: Soil drainage characteristics of the lower Kanaka Creek watershed, representing shallow infiltration capacity of the uppermost layer in the hydrogeological cycle. For an explanation of Soil Map label, see Appendix 1.

Surficial Geology

Surficial geology mapping represents the history of glacial and post-glacial landforms and deposits. At a basic level, the surficial geology units represent the underlying parent materials that over time have been weathered, eroded or otherwise modified to produce the various soil types represented in the Agriculture Canada mapping discussed above. However, surficial geology plays a more pivotal role in the dynamics of groundwater flow and storage. Enhanced storm water infiltration will take place in areas characterized by a relatively rapid connection between the surface and deep groundwater system, with no intervening impermeable or confining layers to impede the downward movement to the groundwater regime.

The surficial geology map used the following data inputs: 1) A digitized version of the Geological Survey of Canada (GSC) 1:50,000-scale surficial geology map (GSC, 1976) provided by the District of Maple Ridge; and 2) Detailed geological descriptions from the original scanned maps from the GSC. The geologic descriptions were compiled and joined to the digital polygons to enable grouping by materials with inferred hydraulic properties: i.e. highly permeable sands and gravels versus low permeability units (e.g. glacial till, or clay-rich materials). This mapping allows us to connect surface materials and processes to equivalent assemblages represented in borehole lithologies, so that the subsurface geology can be better understood in terms of hydrogeological units (aquifers and aquitards). For example, a till unit mapped at surface can be correlated with subsurface tills (e.g., “boulder clay”, or “hardpan” noted by drillers), to form an aquitard unit in the subsurface.

We have chosen to highlight the sand and gravel units that have the highest hydraulic conductivities in the Surficial Geology mapping. Relatively thick accumulations (i.e. greater than 5 m) of permeable sand and gravel tend to be localized, in the case of deltaic deposits or fluvial terraces, or restricted to river valleys, in the case of fluvial outwash plains. As such, these areas represent relatively constrained opportunities for enhanced storm water infiltration to the groundwater regime.

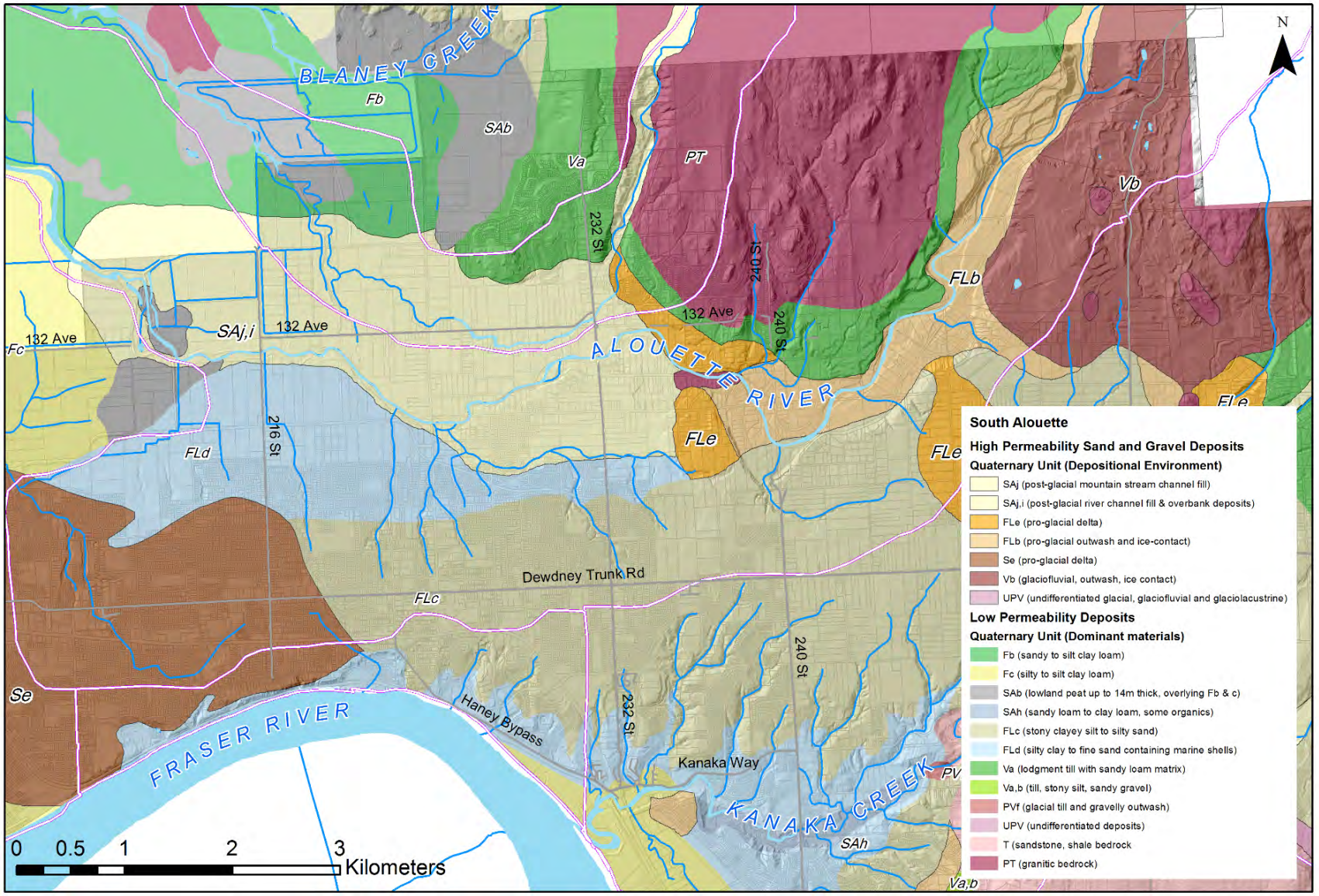


Figure 4: Surficial Geology mapping, South Alouette River.

Hydraulic conductivity (K) is a standard measure of the rate at which a soil, sediment or rock can transmit water, and it can vary across several orders of magnitude. The majority of surficial materials throughout the urbanized area of Maple Ridge originated as marine and glaciomarine deposits when sea level was up to 200 m higher than today. The deposits left behind by the post-glacial marine incursion comprise Unit FLc (stoney, clayey silt to silty sand) and Unit FLd (silty-clay to fine sand). From the relatively fine-grained nature of units FLd and FLc we can infer that the hydraulic conductivity of these soils would be low. Areas with more permeable surficial materials are mapped as Unit FLb (sand, gravel and till), Unit FLe (deltaic sand and gravel), and Unit Se (deltaic sand and gravel). The properties of the surficial units are summarized in tables 1 and 2.

Table 1: Surficial Geology and relative hydraulic conductivities – Alouette River Watershed.

Map Label	Depositional Environment	Characteristic	Approximate Thickness (m)	Hydraulic Conductivity (m/s)
Se	pro-glacial delta	gravel and sand	40	10^{-2} to 10^{-5}
FLb	pro-glacial outwash and ice-contact	gravel and sand, till clasts		10^{-2} to 10^{-5}
FLc	glaciomarine	stony clayey silt to silty sand	8-100	10-9 to 10-12
FLd	marine	silty clay to fine sand containing marine shells	<30	10-5 to 10-9
FLe	pro-glacial delta	gravel and sand		10^{-2} to 10^{-5}
SAj,i	floodplain and channel fill	sand and gravel		10^{-2} to 10^{-5}

The Allouette River floodplain can be divided in two geologically distinct areas: An upland alluvial area east of 224th Street and a lowland floodplain west of 224th Street to Pitt River. Throughout areas east of 224th Street, the Alouette River channel is characterized by channel fill deposits (sand and gravel) of Unit SAi and SAj. Throughout areas west of 224th Street, surficial materials are predominately fine-textured with poor drainage characteristics and a seasonally high water table. This area is mapped as Unit Fb (sandy to silt clay loam) and Fc (silty clay loam) of the Fraser River formation.

Table 2: Surficial Geology Units and Hydraulic Conductivities - Kanaka Creek watershed.

Map Label	Depositional Environment	Characteristic Materials	Unit Approximate Thickness (m)	Hydraulic Conductivity (m/s)
Fc	overbank deposits	silty to silt clay loam	2	10^{-6} to 10^{-9}
FLe	pro-glacial delta	gravel and sand	> 8	10^{-2} to 10^{-5}
Va	glacial	lodgment till with sandy loam matrix, (< 10 m thick) overlain by gravelly ablation till (< 3 m thick)	<13	10^{-6} to 10^{-10}
Vb	glaciofluvial, outwash, ice contact	sandy gravel and gravelly sand, proglacial advance deltaic (< 25 m) deposits	<25	10^{-2} to 10^{-5}
T		sandstone, shale bedrock		10^{-6} to 10^{-10}
PT		granitic bedrock		10^{-4} to 10^{-9}

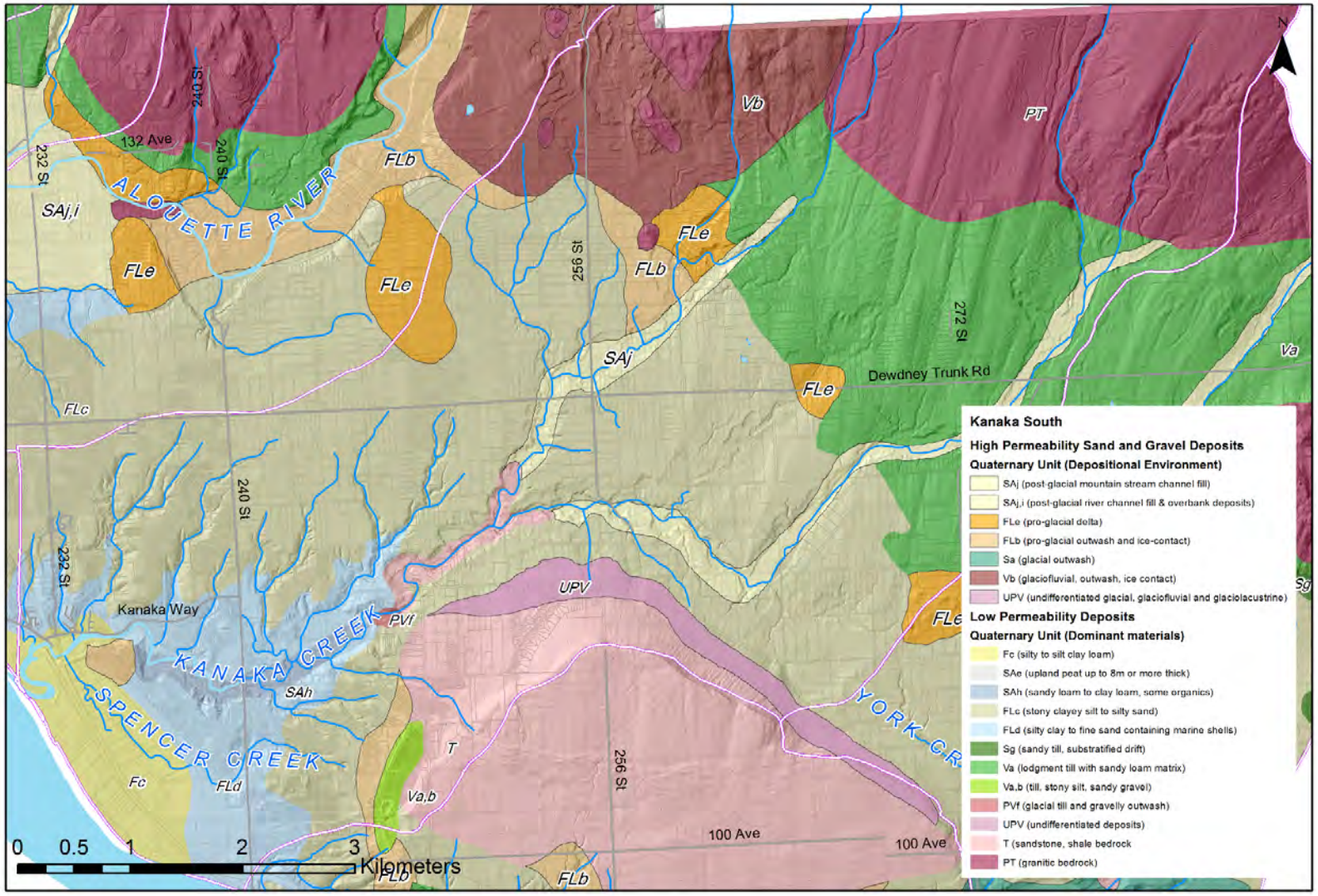


Figure 5: Surficial Geology mapping, Kanaka Creek.

Aquifer Mapping

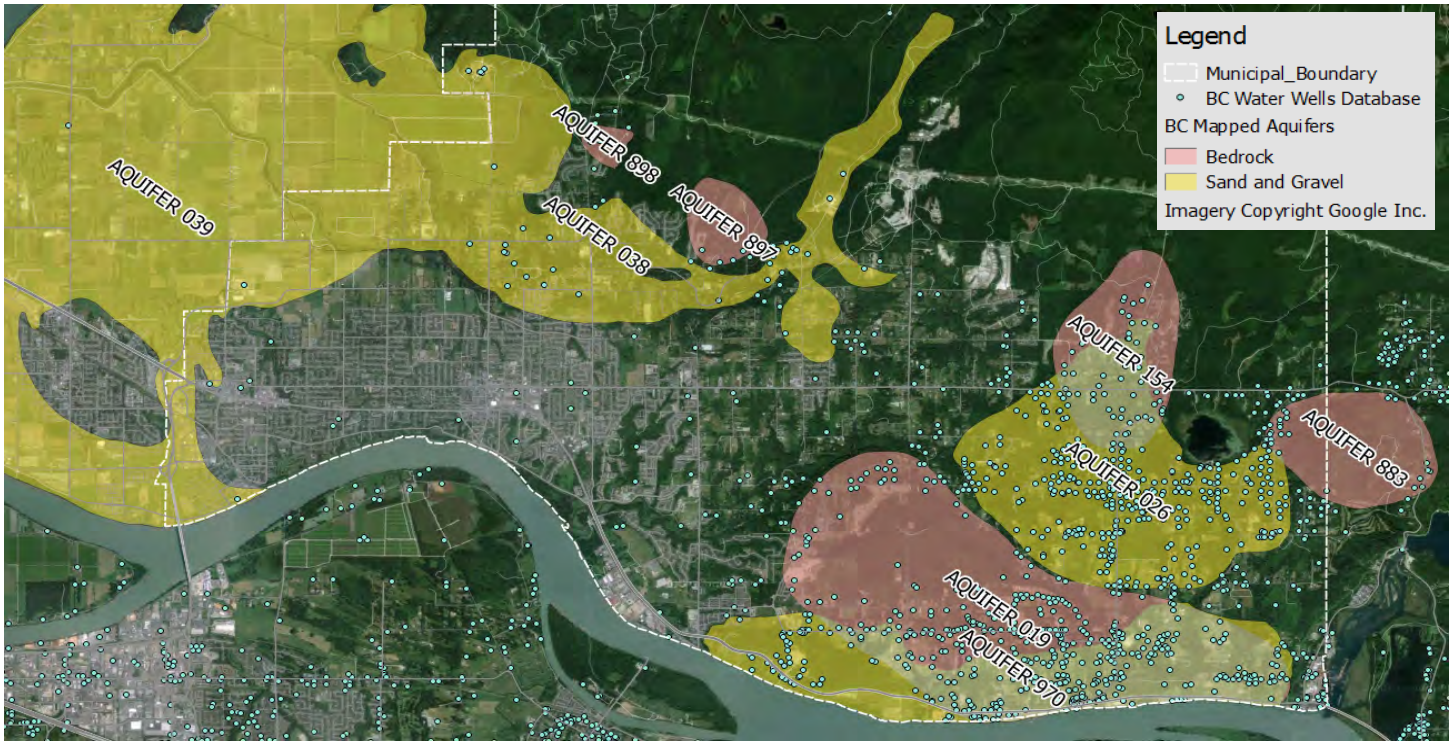


Figure 6: Aquifers of Maple Ridge (according to BC MOE mapping)

The Province of British Columbia classifies aquifers on the basis of their level of development and vulnerability to contamination and provides ranking values for aquifers using hydrogeologic and water use criteria. There are four sand and gravel aquifers and five bedrock aquifers mapped in the study area. These are summarized in Table 3 and their mapped extents are presented in Figure 6.

Table 3: List of aquifers, according to BC MOE mapping and characterisation

Aquifer Number	Aquifer Material	Description	Lithostratigraphic Unit	Vulnerability	Demand
26	Sand and Gravel	Kanaka/Whonnock Creek	Vashon Drift? Fort Langley Formation?	Low	Moderate
38	Sand and Gravel	Alouette	Salish Sediments; Fort Langley Formation	High	Low
39	Sand and Gravel	East Pitt River	Fraser River Sediments	High	Low
970	Sand and Gravel	South of Grant Hill	Sumas Drift and Fort Langley Formation	Moderate	Moderate
19	Bedrock	Grant Hill	Tertiary sandstone, siltstone and shale	High	Moderate
897	Bedrock	North shore Alouette River	Fractured quartz diorite of Coast Plutonic Rocks	Low	Low
898	Bedrock	West side North Alouette River	Fractured quartz diorite of Coast Plutonic Rocks	Low	Moderate
154	Bedrock	Northwest of Whonnock Lake	Tertiary sandstone and fractured quartz diorite	Low	Low
883	Bedrock	Iron Mt, East of Whonnock Lk	Fractured quartz diorite of Coast Plutonic Rocks	High	Low

Hydrogeology Model

Data Sources and Methodology

GW Solutions has developed a hydrogeological conceptual model in order to better understand the surface water - groundwater regime in the South Alouette River, Kanaka Creek and adjacent watersheds. The goal of the model is to define the fundamental hydrogeological building blocks of **aquifers, aquitards, bedrock topography and hydraulic gradients** for the watersheds, and relate these to surface-water infiltration and stormwater management. The Maple Ridge hydrogeological model was developed using Leapfrog Hydro (ARANZ Geo Ltd.). This geological modeling software allows us to visualize multiple datasets in 3D (e.g. boreholes, topography, GIS data (e.g. surficial geology, bedrock outcrops), springs and groundwater levels, and communicate the results to a multidisciplinary audience.

BC Wells Database

The first step in modeling the hydrogeology of the watersheds is a systematic review of the standardized BC Wells database, including water well attributes and lithology records. The standardized well lithologies in this study were refined from the thousands of unique lithological descriptions, generated by water well drillers, and stored in the publicly available BC Wells database. The modelling process involved assessing the standardized lithologies in relation to the following information:

- topography and soils;
- surficial geology;
- mapped aquifers
- bedrock topography;
- depth to water at time of drilling; and
- local and watershed-scale hydraulic gradients.

GW Solutions classifies the water well lithologies in terms of relative permeability: 1) **permeable**; 2) **low-permeability;** and 3) "**ambiguous"** – i.e. units that could be permeable or of low permeability. The "ambiguous" units are lithologies that may be subsequently re-interpreted as either having an affinity with aquifers or aquitards, based on their relation to other information, e.g. details in the driller's notes, screened interval, or the hydraulic head in area wells.

The permeable/low-permeability intervals in well lithologies are interpreted alongside available groundwater elevations, surficial geology, and topography. This step involves the interplay of various datasets in a process of grouping lithologies according to hydrogeologic affinities (i.e. aquifers or aquitards). The grouping of hydrogeologic units in borehole data is informed by the interpretation of the surficial geology of

the area. Glacial fluvial sand and gravel are potential aquifers whereas glacial tills and glaciomarine silts and clays are typically aquitards. All bedrock occurrences are grouped so that a distinction between overburden and bedrock materials can be made.

Bedrock Topography and Overburden Thickness

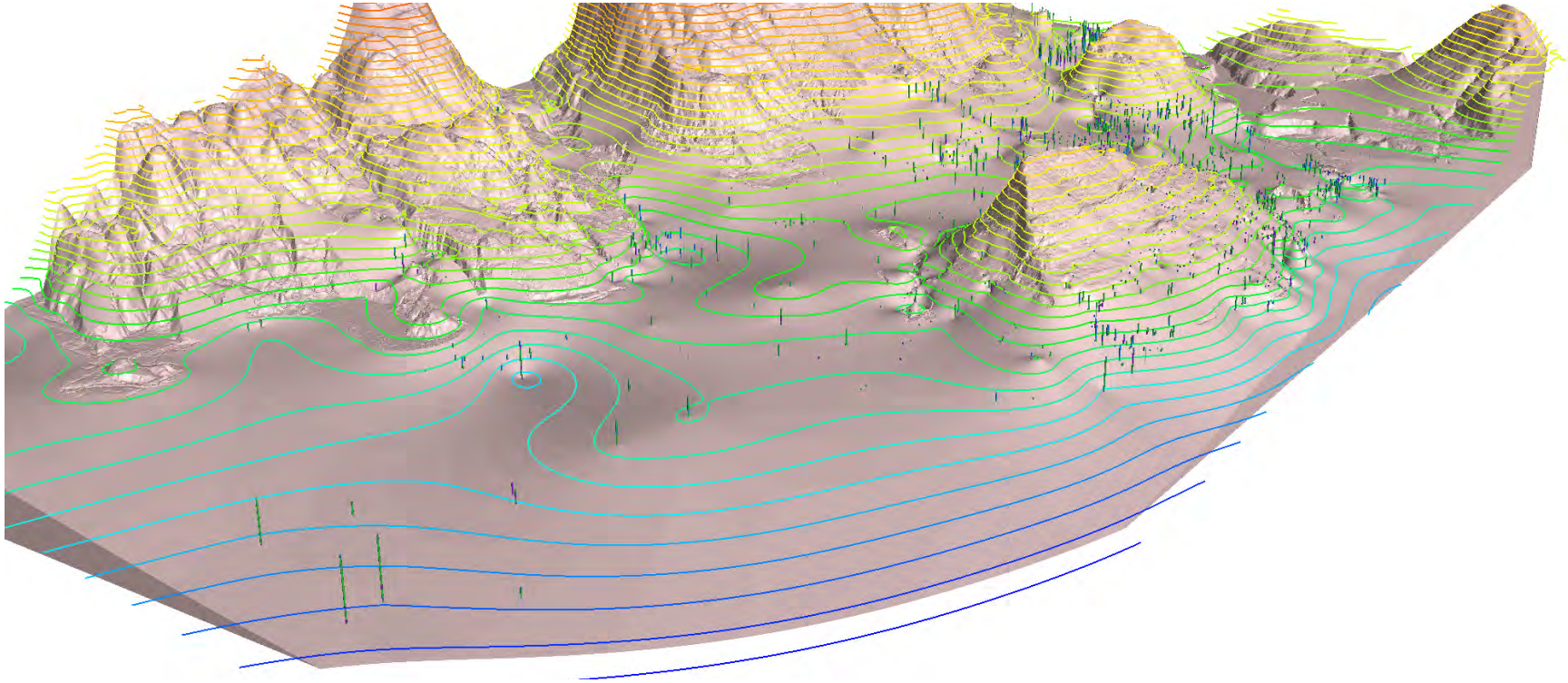


Figure 7: 3D geological model of bedrock topography

The morphology of bedrock exerts a powerful control on groundwater flow, especially in a mountainous, glacially scoured terrain such as the Fraser Valley. A 3D model of the bedrock topography was interpolated in Leapfrog Hydro using available data and geological interpretation of bedrock occurrences at ground level and in the subsurface. Data on depth to bedrock were compiled from first occurrence of bedrock in the standardized Lithology records (BC Wells database). Areas where bedrock is mapped at or near ground level in the GSC Surficial Geology data were draped on the digital elevation model (DEM) from the Maple Ridge LiDAR data. Since the accuracy and spatial

resolution of LiDAR is an order of magnitude greater than that of the original Surficial Geology or Soil mapping, manual adjustments to the bedrock topography could be made through interpretation of the landforms seen in LiDAR.

Three bedrock depressions are interpreted from the available data: one lies between Grant Hill and the mountains to the north, and roughly coincides with the Whonnock-Kanaka Creek system. The second lies along the axis of South Alouette River. The third and dominant bedrock low is of course that of the Fraser River to the south and west of Maple Ridge (Figure 8). A thick wedge of overburden sits on top of the bedrock surrounding Maple Ridge, averaging 30 m throughout the study area. In the bedrock depressions of Alouette and Kanaka, unconsolidated deposits are up to 100 m thick, whereas over intermediate and upland terrain, it is generally less than 5 m thick (Figure 9.).

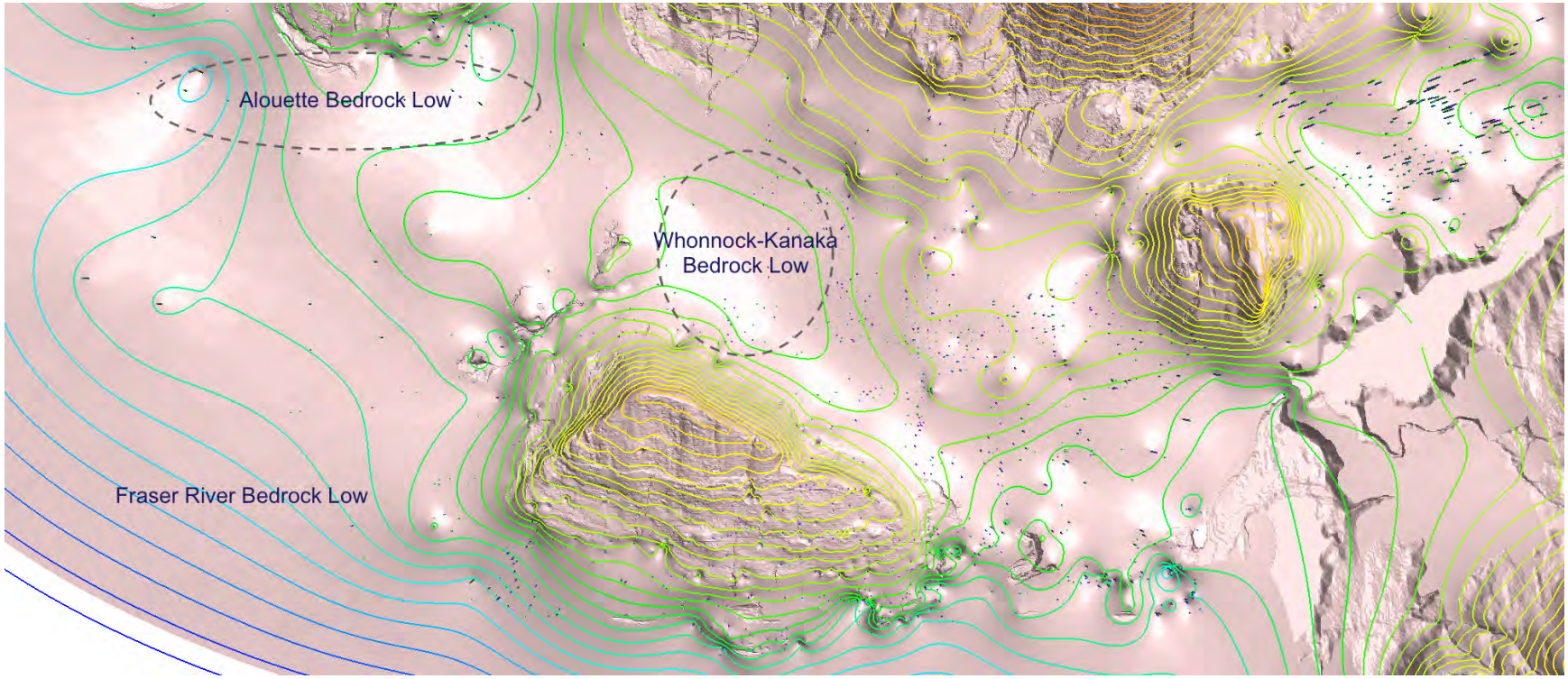


Figure 8: Overview of the modelled bedrock topography showing notable bedrock depressions. Bedrock highs such as Grant Hill and Iron Mt. (east of Whonnock Lake) are clearly visible as topographic features.

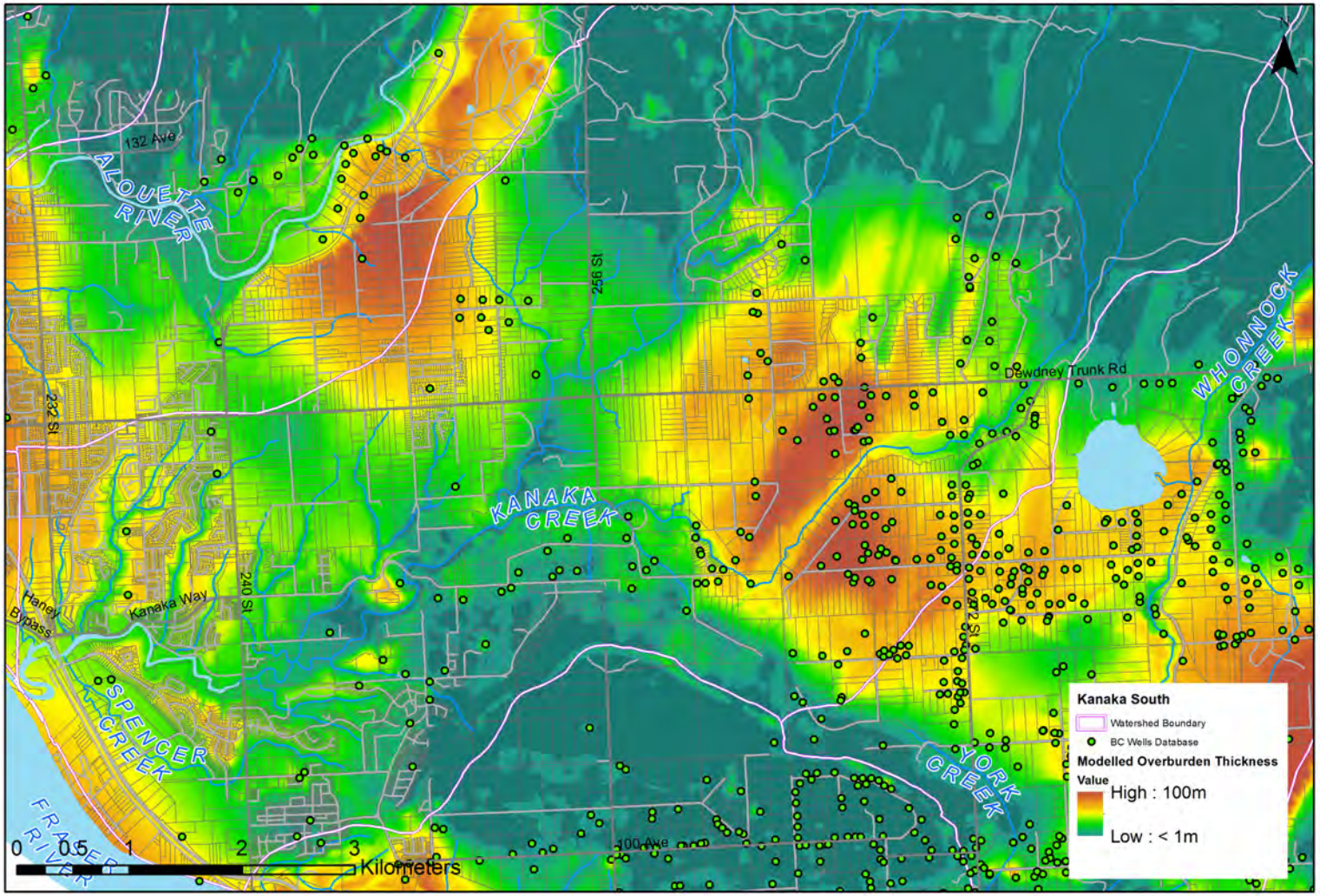


Figure 9: Thick accumulations of overburden underlie areas south and west of Whonnock Lake as well as the south side of the Alouette River, and Maple Ridge urban areas down to the Fraser River, as indicated by the dark orange colours. Rivers have deeply eroded into these layers, in some areas as far as bedrock, as indicated by the dark green colours along the river courses.

Kanaka-Whonnock Aquifer #26

A confined aquifer has capping layers of low-permeability materials such as clay and silt-rich sediment or consolidated glacial till. In the Maple Ridge area, a prime example of such an aquifer is the Kanaka-Whonnock aquifer system, located between Whonnock Lake and Kanaka Creek (Figure 11). In reality, the Kanaka-Whonnock aquifer is not a single geologic entity. Rather, it is a series of sand and gravel lenses encountered at depths ranging from 10 m to approximately 100 m below ground level (Figure 10). This aquifer therefore has a low vulnerability to contamination from surface activities or polluted surface run-off. Being confined, the aquifer is under pressure, and wells completed in the aquifer typically have high hydraulic heads. From a storm water management perspective, this translates into the aquifer having a low potential for passive infiltration of runoff through centralized stormwater disposal such as detention ponds.

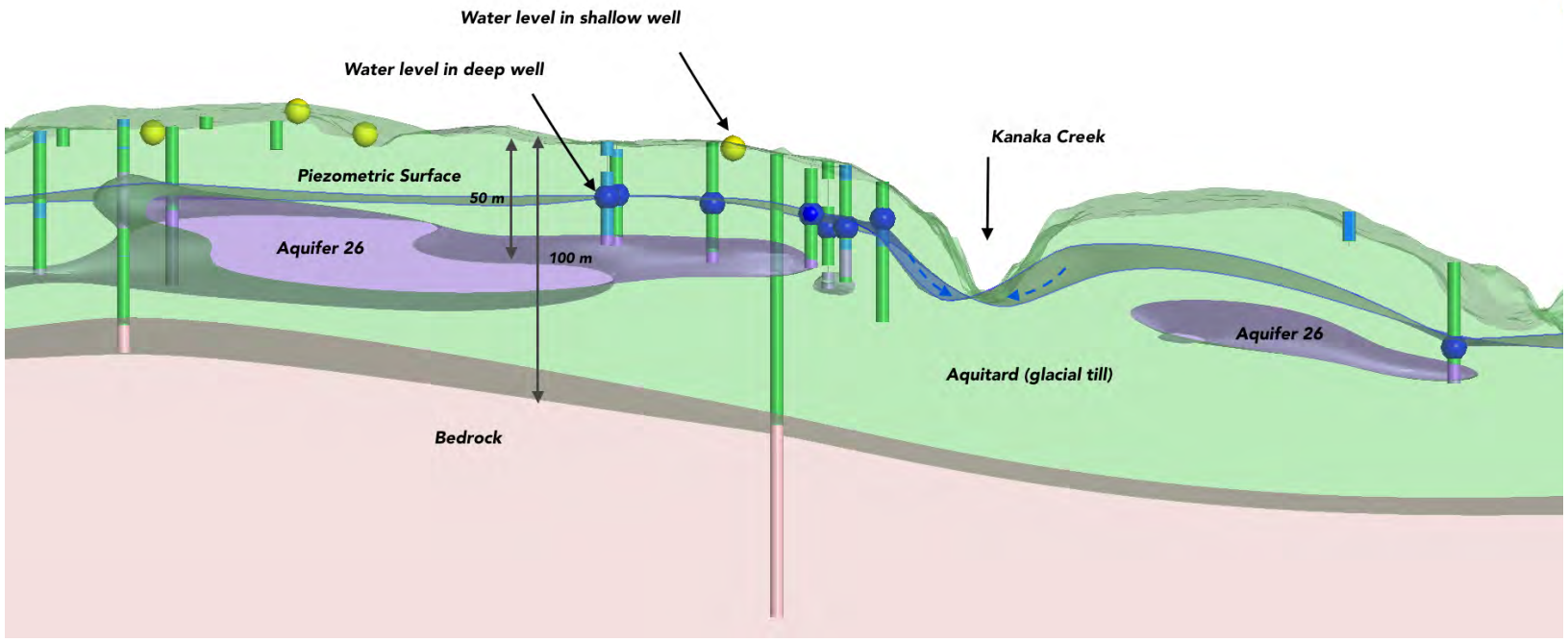


Figure 10: Hydrogeological model slice A-A' (Left to right, looking east) through the Kanaka-Whonnock Aquifer 26, recognized in the subsurface as lenses of sand and gravel lenses (purple "blob") surrounded by green aquitard material (mostly glacial till**).** Shallow water table elevations are yellow circles, dark blue circles indicate reported piezometric levels from wells deeper than 10 m. For location, see Figure 11.

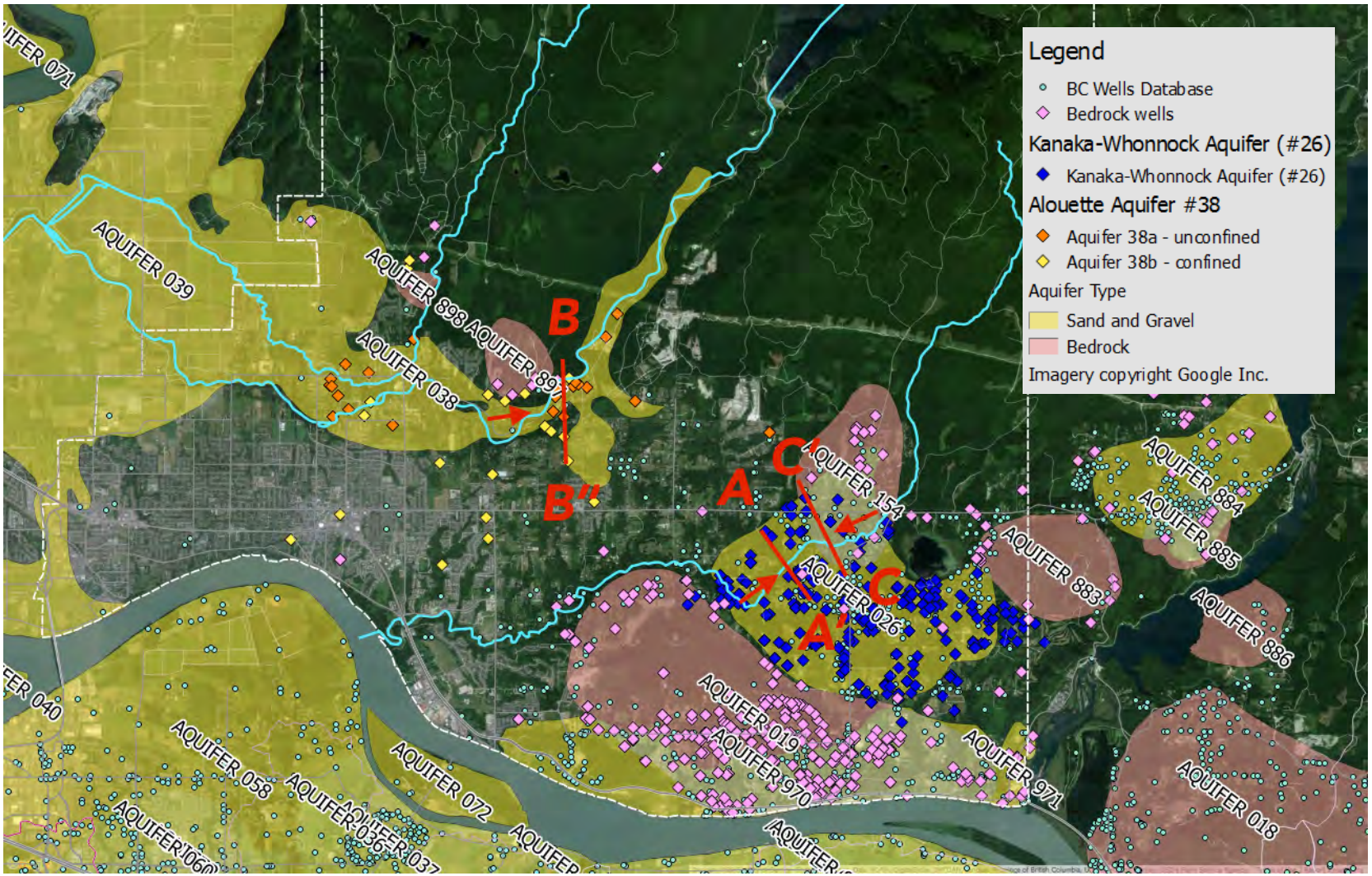


Figure 11: Location of hydrogeological model slices A-A', B-B', and C-C'. Blue diamonds are wells completed in the Whonnock Aquifer (#26); Orange and yellow diamonds are wells completed in the Allouette Aquifers 38a and 38b, respectively. Pink diamonds are bedrock wells.

Alouette Aquifer #38

The Alouette Aquifer corresponds broadly with the floodplain and terraces of the present day North and South Allouette River system, extending from the floodplain to beneath the city. In fact, GW Solutions recognizes at least two stacked aquifers within the Alouette River corridor (Figure 12), including:

- Aquifer 38a, comprising an extensive, unconfined, alluvial aquifer distributed along the main Alouette River floodplain;
- Aquifer 38b comprising sand and gravel lenses encountered at depths ranging from 30 to 100 m below ground level. This deep, confined aquifer possibly extends outwards beneath the city, however boreholes are lacking in this area.

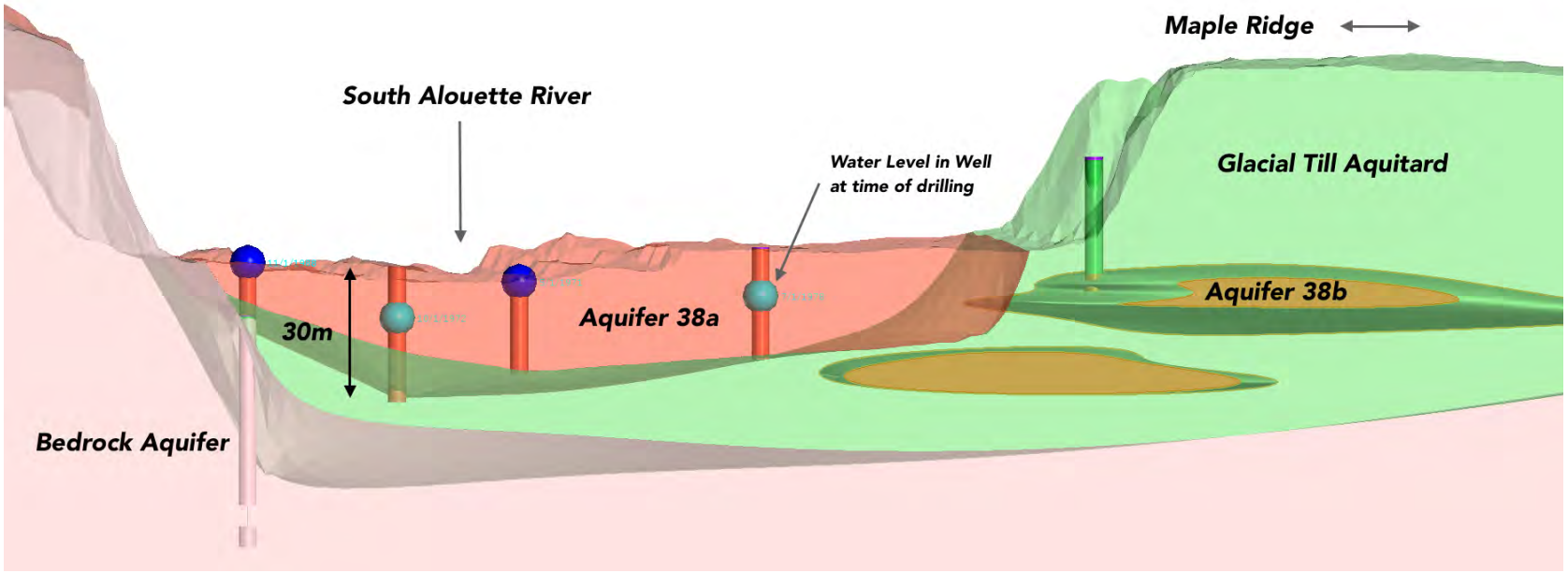
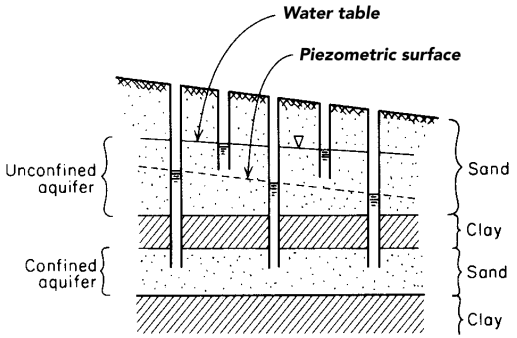


Figure 12: Hydrogeological model slice B-B' (Left to right, looking east) through the unconfined south Alouette River Aquifer 38a and the confined sand and gravel aquifer 38b recognized in well lithologies. Aquifer 38a is expected to be hydraulically connected with the Alouette River, whereas Aquifer 38b may be only partially connected, possibly through river bank seepage or localized springs. Vertical exaggeration is x5. For location, see Figure 11.

Maple Ridge Groundwater Recharge and Discharge Areas

In order to link groundwater recharge areas to areas where groundwater may be discharging to creeks and rivers, we need to spatially model the hydraulic head or piezometric level of groundwater (i.e., elevation of the water table) throughout the watersheds. In an unconfined aquifer, the top of the saturated soil corresponds to both the piezometric level and the water table. In a confined aquifer, the piezometric level is above the "ceiling" of the saturated soils composing the aquifer (see illustration, right).



Source: Freeze and Cherry (1979)

The primary inputs to this interpolation of the water table (for unconfined aquifers) and piezometric levels (for confined aquifers) are water levels in wells recorded at the time of drilling and the LiDAR-derived surface topography. Three broad classes of wells can be distinguished from the Wells data based on the depth drilled and the aquifers encountered in the well:

1) shallow, typically dug wells less than 10 m deep, completed in unconfined, overburden aquifers;
2) deep, drilled wells, greater than 10 m deep completed in confined overburden aquifers; and
3) wells of varying depths drilled into fractured bedrock.

Using only water elevations from wells drilled to depths greater 10 m deep into bedrock and/or overburden, GW Solutions modelled the watershed-scale piezometric surface and contours (Figure 13). Much like topographic contours, the closer together the piezometric contours appear, the steeper the hydraulic gradient. High hydraulic gradients are evident throughout upland areas such as Grant Hill and the mountain north of Maple Ridge. These correspond to bedrock or "mountain block" recharge areas. Contours are markedly curved in the upstream direction around the axis of Kanaka Creek, which is likely indicative of groundwater discharging to the Creek. Moderate hydraulic gradients are prevalent throughout urban areas of Maple Ridge, west towards Pitt River, and south towards the Fraser River.

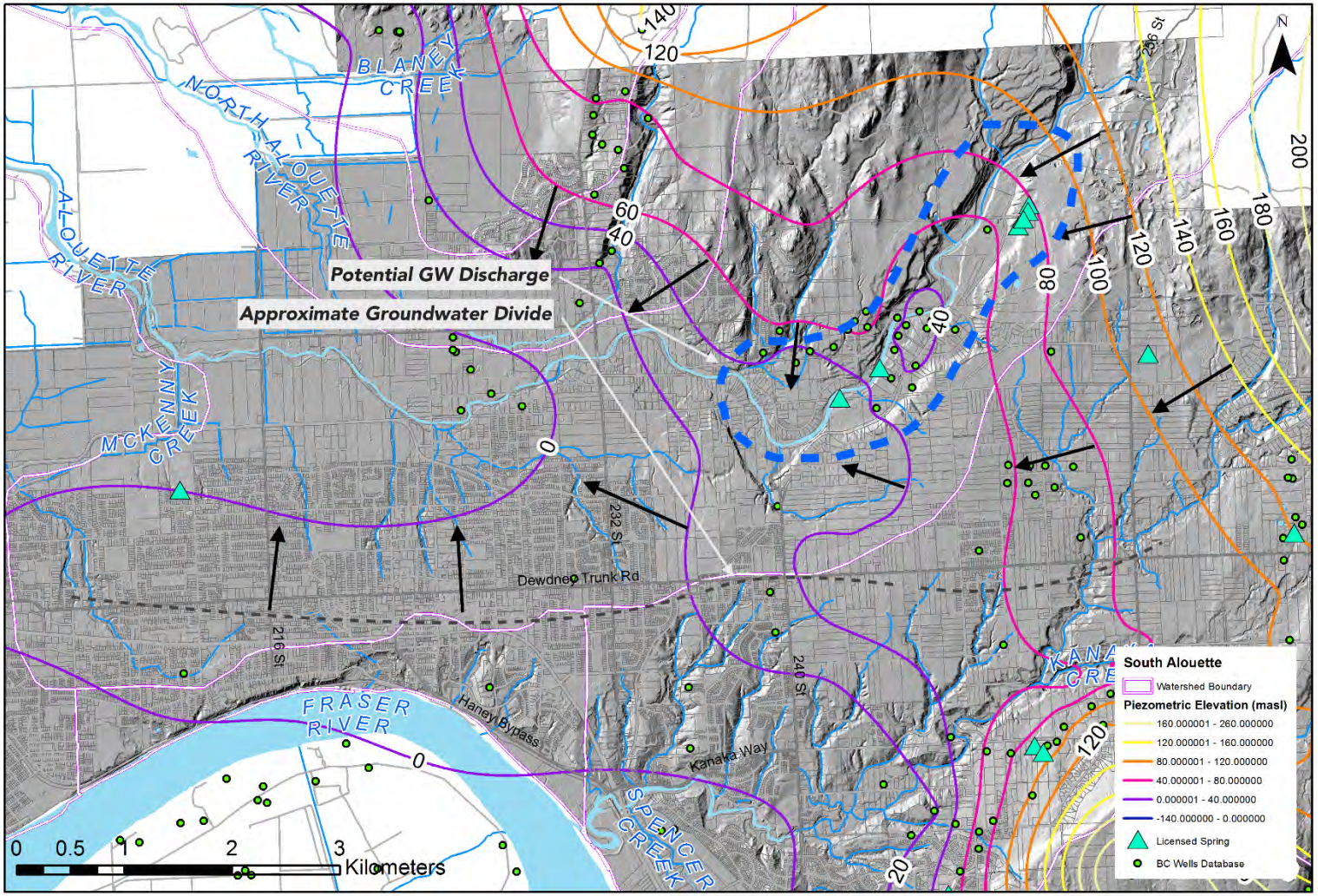


Figure 13: Modelled piezometric contours for overburden and bedrock wells greater than 10 m depth. Contours are elevations above sea level. Note the groundwater divide that bisects the area in an East-West direction whereby groundwater flow is directed either north to the Alouette system of south to Kanaka Creek and Fraser River.

Piezometric Surfaces and Surface Topography

The main rivers in the study area have incised surficial sediments by as much as 50 m in the case of upper Kanaka Creek and up to 80 m in the case of the South Alouette River. These rivers have cut through pre-existing layers of permeable and impermeable deposits including aquifers such as the Whonnock Aquifer (#26) and the Alouette Aquifer (#38). The geology, topography, water table and piezometric surfaces can potentially all intersect along these incised river valleys, producing the interaction with rivers and creeks as depicted in Figure 14 (after Benoit et al., 2015):

Seepage flow occurs when an aquifer or aquitard is exposed at a change in topography, thereby creating a seepage face or spring.

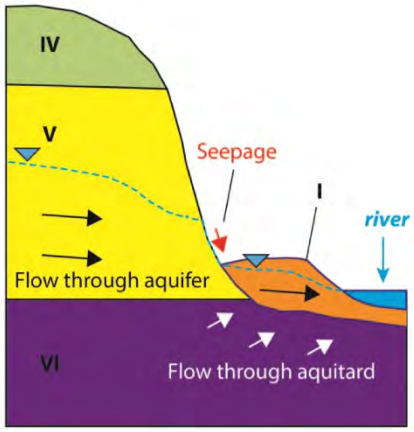


Figure 14. Incised valley surface-water-groundwater interaction. Source: Benoit et al., 2015

Riverbank flow through recent fluvial deposits and river terraces (e.g. Allouette Aquifer #38). There is typically a close connection between river water and groundwater in these river bank terraces.

Aquitard and Bedrock flow occurs when rivers flow directly upon aquitard or bedrock units. The magnitude of this flux is expected to be much smaller than the preceding effects, due to the

relatively lower permeability of the aquitards and bedrock, except locally where the bedrock is heavily fractured.

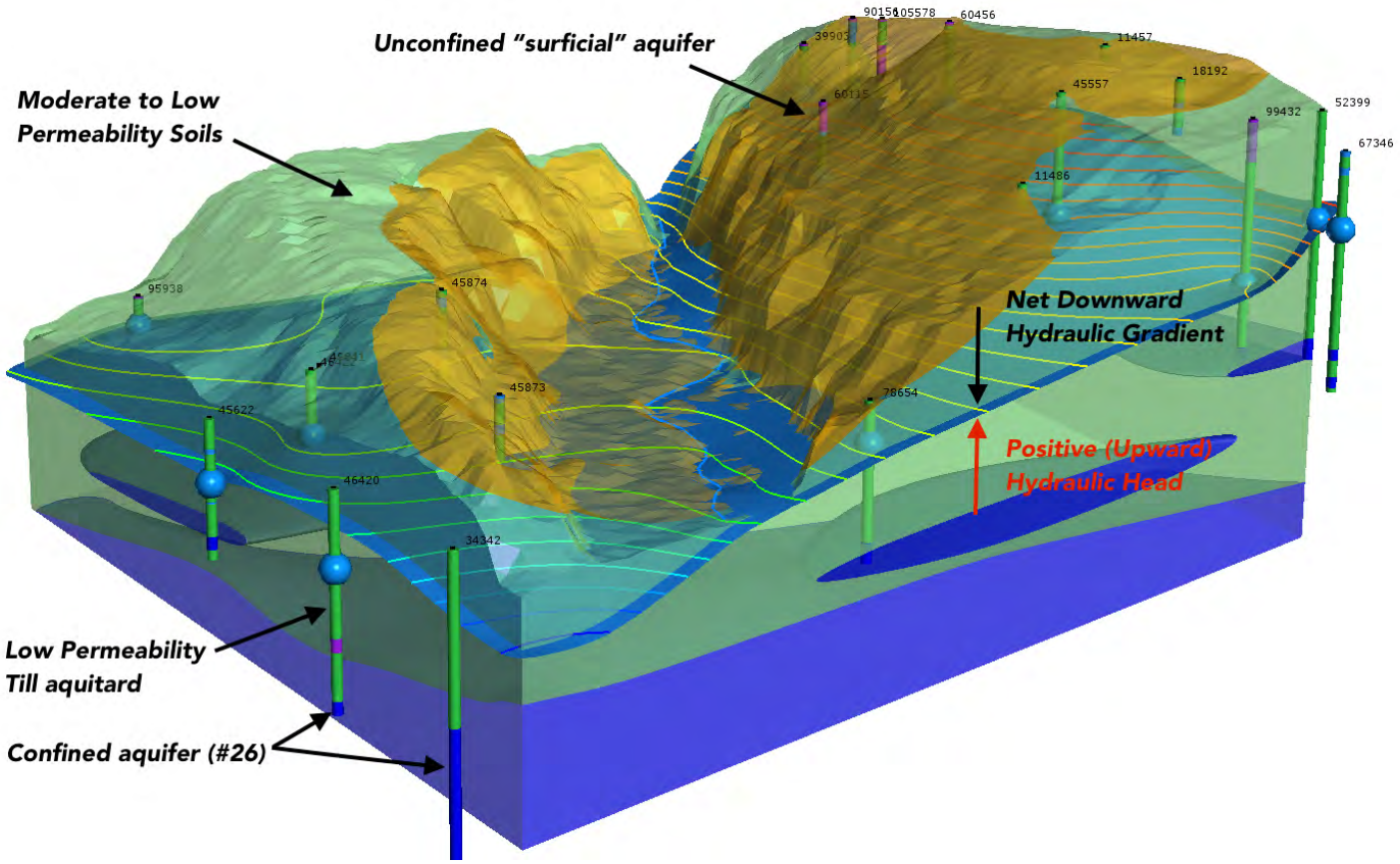


Figure 15: Surface Water-Groundwater Interaction along upper Kanaka Creek. Hydrogeological model scene showing areas where the modelled piezometric surface (green contours and light blue surface) meets Kanaka Creek. Light blue spheres on the borehole traces are water levels at the time of drilling. Dark blue "blobs" represent estimated volumes of confined Aquifer 26 (Whonnock Aquifer).

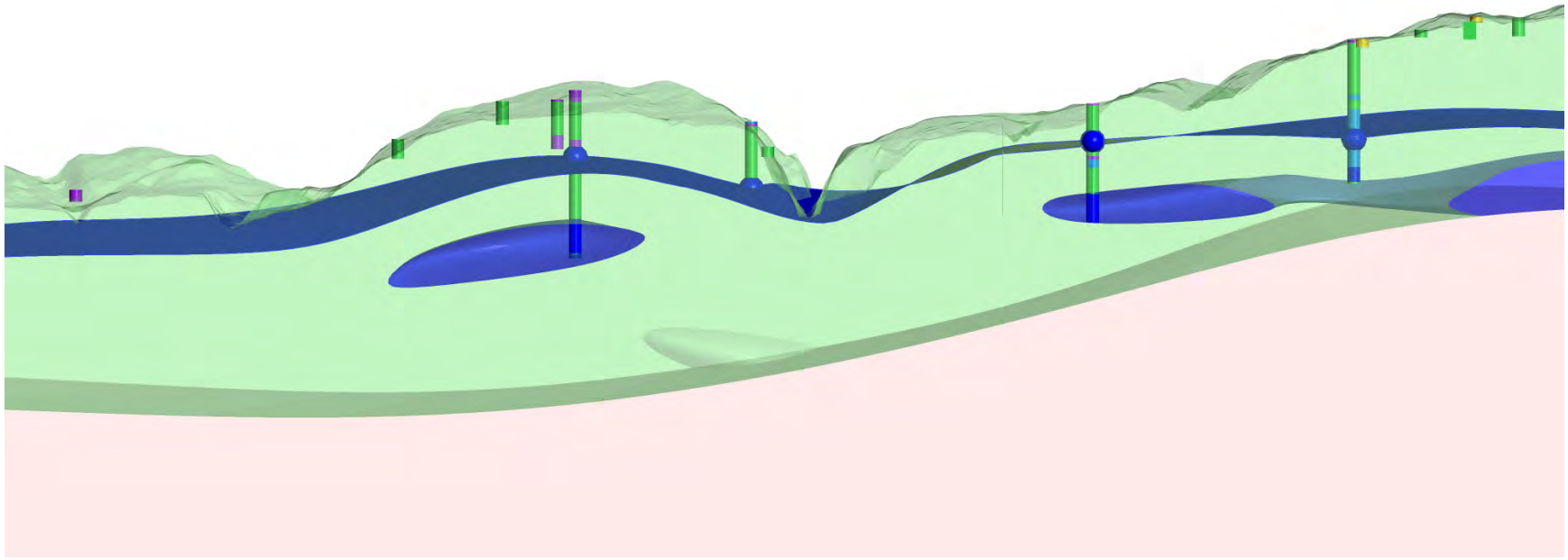


Figure 16: Hydrogeological model slice C-C' through the Kanaka-Whonnock aquifer system (Looking west). Possible zone of groundwater discharge to Kanaka Creek. (Location Kanaka Creek: 1256646.5643, 472869.4225 (BC Albers), 126 m elevation). The dark blue circles indicate reported piezometric levels and the blue "blobs" represent estimated volumes of confined aquifer lenses.

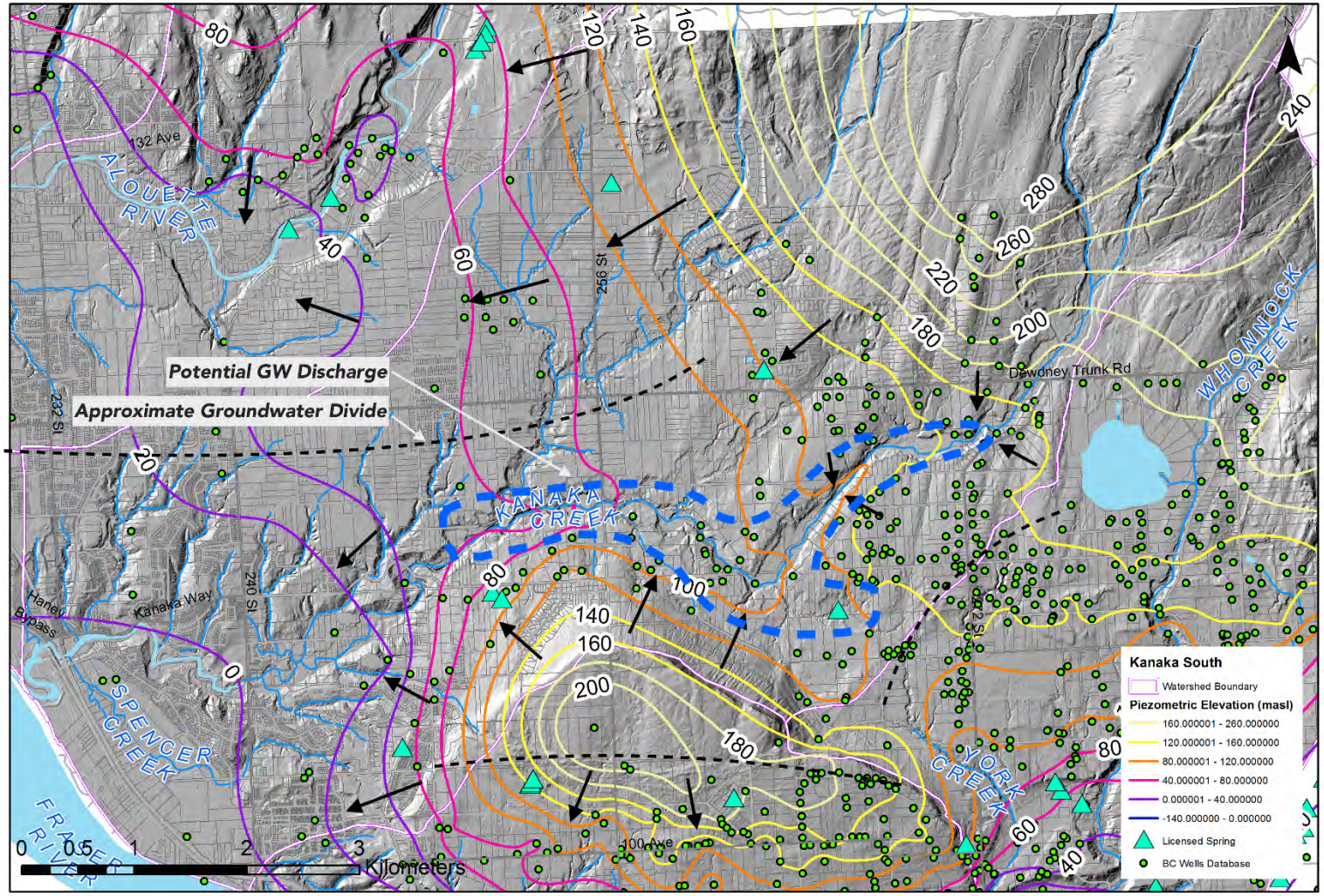


Figure 17: Piezometric contours for wells penetrating the Whonnock-Kanaka Aquifer system. Contours are elevations above sea level. Note that the contours are markedly curved in the upstream direction around the axis of Kanaka Creek, which is likely indicative of the groundwater discharging to the Creek.

Soils and Infiltration Potential

Soils denoted as having a "Perched water table" or "Telluric Seepage" in the provincial soils database are areas characterized by groundwater flow through the soil roughly parallel with the ground surface above a restricting or impermeable layer. Soils that are well to moderately well-drained with coarse textured materials in the database are likely groundwater recharge areas, and may be suitable for enhanced stormwater infiltration strategies.

By filtering the soil properties according to drainage, texture and water table characteristics, we can distinguish four soil groups. These groups offer possible insight into the relationship between the surface, sub-surface and groundwater regimes at each location.

1. Areas with poor drainage characteristics due to the prevalence of fine-grained material with low infiltration rates. These areas correspond to groundwater discharge zones primarily. Groundwater discharge or high water table conditions will also typically occur in low-lying areas, reducing the capacity of infiltrating rain water and runoff.
2. Areas that are well to moderately well-drained that nevertheless have a perched water table or where seepage is observed, indicating a confining impermeable layer, and likely a lack of direct connectivity with the deeper groundwater regime. These areas likely correspond to groundwater discharge areas, locally confirmed by the presence of springs, seepage zones and seasonally high water table.
3. Areas that are well to moderately well-drained that also display potential connectivity between the shallow and deeper groundwater regimes. These correspond to areas with the highest potential for rain water infiltration and groundwater recharge.
4. Areas that are well or rapidly drained due to the presence of a thin overburden layer over bedrock, or consolidated till, combined with steep terrain. These are typically upland areas where recharge to the fractured bedrock aquifer system is likely to occur.

It is important to note that GW Solutions could not assess the subsurface materials throughout the majority of the urbanized area of Maple Ridge (i.e. areas west of 232 Street) due to the lack of borehole information. It is likely that this area is underlain by thick glaciomarine and glacial till deposits of generally low hydraulic conductivity. The majority of the urban area is underlain by soils of Group 2, which has a confining layer at depth. Urban areas west of 216th Street and east of 216th Street within the South Alouette alluvial plain are the exception to this, where soils from Group 3 are more prevalent.

Table 4: Relationship of Soils mapping groups to Surface, Subsurface and Groundwater Regimes.

Soil Group	Drainage/Surface Water Runoff Characteristics	Sub-Surface Flow Characteristics	Relationship to Groundwater Regime
1	Imperfect to Very Poor	seasonally high water table, flooding, seepage	Potential Discharge, slow recharge, if any
2	Moderately Well to Well	perched water table or observed seepage, indicating a confining low-permeability layer	Variably Recharge or Discharge, depending on season and location
3	Moderately Well to Rapid	rapid infiltration rates, no confining layer	Potential Recharge
4	Moderately Well to Rapid	relatively thin overburden over bedrock or till confining layer; steep terrain	Mountain Block/Bedrock Recharge

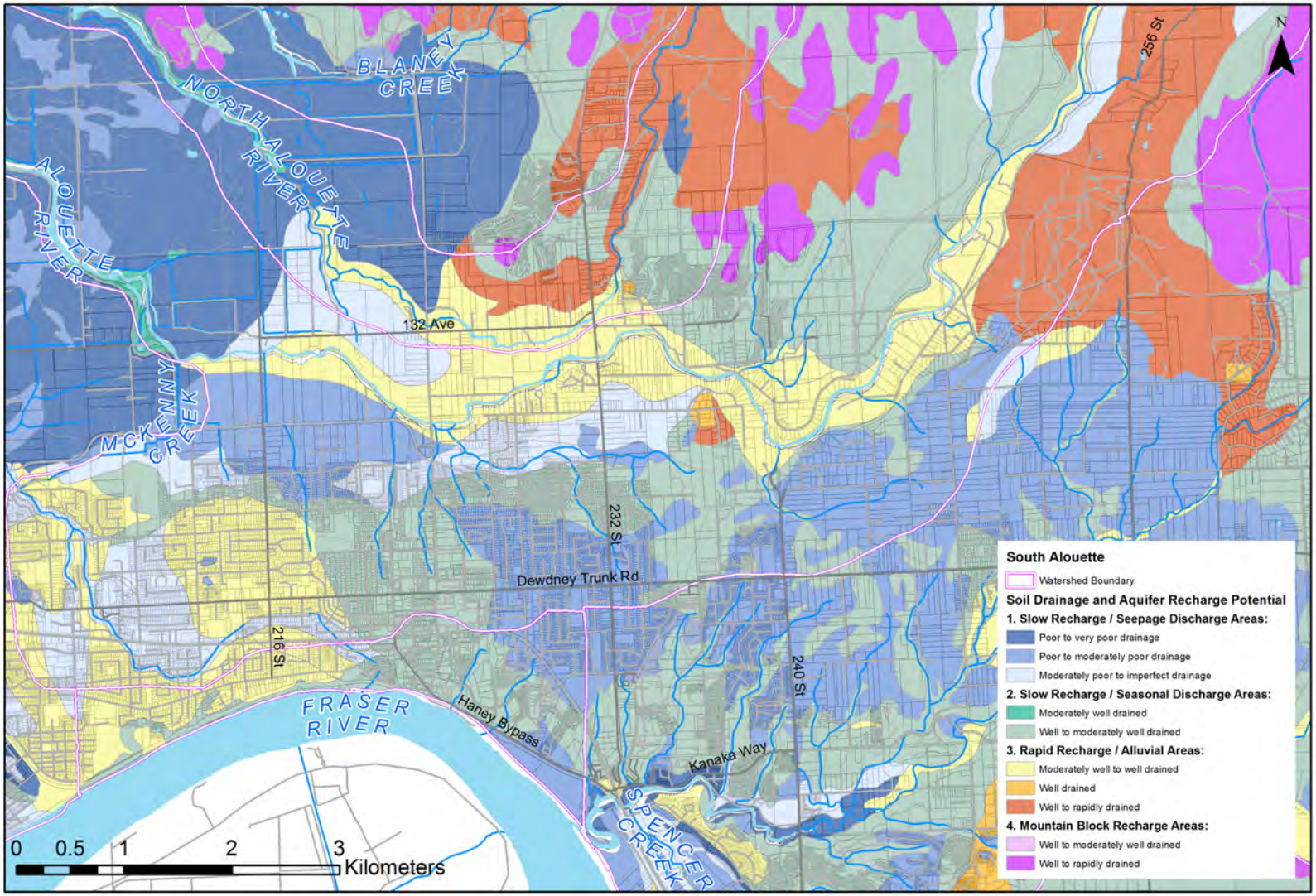


Figure 18: South Alouette soil mapping, drainage/infiltration characteristic related to aquifer recharge/discharge potential.

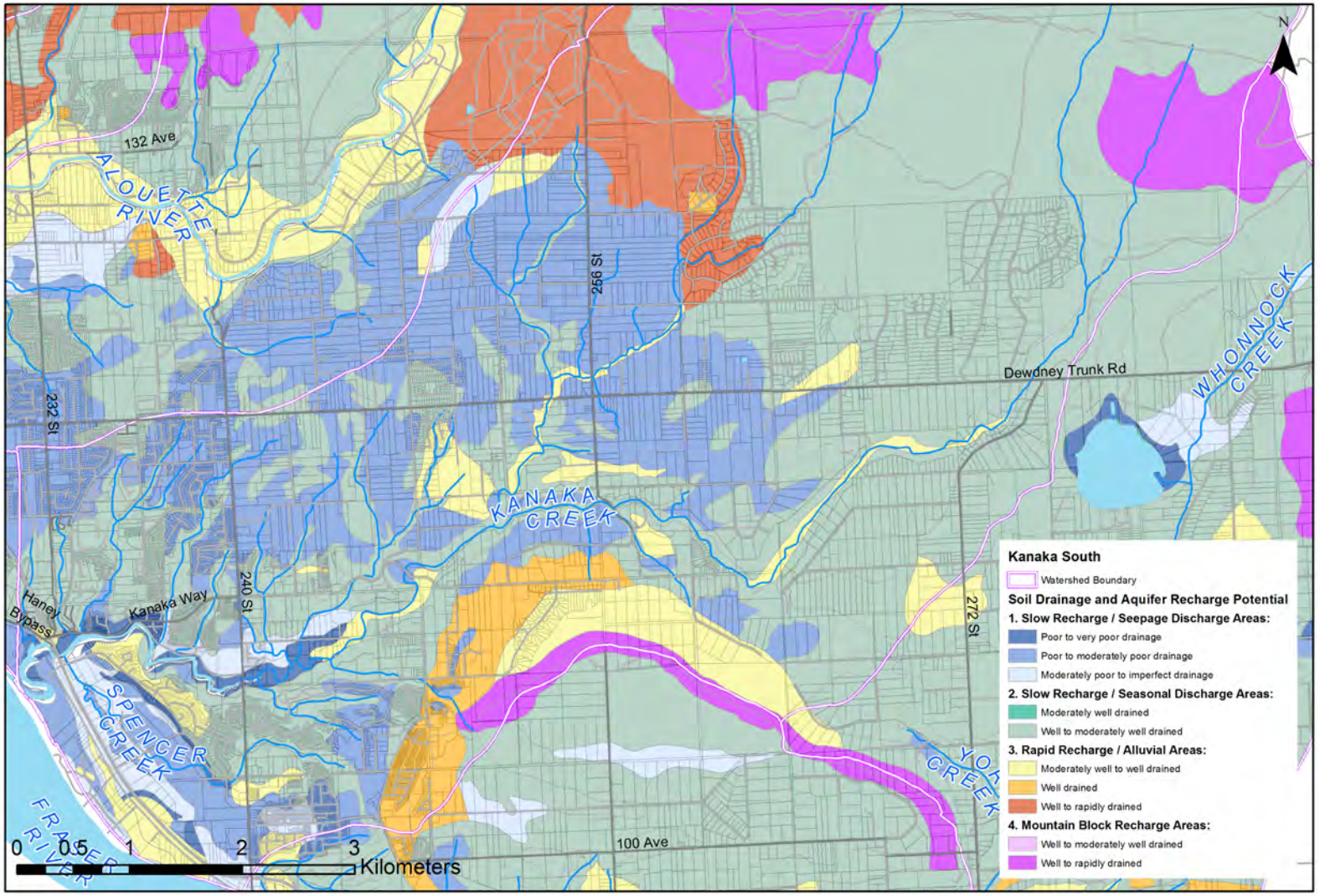


Figure 19: Kanaka West soil mapping, surface drainage/infiltration characteristic related to aquifer recharge/discharge potential.

Recommendations for Stormwater Management

Based on our review of available information, GW Solutions offers the following recommendations for stormwater management with respect to the surface-groundwater regime:

- Potential groundwater discharge areas (Group 1 Soil) are likely not suited to centralized stormwater management techniques due to the inherently low hydraulic conductivities of the shallow and subsurface materials, and corresponding shallow water table. However, these areas may be suitable for designed flooding, provided the appropriate land use and plans are in place (i.e. parks, wetlands, etc). The potential risks associated with design flooding to property and the environment must be properly assessed and are beyond the scope of this report.
- Throughout seasonally affected groundwater recharge-discharge areas (Group 2 soils) as well as mountain block recharge areas (Group 4 soils), the presence of subsurface layers with low hydraulic conductivity precludes concentrating runoff from large areas since it may not infiltrate at rates that are sufficient.
- Areas with Group 3 soils may be suitable for centralized stormwater management facilities due to their inherently high hydraulic conductivities and potential connection with the deeper groundwater system. Detailed investigation of the potential down-gradient effects of enhanced groundwater recharge would be required in this case.
- Small-scale (i.e. lot or street level) stormwater management would likely be the most feasible option throughout the majority of the urban and suburban landscape (mapped as Group 1 and Group 2), due to the widespread occurrence of subsoils with low hydraulic conductivities. A distributed network of small-scale infiltration designs would most closely mimic the pre-urbanized environment.
- Passive infiltration of stormwater into the confined aquifers (i.e. the Kanaka-Whonnock aquifer system, or Alouette Aquifer 38b) is not deemed feasible due to the inherent upward hydraulic gradients present within these aquifers.

Limitations

The opinion expressed in this report is based on limited information and on data available at the time of reporting. GW Solutions could not assess hydrogeological conditions throughout the majority of the urbanized area of Maple Ridge (i.e. areas west of 232 Street) due to the lack of available borehole information. Site specific investigations will be required to confirm the hydrogeological conditions of the proposed recharge areas and to design appropriate rain water management solutions. Detailed and site specific investigations will likely require seasonal monitoring of the water table to define both high and low water table conditions and to confirm the infiltration capacity of the subsurface soils.

Closure

Conclusions and recommendations presented herein are based on available information at the time of the study. The work has been carried out in accordance with generally accepted engineering practice. No other warranty is made, either expressed or implied. Engineering judgment has been applied in producing this memo.

This memo was prepared by personnel with professional experience in the fields covered. Reference should be made to the General Conditions and Limitations attached in Appendix 1.

GW Solutions was pleased to produce this document and is looking forward to working with you on this project. If you have any questions, please do not hesitate to contact me.

Yours truly,
GW Solutions Inc.

Matt Vardal, MSc.,
Project Hydrogeologist

Gilles Wendling, Ph.D., P.Eng.
President

APPENDIX 1 - References

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Leapfrog Hydro. ARANZ Geo Ltd. Geological Modelling Software.

APPENDIX 2 – Soils and Surficial Geology Mapping Tables

Table 5. Soil Map Key and Soil Attributes

KEY (Map Label)	Soil Name	Soil Description	Drainage Description	Drainage Class	Groundwater Recharge-Discharge Soil Group
AB	ALBION	Moderately fine to fine-textured glaciomarine deposits	Moderately poor to poor; perched water table	Moderately poor to poor	1
AG	ADDINGTON	15 to 40 cm of organic material over medium-textured mixed flood-plain deposits	Very poor, high groundwater table; susceptible to flooding	Poor to very poor	1
AL	ALOUETTE	15 to 40 cm of organic material over medium-textured mixed flood-plain deposits	Poor to very poor, high groundwater table	Poor to very poor	1
AN	ANNIS	15 to 40cm of organic material over moderately fine textured floodplain deposits	Poor to very poor, high groundwater table	Poor to very poor	1
BD	BANFORD	40 to 160cm of well-decomposed organic material underlain by moderately fine textured glaciomarine deposits	Poor to very poor, high groundwater table	Poor to very poor	1
BE	BLANEY	Moderately coarse to coarse-textured glacial till	Well to moderately well; telluric seepage	Well to moderately well	2
BN	BONSON	Medium-textured floodplain deposits	Imperfect, fluctuating groundwater table	Imperfect	1
BO	BOSE	30 to 180cm of gravelly lag or glacial outwash deposits over moderately coarse textured glacial till and some moderately fine textured glaciomarine deposits	Well to moderately well; telluric seepage	Well to moderately well	2

BR	**BERRY**	**Moderately fine to fine-textured marine deposits**	**Imperfect; perched water table**	**Imperfect**	**1**
BW	**BURWELL**	**Moderately coarse textured glacial till and some colluvium**	**Imperfect; telluric seepage**	**Imperfect**	**1**
BY	**BOOSEY**	**30 to 160cm of gravelly lag or glacial outwash deposits over moderately coarse textured glacial till and some moderately fine textured glaciomarine deposits**	**Poor; perched water table**	**Poor**	**1**
BZ	**BUNTZEN**	**Moderately coarse to medium-textured glacial till**	**Moderately well; telluric seepage**	**Well to moderately well**	**2**
CD	**CLOVERDALE**	**Moderately fine to fine-textured marine deposits**	**Poor; perched water table**	**Poor**	**1**
CE	**CANNELL**	**10 to 50cm of moderately coarse textured glacial till or colluvium over bedrock**	**Well to rapid**	**Well to rapid**	**4**
CL	**COLUMBIA**	**Gravelly glacial outwash deposits**	**Well to rapid**	**Well to rapid**	**3**
CP	**CAPILANO**	**Gravelly glacial outwash deposits**	**Well to rapid**	**Well to rapid**	**3**
CV	**CARVOLTH**	**Moderately fine textured local stream deposits**	**Poor to very poor; perched water table, susceptible to flooding**	**Poor to very poor**	**1**
DE	**DENNETT**	**More than 10cm of organic material over bedrock**	**Well to moderately well**	**Well to moderately well**	**4**
DN	**DEAN**	**Coarse-textured alluvial fan deposits**	**Moderately well**	**Moderately well**	**3**
DR	**DEFEHR**	**Sandy and gravelly glacial outwash deposits**	**Imperfect; perched water table**	**Imperfect**	**1**
DU	**DURIEU**	**Medium to moderately fine textured glaciomarine deposits**	**Moderately well**	**Moderately well**	**3**
DV	**DEVIL**	**Moderately coarse textured glacial till deposits**	**Moderately well**	**Moderately well**	**3**
ER	**ERROCK**	**Gravelly glacial outwash deposits**	**Imperfect; perched water table, telluric seepage**	**Imperfect**	**1**

EU	EUNICE	More than 10cm of organic material over bedrock	Well to rapid	Well to rapid	4
F	FAIRFIELD	medium to moderately fine textured, laterally accreted floodplain deposits	Imperfect, fluctuating groundwater table	Imperfect	1
GE	GOLDEN EARS	Moderately coarse texture glacial till	Moderately well	Moderately well	3
GN	GIBSON	40 to 160cm of partially decomposed organic material overlying floodplain deposits	Very poor; high groundwater table	Very poor	1
GP	GRAVEL PIT	Active or inactive areas of gravel (or sand) extraction		Well	3
GV	GLEN VALLEY	More than 160cm of undecomposed organic material, mainly reeds, sedges and grasses	Very poor; high groundwater table	Very poor	1
HA	HAMMOND	Medium-textured floodplain deposits	Poor to very poor	Poor to very poor	1
HD	HAZELWOOD	Fine to moderately fine textured, vertically accreted floodplain deposits	Poor; high water table	Poor	1
HJ	HJORTH	Medium- textured laterally accreted floodplain deposits	Poor to moderately poor, high groundwater table	Moderately poor to poor	1
HN	HERON	Coarse-textured littoral deposits over moderately coarse textured glacial till or moderately fine textured glaciomarine deposits	Poor; perched water table	Poor	1
HT	HALLERT	Medium-textured, vertically accreted floodplain deposits	Poor to very poor, high groundwater table	Poor to very poor	1
HV	HOOVER	Moderately coarse-textured colluvium	Moderately well; telluric seepage	Well to moderately well	4
HY	HANEY	Gravelly glaciofluvial deposits	Well to rapid	Well to rapid	3
IS	ISAR	Coarse textured alluvial fan deposits	Well to rapid	Well to rapid	3
JN	JUDSON	40 to 160cm of well-decomposed organic material underlain by moderately fine textured glaciomarine deposits	Very poor; perched water table	Poor to very poor	1

KE	KEYSTONE	Gravelly glaciofluvial deposits	Well	Well	3
KW	KENWORTHY	Moderately coarse to coarse textured colluvium	Well	Well	4
KZ	KATZIE	Fine to moderately fine textured, mixed floodplain deposits	Moderately poor to imperfect; fluctuating groundwater table	Moderately poor to imperfect	1
LM	LUMBUM	More than 160 cm of partially-decomposed organic material	Very poor, high groundwater table	Poor to very poor	1
M	MONROE	Medium-textured laterally accreted floodplain deposits	Well to moderately well	Well to moderately well	3
MQ	MATSQUI	15 to 50 cm of medium-textured, laterally accreted floodplain deposits over sand	Well to moderately well	Well to moderately well	3
MR	MILNER	Fine moderately fine textured marine deposits	Moderately well	Moderately well	3
N	NICHOLSON	Moderately fine-textured glaciomarine deposits	Moderately well; telluric seepage	Well to moderately well	2
NV	NEAVES	Medium-textured, mixed floodplain deposits	Poor to very poor; high groundwater table	Poor to very poor	1
P	PITT	Medium to moderately fine textured floodplain deposits	Poor to moderately poor, high groundwater table	Moderately poor to poor	1
PA	PALISADE	Moderately coarse textured colluvium	Moderately well; telluric seepage	Moderately well	4
PE	PAGE	Medium to moderately fine textured floodplain deposits	Poor to moderately poor, high groundwater table	Moderately poor to poor	1
PN	PATON	Coarse-textured alluvial-colluvial fan deposits	Well	Well	3
PR	PREST	Medium to moderately fine textured floodplain deposits	Very poor, high groundwater table	Poor to very poor	1

RA	RECENT ALLUVIUM	Gravel and sand bars and other areas in or adjacent to rivers and streams.		Moderately Well	2
RH	ROACH	Gravelly glaciofluvial deposits	Moderately well	Moderately well	3
RO	ROCK OUTCROP	Medium to moderately fine textured local stream deposits	Very poor, subject to flooding	Poor to very poor	1
S	SAYRES	10 to 50cm of moderately coarse textured colluvium or glacial till over bedrock	Moderately well; telluric seepage	Moderately well	4
SC	SCAT	Moderately fine-textured glaciomarine deposits	Poor; perched water table	Poor	1
SD	SARDIS	Coarse to moderately coarse textured littoral and glacial outwash deposits over moderately coarse textured till	Moderately well	Moderately well	3
SE	STAVE	Coarse to moderately coarse textured littoral and glacial outwash deposits over moderately coarse textured till	Well to moderately well	Well to moderately well	3
SG	STURGEON	Medium-textured, mixed floodplain deposits	Poor to very poor, high groundwater table, subject to flooding	Poor to very poor	1
SH	SHALISH	Coarse- textured alluvial deposits	Moderately well to well	Well to moderately well	3
SN	STRACHAN	Moderately coarse textured glacial till and some colluvium	Moderately well, telluric seepage	Moderately well	4
SR	SUMMER	Less than 100cm of coarse-textured littoral and glacial outwash deposits over moderately fine or fine-textured glaciomarine and marine deposits	Imperfect perched water table	Imperfect	1
SS	SUNSHINE	Sandy littoral and glacial outwash deposits	Well to moderately well	Well to moderately well	3
ST	STEELHEAD	Moderately coarse textured glacial till	Imperfect; perched water table, telluric seepage	Imperfect	1
SV	SEAVIEW	Medium- textured deltaic deposits	Poor to very poor, high groundwater table	Poor to very poor	1

SY	SEYMOUR	Coarse- textured alluvial deposits	Imperfect; telluric seepage, fluctuating water table	Imperfect	1
TR	TRIGGS	More than 160cm of undecomposed organic materials, mainly sphagnum moss	Very poor; high groundwater table	Very poor	1
W	WHATCOM	Moderately fine textured glaciomarine deposits	Moderately well; telluric seepage	Well to moderately well	2
WG	WIDGEON	40 to 160cm of organic deposits over medium-textured, mixed floodplain deposits	Very poor, high groundwater table	Poor to very poor	1
WH	WHONNOCK	Moderately coarse textured glacial till	Moderately well; telluric seepage	Moderately well	2

Table 6. Surficial Geology Map Key and Polygon Attributes.

Map Label	Depositional Environment	Characteristic Material/Lithology	Unit Approximate Thickness (m)
SAa	landfill	sand, gravel, till, crushed stone and refuse	
SAb	bog, swamp and shallow lake deposits	lowland peat up to 14m thick, overlying Fb, c	14
SAc	bog, swamp and shallow lake deposits	lowland peat up to 1m thick underlying Fb (up to 2m thick)	1
SAd	bog, swamp and shallow lake deposits	lowland organic sandy loam to clay loam 15-45 cm overlying SAg and Fd	0.5
SAe	bog, swamp and shallow lake deposits	upland peat up to 8m or more thick	8
SAf	marine beach deposits:	sand to sandy loam up to 2m thick overlying estuarine, fossiliferous, fine sand and clayey silt 10-185m thick	2-185
SAg	marine beach deposits:	medium to coarse sand and gravel up to 8m thick	8
SAh	lowland stream channel fill and overbank sediments	sandy loam to clay loam, some organics up to 8m thick	8
SAi	mountain stream, marine deltaic	medium to coarse gravel and minor sand	15
SAj	mountain stream channel fill	channel gravel and minor sand	8

SAk	**lowland stream channel fill**	**sand to gravel and minor silt and clay**	**5**
SAp	**landslide and fan deposits**	**gravel and rubble**	**10**
Fa	**channel deposits, along present day river channels**	**fine to medium sand and minor silt**	
Fb	**overbank deposits**	**sandy to silt clay loam**	**2**
Fc	**overbank deposits**	**silty to silt clay loam**	**2**
Fd	**deltaic and distributory channel fill, including tidal flats**	**sandy to silt loam, interbedded fine to medium sand and minor silt beds, minor organics**	**10-40**
SA	**marine shore and fluvial**	**sand**	**8**
Sa	**glacial outwash**	**sand and gravel**	**30**
Sb	**ice contact**	**gravel and sand, till lenses and glaciomarine clasts**	**2-5**
Sc	**ice contact**	**gravel and sand, till lenses and glaciomarine clasts**	**5**
Sd	**ice contact**	**gravel and sand, till lenses and glaciomarine clasts**	**5**
Se	**pro-glacial delta**	**gravel and sand**	**40**
Sf	**glacial**	**sandy till and substratified drift**	**2-10**
Sg	**glacial**	**sandy till and substratified drift**	**0.5-2**
FLa	**lodgment and flow till**	**till with sandy loam matrix, glaciomarine clasts**	
FLb	**pro-glacial outwash and ice-contact**	**gravel and sand, till clasts**	
FLc	**glaciomarine**	**stony clayey silt to silty sand**	**8-100**
FLd	**marine**	**silty clay to fine sand containing marine shells**	**<30**
FLe	**pro-glacial delta**	**gravel and sand**	
Ca	**raised marine beach, sit, bar and lag veneer**	**poorly sorted sand to gravel**	**1-8**
Cb	**raised beach**	**medium to coarse sand**	**1-5**
Cc	**proglacial stream depoits, raised deltaic and channel fill**	**medium sand to cobble gravel**	**15**
Cd	**marine and glaciomarine**	**stony to stoneless silt loam to clay loam, minor sand and silt**	**3-30**
Ce	**marine**	**silt loam to clay loam with minor sand, silt, stony glaciomarine material**	**60**

VC	**glacial drift**	**lodgment till, lenses and interbeds of substratified glaciofluvial sand and gravel**	**8-25**
Va	**glacial**	**lodgment till with sandy loam matrix, (< 10m thick) overlain by gravelly ablation till (< 3m thick)**	**<13**
Vb	**glaciofluvial, outwash, ice contact**	**sandy gravel and gravelly sand, proglacial advance deltaic (<25m) deposits**	**<25**
UPV	**glacial, glaciofluvial and glaciolacustrine**		
PVa	**fluvial channel fill and floodplain deposits**	**cross-bedded sand containing minor silt and gravel lenses**	
PVb	**glacial fluvial deposits, deltaic**	**cross-bedded sand to gravel**	
PVc	**marine**	**interbedded fine sand to clayey silt**	
PVd	**glacial, glaciomarine and glaciolacustrine**	**till**	
PVe	**fluvial, organic colluvial, bog and swamp deposits**	**fluvial, organic colluvial, bog and swamp deposits**	
PVf	**glacial, glacio-fluvial, glaciomarine and glaciolacustine deposits**		
T		**sedimentary bedrock**	
PT		**granitic bedrock**	

Appendix 3 - General Conditions and Limitations

This report incorporates and is subject to these "General Conditions and Limitations".

1.0 USE OF REPORT

This report pertains to a specific area, a specific site, a specific development, and a specific scope of work. It is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site or proposed development would necessitate a supplementary investigation and assessment. This report and the assessments and recommendations contained in it are intended for the sole use of GW SOLUTIONS's client. GW SOLUTIONS does not accept any responsibility for the accuracy of any of the data, the analysis or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than GW SOLUTIONS's client unless otherwise authorized in writing by GW SOLUTIONS. Any unauthorized use of the report is at the sole risk of the user. This report is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of GW SOLUTIONS. Additional copies of the report, if required, may be obtained upon request.

2.0 LIMITATIONS OF REPORT

This report is based solely on the conditions which existed within the study area or on site at the time of GW SOLUTIONS's investigation. The client, and any other parties using this report with the express written consent of the client and GW SOLUTIONS, acknowledge that conditions affecting the environmental assessment of the site can vary with time and that the conclusions and recommendations set out in this report are time sensitive. The client, and any other party using this report with the express written consent of the client and GW SOLUTIONS, also acknowledge that the conclusions and recommendations set out in this report are based on limited observations and testing on the area or subject site and that conditions may vary across the site which, in turn, could affect the conclusions and recommendations made. The client acknowledges that GW SOLUTIONS is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the property, the decisions on which are the sole responsibility of the client.

2.1 INFORMATION PROVIDED TO GW SOLUTIONS BY OTHERS

During the performance of the work and the preparation of this report, GW SOLUTIONS may have relied on information provided by persons other than the client. While GW SOLUTIONS endeavours to verify the accuracy of such information when instructed to do so by the client, GW SOLUTIONS accepts no responsibility for the accuracy or the reliability of such information which may affect the report.

3.0 LIMITATION OF LIABILITY

The client recognizes that property containing contaminants and hazardous wastes creates a high risk of claims brought by third parties arising out of the presence of those materials. In consideration of these risks, and in consideration of GW SOLUTIONS providing the services requested, the client agrees that GW SOLUTIONS's liability to the client, with respect to any issues relating to contaminants or other hazardous wastes located on the subject site shall be limited as follows:
(1) With respect to any claims brought against GW SOLUTIONS by the client arising out of the provision or failure to provide services hereunder shall be limited to the amount of fees paid by the client to GW SOLUTIONS under this Agreement, whether the action is based on breach of contract or tort;
(2) With respect to claims brought by third parties arising out of the presence of contaminants or hazardous wastes on the subject site, the client agrees to indemnify, defend and hold harmless GW SOLUTIONS from and against any and all claim or claims, action or actions, demands, damages, penalties, fines, losses, costs and expenses of every nature and kind whatsoever, including solicitor-client costs, arising or alleged to arise either in whole or

part out of services provided by GW SOLUTIONS, whether the claim be brought against GW SOLUTIONS for breach of contract or tort.

4.0 JOB SITE SAFETY

GW SOLUTIONS is only responsible for the activities of its employees on the job site and is not responsible for the supervision of any other persons whatsoever. The presence of GW SOLUTIONS personnel on site shall not be construed in any way to relieve the client or any other persons on site from their responsibility for job site safety.

5.0 DISCLOSURE OF INFORMATION BY CLIENT

The client agrees to fully cooperate with GW SOLUTIONS with respect to the provision of all available information on the past, present, and proposed conditions on the site, including historical information respecting the use of the site. The client acknowledges that in order for GW SOLUTIONS to properly provide the service, GW SOLUTIONS is relying upon the full disclosure and accuracy of any such information.

6.0 STANDARD OF CARE

Services performed by GW SOLUTIONS for this report have been conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions in the jurisdiction in which the services are provided. Engineering judgement has been applied in developing the conclusions and/or recommendations provided in this report. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of this report.

7.0 EMERGENCY PROCEDURES

The client undertakes to inform GW SOLUTIONS of all hazardous conditions, or possible hazardous conditions which are known to it. The client recognizes that the activities of GW SOLUTIONS may uncover previously unknown hazardous materials or conditions and that such discovery may result in the necessity to undertake emergency procedures to protect GW SOLUTIONS employees, other persons and the environment. These
procedures may involve additional costs outside of any budgets previously agreed upon. The client agrees to pay GW SOLUTIONS for any expenses incurred as a result of such discoveries and to compensate GW SOLUTIONS through payment of additional fees and expenses for time spent by GW SOLUTIONS to deal with the consequences of such discoveries.

8.0 NOTIFICATION OF AUTHORITIES

The client acknowledges that in certain instances the discovery of hazardous substances or conditions and materials may require that regulatory agencies and other persons be informed and the client agrees that notification to such bodies or persons as required may be done by GW SOLUTIONS in its reasonably exercised discretion.

9.0 OWNERSHIP OF INSTRUMENTS OF SERVICE

The client acknowledges that all reports, plans, and data generated by GW SOLUTIONS during the performance of the work and other documents prepared by GW SOLUTIONS are considered its professional work product and shall remain the copyright property of GW SOLUTIONS.

10.0 ALTERNATE REPORT FORMAT

Where GW SOLUTIONS submits both electronic file and hard copy versions of reports, drawings and other project-related documents and deliverables (collectively termed GW SOLUTIONS's instruments of professional service), the Client agrees that only the signed and sealed hard copy versions shall be considered final and legally binding. The hard copy versions submitted by GW SOLUTIONS shall be the original documents for record and working purposes, and, in the event of a dispute or discrepancies, the hard copy versions shall govern over the electronic versions. Furthermore, the Client agrees and waives all future right of dispute that the original hard copy signed version archived by GW SOLUTIONS shall be deemed to be the overall original for the Project. The Client agrees that both electronic file and

hard copy versions of GW SOLUTIONS's instruments of professional service shall not, under any circumstances, no matter who owns or uses them, be altered by any party except GW SOLUTIONS. The Client warrants that GW SOLUTIONS's instruments of professional service will be used only and exactly as submitted by GW SOLUTIONS. The Client recognizes and agrees that electronic files submitted by GW SOLUTIONS have been prepared and submitted using specific software and hardware systems. GW SOLUTIONS makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.

Appendix C: Baseline Drainage Modeling of South Alouette and Kanaka Creek Watershed

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Technical Memorandum

Drainage Modeling of South Alouette River and Kanaka Creek Watersheds (Stage 2)

project:	South Alouette River and Kanaka Creek ISMP
project ID:	2015-016-MAP
date:	July 26, 2017
issued to:	City of Maple Ridge, BC (Maple Ridge) and Urban Systems Ltd. (USL)
issued by:	GeoAdvice Engineering Inc. (GeoAdvice)

1. Introduction

The City of Maple Ridge, BC retained Urban Systems Ltd. (USL) to develop the South Alouette and Kanaka Integrated Stormwater Management Plan (ISMP). GeoAdvice Engineering Inc. (GeoAdvice) partnered with USL as the modeling sub-consultant for this project.

Stage 1 of the project analyzed the existing baseline conditions, while Stage 2 analyzed the future baseline management approach conditions. The Stage 2 modeling assumptions and results are summarized in this technical memorandum (TM) and outlines the capacity analysis of the future conditions and the potential impacts of climate change.

The model development, calibration and the existing baseline condition assessment are summarized in the GeoAdvice TM *Drainage Modeling of South Alouette River and Kanaka Creek Watersheds*, March 14, 2017.

The future condition model was developed according to the parameters summarized in the USL Memo #11.[1]

[1] Urban Systems Ltd. *Memo #11 – Model Parameters Associated with Future Conditions – Final REVISION 2*. May 11, 2017

2. Future Condition Modeling

To assess the impact of areas that are anticipated to undergo land use changes and/or more intensive development on the drainage system, recent and future development areas, as well as future infill development areas were provided to create the future modeling scenario.

Tier A, B, and C controls are applied for each type of land use as summarized in the *Future Conditions Modeling Parameters (REV 2)* table found in the USL Memo #11. This table and the supporting figures included in the USL Memo #11 are also included in Error! Reference source not found. for reference.

2.1. Scenarios

As outlined in USL Memo #11, two future scenarios were proposed for consideration.

Scenario 1 – Baseline Management Approach

In this scenario, the stormwater management controls currently enforced by the City were applied to areas that are anticipated to undergo land use changes. Status quo or current conditions were applied to historical development that is not anticipated to undergo significant changes in land use in the foreseeable future.

Scenario 2 – Enhanced Management Approach

As necessary, subject to the outcomes of Scenario 1, we will identify if additional stormwater management controls are necessary that are not currently required by regulation to areas that are anticipated to undergo land use changes and/or more extensive development.

2.1. Recent and Future Developments

The existing baseline model was developed using orthophotos that were taken in 2011. As a result, it was necessary to account for land use changes and newly constructed controls from development activity that have occurred between 2011 and 2016. GIS polygons showing recently developed areas constructed between 2011 and 2016 and polygons portraying those areas that have potential for future development densification were provided by the City. As agreed with the City and for purposes of the baseline model, recent development areas were defined as equivalent to future development areas, in that the Tier A, B, and C control requirements were applied in a similar manner. Actual constructed stormwater management controls from the recent developments were not modeled. In addition, the modeled total impervious percentage areas that were assigned to recently developed areas were determined

from development plans, whereas the future development total impervious percentages were applied based on the City design criteria manual[2].

Error! Reference source not found. contains tables summarizing the key hydrologic parameters and the OCP land use distributions for the recent and future development areas.

2.2. Infill Development

The City identified infill areas and assumed infill rates ranging between 5% and 20%. GIS polygons showing the infill development areas were provided. Stormwater management controls described in the following section were scaled to the assigned infill rate and then applied to these areas.

As summarized in USL Memo #11, Tier B controls were applied to infill development areas with Rural/Suburban, Low Density, and Medium Density OCP land use coverages. While, Tier A, B and C controls were applied to infill development areas with High Density, Institutional and Industrial/Commercial OCP land use coverages.

2.3. Stormwater Management Controls

The Tier controls were implemented in the model using a combination of depression storages, LID controls, and storage nodes.

Tier A

Tier A controls, applicable to developments with High Density, Institutional, and Industrial OCP land uses, were applied in the model using the depression storage parameter. Depression storage values for impervious surfaces were adjusted until the post-development MAR rainfall was retained such that the resultant runoff was equivalent to half the "forested/woodlot" MAR flow volume. Tier A controls were applied to infill development in a similar manner, except that they were scaled to the infill rate percentage.

Tier A controls are not specifically enforced on Low and Medium Density developments. The sumps (with solid bottoms) currently required by the City, along with roof leaders that are directly connected to these sumps, do not offer a retention function. For rural development, rock pits are required. Within the scope of this model, rock pits are not specifically modeled, rather the impervious surface is directed to a pervious surface.

[2] The City of Maple Ridge Design Criteria Manual (Part 1 in the Design and Construction Documents) dated October 2015.

Tier B

Tier B controls are applicable to all recent development and future development, including infill development. To model Tier B controls, Low Impact Development (LID) controls were assigned at the subcatchment layer, such that the post-development MAR flows were detained and released at the "forested/woodlot" MAR flow.

LID controls are built-in functions within the InfoSWMM modeling software and are integrated in the subcatchment layer. They are designed to capture surface runoff and allow controls to define a combination of detention, infiltration, and evapotranspiration functions. The software can model up to eight different generic types of LID controls; bio-retention cells, rain gardens, green roofs, infiltration trenches, continuous permeable pavement, rain barrels, rooftop disconnection, and vegetative swales.

For the purposes of detaining flow and releasing at a prescribed flow rate, the rain barrel LID function was used as it incorporates a storage layer to define a storage volume and an underdrain layer to define the release flow rate. To determine the required release rate for the Tier B control, it was necessary to simulate flows from the "forested/woodlot" MAR scenario where the total impervious percentage for the recent and future development areas are assumed to be 5%. The storage requirements for the LIDs were then determined by simulating the post-development MAR scenario and sizing the storage such that they do not overflow.

Tier C

Tier C controls are applicable to all recent development and future development areas. Tier C controls require the detention of the 10-year post-development flow to be released at the 2-year "forested/woodlot" flow rate. To simulate these controls, a storage unit with release and overflow conduits were defined for each recent development and future development area subcatchment.

As it was not possible to model separate storage units for each subcatchment within the infill areas as there is no information available that defines the specific location of the controls, LID controls were used to define Tier C controls. It was agreed with the City to have the Tier C controls for infill development areas detain the 10-year post-development flow and released at the 2-year pre-development (existing condition) flow rate.

2.4. Design Storm Events

To assess the system under future conditions with the baseline management approach, several design storm events were simulated, including single storm events, single storm events with consideration of climate change, and extended period rainfall for continuous simulations.

Single Storm Events

Design storm hyetographs were supplied by the City for the four rain gauges associated with the study area, including design events for the ARDSA criteria. **Table 2.1** summarizes each of the design storms simulated and their purpose.

Table 2.1: Simulated Design Storm Events

Design Storm	Purpose
Mean Annual Rainfall (MAR)*	To define Tier A and Tier B controls for future development and infill development
2-Year, All Durations (30-min, 1-hr, 2-hr, 6-hr, 12-hr, and 24-hr)	To define Tier C controls for future development and infill development
10-Year, All Durations (30-min, 1-hr, 2-hr, 6-hr, 12-hr, and 24-hr)	To assess the minor system conveyance capacity
100-Year, All Durations (30-min, 1-hr, 2-hr, 6-hr, 12-hr, and 24-hr)	To assess the major system conveyance capacity
ARDSA 10-Year 2-Day (Summer)	To conduct preliminary assessment of the creek system against the ARDSA criteria
ARDSA 10-Year 5-Day (Winter)	To conduct preliminary assessment of the creek system against the ARDSA criteria

* As agreed with the City, the MAR design storm is defined by 80 mm of total rainfall depth over 24 hours.

Table 2.2 summarizes the total rainfall depth for each simulated 2-Year, 10-Year, and 100-Year design storm duration.

Table 2.2: 2-Year, 10-Year, and 100-Year Design Storm Events

Rain Gauge	Return Period	Total Rainfall (mm)					
		30-min	1-hr	2-hr	6-hr	12-hr	24-hr
Katzie Pump Station (DM44)	2-Year	9.8	14.5	20.3	38.6	56.4	76.2
	10-Year	17.2	26.9	32.0	56.4	93.6	132.9
	100-Year	26.3	42.3	46.7	78.6	140.1	203.7
Maple Ridge Reservoir (DM45)	2-Year	9.1	12.9	18.8	37.0	54.0	75.9
	10-Year	17.1	25.2	31.4	50.2	83.2	118.7
	100-Year	27.2	40.6	47.2	66.8	119.6	172.1
Golden Ears Elementary School (DM62)	2-Year	9.8	14.5	20.3	38.6	56.4	76.2
	10-Year	17.2	26.9	32.0	56.4	93.6	132.9
	100-Year	26.3	42.3	46.7	78.6	140.1	203.7
Haney UBC Research Forest	2-Year	9.4	12.7	19.4	38.4	57.6	86.4
	10-Year	15.2	19.0	25.4	49.2	78.0	122.4
	100-Year	22.5	26.8	32.8	62.4	104.4	168.0

Table 2.3 summarizes the total rainfall depth for each simulated ARDSA design storm event.

Table 2.3: ARDSA Design Storm Events

Design Storm Event	Total Rainfall (mm)
ARDSA – 10yr 2day	84.0
ARDSA – 10yr 5day	193.1

As a conservative approach, all design storms were simulated under winter conditions when soils are assumed to be saturated.

Lastly, a multiplication factor of 1.4 was applied to the precipitation data in areas above the 150 m contour line, as to be consistent with the Design Criteria Manual.

The design storm hyetographs are provided in **Appendix B** for reference.

Climate Change

As agreed with the City, the MAR, 10-year, and 100-year design storms were scaled up by 10% and then again by 20% to assess potential impacts of two climate change assumptions.

Continuous Simulation

Precipitation data recorded during the model calibration simulation period of November 21, 2014 to February 21, 2015 was used to compare the flow regime between the existing and future conditions. This was then used to evaluate potential erosion risks.

2.5. Performance Assessment Criteria

The drainage system is assessed using the same design criteria presented in the Stage 1 modeling technical memorandum. The criteria are reiterated below.

Since specific water depth/pipe Diameter (d/D) or peak flow rate/full pipe flow (q/Q) criteria are not provided in the City design criteria manual, simulation results for existing culverts, pipes and creeks were analyzed for their hydraulic performance as measured against criteria commonly used in the Industry.

From commonly accepted hydraulic criteria, model results were queried for peak flow and maximum water surface conditions and the report mapping shows locations where:

- [q/Q] is less than 1.05 and [d/D] > 1.0 for less than 15 minutes, the pipe is shown GREEN. Creeks under this hydraulic condition are shown BLUE.

- [q/Q] is less than 1.05 and [d/D] > 1.0 for and lasts longer than 15 minutes, the pipe is shown ORANGE.
- [q/Q] is more than 1.05 and [d/D] > 1.0 for and lasts longer than 15 minutes, the pipe is shown RED, the node is surcharging.

Nodes where the maximum hydraulic grade line (HGL) has reached ground elevation and is flooding, the node is shown RED. Note that the "ponding" setting is enabled in the model so that flooded nodes are allowed to pond at the ground surface, allowing the stored water to be later discharged back into the system when capacity becomes available.

2.6. Global Assumptions

The following assumptions were applied to the future condition models:

- Soil parameters defined in the Stage 1 baseline assessment were reapplied in the future condition models.
- Groundwater parameters defined in the Stage 1 baseline assessment were reapplied in the future condition models.
- An impervious percentage of 5% was used to represent the "Woodlot/Forested" conditions.
- Tier A, B, and C controls were configured based on the future baseline condition scenarios. These controls were not adjusted under the climate change scenarios.

3. Existing Condition Capacity Analysis

The existing baseline condition assessment completed in Stage 1 considered the 24-hour duration storm. Although the 24-hour duration is typically the critical duration for the network modeled, it was necessary to consider the suite of durations (30-min, 1-hr, 2-hr, 6-hr, 12-hr, and 24-hr) to ensure that we capture the critical, or peak flow condition for all creeks, culverts, and storm mains. In addition, since the Stage 1 report was prepared, the overall watershed boundary was adjusted in a few locations. As such, the existing baseline condition was reassessed.

Design storms were simulated to assess the hydraulic capacity of the existing system of creeks, culverts and storm mains. The assessment was completed by simulating the design storms summarized in **Section 2.4** and applying the design criteria summarized in **Section 2.5**.

The map figures in **Appendix C** show potential areas of concern. **Appendix F** contains tables summarizing the capacity analysis.

4. Future Condition Capacity Analysis

Design storms were simulated to assess the hydraulic capacity of the existing conveyance system of creeks, culverts and storm mains under future OCP land use conditions. The assessment was completed by simulating the design storms summarized in **Section 2.4** and applying the design criteria summarized in **Section 2.5**.

Note that with any model modification such as changes in subcatchment boundaries, land use conditions, and hydraulic controls, computational "noise" will result. This may be due to a change in the timing of the peak flows or change in the groundwater flow as more or less water is infiltrated and flows through the groundwater layer. To dampen this "noise", the comparative results are presented for a change in flow of 5% or greater. Changes below 5% are considered insignificant and below the margin of error.

The map figures in **Appendix D** show the change in performance within the existing conveyance system. **Appendix F** contains tables summarizing the comparison of the capacity analysis.

Overall system performance did not significantly change for future conditions as compared to performance of the system under existing conditions.

5. Future Condition with Climate Change Capacity Analysis

As described in **Section 2.1**, existing design storms were scaled up by 10% and again by 20% to simulate two different assumptions made regarding an increase in rainfall volume and intensity due to climate change. As agreed with the City, the MAR, 10-Year, and 100-Year design storms were reassessed.

Design storms were simulated to assess the hydraulic capacity of the existing conveyance system of creeks, culverts and storm mains under future OCP land use conditions, with climate change. The assessment was completed by simulating the design storms summarized in **Section 2.4** and applying the design criteria summarized in **Section 2.5**.

The map figures in **Appendix E** show the change in performance within the existing conveyance system. **Appendix F** contains tables summarizing the comparison of the capacity analysis.

Overall future condition system performance worsened under the influence of both climate change assumptions, as compared to the future baseline condition.

6. Simulated Peak Flow Results

Five creek locations were selected with watersheds of various sizes and with various changes to development. These sites were selected as representative samples of how system performance is expected to change at a macro scale, and to specifically assess the relative change in erosion potential within the creek system.

Table 6.1 summarizes the upstream catchment characteristics of each creek location.

Table 6.1: Upstream Catchment Characteristics

Creek Location	Area (ha)	Anticipated Greenfield Development Area Above Existing Baseline Condition (ha)	Infill Redevelopment Area (ha)	Future Development Land Use Distribution	Existing TIMP[2]	Future TIMP[2]
Millionaire Creek @ Fern Cres (CR46077)	452	57	-	12% - Low Density Res. 80% - Medium Density Res. 1% - High Density Res. 6% - Institutional	6%	14%
McFadden Creek @ 264 St. (CR46556)	467	126	-	100% Suburban	8%	13%
T2 Creek @ 126 Ave (CR47667)	117	-	116 (20% of this area is predicted to redevelop)	60% - Low Density Res. 17% - Medium Density Res. 2% - High Density Res. 6% - Institutional 7% - Industrial *Note 1*	45%	55%
Dunlop Creek Discharge to Kanaka Creek (CR47210)	277	41	-	3% - Suburban 87% - Low Density Res. 10% - Institutional	21%	27%
Kanaka Creek @ the d/s of Dunlop Tributary (CR48546)	4,960	469	-	76% - Suburban 19% - Low Density Res. 2% - Institutional 3% - Industrial	11%	14%

Note 1: Percentages based on the total area
Note 2: TIMP = Total Impervious Area

As a comparison to assess the relative change in peak flow rates between existing and future conditions including climate change, simulated design storm unit peak flow rates were compared at the five creek locations.

Table 6.2 summarizes the unit peak flow rate comparison at the five creek locations within the watershed. As mentioned in **Section 4**, comparative changes of less than 5% are not identified.

Table 6.2: Unit Peak Flow Rate Comparison

Creek Location	Existing Peak Runoff Flow Rate (L/s/ha)		
	MAR, 24-Hour	10-year Critical Duration	100-year Critical Duration
Millionaire Creek @ Fern Cres (CR46077)	5.01	12.31	26.18
McFadden Creek @ 264 St. (CR46556)	12.75	24.05	38.56
T2 Creek @ 126 Ave (CR47667)	19.64	39.14	56.06
Dunlop Creek Discharge to Kanaka Creek (CR47210)	8.40	18.38	28.78
Kanaka Creek @ the d/s of Dunlop Tributary (CR48546)	6.42	12.85	18.11
Creek Location	**Future Peak Runoff Flow Rate (L/s/ha)**		
	MAR, 24-Hour	**10-year Critical Duration**	**100-year Critical Duration**
Millionaire Creek @ Fern Cres (CR46077)	4.99	11.69	26.72
McFadden Creek @ 264 St. (CR46556)	12.24	20.72	35.60
T2 Creek @ 126 Ave (CR47667)	18.67	38.96	56.32
Dunlop Creek Discharge to Kanaka Creek (CR47210)	8.64	17.45	25.86
Kanaka Creek @ the d/s of Dunlop Tributary (CR48546)	6.61	12.70	18.19
Creek Location	**Future with 10% Climate Change Peak Runoff Flow Rate (L/s/ha)**		
	MAR, 24-Hour	**10-year Critical Duration**	**100-year Critical Duration**
Millionaire Creek @ Fern Cres (CR46077)	5.67	14.62	33.78
McFadden Creek @ 264 St. (CR46556)	13.27	23.32	41.10
T2 Creek @ 126 Ave (CR47667)	22.42	44.14	59.56
Dunlop Creek Discharge to Kanaka Creek (CR47210)	10.49	19.38	27.37
Kanaka Creek @ the d/s of Dunlop Tributary (CR48546)	7.98	13.91	19.67
Creek Location	**Future with 20% Climate Change Peak Runoff Flow Rate (L/s/ha)**		
	MAR, 24-Hour	**10-year Critical Duration**	**100-year Critical Duration**
Millionaire Creek @ Fern Cres (CR46077)	6.65	17.85	40.01
McFadden Creek @ 264 St. (CR46556)	15.19	26.32	46.48
T2 Creek @ 126 Ave (CR47667)	25.49	47.87	60.94
Dunlop Creek Discharge to Kanaka Creek (CR47210)	12.53	21.10	27.89
Kanaka Creek @ the d/s of Dunlop Tributary (CR48546)	9.34	15.24	20.98

Notes:
Results presented under the 10-year and 100-year return periods represent the worst case from all storm durations assessed (30-min, 1-hr, 2-hr, 6-hr, 12-hr, and 24-hr).
Comparative changes of less than 5% are insignificant and below the margin of error. See note in **Section 4**.

7. MAR Volume

To compare the relative change in the MAR flow volume between existing and future conditions, including climate change, simulated flow volumes were assessed at the five creek locations identified in **Section 6** and shown in the following table.

Table 7.1 summarizes the MAR flow volume comparison at each creek location.

Table 7.1: MAR Flow Volume Comparison

Creek Location	MAR Flow Volume (m^3)			
	Existing Baseline	Future Baseline	Future Climate Change (10% Increase)	Future Climate Change (20% Increase)
Millionaire Creek @ Fern Cres (CR46077)	425.4	423.7 (-1%)	463.0 (+9%)	503.5 (+18%)
McFadden Creek @ 264 St. (CR46556)	1,118.1	1,072.9 (-4%)	1,146.1 (+3%)	1,215.7 (+9%)
T2 Creek @ 126 Ave (CR47667)	80.7	82.3 (+2%)	89.1 (+10%)	97.9 (+21%)
Dunlop Creek Discharge to Kanaka Creek (CR47210)	223.6	234.7 (+5%)	257.3 (+15%)	280.6 (+26%)
Kanaka Creek @ the d/s of Dunlop Tributary (CR48546)	4,855.3	4,807.3 (-1%)	5,274.3 (+9%)	5,747.7 (+18%)
Notes: Comparative changes of less than 5% are insignificant and below the margin of error. See note in **Section 4**.				

The flow at McFadden Creek demonstrated the highest reduction in flow volume and the least impact from climate change. Approximately 27% of the catchment is anticipated to be developed to suburban residential. This land use type has the least impervious surface and runoff is entirely directed to pervious surfaces.

8. Continuous Simulation

As a comparison to assess relative changes between existing and future conditions, continuous simulation runs using rainfall data recorded between November 21, 2014 and February 21, 2015 were simulated. This rainfall period is consistent with the period used for the model calibration. Model results were compared at the five creek locations identified in **Section 6**.

Appendix G includes graphs comparing the existing and future continuous simulation flow hydrographs.

Based on this comparison, it appears that the flow management controls implemented at future developments are offsetting potential increases in flow. In general, model results indicate that future flows are predicted to be relatively consistent with the existing flows with respect to peak flow rates and flow volume.

9. Conclusion

Model results indicate that the recent development, future development, and infill development do not have a significant impact on the overall system performance, provided that the stormwater flow management controls required by regulation are applied and future rainfall volume and intensity do not change.

Where climate change was considered by increasing rainfall by 10% and 20%, system capacity performance noticeably worsened. While these increases in precipitation due to climate change are being assumed at the time of this writing, it is recommended that stormwater flow management controls for future developments be designed in consideration of climate change to offset likely impacts from increased rainfall volume and intensity.

In addition, the changes between the future and existing baseline scenarios seem to occur in the smaller portions of the system and at the top end of the system. This is thought to occur as a result of how runoff is loaded into the truncated model from large subcatchments allocated to a single junction. Under natural conditions, stormwater enters the system at many different locations, rather than the single loading point provided in the truncated model. Performance changes of the larger systems are more apparent when climate change is factored in.

Submission

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July 26, 2017

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Senior Modeling Review

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Appendix A Recent Development and Future Development Hydrologic Parameters

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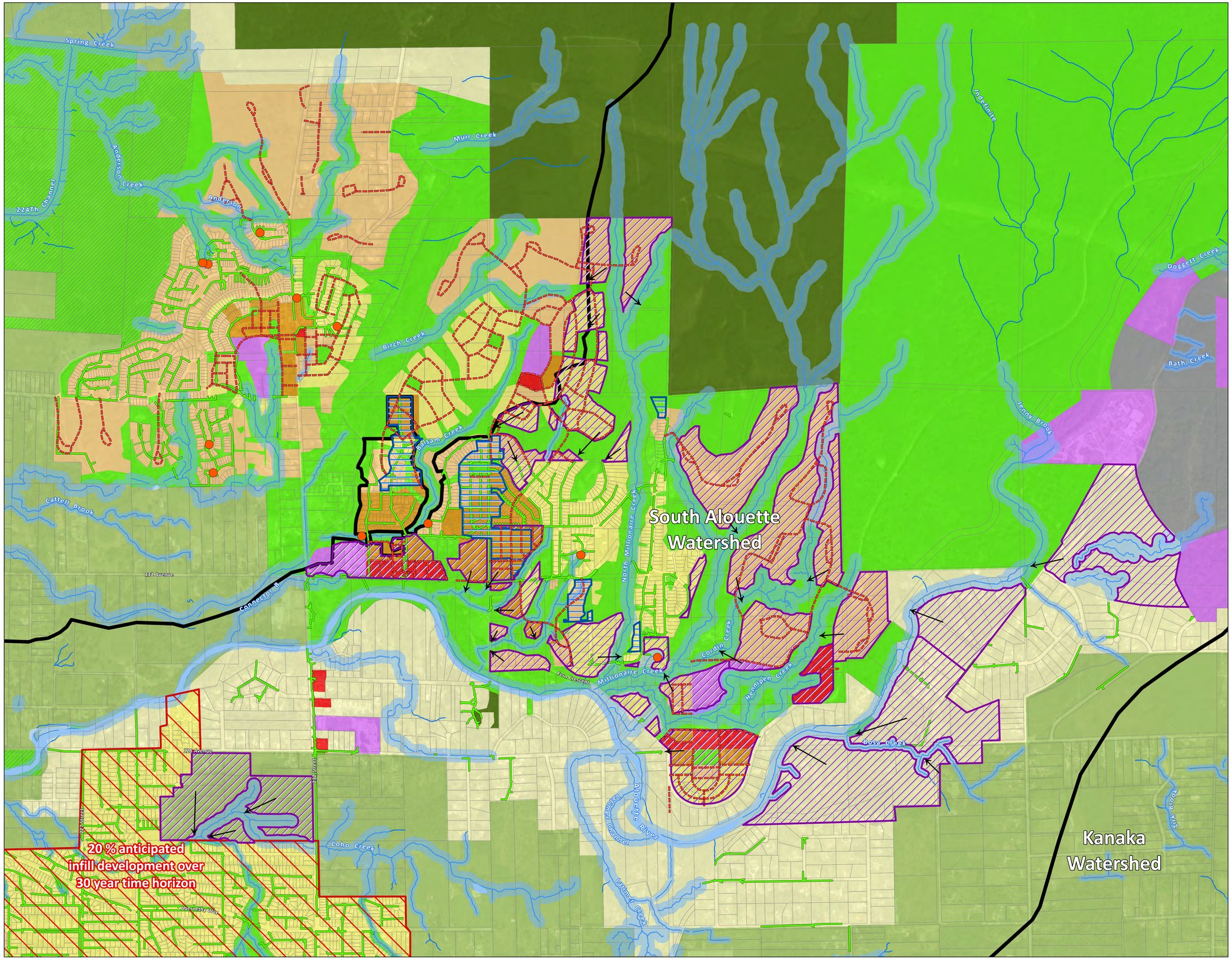
FUTURE CONDITIONS MODELING PARAMETERS (REV 2)

	Rural/Suburban						Low Density means SF						Medium Density (SF lots in most cases)						High Density (multi family)					INSTITUTIONAL					INDUSTRIAL AND COMMERCIAL				
	TIMP	*Routed to Pervious*	*Tier A controls*	*Tier B controls*	*Tier C Control*	*Assumed infill rate to gross area (%)*	*TIMP*	*Routed to Pervious*	*Tier A controls*	*Tier B controls*	*Tier C Control*	*Assumed infill rate to gross area (%)*	*TIMP*	*Routed to Pervious*	*Tier A controls*	*Tier B controls*	*Tier C Control*	*Assumed infill rate to gross area (%)*	*TIMP*	*Tier A control*	*Tier B Control*	*Tier C Control*	*Assumed infill rate to gross area (%)*	*TIMP*	*Tier A control*	*Tier B Control*	*Tier C Control*	*Assumed infill rate to gross area (%)*	*TIMP*	*Tier A control*	*Tier B Control*	*Tier C Control*	*Assumed infill rate to gross area (%)*
Recent Development (since 2015)	0.2	0.2	routed to rock pit. To represent this, simply route imp to pervious	storage to reduce MAR to "forest" condition MAR level	engineered detention 10 post to 2 woodlot	n/a	0.5	0.1	none enforced. Current sump and orifice do not provide retention	storage to reduce MAR to "forest" condition MAR level	engineered detention 10 post to 2 woodlot	n/a	0.7	0.1	none enforced. Current sump and orifice do not provide retention	storage to reduce MAR to "forest" condition MAR level	engineered detention 10 post to 2 woodlot	n/a	0.8	Adjust depression storage value to demonstrate retention of 50% MAR	storage to reduce MAR to "forest" condition MAR level	engineered detention 10 post to 2 woodlot	n/a	0.81	Adjust depression storage value to demonstrate retention of 50% MAR	storage to reduce MAR to "forest" condition MAR level	engineered detention 10 post to 2 woodlot	n/a	0.9	Adjust depression storage value to demonstrate retention of 50% MAR	storage to reduce MAR to "forest" condition MAR level	engineered detention 10 post to 2 woodlot	n/a
Future Development (subdivision)	0.2	0.2	routed to rock pit. To represent this, simply route imp to pervious	storage to reduce MAR to "forest" condition MAR level	engineered detention 10 post to 2 woodlot	n/a	0.5	0.1	none enforced. Current sump and orifice do not provide retention	storage to reduce MAR to "forest" condition MAR level	engineered detention 10 post to 2 woodlot	n/a	0.7	0.1	none enforced. Current sump and orifice do not provide retention	storage to reduce MAR to "forest" condition MAR level	engineered detention 10 post to 2 woodlot	n/a	0.8	Adjust depression storage value to demonstrate retention of 50% MAR	storage to reduce MAR to "forest" condition MAR level	engineered detention 10 post to 2 woodlot	n/a	0.81	Adjust depression storage value to demonstrate retention of 50% MAR	storage to reduce MAR to "forest" condition MAR level	engineered detention 10 post to 2 woodlot	n/a	0.9	Adjust depression storage value to demonstrate retention of 50% MAR	storage to reduce MAR to "forest" condition MAR level	engineered detention 10 post to 2 woodlot	n/a
Infill	0.2	0.2	routed to rock pit. To represent this, simply route imp to pervious	storage to reduce MAR to "forest" condition MAR level	n/a	5%	0.5	0.1	none enforced. Current sump and orifice do not provide retention	storage to reduce MAR to "forest" condition MAR level	n/a	20%	0.7	0.1	none enforced. Current sump and orifice do not provide retention	storage to reduce MAR to "forest" condition MAR level	n/a	20%	0.8	Adjust depression storage value to demonstrate retention of 50% MAR	storage to reduce MAR to "forest" condition MAR level	engineered detention 10 post to 2 pre (Stage 1 condition)	20%	0.81	Adjust depression storage value to demonstrate retention of 50% MAR	storage to reduce MAR to "forest" condition MAR level	engineered detention 10 post to 2 pre (Stage 1 condition)	20%	0.9	Adjust depression storage value to demonstrate retention of 50% MAR	storage to reduce MAR to "forest" condition MAR level	engineered detention 10 post to 2 pre (Stage 1 condition)	20%
Notes							Typically 700 m2 lot, roadway represents 20% of catchment						Tyically 600 m2 lot, roadway represents 20% of catchment						Roadway represents 20% of catchment.					Roadway represents 10% of catchment.					Roadway represents 10% of catchment.				
	Despite a rock pit being applied, they can not be modelled in the ISMP scope. It will be assumed simply that the impervious surface is routed to pervious.						Lot TIMP is 0.40. Roadway TIMP is 0.90. Lot / road area is 80 /20.						Lot TIMP is 0.65. Roadway TIMP is 0.90. Lot / road area is 80 /20.						Lot TIMP is 0.78. Roadway TIMP is 0.90. Lot / road area is 80 /20.					Lot TIMP is 0.80. Roadway TIMP is 0.90. Lot / road area is 90 /10.					Lot TIMP is 0.90. Roadway TIMP is 0.90. Lot / road area is 90 /10.				

NOTE:
1. For High Density and ICI, the City does require the developer to demonstrate they are meeting the 50% MAR retention, but don't prescribe how. For this model, depression storage will be adjusted to demonstrate this. The depression storage value for both impervious and pervious can be adjusted. First routing imp to pervious is not necessary.
2. The term "forest" and "woodlot" is used interchangably, and has the same meaning.
3. The City current criteria requires that for Tier B, MAR flows be reduced to "1:2 year forested" levels. 1:2 year is currently used in the criteria document as an approximation of MAR, however we recently agreed with the City to use 80 mm for MAR. As such, we intend to compute Tier B such that post MAR is reduced to forested MAR.



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MAPLE RIDGE
British Columbia

South Alouette and Kanaka Integrated Storm Water Management Plans

South Alouette Watershed -

Future Land Use Servicing Schematic

- Assumed Future Roadway
- Presumed Drainage Outfall
- Recent Development (2011 - 2016)
- Future Development Densification
- Future Infill Development
- Natural Watershed Boundary

Official Community Plan

- Agriculture
- Forest
- Commercial
- High Density Residential
- Medium Density Residential
- Low Density Residential
- Rural Residential / Suburban Residential
- Industrial
- Parks & Open Space
- Parks within the ALR
- Civic & Institutional
- Creeks
- Drainage Pipes
- Detention Ponds
- Parcel
- Municipal Boundary
- Existing Creek Setbacks

The accuracy & completeness of information shown on this drawing is not guaranteed. It will be the responsibility of the user of the information shown on this drawing to locate & establish the precise location of all existing information whether shown or not.

200 100 0 200 400
m

N

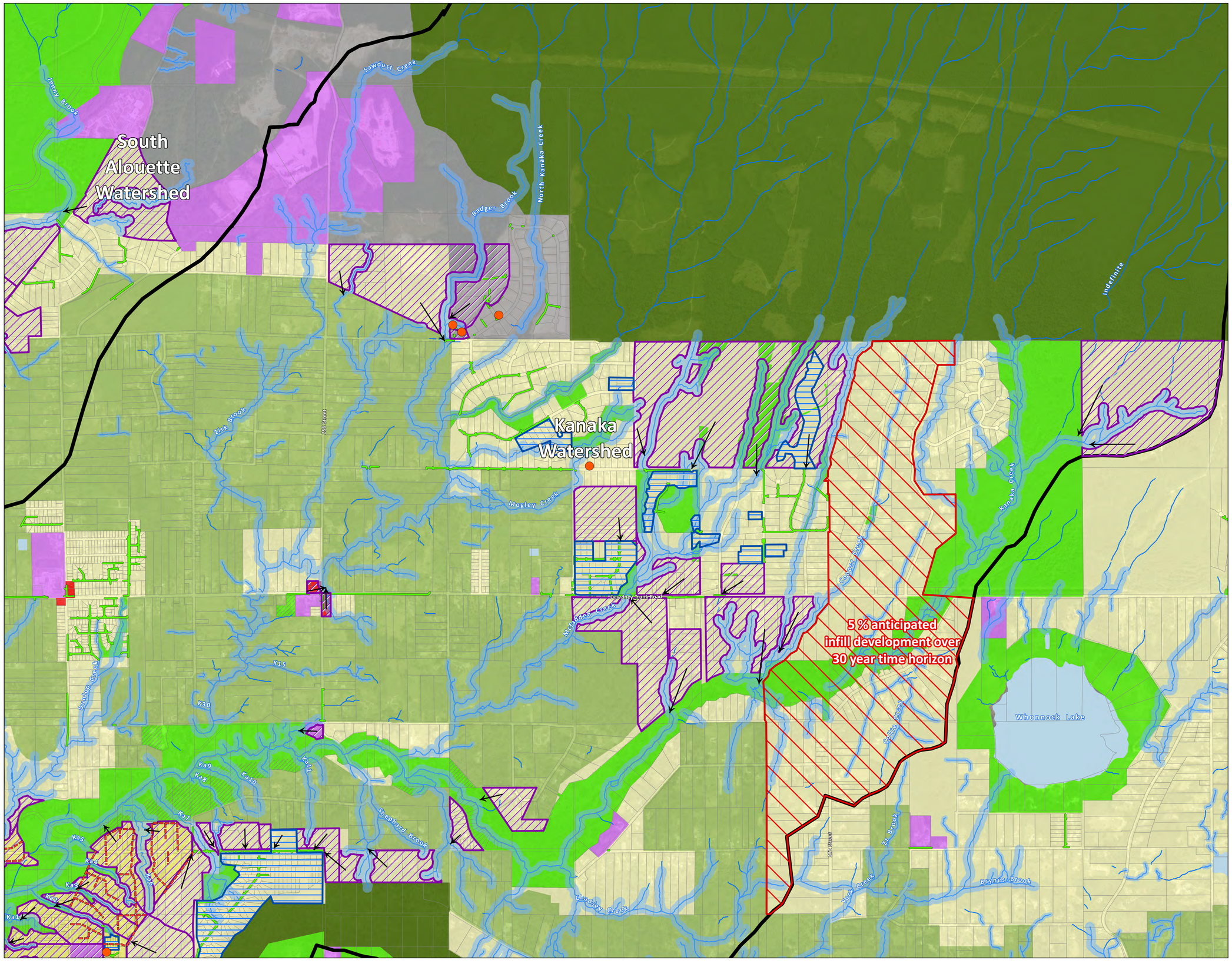
Coordinate System:
NAD 1983 UTM Zone 10N

Data Sources:
City of Maple Ridge
City of Pitt Meadows
BC MoE
NR Canada

Project #:	1279.0025.01
Author:	BG
Checked:	GS
Status:	FINAL
Revision:	N
Date:	2017 / 5 / 10

URBAN systems

FIGURE A



South Alouette and Kanaka Integrated Storm Water Management Plans

Kanaka Creek Watershed -

Future Land Use Servicing Schematic

- Assumed Future Roadway
- Presumed Drainage Outfall
- Recent Development (2011 - 2016)
- Future Development Densification
- Future Infill Development
- Natural Watershed Boundary

Official Community Plan

- Agriculture
- Forest
- Commercial
- Low Density Residential
- Rural Residential / Suburban Residential
- Industrial
- Parks & Open Space
- Parks within the ALR
- Civic & Institutional
- Creeks
- Drainage Pipes
- Detention Ponds
- Parcel
- Municipal Boundary
- Existing Creek Setbacks

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200 100 0 200 400
m

N

Coordinate System:
NAD 1983 UTM Zone 10N

Data Sources:
City of Maple Ridge
City of Pitt Meadows
BC MoE
NR Canada

Project #:	1279.0025.01
Author:	BG
Checked:	GS
Status:	FINAL
Revision:	N
Date:	2017 / 5 / 10

URBAN systems

FIGURE B.1

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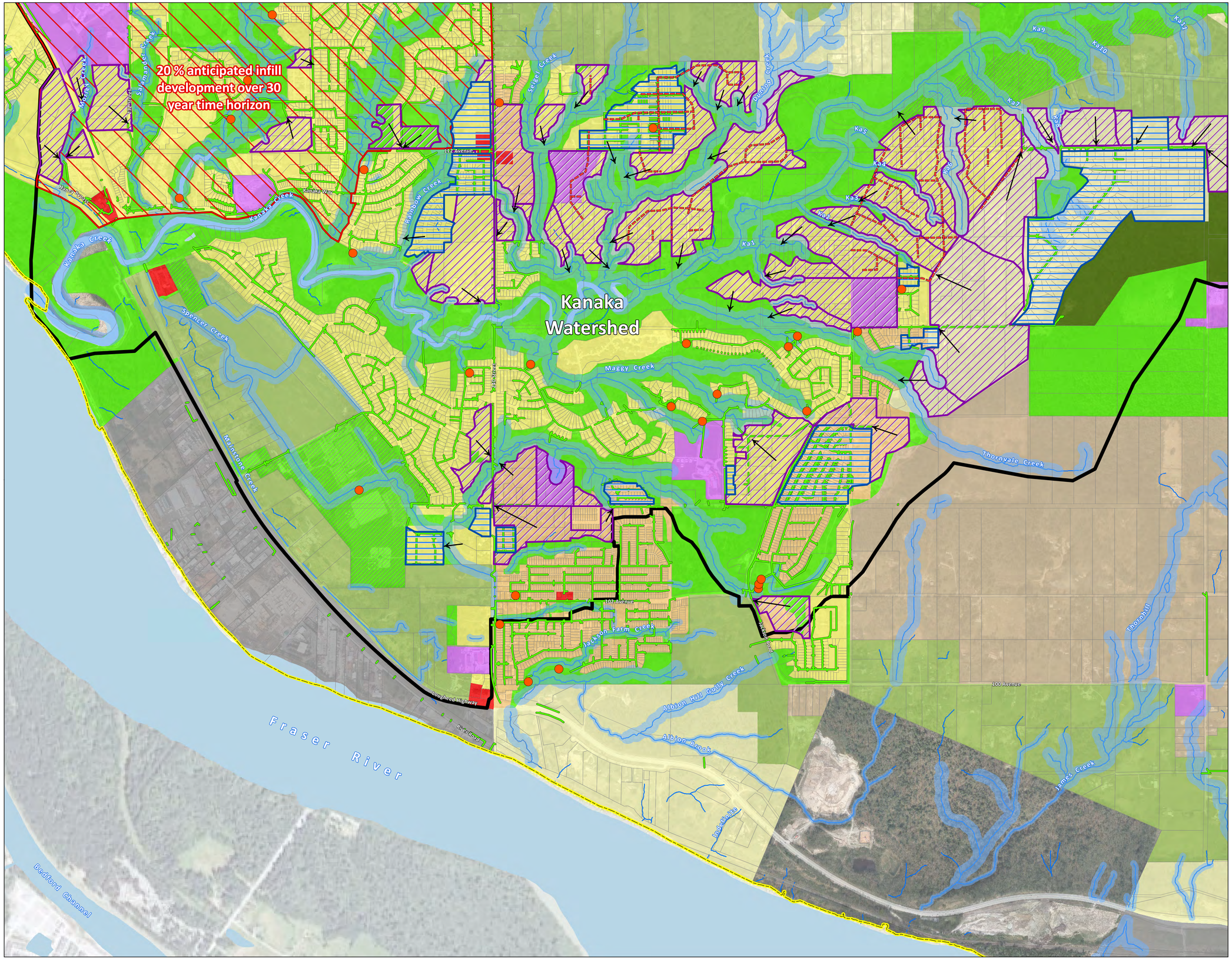

MAPLE RIDGE
British Columbia

South Alouette and Kanaka Integrated Storm Water Management Plans

Kanaka Creek Watershed -

Future Land Use Servicing Schematic

- Municipal_Boundary_Mask
- Assumed Future Roadway
- Presumed Drainage Outfall
- Recent Development (2011 - 2016)
- Future Development Densification
- Future Infill Development
- Natural Watershed Boundary

Official Community Plan

- Urban Reserve
- Agriculture
- Forest
- Commercial
- Medium Density Residential
- Low Density Residential
- Rural Residential / Suburban Residential
- Industrial
- Parks & Open Space
- Parks within the ALR
- Civic & Institutional
- Creeks
- Drainage Pipes
- Detention Ponds
- Parcel
- Municipal Boundary
- Existing Creek Setbacks

The accuracy & completeness of information shown on this drawing is not guaranteed. It will be the responsibility of the user of the information shown on this drawing to locate & establish the precise location of all existing information whether shown or not.

200 100 0 200 400
m

N

Coordinate System:
NAD 1983 UTM Zone 10N

Data Sources:
City of Maple Ridge
City of Pitt Meadows
BC MoE
NR Canada

Project #:	1279.0025.01
Author:	BG
Checked:	GS
Status:	FINAL
Revision:	N
Date:	2017 / 5 / 10

URBAN systems

FIGURE B.2

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MAPLE RIDGE
British Columbia

South Alouette and Kanaka Integrated Storm Water Management Plans

Future Land Use Servicing Schematic

South Alouette Watershed

Kanaka Watershed

20 % anticipated infill development over 30 year time horizon

20 % anticipated infill development over 30 year time horizon

5 % anticipated infill development over 30 year time horizon

Municipal_Boundary_Mask
Assumed Future Roadway
Presumed Drainage Outfall
Recent Development (2011 - 2016)
Future Development Densification
Future Infill Development
Natural Watershed Boundary

Official Community Plan

Urban Reserve
Agriculture
Forest
Commercial
High Density Residential
Medium Density Residential
Low Density Residential
Rural Residential / Suburban Residential
Industrial
Parks & Open Space
Parks within the ALR
Civic & Institutional
Creeks
Drainage Pipes
Detention Ponds
Parcel
Municipal Boundary
Existing Creek Setbacks

The accuracy & completeness of information shown on this drawing is not guaranteed. It will be the responsibility of the user of the information shown on this drawing to locate & establish the precise location of all existing information whether shown or not.

200 0 200 400
m

Coordinate System:
NAD 1983 UTM Zone 10N

Data Sources:
City of Maple Ridge
City of Pitt Meadows
BC MoE
NR Canada

Project #:	1279.0025.01
Author:	BG
Checked:	GS
Status:	FINAL
Revision:	N
Date:	2017 / 5 / 10

URBAN systems

FIGURE C

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Recent Development Hydrologic Parameters and OCP Land Use Distribution

Subcatchment ID	Area (ha)	Total Impervious (%)	Directly Connected Impervious (%)	OCP Land Use (%)					
				Rural/Suburban	Low Density Residential	Medium Density Residential	High Density Residential	Institutional	Industrial and Commercial
RD112	0.45	45	39	0	0	17	0	0	0
RD118	1.48	45	36	0	50	0	0	0	0
RD119	0.42	45	0	0	96	0	0	0	0
RD126	4.34	29	0	100	0	0	0	0	0
RD134	1.26	29	0	100	0	0	0	0	0
RD142	4.76	29	0	100	0	0	0	0	0
RD156	11.89	29	0	100	0	0	0	0	0
RD185	33.67	31	0	100	0	0	0	0	0
RD2	4.69	45	0	0	12	27	45	0	0
RD296A	6.70	31	25	0	99	0	0	0	0
RD296B	4.01	31	25	0	99	0	0	0	0
RD297	7.64	31	25	0	89	0	0	0	11
RD3	9.83	45	45	0	0	30	63	0	0
RD437	1.04	31	31	41	0	59	0	0	0
RD450	0.76	31	25	0	100	0	0	0	0
RD462	10.92	31	25	0	2	97	0	0	0
RD505	0.48	31	25	0	100	0	0	0	0
RD643	1.73	31	26	0	0	100	0	0	0
RD644	1.00	31	27	0	0	100	0	0	0
RD662	0.93	31	26	0	100	0	0	0	0
RD663	2.57	31	0	0	0	0	0	0	0
RD728	0.41	31	1	0	100	0	0	0	0
RD729	4.23	31	0	0	23	0	0	0	75
RD734	8.02	29	0	100	0	0	0	0	0
RD735	1.61	29	29	100	0	0	0	0	0
RD736	0.96	29	29	100	0	0	0	0	0
RD737	1.67	29	29	100	0	0	0	0	0
RD738	0.41	29	0	100	0	0	0	0	0
RD739	0.64	31	3	0	100	0	0	0	0
RD740	0.32	31	31	0	99	0	0	0	0

Future Development Hydrologic Parameters and OCP Land Use Distribution

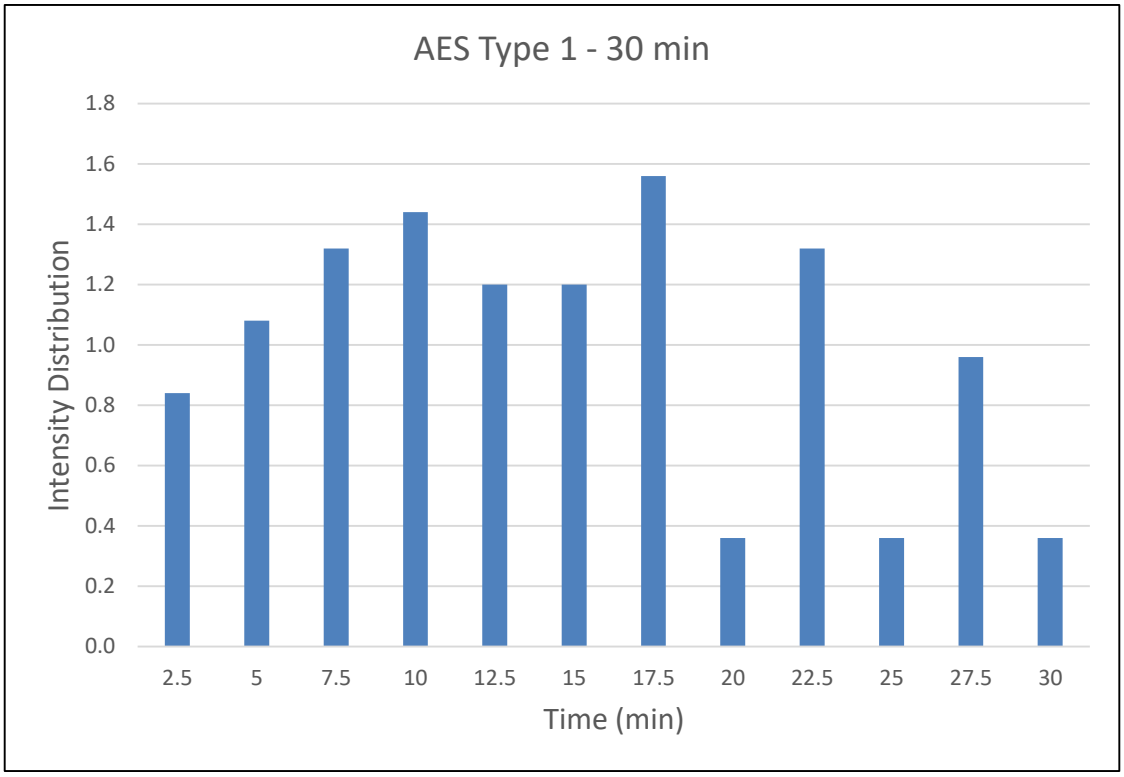
Subcatchment ID	Area (ha)	Total Impervious (%)	Directly Connected Impervious (%)	OCP Land Use (%)					
				Rural/Suburban	Low Density Residential	Medium Density Residential	High Density Residential	Institutional	Industrial and Commercial
FD1	0.71	70	60	0	0	100	0	0	0
FD10	1.50	50	40	0	100	0	0	0	0
FD101	0.51	20	0	100	0	0	0	0	0
FD102	12.64	20	0	100	0	0	0	0	0
FD103A	33.66	20	0	100	0	0	0	0	0
FD103B	9.79	20	0	100	0	0	0	0	0
FD105	6.49	20	0	100	0	0	0	0	0
FD106	0.58	20	0	100	0	0	0	0	0
FD107	47.73	20	0	100	0	0	0	0	0
FD109	11.13	50	40	0	100	0	0	0	0
FD11	5.36	50	40	0	100	0	0	0	0
FD113	0.13	50	40	0	100	0	0	0	0
FD115	0.91	80	80	0	0	0	100	0	0
FD116	0.76	80	80	0	0	0	100	0	0
FD117	4.81	50	40	0	100	0	0	0	0
FD119	0.05	50	40	0	100	0	0	0	0
FD12	5.57	50	40	0	100	0	0	0	0
FD120	0.98	41	34	0	82	0	0	0	0
FD121	0.46	70	60	0	0	100	0	0	0
FD122	2.51	61	51	0	46	54	0	0	0
FD123	19.66	20	0	100	0	0	0	0	0
FD124	2.57	19	1	96	0	0	0	0	0
FD127	1.97	20	0	100	0	0	0	0	0
FD128	6.85	20	0	100	0	0	0	0	0
FD129	1.18	0	0	0	0	0	0	0	0
FD130A	10.18	0	0	0	0	0	0	0	0
FD130B	5.75	0	0	0	0	0	0	0	0
FD131	5.00	20	0	100	0	0	0	0	0
FD132	26.69	28	3	89	0	0	0	0	11
FD133	10.72	90	90	0	0	0	0	0	100
FD134	0.60	20	0	99	0	0	0	0	0
FD135	1.11	20	0	100	0	0	0	0	0
FD136	1.22	20	0	100	0	0	0	0	0
FD137	11.47	20	0	100	0	0	0	0	0
FD14	6.08	50	40	0	100	0	0	0	0
FD15	8.96	50	40	0	100	0	0	0	0
FD16	9.62	50	40	0	100	0	0	0	0
FD17	6.25	72	62	0	0	91	0	0	9
FD18	8.60	64	57	0	55	0	0	45	0
FD19	1.29	50	40	0	100	0	0	0	0
FD2	2.93	81	81	0	0	0	0	100	0
FD20	0.59	50	40	0	100	0	0	0	0
FD21	1.69	50	40	0	100	0	0	0	0
FD22	5.17	50	40	0	99	0	0	0	0
FD23	0.68	50	40	0	100	0	0	0	0
FD24	0.67	81	81	0	0	0	0	100	0
FD25	0.58	90	90	0	0	0	0	0	100
FD26	10.97	64	58	0	39	7	20	0	26
FD27	0.31	50	40	0	100	0	0	0	0
FD28	1.05	50	40	0	100	0	0	0	0
FD29	4.15	76	72	0	0	43	0	57	0
FD3	4.15	70	60	0	0	100	0	0	0
FD30	2.03	70	60	0	0	100	0	0	0
FD31	2.65	90	90	0	0	0	0	0	100
FD32	0.67	80	80	0	0	0	100	0	0
FD33	0.43	70	60	0	0	100	0	0	0
FD34	0.49	80	80	0	0	0	100	0	0
FD35	7.54	71	62	0	0	90	0	10	0
FD36	0.25	80	80	0	0	0	100	0	0
FD37	7.39	70	60	0	0	100	0	0	0

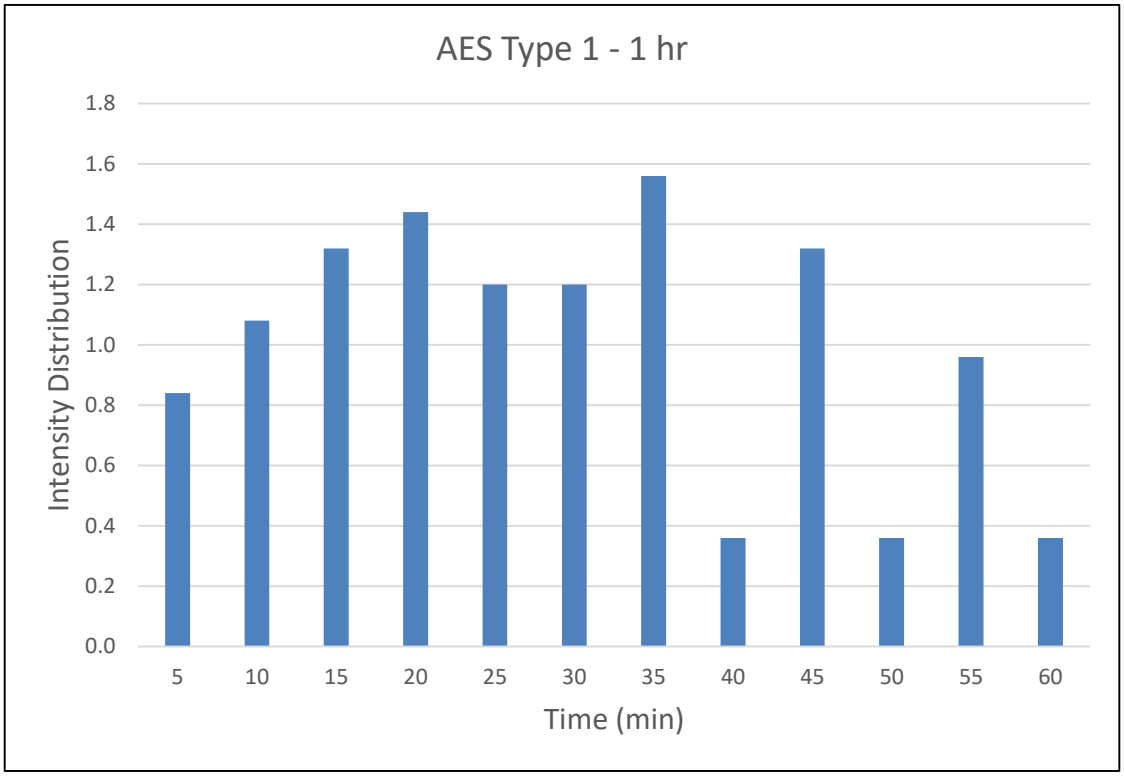
Future Development Hydrologic Parameters and OCP Land Use Distribution

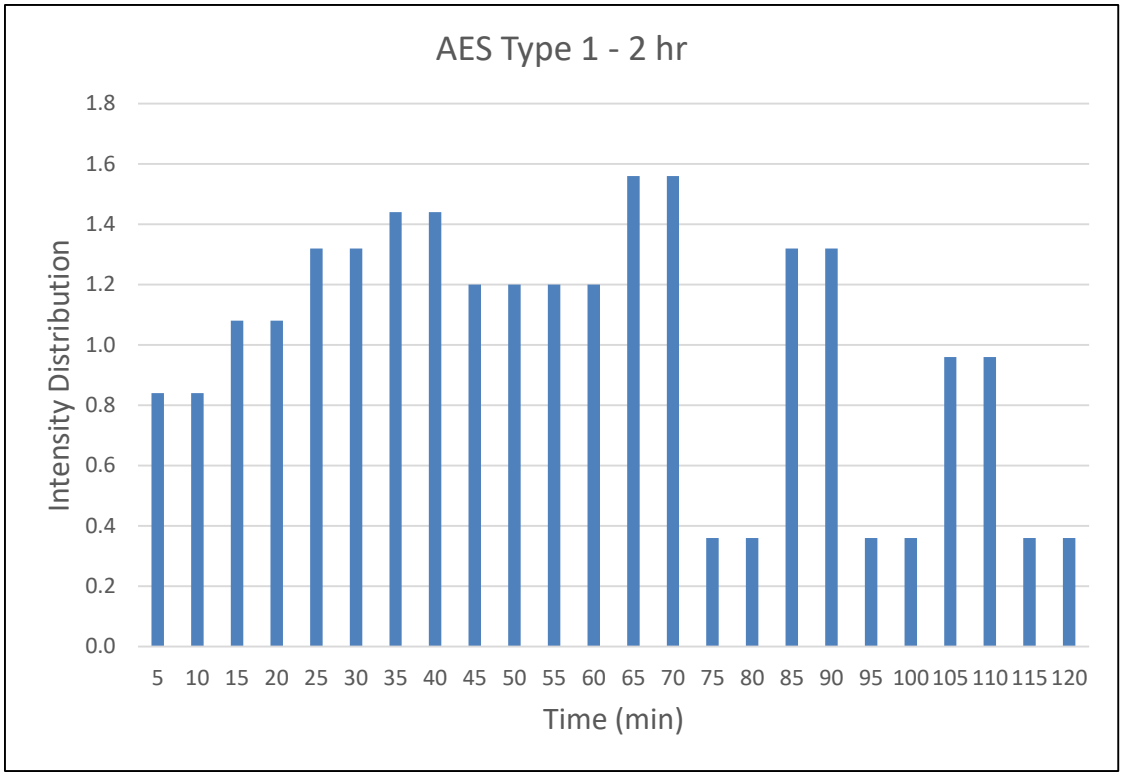
Subcatchment ID	Area (ha)	Total Impervious (%)	Directly Connected Impervious (%)	OCP Land Use (%)					
				Rural/Suburban	Low Density Residential	Medium Density Residential	High Density Residential	Institutional	Industrial and Commercial
FD38	1.78	60	53	0	58	0	39	0	0
FD39	8.06	81	81	0	0	0	26	35	35
FD4	1.69	50	40	0	100	0	0	0	0
FD40	2.47	80	80	0	0	0	100	0	0
FD42	4.92	70	60	0	0	100	0	0	0
FD43	0.24	50	40	0	100	0	0	0	0
FD44	14.01	70	60	0	0	100	0	0	0
FD45	13.50	70	60	0	0	100	0	0	0
FD46	6.54	50	40	0	100	0	0	0	0
FD47	0.52	50	40	0	100	0	0	0	0
FD48	3.01	50	40	0	100	0	0	0	0
FD49	3.32	70	60	0	0	100	0	0	0
FD5	11.24	63	56	0	58	0	0	42	0
FD50	4.47	70	60	0	0	100	0	0	0
FD51	4.71	50	40	0	100	0	0	0	0
FD52	4.64	50	40	0	100	0	0	0	0
FD53A	5.69	70	60	0	0	100	0	0	0
FD53B	0.96	70	60	0	0	100	0	0	0
FD54	0.38	50	40	0	100	0	0	0	0
FD55	2.96	50	40	0	100	0	0	0	0
FD56	0.43	50	40	0	100	0	0	0	0
FD57	0.96	51	41	0	96	4	0	0	0
FD58	2.88	50	40	0	100	0	0	0	0
FD59	0.59	50	40	0	100	0	0	0	0
FD6	2.58	50	40	0	100	0	0	0	0
FD61	0.96	50	40	0	100	0	0	0	0
FD62	0.85	50	40	0	99	0	0	0	0
FD63	5.59	50	40	0	100	0	0	0	0
FD65	0.77	50	40	0	100	0	0	0	0
FD66	0.89	50	40	0	100	0	0	0	0
FD67	1.58	50	40	0	100	0	0	0	0
FD69A	13.28	20	0	100	0	0	0	0	0
FD69B	11.04	20	0	100	0	0	0	0	0
FD7	0.92	50	40	0	100	0	0	0	0
FD70	1.05	20	0	100	0	0	0	0	0
FD71	4.19	20	0	99	0	0	0	0	0
FD72	9.76	50	40	0	100	0	0	0	0
FD74	6.26	20	0	100	0	0	0	0	0
FD75	3.21	20	0	100	0	0	0	0	0
FD77	0.86	90	90	0	0	0	0	0	100
FD78	18.54	20	0	99	0	0	0	0	0
FD79	10.96	20	0	100	0	0	0	0	0
FD8	6.93	50	40	0	100	0	0	0	0
FD80	23.20	20	0	98	0	0	0	0	0
FD82	17.93	20	0	100	0	0	0	0	0
FD85	13.54	20	0	100	0	0	0	0	0
FD86	5.20	20	0	100	0	0	0	0	0
FD87	7.34	20	0	100	0	0	0	0	0
FD88	13.88	20	0	100	0	0	0	0	0
FD89	2.58	20	0	100	0	0	0	0	0
FD9	5.57	50	40	0	100	0	0	0	0
FD90	1.20	20	0	99	0	0	0	0	0
FD91	1.41	50	40	0	100	0	0	0	0
FD92	1.33	50	40	0	99	0	0	0	0
FD93	3.69	10	9	0	19	0	0	0	0
FD94	5.79	69	59	0	0	99	0	0	0
FD95	3.34	57	47	0	63	37	0	0	0
FD96	11.19	20	0	100	0	0	0	0	0
FD97	2.59	20	0	99	0	0	0	0	0
FD98	4.06	20	0	100	0	0	0	0	0

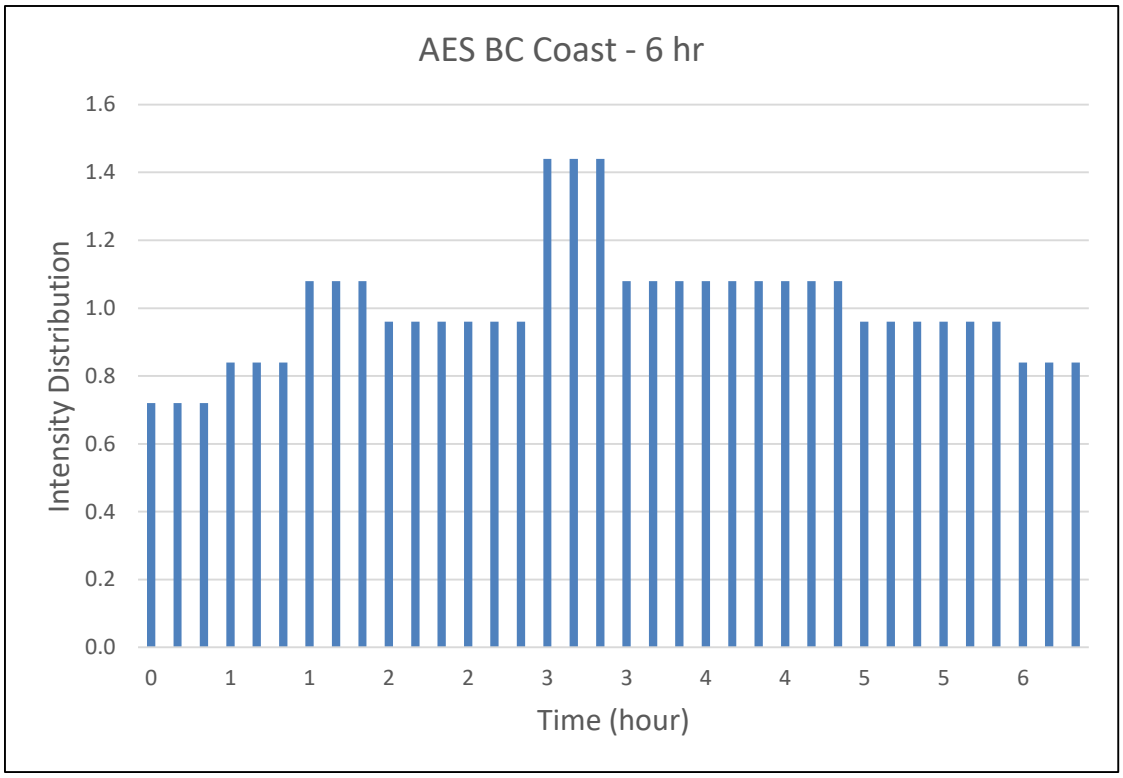
Appendix B Design Storm Hyetographs

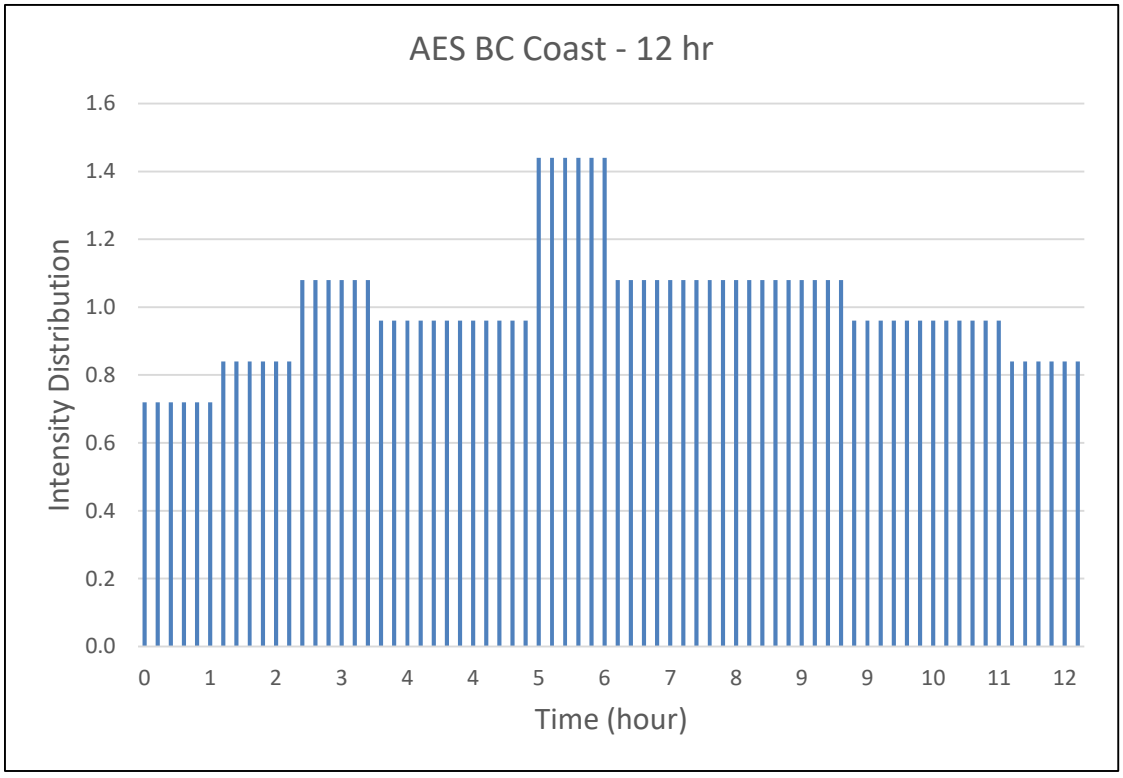
Rain Gauge	Return Period	Total Rainfall (mm)					
		30-min	1-hr	2-hr	6-hr	12-hr	24-hr
Katzie Pump Station (DM44)	2-Year	9.8	14.5	20.3	38.6	56.4	76.2
	10-Year	17.2	26.9	32.0	56.4	93.6	132.9
	100-Year	26.3	42.3	46.7	78.6	140.1	203.7
Maple Ridge Reservoir (DM45)	2-Year	9.1	12.9	18.8	37.0	54.0	75.9
	10-Year	17.1	25.2	31.4	50.2	83.2	118.7
	100-Year	27.2	40.6	47.2	66.8	119.6	172.1
Golden Ears Elementary School (DM62)	2-Year	9.8	14.5	20.3	38.6	56.4	76.2
	10-Year	17.2	26.9	32.0	56.4	93.6	132.9
	100-Year	26.3	42.3	46.7	78.6	140.1	203.7
Haney UBC Research Forest	2-Year	9.4	12.7	19.4	38.4	57.6	86.4
	10-Year	15.2	19.0	25.4	49.2	78.0	122.4
	100-Year	22.5	26.8	32.8	62.4	104.4	168.0

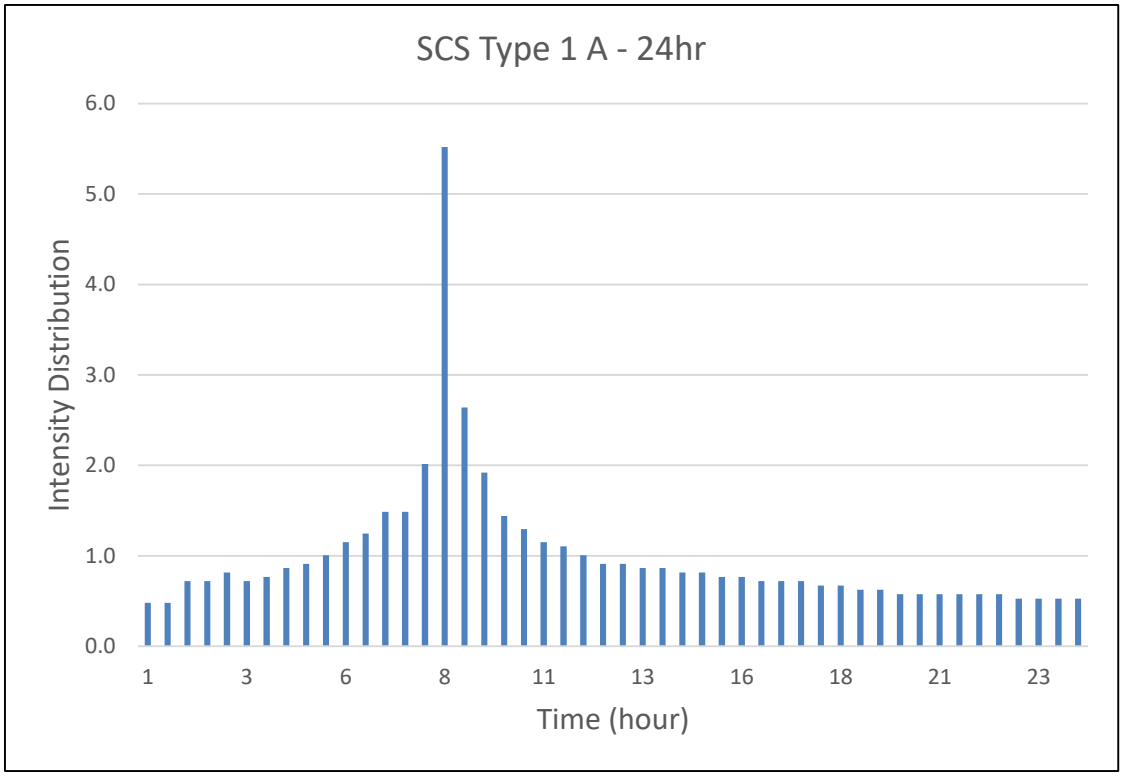


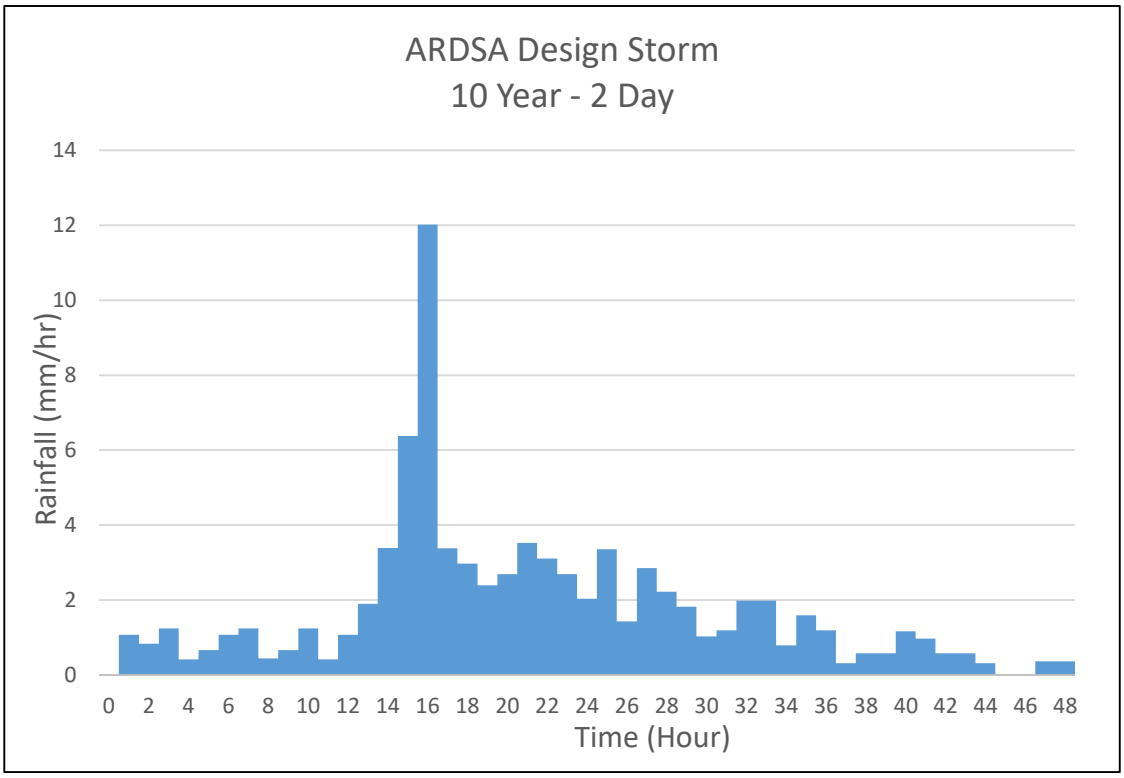

AES Type 1 - 1 hr
Intensity Distribution
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
5 10 15 20 25 30 35 40 45 50 55 60
Time (min)

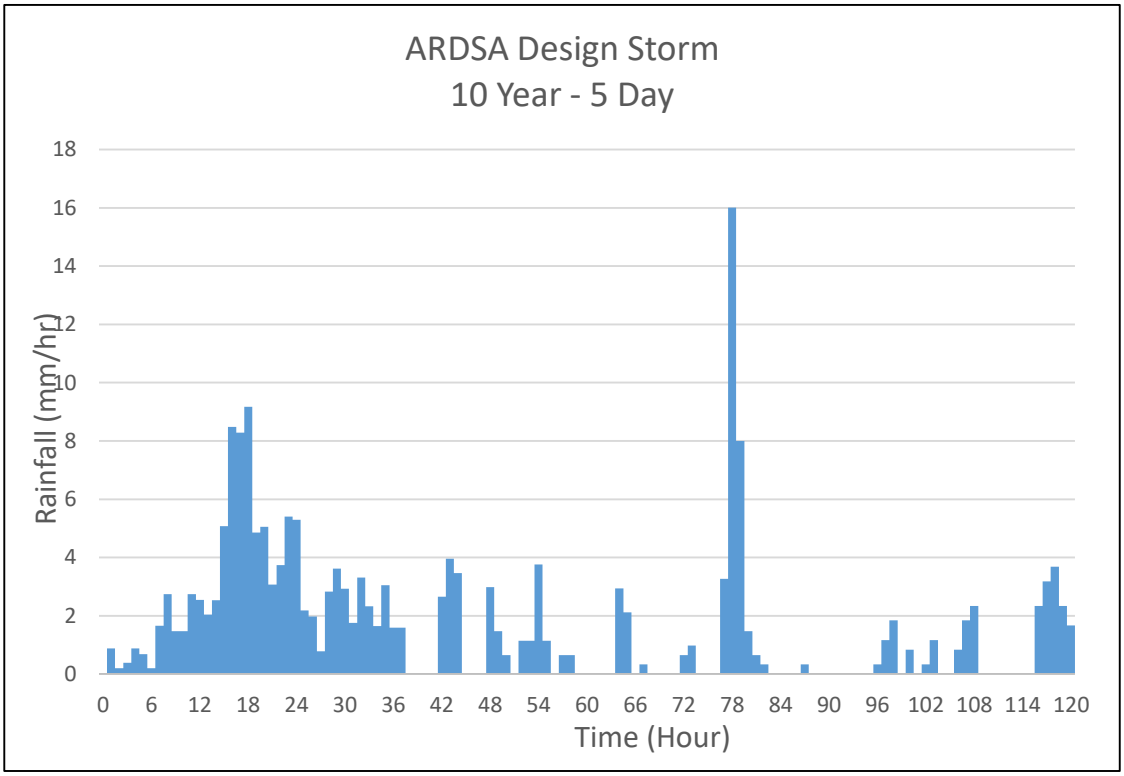

AES Type 1 - 2 hr
Intensity Distribution
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110 115 120
Time (min)


AES BC Coast - 6 hr
Intensity Distribution
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0 1 1 2 2 3 3 4 4 5 5 6
Time (hour)


AES BC Coast - 12 hr
Intensity Distribution
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0 1 2 3 4 4 5 6 7 8 9 9 10 11 12
Time (hour)

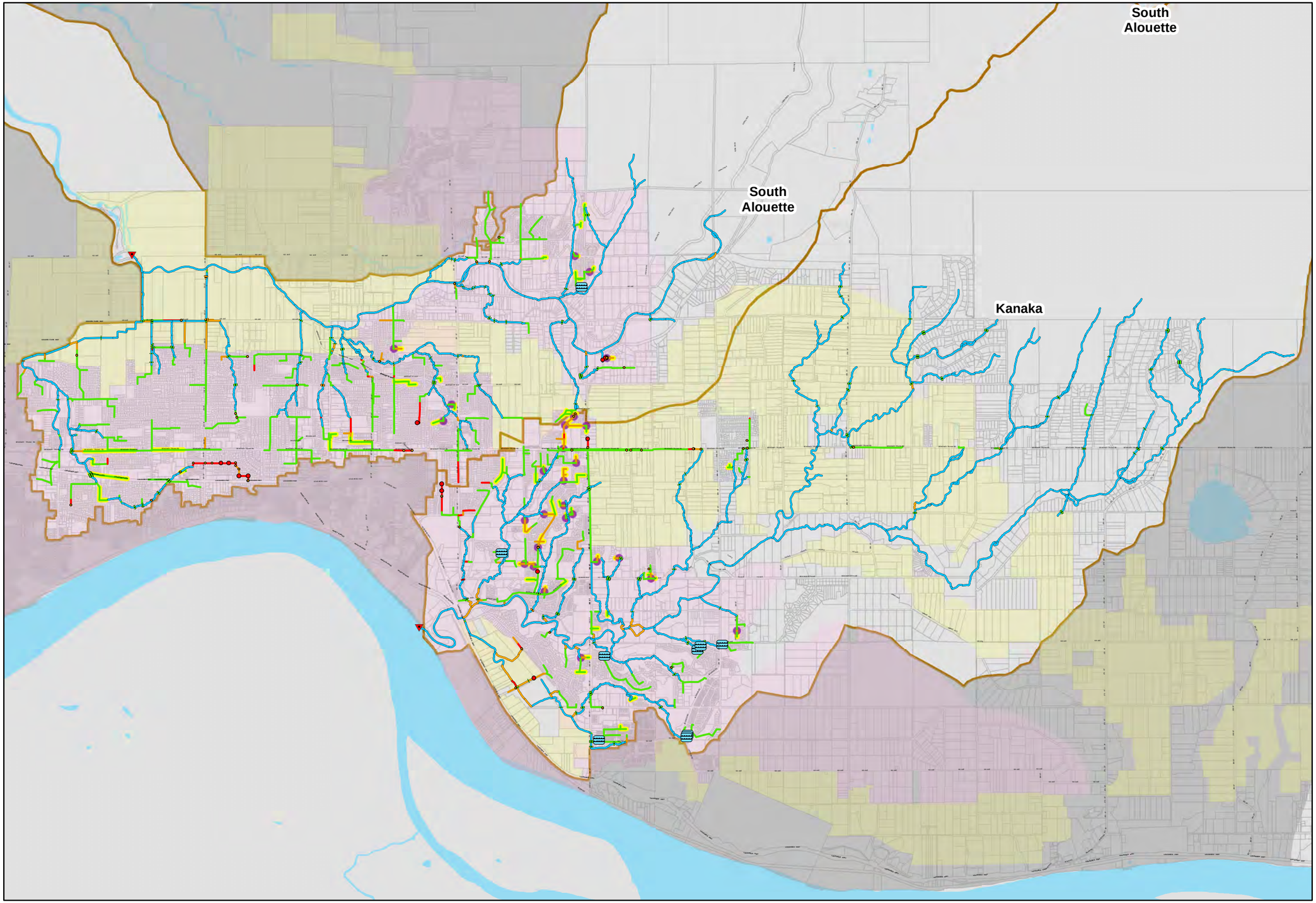

SCS Type 1 A - 24hr
Intensity Distribution
6.0
5.0
4.0
3.0
2.0
1.0
0.0
1 3 6 8 11 13 16 18 21 23
Time (hour)


ARDSA Design Storm
10 Year - 2 Day
Rainfall (mm/hr)
0
2
4
6
8
10
12
14
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48
Time (Hour)


ARDSA Design Storm
10 Year - 5 Day
Rainfall (mm/hr)
0
2
4
6
8
10
12
14
16
18
0 6 12 18 24 30 36 42 48 54 60 66 72 78 84 90 96 102 108 114 120
Time (Hour)

Appendix C Existing Condition System Capacity Figures

Unit 203, 2502 St Johns Street
Port Moody, British Columbia
V3H 2B4 Canada
Tel (604) 931-0550



GeoAdvice Engineering Inc.

Legend

- Agricultural Land Reserve
- Urban Containment Boundary
- Watershed Boundary
- Parcel
- Detention Pond
- Outfall
- Flow Control Manhole
- Storage

Culvert

Peak Flow / Pipe Full Capacity

- < 1.05 OR Surcharge < 15 min (128)
- < 1.05 AND Surcharge > 15 min (6)
- >= 1.05 AND Surcharge > 15 min (2)

Creek

Peak Flow / Creek Full Capacity

- < 1.05 OR Surcharge < 15 min (1,053)
- < 1.05 AND Surcharge > 15 min (45)
- >= 1.05 AND Surcharge > 15 min (Potential Breach of Creek) (1)

Storm Main

Peak Flow / Pipe Full Capacity

- <1.05 OR Surcharge < 15 min (1,086)
- < 1.05 AND Surcharge > 15 min (135)
- >= 1.05 AND Surcharge > 15 min (55)

Junction

Maximum Water Surface Elevation @ Modeled Junctions (Represents Underground Conveyance HGL)

- > Ground (13)
- <= Ground and > Ground - 0.6 m (58)

Mean Annual Rainfall Capacity Analysis (Existing Land Use)

MAPLE RIDGE
BRITISH COLUMBIA

Project: South Alouette and Kanaka Integrated Storm Water Management Plans
Client: City of Maple Ridge, BC
Date: July 2017
Created by: JH
Reviewed by: WdS

DISCLAIMER: GeoAdvice does not warrant in any way the accuracy and completeness of the information shown on this map. Field verification of the accuracy and completeness of the information shown on this map is the sole responsibility of the user.

0 0.75 1.5 3
Kilometers

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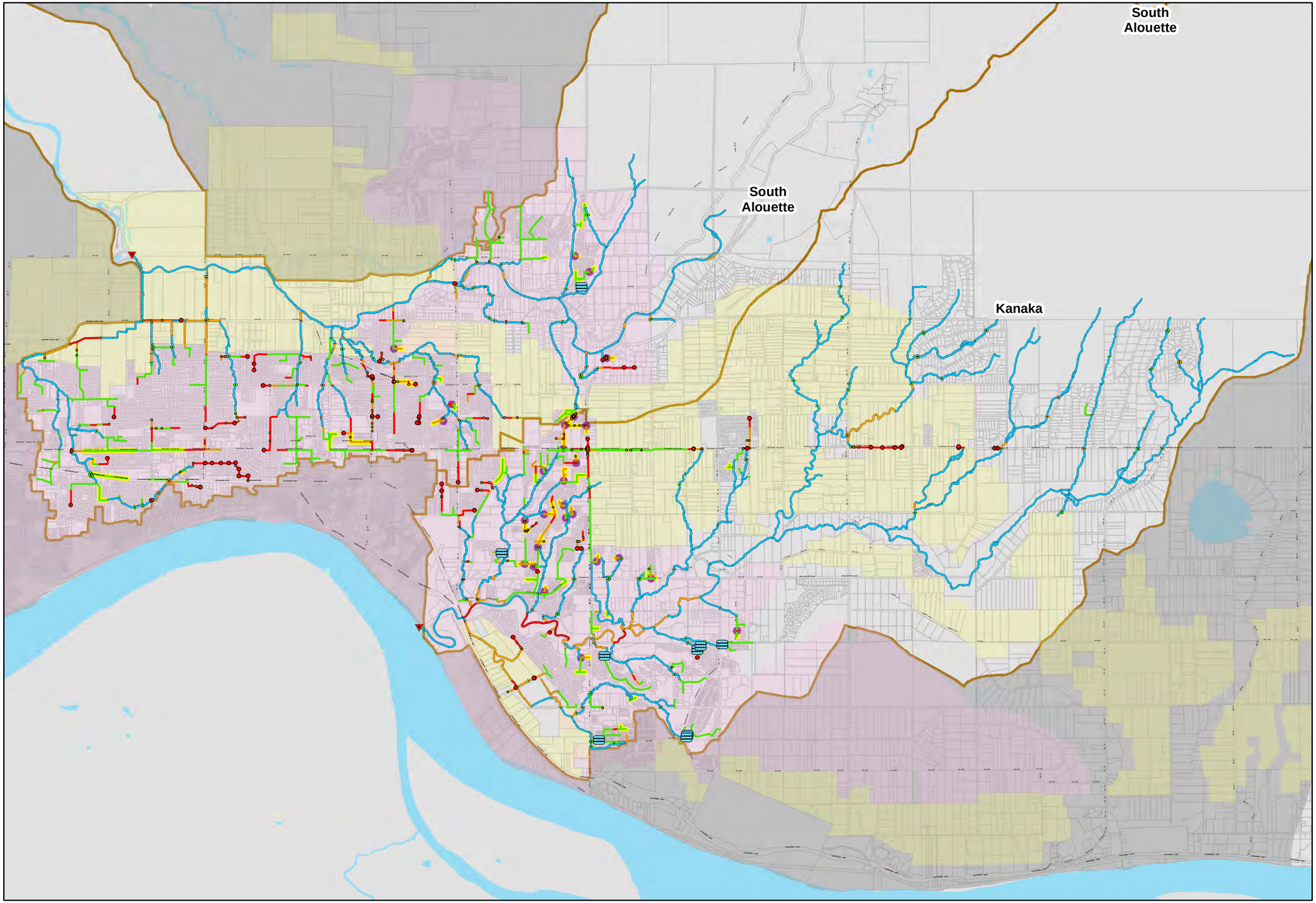
Figure C.1



GeoAdvice Engineering Inc.

Legend

- Agricultural Land Reserve
- Urban Containment Boundary
- Watershed Boundary
- Parcel
- Detention Pond
- Outfall
- Flow Control Manhole
- Storage

Culvert

Peak Flow / Pipe Full Capacity

- < 1.05 OR Surcharge < 15 min (103)
- < 1.05 AND Surcharge > 15 min (29)
- >= 1.05 AND Surcharge > 15 min (4)

Creek

Peak Flow / Creek Full Capacity

- < 1.05 OR Surcharge < 15 min (998)
- < 1.05 AND Surcharge > 15 min (90)
- >= 1.05 AND Surcharge > 15 min (Potential Breach of Creek) (11)

Storm Main

Peak Flow / Pipe Full Capacity

- <1.05 OR Surcharge < 15 min (833)
- < 1.05 AND Surcharge > 15 min (232)
- >= 1.05 AND Surcharge > 15 min (211)

Junction

Maximum Water Surface Elevation @ Modeled Junctions (Represents Underground Conveyance HGL)

- > Ground (72)
- <= Ground and > Ground - 0.6 m (138)

Results presented represent the worst case hydraulic condition for each reach and control from all storm durations simulated
(30-min, 1-hr, 2-hr, 6-hr, 12-hr, and 24-hr)

10-Year, Critical Duration Capacity Analysis (Existing Land Use)

MAPLE RIDGE
BRITISH COLUMBIA

Project:	South Alouette and Kanaka Integrated Storm Water Management Plans
Client:	City of Maple Ridge, BC
Date:	July 2017
Created by:	JH
Reviewed by:	WdS

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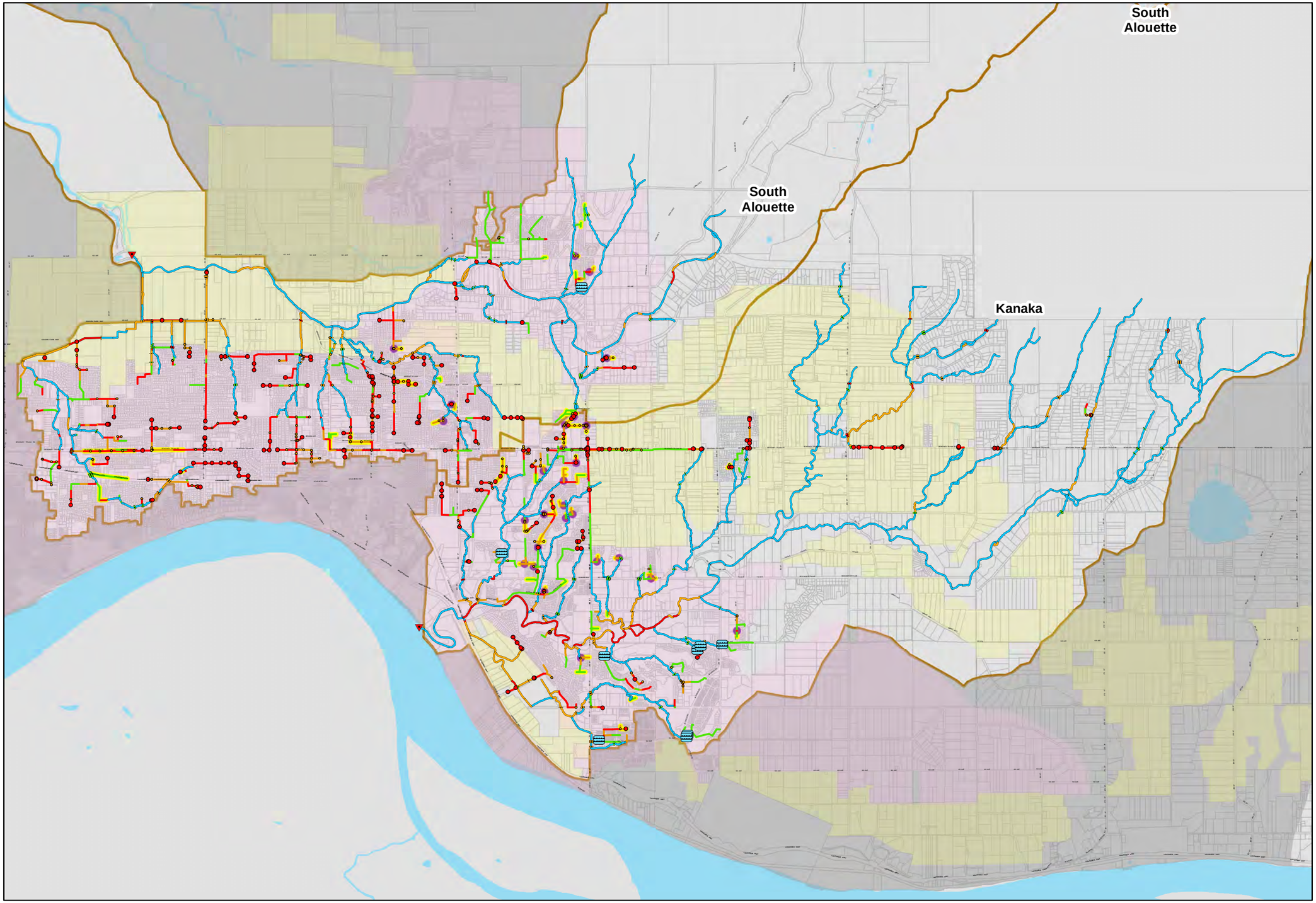
0 0.75 1.5 3
Kilometers

N W E S

Figure C.2



GeoAdvice Engineering Inc.

Legend

- Agricultural Land Reserve
- Urban Containment Boundary
- Watershed Boundary
- Parcel
- Detention Pond
- Outfall
- Flow Control Manhole
- Storage

Culvert

Peak Flow / Pipe Full Capacity

- < 1.05 OR Surcharge < 15 min (69)
- < 1.05 AND Surcharge > 15 min (49)
- >= 1.05 AND Surcharge > 15 min (18)

Creek

Peak Flow / Creek Full Capacity

- < 1.05 OR Surcharge < 15 min (920)
- < 1.05 AND Surcharge > 15 min (151)
- >= 1.05 AND Surcharge > 15 min (Potential Breach of Creek) (28)

Storm Main

Peak Flow / Pipe Full Capacity

- <1.05 OR Surcharge < 15 min (481)
- < 1.05 AND Surcharge > 15 min (366)
- >= 1.05 AND Surcharge > 15 min (429)

Junction

Maximum Water Surface Elevation @ Modeled Junctions (Represents Underground Conveyance HGL)

- > Ground (227)
- <= Ground and > Ground - 0.6 m (225)

Results presented represent the worst case hydraulic condition for each reach and control from all storm durations simulated
(30-min, 1-hr, 2-hr, 6-hr, 12-hr, and 24-hr)

100-Year, Critical Duration Capacity Analysis (Existing Land Use)

MAPLE RIDGE
BRITISH COLUMBIA

Project:	South Alouette and Kanaka Integrated Storm Water Management Plans
Client:	City of Maple Ridge, BC
Date:	July 2017
Created by:	JH
Reviewed by:	WdS

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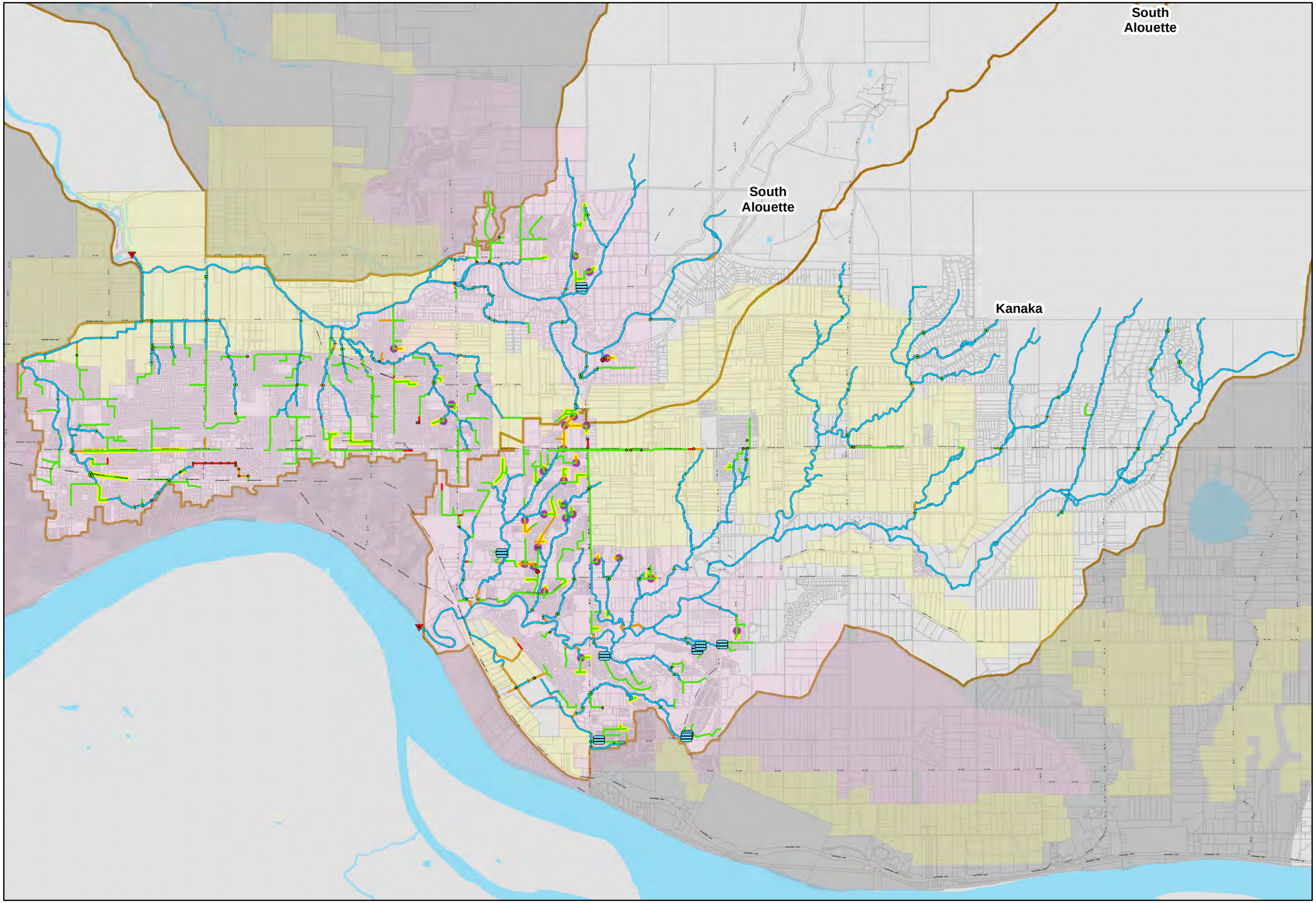
0 0.75 1.5 3
Kilometers

N W E S

Figure C.3



GeoAdvice Engineering Inc.

Legend

- Agricultural Land Reserve
- Urban Containment Boundary
- Watershed Boundary
- Parcel
- Detention Pond
- Outfall
- Flow Control Manhole
- Storage

Culvert

Peak Flow / Pipe Full Capacity

- < 1.05 OR Surcharge < 15 min (129)
- < 1.05 AND Surcharge > 15 min (6)
- >= 1.05 AND Surcharge > 15 min (1)

Creek

Peak Flow / Creek Full Capacity

- < 1.05 OR Surcharge < 15 min (1,065)
- < 1.05 AND Surcharge > 15 min (34)
- >= 1.05 AND Surcharge > 15 min (Potential Breach of Creek) (0)

Storm Main

Peak Flow / Pipe Full Capacity

- <1.05 OR Surcharge < 15 min (1,142)
- < 1.05 AND Surcharge > 15 min (105)
- >= 1.05 AND Surcharge > 15 min (29)

Junction

Maximum Water Surface Elevation @ Modeled Junctions (Represents Underground Conveyance HGL)

- > Ground (2)
- <= Ground and > Ground - 0.6 m (47)

ARDSA 10-Year, 2-Day Capacity Analysis (Existing Land Use)

MAPLE RIDGE
BRITISH COLUMBIA

Project:	South Alouette and Kanaka Integrated Storm Water Management Plans
Client:	City of Maple Ridge, BC
Date:	July 2017
Created by:	JH
Reviewed by:	WdS

DISCLAIMER: GeoAdvice does not warrant in any way the accuracy and completeness of the information shown on this map. Field verification of the accuracy and completeness of the information shown on this map is the sole responsibility of the user.

0 0.75 1.5 3
Kilometers

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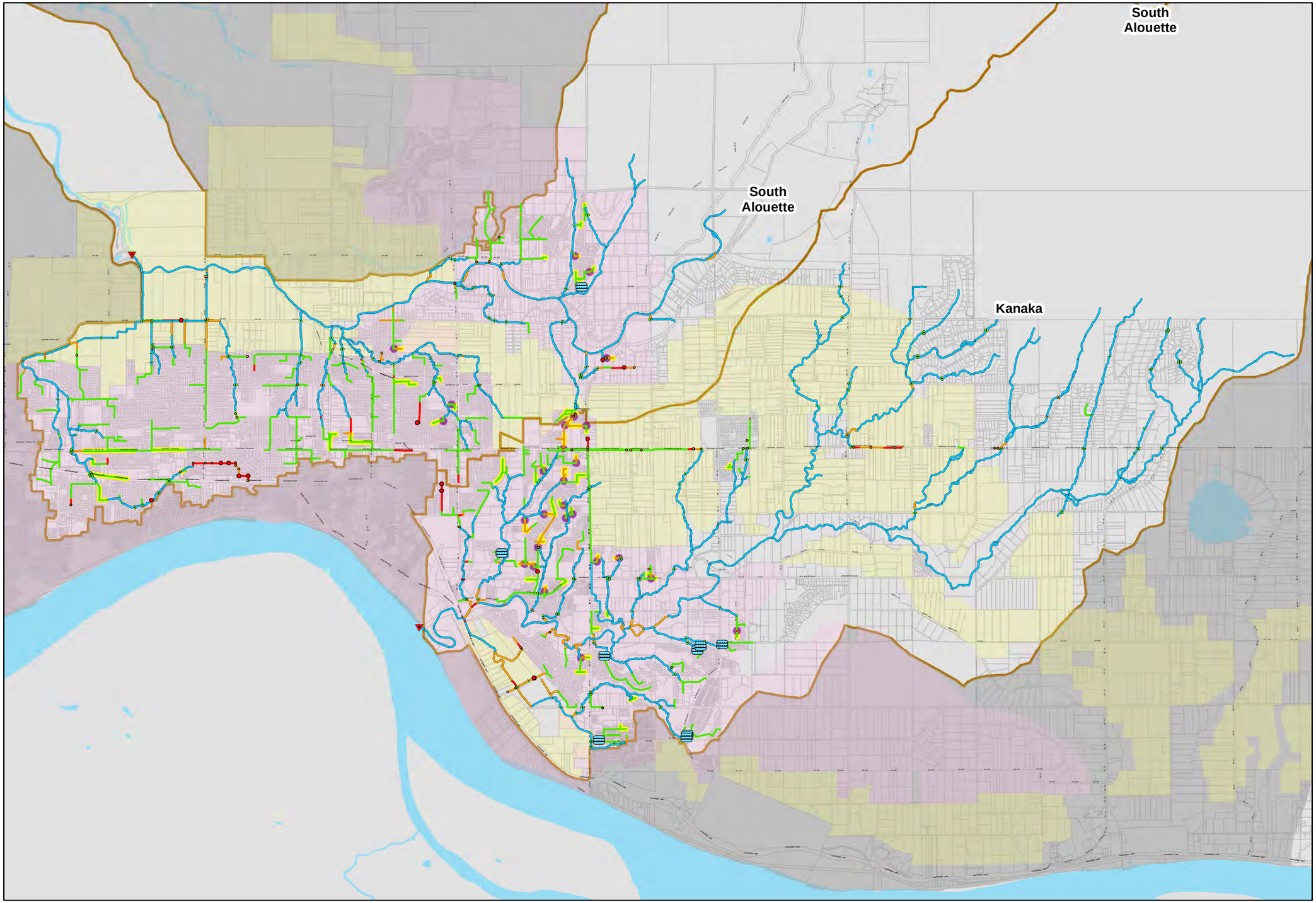
Figure C.4



GeoAdvice Engineering Inc.

Legend

- Agricultural Land Reserve
- Urban Containment Boundary
- Watershed Boundary
- Parcel
- Detention Pond
- Outfall
- Flow Control Manhole
- Storage

Culvert

Peak Flow / Pipe Full Capacity

- < 1.05 OR Surcharge < 15 min (124)
- < 1.05 AND Surcharge > 15 min (10)
- >= 1.05 AND Surcharge > 15 min (2)

Creek

Peak Flow / Creek Full Capacity

- < 1.05 OR Surcharge < 15 min (1,037)
- < 1.05 AND Surcharge > 15 min (60)
- >= 1.05 AND Surcharge > 15 min (Potential Breach of Creek) (2)

Storm Main

Peak Flow / Pipe Full Capacity

- <1.05 OR Surcharge < 15 min (1,074)
- < 1.05 AND Surcharge > 15 min (145)
- >= 1.05 AND Surcharge > 15 min (57)

Junction

Maximum Water Surface Elevation @ Modeled Junctions (Represents Underground Conveyance HGL)

- > Ground (16)
- <= Ground and > Ground - 0.6 m (59)

ARDSA 10-Year, 5-Day Capacity Analysis (Existing Land Use)

MAPLE RIDGE
BRITISH COLUMBIA

Project: South Alouette and Kanaka Integrated Storm Water Management Plans
Client: City of Maple Ridge, BC
Date: July 2017
Created by: JH
Reviewed by: WdS

DISCLAIMER: GeoAdvice does not warrant in any way the accuracy and completeness of the information shown on this map. Field verification of the accuracy and completeness of the information shown on this map is the sole responsibility of the user.

0 0.75 1.5 3
Kilometers

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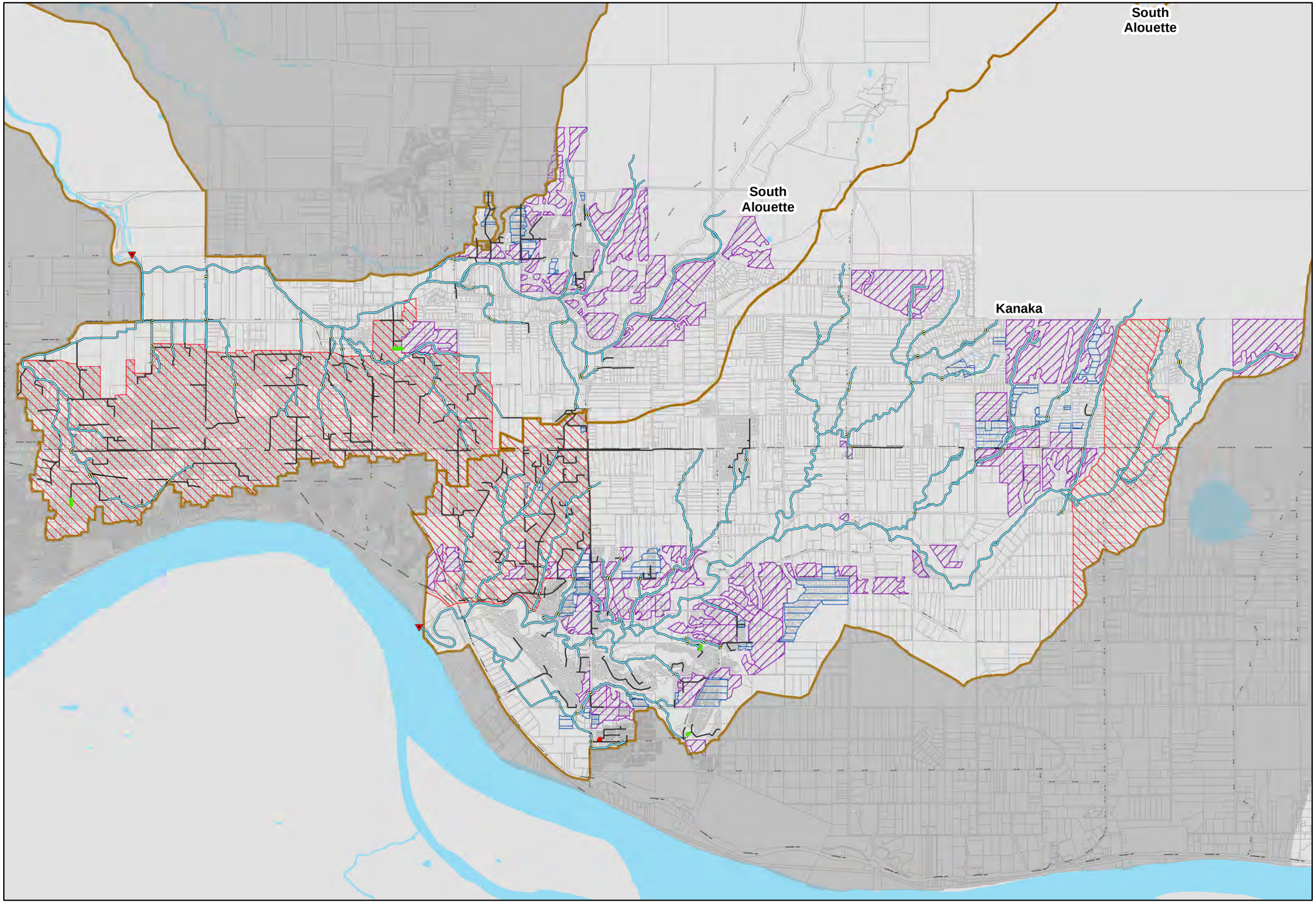
Figure C.5

Appendix D Change in Performance – Future Land Use vs Existing Land Use Figures

Unit 203, 2502 St Johns Street
Port Moody, British Columbia
V3H 2B4 Canada
Tel (604) 931-0550



GeoAdvice Engineering Inc.

Legend

- Watershed Boundary
- Recent Development (2011 - 2016)
- Future Development Densification
- Future Infill Development
- Parcel
- Outfall

Culvert Available Capacity Change

- Available Capacity Improves (0)
- Available Capacity Worsens (0)
- Culvert

Creek Available Capacity Change

- Available Capacity Improves (0)
- Available Capacity Worsens (0)
- Creek

Storm Main Available Capacity Change

- Available Capacity Improves (5)
- Available Capacity Worsens (1)
- Storm Main

Tiers A & B controls applied to recent, future and infill development.

Comparative changes of less than 5% are not shown as they are considered insignificant and below the margin of error.

Mean Annual Rainfall Available Capacity Change (Future Land Use vs Existing Land Use)

MAPLE RIDGE
BRITISH COLUMBIA

Project:	South Alouette and Kanaka Integrated Storm Water Management Plans
Client:	City of Maple Ridge, BC
Date:	July 2017
Created by:	JH
Reviewed by:	WdS

DISCLAIMER: GeoAdvice does not warrant in any way the accuracy and completeness of the information shown on this map. Field verification of the accuracy and completeness of the information shown on this map is the sole responsibility of the user.

0 0.75 1.5 3
Kilometers

N
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Figure D.1

South Alouette

South Alouette

Kanaka

GeoAdvice Engineering Inc.

Legend

- Watershed Boundary
- Recent Development (2011 - 2016)
- Future Development Densification
- Future Infill Development
- Parcel
- Outfall

Culvert Available Capacity Change

- Available Capacity Improves(0)
- Available Capacity Worsens(2)
- Culvert

Creek Available Capacity Change

- Available Capacity Improves(0)
- Available Capacity Worsens(1)
- Creek

Storm Main Available Capacity Change

- Available Capacity Improves(1)
- Available Capacity Worsens(11)
- Storm Main

Results presented represent the worst case hydraulic condition for each reach and control from all storm durations simulated
(30-min, 1-hr, 2-hr, 6-hr, 12-hr, and 24-hr)

Tier A, B & C controls applied to recent and future development.

Tier A & C controls applied to infill development.

Comparative changes of less than 5% are not shown as they are considered insignificant and below the margin of error.

10-Year, Critical Duration Available Capacity Change (Future Land Use vs Existing Land Use)

MAPLE RIDGE
BRITISH COLUMBIA

Project: South Alouette and Kanaka Integrated Storm Water Management Plans
Client: City of Maple Ridge, BC
Date: July 2017
Created by: JH
Reviewed by: WdS

DISCLAIMER: GeoAdvice does not warrant in any way the accuracy and completeness of the information shown on this map. Field verification of the accuracy and completeness of the information shown on this map is the sole responsibility of the user.

0 0.75 1.5 3
Kilometers

N
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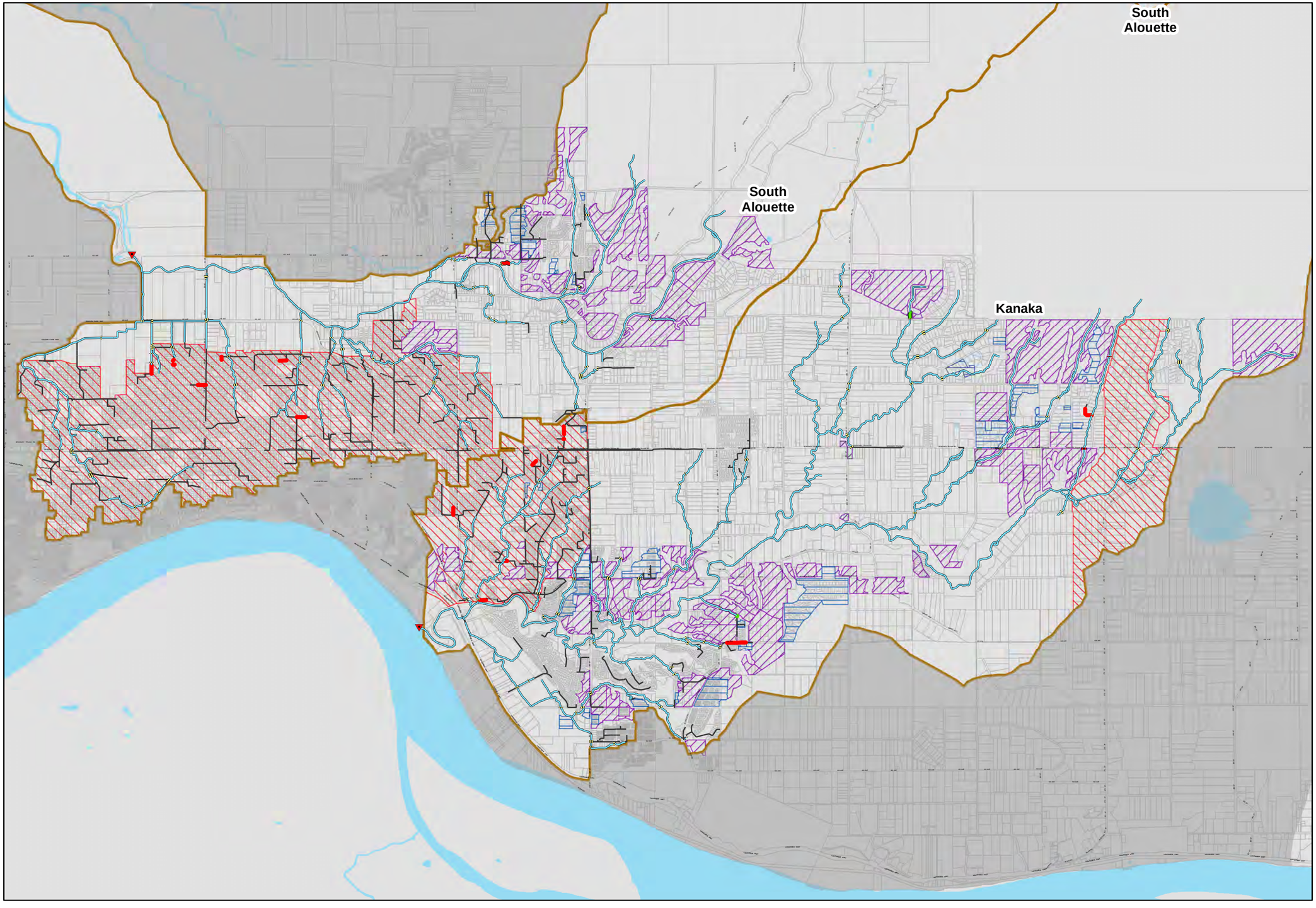
Figure D.2



GeoAdvice Engineering Inc.

Legend

- Watershed Boundary
- Recent Development (2011 - 2016)
- Future Development Densification
- Future Infill Development
- Parcel
- Outfall

Culvert Available Capacity Change

- Available Capacity Improves(0)
- Available Capacity Worsens(2)
- Culvert

Creek Available Capacity Change

- Available Capacity Improves(1)
- Available Capacity Worsens(1)
- Creek

Storm Main Available Capacity Change

- Available Capacity Improves(1)
- Available Capacity Worsens(23)
- Storm Main

Results presented represent the worst case hydraulic condition for each reach and control from all storm durations simulated
(30-min, 1-hr, 2-hr, 6-hr, 12-hr, and 24-hr)

Tier A, B & C controls applied to recent and future development.

Tier A & C controls applied to infill development.

Comparative changes of less than 5% are not shown as they are considered insignificant and below the margin of error.

100-Year, Critical Duration Available Capacity Change (Future Land Use vs Existing Land Use)

MAPLE RIDGE
BRITISH COLUMBIA

Project:	South Alouette and Kanaka Integrated Storm Water Management Plans
Client:	City of Maple Ridge, BC
Date:	July 2017
Created by:	JH
Reviewed by:	WdS

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0 0.75 1.5 3
Kilometers

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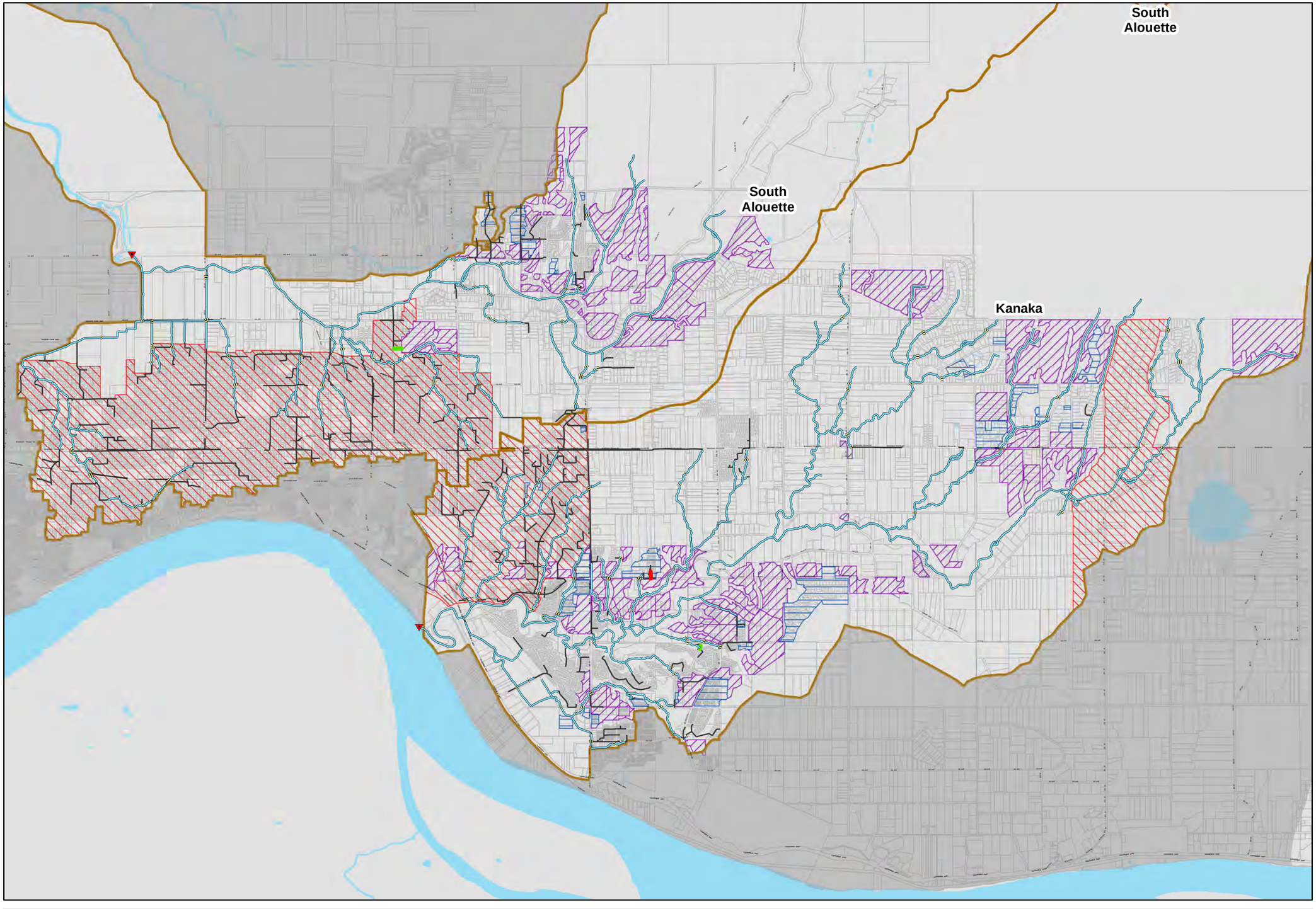
Figure D.3



GeoAdvice Engineering Inc.

Legend

- Watershed Boundary
- Recent Development (2011 - 2016)
- Future Development Densification
- Future Infill Development
- Parcel
- Outfall

Culvert Available Capacity Change

- Available Capacity Improves (0)
- Available Capacity Worsens (0)
- Culvert

Creek Available Capacity Change

- Available Capacity Improves (0)
- Available Capacity Worsens (0)
- Creek

Storm Main Available Capacity Change

- Available Capacity Improves (3)
- Available Capacity Worsens (2)
- Storm Main

Tier A, B & C controls applied to recent and future development.

Tier A & C controls applied to infill development.

Comparative changes of less than 5% are not shown as they are considered insignificant and below the margin of error.

ARDSA 10-Year, 2-Day Available Capacity Change (Future Land Use vs Existing Land Use)

MAPLE RIDGE
BRITISH COLUMBIA

Project:	South Alouette and Kanaka Integrated Storm Water Management Plans
Client:	City of Maple Ridge, BC
Date:	July 2017
Created by:	JH
Reviewed by:	WdS

DISCLAIMER: GeoAdvice does not warrant in any way the accuracy and completeness of the information shown on this map. Field verification of the accuracy and completeness of the information shown on this map is the sole responsibility of the user.

0 0.75 1.5 3
Kilometers

N
W E
S

Figure D.4

South Alouette

South Alouette

Kanaka

GeoAdvice Engineering Inc.

Legend

- Watershed Boundary
- Recent Development (2011 - 2016)
- Future Development Densification
- Future Infill Development
- Parcel
- Outfall

Culvert Available Capacity Change

- Available Capacity Improves (0)
- Available Capacity Worsens (4)
- Culvert

Creek Available Capacity Change

- Available Capacity Improves (0)
- Available Capacity Worsens (0)
- Creek

Storm Main Available Capacity Change

- Available Capacity Improves (3)
- Available Capacity Worsens (10)
- Storm Main

Tier A, B & C controls applied to recent and future development.

Tier A & C controls applied to infill development.

Comparative changes of less than 5% are not shown as they are considered insignificant and below the margin of error.

ARDSA 10-Year, 5-Day Available Capacity Change (Future Land Use vs Existing Land Use)

MAPLE RIDGE
BRITISH COLUMBIA

Project: South Alouette and Kanaka Integrated Storm Water Management Plans
Client: City of Maple Ridge, BC
Date: July 2017
Created by: JH
Reviewed by: WdS

DISCLAIMER: GeoAdvice does not warrant in any way the accuracy and completeness of the information shown on this map. Field verification of the accuracy and completeness of the information shown on this map is the sole responsibility of the user.

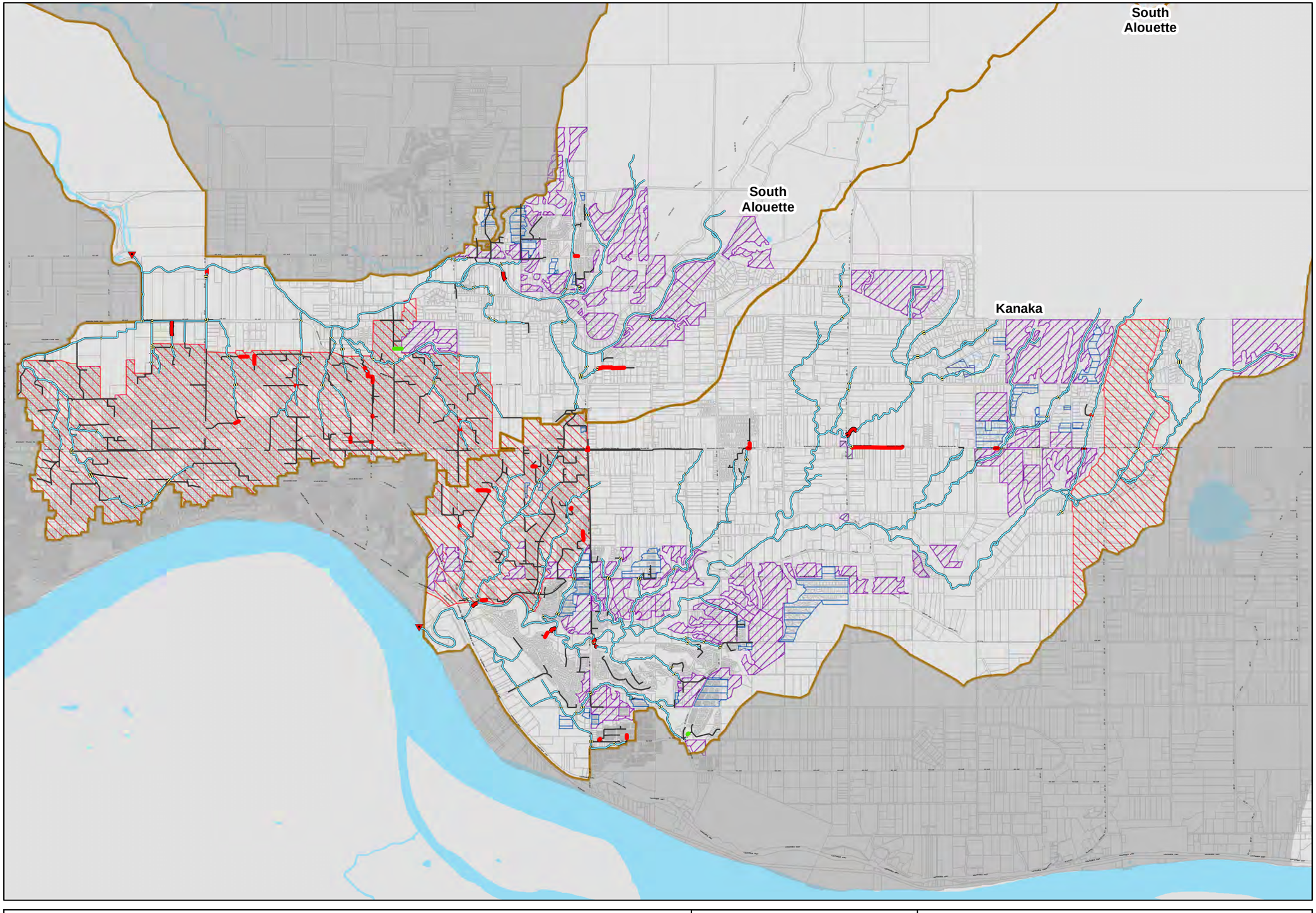
0 0.75 1.5 3
Kilometers

N
W E
S

Figure D.5

Appendix E Change in Performance – Future Land Use vs Existing Land Use – With Climate Change Figures

Unit 203, 2502 St Johns Street
Port Moody, British Columbia
V3H 2B4 Canada
Tel (604) 931-0550



GeoAdvice Engineering Inc.

Legend

- Watershed Boundary
- Recent Development (2011 - 2016)
- Future Development Densification
- Future Infill Development
- Parcel
- Outfall

Culvert Available Capacity Change

- Available Capacity Improves (0)
- Available Capacity Worsens (2)
- Culvert

Creek Available Capacity Change

- Available Capacity Improves (0)
- Available Capacity Worsens (7)
- Creek

Storm Main Available Capacity Change

- Available Capacity Improves (2)
- Available Capacity Worsens (50)
- Storm Main

Tier A & B controls applied to recent, future and infill development.

Comparative changes of less than 5% are not shown as they are considered insignificant and below the margin of error.

Mean Annual Rainfall With 10% Climate Change Available Capacity Change (Future Land Use vs Existing Land Use)

MAPLE RIDGE
BRITISH COLUMBIA

Project:	South Alouette and Kanaka Integrated Storm Water Management Plans
Client:	City of Maple Ridge, BC
Date:	July 2017
Created by:	JH
Reviewed by:	WdS

DISCLAIMER: GeoAdvice does not warrant in any way the accuracy and completeness of the information shown on this map. Field verification of the accuracy and completeness of the information shown on this map is the sole responsibility of the user.

0 0.75 1.5 3
Kilometers

N
W E
S

Figure E.1

South Alouette

South Alouette

Kanaka

GeoAdvice Engineering Inc.

Legend

- Watershed Boundary
- Recent Development (2011 - 2016)
- Future Development Densification
- Future Infill Development
- Parcel
- Outfall

Culvert Available Capacity Change

- Available Capacity Improves (0)
- Available Capacity Worsens (14)
- Culvert

Creek Available Capacity Change

- Available Capacity Improves (0)
- Available Capacity Worsens (14)
- Creek

Storm Main Available Capacity Change

- Available Capacity Improves (0)
- Available Capacity Worsens (68)
- Storm Main

Results presented represent the worst case hydraulic condition for each reach and control from all storm durations simulated
(30-min, 1-hr, 2-hr, 6-hr, 12-hr, and 24-hr)

Tier A, B & C controls applied to recent and future development.

Tier A & C controls applied to infill development.

Comparative changes of less than 5% are not shown as they are considered insignificant and below the margin of error.

10-Year, Critical Duration With 10% Climate Change Available Capacity Change (Future Land Use vs Existing Land Use)

MAPLE RIDGE
BRITISH COLUMBIA

Project: South Alouette and Kanaka Integrated Storm Water Management Plans
Client: City of Maple Ridge, BC
Date: July 2017
Created by: JH
Reviewed by: WdS

DISCLAIMER: GeoAdvice does not warrant in any way the accuracy and completeness of the information shown on this map. Field verification of the accuracy and completeness of the information shown on this map is the sole responsibility of the user.

0 0.75 1.5 3
Kilometers

N
W E
S

Figure E.2

South Alouette

South Alouette

Kanaka

GeoAdvice Engineering Inc.

Legend

- Watershed Boundary
- Recent Development (2011 - 2016)
- Future Development Densification
- Future Infill Development
- Parcel
- Outfall

Culvert Available Capacity Change

- Available Capacity Improves (0)
- Available Capacity Worsens (10)
- Culvert

Creek Available Capacity Change

- Available Capacity Improves (0)
- Available Capacity Worsens (31)
- Creek

Storm Main Available Capacity Change

- Available Capacity Improves (2)
- Available Capacity Worsens (87)
- Storm Main

Results presented represent the worst case hydraulic condition for each reach and control from all storm durations simulated
(30-min, 1-hr, 2-hr, 6-hr, 12-hr, and 24-hr)

Tier A, B & C controls applied to recent and future development.

Tier A & C controls applied to infill development.

Comparative changes of less than 5% are not shown as they are considered insignificant and below the margin of error.

100-Year, Critical Duration With 10% Climate Change Available Capacity Change (Future Land Use vs Existing Land Use)

MAPLE RIDGE
BRITISH COLUMBIA

Project:	South Alouette and Kanaka Integrated Storm Water Management Plans
Client:	City of Maple Ridge, BC
Date:	July 2017
Created by:	JH
Reviewed by:	WdS

DISCLAIMER: GeoAdvice does not warrant in any way the accuracy and completeness of the information shown on this map. Field verification of the accuracy and completeness of the information shown on this map is the sole responsibility of the user.

0 0.75 1.5 3
Kilometers

N
W E
S

Figure E.3

South Alouette

South Alouette

Kanaka

GeoAdvice Engineering Inc.

Legend

- Watershed Boundary
- Recent Development (2011 - 2016)
- Future Development Densification
- Future Infill Development
- Parcel
- Outfall

Culvert Available Capacity Change

- Available Capacity Improves (0)
- Available Capacity Worsens (8)
- Culvert

Creek Available Capacity Change

- Available Capacity Improves (0)
- Available Capacity Worsens (14)
- Creek

Storm Main Available Capacity Change

- Available Capacity Improves (1)
- Available Capacity Worsens (105)
- Storm Main

Tier A & B controls applied to recent, future and infill development.

Comparative changes of less than 5% are not shown as they are considered insignificant and below the margin of error.

Mean Annual Rainfall With 20% Climate Change Available Capacity Change (Future Land Use vs Existing Land Use)

MAPLE RIDGE
BRITISH COLUMBIA

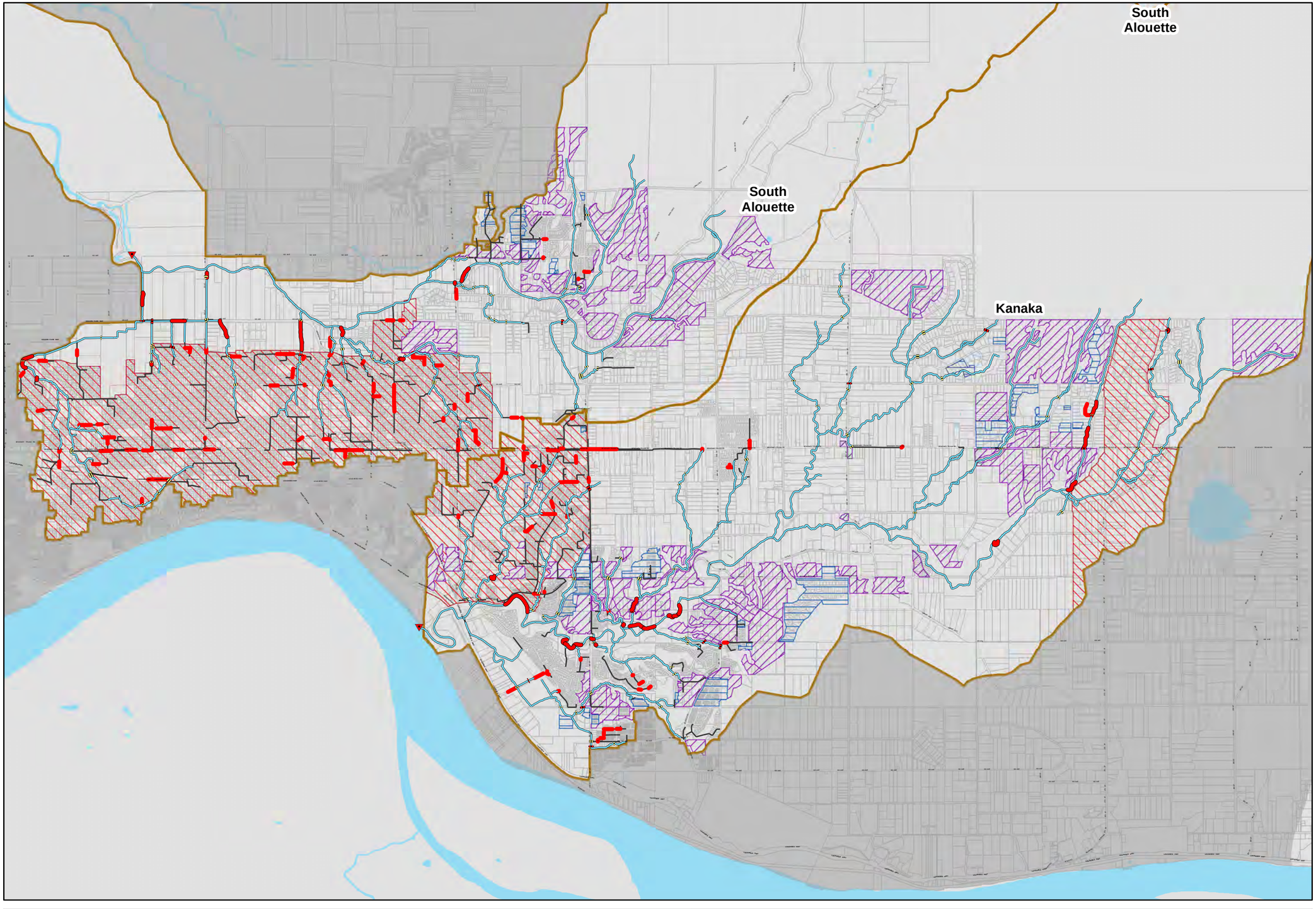
Project:	South Alouette and Kanaka Integrated Storm Water Management Plans
Client:	City of Maple Ridge, BC
Date:	July 2017
Created by:	JH
Reviewed by:	WdS

DISCLAIMER: GeoAdvice does not warrant in any way the accuracy and completeness of the information shown on this map. Field verification of the accuracy and completeness of the information shown on this map is the sole responsibility of the user.

0 0.75 1.5 3
Kilometers

N
W E
S

Figure E.4



GeoAdvice Engineering Inc.

Legend

- Watershed Boundary
- Recent Development (2011 - 2016)
- Future Development Densification
- Future Infill Development
- Parcel
- Outfall

Culvert Available Capacity Change

- Available Capacity Improves (0)
- Available Capacity Worsens (19)
- Culvert

Creek Available Capacity Change

- Available Capacity Improves (0)
- Available Capacity Worsens (32)
- Creek

Storm Main Available Capacity Change

- Available Capacity Improves (0)
- Available Capacity Worsens (161)
- Storm Main

Results presented represent the worst case hydraulic condition for each reach and control from all storm durations simulated
(30-min, 1-hr, 2-hr, 6-hr, 12-hr, and 24-hr)

Tier A, B & C controls applied to recent and future development.

Tier A & C controls applied to infill development.

Comparative changes of less than 5% are not shown as they are considered insignificant and below the margin of error.

10-Year, Critical Duration With 20% Climate Change Available Capacity Change (Future Land Use vs Existing Land Use)

MAPLE RIDGE
BRITISH COLUMBIA

Project: South Alouette and Kanaka Integrated Storm Water Management Plans
Client: City of Maple Ridge, BC
Date: July 2017
Created by: JH
Reviewed by: WdS

DISCLAIMER: GeoAdvice does not warrant in any way the accuracy and completeness of the information shown on this map. Field verification of the accuracy and completeness of the information shown on this map is the sole responsibility of the user.

0 0.75 1.5 3
Kilometers

N
W E
S

Figure E.5

South Alouette

South Alouette

Kanaka

GeoAdvice Engineering Inc.

Legend

- Watershed Boundary
- Recent Development (2011 - 2016)
- Future Development Densification
- Future Infill Development
- Parcel
- Outfall

Culvert Available Capacity Change

- Available Capacity Improves (0)
- Available Capacity Improves (17)
- Culvert

Creek Available Capacity Change

- Available Capacity Improves (0)
- Available Capacity Worsens (62)
- Creek

Storm Main Available Capacity Change

- Available Capacity Improves (3)
- Available Capacity Worsens (137)
- Storm Main

Results presented represent the worst case hydraulic condition for each reach and control from all storm durations simulated
(30-min, 1-hr, 2-hr, 6-hr, 12-hr, and 24-hr)

Tier A, B & C controls applied to recent and future development.

Tier A & C controls applied to infill development.

Comparative changes of less than 5% are not shown as they are considered insignificant and below the margin of error.

100-Year, Critical Duration With 20% Climate Change Available Capacity Change (Future Land Use vs Existing Land Use)

MAPLE RIDGE
BRITISH COLUMBIA

Project: South Alouette and Kanaka Integrated Storm Water Management Plans
Client: City of Maple Ridge, BC
Date: July 2017
Created by: JH
Reviewed by: WdS

DISCLAIMER: GeoAdvice does not warrant in any way the accuracy and completeness of the information shown on this map. Field verification of the accuracy and completeness of the information shown on this map is the sole responsibility of the user.

0 0.75 1.5 3
Kilometers

N
W E
S

Figure E.6

Appendix F Capacity Analysis Comparison Table

Unit 203, 2502 St Johns Street
Port Moody, British Columbia
V3H 2B4 Canada
Tel (604) 931-0550

South Alouette River and Kanaka Creek ISMP
Drainage Modeling of South Alouette River and Kanaka Creek Watersheds (Stage 2)

Capacity Assessment Comparison

Mean Annual Rainfall

Storm Main		Existing				Future (No Climate Change)				Future (10% Climate Change)				Future (20% Climate Change)			
Peak Flow / Pipe Full Capacity		**Count**	**Count %**	**Length**	**Length %**	**Count**	**Count %**	**Length**	**Length %**	**Count**	**Count %**	**Length**	**Length %**	**Count**	**Count %**	**Length**	**Length %**
GREEN	*< 1.05 OR Surcharge < 15 min*	1,086	85%	55,809	86%	1,090	85%	56,035	86%	1,034	81%	53,444	82%	990	78%	51,100	78%
YELLOW	*< 1.05 AND Surcharge > 15 min*	135	11%	5,852	9%	133	10%	5,767	9%	165	13%	6,997	11%	176	14%	7,465	11%
RED	*>= 1.05 AND Surcharge > 15 min*	55	4%	3,522	5%	53	4%	3,381	5%	77	6%	4,742	7%	110	9%	6,618	10%
Creek																	
Peak Flow / Creek Full Capacity																	
BLUE	*< 1.05 OR Surcharge < 15 min*	1,053	96%	115,399	96%	1,053	96%	115,399	96%	1,046	95%	114,467	95%	1040	95%	113,371	94%
YELLOW	*< 1.05 AND Surcharge > 15 min*	45	4%	4,638	4%	45	4%	4,638	4%	51	5%	5,484	5%	57	5%	6,580	5%
RED	*>= 1.05 AND Surcharge > 15 min (Potential Breach of Creek)*	1	0%	94	0%	1	0%	94	0%	2	0%	179	0%	2	0%	179	0%
Culvert																	
Peak Flow / Pipe Full Capacity																	
GREEN	*< 1.05 OR Surcharge < 15 min*	128	94%	2,505	94%	128	94%	2,505	94%	126	93%	2,453	92%	119	88%	2,334	87%
YELLOW	*< 1.05 AND Surcharge > 15 min*	6	4%	125	5%	6	4%	125	5%	8	6%	177	7%	15	11%	295	11%
RED	*>= 1.05 AND Surcharge > 15 min*	2	1%	40	2%	2	1%	40	2%	2	1%	40	2%	2	1%	40	2%
Junction (Only Junctions Connected to Storm Mains)																	
Maximum Water Surface Elevation @ Modeled Junctions																	
(Represents Underground Conveyance HGL)																	
GREEN	*< Ground - 0.6 m*	1,355	95%	NA	NA	1,358	95%	NA	NA	1,334	94%	NA	NA	1319	92%	NA	NA
YELLOW	*<= Ground and > Ground - 0.6 m*	58	4%	NA	NA	57	4%	NA	NA	76	5%	NA	NA	79	6%	NA	NA
RED	*> Ground*	13	1%	NA	NA	11	1%	NA	NA	16	1%	NA	NA	28	2%	NA	NA

Tier A & B controls applied to recent, future and infill development.

Capacity Assessment Comparison

10 Year, Critical Duration

Storm Main Peak Flow / Pipe Full Capacity		Existing				Future (No Climate Change)				Future (10% Climate Change)				Future (20% Climate Change)			
		Count	Count %	Length	Length %	Count	Count %	Length	Length %	Count	Count %	Length	Length %	Count	Count %	Length	Length %
GREEN	*< 1.05 OR Surcharge < 15 min*	833	65%	42,085	65%	831	65%	41,971	64%	769	60%	38,608	59%	695	54%	34,451	53%
YELLOW	*< 1.05 AND Surcharge > 15 min*	232	18%	10,325	16%	231	18%	10,168	16%	249	20%	10,886	17%	282	22%	12,397	19%
RED	*>= 1.05 AND Surcharge > 15 min*	211	17%	12,774	20%	214	17%	13,044	20%	258	20%	15,689	24%	299	23%	18,335	28%
Creek **Peak Flow / Creek Full Capacity**																	
BLUE	*< 1.05 OR Surcharge < 15 min*	998	91%	107,025	89%	997	91%	106,691	89%	982	89%	105,343	88%	969	88%	103,111	86%
YELLOW	*< 1.05 AND Surcharge > 15 min*	90	8%	11,022	9%	91	8%	11,356	9%	106	10%	12,704	11%	112	10%	13,905	12%
RED	*>= 1.05 AND Surcharge > 15 min (Potential Breach of Creek)*	11	1%	2,083	2%	11	1%	2,083	2%	11	1%	2,083	2%	18	2%	3,114	3%
Culvert **Peak Flow / Pipe Full Capacity**																	
GREEN	*< 1.05 OR Surcharge < 15 min*	103	76%	2,013	75%	101	74%	1,968	74%	90	66%	1,763	66%	87	64%	1,692	63%
YELLOW	*< 1.05 AND Surcharge > 15 min*	29	21%	568	21%	30	22%	590	22%	38	28%	721	27%	37	27%	725	27%
RED	*>= 1.05 AND Surcharge > 15 min*	4	3%	89	3%	5	4%	112	4%	8	6%	186	7%	12	9%	253	9%
Junction (Only Junctions Connected to Storm Mains) **Maximum Water Surface Elevation @ Modeled Junctions** **(Represents Underground Conveyance HGL)**																	
GREEN	*< Ground - 0.6 m*	1,216	85%	NA	NA	1,227	86%	NA	NA	1,183	83%	NA	NA	1,140	80%	NA	NA
YELLOW	*<= Ground and > Ground - 0.6 m*	138	10%	NA	NA	124	9%	NA	NA	142	10%	NA	NA	153	11%	NA	NA
RED	*> Ground*	72	5%	NA	NA	75	5%	NA	NA	101	7%	NA	NA	133	9%	NA	NA

Results presented represent the worst case hydraulic condition for each reach and control from all storm durations simulated (30-min, 1-hr, 2-hr, 6-hr, 12-hr, and 24-hr)

Tier A, B & C controls applied to recent and future development.

Tier A & C controls applied to infill development.

South Alouette River and Kanaka Creek ISMP
Drainage Modeling of South Alouette River and Kanaka Creek Watersheds (Stage 2)

Capacity Assessment Comparison

100 Year, Critical Duration

Storm Main Peak Flow / Pipe Full Capacity		Existing				Future (No Climate Change)				Future (10% Climate Change)				Future (20% Climate Change)			
		Count	Count %	Length	Length %	Count	Count %	Length	Length %	Count	Count %	Length	Length %	Count	Count %	Length	Length %
GREEN	*< 1.05 OR Surcharge < 15 min*	481	38%	22,277	34%	493	39%	22,629	35%	417	33%	18,631	29%	378	30%	16,930	26%
YELLOW	*< 1.05 AND Surcharge > 15 min*	366	29%	16,666	26%	345	27%	15,842	24%	377	30%	17,393	27%	385	30%	17,490	27%
RED	*>= 1.05 AND Surcharge > 15 min*	429	34%	26,241	40%	438	34%	26,712	41%	482	38%	29,160	45%	513	40%	30,763	47%
Creek **Peak Flow / Creek Full Capacity**																	
BLUE	*< 1.05 OR Surcharge < 15 min*	920	84%	98,020	82%	924	84%	98,525	82%	892	81%	92,807	77%	866	79%	89,700	75%
YELLOW	*< 1.05 AND Surcharge > 15 min*	151	14%	17,615	15%	146	13%	17,073	14%	172	16%	21,243	18%	188	17%	22,571	19%
RED	*>= 1.05 AND Surcharge > 15 min (Potential Breach of Creek)*	28	3%	4,496	4%	29	3%	4,532	4%	35	3%	6,080	5%	45	4%	7,859	7%
Culvert **Peak Flow / Pipe Full Capacity**																	
GREEN	*< 1.05 OR Surcharge < 15 min*	69	51%	1,351	51%	69	51%	1,376	52%	63	46%	1,253	47%	60	44%	1,197	45%
YELLOW	*< 1.05 AND Surcharge > 15 min*	49	36%	956	36%	47	35%	886	33%	49	36%	939	35%	49	36%	931	35%
RED	*>= 1.05 AND Surcharge > 15 min*	18	13%	363	14%	20	15%	407	15%	24	18%	478	18%	27	20%	542	20%
Junction (Only Junctions Connected to Storm Mains) **Maximum Water Surface Elevation @ Modeled Junctions** **(Represents Underground Conveyance HGL)**																	
GREEN	*< Ground - 0.6 m*	974	68%	NA	NA	970	68%	NA	NA	888	62%	NA	NA	817	57%	NA	NA
YELLOW	*<= Ground and > Ground - 0.6 m*	225	16%	NA	NA	214	15%	NA	NA	238	17%	NA	NA	258	18%	NA	NA
RED	*> Ground*	227	16%	NA	NA	242	17%	NA	NA	300	21%	NA	NA	351	25%	NA	NA

Results presented represent the worst case hydraulic condition for each reach and control from all storm durations simulated (30-min, 1-hr, 2-hr, 6-hr, 12-hr, and 24-hr)

Tier A, B & C controls applied to recent and future development.

Tier A & C controls applied to infill development.

ARDSA 10-Year 2-Day

Storm Main		Existing				Future (No Climate Change)			
Peak Flow / Pipe Full Capacity		**Count**	**Count %**	**Length**	**Length %**	**Count**	**Count %**	**Length**	**Length %**
GREEN	*< 1.05 OR Surcharge < 15 min*	1,142	89%	58,914	90%	1,143	90%	59,027	91%
YELLOW	*< 1.05 AND Surcharge > 15 min*	105	8%	4,703	7%	108	8%	4,972	8%
RED	*>= 1.05 AND Surcharge > 15 min*	29	2%	1,566	2%	25	2%	1,185	2%
Creek									
Peak Flow / Creek Full Capacity									
BLUE	*< 1.05 OR Surcharge < 15 min*	1,065	97%	117,272	98%	1,065	97%	117,272	98%
YELLOW	*< 1.05 AND Surcharge > 15 min*	34	3%	2,858	2%	34	3%	2,858	2%
RED	*>= 1.05 AND Surcharge > 15 min (Potential Breach of Creek)*	0	0%	-	0%	0	0%	-	0%
Culvert									
Peak Flow / Pipe Full Capacity									
GREEN	*< 1.05 OR Surcharge < 15 min*	129	95%	2,541	95%	130	96%	2,557	96%
YELLOW	*< 1.05 AND Surcharge > 15 min*	6	4%	109	4%	5	4%	93	4%
RED	*>= 1.05 AND Surcharge > 15 min*	1	1%	20	1%	1	1%	20	1%
Junction (Only Junctions Connected to Storm Mains)									
(Represents Underground Conveyance HGL)									
GREEN	*< Ground - 0.6 m*	1,377	97%	NA	NA	1,379	97%	NA	NA
YELLOW	*<= Ground and > Ground - 0.6 m*	47	3%	NA	NA	45	3%	NA	NA
RED	*> Ground*	2	0%	NA	NA	2	0%	NA	NA

Tier A, B & C controls applied to recent and future development.

Tier A & C controls applied to infill development.

ARDSA 10-Year 5-Day

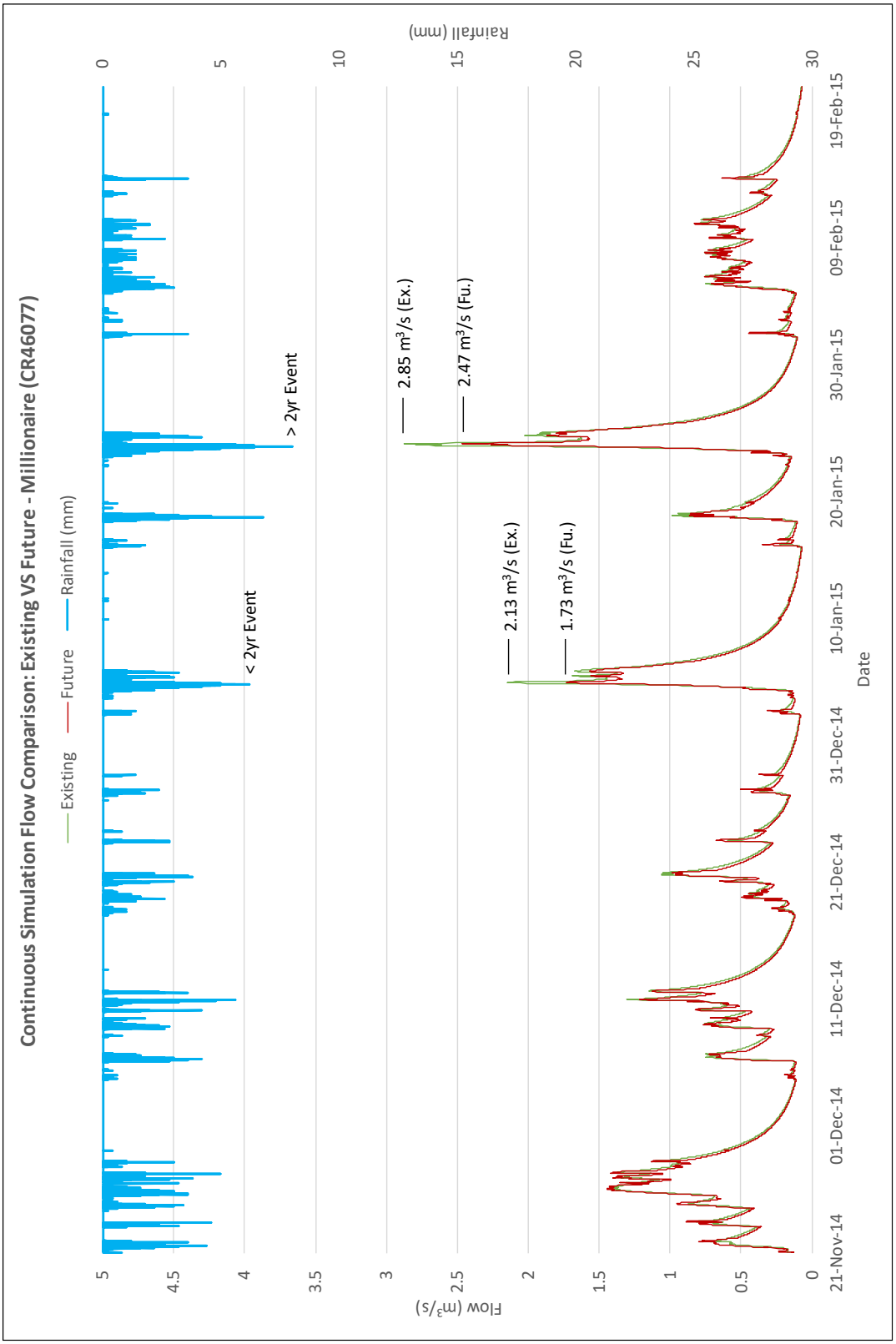
Storm Main		Existing				Future (No Climate Change)			
Peak Flow / Pipe Full Capacity		**Count**	**Count %**	**Length**	**Length %**	**Count**	**Count %**	**Length**	**Length %**
GREEN	*< 1.05 OR Surcharge < 15 min*	1,074	84%	54,888	84%	1,068	84%	54,686	84%
YELLOW	*< 1.05 AND Surcharge > 15 min*	145	11%	6,742	10%	148	12%	6,756	10%
RED	*>= 1.05 AND Surcharge > 15 min*	57	4%	3,553	5%	60	5%	3,742	6%
Creek									
Peak Flow / Creek Full Capacity									
BLUE	*< 1.05 OR Surcharge < 15 min*	1,037	94%	113,064	94%	1,037	94%	113,064	94%
YELLOW	*< 1.05 AND Surcharge > 15 min*	60	5%	6,887	6%	60	5%	6,887	6%
RED	*>= 1.05 AND Surcharge > 15 min (Potential Breach of Creek)*	2	0%	179	0%	2	0%	179	0%
Culvert									
Peak Flow / Pipe Full Capacity									
GREEN	*< 1.05 OR Surcharge < 15 min*	124	91%	2,426	91%	120	88%	2,354	88%
YELLOW	*< 1.05 AND Surcharge > 15 min*	10	7%	204	8%	13	10%	257	10%
RED	*>= 1.05 AND Surcharge > 15 min*	2	1%	40	2%	3	2%	60	2%
Junction (Only Junctions Connected to Storm Mains)									
(Represents Underground Conveyance HGL)									
GREEN	*< Ground - 0.6 m*	1,351	95%	NA	NA	1,352	95%	NA	NA
YELLOW	*<= Ground and > Ground - 0.6 m*	59	4%	NA	NA	60	4%	NA	NA
RED	*> Ground*	16	1%	NA	NA	14	1%	NA	NA

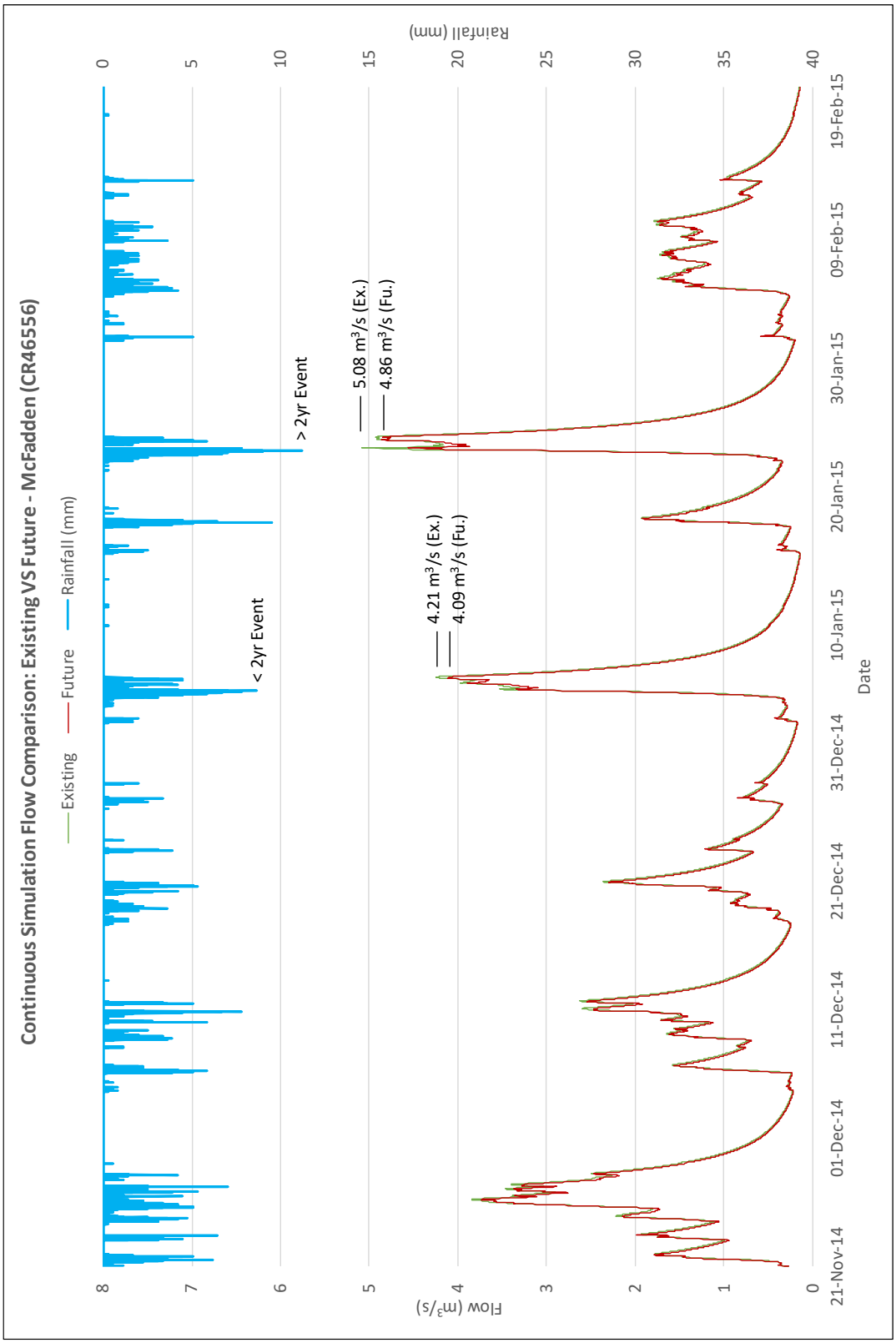
Tier A, B & C controls applied to recent and future development.

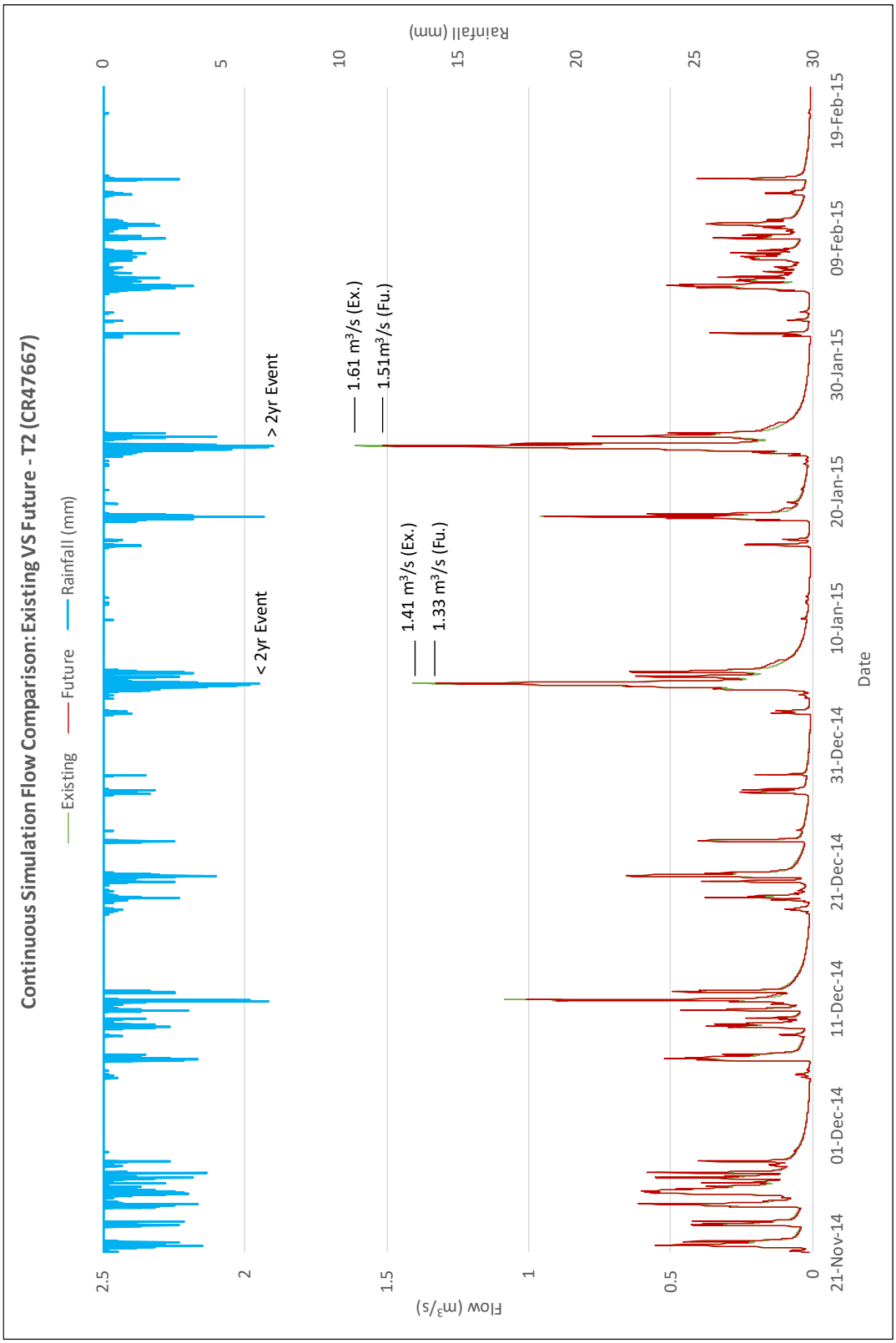
Tier A & C controls applied to infill development.

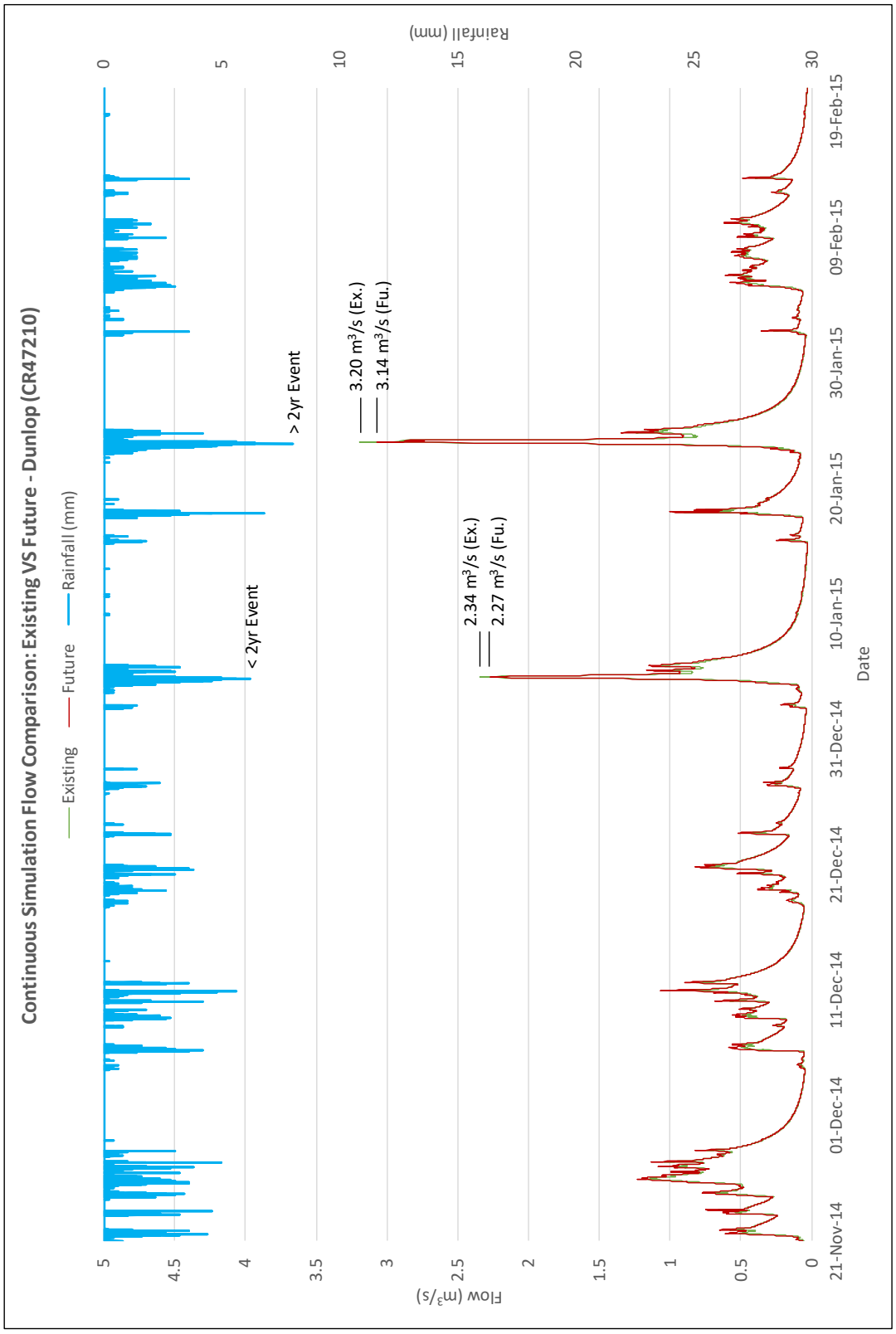
Appendix G Continuous Simulation Results

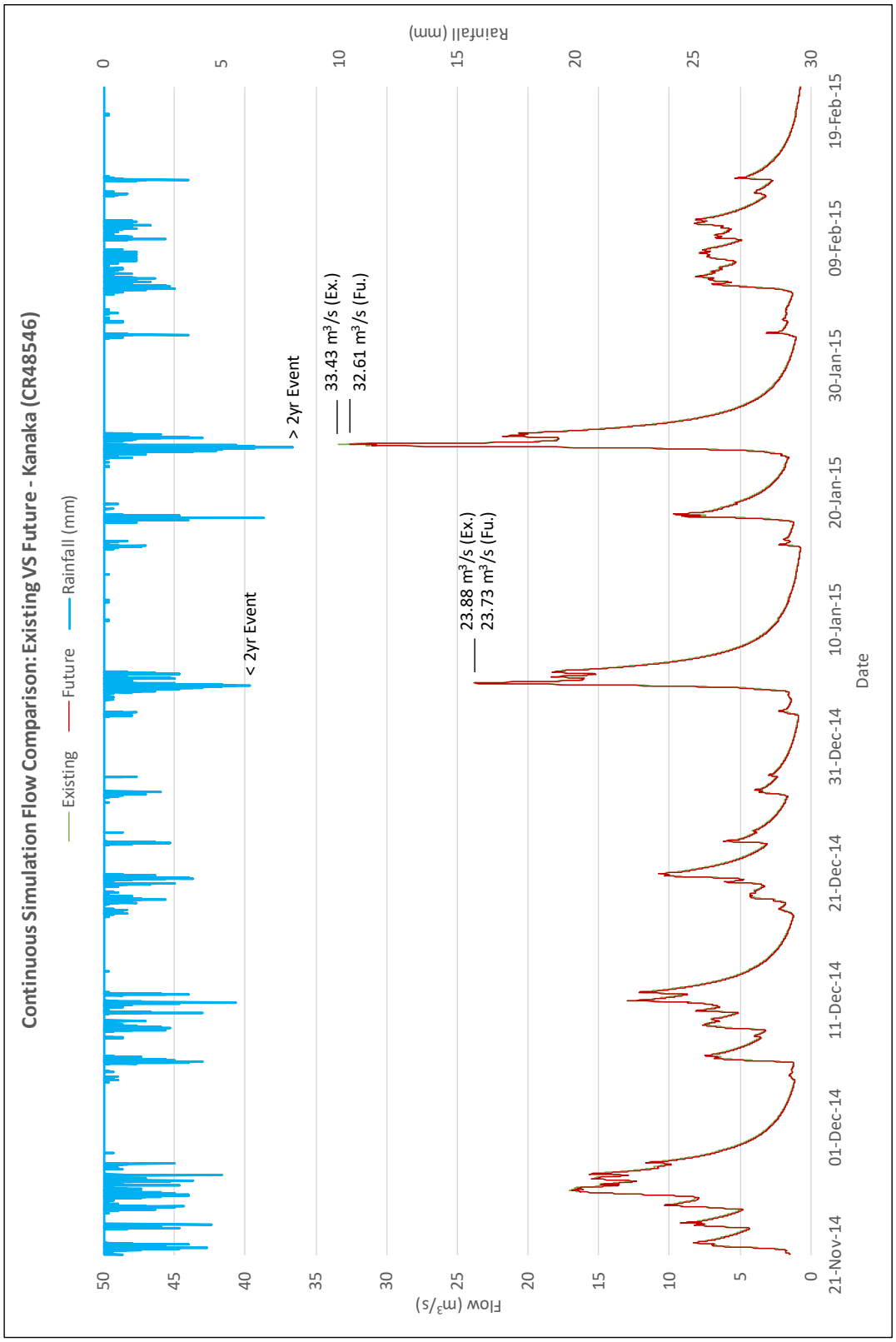
Unit 203, 2502 St Johns Street
Port Moody, British Columbia
V3H 2B4 Canada
Tel (604) 931-0550

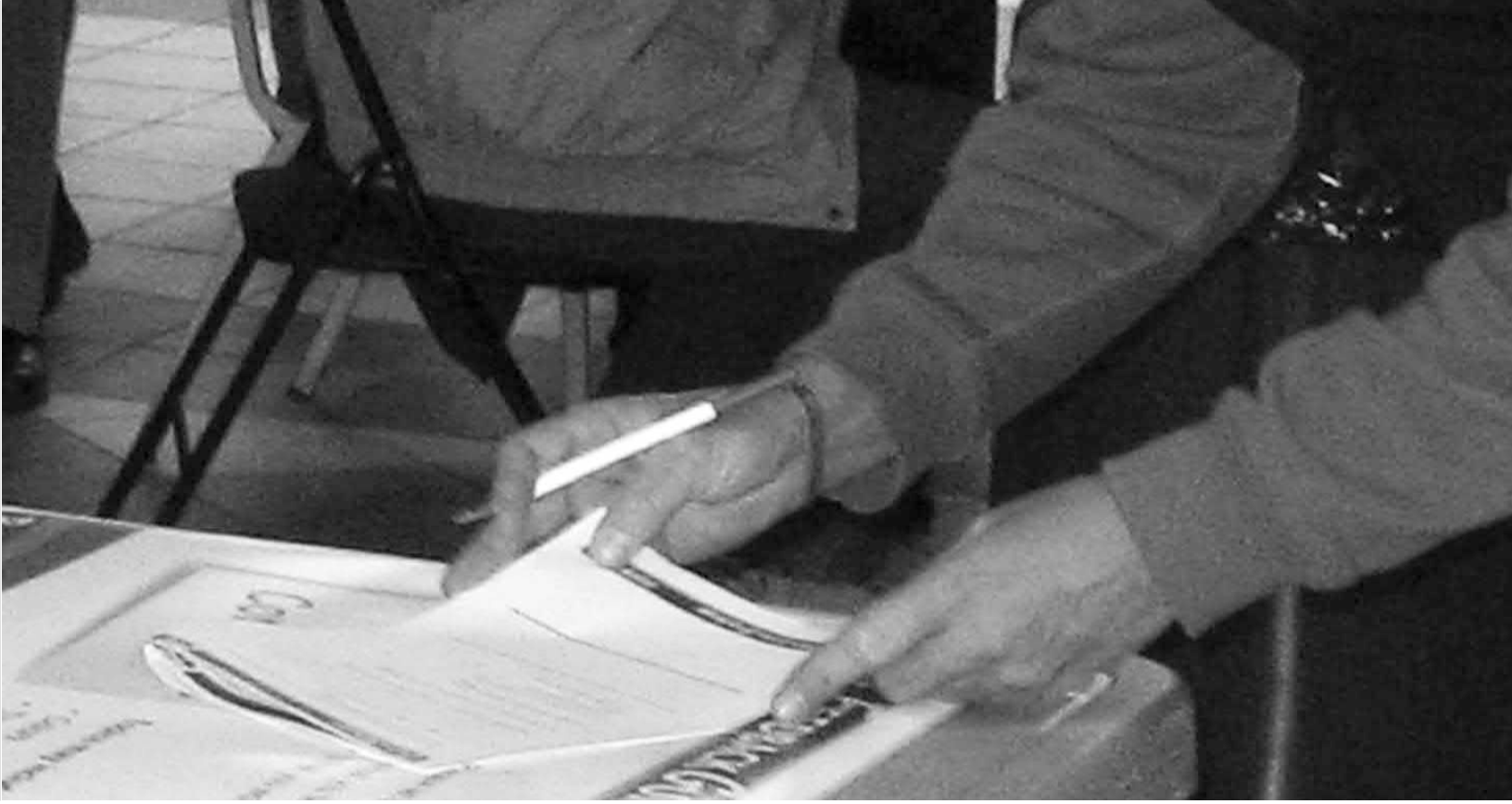

Continuous Simulation Flow Comparison: Existing VS Future - Millionaire (CR46077)
Existing
Future
Rainfall (mm)
< 2yr Event
> 2yr Event
2.85 m³/s (Ex.)
2.47 m³/s (Fu.)
2.13 m³/s (Ex.)
1.73 m³/s (Fu.)
Flow (m³/s)
Rainfall (mm)
Date
21-Nov-14
01-Dec-14
11-Dec-14
21-Dec-14
31-Dec-14
10-Jan-15
20-Jan-15
30-Jan-15
09-Feb-15
19-Feb-15


Continuous Simulation Flow Comparison: Existing VS Future - McFadden (CR46556)
Existing
Future
Rainfall (mm)
Rainfall (mm)
Flow (m³/s)
Date
< 2yr Event
> 2yr Event
5.08 m³/s (Ex.)
4.86 m³/s (Fu.)
4.21 m³/s (Ex.)
4.09 m³/s (Fu.)
21-Nov-14
01-Dec-14
11-Dec-14
21-Dec-14
31-Dec-14
10-Jan-15
20-Jan-15
30-Jan-15
09-Feb-15
19-Feb-15


Continuous Simulation Flow Comparison: Existing VS Future - T2 (CR47667)
Existing
Future
Rainfall (mm)
> 2yr Event
< 2yr Event
1.61 m³/s (Ex.)
1.51m³/s (Fu.)
1.41 m³/s (Ex.)
1.33 m³/s (Fu.)
Rainfall (mm)
Flow (m³/s)
Date
0
5
10
15
20
25
30
2.5
2
1.5
1
0.5
0
21-Nov-14
01-Dec-14
11-Dec-14
21-Dec-14
31-Dec-14
10-Jan-15
20-Jan-15
30-Jan-15
09-Feb-15
19-Feb-15


Continuous Simulation Flow Comparison: Existing VS Future - Dunlop (CR47210)
Existing
Future
Rainfall (mm)
< 2yr Event
> 2yr Event
3.20 m³/s (Ex.)
3.14 m³/s (Fu.)
2.34 m³/s (Ex.)
2.27 m³/s (Fu.)
Flow (m³/s)
Rainfall (mm)
Date
21-Nov-14
01-Dec-14
11-Dec-14
21-Dec-14
31-Dec-14
10-Jan-15
20-Jan-15
30-Jan-15
09-Feb-15
19-Feb-15


Continuous Simulation Flow Comparison: Existing VS Future - Kanaka (CR48546)
Existing
Future
Rainfall (mm)
Rainfall (mm)
Flow (m³/s)
Date
< 2yr Event
> 2yr Event
33.43 m³/s (Ex.)
32.61 m³/s (Fu.)
23.88 m³/s (Ex.)
23.73 m³/s (Fu.)
0
5
10
15
20
25
30
0
5
10
15
20
25
30
35
40
45
50
21-Nov-14
01-Dec-14
11-Dec-14
21-Dec-14
31-Dec-14
10-Jan-15
20-Jan-15
30-Jan-15
09-Feb-15
19-Feb-15



Appendix D: Erosion Potential Index

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GA Reach #	SECTIONNUM	STREAMNAME	SUBSTRATECLAYS	SUBSTRATESANDS	SUBSTRATEGRAVEL	SUBSTRATECOBBLES	SUBSTRATEBOLDERS	SUBSTRATECOMPACTION
CR46077	350	MILLIONAIRE CREEK	10	25	15	20	30	Medium
CR46556	11215	MCFADDEN CREEK	10	25	25	25	15	Medium
CR47210	2080	DUNLOP CREEK	10	65	25	0	0	Medium
CR47667	17003	T2	15	15	35	35	0	High
CR48546	32354	KANAKA CREEK	45	25	30	0	0	Medium

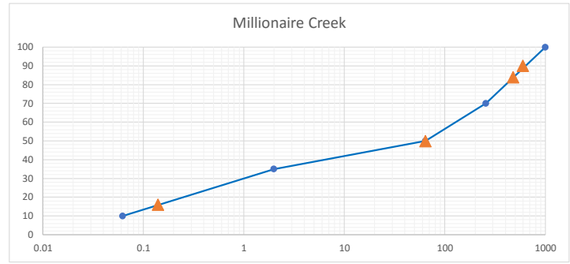
PSDs and associated Critical Bed Shear Stress values for Subject Sites:

1.181280602

0.667523766

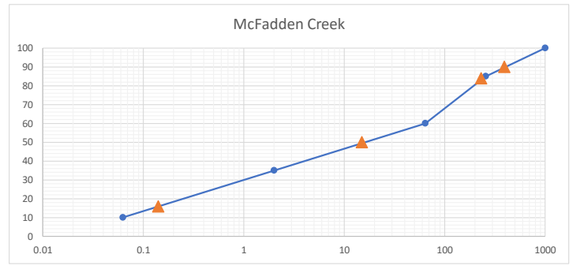
Millionaire Creek

1000	30	100	873.8 N/m2	
256	20	70	223.7 N/m2	
64	15	50	53.9 N/m2	
2	25	35	1.3 N/m2	
0.0625	10	10	0.1 N/m2	
	Estimated PSD (with critical bed shear stress value:			
	90	600 mm		524.3 N/m2
	84	480 mm		
	50	64 mm		53.9 N/m2
	16	0.14 mm		



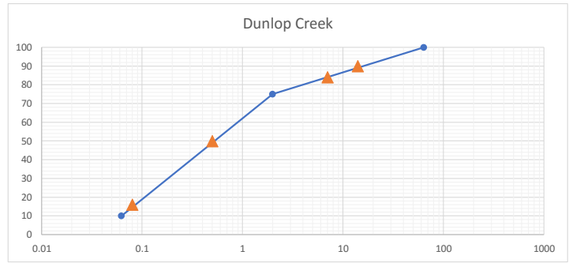
McFadden Creek

1000	15	100	873.8	
256	25	85	223.7	
64	25	60	53.9	
2	25	35	1.3	
0.0625	10	10	0.1	
	Estimated PSD			
	90	390 mm		340.8 N/m2
	84	230 mm		
	50	15 mm		11.4 N/m2
	16	0.14 mm		



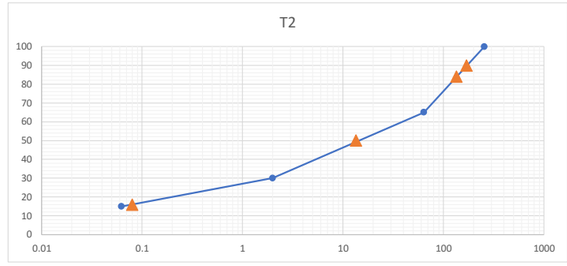
Dunlop Creek

1000	0		873.8	
256	0		223.7	
64	25	100	53.9	
2	65	75	1.3	
0.0625	10	10	0.1	
	Estimated PSD			
	90	14 mm		10.4 N/m2
	84	7 mm		
	50	0.5 mm		0.27 N/m2
	16	0.08 mm		



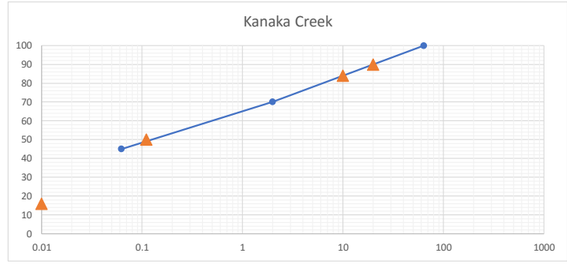
T2

1000	0		873.8	
256	35	100	223.7	
64	35	65	53.9	
2	15	30	1.3	
0.0625	15	15	0.1	
Estimated PSD				
	90	170 mm		148.5 N/m2
	84	135 mm		
	50	13.5 mm		10.0 N/m2
	16	0.08 mm		



Kanaka Creek

1000	0		873.8	
256	0		223.7	
64	30	100	53.9	
2	25	70	1.3	
0.0625	45	45	0.1	
Estimated PSD				
	90	20 mm		15.5 N/m2
	84	10 mm		
	50	0.11 mm		0.12 N/m2
	16	0.01 mm		



Model Creek ID	Creek Name	Location	Existing Max Flow (m3/s)	Future Max Flow (m3/s)	Climate Change 10% Flow (m3/s)	Climate Change 20% Flow (m3/s)	Length (m)	Roughness Coefficient	Slope
CR46077	Millionaire	Fern Cres.	2.878	2.468	2.749	3.148	67.277	0.03	0.052
CR46556	McFadden	264 St.	5.082	4.857	5.238	5.797	153.787	0.03	0.056
CR47667	T2	126 Ave.	1.613	1.513	1.760	2.121	111.865	0.03	0.011
CR47210	Dunlop	Discharge to Kanaka	3.195	3.073	3.604	4.070	48.183	0.03	0.019
CR48546	Kanaka	Downstream Dunlop Tributary	33.427	32.609	38.839	45.192	53.067	0.03	0.004

Simulation Period:

From	2014-11-21
To	2015-02-21

Millionaire Creek | **Existing**

Erosion Potential Analysis | **Existing: Continuous-Winter-2014-2015**

Final Date	Days-Hour	Flow (m3/s)	Depth (m)	Flow Volume (m3)	Top Width (m)	Hydraulic Depth (m)	Velocity (m/s)
21-Nov-14	Day 0; 00:15	0.148	0.157	55.04	6.998	0.117	0.199
21-Nov-14	Day 0; 00:30	0.142	0.156	54.668	6.988	0.116	0.192
21-Nov-14	Day 0; 00:45	0.129	0.15	52.321	6.939	0.112	0.183
21-Nov-14	Day 0; 01:00	0.135	0.153	53.388	6.961	0.114	0.187
21-Nov-14	Day 0; 01:15	0.15	0.157	55.224	7.003	0.117	0.2
21-Nov-14	Day 0; 01:30	0.16	0.159	55.847	7.018	0.118	0.21
21-Nov-14	Day 0; 01:45	0.166	0.16	56.245	7.028	0.119	0.216
20-Feb-15	Day 91; 23:15	0.074	0.138	47.828	6.819	0.104	0.119
20-Feb-15	Day 91; 23:30	0.074	0.138	47.816	6.818	0.104	0.119
20-Feb-15	Day 91; 23:45	0.074	0.138	47.804	6.818	0.104	0.119
21-Feb-15	Day 92; 00:00	0.074	0.138	47.792	6.818	0.104	0.119
***	**Mean**	**0.413**	**0.203**	**79.482**	**7.460**	**0.155**	**0.324**
	Median	**0.292**	**0.187**	**68.660**	**7.294**	**0.140**	**0.303**
	Max	**2.878**	**0.478**	**277.185**	**11.130**	**0.370**	**0.832**

Future

Future: Continuous-Winter-2014-2015

HGL (m)	Froude #	Shear Stress (Tractive Force) (N/m2)	Flow (m3/s)	Depth (m)	Flow Volume (m3)	Top Width (m)
25.107	0.186	59.663	0.145	0.156	54.871	6.993
25.106	0.180	59.153	0.139	0.155	54.536	6.984
25.103	0.175	57.114	0.13	0.151	52.341	6.94
25.105	0.177	58.134	0.144	0.154	53.722	6.972
25.108	0.187	59.663	0.168	0.159	55.92	7.023
25.11	0.195	60.173	0.183	0.161	56.805	7.044
25.111	0.200	60.683	0.2	0.163	57.614	7.065
25.09	0.118	53.034	0.071	0.138	47.673	6.813
25.09	0.118	53.034	0.071	0.138	47.661	6.813
25.09	0.118	53.034	0.07	0.138	47.65	6.813
25.09	0.118	53.034	0.07	0.138	47.638	6.812
25.137	**0.256**	**78.924**	**0.391**	**0.201**	**78.782**	**7.444**
25.132	**0.257**	**71.392**	**0.276**	**0.185**	**68.189**	**7.282**
25.276	**0.454**	**188.679**	**2.468**	**0.467**	**269.789**	**10.926**

					Future Climate Change by 10%: Continuous-Winte	
Hydraulic Depth (m)	Velocity (m/s)	HGL (m)	Froude #	Shear Stress (Tractive Force) (N/m2)	Flow (m3/s)	Depth (m)
0.117	0.195	25.107	0.18	59.663	0.145	0.156
0.116	0.189	25.105	0.18	59.153	0.139	0.155
0.112	0.185	25.104	0.18	57.114	0.131	0.151
0.115	0.198	25.107	0.19	58.643	0.147	0.154
0.118	0.22	25.111	0.20	60.173	0.171	0.159
0.12	0.235	25.114	0.22	61.193	0.188	0.162
0.121	0.252	25.117	0.23	61.703	0.207	0.164
0.104	0.114	25.089	0.11	53.034	0.074	0.139
0.104	0.114	25.089	0.11	53.034	0.074	0.139
0.104	0.114	25.089	0.11	53.034	0.074	0.139
0.104	0.114	25.089	0.11	53.034	0.074	0.138
0.154	**0.311**	**25.135**	**0.247**	**78.439**	**0.430**	**0.207**
0.139	**0.288**	**25.130**	**0.245**	**70.882**	**0.299**	**0.189**
0.367	**0.718**	**25.260**	**0.424**	**187.149**	**2.749**	**0.494**

er-2014-2015

Flow Volume (m3)	Top Width (m)	Hydraulic Depth (m)	Velocity (m/s)	HGL (m)	Froude #	Shear Stress (Tractive Force) (N/m2)
54.872	6.993	0.117	0.195	25.107	0.182	59.663
54.542	6.984	0.116	0.189	25.105	0.177	59.153
52.378	6.941	0.112	0.186	25.104	0.177	57.114
53.821	6.975	0.115	0.201	25.107	0.189	58.643
56.089	7.027	0.119	0.223	25.112	0.206	60.683
57.03	7.05	0.12	0.239	25.115	0.220	61.193
57.928	7.073	0.122	0.258	25.118	0.236	62.213
47.971	6.821	0.105	0.119	25.09	0.117	53.544
47.959	6.821	0.105	0.118	25.09	0.116	53.544
47.946	6.821	0.104	0.118	25.09	0.117	53.034
47.934	6.82	0.104	0.118	25.09	0.117	53.034
81.966	**7.502**	**0.158**	**0.326**	**25.138**	**0.255**	**80.709**
70.036	**7.321**	**0.142**	**0.301**	**25.133**	**0.253**	**72.412**
294.297	**11.437**	**0.383**	**0.769**	**25.271**	**0.429**	**195.308**

Future

Climate Change by 20%: Continuous-Winter-2014-2015

Flow (m3/s)	Depth (m)	Flow Volume (m3)	Top Width (m)	Hydraulic Depth (m)	Velocity (m/s)	HGL (m)
0.145	0.156	54.873	6.993	0.117	0.195	25.107
0.139	0.155	54.549	6.985	0.116	0.189	25.105
0.132	0.151	52.415	6.942	0.112	0.187	25.104
0.149	0.155	53.923	6.978	0.115	0.203	25.107
0.175	0.16	56.26	7.031	0.119	0.227	25.112
0.192	0.162	57.256	7.056	0.121	0.244	25.116
0.213	0.165	58.243	7.081	0.122	0.264	25.119
0.077	0.139	48.249	6.829	0.105	0.122	25.091
0.077	0.139	48.236	6.829	0.105	0.122	25.091
0.077	0.139	48.222	6.828	0.105	0.122	25.091
0.076	0.139	48.209	6.828	0.105	0.122	25.091
0.469	**0.212**	**85.090**	**7.559**	**0.162**	**0.340**	**25.141**
0.320	**0.193**	**71.822**	**7.358**	**0.145**	**0.313**	**25.136**
3.148	**0.533**	**331.611**	**12.402**	**0.398**	**0.825**	**25.285**

			Existing Excess Shear Stress, by PSD			
		Particle Size (d) (mm)	0.0625		2	
		Critical Shear Stress (N/m2)	0.1	1	1.3	10
Froude #	Shear Stress (Tractive Force) (N/m2)		(N/m2)	(N/m2)	(N/m2)	(N/m2)
0.182	59.663		459.69	449.31	445.87	349.98
0.177	59.153		453.80	443.46	440.04	344.61
0.178	57.114		430.50	420.35	416.98	323.39
0.191	58.643		442.10	431.86	428.46	333.95
0.210	60.683		459.69	449.31	445.87	349.98
0.224	61.703		465.61	455.18	451.73	355.39
0.241	62.213		471.55	461.08	457.61	360.82
0.120	53.544		385.13	375.35	372.10	282.30
0.120	53.544		385.13	375.35	372.10	282.30
0.120	53.544		385.13	375.35	372.10	282.30
0.120	53.544		385.13	375.35	372.10	282.30
0.262	**82.865**	**Sum**	**6381228.32**	**6276727.60**	**6242037.81**	**5266845.21**
0.261	**73.942**	**Erosion Potential Index**	**1**	**1**	**1**	**1**
0.434	**202.957**					

					For D50	For D90
64		256		1000	64	600
53.9	100	223.7	500	873.8	53.9	524.3
(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)
13.83	0.00	0.00	0.00	0.00	13.83	0.00
12.04	0.00	0.00	0.00	0.00	12.04	0.00
5.76	0.00	0.00	0.00	0.00	5.76	0.00
8.71	0.00	0.00	0.00	0.00	8.71	0.00
13.83	0.00	0.00	0.00	0.00	13.83	0.00
15.71	0.00	0.00	0.00	0.00	15.71	0.00
17.67	0.00	0.00	0.00	0.00	17.67	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00
1447721.69	**194113.44**	**0.00**	**0.00**	**0.00**	**1447721.69**	**0.00**
1	**1**	**1**	**1**	**1**	**1**	**1**

Future Excess Shear Stress, by PSD

0.0625		2		64		256
0.1	1	1.3	10	53.9	100	223.7
(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)
459.69	449.31	445.87	349.98	13.83	0.00	0.00
453.80	443.46	440.04	344.61	12.04	0.00	0.00
430.50	420.35	416.98	323.39	5.76	0.00	0.00
447.93	437.64	434.23	339.26	10.33	0.00	0.00
465.61	455.18	451.73	355.39	15.71	0.00	0.00
477.52	467.00	463.52	366.28	19.70	0.00	0.00
483.51	472.95	469.45	371.77	21.80	0.00	0.00
385.13	375.35	372.10	282.30	0.00	0.00	0.00
385.13	375.35	372.10	282.30	0.00	0.00	0.00
385.13	375.35	372.10	282.30	0.00	0.00	0.00
385.13	375.35	372.10	282.30	0.00	0.00	0.00
6320265.21	**6216075.65**	**6181489.83**	**5209401.62**	**1410648.56**	**186141.42**	**0.00**
0.990	**0.990**	**0.990**	**0.989**	**0.974**	**0.959**	**#DIV/0!**

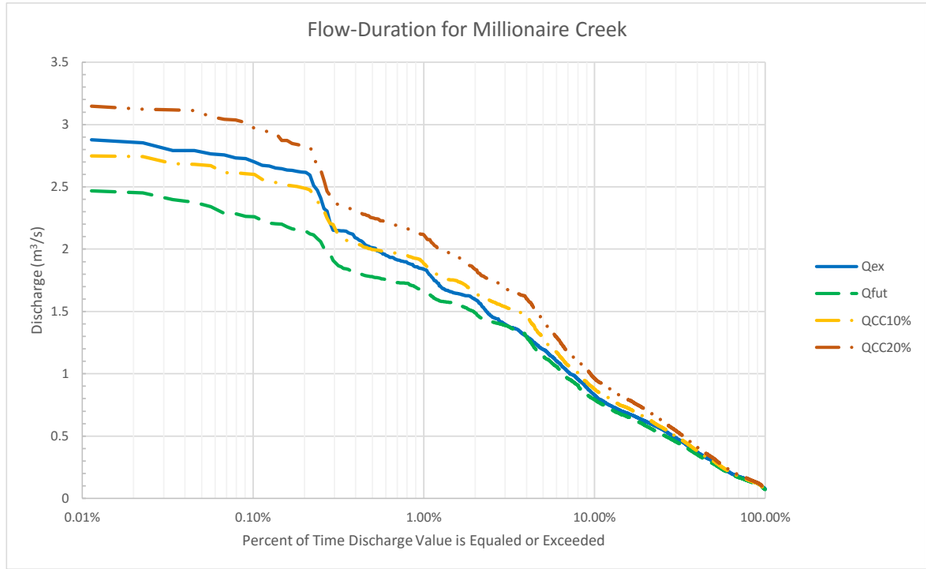
		For D50	For D90	Future 10% Climate Change Excess Shear Stress, by PSD		
	1000	64	600	0.0625		2
500	873.8	53.9	524.3	0.1	1	1.3
(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)
0.00	0.00	13.83	0.00	459.69	449.31	445.87
0.00	0.00	12.04	0.00	453.80	443.46	440.04
0.00	0.00	5.76	0.00	430.50	420.35	416.98
0.00	0.00	10.33	0.00	447.93	437.64	434.23
0.00	0.00	15.71	0.00	471.55	461.08	457.61
0.00	0.00	19.70	0.00	477.52	467.00	463.52
0.00	0.00	21.80	0.00	489.52	478.92	475.41
0.00	0.00	0.00	0.00	390.70	380.88	377.62
0.00	0.00	0.00	0.00	390.70	380.88	377.62
0.00	0.00	0.00	0.00	385.13	375.35	372.10
0.00	0.00	0.00	0.00	385.13	375.35	372.10
0.00	**0.00**	**1410648.56**	**0.00**	**6617705.35**	**6512116.53**	**6477063.08**
#DIV/0!	**#DIV/0!**	**0.974**	**#DIV/0!**	**1.037**	**1.038**	**1.038**

						For D50
	64		256		1000	64
10	53.9	100	223.7	500	873.8	53.9
(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)
349.98	13.83	0.00	0.00	0.00	0.00	13.83
344.61	12.04	0.00	0.00	0.00	0.00	12.04
323.39	5.76	0.00	0.00	0.00	0.00	5.76
339.26	10.33	0.00	0.00	0.00	0.00	10.33
360.82	17.67	0.00	0.00	0.00	0.00	17.67
366.28	19.70	0.00	0.00	0.00	0.00	19.70
377.28	23.97	0.00	0.00	0.00	0.00	23.97
287.34	0.00	0.00	0.00	0.00	0.00	0.00
287.34	0.00	0.00	0.00	0.00	0.00	0.00
282.30	0.00	0.00	0.00	0.00	0.00	0.00
282.30	0.00	0.00	0.00	0.00	0.00	0.00
5491025.00	1603038.03	247979.20	0.00	0.00	0.00	1603038.03
1.043	1.107	1.277	#DIV/0!	#DIV/0!	#DIV/0!	1.107

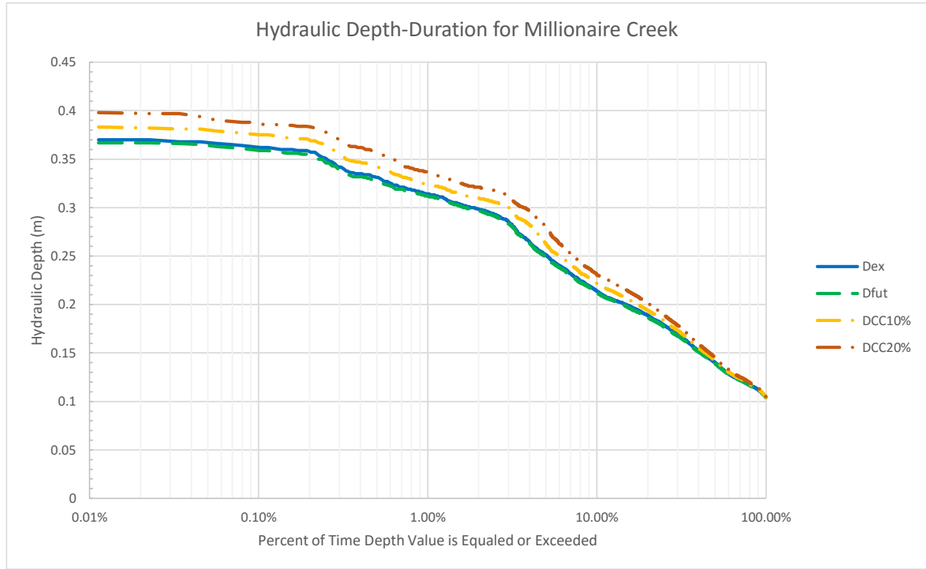
For D90	Future 20% Climate Change Excess Shear Stress, by PSD					
600	0.0625		2		64	
524.3	0.1	1	1.3	10	53.9	100
(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)
0.00	459.69	449.31	445.87	349.98	13.83	0.00
0.00	453.80	443.46	440.04	344.61	12.04	0.00
0.00	430.50	420.35	416.98	323.39	5.76	0.00
0.00	447.93	437.64	434.23	339.26	10.33	0.00
0.00	471.55	461.08	457.61	360.82	17.67	0.00
0.00	483.51	472.95	469.45	371.77	21.80	0.00
0.00	489.52	478.92	475.41	377.28	23.97	0.00
0.00	390.70	380.88	377.62	287.34	0.00	0.00
0.00	390.70	380.88	377.62	287.34	0.00	0.00
0.00	390.70	380.88	377.62	287.34	0.00	0.00
0.00	390.70	380.88	377.62	287.34	0.00	0.00
0.00	**6904929.20**	**6798028.85**	**6762537.15**	**5763450.95**	**1792831.64**	**315934.48**
#DIV/0!	**1.082**	**1.083**	**1.083**	**1.094**	**1.238**	**1.628**

				For D50	For D90
256		1000		64	600
223.7	500	873.8		53.9	524.3
(N/m2)	(N/m2)	(N/m2)		(N/m2)	(N/m2)
0.00	0.00	0.00		13.83	0.00
0.00	0.00	0.00		12.04	0.00
0.00	0.00	0.00		5.76	0.00
0.00	0.00	0.00		10.33	0.00
0.00	0.00	0.00		17.67	0.00
0.00	0.00	0.00		21.80	0.00
0.00	0.00	0.00		23.97	0.00
0.00	0.00	0.00		0.00	0.00
0.00	0.00	0.00		0.00	0.00
0.00	0.00	0.00		0.00	0.00
0.00	0.00	0.00		0.00	0.00
0.00	**0.00**	**0.00**		**1792831.64**	**0.00**
#DIV/0!	**#DIV/0!**	**#DIV/0!**		**1.238**	**#DIV/0!**

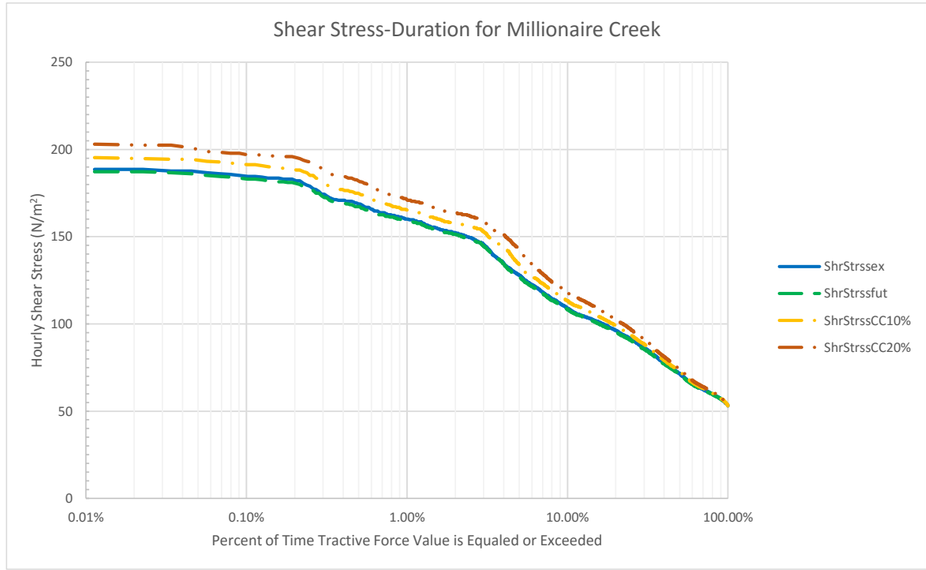
	Plot Pos	Q_{ex}	Q_{fut}	$Q_{CC10\%}$	$Q_{CC20\%}$
Count	8832	(m3/s)	(m3/s)	(m3/s)	(m3/s)
1	0.01132%	2.878	2.468	2.749	3.148
2	0.02264%	2.852	2.452	2.742	3.124
3	0.03396%	2.792	2.397	2.686	3.118
4	0.04528%	2.792	2.376	2.681	3.111
5	0.05661%	2.764	2.342	2.67	3.064
6	0.06793%	2.756	2.288	2.614	3.041
7	0.07925%	2.732	2.285	2.613	3.037
8	0.09057%	2.726	2.263	2.606	3.016
9	0.10189%	2.699	2.26	2.599	2.969
10	0.11321%	2.672	2.231	2.56	2.95
11	0.12453%	2.667	2.209	2.546	2.941
12	0.13585%	2.65	2.203	2.536	2.935
13	0.14718%	2.645	2.201	2.518	2.873
14	0.15850%	2.635	2.179	2.513	2.872
15	0.16982%	2.633	2.164	2.507	2.848
16	0.18114%	2.625	2.156	2.502	2.839
17	0.19246%	2.62	2.146	2.494	2.833
18	0.20378%	2.615	2.145	2.486	2.83
19	0.21510%	2.595	2.123	2.476	2.818
20	0.22642%	2.51	2.115	2.432	2.766
21	0.23774%	2.474	2.085	2.376	2.643
22	0.24907%	2.41	2.06	2.374	2.637
23	0.26039%	2.325	2.006	2.309	2.552
24	0.27171%	2.306	2.002	2.25	2.466
25	0.28303%	2.211	1.963	2.207	2.429
26	0.29435%	2.151	1.909	2.197	2.399
27	0.30567%	2.15	1.888	2.152	2.363
28	0.31699%	2.149	1.866	2.113	2.361
29	0.32831%	2.148	1.859	2.088	2.352
30	0.33964%	2.147	1.846	2.077	2.346
31	0.35096%	2.145	1.843	2.07	2.34
32	0.36228%	2.13	1.836	2.065	2.335



	Plot Pos	D_{ex}	D_{fut}	$D_{CC10\%}$	$D_{CC20\%}$
Count	8832	(m)	(m)	(m)	(m)
1	0.01132%	0.37	0.367	0.383	0.398
2	0.02264%	0.37	0.367	0.382	0.397
3	0.03396%	0.368	0.366	0.381	0.397
4	0.04528%	0.368	0.365	0.381	0.394
5	0.05661%	0.366	0.363	0.379	0.39
6	0.06793%	0.365	0.362	0.378	0.389
7	0.07925%	0.364	0.361	0.377	0.388
8	0.09057%	0.363	0.36	0.376	0.388
9	0.10189%	0.362	0.359	0.375	0.386
10	0.11321%	0.362	0.359	0.375	0.386
11	0.12453%	0.361	0.358	0.374	0.386
12	0.13585%	0.36	0.357	0.373	0.385
13	0.14718%	0.36	0.356	0.372	0.385
14	0.15850%	0.36	0.356	0.372	0.385
15	0.16982%	0.359	0.356	0.371	0.384
16	0.18114%	0.359	0.355	0.371	0.384
17	0.19246%	0.359	0.355	0.371	0.384
18	0.20378%	0.357	0.354	0.369	0.383
19	0.21510%	0.357	0.353	0.369	0.382
20	0.22642%	0.354	0.35	0.367	0.38
21	0.23774%	0.352	0.35	0.366	0.379
22	0.24907%	0.351	0.346	0.363	0.378
23	0.26039%	0.348	0.346	0.363	0.376
24	0.27171%	0.347	0.343	0.36	0.375
25	0.28303%	0.345	0.343	0.359	0.373
26	0.29435%	0.342	0.34	0.356	0.371
27	0.30567%	0.342	0.338	0.355	0.37
28	0.31699%	0.34	0.338	0.353	0.367
29	0.32831%	0.338	0.335	0.35	0.365
30	0.33964%	0.337	0.334	0.349	0.364
31	0.35096%	0.336	0.333	0.348	0.363
32	0.36228%	0.336	0.332	0.348	0.363

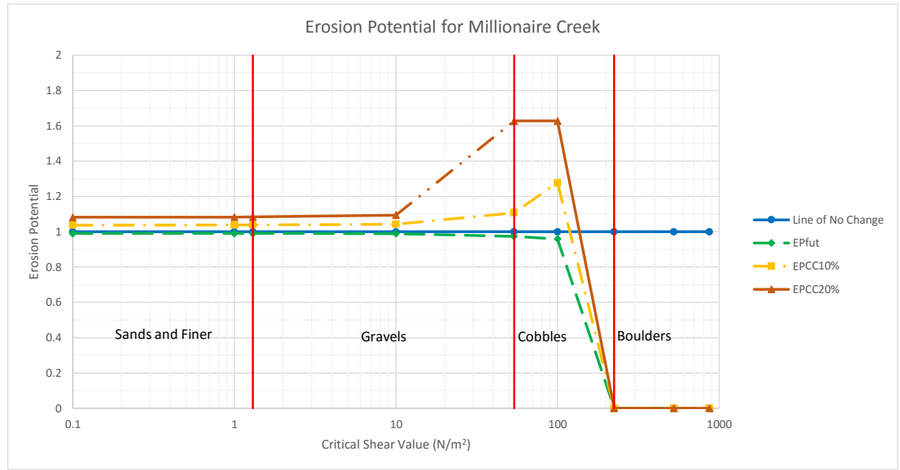


	Plot Pos	$ShrStrss_{ex}$	$ShrStrss_{fut}$	$ShrStrssCC_{10\%}$	$ShrStrss_{CC20\%}$
Count	8832	(N/m2)	(N/m2)	(N/m2)	(N/m2)
1	0.01132%	188.679	187.149	195.308	202.957
2	0.02264%	188.679	187.149	194.798	202.447
3	0.03396%	187.659	186.639	194.288	202.447
4	0.04528%	187.659	186.129	194.288	200.918
5	0.05661%	186.639	185.109	193.268	198.878
6	0.06793%	186.129	184.599	192.759	198.368
7	0.07925%	185.619	184.089	192.249	197.858
8	0.09057%	185.109	183.58	191.739	197.858
9	0.10189%	184.599	183.07	191.229	196.838
10	0.11321%	184.599	183.07	191.229	196.838
11	0.12453%	184.089	182.56	190.719	196.838
12	0.13585%	183.58	182.05	190.209	196.328
13	0.14718%	183.58	181.54	189.699	196.328
14	0.15850%	183.58	181.54	189.699	196.328
15	0.16982%	183.07	181.54	189.189	195.818
16	0.18114%	183.07	181.03	189.189	195.818
17	0.19246%	183.07	181.03	189.189	195.818
18	0.20378%	182.05	180.52	188.169	195.308
19	0.21510%	182.05	180.01	188.169	194.798
20	0.22642%	180.52	178.48	187.149	193.778
21	0.23774%	179.5	178.48	186.639	193.268
22	0.24907%	178.99	176.44	185.109	192.759
23	0.26039%	177.46	176.44	185.109	191.739
24	0.27171%	176.95	174.911	183.58	191.229
25	0.28303%	175.93	174.911	183.07	190.209
26	0.29435%	174.401	173.381	181.54	189.189
27	0.30567%	174.401	172.361	181.03	188.679
28	0.31699%	173.381	172.361	180.01	187.149
29	0.32831%	172.361	170.831	178.48	186.129
30	0.33964%	171.851	170.321	177.97	185.619
31	0.35096%	171.341	169.811	177.46	185.109
32	0.36228%	171.341	169.301	177.46	185.109

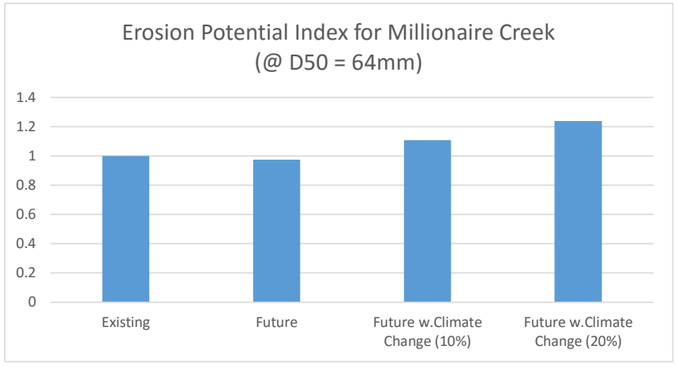


	Critical Shear Value (N/m2)	Corresponding Particle Size (mm)	Line of No Change	EP_{fut}	$EP_{CC10\%}$	$EP_{CC20\%}$
	0.1	0.0625	1	0.990	1.037	1.082
	1		1	0.990	1.038	1.083
	1.3	2	1	0.990	1.038	1.083
	10		1	0.989	1.043	1.094
D50	53.9	64	1	0.974	1.107	1.628
	100		1	0.959	1.277	1.628
	223.7	256	1	#DIV/0!	#DIV/0!	#DIV/0!
D90	524.3	600	1	#DIV/0!	#DIV/0!	#DIV/0!
	873.8	1000	1	#DIV/0!	#DIV/0!	#DIV/0!

Sand-Gravel line	
1.3	0
1.3	100
Gravel-Cobble line	
53.9	0
53.9	100
Cobble-Boulder line	
223.7	0
223.7	100



	Winter 2014-2015 Erosion Potential	
	@D50 (N/m2)	EPI @ D50
Existing	1447721.69	1
Future	1410648.56	0.974392
Future w.Climate Change (10%)	1603038.03	1.107283
Future w.Climate Change (20%)	1792831.64	1.238381



Model Creek ID	Creek Name	Location	Existing Max Flow (m3/s)	Future Max Flow (m3/s)	Climate Change 10% Flow (m3/s)	Climate Change 20% Flow (m3/s)	Length (m)	Roughness Coefficient	Slope
CR46077	Millionaire	Fern Cres.	2.878	2.468	2.749	3.148	67.277	0.03	0.052
CR46556	McFadden	264 St.	5.082	4.857	5.238	5.797	153.787	0.03	0.056
CR47667	T2	126 Ave.	1.613	1.513	1.760	2.121	111.865	0.03	0.011
CR47210	Dunlop	Discharge to Kanaka	3.195	3.073	3.604	4.070	48.183	0.03	0.019
CR48546	Kanaka	Downstream Dunlop Tributary	33.427	32.609	38.839	45.192	53.067	0.03	0.004

Simulation Period:

From	2014-11-21
To	2015-02-21

McFadden Creek
Erosion Potential Analysis

Existing
Existing: Continuous-Winter-2014-2015

Future
Future: Continuous-Winter-2014-2015

Final Date	Days-Hour	Flow (m3/s)	Depth (m)	Flow Volume (m3)	Top Width (m)	Hydraulic Depth (m)	Velocity (m/s)	HGL (m)	Froude #	Shear Stress (Tractive Force) (N/m2)	Flow (m3/s)	Depth (m)	Flow Volume (m3)	Top Width (m)	Hydraulic Depth (m)	Velocity (m/s)	HGL (m)
21-Nov-14	Day 0; 00:15	0.313	0.115	38.93	3.092	0.082	1.239	118.333	1.382	45.032	0.306	0.113	38.392	3.078	0.081	1.228	118.332
21-Nov-14	Day 0; 00:30	0.319	0.115	39.315	3.101	0.082	1.251	118.334	1.395	45.032	0.308	0.114	38.471	3.08	0.081	1.232	118.332
21-Nov-14	Day 0; 00:45	0.319	0.115	39.361	3.102	0.083	1.248	118.334	1.383	45.581	0.312	0.114	38.809	3.089	0.082	1.239	118.333
21-Nov-14	Day 0; 01:00	0.294	0.112	37.625	3.059	0.08	1.203	118.33	1.358	43.934	0.295	0.112	37.692	3.061	0.08	1.206	118.33
21-Nov-14	Day 0; 01:15	0.268	0.107	35.548	3.007	0.077	1.163	118.326	1.338	42.286	0.271	0.108	35.792	3.013	0.077	1.169	118.326
21-Nov-14	Day 0; 01:30	0.294	0.111	37.252	3.05	0.079	1.216	118.33	1.382	43.384	0.297	0.111	37.479	3.056	0.08	1.221	118.331
21-Nov-14	Day 0; 01:45	0.328	0.117	39.866	3.115	0.083	1.268	118.336	1.405	45.581	0.339	0.118	40.6	3.133	0.084	1.285	118.337
20-Feb-15	Day 91; 23:15	0.146	0.083	24.774	2.718	0.059	0.907	118.301	1.192	32.401	0.139	0.081	24.152	2.7	0.058	0.891	118.299
20-Feb-15	Day 91; 23:30	0.145	0.083	24.747	2.717	0.059	0.907	118.301	1.192	32.401	0.139	0.081	24.126	2.699	0.058	0.891	118.299
20-Feb-15	Day 91; 23:45	0.145	0.083	24.72	2.716	0.059	0.906	118.301	1.191	32.401	0.139	0.081	24.1	2.698	0.058	0.89	118.299
21-Feb-15	Day 92; 00:00	0.145	0.083	24.693	2.716	0.059	0.905	118.301	1.190	32.401	0.138	0.081	24.074	2.698	0.058	0.889	118.299
***	**Mean**	**0.961**	**0.171**	**72.975**	**3.758**	**0.118**	**1.724**	**118.395**	**1.589**	**64.731**	**0.928**	**0.168**	**71.341**	**3.725**	**0.116**	**1.704**	**118.392**
	Median	**0.645**	**0.156**	**60.750**	**3.582**	**0.110**	**1.634**	**118.378**	**1.572**	**60.409**	**0.627**	**0.154**	**59.543**	**3.559**	**0.109**	**1.618**	**118.376**
	Max	**5.082**	**0.414**	**266.919**	**8.164**	**0.244**	**3.118**	**118.687**	**2.060**	**133.997**	**4.857**	**0.408**	**258.483**	**7.810**	**0.244**	**3.118**	**118.680**

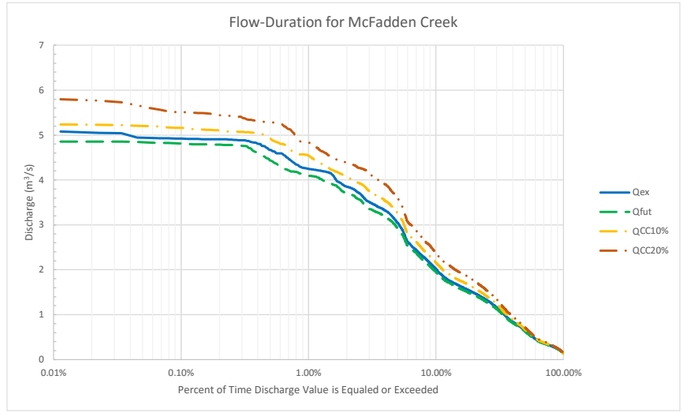
		Future Climate Change by 10%: Continuous-Winter-2014-2015								Future Climate Change by 20%: Continuous-Winter-2014-2015						
Froude #	Shear Stress (Tractive Force) (N/m2)	Flow (m3/s)	Depth (m)	Flow Volume (m3)	Top Width (m)	Hydraulic Depth (m)	Velocity (m/s)	HGL (m)	Froude #	Shear Stress (Tractive Force) (N/m2)	Flow (m3/s)	Depth (m)	Flow Volume (m3)	Top Width (m)	Hydraulic Depth (m)	Velocity (m/s)	HGL (m)
1.38	44.483	0.306	0.113	38.394	3.078	0.081	1.228	118.332	1.378	44.483	0.306	0.113	38.397	3.078	0.081	1.228	118.332
1.38	44.483	0.308	0.114	38.485	3.081	0.081	1.233	118.332	1.383	44.483	0.308	0.114	38.499	3.081	0.081	1.233	118.333
1.38	45.032	0.313	0.114	38.868	3.09	0.082	1.24	118.333	1.383	45.032	0.314	0.115	38.929	3.092	0.082	1.242	118.333
1.36	43.934	0.297	0.112	37.804	3.063	0.08	1.209	118.331	1.365	43.934	0.298	0.112	37.92	3.066	0.08	1.212	118.331
1.35	42.286	0.274	0.108	35.97	3.017	0.078	1.173	118.327	1.341	42.835	0.276	0.109	36.151	3.022	0.078	1.178	118.327
1.38	43.934	0.301	0.112	37.739	3.062	0.08	1.227	118.331	1.385	43.934	0.304	0.113	38.003	3.069	0.081	1.233	118.332
1.42	46.13	0.344	0.119	40.974	3.142	0.085	1.293	118.338	1.416	46.679	0.349	0.12	41.343	3.151	0.085	1.301	118.339
1.18	31.852	0.145	0.083	24.71	2.716	0.059	0.906	118.301	1.191	32.401	0.15	0.084	25.226	2.731	0.06	0.919	118.302
1.18	31.852	0.145	0.083	24.683	2.715	0.059	0.905	118.301	1.190	32.401	0.15	0.084	25.198	2.73	0.06	0.918	118.302
1.18	31.852	0.144	0.082	24.656	2.715	0.059	0.904	118.3	1.188	32.401	0.15	0.084	25.169	2.73	0.06	0.917	118.302
1.18	31.852	0.144	0.082	24.629	2.714	0.059	0.904	118.3	1.188	32.401	0.149	0.084	25.141	2.729	0.06	0.917	118.302
1.581	**63.894**	**1.016**	**0.175**	**75.582**	**3.807**	**0.120**	**1.752**	**118.399**	**1.600**	**65.932**	**1.102**	**0.181**	**79.696**	**3.886**	**0.123**	**1.796**	**118.406**
1.567	**59.859**	**0.673**	**0.159**	**62.501**	**3.617**	**0.112**	**1.657**	**118.381**	**1.578**	**61.507**	**0.718**	**0.164**	**65.190**	**3.669**	**0.116**	**1.694**	**118.385**
2.058	**133.997**	**5.238**	**0.419**	**272.920**	**8.405**	**0.244**	**3.119**	**118.691**	**2.097**	**133.997**	**5.797**	**0.435**	**294.142**	**9.241**	**0.244**	**3.150**	**118.708**

			Existing Excess Shear Stress, by PSD									For D50	For D90	Future Excess Shear Stress, by PSD		
		Particle Size (d) (mm)	0.0625		2		64		256		1000	15	390	0.0625		2
		Critical Shear Stress (N/m2)	0.1	1	1.3	10	53.9	100	223.7	500	873.8	11.4	340.8	0.1	1	1.3
Froude #	Shear Stress (Tractive Force) (N/m2)		(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)
1.378	44.483		301.19	292.18	289.20	207.35	0.00	0.00	0.00	0.00	0.00	195.04	0.00	295.68	286.73	283.77
1.383	44.483		301.19	292.18	289.20	207.35	0.00	0.00	0.00	0.00	0.00	195.04	0.00	295.68	286.73	283.77
1.385	45.032		306.72	297.66	294.66	212.24	0.00	0.00	0.00	0.00	0.00	199.84	0.00	301.19	292.18	289.20
1.368	43.934		290.21	281.32	278.38	197.68	0.00	0.00	0.00	0.00	0.00	185.57	0.00	290.21	281.32	278.38
1.347	42.835		274.00	265.28	262.39	183.45	0.00	0.00	0.00	0.00	0.00	171.65	0.00	274.00	265.28	262.39
1.383	44.483		284.77	275.93	273.01	192.89	0.00	0.00	0.00	0.00	0.00	180.88	0.00	290.21	281.32	278.38
1.425	46.679		306.72	297.66	294.66	212.24	0.00	0.00	0.00	0.00	0.00	199.84	0.00	312.29	303.18	300.16
1.198	32.950		183.58	175.96	173.44	106.02	0.00	0.00	0.00	0.00	0.00	96.24	0.00	178.92	171.37	168.87
1.197	32.950		183.58	175.96	173.44	106.02	0.00	0.00	0.00	0.00	0.00	96.24	0.00	178.92	171.37	168.87
1.195	32.950		183.58	175.96	173.44	106.02	0.00	0.00	0.00	0.00	0.00	96.24	0.00	178.92	171.37	168.87
1.195	32.950		183.58	175.96	173.44	106.02	0.00	0.00	0.00	0.00	0.00	96.24	0.00	178.92	171.37	168.87
1.618	67.811	Sum	4789631.80	4695490.58	4664256.95	3793681.84	782760.52	45432.86	0.00	0.00	0.00	3660140.67	0.00	4697390.95	4603868.62	4572843.17
1.591	63.704	Erosion Potential Index	1	1	1	1	1	1	1	1	1	1	1	0.981	0.980	0.980
2.211	133.997															

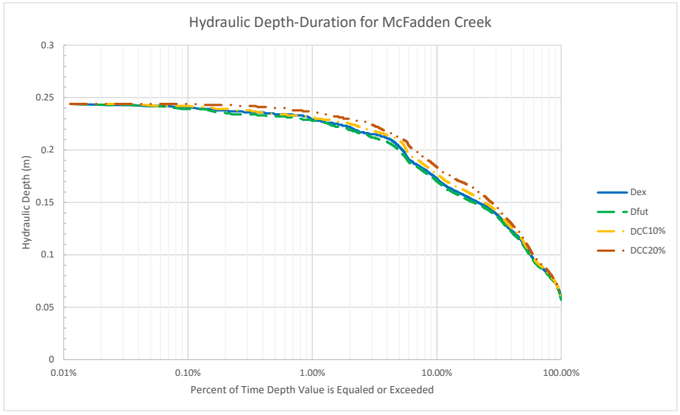
							For D50	For D90	Future 10% Climate Change Excess Shear Stress, by PSD									For D50
	64		256		1000		15	390	0.0625		2		64		256		1000	15
10	53.9	100	223.7	500	873.8		11.4	340.8	0.1	1	1.3	10	53.9	100	223.7	500	873.8	11.4
(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)		(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)
202.49	0.00	0.00	0.00	0.00	0.00		190.29	0.00	295.68	286.73	283.77	202.49	0.00	0.00	0.00	0.00	0.00	190.29
202.49	0.00	0.00	0.00	0.00	0.00		190.29	0.00	295.68	286.73	283.77	202.49	0.00	0.00	0.00	0.00	0.00	190.29
207.35	0.00	0.00	0.00	0.00	0.00		195.04	0.00	301.19	292.18	289.20	207.35	0.00	0.00	0.00	0.00	0.00	195.04
197.68	0.00	0.00	0.00	0.00	0.00		185.57	0.00	290.21	281.32	278.38	197.68	0.00	0.00	0.00	0.00	0.00	185.57
183.45	0.00	0.00	0.00	0.00	0.00		171.65	0.00	279.37	270.59	267.68	188.15	0.00	0.00	0.00	0.00	0.00	176.25
197.68	0.00	0.00	0.00	0.00	0.00		185.57	0.00	290.21	281.32	278.38	197.68	0.00	0.00	0.00	0.00	0.00	185.57
217.17	0.00	0.00	0.00	0.00	0.00		204.67	0.00	317.90	308.73	305.69	222.14	0.00	0.00	0.00	0.00	0.00	209.54
102.15	0.00	0.00	0.00	0.00	0.00		92.49	0.00	183.58	175.96	173.44	106.02	0.00	0.00	0.00	0.00	0.00	96.24
102.15	0.00	0.00	0.00	0.00	0.00		92.49	0.00	183.58	175.96	173.44	106.02	0.00	0.00	0.00	0.00	0.00	96.24
102.15	0.00	0.00	0.00	0.00	0.00		92.49	0.00	183.58	175.96	173.44	106.02	0.00	0.00	0.00	0.00	0.00	96.24
102.15	0.00	0.00	0.00	0.00	0.00		92.49	0.00	183.58	175.96	173.44	106.02	0.00	0.00	0.00	0.00	0.00	96.24
3708537.04	743400.53	40561.93	0.00	0.00	0.00		3576055.92	0.00	4929975.59	4835004.13	4803494.10	3924591.13	854760.24	52890.75	0.00	0.00	0.00	3789654.33
0.978	0.950	0.893	#DIV/0!	#DIV/0!	#DIV/0!		0.977	#DIV/0!	1.029	1.030	1.030	1.035	1.092	1.164	#DIV/0!	#DIV/0!	#DIV/0!	1.035

For D90	Future 20% Climate Change Excess Shear Stress, by PSD									For D50	For D90
390	0.0625		2		64		256		1000	15	390
340.8	0.1	1	1.3	10	53.9	100	223.7	500	873.8	11.4	340.8
(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)
0.00	295.68	286.73	283.77	202.49	0.00	0.00	0.00	0.00	0.00	190.29	0.00
0.00	295.68	286.73	283.77	202.49	0.00	0.00	0.00	0.00	0.00	190.29	0.00
0.00	301.19	292.18	289.20	207.35	0.00	0.00	0.00	0.00	0.00	195.04	0.00
0.00	290.21	281.32	278.38	197.68	0.00	0.00	0.00	0.00	0.00	185.57	0.00
0.00	279.37	270.59	267.68	188.15	0.00	0.00	0.00	0.00	0.00	176.25	0.00
0.00	295.68	286.73	283.77	202.49	0.00	0.00	0.00	0.00	0.00	190.29	0.00
0.00	317.90	308.73	305.69	222.14	0.00	0.00	0.00	0.00	0.00	209.54	0.00
0.00	188.28	180.60	178.06	109.94	0.00	0.00	0.00	0.00	0.00	100.04	0.00
0.00	188.28	180.60	178.06	109.94	0.00	0.00	0.00	0.00	0.00	100.04	0.00
0.00	188.28	180.60	178.06	109.94	0.00	0.00	0.00	0.00	0.00	100.04	0.00
0.00	188.28	180.60	178.06	109.94	0.00	0.00	0.00	0.00	0.00	100.04	0.00
0.00	5147263.44	5050973.18	5019022.06	4126847.29	962221.70	65568.07	0.00	0.00	0.00	3989680.06	0.00
#DIV/0!	1.075	1.076	1.076	1.088	1.229	1.443	#DIV/0!	#DIV/0!	#DIV/0!	1.090	#DIV/0!

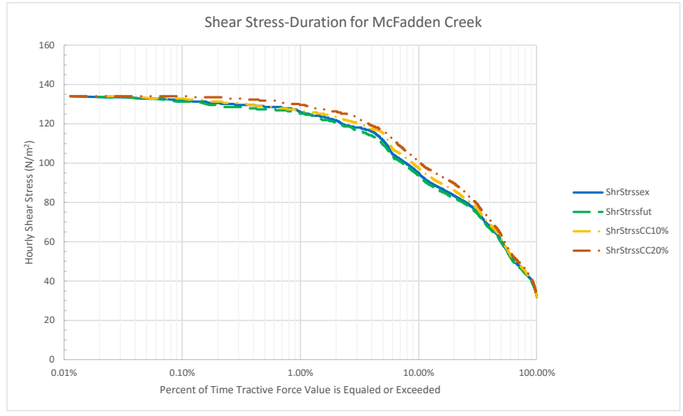
	Plot Pos	Q_{ex}	Q_{fut}	$Q_{CC10\%}$	$Q_{CC20\%}$
Count	8832	(m3/s)	(m3/s)	(m3/s)	(m3/s)
1	0.01132%	5.082	4.857	5.238	5.797
2	0.02264%	5.05	4.855	5.232	5.77
3	0.03396%	5.041	4.852	5.218	5.733
4	0.04528%	4.943	4.849	5.203	5.659
5	0.05661%	4.936	4.831	5.201	5.604
6	0.06793%	4.932	4.827	5.188	5.563
7	0.07925%	4.93	4.826	5.171	5.524
8	0.09057%	4.921	4.815	5.158	5.514
9	0.10189%	4.919	4.808	5.158	5.509
10	0.11321%	4.912	4.799	5.143	5.507
11	0.12453%	4.912	4.797	5.133	5.498
12	0.13585%	4.911	4.796	5.128	5.493
13	0.14718%	4.91	4.795	5.124	5.488
14	0.15850%	4.908	4.792	5.118	5.48
15	0.16982%	4.908	4.788	5.115	5.476
16	0.18114%	4.908	4.788	5.11	5.461
17	0.19246%	4.906	4.787	5.108	5.459
18	0.20378%	4.906	4.784	5.096	5.441
19	0.21510%	4.904	4.78	5.084	5.439
20	0.22642%	4.904	4.779	5.082	5.432
21	0.23774%	4.897	4.778	5.08	5.43
22	0.24907%	4.896	4.778	5.079	5.423
23	0.26039%	4.894	4.777	5.079	5.423
24	0.27171%	4.893	4.776	5.077	5.417
25	0.28303%	4.885	4.769	5.075	5.41
26	0.29435%	4.885	4.763	5.071	5.406
27	0.30567%	4.882	4.76	5.069	5.375
28	0.31699%	4.881	4.758	5.065	5.372
29	0.32831%	4.872	4.751	5.064	5.348
30	0.33964%	4.866	4.714	5.062	5.34
31	0.35096%	4.85	4.704	5.059	5.338
32	0.36228%	4.842	4.661	5.056	5.335



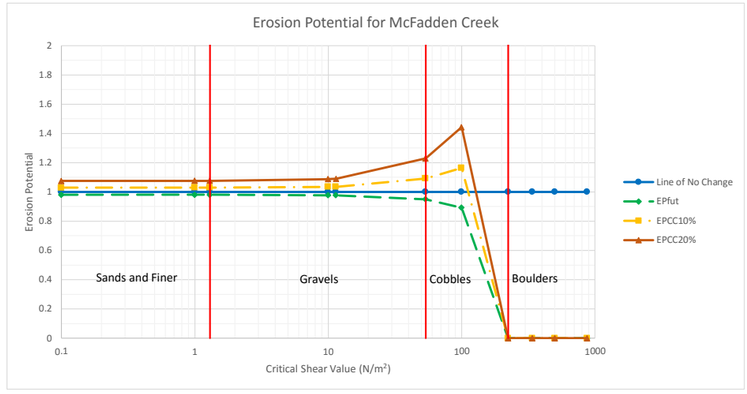
	Plot Pos	D_{ex}	D_{fut}	$D_{CC10\%}$	$D_{CC20\%}$
Count	8832	(m)	(m)	(m)	(m)
1	0.01132%	0.244	0.244	0.244	0.244
2	0.02264%	0.243	0.243	0.244	0.244
3	0.03396%	0.243	0.243	0.244	0.244
4	0.04528%	0.242	0.242	0.243	0.244
5	0.05661%	0.242	0.242	0.242	0.244
6	0.06793%	0.242	0.241	0.242	0.244
7	0.07925%	0.241	0.24	0.242	0.244
8	0.09057%	0.241	0.239	0.242	0.244
9	0.10189%	0.241	0.239	0.242	0.244
10	0.11321%	0.24	0.239	0.241	0.244
11	0.12453%	0.239	0.239	0.241	0.243
12	0.13585%	0.239	0.239	0.241	0.243
13	0.14718%	0.239	0.238	0.241	0.243
14	0.15850%	0.239	0.237	0.24	0.243
15	0.16982%	0.238	0.236	0.239	0.243
16	0.18114%	0.238	0.236	0.239	0.243
17	0.19246%	0.238	0.236	0.239	0.243
18	0.20378%	0.238	0.235	0.239	0.243
19	0.21510%	0.237	0.235	0.239	0.243
20	0.22642%	0.237	0.234	0.238	0.243
21	0.23774%	0.237	0.234	0.238	0.242
22	0.24907%	0.237	0.234	0.238	0.242
23	0.26039%	0.237	0.234	0.238	0.242
24	0.27171%	0.237	0.234	0.238	0.242
25	0.28303%	0.236	0.234	0.238	0.242
26	0.29435%	0.236	0.234	0.238	0.242
27	0.30567%	0.236	0.234	0.238	0.242
28	0.31699%	0.236	0.234	0.238	0.242
29	0.32831%	0.236	0.234	0.237	0.242
30	0.33964%	0.236	0.234	0.237	0.242
31	0.35096%	0.236	0.234	0.237	0.242
32	0.36228%	0.236	0.233	0.236	0.241



	Plot Pos	$ShrStrss_{ex}$	$ShrStrss_{fut}$	$ShrStrssCC_{10\%}$	$ShrStrss_{CC20\%}$
Count	8832	(N/m2)	(N/m2)	(N/m2)	(N/m2)
1	0.01132%	133.997	133.997	133.997	133.997
2	0.02264%	133.448	133.448	133.997	133.997
3	0.03396%	133.448	133.448	133.997	133.997
4	0.04528%	132.899	132.899	133.448	133.997
5	0.05661%	132.899	132.899	132.899	133.997
6	0.06793%	132.899	132.35	132.899	133.997
7	0.07925%	132.35	131.801	132.899	133.997
8	0.09057%	132.35	131.252	132.899	133.997
9	0.10189%	132.35	131.252	132.899	133.997
10	0.11321%	131.801	131.252	132.35	133.997
11	0.12453%	131.252	131.252	132.35	133.448
12	0.13585%	131.252	131.252	132.35	133.448
13	0.14718%	131.252	130.702	132.35	133.448
14	0.15850%	131.252	130.153	131.801	133.448
15	0.16982%	130.702	129.604	131.252	133.448
16	0.18114%	130.702	129.604	131.252	133.448
17	0.19246%	130.702	129.604	131.252	133.448
18	0.20378%	130.702	129.055	131.252	133.448
19	0.21510%	130.153	129.055	131.252	133.448
20	0.22642%	130.153	128.506	130.702	133.448
21	0.23774%	130.153	128.506	130.702	132.899
22	0.24907%	130.153	128.506	130.702	132.899
23	0.26039%	130.153	128.506	130.702	132.899
24	0.27171%	130.153	128.506	130.702	132.899
25	0.28303%	129.604	128.506	130.702	132.899
26	0.29435%	129.604	128.506	130.702	132.899
27	0.30567%	129.604	128.506	130.702	132.899
28	0.31699%	129.604	128.506	130.702	132.899
29	0.32831%	129.604	128.506	130.153	132.899
30	0.33964%	129.604	128.506	130.153	132.899
31	0.35096%	129.604	128.506	130.153	132.899
32	0.36228%	129.604	127.957	129.604	132.35

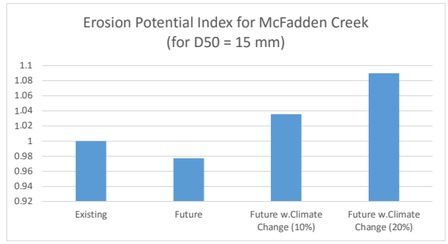


	Critical Shear Value (N/m2)	Corresponding Particle Size (mm)	Line of No Change	EP_{fut}	$EP_{CC10\%}$	$EP_{CC20\%}$
	0.1	0.0625	1	0.981	1.029	1.075
	1		1	0.980	1.030	1.076
	1.3	2	1	0.980	1.030	1.076
	10		1	0.978	1.035	1.088
D50	11.4	15	1	0.977	1.035	1.090
	53.9	64	1	0.950	1.092	1.229
	100		1	0.893	1.164	1.443
D90	223.7	256	1	#DIV/0!	#DIV/0!	#DIV/0!
	340.8	390	1	#DIV/0!	#DIV/0!	#DIV/0!
	500		1	#DIV/0!	#DIV/0!	#DIV/0!
	873.8	1000	1	#DIV/0!	#DIV/0!	#DIV/0!



Sand-Gravel line
1.3 0
1.3 100
Gravel-Cobble line
53.9 0
53.9 100
Cobble-Boulder line
223.7 0
223.7 100

	Winter 2014-2015 Erosion Potential @D50 (N/m2)	EPI @ D50
Existing	3660140.67	1
Future	3576055.92	0.977026908
Future w.Climate Change (10%)	3789654.33	1.035384886
Future w.Climate Change (20%)	3989680.06	1.090034624



Model Creek ID	Creek Name	Location	Existing Max Flow (m3/s)	Future Max Flow (m3/s)	Climate Change 10% Flow (m3/s)	Climate Change 20% Flow (m3/s)	Length (m)	Roughness Coefficient	Slope
CR46077	Millionaire	Fern Cres.	2.878	2.468	2.749	3.148	67.277	0.03	0.052
CR46556	McFadden	264 St.	5.082	4.857	5.238	5.797	153.787	0.03	0.056
CR47667	T2	126 Ave.	1.613	1.513	1.760	2.121	111.865	0.03	0.011
CR47210	Dunlop	Discharge to Kanaka	3.195	3.073	3.604	4.070	48.183	0.03	0.019
CR48546	Kanaka	Downstream Dunlop Tributary	33.427	32.609	38.839	45.192	53.067	0.03	0.004

Simulation Period:

From	2014-11-21
To	2015-02-21

Dunlop Creek

Erosion Potential Analysis

Existing

Existing: Continuous-Winter-2014-2015

Final Date	Days-Hour	Flow (m3/s)	Depth (m)	Flow Volume (m3)	Top Width (m)	Hydraulic Depth (m)	Velocity (m/s)
21-Nov-14	Day 0; 00:15	0.058	0.166	51.008	4.386	0.241	0.146
21-Nov-14	Day 0; 00:30	0.057	0.165	50.514	4.367	0.24	0.144
21-Nov-14	Day 0; 00:45	0.057	0.165	50.389	4.363	0.24	0.145
21-Nov-14	Day 0; 01:00	0.057	0.165	50.272	4.359	0.239	0.145
21-Nov-14	Day 0; 01:15	0.057	0.165	50.179	4.355	0.239	0.145
21-Nov-14	Day 0; 01:30	0.057	0.165	50.292	4.361	0.239	0.146
21-Nov-14	Day 0; 01:45	0.059	0.166	50.568	4.374	0.24	0.148
20-Feb-15	Day 91; 23:15	0.031	0.123	28.594	3.465	0.171	0.134
20-Feb-15	Day 91; 23:30	0.03	0.123	28.559	3.463	0.171	0.134
20-Feb-15	Day 91; 23:45	0.03	0.123	28.523	3.461	0.171	0.134
21-Feb-15	Day 92; 00:00	0.03	0.123	28.488	3.459	0.171	0.134
***	**Mean**	**0.253**	**0.277**	**176.145**	**7.568**	**0.399**	**0.185**
	Median	**0.152**	**0.243**	**108.325**	**6.041**	**0.372**	**0.182**
	Max	**3.195**	**0.851**	**1268.327**	**20.921**	**1.358**	**0.375**

Future

Future: Continuous-Winter-2014-2015

HGL (m)	Froude #	Shear Stress (Tractive Force) (N/m2)	Flow (m3/s)	Depth (m)	Flow Volume (m3)	Top Width (m)	Hydraulic Depth (m)
4.376	0.095	44.904	0.061	0.166	50.327	4.373	0.239
4.375	0.094	44.718	0.061	0.165	50.13	4.367	0.238
4.375	0.095	44.718	0.064	0.166	50.306	4.38	0.238
4.375	0.095	44.532	0.066	0.166	50.499	4.392	0.239
4.375	0.095	44.532	0.068	0.167	50.843	4.41	0.239
4.376	0.095	44.532	0.072	0.169	51.649	4.449	0.241
4.376	0.096	44.718	0.08	0.172	53.041	4.513	0.244
4.356	0.103	31.862	0.031	0.123	28.359	3.458	0.17
4.356	0.103	31.862	0.031	0.122	28.325	3.457	0.17
4.356	0.103	31.862	0.031	0.122	28.291	3.455	0.17
4.356	0.103	31.862	0.031	0.122	28.257	3.453	0.17
4.430	**0.098**	**74.369**	**0.266**	**0.277**	**174.390**	**7.553**	**0.396**
4.416	**0.098**	**69.313**	**0.159**	**0.242**	**106.596**	**6.011**	**0.367**
4.722	**0.207**	**253.030**	**3.073**	**0.848**	**1264.202**	**20.357**	**1.349**

Future

Climate Change by 10%: Continuous-Winter-2014-2015

Velocity (m/s)	HGL (m)	Froude #	Shear Stress (Tractive Force) (N/m2)	Flow (m3/s)	Depth (m)	Flow Volume (m3)	Top Width (m)
0.155	4.378	0.10	44.532	0.061	0.166	50.327	4.373
0.155	4.378	0.10	44.345	0.061	0.165	50.143	4.368
0.161	4.379	0.11	44.345	0.064	0.166	50.378	4.384
0.164	4.38	0.11	44.532	0.066	0.167	50.641	4.399
0.168	4.381	0.11	44.532	0.069	0.168	51.057	4.42
0.176	4.384	0.11	44.904	0.074	0.17	51.962	4.464
0.189	4.387	0.12	45.463	0.083	0.173	53.537	4.535
0.138	4.357	0.11	31.675	0.033	0.125	29.205	3.501
0.138	4.357	0.11	31.675	0.032	0.124	29.168	3.499
0.137	4.357	0.11	31.675	0.032	0.124	29.132	3.497
0.137	4.357	0.11	31.675	0.032	0.124	29.095	3.495
0.195	**4.433**	**0.104**	**73.737**	**0.292**	**0.289**	**191.899**	**7.890**
0.189	**4.418**	**0.103**	**68.381**	**0.170**	**0.251**	**116.154**	**6.267**
0.419	**4.716**	**0.230**	**251.353**	**3.604**	**0.860**	**1281.824**	**25.425**

Future

Climate Change by 20%: Continuous-Winter-2014-2015

Hydraulic Depth (m)	Velocity (m/s)	HGL (m)	Froude #	Shear Stress (Tractive Force) (N/m2)	Flow (m3/s)	Depth (m)	Flow Volume (m3)
0.239	0.155	4.378	0.101	44.532	0.061	0.166	50.328
0.238	0.155	4.378	0.101	44.345	0.061	0.165	50.158
0.238	0.161	4.379	0.105	44.345	0.065	0.166	50.452
0.239	0.166	4.381	0.108	44.532	0.067	0.167	50.785
0.24	0.17	4.382	0.111	44.718	0.07	0.168	51.274
0.242	0.179	4.385	0.116	45.091	0.076	0.17	52.283
0.245	0.193	4.389	0.125	45.650	0.085	0.174	54.044
0.173	0.139	4.358	0.107	32.234	0.034	0.126	30.03
0.173	0.139	4.358	0.107	32.234	0.034	0.126	29.983
0.173	0.139	4.358	0.107	32.234	0.034	0.126	29.937
0.173	0.139	4.358	0.107	32.234	0.034	0.126	29.896
0.414	**0.194**	**4.437**	**0.102**	**77.074**	**0.317**	**0.301**	**208.999**
0.384	**0.189**	**4.422**	**0.101**	**71.549**	**0.181**	**0.259**	**125.097**
1.351	**0.410**	**4.740**	**0.227**	**251.726**	**4.070**	**0.885**	**1320.489**

Top Width (m)	Hydraulic Depth (m)	Velocity (m/s)	HGL (m)	Froude #	Shear Stress (Tractive Force) (N/m2)	Particle Size (d) (mm) Critical Shear Stress (N/m2)
4.373	0.239	0.155	4.378	0.101	44.532	
4.369	0.238	0.156	4.378	0.102	44.345	
4.388	0.239	0.162	4.38	0.106	44.532	
4.406	0.239	0.167	4.381	0.109	44.532	
4.43	0.24	0.172	4.382	0.112	44.718	
4.479	0.242	0.182	4.385	0.118	45.091	
4.558	0.246	0.197	4.39	0.127	45.836	
3.542	0.176	0.141	4.359	0.107	32.793	
3.539	0.176	0.14	4.359	0.107	32.793	
3.537	0.176	0.14	4.359	0.107	32.793	
3.535	0.176	0.14	4.359	0.107	32.793	
8.195	**0.431**	**0.194**	**4.442**	**0.100**	**80.313**	**Sum**
6.534	**0.398**	**0.189**	**4.425**	**0.099**	**74.158**	**Erosion Potential Index**
27.532	**1.354**	**0.417**	**4.790**	**0.228**	**252.285**	

Existing Excess Shear Stress, by PSD

0.0625		2		64		256	
0.1	1	1.3	10	53.9	100	223.7	500
(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)
299.90	290.91	287.93	206.21	0.00	0.00	0.00	0.00
298.03	289.06	286.09	204.57	0.00	0.00	0.00	0.00
298.03	289.06	286.09	204.57	0.00	0.00	0.00	0.00
296.17	287.22	284.25	202.92	0.00	0.00	0.00	0.00
296.17	287.22	284.25	202.92	0.00	0.00	0.00	0.00
296.17	287.22	284.25	202.92	0.00	0.00	0.00	0.00
298.03	289.06	286.09	204.57	0.00	0.00	0.00	0.00
179.00	171.45	168.96	102.22	0.00	0.00	0.00	0.00
179.00	171.45	168.96	102.22	0.00	0.00	0.00	0.00
179.00	171.45	168.96	102.22	0.00	0.00	0.00	0.00
179.00	171.45	168.96	102.22	0.00	0.00	0.00	0.00
6068091.38	**5968017.39**	**5934808.17**	**5005110.73**	**1607589.41**	**358658.18**	**2044.01**	**0.00**
1	**1**	**1**	**1**	**1**	**1**	**1**	**1**

	For D50	For D90	Future Excess Shear Stress, by PSD				
1000	0.5	14	0.0625		2		64
873.8	0.27	10.4	0.1	1	1.3	10	53.9
(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)
0.00	298.19	202.68	296.17	287.22	284.25	202.92	0.00
0.00	296.33	201.04	294.30	285.37	282.41	201.28	0.00
0.00	296.33	201.04	294.30	285.37	282.41	201.28	0.00
0.00	294.47	199.41	296.17	287.22	284.25	202.92	0.00
0.00	294.47	199.41	296.17	287.22	284.25	202.92	0.00
0.00	294.47	199.41	299.90	290.91	287.93	206.21	0.00
0.00	296.33	201.04	305.53	296.48	293.49	211.19	0.00
0.00	177.57	99.43	177.43	169.89	167.41	100.91	0.00
0.00	177.57	99.43	177.43	169.89	167.41	100.91	0.00
0.00	177.57	99.43	177.43	169.89	167.41	100.91	0.00
0.00	177.57	99.43	177.43	169.89	167.41	100.91	0.00
0.00	**6049135.81**	**4963969.16**	**5992042.56**	**5892400.73**	**5859336.03**	**4933984.51**	**1566592.74**
1	**1**	**1**	**0.987**	**0.987**	**0.987**	**0.986**	**0.974**

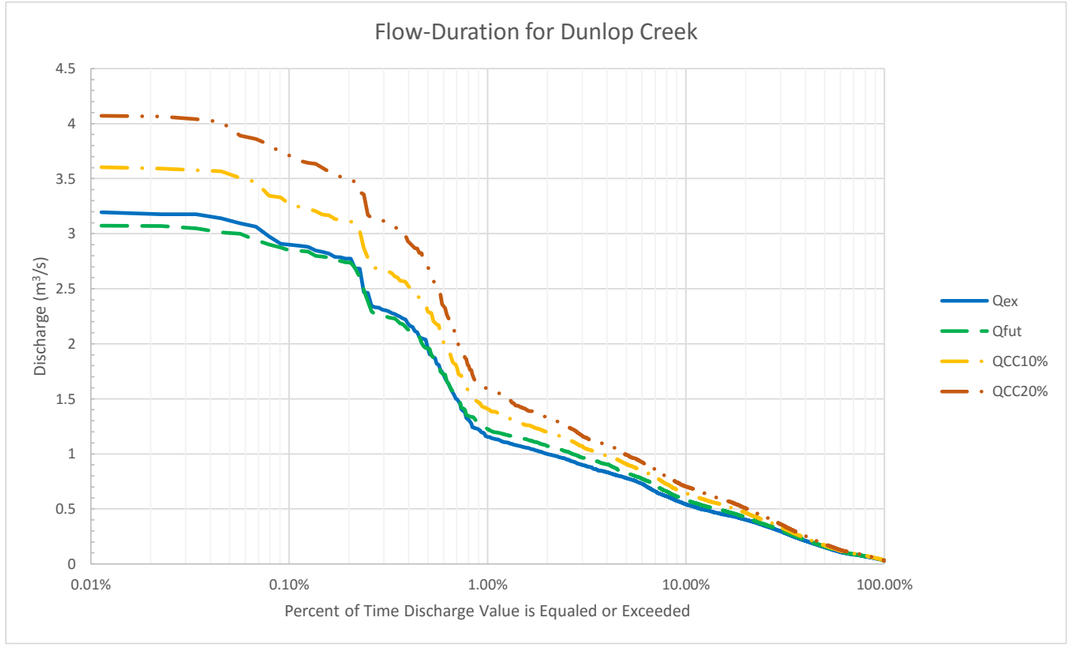
				For D50	For D90	Future 10% Climate Change Excess Shear S	
	256		1000	0.5	14	0.0625	
100	223.7	500	873.8	0.27	10.4	0.1	1
(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)
0.00	0.00	0.00	0.00	294.47	199.41	296.17	287.22
0.00	0.00	0.00	0.00	292.61	197.77	294.30	285.37
0.00	0.00	0.00	0.00	292.61	197.77	294.30	285.37
0.00	0.00	0.00	0.00	294.47	199.41	296.17	287.22
0.00	0.00	0.00	0.00	294.47	199.41	298.03	289.06
0.00	0.00	0.00	0.00	298.19	202.68	301.78	292.77
0.00	0.00	0.00	0.00	303.81	207.62	307.42	298.35
0.00	0.00	0.00	0.00	175.99	98.13	182.16	174.56
0.00	0.00	0.00	0.00	175.99	98.13	182.16	174.56
0.00	0.00	0.00	0.00	175.99	98.13	182.16	174.56
0.00	0.00	0.00	0.00	175.99	98.13	182.16	174.56
348612.09	2204.78	0.00	0.00	5973168.37	4893049.49	6429754.22	6327998.94
0.972	1.079	#DIV/0!	#DIV/0!	0.987	0.986	1.060	1.060

tress, by PSD							For D50
2		64		256		1000	0.5
1.3	10	53.9	100	223.7	500	873.8	0.27
(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)
284.25	202.92	0.00	0.00	0.00	0.00	0.00	294.47
282.41	201.28	0.00	0.00	0.00	0.00	0.00	292.61
282.41	201.28	0.00	0.00	0.00	0.00	0.00	292.61
284.25	202.92	0.00	0.00	0.00	0.00	0.00	294.47
286.09	204.57	0.00	0.00	0.00	0.00	0.00	296.33
289.79	207.87	0.00	0.00	0.00	0.00	0.00	300.07
295.35	212.86	0.00	0.00	0.00	0.00	0.00	305.70
172.05	104.84	0.00	0.00	0.00	0.00	0.00	180.71
172.05	104.84	0.00	0.00	0.00	0.00	0.00	180.71
172.05	104.84	0.00	0.00	0.00	0.00	0.00	180.71
172.05	104.84	0.00	0.00	0.00	0.00	0.00	180.71
6294227.45	5347718.26	1836940.07	461305.22	3008.65	0.00	0.00	6410481.72
1.061	1.068	1.143	1.286	1.472	#DIV/0!	#DIV/0!	1.060

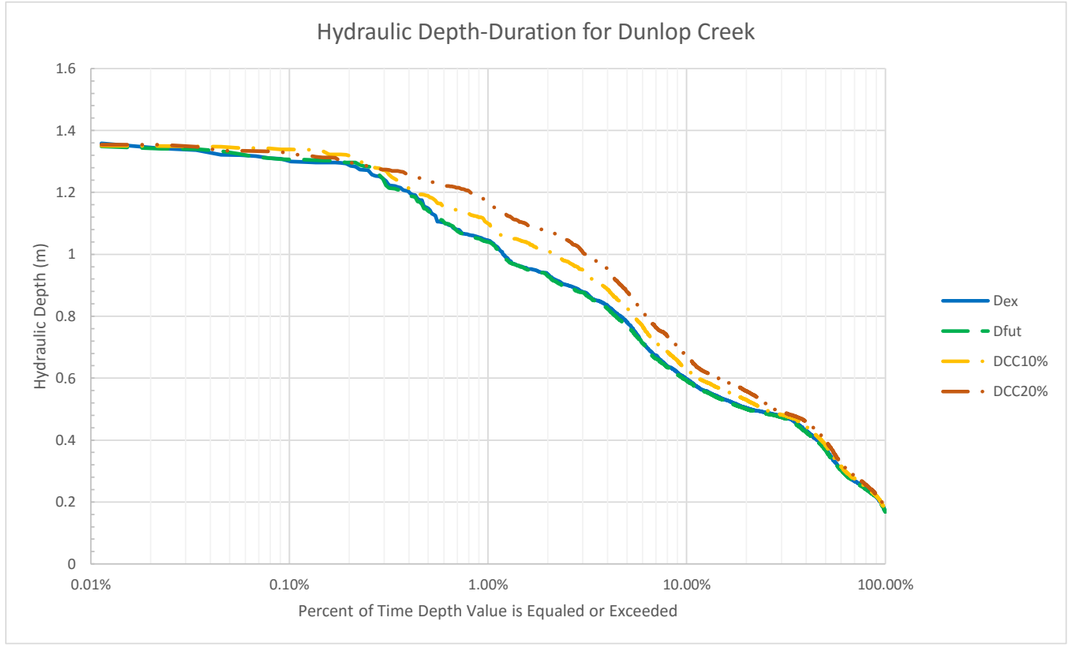
For D90	Future 20% Climate Change Excess Shear Stress, by PSD						
14	0.0625		2		64		256
10.4	0.1	1	1.3	10	53.9	100	223.7
(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)
199.41	296.17	287.22	284.25	202.92	0.00	0.00	0.00
197.77	294.30	285.37	282.41	201.28	0.00	0.00	0.00
197.77	296.17	287.22	284.25	202.92	0.00	0.00	0.00
199.41	296.17	287.22	284.25	202.92	0.00	0.00	0.00
201.04	298.03	289.06	286.09	204.57	0.00	0.00	0.00
204.33	301.78	292.77	289.79	207.87	0.00	0.00	0.00
209.29	309.31	300.22	297.21	214.53	0.00	0.00	0.00
102.02	186.93	179.27	176.73	108.82	0.00	0.00	0.00
102.02	186.93	179.27	176.73	108.82	0.00	0.00	0.00
102.02	186.93	179.27	176.73	108.82	0.00	0.00	0.00
102.02	186.93	179.27	176.73	108.82	0.00	0.00	0.00
5305777.18	**6865262.46**	**6761506.65**	**6727065.60**	**5760553.03**	**2115568.73**	**589108.72**	**3282.73**
1.069	**1.131**	**1.133**	**1.133**	**1.151**	**1.316**	**1.643**	**1.606**

		For D50	For D90
	1000	0.5	14
500	873.8	0.27	10.4
(N/m2)	(N/m2)	(N/m2)	(N/m2)
0.00	0.00	294.47	199.41
0.00	0.00	292.61	197.77
0.00	0.00	294.47	199.41
0.00	0.00	294.47	199.41
0.00	0.00	296.33	201.04
0.00	0.00	300.07	204.33
0.00	0.00	307.58	210.94
0.00	0.00	185.48	105.97
0.00	0.00	185.48	105.97
0.00	0.00	185.48	105.97
0.00	0.00	185.48	105.97
0.00	**0.00**	**6845612.94**	**5717662.40**
#DIV/0!	**#DIV/0!**	**1.132**	**1.152**

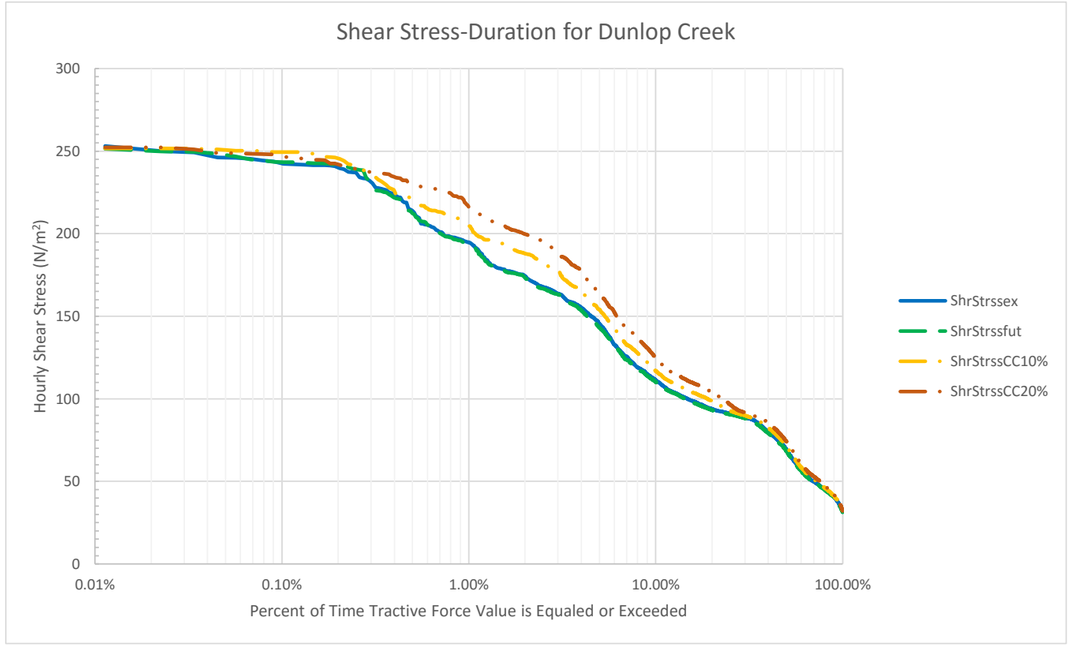
Count	Plot Pos 8832	Q_{ex} (m3/s)	Q_{fut} (m3/s)	$Q_{CC10\%}$ (m3/s)	$Q_{CC20\%}$ (m3/s)
1	0.01132%	3.195	3.073	3.604	4.07
2	0.02264%	3.177	3.068	3.592	4.063
3	0.03396%	3.176	3.048	3.576	4.039
4	0.04528%	3.141	3.01	3.568	4.017
5	0.05661%	3.093	3	3.505	3.89
6	0.06793%	3.062	2.94	3.47	3.859
7	0.07925%	2.974	2.903	3.344	3.807
8	0.09057%	2.907	2.875	3.328	3.738
9	0.10189%	2.898	2.845	3.257	3.705
10	0.11321%	2.888	2.843	3.243	3.661
11	0.12453%	2.881	2.837	3.227	3.644
12	0.13585%	2.848	2.799	3.204	3.633
13	0.14718%	2.834	2.793	3.172	3.599
14	0.15850%	2.82	2.784	3.167	3.563
15	0.16982%	2.788	2.753	3.134	3.537
16	0.18114%	2.787	2.751	3.121	3.517
17	0.19246%	2.774	2.741	3.117	3.486
18	0.20378%	2.772	2.738	3.109	3.484
19	0.21510%	2.685	2.688	3.1	3.471
20	0.22642%	2.683	2.603	3.023	3.379
21	0.23774%	2.469	2.486	2.868	3.355
22	0.24907%	2.463	2.387	2.781	3.17
23	0.26039%	2.344	2.293	2.696	3.143
24	0.27171%	2.332	2.268	2.688	3.138
25	0.28303%	2.329	2.261	2.679	3.137
26	0.29435%	2.311	2.259	2.677	3.12
27	0.30567%	2.304	2.248	2.671	3.107
28	0.31699%	2.294	2.239	2.653	3.103
29	0.32831%	2.28	2.234	2.643	3.088
30	0.33964%	2.27	2.229	2.611	3.071
31	0.35096%	2.258	2.208	2.603	3.04
32	0.36228%	2.245	2.185	2.572	2.993



Count	Plot Pos 8832	D_{ex} (m)	D_{fut} (m)	$D_{CC10\%}$ (m)	$D_{CC20\%}$ (m)
1	0.01132%	1.358	1.349	1.351	1.354
2	0.02264%	1.342	1.341	1.35	1.354
3	0.03396%	1.337	1.34	1.349	1.347
4	0.04528%	1.321	1.333	1.347	1.335
5	0.05661%	1.32	1.324	1.343	1.335
6	0.06793%	1.317	1.314	1.343	1.333
7	0.07925%	1.311	1.311	1.342	1.332
8	0.09057%	1.308	1.307	1.339	1.331
9	0.10189%	1.3	1.306	1.339	1.323
10	0.11321%	1.299	1.306	1.338	1.321
11	0.12453%	1.298	1.305	1.338	1.319
12	0.13585%	1.297	1.304	1.338	1.315
13	0.14718%	1.296	1.303	1.333	1.313
14	0.15850%	1.296	1.303	1.323	1.313
15	0.16982%	1.296	1.301	1.323	1.312
16	0.18114%	1.295	1.3	1.322	1.301
17	0.19246%	1.293	1.297	1.321	1.301
18	0.20378%	1.286	1.296	1.317	1.297
19	0.21510%	1.283	1.296	1.31	1.292
20	0.22642%	1.274	1.289	1.299	1.29
21	0.23774%	1.273	1.285	1.297	1.289
22	0.24907%	1.272	1.283	1.285	1.283
23	0.26039%	1.257	1.281	1.283	1.281
24	0.27171%	1.253	1.28	1.279	1.276
25	0.28303%	1.252	1.256	1.278	1.276
26	0.29435%	1.246	1.245	1.273	1.274
27	0.30567%	1.237	1.223	1.27	1.274
28	0.31699%	1.223	1.214	1.257	1.273
29	0.32831%	1.222	1.213	1.249	1.269
30	0.33964%	1.22	1.212	1.243	1.269
31	0.35096%	1.217	1.209	1.238	1.269
32	0.36228%	1.215	1.207	1.231	1.267

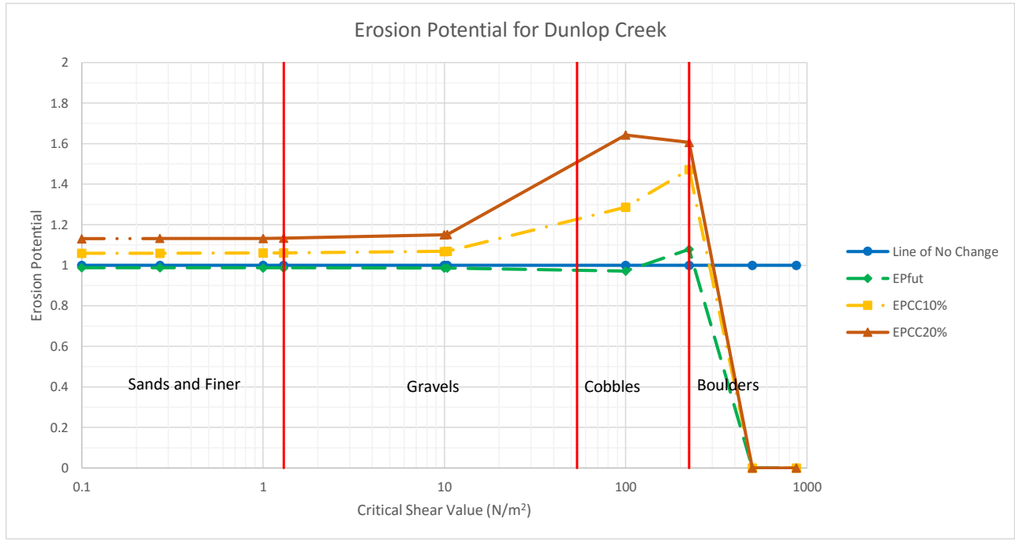


	Plot Pos	$ShrStrss_{ex}$	$ShrStrss_{fut}$	$ShrStrssCC_{10\%}$	$ShrStrss_{CC20\%}$
Count	8832	(N/m2)	(N/m2)	(N/m2)	(N/m2)
1	0.01132%	253.03	251.353	251.726	252.285
2	0.02264%	250.049	249.862	251.539	252.285
3	0.03396%	249.117	249.676	251.353	250.98
4	0.04528%	246.136	248.372	250.98	248.744
5	0.05661%	245.95	246.695	250.235	248.744
6	0.06793%	245.391	244.832	250.235	248.372
7	0.07925%	244.273	244.273	250.049	248.185
8	0.09057%	243.714	243.527	249.49	247.999
9	0.10189%	242.223	243.341	249.49	246.509
10	0.11321%	242.037	243.341	249.303	246.136
11	0.12453%	241.85	243.155	249.303	245.763
12	0.13585%	241.664	242.968	249.303	245.018
13	0.14718%	241.478	242.782	248.372	244.645
14	0.15850%	241.478	242.782	246.509	244.645
15	0.16982%	241.478	242.409	246.509	244.459
16	0.18114%	241.291	242.223	246.322	242.409
17	0.19246%	240.919	241.664	246.136	242.409
18	0.20378%	239.614	241.478	245.391	241.664
19	0.21510%	239.055	241.478	244.086	240.732
20	0.22642%	237.379	240.173	242.037	240.36
21	0.23774%	237.192	239.428	241.664	240.173
22	0.24907%	237.006	239.055	239.428	239.055
23	0.26039%	234.211	238.683	239.055	238.683
24	0.27171%	233.466	238.497	238.31	237.751
25	0.28303%	233.279	234.025	238.124	237.751
26	0.29435%	232.161	231.975	237.192	237.379
27	0.30567%	230.485	227.876	236.633	237.379
28	0.31699%	227.876	226.199	234.211	237.192
29	0.32831%	227.69	226.013	232.72	236.447
30	0.33964%	227.317	225.826	231.602	236.447
31	0.35096%	226.758	225.267	230.671	236.447
32	0.36228%	226.385	224.895	229.367	236.074



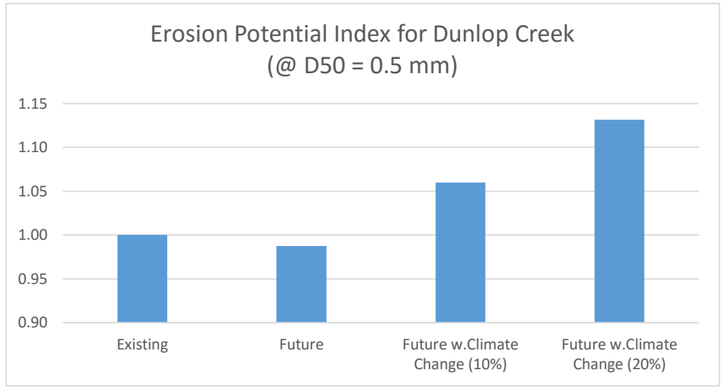
	Critical Shear Value (N/m2)	Corresponding Particle Size (mm)	Line of No Change	EP_{fut}	$EP_{CC10\%}$	$EP_{CC20\%}$
	0.1	0.0625	1	0.987	1.060	1.131
D50	0.27	0.5	1	0.987	1.060	1.132
	1		1	0.987	1.060	1.133
	1.3	2	1	0.987	1.061	1.133
	10		1	0.986	1.068	1.151
D90	10.4	14	1	0.986	1.069	1.152
	100		1	0.972	1.286	1.643
	223.7	256	1	1.079	1.472	1.606
	500		1	#DIV/0!	#DIV/0!	#DIV/0!
	873.8	1000	1	#DIV/0!	#DIV/0!	#DIV/0!

Sand-Gravel line	
1.3	0
1.3	100
Gravel-Cobble line	
53.9	0
53.9	100
Cobble-Boulder line	
223.7	0
223.7	100



Winter 2014-2015 Erosion Potential

	@D50 (N/m2)	EPI @ D50
Existing	6,049,136	1.00
Future	5,973,168	0.99
Future w.Climate Change (10%)	6,410,482	1.06
Future w.Climate Change (20%)	6,845,613	1.13



Model Creek ID	Creek Name	Location	Existing Max Flow (m3/s)	Future Max Flow (m3/s)	Climate Change 10% Flow (m3/s)	Climate Change 20% Flow (m3/s)	Length (m)	Roughness Coefficient	Slope
CR46077	Millionaire	Fern Cres.	2.878	2.468	2.749	3.148	67.277	0.03	0.052
CR46556	McFadden	264 St.	5.082	4.857	5.238	5.797	153.787	0.03	0.056
CR47667	T2	126 Ave.	1.613	1.513	1.760	2.121	111.865	0.03	0.011
CR47210	Dunlop	Discharge to Kanaka	3.195	3.073	3.604	4.070	48.183	0.03	0.019
CR48546	Kanaka	Downstream Dunlop Tributary	33.427	32.609	38.839	45.192	53.067	0.03	0.004

Simulation Period:

From	2014-11-21
To	2015-02-21

T2

Erosion Potential Analysis

Existing

Existing: Continuous-Winter-2014-2015

1.67

Final Date	Days-Hour	Flow (m3/s)	Depth (m)	Flow Volume (m3)	Top Width (m)	Hydraulic Depth (m)	Velocity (m/s)	HGL (m)	Froude #	Shear Stress (Tractive Force) (N/m2)
21-Nov-14	Day 0; 00:15	0.011	0.08	1.11	0.557	0.018	0.493	7.798	1.173	1.942
21-Nov-14	Day 0; 00:30	0.011	0.079	1.087	0.551	0.018	0.497	7.798	1.183	1.942
21-Nov-14	Day 0; 00:45	0.014	0.084	1.218	0.587	0.019	0.542	7.804	1.256	2.050
21-Nov-14	Day 0; 01:00	0.017	0.091	1.392	0.633	0.02	0.578	7.812	1.305	2.157
21-Nov-14	Day 0; 01:15	0.021	0.098	1.649	0.685	0.022	0.613	7.82	1.320	2.373
21-Nov-14	Day 0; 01:30	0.026	0.107	1.952	0.744	0.023	0.653	7.829	1.375	2.481
21-Nov-14	Day 0; 01:45	0.034	0.117	2.329	0.817	0.025	0.708	7.841	1.430	2.697
20-Feb-15	Day 91; 23:15	0.006	0.063	0.673	0.438	0.014	0.396	7.78	1.069	1.510
20-Feb-15	Day 91; 23:30	0.006	0.063	0.672	0.438	0.014	0.396	7.78	1.069	1.510
20-Feb-15	Day 91; 23:45	0.006	0.063	0.671	0.437	0.014	0.396	7.78	1.069	1.510
21-Feb-15	Day 92; 00:00	0.005	0.063	0.671	0.437	0.014	0.396	7.78	1.069	1.510
***	**Mean**	**0.081**	**0.132**	**3.643**	**0.916**	**0.029**	**0.771**	**7.858**	**1.437**	**3.113**
	Median	**0.031**	**0.113**	**2.184**	**0.790**	**0.025**	**0.680**	**7.836**	**1.379**	**2.697**
	Max	**1.613**	**0.499**	**40.240**	**2.951**	**0.122**	**1.931**	**8.223**	**1.908**	**13.160**

Future

Future: Continuous-Winter-2014-2015

Flow (m3/s)	Depth (m)	Flow Volume (m3)	Top Width (m)	Hydraulic Depth (m)	Velocity (m/s)	HGL (m)	Froude #	Shear Stress (Tractive Force) (N/m2)
0.011	0.08	1.111	0.558	0.018	0.493	7.798	1.17	1.942
0.012	0.08	1.115	0.559	0.018	0.512	7.799	1.22	1.942
0.016	0.089	1.349	0.623	0.019	0.578	7.811	1.34	2.05
0.022	0.1	1.716	0.698	0.022	0.628	7.823	1.35	2.373
0.027	0.108	1.992	0.752	0.024	0.656	7.83	1.35	2.589
0.034	0.117	2.332	0.818	0.025	0.71	7.842	1.43	2.697
0.046	0.13	2.863	0.906	0.028	0.78	7.856	1.49	3.02
0.005	0.062	0.655	0.433	0.014	0.393	7.78	1.06	1.51
0.005	0.062	0.654	0.432	0.014	0.393	7.78	1.06	1.51
0.005	0.062	0.654	0.432	0.014	0.393	7.779	1.06	1.51
0.005	0.062	0.653	0.432	0.014	0.393	7.779	1.06	1.51
0.083	**0.132**	**3.682**	**0.916**	**0.029**	**0.769**	**7.858**	**1.432**	**3.113**
0.029	**0.111**	**2.119**	**0.777**	**0.024**	**0.669**	**7.833**	**1.368**	**2.589**
1.513	**0.487**	**38.466**	**2.914**	**0.118**	**1.896**	**8.211**	**1.912**	**12.729**

Future

Climate Change by 10%: Continuous-Winter-2014-2015

Flow (m3/s)	Depth (m)	Flow Volume (m3)	Top Width (m)	Hydraulic Depth (m)	Velocity (m/s)	HGL (m)	Froude #	Shear Stress (Tractive Force) (N/m2)
0.011	0.08	1.111	0.558	0.018	0.493	7.798	1.173	1.942
0.012	0.081	1.126	0.562	0.018	0.517	7.8	1.231	1.942
0.017	0.091	1.398	0.633	0.02	0.591	7.813	1.334	2.157
0.024	0.103	1.802	0.715	0.023	0.639	7.825	1.345	2.481
0.029	0.111	2.103	0.774	0.024	0.672	7.834	1.385	2.589
0.038	0.121	2.503	0.847	0.026	0.739	7.846	1.464	2.805
0.052	0.135	3.085	0.939	0.029	0.808	7.862	1.515	3.128
0.006	0.063	0.673	0.438	0.014	0.396	7.78	1.069	1.510
0.006	0.063	0.672	0.438	0.014	0.396	7.78	1.069	1.510
0.006	0.063	0.671	0.437	0.014	0.396	7.78	1.069	1.510
0.005	0.063	0.67	0.437	0.014	0.396	7.78	1.069	1.510
0.092	**0.136**	**3.943**	**0.943**	**0.030**	**0.788**	**7.862**	**1.446**	**3.209**
0.031	**0.114**	**2.214**	**0.795**	**0.025**	**0.685**	**7.837**	**1.383**	**2.697**
1.760	**0.519**	**42.992**	**3.008**	**0.128**	**1.972**	**8.240**	**1.915**	**13.808**

Future

Climate Change by 20%: Continuous-Winter-2014-2015

Flow (m3/s)	Depth (m)	Flow Volume (m3)	Top Width (m)	Hydraulic Depth (m)	Velocity (m/s)	HGL (m)	Froude #	Shear Stress (Tractive Force) (N/m2)
0.011	0.08	1.112	0.558	0.018	0.494	7.798	1.176	1.942
0.012	0.081	1.137	0.565	0.018	0.521	7.801	1.240	1.942
0.018	0.092	1.447	0.644	0.02	0.602	7.815	1.359	2.157
0.026	0.105	1.889	0.732	0.023	0.651	7.828	1.371	2.481
0.032	0.114	2.216	0.795	0.025	0.688	7.837	1.390	2.697
0.042	0.125	2.667	0.874	0.027	0.76	7.851	1.477	2.913
0.057	0.139	3.299	0.971	0.03	0.836	7.867	1.541	3.236
0.006	0.064	0.69	0.443	0.014	0.399	7.781	1.077	1.510
0.006	0.063	0.689	0.443	0.014	0.399	7.781	1.077	1.510
0.006	0.063	0.688	0.442	0.014	0.399	7.781	1.077	1.510
0.006	0.063	0.687	0.442	0.014	0.399	7.781	1.077	1.510
0.101	**0.139**	**4.198**	**0.968**	**0.031**	**0.805**	**7.867**	**1.458**	**3.299**
0.033	**0.116**	**2.300**	**0.812**	**0.025**	**0.698**	**7.840**	**1.404**	**2.697**
2.121	**0.561**	**49.332**	**3.134**	**0.141**	**2.076**	**8.280**	**1.925**	**15.210**

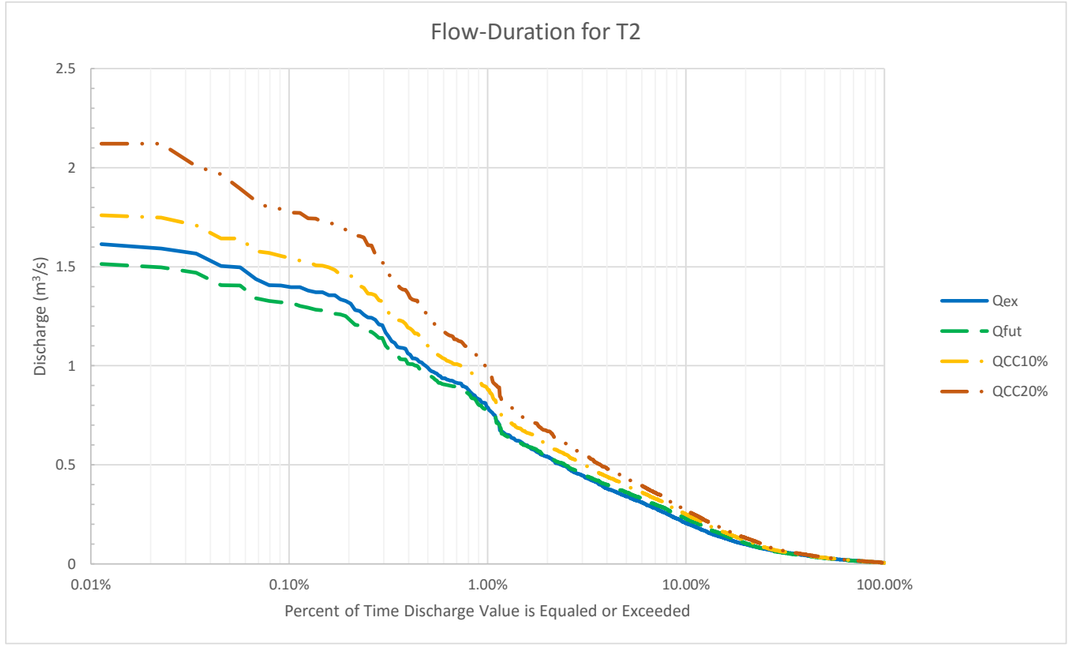
	Existing Excess Shear Stress, by PSD									For D50	For D90
Particle Size (d) (mm)	0.0625		2		64		256		1000	13.5	170
Critical Shear Stress (N/m2)	0.1	1	1.3	10	53.9	100	223.7	500	873.8	10	148.5
	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)
	2.50	0.91	0.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2.50	0.91	0.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2.72	1.08	0.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2.95	1.24	0.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3.43	1.61	1.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3.67	1.80	1.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4.19	2.21	1.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	1.67	0.36	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	1.67	0.36	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	1.67	0.36	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	1.67	0.36	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sum	50174.71	31778.08	26541.50	83.80	0.00	0.00	0.00	0.00	0.00	83.80	0.00
Erosion Potential Index	1	1	1	1	1	1	1	1	1	1	1

Future Excess Shear Stress, by PSD										For D50	For D90
0.0625		2		64		256		1000		13.5	170
0.1	1	1.3	10	53.9	100	223.7	500	873.8		10	148.5
(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)		(N/m2)	(N/m2)
2.50	0.91	0.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.50	0.91	0.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.72	1.08	0.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.43	1.61	1.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.93	2.00	1.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.19	2.21	1.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.99	2.87	2.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.67	0.36	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.67	0.36	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.67	0.36	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.67	0.36	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50378.78	**32021.90**	**26806.61**	**59.61**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**		**59.61**	**0.00**
1.004	**1.008**	**1.010**	**0.711**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**		**0.711**	**#DIV/0!**

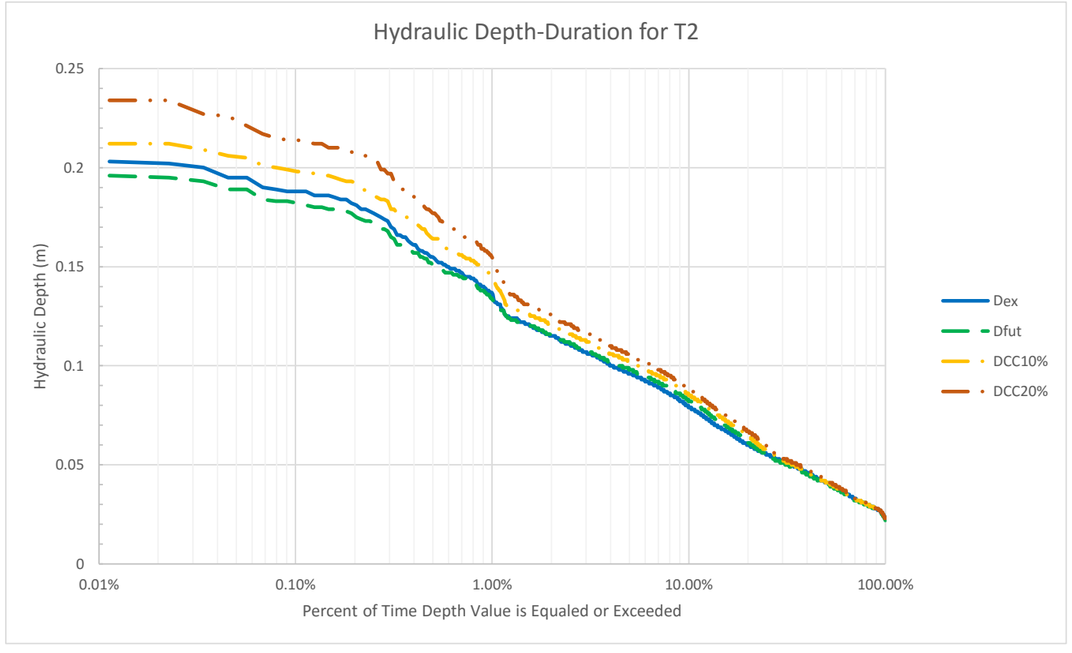
Future 10% Climate Change Excess Shear Stress, by PSD										For D50	For D90
0.0625		2		64		256		1000		13.5	170
0.1	1	1.3	10	53.9	100	223.7	500	873.8		10	148.5
(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)		(N/m2)	(N/m2)
2.50	0.91	0.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.50	0.91	0.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.95	1.24	0.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.67	1.80	1.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.93	2.00	1.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.45	2.43	1.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.27	3.10	2.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.67	0.36	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.67	0.36	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.67	0.36	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.67	0.36	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
53048.81	34381.06	29046.95	143.28	0.00	0.00	0.00	0.00	0.00	143.28	0.00	
1.057	1.082	1.094	1.710	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	1.710	#DIV/0!	

Future 20% Climate Change Excess Shear Stress, by PSD										For D50	For D90
0.0625		2		64		256		1000		13.5	170
0.1	1	1.3	10	53.9	100	223.7	500	873.8		10	148.5
(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)		(N/m2)	(N/m2)
2.50	0.91	0.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.50	0.91	0.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.95	1.24	0.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.67	1.80	1.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.19	2.21	1.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.72	2.65	2.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.55	3.34	2.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.67	0.36	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.67	0.36	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.67	0.36	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.67	0.36	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
55644.58	36687.53	31243.46	271.67	0.00	0.00	0.00	0.00	0.00	271.67	0.00	
1.109	1.154	1.177	3.242	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	3.242	#DIV/0!	

	Plot Pos	Q_{ex}	Q_{fut}	$Q_{CC10\%}$	$Q_{CC20\%}$
Count	8832	(m3/s)	(m3/s)	(m3/s)	(m3/s)
1	0.01132%	1.613	1.513	1.76	2.121
2	0.02264%	1.592	1.496	1.747	2.12
3	0.03396%	1.567	1.469	1.709	2.007
4	0.04528%	1.503	1.406	1.643	1.967
5	0.05661%	1.496	1.405	1.642	1.894
6	0.06793%	1.437	1.341	1.578	1.831
7	0.07925%	1.407	1.327	1.57	1.796
8	0.09057%	1.405	1.321	1.554	1.791
9	0.10189%	1.396	1.318	1.542	1.773
10	0.11321%	1.396	1.301	1.53	1.772
11	0.12453%	1.379	1.294	1.526	1.745
12	0.13585%	1.372	1.283	1.507	1.742
13	0.14718%	1.371	1.279	1.505	1.726
14	0.15850%	1.356	1.274	1.497	1.719
15	0.16982%	1.356	1.263	1.483	1.717
16	0.18114%	1.336	1.26	1.459	1.703
17	0.19246%	1.327	1.251	1.456	1.687
18	0.20378%	1.314	1.227	1.455	1.665
19	0.21510%	1.281	1.207	1.439	1.657
20	0.22642%	1.276	1.203	1.404	1.655
21	0.23774%	1.258	1.192	1.394	1.648
22	0.24907%	1.244	1.175	1.365	1.608
23	0.26039%	1.242	1.171	1.362	1.607
24	0.27171%	1.233	1.158	1.356	1.563
25	0.28303%	1.209	1.141	1.33	1.561
26	0.29435%	1.205	1.14	1.326	1.52
27	0.30567%	1.167	1.101	1.279	1.513
28	0.31699%	1.147	1.084	1.268	1.467
29	0.32831%	1.124	1.067	1.233	1.434
30	0.33964%	1.115	1.061	1.232	1.421
31	0.35096%	1.095	1.054	1.23	1.41
32	0.36228%	1.092	1.034	1.228	1.393



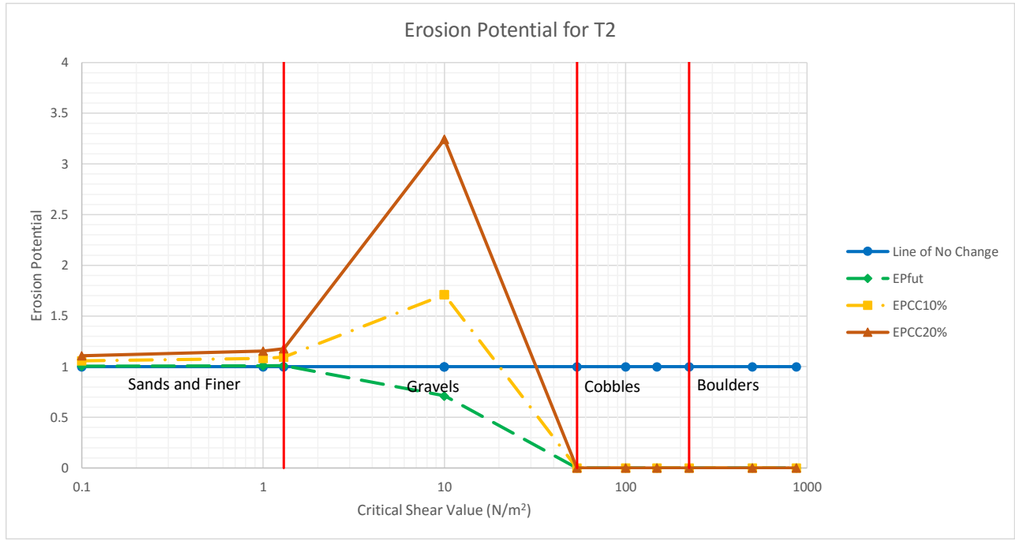
Count	Plot Pos 8832	D_{ex} (m)	D_{fut} (m)	$D_{CC10\%}$ (m)	$D_{CC20\%}$ (m)
1	0.01132%	0.203	0.196	0.212	0.234
2	0.02264%	0.202	0.195	0.212	0.234
3	0.03396%	0.2	0.193	0.209	0.227
4	0.04528%	0.195	0.189	0.206	0.226
5	0.05661%	0.195	0.189	0.205	0.221
6	0.06793%	0.19	0.184	0.201	0.217
7	0.07925%	0.189	0.183	0.2	0.215
8	0.09057%	0.188	0.183	0.199	0.214
9	0.10189%	0.188	0.182	0.198	0.214
10	0.11321%	0.188	0.181	0.198	0.213
11	0.12453%	0.186	0.18	0.197	0.212
12	0.13585%	0.186	0.18	0.196	0.212
13	0.14718%	0.186	0.179	0.196	0.21
14	0.15850%	0.185	0.179	0.195	0.21
15	0.16982%	0.184	0.178	0.194	0.21
16	0.18114%	0.184	0.178	0.193	0.209
17	0.19246%	0.182	0.177	0.193	0.208
18	0.20378%	0.181	0.175	0.192	0.206
19	0.21510%	0.179	0.174	0.191	0.206
20	0.22642%	0.179	0.173	0.188	0.206
21	0.23774%	0.178	0.173	0.188	0.205
22	0.24907%	0.177	0.172	0.186	0.203
23	0.26039%	0.176	0.171	0.185	0.203
24	0.27171%	0.175	0.169	0.184	0.199
25	0.28303%	0.174	0.169	0.184	0.199
26	0.29435%	0.173	0.168	0.183	0.197
27	0.30567%	0.17	0.165	0.179	0.197
28	0.31699%	0.169	0.164	0.179	0.193
29	0.32831%	0.166	0.161	0.177	0.191
30	0.33964%	0.166	0.161	0.175	0.189
31	0.35096%	0.165	0.161	0.175	0.189
32	0.36228%	0.165	0.16	0.175	0.189



	Plot Pos	$ShrStrss_{ex}$	$ShrStrss_{fut}$	$ShrStrssCC_{10\%}$	$ShrStrss_{CC20\%}$
Count	8832	(N/m2)	(N/m2)	(N/m2)	(N/m2)
1	0.01132%	103.518	99.949	108.108	119.327
2	0.02264%	103.009	99.439	108.108	119.327
3	0.03396%	101.989	98.419	106.578	115.757
4	0.04528%	99.439	96.379	105.048	115.247
5	0.05661%	99.439	96.379	104.538	112.697
6	0.06793%	96.889	93.83	102.499	110.658
7	0.07925%	96.379	93.32	101.989	109.638
8	0.09057%	95.869	93.32	101.479	109.128
9	0.10189%	95.869	92.81	100.969	109.128
10	0.11321%	95.869	92.3	100.969	108.618
11	0.12453%	94.849	91.79	100.459	108.108
12	0.13585%	94.849	91.79	99.949	108.108
13	0.14718%	94.849	91.28	99.949	107.088
14	0.15850%	94.339	91.28	99.439	107.088
15	0.16982%	93.83	90.77	98.929	107.088
16	0.18114%	93.83	90.77	98.419	106.578
17	0.19246%	92.81	90.26	98.419	106.068
18	0.20378%	92.3	89.24	97.909	105.048
19	0.21510%	91.28	88.73	97.399	105.048
20	0.22642%	91.28	88.22	95.869	105.048
21	0.23774%	90.77	88.22	95.869	104.538
22	0.24907%	90.26	87.71	94.849	103.518
23	0.26039%	89.75	87.2	94.339	103.518
24	0.27171%	89.24	86.18	93.83	101.479
25	0.28303%	88.73	86.18	93.83	101.479
26	0.29435%	88.22	85.67	93.32	100.459
27	0.30567%	86.69	84.141	91.28	100.459
28	0.31699%	86.18	83.631	91.28	98.419
29	0.32831%	84.651	82.101	90.26	97.399
30	0.33964%	84.651	82.101	89.24	96.379
31	0.35096%	84.141	82.101	89.24	96.379
32	0.36228%	84.141	81.591	89.24	96.379

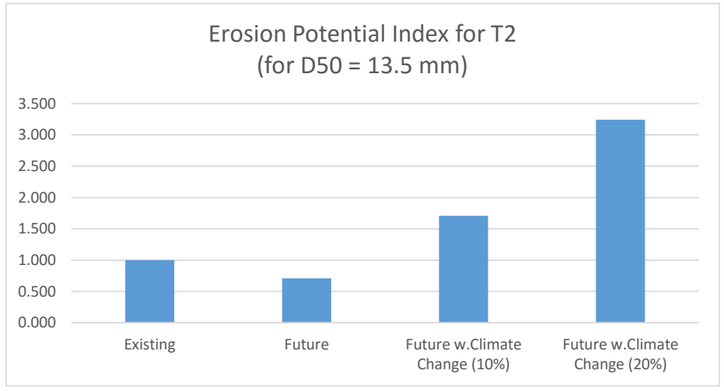
	Critical Shear Value (N/m2)	Corresponding Particle Size (mm)	Line of No Change	EP_{fut}	$EP_{CC10\%}$	$EP_{CC20\%}$
	0.1	0.0625	1	1.004	1.057	1.109
	1		1	1.008	1.082	1.154
	1.3	2	1	1.010	1.094	1.177
	10		1	0.711	1.710	3.242
D50	10	13.5	1	0.711	1.710	3.242
	53.9	64	1	#DIV/0!	#DIV/0!	#DIV/0!
	100		1	#DIV/0!	#DIV/0!	#DIV/0!
D90	148.5	170	1	#DIV/0!	#DIV/0!	#DIV/0!
	223.7	256	1	#DIV/0!	#DIV/0!	#DIV/0!
	500		1	#DIV/0!	#DIV/0!	#DIV/0!
	873.8	1000	1	#DIV/0!	#DIV/0!	#DIV/0!

Sand-Gravel line	
1.3	0
1.3	100
Gravel-Cobble line	
53.9	0
53.9	100
Cobble-Boulder line	
223.7	0
223.7	100



Winter 2014-2015 Erosion Potential

	@D50 (N/m2)	EPI @ D50
Existing	83.80	1.000
Future	59.61	0.711
Future w.Climate Change (10%)	143.28	1.710
Future w.Climate Change (20%)	271.67	3.242



Model Creek ID	Creek Name	Location	Existing Max Flow (m3/s)	Future Max Flow (m3/s)	Climate Change 10% Flow (m3/s)	Climate Change 20% Flow (m3/s)	Length (m)	Roughness Coefficient	Slope
CR46077	Millionaire	Fern Cres.	2.878	2.468	2.749	3.148	67.277	0.03	0.052
CR46556	McFadden	264 St.	5.082	4.857	5.238	5.797	153.787	0.03	0.056
CR47667	T2	126 Ave.	1.613	1.513	1.760	2.121	111.865	0.03	0.011
CR47210	Dunlop	Discharge to Kanaka	3.195	3.073	3.604	4.070	48.183	0.03	0.019
CR48546	Kanaka	Downstream Dunlop Tributary	33.427	32.609	38.839	45.192	53.067	0.03	0.004

Simulation Period:

From	2014-11-21
To	2015-02-21

Kanaka Creek | **Existing**

Erosion Potential Analysis | **Existing: Continuous-Winter-2014-2015**

Final Date	Days-Hour	Flow (m3/s)	Depth (m)	Flow Volume (m3)	Top Width (m)	Hydraulic Depth (m)	Velocity (m/s)
21-Nov-14	Day 0; 00:15	1.512	0.366	188.598	11.336	0.314	0.429
21-Nov-14	Day 0; 00:30	1.498	0.365	187.823	11.33	0.312	0.426
21-Nov-14	Day 0; 00:45	1.492	0.364	187.241	11.325	0.312	0.426
21-Nov-14	Day 0; 01:00	1.488	0.364	186.994	11.322	0.311	0.425
21-Nov-14	Day 0; 01:15	1.484	0.363	186.792	11.321	0.311	0.425
21-Nov-14	Day 0; 01:30	1.485	0.363	186.816	11.321	0.311	0.425
21-Nov-14	Day 0; 01:45	1.489	0.364	187.078	11.323	0.311	0.426
20-Feb-15	Day 91; 23:15	0.753	0.272	133.336	10.84	0.232	0.303
20-Feb-15	Day 91; 23:30	0.752	0.272	133.202	10.839	0.232	0.303
20-Feb-15	Day 91; 23:45	0.751	0.272	133.069	10.838	0.231	0.303
21-Feb-15	Day 92; 00:00	0.749	0.272	132.936	10.837	0.231	0.303
***	**Mean**	**4.442**	**0.542**	**304.335**	**12.251**	**0.454**	**0.658**
	Median	**3.021**	**0.493**	**266.702**	**12.003**	**0.419**	**0.604**
	Max	**33.427**	**1.572**	**1106.234**	**17.158**	**1.215**	**1.604**

Future

Future: Continuous-Winter-2014-2015

HGL (m)	Froude #	Shear Stress (Tractive Force) (N/m2)	Flow (m3/s)	Depth (m)	Flow Volume (m3)	Top Width (m)	Hydraulic Depth (m)
3.282	0.244	12.317	1.469	0.362	185.956	11.313	0.31
3.281	0.244	12.239	1.461	0.361	185.502	11.309	0.309
3.28	0.244	12.239	1.456	0.361	185.078	11.306	0.308
3.279	0.243	12.199	1.453	0.36	184.858	11.304	0.308
3.279	0.243	12.199	1.456	0.36	184.984	11.305	0.308
3.279	0.243	12.199	1.465	0.361	185.551	11.31	0.309
3.28	0.244	12.199	1.482	0.363	186.598	11.319	0.311
3.185	0.201	9.101	0.736	0.269	131.38	10.823	0.229
3.184	0.201	9.101	0.734	0.269	131.251	10.821	0.229
3.184	0.201	9.061	0.733	0.268	131.122	10.82	0.228
3.184	0.201	9.061	0.732	0.268	130.993	10.819	0.228
3.464	**0.305**	**17.810**	**4.372**	**0.538**	**301.457**	**12.229**	**0.451**
3.414	**0.298**	**16.436**	**2.959**	**0.488**	**263.700**	**11.978**	**0.415**
4.505	**0.471**	**47.660**	**32.609**	**1.548**	**1084.324**	**17.054**	**1.198**

Future

Climate Change by 10%: Continuous-Winter-2014-2015

Velocity (m/s)	HGL (m)	Froude #	Shear Stress (Tractive Force) (N/m2)	Flow (m3/s)	Depth (m)	Flow Volume (m3)	Top Width (m)
0.422	3.278	0.24	12.160	1.469	0.362	185.956	11.313
0.421	3.277	0.24	12.121	1.461	0.361	185.506	11.309
0.421	3.276	0.24	12.082	1.456	0.361	185.104	11.306
0.42	3.276	0.24	12.082	1.455	0.36	184.934	11.304
0.421	3.276	0.24	12.082	1.458	0.361	185.136	11.306
0.422	3.277	0.24	12.121	1.469	0.362	185.81	11.312
0.425	3.279	0.24	12.199	1.488	0.364	186.998	11.322
0.301	3.181	0.20	8.983	0.769	0.275	134.808	10.854
0.3	3.181	0.20	8.983	0.768	0.275	134.667	10.853
0.3	3.181	0.20	8.944	0.766	0.274	134.528	10.851
0.3	3.18	0.20	8.944	0.765	0.274	134.388	10.85
0.653	**3.459**	**0.304**	**17.674**	**4.804**	**0.559**	**316.037**	**12.335**
0.598	**3.409**	**0.296**	**16.279**	**3.177**	**0.503**	**273.452**	**12.059**
1.598	**4.481**	**0.471**	**46.993**	**38.839**	**1.705**	**1227.859**	**17.410**

					Future Climate Change by 20%: Continuous-Winter-2014-2015		
Hydraulic Depth (m)	Velocity (m/s)	HGL (m)	Froude #	Shear Stress (Tractive Force) (N/m2)	Flow (m3/s)	Depth (m)	Flow Volume (m3)
0.310	0.422	3.278	0.242	12.160	1.469	0.362	185.957
0.309	0.421	3.277	0.242	12.121	1.462	0.361	185.51
0.309	0.421	3.276	0.242	12.121	1.457	0.361	185.13
0.308	0.421	3.276	0.242	12.082	1.456	0.36	185.012
0.309	0.421	3.276	0.242	12.121	1.461	0.361	185.292
0.310	0.423	3.277	0.243	12.160	1.473	0.362	186.074
0.311	0.426	3.279	0.244	12.199	1.495	0.364	187.407
0.234	0.306	3.187	0.202	9.179	0.8	0.281	138.042
0.234	0.306	3.187	0.202	9.179	0.799	0.28	137.895
0.234	0.306	3.187	0.202	9.179	0.797	0.28	137.748
0.233	0.305	3.186	0.202	9.140	0.796	0.28	137.6
0.467	**0.679**	**3.481**	**0.310**	**18.316**	**5.236**	**0.579**	**330.103**
0.427	**0.619**	**3.425**	**0.302**	**16.750**	**3.386**	**0.518**	**282.531**
1.329	**1.679**	**4.636**	**0.473**	**52.132**	**45.192**	**1.835**	**1348.689**

Top Width (m)	Hydraulic Depth (m)	Velocity (m/s)	HGL (m)	Froude #	Shear Stress (Tractive Force) (N/m2)	Particle Size (d) (mm) Critical Shear Stress (N/m2)
11.313	0.31	0.422	3.278	0.242	12.160	
11.309	0.309	0.421	3.277	0.242	12.121	
11.306	0.309	0.421	3.276	0.242	12.121	
11.305	0.308	0.421	3.276	0.242	12.082	
11.307	0.309	0.422	3.276	0.242	12.121	
11.314	0.31	0.423	3.278	0.243	12.160	
11.326	0.312	0.427	3.28	0.244	12.239	
10.884	0.239	0.311	3.193	0.203	9.375	
10.882	0.239	0.311	3.192	0.203	9.375	
10.881	0.239	0.311	3.192	0.203	9.375	
10.879	0.238	0.31	3.192	0.203	9.336	
12.435	**0.482**	**0.702**	**3.501**	**0.316**	**18.925**	**Sum**
12.134	**0.439**	**0.639**	**3.439**	**0.308**	**17.220**	**Erosion Potential Index**
17.650	**1.440**	**1.779**	**4.766**	**0.475**	**56.486**	

Existing Excess Shear Stress, by PSD

0.0625		2		64		256	
0.1	1	1.3	10	53.9	100	223.7	500
(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)
42.70	38.07	36.57	3.53	0.00	0.00	0.00	0.00
42.29	37.68	36.18	3.35	0.00	0.00	0.00	0.00
42.29	37.68	36.18	3.35	0.00	0.00	0.00	0.00
42.08	37.48	35.98	3.26	0.00	0.00	0.00	0.00
42.08	37.48	35.98	3.26	0.00	0.00	0.00	0.00
42.08	37.48	35.98	3.26	0.00	0.00	0.00	0.00
42.08	37.48	35.98	3.26	0.00	0.00	0.00	0.00
27.00	23.06	21.79	0.00	0.00	0.00	0.00	0.00
27.00	23.06	21.79	0.00	0.00	0.00	0.00	0.00
26.82	22.89	21.62	0.00	0.00	0.00	0.00	0.00
26.82	22.89	21.62	0.00	0.00	0.00	0.00	0.00
688910.25	**640147.85**	**624197.33**	**239012.00**	**0.00**	**0.00**	**0.00**	**0.00**
1	**1**	**1**	**1**	**1**	**1**	**1**	**1**

	For D50	For D90	Future Excess Shear Stress, by PSD				
1000	0.11	20	0.0625		2		64
873.8	0.12	15.5	0.1	1	1.3	10	53.9
(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)
0.00	42.60	0.00	41.88	37.28	35.79	3.17	0.00
0.00	42.19	0.00	41.68	37.09	35.60	3.09	0.00
0.00	42.19	0.00	41.48	36.89	35.40	3.00	0.00
0.00	41.98	0.00	41.48	36.89	35.40	3.00	0.00
0.00	41.98	0.00	41.48	36.89	35.40	3.00	0.00
0.00	41.98	0.00	41.68	37.09	35.60	3.09	0.00
0.00	41.98	0.00	42.08	37.48	35.98	3.26	0.00
0.00	26.91	0.00	26.48	22.56	21.30	0.00	0.00
0.00	26.91	0.00	26.48	22.56	21.30	0.00	0.00
0.00	26.73	0.00	26.30	22.39	21.13	0.00	0.00
0.00	26.73	0.00	26.30	22.39	21.13	0.00	0.00
0.00	**687810.75**	**103533.72**	**681191.26**	**632626.86**	**616744.38**	**234056.07**	**0.00**
1	**1**	**1**	**0.989**	**0.988**	**0.988**	**0.979**	**#DIV/0!**

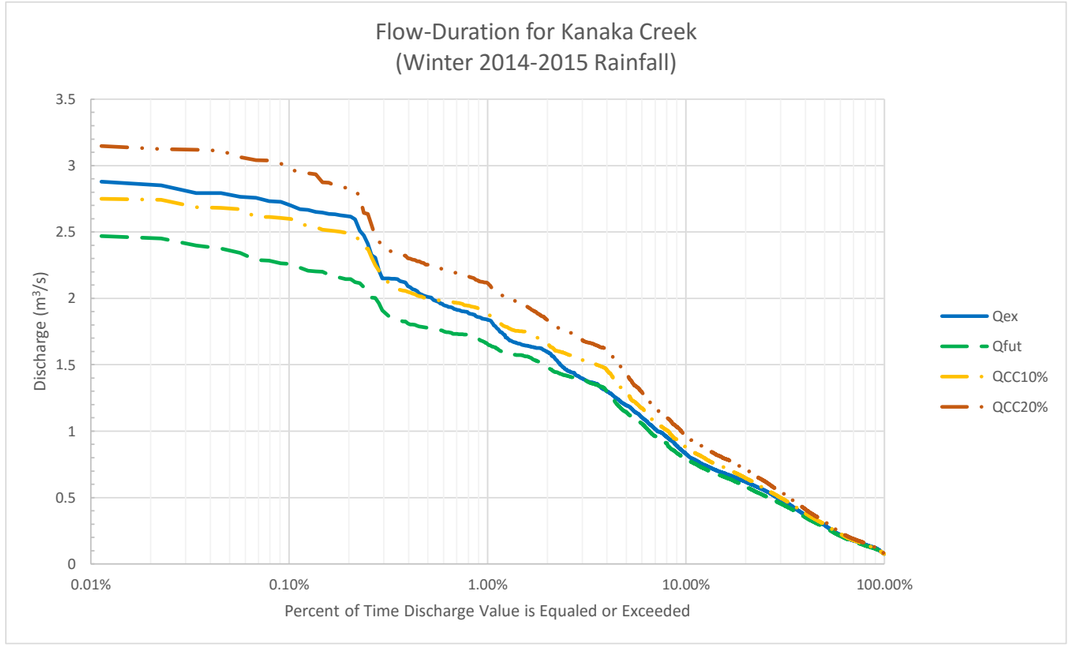
				For D50	For D90	Future 10% Climate Change Excess Shear S	
	256		1000	0.11	20	0.0625	
100	223.7	500	873.8	0.12	15.5	0.1	1
(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)
0.00	0.00	0.00	0.00	41.78	0.00	41.88	37.28
0.00	0.00	0.00	0.00	41.57	0.00	41.68	37.09
0.00	0.00	0.00	0.00	41.37	0.00	41.68	37.09
0.00	0.00	0.00	0.00	41.37	0.00	41.48	36.89
0.00	0.00	0.00	0.00	41.37	0.00	41.68	37.09
0.00	0.00	0.00	0.00	41.57	0.00	41.88	37.28
0.00	0.00	0.00	0.00	41.98	0.00	42.08	37.48
0.00	0.00	0.00	0.00	26.39	0.00	27.36	23.39
0.00	0.00	0.00	0.00	26.39	0.00	27.36	23.39
0.00	0.00	0.00	0.00	26.21	0.00	27.36	23.39
0.00	0.00	0.00	0.00	26.21	0.00	27.18	23.22
0.00	0.00	0.00	0.00	680095.71	100715.23	720990.14	671569.11
#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	0.989	0.973	1.047	1.049

tress, by PSD							For D50
2		64		256		1000	0.11
1.3	10	53.9	100	223.7	500	873.8	0.12
(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)
35.79	3.17	0.00	0.00	0.00	0.00	0.00	41.78
35.60	3.09	0.00	0.00	0.00	0.00	0.00	41.57
35.60	3.09	0.00	0.00	0.00	0.00	0.00	41.57
35.40	3.00	0.00	0.00	0.00	0.00	0.00	41.37
35.60	3.09	0.00	0.00	0.00	0.00	0.00	41.57
35.79	3.17	0.00	0.00	0.00	0.00	0.00	41.78
35.98	3.26	0.00	0.00	0.00	0.00	0.00	41.98
22.12	0.00	0.00	0.00	0.00	0.00	0.00	27.27
22.12	0.00	0.00	0.00	0.00	0.00	0.00	27.27
22.12	0.00	0.00	0.00	0.00	0.00	0.00	27.27
21.95	0.00	0.00	0.00	0.00	0.00	0.00	27.09
655395.58	262534.63	0.00	0.00	0.00	0.00	0.00	719876.02
1.050	1.098	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	1.047

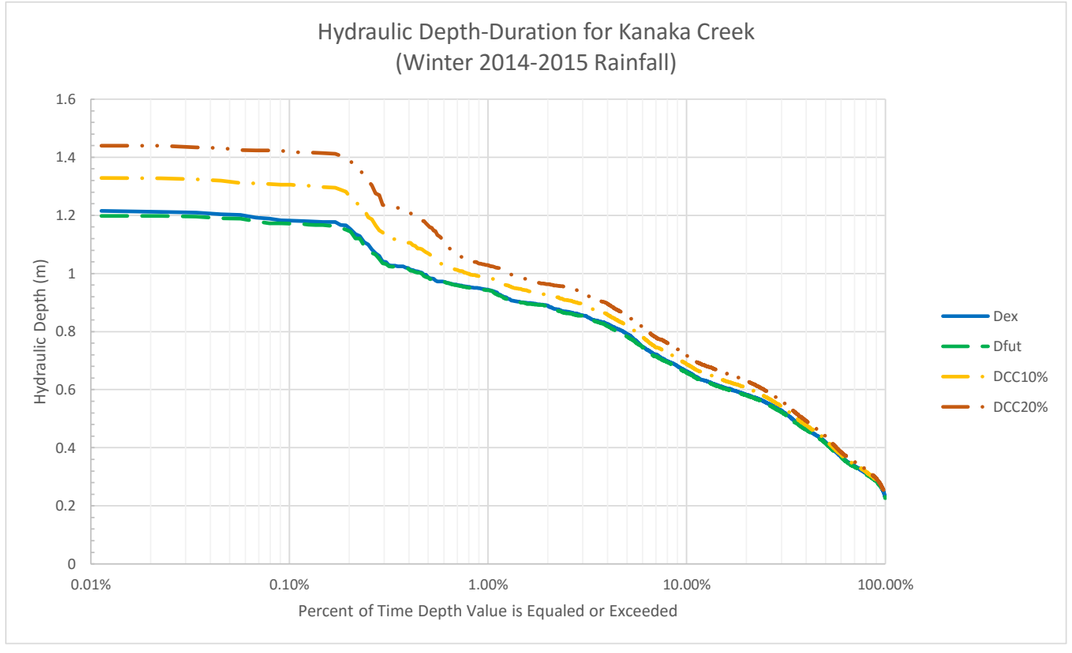
For D90	Future 20% Climate Change Excess Shear Stress, by PSD						
20	0.0625		2		64		256
15.5	0.1	1	1.3	10	53.9	100	223.7
(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)	(N/m2)
0.00	41.88	37.28	35.79	3.17	0.00	0.00	0.00
0.00	41.68	37.09	35.60	3.09	0.00	0.00	0.00
0.00	41.68	37.09	35.60	3.09	0.00	0.00	0.00
0.00	41.48	36.89	35.40	3.00	0.00	0.00	0.00
0.00	41.68	37.09	35.60	3.09	0.00	0.00	0.00
0.00	41.88	37.28	35.79	3.17	0.00	0.00	0.00
0.00	42.29	37.68	36.18	3.35	0.00	0.00	0.00
0.00	28.25	24.24	22.95	0.00	0.00	0.00	0.00
0.00	28.25	24.24	22.95	0.00	0.00	0.00	0.00
0.00	28.25	24.24	22.95	0.00	0.00	0.00	0.00
0.00	28.07	24.07	22.78	0.00	0.00	0.00	0.00
120235.48	759567.75	709353.24	692910.69	290738.34	42.98	0.00	0.00
1.161	1.103	1.108	1.110	1.216	#DIV/0!	#DIV/0!	#DIV/0!

		For D50	For D90
	1000	0.11	20
500	873.8	0.12	15.5
(N/m2)	(N/m2)	(N/m2)	(N/m2)
0.00	0.00	41.78	0.00
0.00	0.00	41.57	0.00
0.00	0.00	41.57	0.00
0.00	0.00	41.37	0.00
0.00	0.00	41.57	0.00
0.00	0.00	41.78	0.00
0.00	0.00	42.19	0.00
0.00	0.00	28.16	0.00
0.00	0.00	28.16	0.00
0.00	0.00	28.16	0.00
0.00	0.00	27.98	0.00
0.00	0.00	758436.64	140200.60
#DIV/0!	#DIV/0!	1.103	1.354

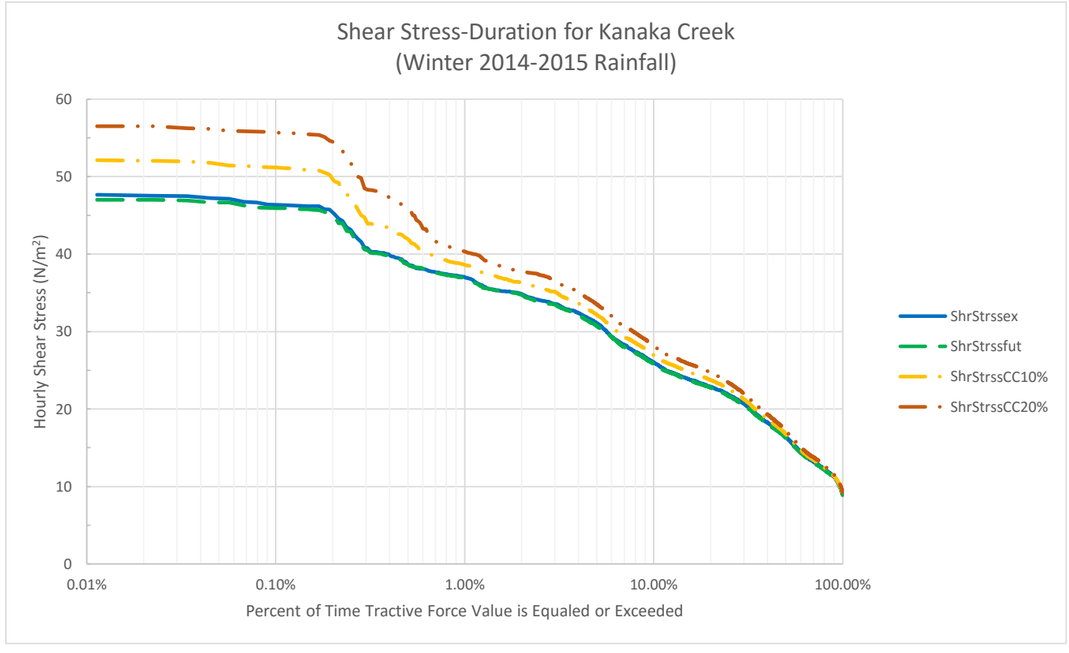
	Plot Pos	Q_{ex}	Q_{fut}	$Q_{CC10\%}$	$Q_{CC20\%}$
Count	8832	(m3/s)	(m3/s)	(m3/s)	(m3/s)
1	0.01132%	2.878	2.468	2.749	3.148
2	0.02264%	2.852	2.452	2.742	3.124
3	0.03396%	2.792	2.397	2.686	3.118
4	0.04528%	2.792	2.376	2.681	3.111
5	0.05661%	2.764	2.342	2.67	3.064
6	0.06793%	2.756	2.288	2.614	3.041
7	0.07925%	2.732	2.285	2.613	3.037
8	0.09057%	2.726	2.263	2.606	3.016
9	0.10189%	2.699	2.26	2.599	2.969
10	0.11321%	2.672	2.231	2.56	2.95
11	0.12453%	2.667	2.209	2.546	2.941
12	0.13585%	2.65	2.203	2.536	2.935
13	0.14718%	2.645	2.201	2.518	2.873
14	0.15850%	2.635	2.179	2.513	2.872
15	0.16982%	2.633	2.164	2.507	2.848
16	0.18114%	2.625	2.156	2.502	2.839
17	0.19246%	2.62	2.146	2.494	2.833
18	0.20378%	2.615	2.145	2.486	2.83
19	0.21510%	2.595	2.123	2.476	2.818
20	0.22642%	2.51	2.115	2.432	2.766
21	0.23774%	2.474	2.085	2.376	2.643
22	0.24907%	2.41	2.06	2.374	2.637
23	0.26039%	2.325	2.006	2.309	2.552
24	0.27171%	2.306	2.002	2.25	2.466
25	0.28303%	2.211	1.963	2.207	2.429
26	0.29435%	2.151	1.909	2.197	2.399
27	0.30567%	2.15	1.888	2.152	2.363
28	0.31699%	2.149	1.866	2.113	2.361
29	0.32831%	2.148	1.859	2.088	2.352
30	0.33964%	2.147	1.846	2.077	2.346
31	0.35096%	2.145	1.843	2.07	2.34
32	0.36228%	2.13	1.836	2.065	2.335



	Plot Pos	D_{ex}	D_{fut}	$D_{CC10\%}$	$D_{CC20\%}$
Count	8832	(m)	(m)	(m)	(m)
1	0.01132%	1.215	1.198	1.329	1.44
2	0.02264%	1.212	1.198	1.327	1.44
3	0.03396%	1.21	1.196	1.324	1.434
4	0.04528%	1.204	1.19	1.32	1.432
5	0.05661%	1.202	1.189	1.311	1.425
6	0.06793%	1.192	1.179	1.31	1.424
7	0.07925%	1.189	1.173	1.308	1.423
8	0.09057%	1.183	1.172	1.306	1.422
9	0.10189%	1.182	1.171	1.305	1.419
10	0.11321%	1.181	1.171	1.302	1.417
11	0.12453%	1.18	1.168	1.302	1.417
12	0.13585%	1.178	1.167	1.298	1.416
13	0.14718%	1.177	1.167	1.297	1.414
14	0.15850%	1.177	1.165	1.296	1.413
15	0.16982%	1.177	1.164	1.295	1.412
16	0.18114%	1.167	1.158	1.288	1.405
17	0.19246%	1.166	1.151	1.281	1.393
18	0.20378%	1.152	1.144	1.259	1.387
19	0.21510%	1.136	1.121	1.255	1.365
20	0.22642%	1.129	1.121	1.223	1.359
21	0.23774%	1.108	1.095	1.221	1.334
22	0.24907%	1.1	1.093	1.193	1.319
23	0.26039%	1.082	1.071	1.187	1.303
24	0.27171%	1.07	1.065	1.166	1.275
25	0.28303%	1.06	1.05	1.148	1.27
26	0.29435%	1.041	1.035	1.141	1.236
27	0.30567%	1.039	1.033	1.12	1.231
28	0.31699%	1.028	1.024	1.12	1.23
29	0.32831%	1.027	1.023	1.118	1.229
30	0.33964%	1.027	1.023	1.118	1.227
31	0.35096%	1.025	1.021	1.114	1.226
32	0.36228%	1.024	1.02	1.113	1.225

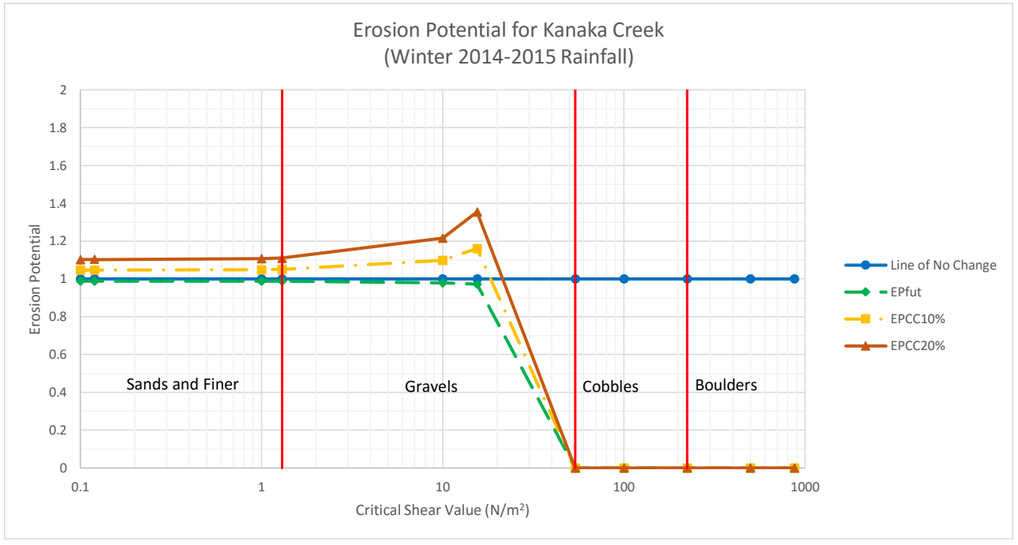


	Plot Pos	$ShrStrss_{ex}$	$ShrStrss_{fut}$	$ShrStrssCC_{10\%}$	$ShrStrss_{CC20\%}$
Count	8832	(N/m2)	(N/m2)	(N/m2)	(N/m2)
1	0.01132%	47.66	46.993	52.132	56.486
2	0.02264%	47.542	46.993	52.053	56.486
3	0.03396%	47.464	46.915	51.936	56.251
4	0.04528%	47.229	46.679	51.779	56.172
5	0.05661%	47.15	46.64	51.426	55.898
6	0.06793%	46.758	46.248	51.387	55.858
7	0.07925%	46.64	46.013	51.308	55.819
8	0.09057%	46.405	45.973	51.23	55.78
9	0.10189%	46.366	45.934	51.19	55.662
10	0.11321%	46.326	45.934	51.073	55.584
11	0.12453%	46.287	45.816	51.073	55.584
12	0.13585%	46.209	45.777	50.916	55.545
13	0.14718%	46.169	45.777	50.877	55.466
14	0.15850%	46.169	45.699	50.837	55.427
15	0.16982%	46.169	45.66	50.798	55.388
16	0.18114%	45.777	45.424	50.524	55.113
17	0.19246%	45.738	45.15	50.249	54.642
18	0.20378%	45.189	44.875	49.386	54.407
19	0.21510%	44.561	43.973	49.229	53.544
20	0.22642%	44.287	43.973	47.974	53.309
21	0.23774%	43.463	42.953	47.895	52.328
22	0.24907%	43.149	42.874	46.797	51.74
23	0.26039%	42.443	42.011	46.562	51.112
24	0.27171%	41.972	41.776	45.738	50.014
25	0.28303%	41.58	41.188	45.032	49.818
26	0.29435%	40.835	40.599	44.757	48.484
27	0.30567%	40.756	40.521	43.934	48.288
28	0.31699%	40.325	40.168	43.934	48.248
29	0.32831%	40.286	40.129	43.855	48.209
30	0.33964%	40.286	40.129	43.855	48.131
31	0.35096%	40.207	40.05	43.698	48.092
32	0.36228%	40.168	40.011	43.659	48.052



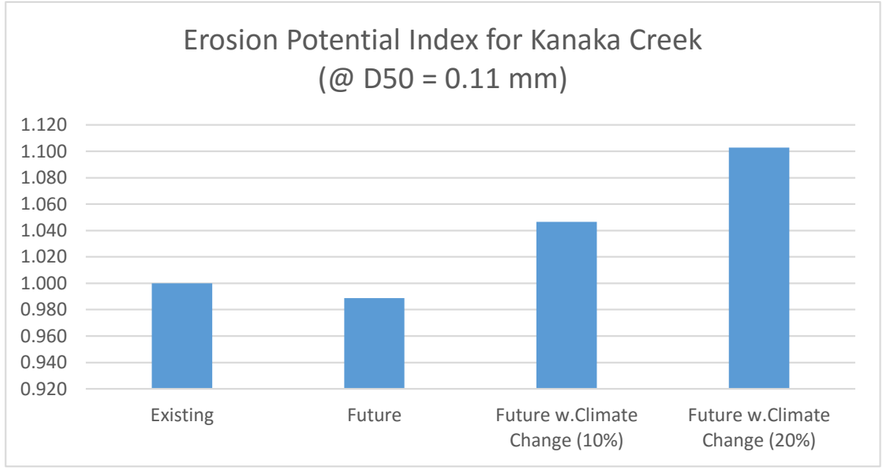
	Critical Shear Value (N/m2)	Corresponding Particle Size (mm)	Line of No Change	EP_{fut}	$EP_{CC10\%}$	$EP_{CC20\%}$
	0.1	0.0625	1	0.989	1.047	1.103
D50	0.12	0.11	1	0.989	1.047	1.103
	1		1	0.988	1.049	1.108
	1.3	2	1	0.988	1.050	1.110
	10		1	0.979	1.098	1.216
D90	15.5	20	1	0.973	1.161	1.354
	53.9		1	#DIV/0!	#DIV/0!	#DIV/0!
	100		1	#DIV/0!	#DIV/0!	#DIV/0!
	223.7	256	1	#DIV/0!	#DIV/0!	#DIV/0!
	500		1	#DIV/0!	#DIV/0!	#DIV/0!
	873.8	1000	1	#DIV/0!	#DIV/0!	#DIV/0!

Sand-Gravel line	
1.3	0
1.3	100
Gravel-Cobble line	
53.9	0
53.9	100
Cobble-Boulder line	
223.7	0
223.7	100



Winter 2014-2015 Erosion Potential

	@D50 (N/m2)	EPI @ D50
Existing	687810.75	1.000
Future	680095.71	0.989
Future w.Climate Change (10%)	719876.02	1.047
Future w.Climate Change (20%)	758436.64	1.103



Appendix E: Fraser River Escarpment – Control or Surficial and Groundwater Discharge

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POLICY STATEMENT

District of Maple Ridge

Title: **Control of Surficial and Groundwater Discharge in the Area Bounded by 207 Street, 124 Avenue, 224 Street and the Crest of the Fraser River Escarpment**	**Policy No : 6.23** **Supersedes: 6.04**
Authority: **Council** **Approval:** **March 23, 2004**	**Effective Date:** **March 24, 2004**

Policy Statement:

That the consideration of surficial or groundwater discharge within the area bounded by 207 Street, 124 Avenue, 224 Street and the crest of the Fraser River Escarpment be subject to the provisions and accompanying procedures that form part of this policy.

Purpose:

To set out conditions for the consideration of surficial or groundwater discharge in the area bounded by 207 Street, 124 Avenue, and 224 Street to the crest of the Fraser River Escarpment without compromising the stability of the entire Escarpment. This policy should be read in conjunction with Policy No. 6.24 – " Subdivision of, or building on, Land within 300 Metres of the Crest of the Fraser River Escarpment."

Definitions:

Crest (Top of Bank): The general crest (top of bank) as identified in the attached map prepared by Golder Associates Ltd. entitled "Fraser River Escarpment: Attachment 1", or as determined by a British Columbia Land Surveyor (BCLS).

Fraser River Escarpment (Escarpment): The area bounded by Fraserview Street to the west and Carshill Road to the east, extending from the crest of the Escarpment to north of River Road.

Geotechnical Engineer: A qualified geotechnical engineer or geoscientist in good standing in the Province of British Columbia.

Setback: The distance in metres from the delineated crest of the escarpment.

PROCEDURE (OPERATING REGULATION)

District of Maple Ridge

Title: Control of Surficial and Groundwater Discharge in the Area Bounded by 207 Street, 124 Avenue, 224 Street and the Crest of the Fraser River Escarpment.	**Policy No : 6.23** **Supersedes: 6.04**
Authority: Council **Approval: March 23, 2004**	**Effective Date:** **March 24, 2004**

1.0 POLICY STATEMENT (adopted)

That the consideration of surficial or groundwater discharge within the area bounded by 207 Street, 124 Avenue, 224 Street and the crest of the Fraser River Escarpment be subject to the provisions and accompanying procedures that form part of this policy.

2.0 KEY AREAS OF RESPONSIBILITY

Action to Take

1. Storm drainage ditches or buried storm services shall be provided where existing roads, residential and commercial run-off causes ponding of water.

2. Buried storm services shall be provided for all new roads or upgraded facilities.

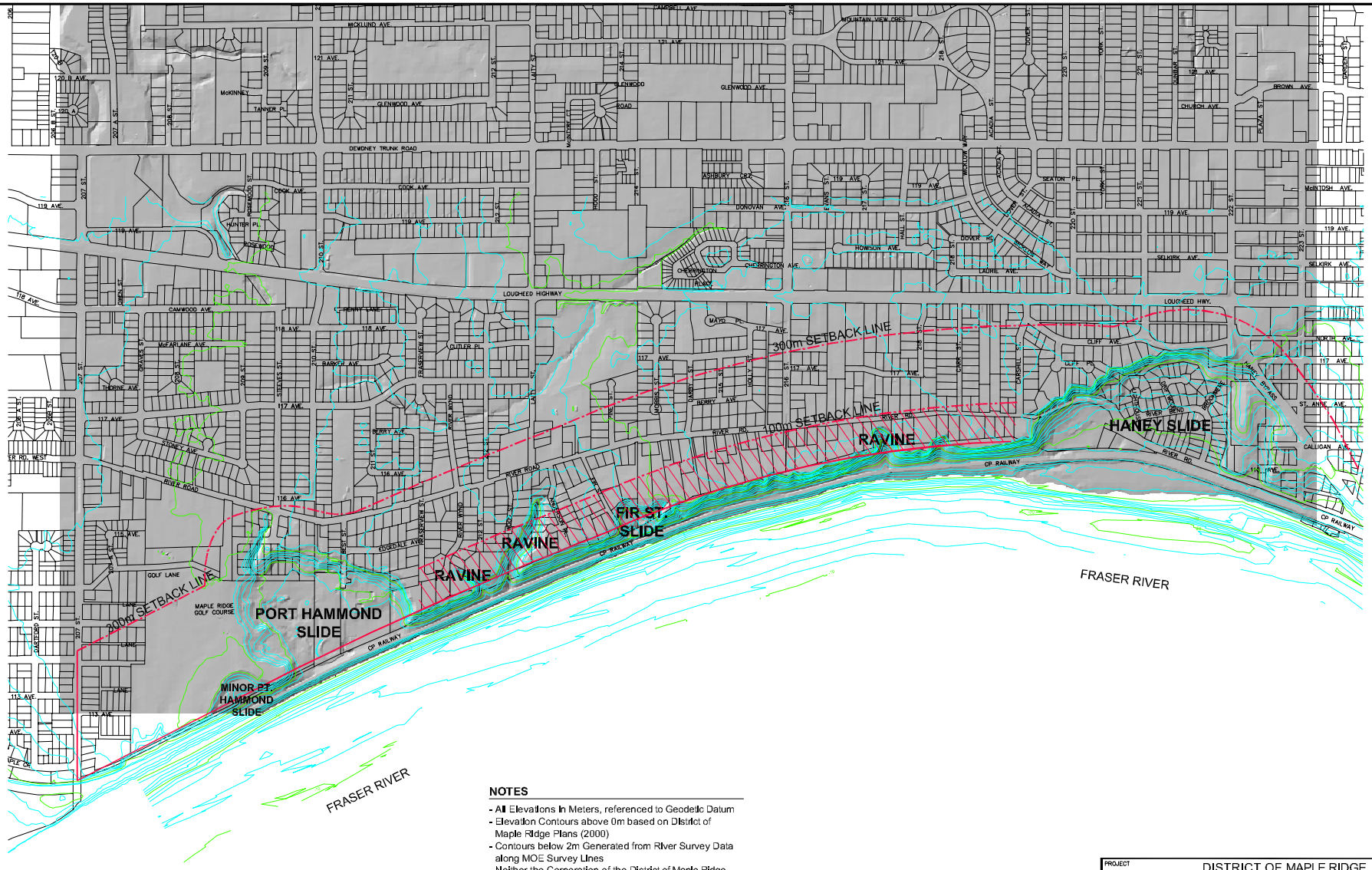
3. All storm drainage facilities shall be designed in accordance with the current storm water management criteria.

4. No ground water discharge of new construction residential, commercial, road or parking areas shall be allowed. All such drainage shall be carried to storm water ditches or sewers.

5. Septic fields shall be avoided and sanitary sewers provided where possible. Where existing residences are on septic systems they should be converted where possible. All new residences shall require sanitary sewers.

6. All storm ditches shall be constructed to avoid ponding of water. All ditches shall drain to the north and west by gravity. No discharge shall be allowed into river bank ravines.

7. No storm water discharge shall be permitted over the river bank slopes or ravines unless transferred to river level in continuous storm sewers or pipes. If approval cannot be obtained to discharge storm water by pipe into the Fraser River then the discharge must be directed to a storm drainage system - ditch or storm sewer - on the road right-of-way. Where there is no storm water collection system within the road right-of-way fronting the property then consideration must be given to the extension of the existing storm drainage system. 8. Landscape ponding is not permitted. 9. Swimming pools are not permitted to drain into rock pits.	


300m SETBACK LINE
100m SETBACK LINE
RAVINE
HANEY SLIDE
FIR ST. SLIDE
RAVINE
RAVINE
PORT HAMMOND SLIDE
MINOR PT. HAMMOND SLIDE
FRASER RIVER
FRASER RIVER
LOUGHEED HIGHWAY
CP RAILWAY
MAPLE RIDGE GOLF COURSE
GOLF LANE
RIVER ROAD
DEWDNEY TRUNK ROAD
GLENWOOD AVE
MOUNTAIN VIEW CRES
MCKLUND AVE
COOK AVE
CAMWOOD AVE
McFARLANE AVE
THORNE AVE
SYDNEY AVE
BERRY AVE
CLIFF AVE
SELKIRK AVE
LOUGHEED HWY.
ST. ANNE AVE
CALLIOAN AVE
HOWISON AVE
LADRIE AVE
DONOVAN AVE
CHERRINGTON AVE
ASHBURY CRT.
MAYO PL.
CUTLER PL.
HUNTER PL.
ROSEWOOD
TANNER PL.
McKINNEY
SEATON PL.
MACKAY PL.
DOVER PL.
DOVER RD.
MACKAY ST.
MONTAIN ST.
WICKLOW WAY
MAPLE CRES.
CHURCH AVE.
BROWN AVE.
McINTOSH AVE.
NORTH AVE.
CLIFF PL.
CARSHILL ST.
DOLLY ST.
MORRIS ST.
CHAPEL ST.
LAITY ST.
ROOT ST.
ELLIOTT ST.
ROBERTSON ST.
BEST ST.
ASHWORTH ST.
EDGEDALE AVE
ROCK MTN.
RIVER BEND
BROADWAY
ALOUETTE RIVER BYPASS
LOWER RIVER RD.
UPPER DR.
LANE
LANE
LANE

Appendix F: Water Quality Treatment References

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References cited in the WQ section of the Maple Ridge ISMP report (Section 13.1.5):

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