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Sh-hwuykwselu (Busy Place) Creek Stormwater Management and Mitigation Plan

Volume 1 of 2 – Report

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Prepared for:
Cowichan Valley Regional District and Cowichan Tribes

Funding Partners:
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Executive Summary

Sh-hwuykwselu (Busy Place) Creek drains a relatively small watershed with complex stormwater management challenges related to:

1. Inadequate stormwater management and drainage infrastructure leading to increased flood risk;
2. Declining water quality and stream habitat health;
3. Pressure for development for residential and commercial/light industrial uses; and
4. Multi-jurisdictional responsibility for stormwater management.

The Sh-hwuykwselu (Busy Place) Creek Stormwater Management and Mitigation Plan (the Plan) was developed through integrated solutions to the stormwater-related issues by:

- engagement with the community and stakeholders to identify concerns, opportunities, and stormwater management goals (Section 3);
- identification of drainage improvements through hydrological and hydraulic modelling to reduce flood risk with preference to restoring natural watershed function (Section 4 and Section 5);
- consideration of stormwater source control policy and standards to better manage stormwater runoff as part of redevelopment (Section 7);
- development of cost-effective solutions; and
- identification of opportunities for public education to promote community stewardship of the watershed.

A comprehensive mitigation and implementation plan was developed and prioritized for short term, medium term, and long-term goals as summarized in Table i and Figure i. The Plan includes:

1. Drainage improvements and upgrades to culverts, bridges, road raising and lower watershed diking, pumping, and installation of flood box.
2. Erosion management through constructing a detention pond/wetland and diversions
3. Aquifer water quality protection through requiring pre-treatment of runoff from pollutant generating surfaces such as roads and parking areas.
4. Stormwater management, low impact development, requirements for future development and redevelopment to: 1. implement erosion and sediment controls during construction; 2. construct low impact development measures for volume reduction 3. detention facilities for rate control and 4. Adequate drainage system for flood conveyance.
5. Environmental enhancements such as fish passage improvements, riparian area protection and restoration areas,
6. O&M recommendations
7. Identification of further studies such as Koksilah River Flood Management, Koksilah Business Park 200-year Flood Levels, Geotechnical assessment of Allenby Road slopes and Gravel and Debris Management Planning.

The Plan is intended to be the first phase of a broader stormwater management process for the watershed. Further consultation, public engagement, studies, planning, and design will be required as part of implementation of proposed projects and policies recommended in the Plan.

Given the multi-jurisdictional nature of the watershed, it is recommended that a Stormwater Management Plan Implementation Team be initiated by Cowichan Valley Regional District (CVRD), Cowichan Tribes (CT), and Ministry of Transportation and Infrastructure (MoTI) to coordinate and expedite the following phases of project implementation and fund-raising.

The total life-cycle cost of the Plan (planning costs, capital costs and 25-year maintenance/operation costs) has been estimated at approximately $21.1 million and is broken down into the following priorities.

Priority	Total Life Cycle Costs for Stormwater Management Priorities
1st	$2.1 million
2nd	$7.6 million
3rd	$11.4 million
Note: Total life-cycle costs include planning, capital construction, and ongoing maintenance/operation for 25-years. The costs do not include future discounting or inflation. They are considered to be order of magnitude costs for the purposes of long-term planning and option comparison having an accuracy of about +50% to -30%.	

Table i: Summary of Sh-hwuykwselu (Busy Place) Creek Stormwater Management and Mitigation Plan & Implementation Strategy

Phase (Priority)	Proposed SMMP	Prerequisite Actions	Type of Action					Land Manager/ Owner	Capital Cost[1]	Average Annual O&M Cost	Total Life Cycle Cost[2]
			Further Study/ Planning	Education, Engagement & Demonstration	Develop/ Implement Policy & Planning Guidelines	Capital Infrastructure	O&M or Monitoring				
Flood Management Actions											
A (1st Priority)	Improve ditch cleaning/catch basin clearing maintenance						X				
	Initiate Koksilah River Flood Management Plan	None	X								
	Assess Koksilah Business Park 200-Year Flood Construction Levels (FCL)	None	X								
	Carry out additional geotechnical investigation of steep slopes along Alenby Road		X								
	Prepare Koksilah Rive Debris and Gravel Management Plan (Project 13)	None	X								
B (2nd Priority)	Upgrade Miller Road near Highway 1 Culverts (Project 5)					X		MoTI	$670,000	$10,000	$920,000
	Design/Install Trestle Village Floodbox (Project 6)					X		CT	$350,000	$10,000	$600,000
	Design/Construct Trestle Village Upland Diversion (Project 9)					X		CT	$340,000	$10,000	$590,000
	Implement Koksilah River Debris and Gravel Management (Project 13)						X	CT/ MFLNRORD/ CVRD	TBD[3]	TBD[3]	TBD[3]
	Establish special development permit area for properties above and below steep slopes on Alenby Road	Geotechnical Investigation			X						
	Establish Minimum Building Elevation for Koksilah Business Park (bylaw)	Koksilah Business Park FCL			X						
C (3rd Priority)	Design/Upgrade Culverts/Fish Passage Improvements for Hykway, Koksilah & Tzinquaw Road Culverts (Project 2) OR Construct of Keating Farm Detention Storage (Project 1A)[4]	Assess feasibility				X		MoTI	$1,500,000	$10,000	$1,750,000
	Design/Upgrade Trestle Village Dike and Design/Construct Pump Station (Project 7 and 8)					X		CT	$4,300,000	$60,000	$5,800,000
D (4th Priority)	Upgrade E&N Railway and Bridge Flow Conveyance (Project 14)	Koksilah Flood Management Plan				X					
Erosion Management Actions											
C (3rd Priority)	Construct Keating Farm Wetland (Project 1B) (Assuming Culvert Upgrades in Phase C)					X		Private Land	$525,000	$30,000	$1,280,000
Water Quality Protection Actions											
A (1st Priority)	Require water quality pre-treatment for development and redevelopment occurring over vulnerable aquifer. Develop guidance document and / or bylaw.				X						
Environmental Enhancement Projects											
A (1st Priority)	Conduct Detailed Habitat Assessment		X								
D (4th Priority)	Design/Construct Hykway Park Diversion (Project 3)					X		CVRD	$430,000	$10,000	$680,000
	Design/Construct Polkey Road Realignment and Floodplain Riparian Improvements (Project 4)					X		MoTI	$4,600,000	$20,000	$5,100,000
	Design/construct Headwaters Channel Daylighting and Protect Riparian Areas(Project 10)					X		MoTI/Private CT/ CVRD	$570,000	$5,000	$695,000

Phase (Priority)	Proposed SMMP	Prerequisite Actions	Type of Action					Land Manager/ Owner	Capital Cost[1]	Average Annual O&M Cost	Total Life Cycle Cost[2]
			Further Study/ Planning	Education, Engagement & Demonstration	Develop/ Implement Policy & Planning Guidelines	Capital Infrastructure	O&M or Monitoring				
Low Impact Development Actions[5]											
A (1st Priority)	Seek SMMP Support from CT Council and CVRD Board			X							
	Organize SM Implementation Team with staff / coordinator			X							
	Conduct Culvert/drain/catch basin cleaning action / awareness			X							
	Water quality control action / awareness			X							
	Require Stormwater LID in large rezoning				X						
	Integrate LID demonstration/learning in current projects			X							
B (2nd Priority)	SM/LID public awareness 1.0			X							
	Identify priority areas for LID demonstration & implementation on common lands			X							
	Update Engineering standards to include SM and LID				X						
	Design Watershed Health Tracking System				X						
C (3rd Priority)	Review financial incentive program options				X						
	Require SM / LID in new MF ICI projects (update regs)				X						
	Street block SM and LID demo / monitoring projects			X							
	Parks/Common Land site SM, LID and biodiversity demo / monitoring projects			X							
	CVRD/CT Off-Street Property SM demo / monitoring projects			X							
	SM/LID public awareness 2.0			X							
D (4th Priority)	SM/LID public awareness 3.0 focused on single family/small projects			X							
	Private SF SM/LID demo / monitoring projects			X							
	Require SM/LID in new SF/Duplex projects (update regs)				X						
	Private surface parking SM/LID demo / monitoring projects			X							
	Launch charges/incentives for SM/LID in ex private surface parking or retrofits				X						
	Regulation changes to require/encourage/support SM/LID retrofits				X						
	On-going Watershed Health Tracking System				X						

Notes:
1. Order of Magnitude (Class 5) cost estimate for capital works including planning, design, environmental, construction and contingency. Does not include property/access acquisitions, staff co-ordination costs, further consultation costs, detailed geotechnical or archeological investigations. Detailed basis of cost estimate provided in Appendix E.
2. Total life cycle costs assume 25-year project life.
3. Cost to be determined as part of detailed Koksilah Gravel and Debris Management Plan
4. Construct detention pond or upgrade culvets depending on outcome of additional planning/discussions regarding the proposed detention pond including dam safety requirements, private property access/acquisition, etc.
5. The highlighted cells refer to the steps of LID implementation: Public Awareness/Outreach/Engagement, demonstration projects and regulation updates/full implementation of LID during development

Abbreviations

SMMP – Stormwater Management and Mitigation Plan
SM – Stormwater Management
LID – Low Impact Development
MF ICI – Multi-family, Industrial, Commercial and Institutional
SF – Single family
CT – Cowichan Tribes
CVRD – Cowichan Valley Regional District
MFLNRORD - Ministry of Forests, Lands, Natural Resource Operations and Rural Development

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Cowichan Valley Regional District

Sh-hwuykwselu (Busy Place) Creek Stormwater Management and Mitigation Plan

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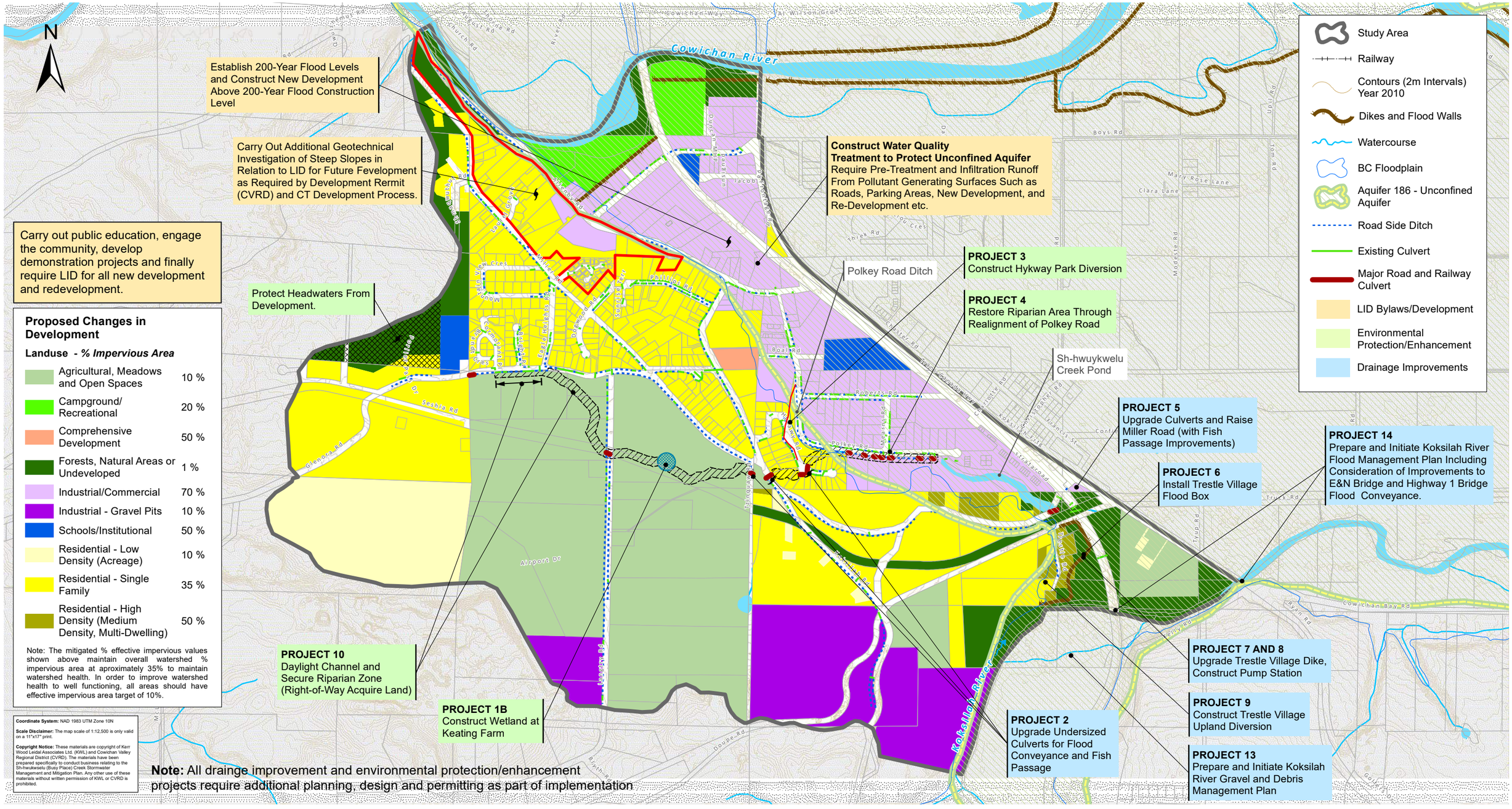

Proposed Changes in Development

Landuse - *% Impervious Area*

Agricultural, Meadows and Open Spaces	10 %
Campground/ Recreational	20 %
Comprehensive Development	50 %
Forests, Natural Areas or Undeveloped	1 %
Industrial/Commercial	70 %
Industrial - Gravel Pits	10 %
Schools/Institutional	50 %
Residential - Low Density (Acreage)	10 %
Residential - Single Family	35 %
Residential - High Density (Medium Density, Multi-Dwelling)	50 %

Note: The mitigated % effective impervious values shown above maintain overall watershed % impervious area at aproximately 35% to maintain watershed health. In order to improve watershed health to well functioning, all areas should have effective impervious area target of 10%.

Note: All drainge improvement and environmental protection/enhancement projects require additional planning, design and permitting as part of implementation

Project No. 2212.071

Date March 2019

Scale 1:12,500

200 100 0 200 m

Sh-hwuykwselu (Busy Place) Creek Stormwater Management and Mitigation Plan

Figure i

1. Introduction

1.1 Background

Sh-hwuykwselu (Busy Place) Creek drains a relatively small (316.4 ha) but complex watershed. Along its 2.5 km path, the creek flows through residential neighbourhoods, agricultural reserve lands, a light industrial park, and Cowichan Indian Reserve Lands before flowing into the Koksilah River. The creek has experienced flooding in the past, there is evidence of erosion along the channel and poor water quality occurs during periods of higher runoff. The lower reaches of the creek currently support a salmon population, while the creek historically supported salmon along its full length to the headwaters prior to installation of drainage culverts and other infrastructure.

Sh-hwuykwselu Creek Stewardship Sign at Koksilah Road Crossing

The multi-jurisdictional responsibility for the watershed includes Cowichan Valley Regional District (CVRD), Cowichan Tribes (CT), Ministry of Transportation and Infrastructure (MoTI), Ministry of Agriculture (AGRI), and other agencies. This is important to address the issues within the watershed in an integrated manner. The CVRD, in partnership with CT, has undertaken the following Stormwater Management and Mitigation Plan (the Plan) for the Sh-hwuykwselu (Busy Place) Watershed in the Cowichan/Koksilah floodplain in the CVRD. The Plan will guide prioritized stormwater infrastructure improvements to mitigate flooding and erosion risk from high flows, to enhance watershed health, to improve the quality of stormwater runoff and protect the quality of groundwater aquifers.

1.2 Key Issues

Some of the key issues identified in the watershed include:

Flooding and Erosion

- Flooding and erosion in watershed areas including residential, industrial, roads, and wetlands, particularly after heavy rain;
- Water backflows into the creek from high water levels in the Koksilah River resulting in high water and drainage issues;
- Current undersized infrastructure capacity (dikes, bridges, roads etc.);
- Logs jams and sediment;
- Gravel deposition; and
- Issues aggravated by climate change impacts.

Water Quality and Environmental Degradation

- Water quality issues caused by pollution, surface water contamination (point-source issues);
- Vulnerability of ground water in the unconfined aquifer to degraded water quality from surface contamination; and
- Environmental impacts on aquatic and riparian habitats.

Land Use

- Development pressures;
- Land use complexity (residential, light industrial/commercial, and agricultural); and
- Issues with other ongoing activities (e.g., industry supporting community vision through updated OCP).

Governance and Policy

- Lack of an efficient, coordinated approach to address key issues in the region;
- Lack of data and information on diverse watershed environments, pervious/impervious areas, monitoring, etc.;
- Lack of management and maintenance of drainage designs, sediment control;
- Lack of regulation and authority for the watershed, development, etc.;
- Limited funding, housing constraints on the limited land area, limited resources (Cowichan Tribes); and
- Public perception of low impact development, funding, and issues of flooding.

These issues were identified as part of First Nations, community, and stakeholder engagement, which is described in more detail in Section 3.

1.3 Plan Objectives and Study Scope

Plan Objectives

The objective of the Plan is to outline a phased, risk-based approach for stormwater management in the watershed to address the issues outlined. The solutions and approaches to stormwater management include:

1. Improving public safety, reducing risk to property, and reducing negative impacts of flooding to agricultural, commercial, and community activities in the watershed;
2. Cost-effective drainage solutions that reduce the risk of flooding and property damage;
3. Management of future development plans to limit increases in peak runoff flows and volumes;
4. Protection and enhancement of watershed natural function;
5. Protection and enhancement of stream and riparian habitats; and
6. Protection and improvement of both surface water and groundwater quality.

The approaches to stormwater management considered in the Plan include:

1. Policy development including environmental, land use, development, infrastructure, and construction;

2. Drainage infrastructure improvements; and
3. Using naturalized systems such as channels, wetlands, and ponds as much as possible.

The development of stormwater management approaches was guided by input from community engagement throughout the development of the Plan.

Study Scope

The scope of the study includes the following major tasks or phases of work.

1. Project Initiation, Background Information Collection, Site Visit, and Base Mapping;
2. Engagement and Communication Plan;
3. Round 1 Community Engagement – Understanding Issues and Opportunities;
4. Hydrological Modelling;
5. Hydraulic Modelling;
6. Drainage Infrastructure Assessment;
7. Round 2 Community Engagement – Development of Options and Values for Options Analysis; and
8. Stormwater Management and Mitigation Plan.

Limitations of the Study

The purpose of the study is to provide recommendations for the first phase of a broader stormwater management process for the area. The study does not provide detailed designs for drainage improvements or detailed updates to stormwater management planning policy. The actions recommended in this study will require additional planning prior to implementation including:

1. Consultation with stakeholders;
2. Public engagement for specific projects;
3. Further technical studies for specific drainage improvement, habitat enhancement projects and policy development;
4. Development of detailed land use policy and planning documents for stormwater management;
5. Detailed design of drainage improvement projects; and
6. Environmental Permitting and other regulatory approvals for projects.

1.4 Previous Studies and Background Information

The following reports were reviewed to provide background context for the area:

1. Assessing the Worth of Ecological Services Using the Ecological Accounting Process for Sh-hwuykwselu (Busy Place Creek) Watershed, Draft, the Partnership for Water Sustainability in BC, January 2018.
2. Trestle Road Triplex Stormwater Study, by Chatwin Engineering, November 2017.
3. Updated Electoral Area E OCP Land Use Designations, OCP Bylaw No. 1690, 2016.

4. Cowichan Tribes Draft Land Use Framework and Atlas, Draft, 2014.
5. Archaeological Impact Assessment for Trestle Road/Wilson Road Water System, Madrone Environmental Services, 2014.
6. Culvert Sizing and Watershed Drainage Review, Cowichan Valley, Stantec, 2009.
7. Lower Cowichan/Koksilah River Integrated Flood Management Plan, NHC, 2009.
8. Busy Place Creek in the Cowichan Valley - A Pilot for a Water-Centric Approach to Land Use Planning, 2008. waterbucket.ca.
9. Climate Projects for the Cowichan Valley Regional District, CVRD. https://www.cvrd.bc.ca/DocumentCenter/View/81884/Climate-Projections-Report?bidId=

Other references noted in the report are included at the end of the report in Section 13.

1.5 Project Team

The project team consists of the following key personnel.

Partners

Kate Miller – Cowichan Valley Regional District

Keith Lawrence – Cowichan Valley Regional District

Tracy Fleming – Cowichan Tribes

Andrew Newall – Ministry of Transportation and Infrastructure

Ian Foss – Emergency Management BC, Vancouver Island

Kerr Wood Leidal

Craig Sutherland, M.Sc., P.Eng. – Project Manager and Project Engineer

Crystal Campbell, P.Eng. – Principal in Charge

Laurel Morgan, P.Eng. – Senior Stormwater Planning Technical Review

David Zabil, M.Sc., P.Eng. – Senior Stormwater Modeller and Engineer

Clayton McBride, EIT – Stormwater Modeller

Jack Lau – GIS/Mapping Specialist

Lanarc

David Reid, FCSLA – Senior Planner/Landscape Architect

Kritsen Falconer, PGD, IAP2 – Communication and Community Engagement Specialist

1.6 Acknowledgements

Funding for this study was provided from Public Safety and Emergency Preparedness Canada and Emergency Management BC. CVRD and CT wish to acknowledge the following people who contributed their time and ideas to the Plan:

First Name	Last Name	Organization
Cam	Williams	CDW Surveyor
Emmet	McCusker	City of Duncan
Fred	Bosma	Cowichan Tribes
Candace	Charlie	Cowichan Tribes
Arvid	Charlie (Luschiim)	Cowichan Tribes
Terry	Daniels	Cowichan Tribes
Cindy	Daniels	Cowichan Tribes
Ron	Daniels	Cowichan Tribes
Diane	Daniels	Cowichan Tribes
Zachary	Elliott	Cowichan Tribes
Eyvette	Elliott	Cowichan Tribes
Deanna	George	Cowichan Tribes
Tim	Kulchyski	Cowichan Tribes
Simon	Kulchyski	Cowichan Tribes
Nola	Kulchyski	Cowichan Tribes
Lemo	Smith	Cowichan Tribes
Melissa	Tokarek	Cowichan Tribes
Peter	Williams	Cowichan Tribes
Philomena	Williams	Cowichan Tribes
Mary	Wilson	Cowichan Tribes
Rick	Wilson	Cowichan Tribes
Kasia	Biegun	Cowichan Valley Regional District
Coralie	Breen	Cowichan Valley Regional District
Rob	Conway	Cowichan Valley Regional District
Graham	Gidden	Cowichan Valley Regional District
Steve	Godfrey	Cowichan Valley Regional District
Hamid	Hatami	Cowichan Valley Regional District
Louise	Knodel-Joy	Cowichan Valley Regional District
Ian	MacDonald	Cowichan Valley Regional District
Amy	Melmock	Cowichan Valley Regional District
Jeff	Moore	Cowichan Valley Regional District

Alison	Nicholson	Cowichan Valley Regional District
Rachelle	Rondeau	Cowichan Valley Regional District
Sybille	Sanderson	Cowichan Valley Regional District
Bev	Suderman	Cowichan Valley Regional District
Mike	Tippett	Cowichan Valley Regional District
Tom	Rutherford	Cowichan Watershed Board
Dave	Turner	Dalven Holdings
Melissa	Nottingham	Department of Fisheries and Oceans
Candice	Campbell	Landowner
Doug	Pepper	Ministry of Agriculture
Mike	Boissonneault	Ministry of Transportation and Infrastructure
Jake	Roder	Ministry of Transportation and Infrastructure
Pete	Webber	Ministry of Transportation and Infrastructure
Steve	Allen	Resident
Kathy	O'Donnell	Resident
Susan	Doughty	Resident
Teresa	Emery	Resident
Jill	Heard	Resident
Susan	Kaufmann	Resident
Tom	Paterson	Resident
Fran	Williams	Resident
Lynn	Woodgate	Resident
Steve	Allen	Resident
Elizabeth Lisa	Daniels	TWT Health (Cowichan Tribes)
Alicia	Parayno	Vancouver Island Health (VIHA)
Shannon	Waters	Vancouver Island Health (VIHA)

2. Study Area Characteristics

2.1 Limits of the Study Area

The Sh-hwuykwselu (Busy Place) Creek Watershed is located south of the City of Duncan, BC. The creek flows for about 2.5 km from headwaters near Quw'utsun Smuneem Elementary School to the confluence with the Koksilah River at Trestle Village. The study area includes the Sh-hwuykwselu (Busy Place) Creek Watershed plus two smaller areas to the north and south that drain directly into the Cowichan River and Koksilah River, respectively. The study area covers approximately 316.4 ha and is bounded to:

- the north by the Cowichan River and a ridge that follows the north end of Miller Road;
- the west by wetland adjacent to Quw'utsun Smuneem Elementary School and the height of land near the Duncan Airport;
- the south by the height of land between Langtry Road and Koksilah Road as well as the Koksilah River; and
- to the east by Highway 1.

A plan view of the study area is shown in Figure 2-1.

2.2 Brief History

Historically, the Cowichan River branched into many channels on its path to the sea at Cowichan Bay. One of these channels met and joined the Koksilah River. This location became a meeting place for First Nations trade and exchanges, thus the name Sh-hwuykwselu or Busy Place (pers. com. Luschiim). A map of the historical channels in the Cowichan and Koksilah River floodplain is shown in Figure 2-2.

Today, the Cowichan and Koksilah rivers still flow across the floodplain to Cowichan Bay, but diking, channelization and landfill have changed the flow paths. The tributary channels of the Cowichan River and Koksilah River no longer meet at Sh-hwuykwselu, except for a smaller stream flowing from the upland area to the west. It is this creek that is now known as Sh-hwuykwselu (Busy Place) Creek and the village at Sh-hwuykwselu is now known as Trestle Village.

Historical Image of Koksilah River near confluence with Sh-hwuykwselu Creek. (Source: BC Archives)

2.3 Geophysical Characteristics

Ecosystems

Sh-hwuykwselu (Busy Place) Creek watershed is located within the Coastal Douglas Fir (CDF) ecosystem which is the dominant ecosystem along the eastern coast of southern Vancouver Island. The climate of the region is strongly influenced by the Pacific Ocean and considered to be Coastal Mediterranean Climate with cool wet winters and warm dry summers. The eastern coast of Vancouver Island is in the rain shadow of the Vancouver Island mountains and is much drier and sunnier than the neighbouring Coastal Western Hemlock zone which covers the central and west coast of Vancouver Island.

Soils

The surficial geology of the study area is complex with marine deposits, glacio-fluvial deposits, and more recent fluvial Salish sediments (Halstead, 1966). The majority of the western uplands of the watershed is underlain by marine and glacio-marine deposits consisting of silt, clay, stony clay, and till. The southern part of the watershed is underlain by glacio-fluvial deposits consisting of hummock gravel deposits with lenses of sand. The eastern lowlands are underlain by fluvial-deltaic sediments deposited by the Cowichan River and Koksilah River consisting of gravel, sand, silt, and clay. The Koksilah Industrial area is also underlain by earth fill that was used to raise the area as part of development. The consistency and thickness of the earth fill material are unknown, refer to Figure 2-3.

Aquifers

The BC Aquifer Mapping Program (Berardinucci & Ronneseth, 2002) indicates the study area is underlain by two mapped aquifers.

The western part of the watershed is underlain by Aquifer 185 which is described as a confined clay and silt aquifer within the glacio-fluvial deposits. This aquifer is classified as having low vulnerability to contamination as it is a confined aquifer with moderately high confinement. The depth to water table is about 12 m on average and is overlain by confining clay and silt that is about 10 m thick on average.

The eastern part of the watershed is underlain by Aquifer 186 which is described as unconfined sand and gravel aquifer within the fluvial and deltaic deposits of the Cowichan River and Koksilah River. This aquifer has been identified as having a high vulnerability to contamination as it is unconfined within a highly permeable material and the depth to groundwater is shallow (mean depth of about 2.2 m). This aquifer is the main water supply for the City of Duncan and North Cowichan wells located near the Cowichan River as well as water supply for fish hatcheries, other aquaculture operations and commercial uses.

A copy of soils and aquifer map is shown in Figure 2-3.

2.4 Watershed Land Use – Historical, Current, and Future

One of the key influences of the quantity and quality of stormwater flows is how land use change within the watershed. Prior to European Settlement, the upper watershed would have been covered by forests while the lower watershed, within the Cowichan-Koksilah Floodplain, would have consisted of wetlands and side channels.

After settlement, the primary land use in the watershed was agriculture, with parts of the upper watershed cleared of forests while the lower watershed was channelized and filled. More recently, parts of the upper watershed have been developed into residential development while the lower portion of the watershed was developed into an industrial area.

Current and future land-use have been used to assess the impacts of development on stormwater runoff. The current land use and future land use conditions are based on available air photos and plans as follows:

- Current land use conditions – air photos and zoning mapping (CVRD Zoning Bylaw No. 1840); and
- Full Build-out according to the existing 1994 Electoral area E Official Community Plan (OCP) and Cowichan Tribes Draft Land Use Framework.

Refer to existing and future land uses in Figure 2-4 and Figure 2-5, respectively. A summary of the change in impervious areas from the current condition to potential future conditions is shown in Table 2-1.

Table 2-1: Percentage Impervious Areas for Existing Land Use and Future Land Use Conditions

Land Use Type	Percent Impervious	Existing Conditions[1]		Future Conditions[2]	
		Area (ha)	Percent of Total Area	Area (ha)	Percent of Total Area
Agricultural, Meadow, and Open Spaces	10%	96.6	25%	95.7	25%
Campground/Recreational	20%	3.5	1%	3.4	1%
Commercial/Industrial	90%	52.4	14%	51.2	13%
Comprehensive	50%	0	0%	1.1	0.3%
Forests, Natural Areas, or Undeveloped	5%	92.1	24%	25.3	7%
Industrial - Gravel Pits	10%	24.3	6%	24.3	6%
Institutional, Schools	50%	4.8	1%	4.8	1%
Residential - Low Density (Acreage)	10%	5.4	1%	22.1	6%
Residential - Single Family	50%	52.6	14%	101.9	27%
Residential - High Density (Medium Density, Multi-Dwelling)	70%	2.1	1%	3.5	1%
Transportation	90%	48.0	13%	48.4	13%
Area-weighted Average Percentage Impervious		36%		42%	

Notes:
1 – Existing land use conditions based on a review of air photos and current zoning bylaw (CVRD Zoning Bylaw No. 1840).
2 – Future land use conditions assume full build-out in accordance with 1994 Electoral Area E OCP and Cowichan Tribes Draft Land Use Framework.

2.5 Drainage Inventory

An inventory of the existing drainage system was collected to assess the drainage capacity of the existing drainage system. A summary of the known drainage issues has been compiled below.

Drainage Inventory

A topographic survey of ditches, culverts and storm drains was carried out within the watershed by CDW Survey and Design Services Ltd. (CDW) in March and April 2018, with follow up survey in June and July of 2018. This data was used to compile a base map of the existing stormwater drainage system. Existing record drawings and available LiDAR data were used to supplement the topographic survey.

An overview of the sub-watersheds and drainage systems in the study area is shown in Figure 2-6. A detailed inventory of the drainage system is included in Appendix A and included with the GIS database delivered to CVRD as part of this study.

Known Drainage Issues

The key drainage issues (from upstream to downstream) that are known to CVRD Staff, CT members and other stakeholders include:

1. Loss of headwater storage. Historical failure of the pond in the upland agriculture area downstream of Langtry Road, and the loss of storage pond in the area upstream of Langtry Road;
2. Twin culverts at the Miller Road/Koksilah Road and 5 side of the culverts and potential flood hazard to the upstream properties;
3. Ponding of water observed within the Koksilah Business Park area including the corner of Boys Road and Allenby Road as well as Roberts Road near Highway 1;
4. Flooding has occurred at the confluence of Busy Place Creek and Polkey Road near the ICBC building;
5. Miller Road at Highway 1 is frequently overtopped and flooded during heavy rainfall periods; and

January 2018, Flooding of Miller Road and E&N Railway

6. Trestle Road flooding. There is no outlet from the diked area of Trestle Road to discharge water during the rainy season which can result in ponding of water and potential for flooding of residential properties within Cowichan Indian Reserve Lands.

2.6 Steep Slopes

The study area is bisected by steep bluffs consisting of sandy/silty material with larger trees (shown in Figure 2-7). There is evidence that there has been movement of these steeper slopes with some of the trees leaning or curved. However, detailed geotechnical assessment of the slopes was beyond the scope of this study.

2.7 Water Quality

In 2013 and 2014, a water quality study for the Cowichan Watershed was carried out by the Ministry of Environment (MoE, 2014) which included water quality sampling within the Sh-hwuykwselu (Busy Place) Creek watershed. The main findings for Sh-hwuykwselu (Busy Place) Creek for the fall sampling period (October – April) are as follows.

1. On average E. Coli levels within Sh-hwuykwselu (Busy Place) Creek are lower than water quality objectives (WQO) for primary recreation contact (<77 CFU/100 ml). However, the 90th percentile of the samples was 118.8 CFU/100 ml which exceed the WQO indicating periodic exceedances likely occurring during high runoff events.
2. Dissolved oxygen (DO) levels fall below the minimum WQO (<11.2 mg/L).
3. Water temperature was on average about 6℃ in the upper watershed and about 12℃ in the lower watershed which is lower than the maximum WQO (<=17℃) for temperature.
4. Concentrations of lead and copper for all samples were below the respective WQO (<11 ug/L for lead and <4ug/L for copper).
5. The average concentrations of zinc at one of the sampling locations exceeded the average WQO (<7.5 ug/L) with the maximum sampled concentration less than the maximum WQO (<33 ug/L).

It should be noted these findings are based on a limited number of samples taken during the fall sampling period (October - April) in 2013/14. No sampling was carried out in summer which would likely indicate higher water temperatures and lower DO than observed in the fall.

The 2013 study recommended to continue water quality monitoring on Sh-hwuykwselu (Busy Place) Creek for Temperature, DO, E. Coli, Metals, and Turbidity and to include a program of water quality monitoring during summer months.

2.8 Habitat Values

To date, no detailed study has been carried out to quantify and assess the quality of habitat along Sh-hwuykwselu (Busy Place) Creek. A detailed habitat assessment carried out by a qualified biologist is beyond the scope of this study. However, general observations of the creek channel indicate that:

1. Limited gravel in the river bed in upper reaches of the stream with the underlying glacial till exposed;
2. Evidence of bank erosion;
3. Gravel deposition in the lower reaches of the stream that have a lower gradient; and
4. Lack of fish passage into the upper watershed due to road culverts.

The location of these observations is shown in Figure 2-8.

Koksilah Road/Miller Road Culvert Crossing showing complete obstruction of fish passage.

These observations are indicative of a 'flashy' hydrological response where the stream flows increase quickly with rainfall and then drop again quickly once rainfall stops. Exacerbation of this flashy response degrades stream and riparian habitat.

There have been observations of adult salmon in the lower reaches of Sh-hwuykwselu (Busy Place) Creek along Polkey Road channel. Traditional ecological knowledge from Cowichan indicates that the upper watershed may have supported salmon in the past.

Despite this lack of detailed understanding of the state of the habitat within the watershed, there has been a significant investment in stewardship and enhancement within the watershed. In recent years these have included:

Sh-hwuykwselu (Busy Place) Creek Channel near Trestle Village

1. Minor wetland enhancement by Cowichan Tribes near Quw'utsun Smuneem elementary school which was built 2003 at the headwaters of Sh-hwuykwselu (Busy Place) Creek;
2. Sh-hwuykwselu Creek pond upstream of Miller Road which was constructed in 2010 and provides 5,000 m^3 of summer rearing and winter off-channel habitat for Coho salmon and trout;
3. The Sh-hwuykwselu Stream Keepers working with various collaborators on stream maintenance (removal of invasive species, planting of native species); and
4. A number of enhancement projects, including the Sh-hwuykwselu Creek pond upstream of Miller Road which has provided rearing habitat.

In total, about 18,500 volunteer hours have been invested in stewardship and enhancement over the past 15-year period.

2.9 Archaeological Values

Important archaeological sites have been identified within the Sh-hwuykwselu (Busy Place) Creek.

The Cowichan Tribes Draft Land Use Framework includes recommendations on the protection of important archeological and cultural sites which will need to be considered as part of the implementation of the Plan. Where appropriate, implementation of stormwater management and habitat rehabilitation projects may also provide opportunities to interpret and celebrate sacred and cultural sites.

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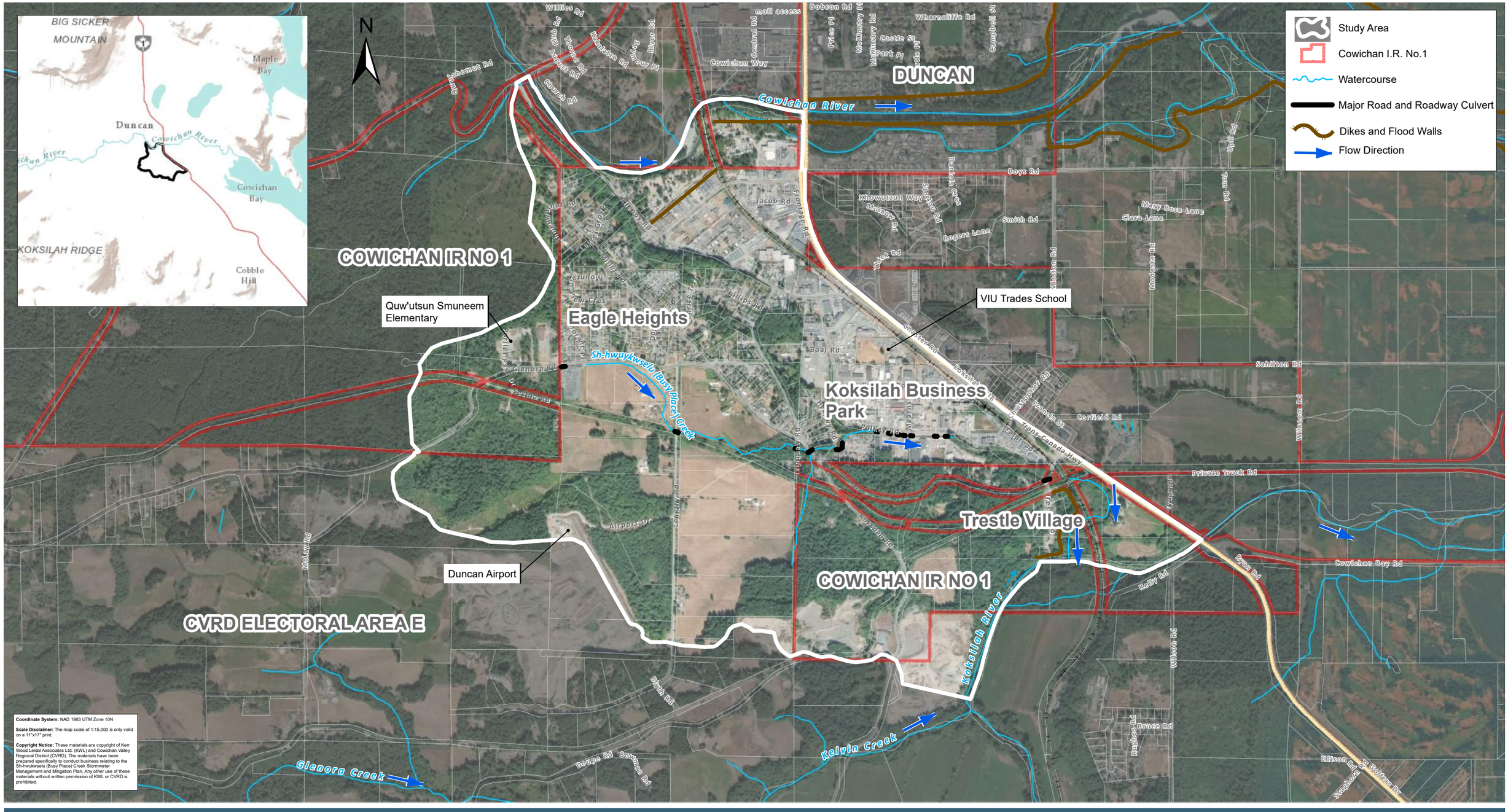
Cowichan Valley Regional District

Sh-hwuykwselu (Busy Place) Creek Stormwater Management and Mitigation Plan

KERR WOOD LEIDAL consulting engineers



Coordinate System: NAD 1983 UTM Zone 10N

Scale Disclaimer: The map scale of 1:15,000 is only valid on a 11"x17" print.

Project No.	2212.071
Date	March 2019
Scale	1:15,000

200 100 0 200 m

Study Area

Figure 2-1

Project No. 2212.071
Date March 2019
Scale 1:15,000

200 100 0 200 m

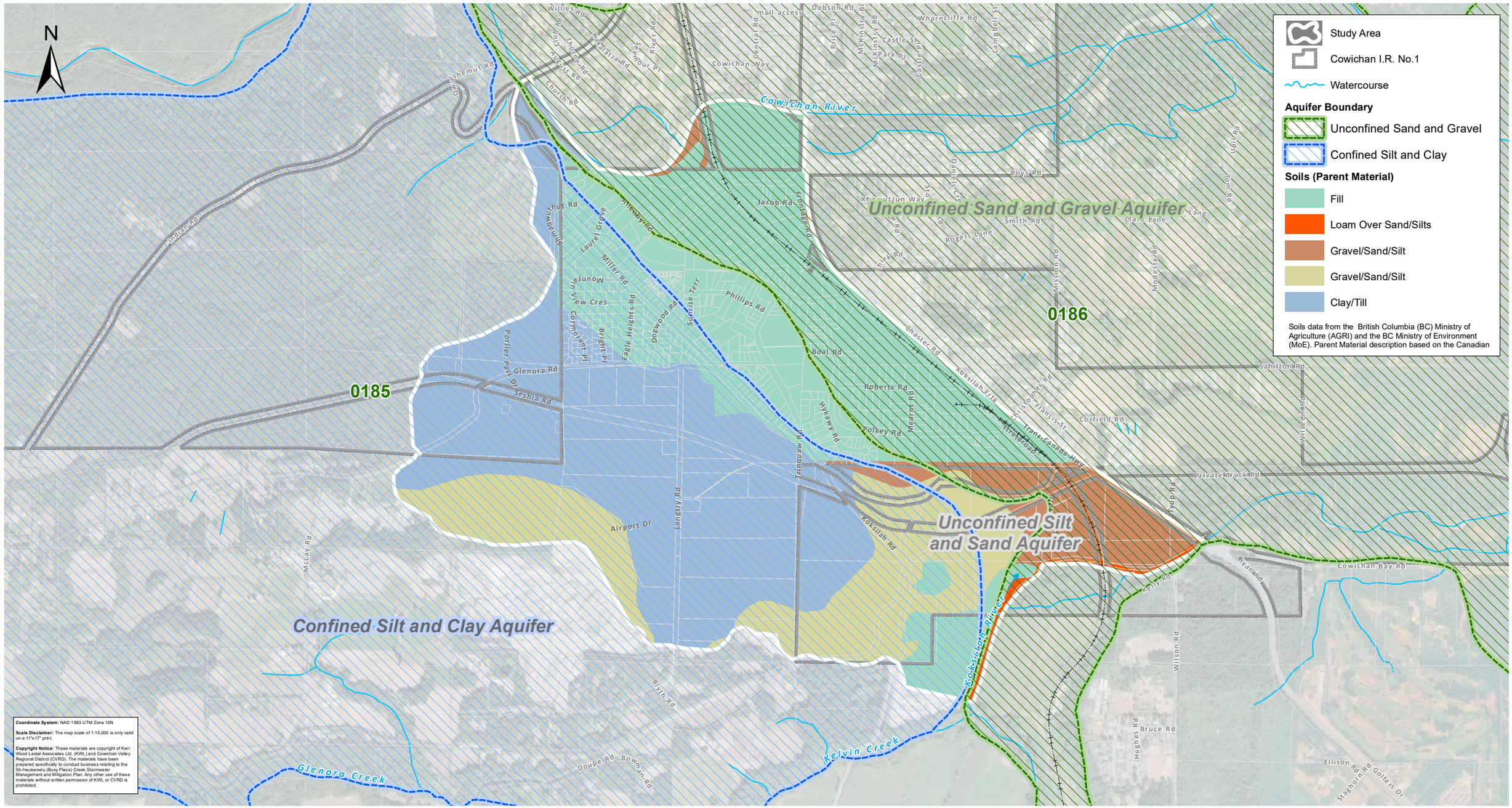
Historical Channels within the Cowichan River and Koksilah River Floodplain

Figure 2-2

Cowichan Valley Regional District

Sh-hwuykwselu (Busy Place) Creek Stormwater Management and Mitigation Plan

KERR WOOD LEIDAL consulting engineers



Project No. 2212.071

Date March 2019

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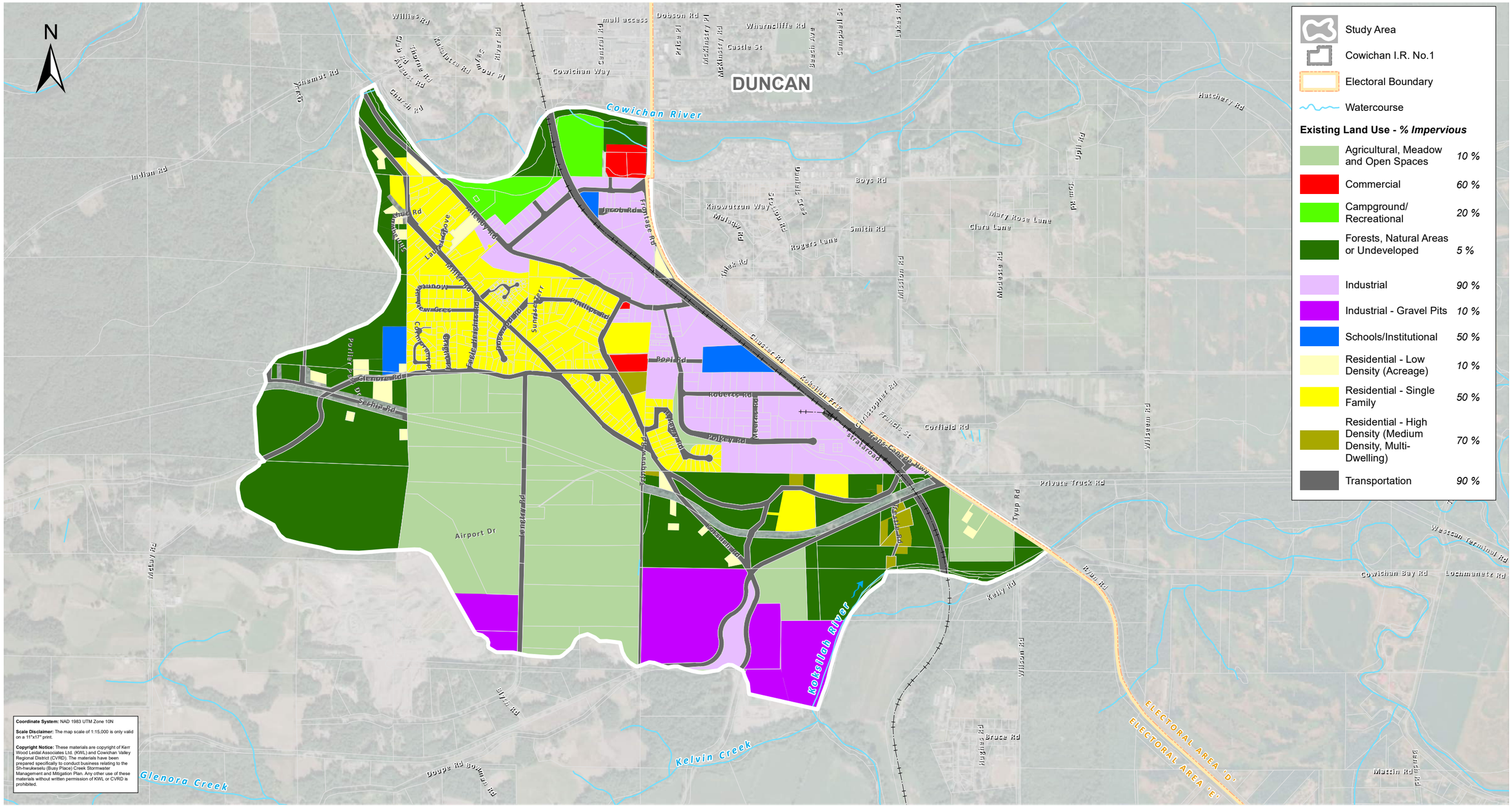
Soils and Aquifer Map

Figure 2-3

Cowichan Valley Regional District

Sh-hwuykwselu (Busy Place) Creek Stormwater Management and Mitigation Plan

KERR WOOD LEIDAL consulting engineers



Coordinate System: NAD 1983 UTM Zone 10N

Scale Disclaimer: The map scale of 1:15,000 is only valid on a 11"x17" print.

Project No. 2212.071

Date March 2019

Scale 1:15,000

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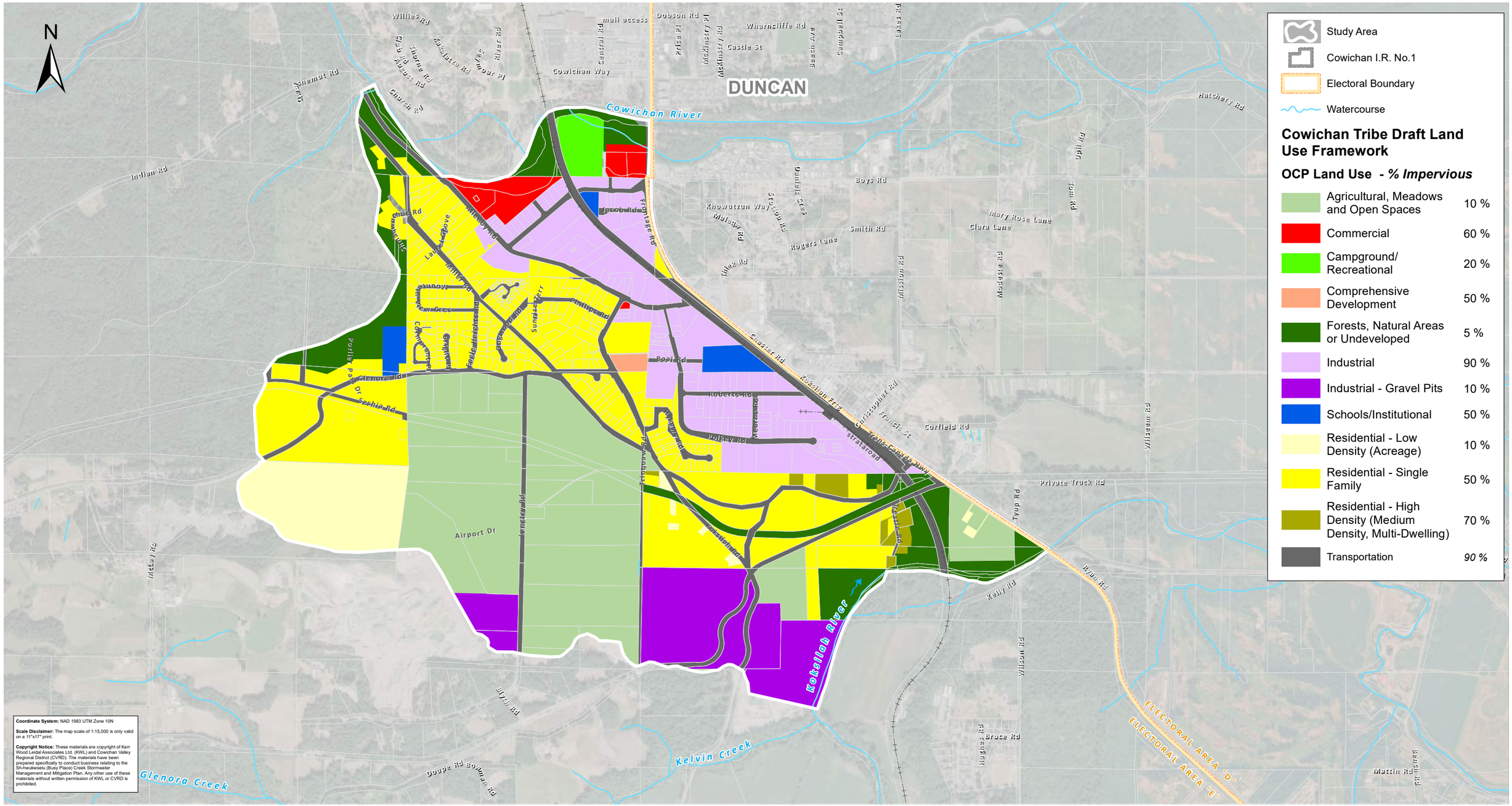
Percent Impervious for Existing (2018) Land Use

Figure 2-4

Cowichan Valley Regional District

Sh-hwuykwselu (Busy Place) Creek Stormwater Management and Mitigation Plan

KERR WOOD LEIDAL consulting engineers



Study Area

Cowichan I.R. No.1

Electoral Boundary

Watercourse

Cowichan Tribe Draft Land Use Framework

OCP Land Use - *% Impervious*

Agricultural, Meadows and Open Spaces	10 %
Commercial	60 %
Campground/ Recreational	20 %
Comprehensive Development	50 %
Forests, Natural Areas or Undeveloped	5 %
Industrial	90 %
Industrial - Gravel Pits	10 %
Schools/Institutional	50 %
Residential - Low Density (Acreage)	10 %
Residential - Single Family	50 %
Residential - High Density (Medium Density, Multi-Dwelling)	70 %
Transportation	*90 %*

Coordinate System: NAD 1983 UTM Zone 10N

Scale Disclaimer: The map scale of 1:15,000 is only valid on a 11"x17" print.

Project No. 2212.071

Date March 2019

Scale 1:15,000

200 100 0 200 m

Percentage Imperviousness for Future Land Use

Figure 2-5

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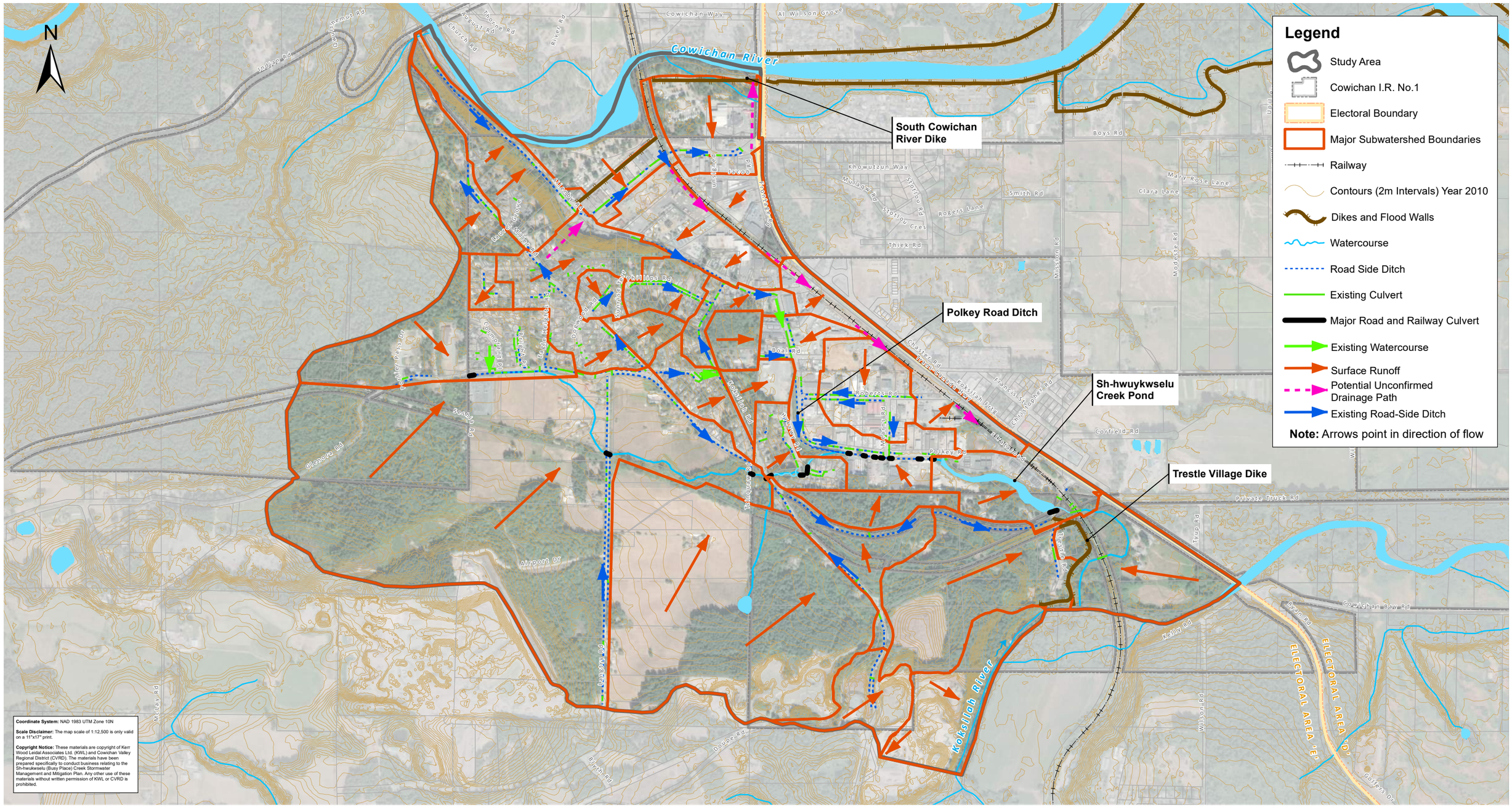
Cowichan Valley Regional District

Sh-hwuykwselu (Busy Place) Creek Stormwater Management and Mitigation Plan

KERR WOOD LEIDAL consulting engineers



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Scale Disclaimer: The map scale of 1:12,500 is only valid on a 11"x17" print.

Project No. 2212.071

Date March 2019

Scale 1:12,500

200 100 0 200 m

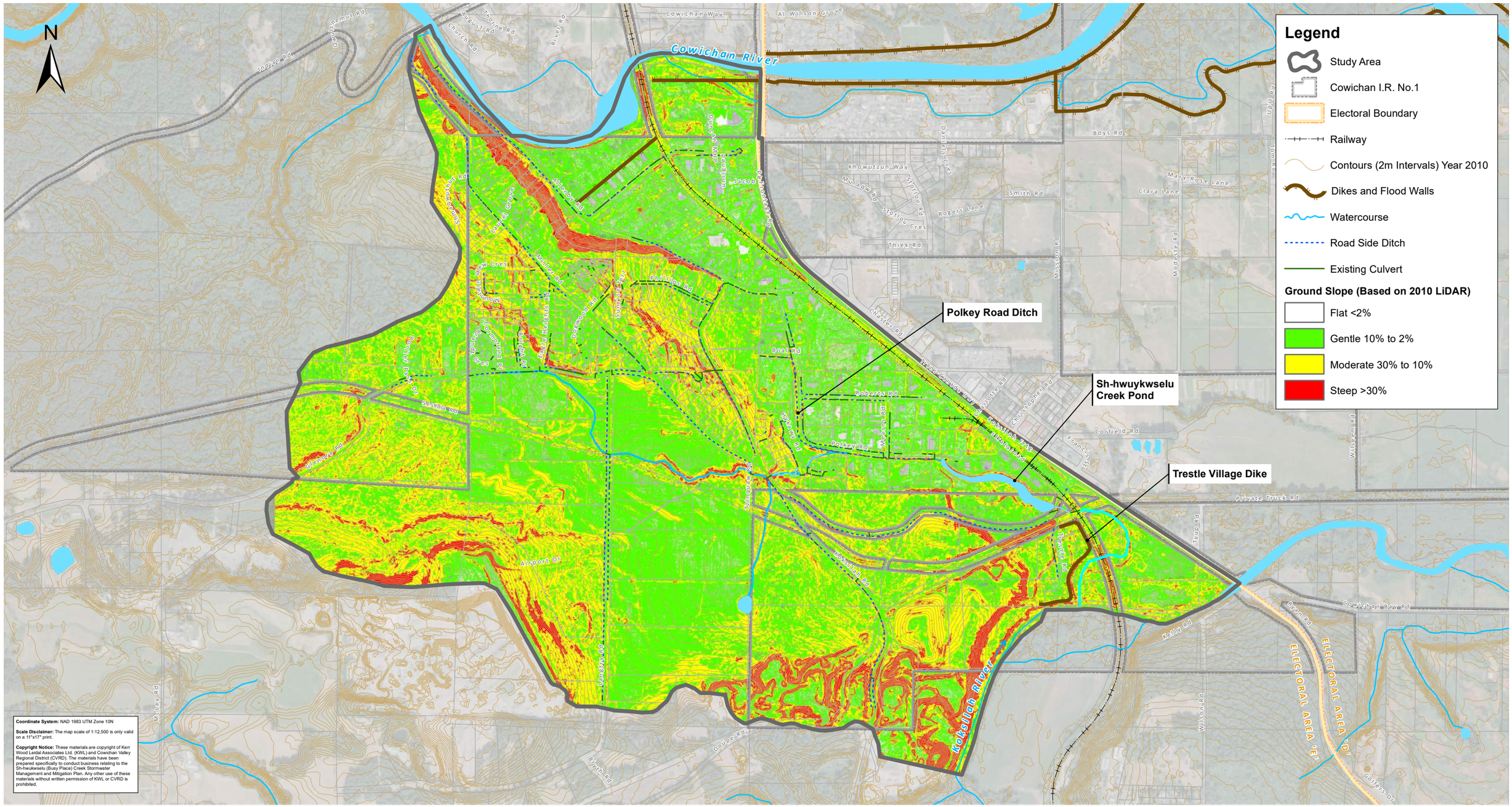
Drainage Overview

Figure 2-6

Cowichan Valley Regional District

Sh-hwuykwselu (Busy Place) Creek Stormwater Management and Mitigation Plan

KERR WOOD LEIDAL consulting engineers



Project No. 2212.071

Date March 2019

Scale 1:12,500

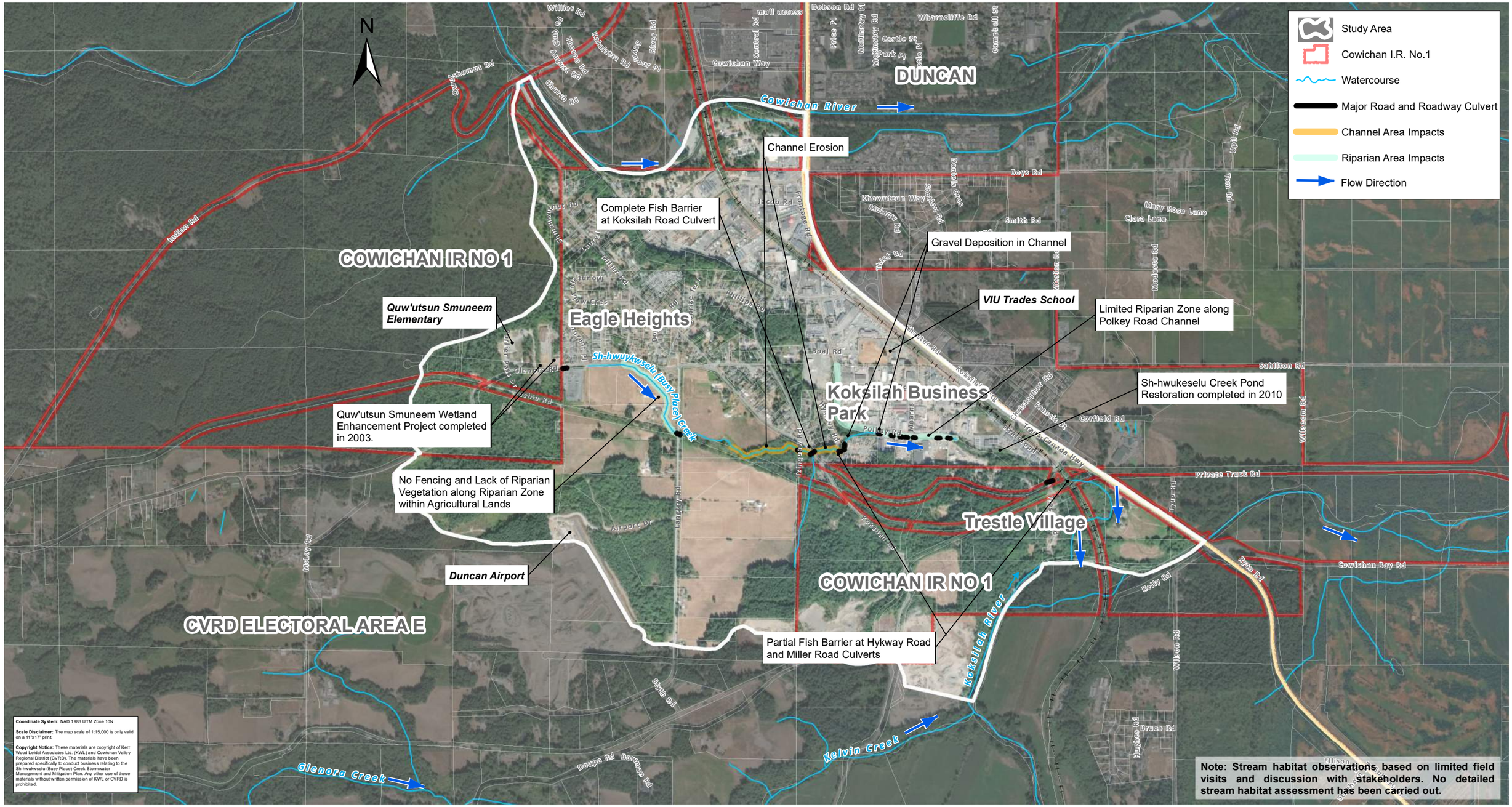
Sh-hwuykwselu (Busy Place) Creek Watershed Slope Grades

Figure 2-7

Cowichan Valley Regional District

Sh-hwuykwselu (Busy Place) Creek Stormwater Management and Mitigation Plan

KERR WOOD LEIDAL consulting engineers



Coordinate System: NAD 1983 UTM Zone 10N

Scale Disclaimer: The map scale of 1:15,000 is only valid on a 11"x17" print.

Note: Stream habitat observations based on limited field visits and discussion with stakeholders. No detailed stream habitat assessment has been carried out.

Project No. 2212.071

Date March 2019

Scale 1:15,000

200 100 0 200 m

Stream Habitat Condition Observations

Figure 2-8

3. Community Engagement

This section summarizes the community engagement carried out in this study. A copy of the engagement plan and summaries of the community engagement and feedback are included in Appendix B and Appendix C, respectively.

3.1 Objectives

Community input was key to developing a plan that can be effectively implemented through policy development and community support. The engagement process that was carried out as part of the study aimed to:

1. Introduce the project to the Technical Advisory Group (TAG), Cowichan Tribes, and Other Interested Stakeholders including the process, anticipated outcomes, and what has been achieved in terms of stormwater management and mitigation efforts in the CVRD to date;
2. Gather input to understand current conditions, future plans, key related issues, and potential opportunities related to public safety, environmental, economic, land use, or climate change aspects;
3. Gather feedback related to stormwater management and mitigation issues and identify how these issues can be translated into opportunities to enhance stormwater management in the CVRD through policy development as related to environmental management;
4. Confirm assumptions of hydrological and hydraulic modelling based on “on the ground” observations;
5. Build public support for implementing stormwater best practices within the community through an understanding of the issues and potential solutions through effective communication of technical information; and
6. Facilitate a dialogue amongst community members to find an acceptable balance among often-competing values and priorities.

3.2 Process

The community engagement process included two phases.

Phase 1: Understanding Issues and Opportunities

The first phase focused on gathering and analyzing data and perspectives about the study area’s current situation in terms of stormwater management and mitigation efforts to-date. This phase introduced the project to TAG members, Cowichan Tribes, and Other Interested Stakeholders by providing background information early in the process. The focus was on listening to stakeholders about their experiences, concerns, and ideas. The first phase also provided an opportunity to confirm the assumptions used in the hydrological model and hydraulic model with TAG stakeholders. Input from the first phase of engagement was used to define the criteria, assumptions, and alternatives for the technical drainage analysis.

Key consultation components for this phase were to:

1. Raise awareness about the planning process and outline what it means for the community;

2. Develop a consultation strategy to parallel the technical process and to reach a broad cross-section of community members who may be impacted by policy changes;
3. Provide initial outreach to connect with a variety of groups that may have an interest in stormwater management and mitigation in the CVRD and encourage participation in the process;
4. Understand current conditions, key issues, plans, growth scenarios, opportunities, priorities, and assumptions to inform draft recommendations development through stakeholder consultation; and
5. Develop communications to stakeholder consultation to encourage participation and provide project background information and anticipated outcomes and information to solicit feedback.

Phase 2: Development and Review of Options Selection and Evaluation

The second phase focused on developing, reviewing, and refining potential stormwater mitigation options and to confirm community values to be used in comparing the benefits of the various options by welcoming input from stakeholders.

The feedback informed:

1. The development of options;
2. Exploration of potential policy and project development;
3. Potential roles and responsibilities;
4. Potential short-to-medium-to long-term phasing; and
5. Funding as part of implementation as a secondary step.

Consultation during the second round provided the TAG with an opportunity to review model results and confirm drainage improvement options and design flows as input into the Draft Plan development. Input from engagement during the second phase refined draft plan recommendations for the Plan.

3.3 Community Feedback

Community input for both Round 1 and Round 2 of engagement was received through:

- discussion during engagement events documented through discussion notes.
- discussion guide comments (for each TAG workshop).
- public questionnaire responses (for Cowichan Tribes and Interested Public).

Key Themes

Community feedback was compiled and summarized into the key themes relating to managing rain and flood waters in the watershed and improving water quality including:

- Partnership/Cooperation;
- Environmental Considerations;
- Planning and Management;
- Technological Considerations/Innovations; and
- Community Impacts.

Round 1: Issues and Opportunities

Key Issues

1. Historical issues (i.e., several channels that are now blocked used to connect the Cowichan and Koksilah Rivers) combined with changing, dynamic rivers (i.e., gravel deposition/accumulation and log jams) and narrow bridges/road crossings that restrict flows are creating flooding and erosion.
2. Lowland flooding and associated erosion are primary issues, some in key areas (e.g., residential areas, Trestle Village).
3. Climate change has the potential to increase flooding and erosion issues and needs to be considered as part of watershed management.
4. Floodwaters backing up from Koksilah River are a fundamental driver.
5. Bridges on Koksilah River, as well as intermittent log jams and gravel bars, influence Koksilah flood levels which spill over into Sh-hwuykwselu Creek.
6. Culvert and ditch/swale sizing need to be reviewed, as well as low impact techniques and riparian areas. Some current infrastructure (e.g., Trestle Village dike) and traditional approaches do not alleviate the issues.
7. Stability of steep slopes is suspect.
8. Habitat and water quality for salmon are at risk.
9. Lack of an efficient, coordinated approach among multiple agencies across the watershed to mitigate flooding and habitat impacts.
10. The complexities of various land use, watershed boundaries, other ongoing activities (e.g., highways), and limited land for development present challenges for water quality and quantity management.
11. Limited funding and resources to address issues.

Key Opportunities

1. General support for a forward-thinking approach to alleviate issues for the watershed that will positively impact overall environmental health due to connectivity through the system.
2. Alignment with current policies and plans for sustainability including opportunities to prioritize investment over time.
3. In Electoral Areas, development outside the Agricultural Land Reserve (ALR) is well advanced – redevelopment could provide opportunities to reduce effective impervious area or include flood mitigation.
4. In Cowichan Tribes lands, development to date is concentrated in Trestle Village where flooding is an issue. There is very high demand for additional on-reserve housing and the need to accommodate some of that in this study area.
5. The split jurisdiction for the watershed, flood, and habitat management, maintenance, and monitoring makes coordinated efforts difficult, but also critical to success.
6. Collaboration and clear roles and responsibilities could lead to a greater chance of success in senior government funding/support, which may help alleviate challenges with limited funding and resources.

7. Support for measures such as flood management, storage, low impact development, risk management, and sustainable infrastructure.
8. Systems for sharing data and information, as well as monitoring stormwater management objectives.
9. Providing public education and opportunities for community involvement and public engagement can support initiatives for watershed health and management.
10. Environmental values, such as the value of natural capital and habitat restoration, are important to the community and should be considered in the context of stormwater management.
11. Acknowledgement of CVRD and Cowichan Tribes leadership to manage flooding and erosion in the watershed.

Round 2: Development and Review of Options Selection and Evaluation

Option Evaluation Criteria

Participants were asked to review the draft Multiple Account Evaluation (MAE) accounts and criteria (both qualitative and quantitative) that would be used to evaluate preliminary options and consider if the accounts and criteria are appropriate to compare options and understand the range of implications.

Financial Account:

1. Cost and implementation are key criteria.
2. Consider the definition and range of 'costs' criterion such as installation cost, opportunity cost, base case scenario (the cost of no action), operating and maintenance costs, cost/benefit, capital costs, life-cycle costs, land value, long-term financial stability, and equity.
3. Transferable and reflective of Cowichan Tribes member concerns for financial equity.
4. Addition of system operation (e.g., tax or maintenance) perspective for each of the three options.

Environmental Account:

1. Transferable and reflective of Cowichan Tribes member concerns for environmental values.
2. Differentiate between drinking water quality and recreational water quality.
3. Inclusive of criteria for reduction of stormwater contaminants that reduce water quality.
4. Consider land development and effects on natural water balance.
5. Reflective of natural capital, habitat protection, and conversation principles.

Regulatory/Political Account:

1. Consider if preliminary options to address rain and flood waters align with current best practices and are reflective of key strategic priorities of the partners.
2. Consider the likelihood of approval and implementation.
3. Omit criteria concerning development approval and permitting.

Socio-Community Account:

1. Transferable and reflective of Cowichan Tribes member interests and concerns for cultural values and activities (e.g., food gathering, fishing).

2. Include water quality impacts for recreation.
3. Include agricultural and industry considerations and impacts.
4. Include considerations in the lens of public health and safety.
5. Consider the likelihood of public acceptability/support and opportunities for public education.

Constraints/Risks:

1. Consider how physical site constraints will apply to options and constructability.
2. Include considerations regarding private property impacts including retaining features, maintenance.

General:

1. Consider combining some criteria together to avoid redundancy.
2. Provide further explanation on some criterion and how it will be used in the evaluation.
3. Some weighted categories (e.g., cost, community impact) and may be based on various stakeholder interests; however, the ranking for MAE should be considered across stakeholders.

These were considered in option evaluation.

4. Design Criteria

4.1 Drainage Assessment Objectives

In order to assess how well the existing drainage system is functioning, a set of stormwater management targets have been established. Traditionally, stormwater management focused solely on providing sufficient conveyance for runoff from infrequent high-intensity rainfall events to prevent flooding of streets and properties.

The adopted targets for the Plan are based on the concept of managing stormwater across the full spectrum of rainfall events. The *BC Stormwater Planning Guidebook* (BC Government, 2002 and 2007) divides the hydrological regime into three components:

1. Rare extreme events (peak flow greater than two-year return period) that should be efficiently carried away to protect public safety and property from flooding;
2. Infrequent large events (peak flow up to two-year return period) that should be detained and released at pre-development rates to protect stream and riparian corridors from erosion and habitat degradation; and
3. Frequent small events (up to 6-month return period) that should be captured and infiltrated on-site to protect baseflows, reduce erosive runoff volume and improve water quality.

Jan 2018, Bank full flow in Polkey Road Channel

By considering the full spectrum of rainfall intensities and frequencies, the appropriate design criteria for each of the stormwater management targets have been selected.

4.2 Drainage and Stormwater Design Guidelines and Bylaw Review

Relevant bylaws and guidelines were reviewed to establish the assessment criteria for the Busy Place Creek drainage system.

Ministry and Transportation and Infrastructure (MoTI), 2007. BC Supplement to TAC Geometric Design Guide

Develop design storms for 2-year, 10-year, 50-year and 100-year return periods using available IDF curves and design storm rainfall temporal distributions. The recommended design return period of road drainage structures is provided in Table 4-1. Road classification for the roads and Highway within the study area were provided by MoTI.

Table 4-1: Design Return Periods for Hydraulic Structures (Years)

Road Classification Hydraulic Structures	Low Volume	Local	Collector	Arterial	Freeway
Storm Sewers	-	10-25	10-25	10-25	10-25
Highway Ditches	10-25	10-25	10-25	10-25	10-25
Culverts <3 m Span	50-100	50-100	100	100	100
Culverts >3 m Span	100	200	200	200	200
Bridges	100	200	200	200	200
River Training and Channel Control Works	100	200	200	200	200

The Requirement for Drainage Designs

1. The minor or piped system consists primarily of the storm sewer system comprised of inlets, conduits, manholes and other appurtenances designed to collect and discharge into a major system for frequently occurring storms (e.g., less than 5 to 10-year return period).
2. The major or overland system will come into operation once the minor system's capacity is exceeded. Thus, in developments where the major system has been planned, the streets and ditches may act as open channels directing the excess stormwater to nearby watercourses without endangering the public, damaging property, or causing excessive erosion. The major system shall be designed to convey a peak discharge having a return period of 100-years.
3. Water Quality: Design considerations include using catch basins to direct pavement run-off overland instead of direct discharge to streams, topsoil and sod lined ditches, filtration ditch blocks, and/or water quality ponds at ditch outlets to streams. A Registered Professional Biologist shall be involved with these designs.

Discharge Rates for Land Development

1. All drainage systems must include run-off controls to limit post-development peak discharge rates to the predevelopment rates for 5-year return period storms.
2. The BC Supplement to TAC Geometric Design Guide refers to MMCD Design Guideline Manual (2005) for storm drainage design.
3. The BC Supplement to TAC Geometric Design Guide refers to Stormwater Planning: A Guidebook for British Columbia (2002) for Stormwater Management.

MMCD, 2014 Stormwater Drainage Design

The MMCD guideline is listed as follows:

1. The minor system consists of pipes, gutters, catch basins, driveway culverts, open channels, watercourse, and stormwater management best management practices (BMP) designed to capture, convey, treat, or modify flows up to a set return frequency (e.g., 5-year or 10-year), as directed by the local authority.
2. The major system consists of surface flood paths, roadways, roadway culverts, watercourses, and stormwater management facilities designed to capture, convey, treat, or modify larger flows up to a set return frequency (e.g., 100-year or possibly 200-year).

City of Duncan, Works and Services Bylaw No. 3158, 2017

The Works and Services Bylaw No. 3158, for the City of Duncan was also reviewed as a reference.

The following return frequencies shall be used for design:

- Minor system: 10-year return period for conventional design (i.e., conveyance);
- Minor system: 5-year return period for stormwater management; and
- Major system: 100-year return period.

Regional Agricultural Drainage Criteria, ARDSA/MoA, 2002

The regional drainage criteria for agricultural lands are:

1. To remove the runoff from the 10-year, 5-day storm within 5 days in the dormant period (November 1 to February 28);
2. To remove the runoff from the 10-year, 2-day storm within 2 days in the growing season period (March 1 to October 31);
3. To maintain baseflow in the channels a minimum of 1.2 m below the minimum field elevation; and
4. The conveyance system should be designed to safely pass both the baseflow and design storm flows.

4.3 Proposed Design Criteria

The following design criteria were proposed based on BC Supplement to TAC Geometric Design Guide (2007), Master Municipal Construction Documents (MMCD) Stormwater Drainage Design (2014) and the Agriculture and Rural Development Subsidiary Agreement (ARDSA) Drainage Criteria for agricultural lands (MoA, 2002). Input was also received from MoTI staff on the road classification and recommended design criteria.

The drainage system in the study area composed of the minor drainage system (storm sewers, roadside ditches, and ditch connecting culverts) and the major drainage system (natural watercourses, stream crossing culverts, and overland flow routes). These networks collect both stormwater from impervious surfaces such as roads and roofs and some stormwater that infiltrates into the ground. All storm sewer pipes (>300 mm), creeks, and ditches contained in the storm sewer database will be included within the model. The drainage assessment criteria are listed in Table 4-2.

The stormwater management criteria (including water quality, volume, and rate control) was proposed based on the Stormwater Planning Guide Book. The guide book recommends that storms up to the 6-month return period event be captured on-site. However, there is no typical approach to calculating the volume of the 6-month storm. Based on previous stormwater management studies, KWL has estimated that the 6-month storm is roughly equivalent to 72 per cent of the 2-year return period (50 per cent annual exceedance probability) 24-hour storm.

Table 4-2: Proposed Drainage Assessment Criteria

Application		Criteria/Methodology
Flood Protection	Storm sewers, roadside ditches, and culverts connecting ditches	• 10-year return period design event (minor system)[1]
	Rate Control for Flood Protection	• Reduce peak runoff from 10-year return period flood as to not overwhelm any identified downstream capacity constraints in drainage system[1]
	Stream crossing culverts <3 m span	• 100-year return period design event (major system)[2]
	Natural watercourses	• 100-year return period design event[2]
	Agricultural Drainage	• 10-year return period[3]
	Bridges and culvert > 3 m diameter	• 100-year return period design event (low volume road)[2] • 200-year return period design event (local, collector, artery, freeway)[2]
	River training, channel control and flood protection (dikes) works	• 200-year return period design event
Stormwater Management	Volume Reduction & Water Quality (source controls)	• On-site rainfall captures up to the 6-month return period event (72% of the 2-year 24-hour storm) and remove 80% total suspended solids [4]
	Rate Control (Detention/Diversion)	• Control post-development flows to pre-development levels for 2-year 24-hour events.[4]
	Riparian	• Establish and protect riparian setbacks.[5 and 6]

1. MMCD, 2014. Stormwater Drainage Design.
2. BC Ministry of Transportation Supplement to Transportation Assoc. of Canada Geometric Design Guide, 2007.
3. ARDSA Agricultural Drainage Criteria, 2002.
4. Stormwater Planning: A Guidebook for British Columbia, 2002; Beyond the Guidebook - June 2007and KWL estimate of the 6-month volume of 72% of 2-year return period 24-hour storm.
5. British Columbia *Riparian Areas Regulation*, 2006.
6. Agriculture Research and Development Corporation, Environmental Farm Plan Reference Guide, 2010.

5. Hydrological and Hydraulic Modelling

5.1 Introduction

This section summarizes the hydrologic and hydraulic modelling analysis. The purpose was to:

- Develop a model to predict the rainfall-runoff response of watershed; and
- Determine peak design flow estimates at strategic locations under existing land-use and future land-use (OCP) conditions.

The model was built using the drainage inventory data to assess the existing drainage system under different design event conditions. The results of the analyses are presented in Section 6.

Further details of the model development, verification and limitations, and assumptions are provided in technical memorandum #1 included in Appendix D.

5.2 Model Development and Verification

Model Selection and Development

The PCSWMM software was selected to carry out the hydrological and hydraulic assessment of the watershed. The advantages of the PCSWMM software are that it:

1. Uses the industry standard Stormwater Management Model (SWMM) algorithms developed by the US Environmental Protection Agency (EPA) as the basis for stormwater runoff estimates and drainage hydraulic calculations;
2. Operates fully within the ESRI ArcGIS environment such that data relating to the stormwater system does not have to be re-entered into a separate model software, thus making modelling more efficient; and
3. An affordable software package that is user-friendly and supported to facilitate future model updates.

In addition, the model allows for both one-dimensional channel and pipe flow as well as two-dimensional overland flow to be integrated into a single model for the purposes of identifying overland flow paths and ponding areas.

The stormwater model was developed using CVRD's existing GIS-database, supplemented with as-built drawings and information gathered as part of the drainage and a topographic survey carried out by CDW consultants in June and July 2018.

Model Verification

The parameters used in the hydrological and hydraulic model are based on typical values used for other stormwater management studies in coastal British Columbia. There are no records of discharge or water level along Sh-hwuykwselu (Busy Place) Creek. Therefore, the validity of the parameters and the model set up has been checked by comparing model results based on rainfall data and Koksilah River water levels data for the December 2017 storm event to field conditions recorded in photographs and video taken. The key comparisons of the validation model and the field observations are:

1. No overtopping of any of the major road crossing culverts except for Miller Road near Trestle Village; and
2. Near bankfull water levels along the Polkey Road channel.

Figure 5-1 compares model results with photographs taken of the over-topping of Miller Road during the December 2017 flood event. These comparisons indicate that the model results generally represent observed flood conditions along the creek.

5.3 Key Modelling Assumptions and Limitations

The key assumptions and limitations of the modelling include the following.

1. Catchment delineation for areas with natural drainage was based on available contour and LiDAR data provided by CVRD.
2. Catchment delineation for areas served by the stormwater network (culverts, storm drain, and ditches), is based on the topography data and drainage inventory data provided by CVRD. Where drainage inventory was not able to confirm the direction of drainage paths, the routes of drainage network were assumed to provide conservative flow results.
3. The groundwater module of the PCSWMM package has been used to simulate infiltration, shallow groundwater, and interflow components of the hydrological cycle. Soil infiltration rates, soil depths, and soil hydraulic conductivity parameter values are based on typical values selected for previously calibrated models developed for other studies in coastal BC. Soils conditions in the watershed used to select appropriate soils parameters are based on soils map prepared by AGRI and MoE shown in Section 2 (Figure 2-3).
4. Design storms developed for simulation of existing conditions are based on rainfall Intensity-Duration-Frequency (IDF) analysis carried out by Environment Canada using data from the North Cowichan climate station (E 1015628). This climate station was selected as it is located within close proximity to the study area (approximately 7 km), is located within the same climatic zone and provides the longest and most current record of rainfall in the region.
5. The temporal distribution of design rainfall for short duration events (1 hour to 12 hours) is based on a Chicago storm distribution (which assumes that for a given return period storm the total rainfall depths for all durations match the design rainfall intensities for the return period). The Chicago storm was selected for shorter duration events as it results in higher peak flows appropriate for drainage capacity analysis. For long duration events (24-hour) the rainfall distribution is based on the SCS Type 1 A. This storm distribution was selected as it is recommended in the MoTI drainage design guidelines and provides the best estimate of total rainfall volumes for the purposes of detention storage analysis.
6. The downstream water level boundary conditions in the Koksilah River are based on modelled peak design water level results developed for the Cowichan-Koksilah Integrated Flood Management Plan (IFMP). The model provided peak water level results for the 20-year return period event and the 200-year return period event. The design water levels for other return periods have been estimated by developing water level vs discharge relationships at the confluence of the Koksilah River and Sh-hwuykwselu (Busy Place) Creek.
7. Channel and floodplain roughness values used for hydraulic modelling are selected for each of the land use types based on field observations and typical values developed from previously calibrated models.

5.4 Climate Change

The CVRD has carried out a regional climate change projection study for the Cowichan Valley region (CVRD, 2017). The projected changes in climate are expected to impact hydrology and flood levels in the Sh-hwuykwselu (Busy Place) Creek watershed in several ways:

1. Peak rainfall intensities are projected to increase resulting in higher peak discharges and thus flood levels throughout the watershed;
2. Storms and winter rainfall across the Koksilah River and Cowichan River watersheds are projected to increase, thus resulting in higher discharges and thus peak water levels at the confluence of Sh-hwuykwselu (Busy Place) Creek and Koksilah River;
3. Projected sea level rise is expected to increase peak water levels in Cowichan Bay which will impact the ability of storm flows to drain from Koksilah River and thus increase peak water levels along the Koksilah River near the confluence with Sh-hwuykwselu (Busy Place) Creek; and
4. Projected increased summer temperatures, longer summer dry periods and less summer rainfall has the potential to reduce summer baseflows and increase summer water temperatures in the creek.

The regional climate study provides general information on trends and magnitudes across the region. It provides forecasts at a daily time-scale resolution. However, in order to project future changes in flood hydrology in the Sh-hwuykwselu (Busy Place) Creek watershed projections of sub-daily resolution (hourly) is required and more detailed analysis of rainfall data is required.

Projected changes in sub-daily rainfall intensities in Sh-hwuykwselu (Busy Place) Creek have been derived from the online IDF-CC tool developed by Western University (Sandink, Simonovic, Schardong, & Srivaastav, 2016). As recommended by the Pacific Climate Impacts Consortium (Spittlehouse & Murdoch, 2011), the results from the Western Canada Climate Model (CanESM2) have been selected to project future rainfall conditions for the 2050s climate normal period (2040 to 2069). The highest projected greenhouse gas pathway, RCP 8.5 has been selected for stormwater design and planning purposes.

The projected 10-year return period 24-hour rainfall totals from the IDF-CC tool are lower than the 10-yer 24-hour projections from the regional climate study. Therefore, in order to be consistent with the regional study, the rainfall intensities across all durations and frequencies have been increased by 6%, the difference between the 10-year return period 24-hour rainfall totals from the IDF-CC tool and the 10-year 24-hour projections from the regional climate study. The results indicate between an 18 per cent increase to 32 per cent increase in total rainfall for the 2-year return period and 200-year return period respectively as shown in Table 5-1.

Table 5-1: Factors applied to current IDF rainfall to adjust to future (2050s) climate IDF rainfall

Duration	Total Rainfall (mm)$_1$ Return Period				
	2-Year	10-Year	50-Year	100-Year	200-Year$_2$
1-hour	1.18	1.19	1.25	1.30	1.30
2-hour	1.18	1.20	1.27	1.31	1.32
6-hour	1.18	1.21	1.25	1.28	1.29
12-hour	1.18	1.21	1.24	1.25	1.27
24-hour	1.18	1.21	1.26	1.28	1.30

5.5 Design Rainfall

The total design rainfall for the Sh-hwuykwselu (Busy Place) Creek watershed for various return periods and durations for current climate and future climate are shown in Table 5-2 and Table 5-3.

Table 5-2: Total Precipitation Amounts for Design Storms (Existing Condition)

Duration	Total Rainfall (mm)[1] Return Period				
	2-Year	10-Year	50-Year	100-Year	200-Year[2]
1-hour	9.2	12.5	15.4	16.7	18.1
2-hour	13.7	18.2	22.1	23.8	25.7
6-hour	28.4	35.9	42.4	45.1	48.3
12-hour	42.0	55.0	66.4	71.2	76.7
24-hour	57.8	79.4	98.4	106.5	115.6

Note:
1. Design rainfall totals based on North Cowichan IDF Curve with data for the period from 1982 to 2005.
2. 200-year return period by extrapolation.

Table 5-3: Total Precipitation Amounts for Design Storms (Year 2050 Climate Change Conditions)

Duration	Total Rainfall (mm)[1] Return Period						
	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year	200-Year[1]
1-hour	10.9	13.2	14.9	17.4	19.3	21.7	23.5
2-hour	16.1	19.4	21.9	25.2	28.1	31.2	34.0
6-hour	33.4	39.1	43.3	48.9	53.2	57.6	62.5
12-hour	49.4	59.3	66.3	75.5	82.4	89.3	97.6
24-hour	68.0	84.2	96.0	111.6	123.7	136.2	150.1

1. Future design rainfall amounts based on projections from IDF-CC tool using CanESM2 model results adjusted to match future projections from CVRD regional climate change study for daily 10-year return period rainfall totals.

A plot comparing current and future IDF curves for the Sh-hwuykwselu (Busy Place) Creek watershed is shown in Figure 5-2.

5.6 Summary of Existing and Future Estimated Peak Flows

A summary of the estimated peak flows for design rainfall events is shown in Table 5-4. The results indicate that future peak flows for all return periods will increase under unmitigated future land use conditions and future climate. The model indicates that the greatest increase flow will be at the Koksilah Road culvert with an increase between 58 per cent for 2-year return period flood to 30 per cent for the 100-year return period flood. The model also indicates that flows at the Miller Road near Trestle village culvert will also increase significantly under future conditions for larger return period events. The culverts under Miller Road restrict the increase in flow for the lower return period floods. However, once the road overtops the peak flows increase significantly.

The following Section 6 outlines modelling carried out to assess drainage improvements required to safely convey the increased flows projected by the modelling.

Table 5-4: Modelled Peak Flows (m^3/s) for Existing and Future Conditions

Location	2-year 24-hr return period storm			10-year 12-hr return period storm			100-year 12-hr return period storm		
	Existing Land Use and Climate	Future and Use and Climate (2050s)	% Change	Existing Land Use and Climate	Existing Land Use and Climate	% Change	Existing Land Use and Climate	Future and Use and Climate (2050s)	% Change
Langtry Road Culvert	0.83	1.35	63%	1.13	1.56	38%	1.56	1.98	27%
Tzinquaw Road Culvert	0.97	1.02	6%	1.01	1.04	3%	1.04	1.08	4%
Koksilah Road Culvert	1.45	2.29	58%	2.01	2.79	39%	2.83	3.67	30%
Hykway Road Culvert	1.71	2.53	48%	2.30	2.86	24%	2.91	3.43	18%
Culvert across Boys Road at E&N Railway	0.2	0.21	3%	0.21	0.21	2%	0.22	0.23	5%
Channel at Polkey Road and Mearns Road	2.94	3.81	30%	2.97	3.97	34%	2.99	3.77	26%
Miller Road near Trestle Village	1.64	2.05	25%	2.08	3.81	83%	2.25	4.10	82%

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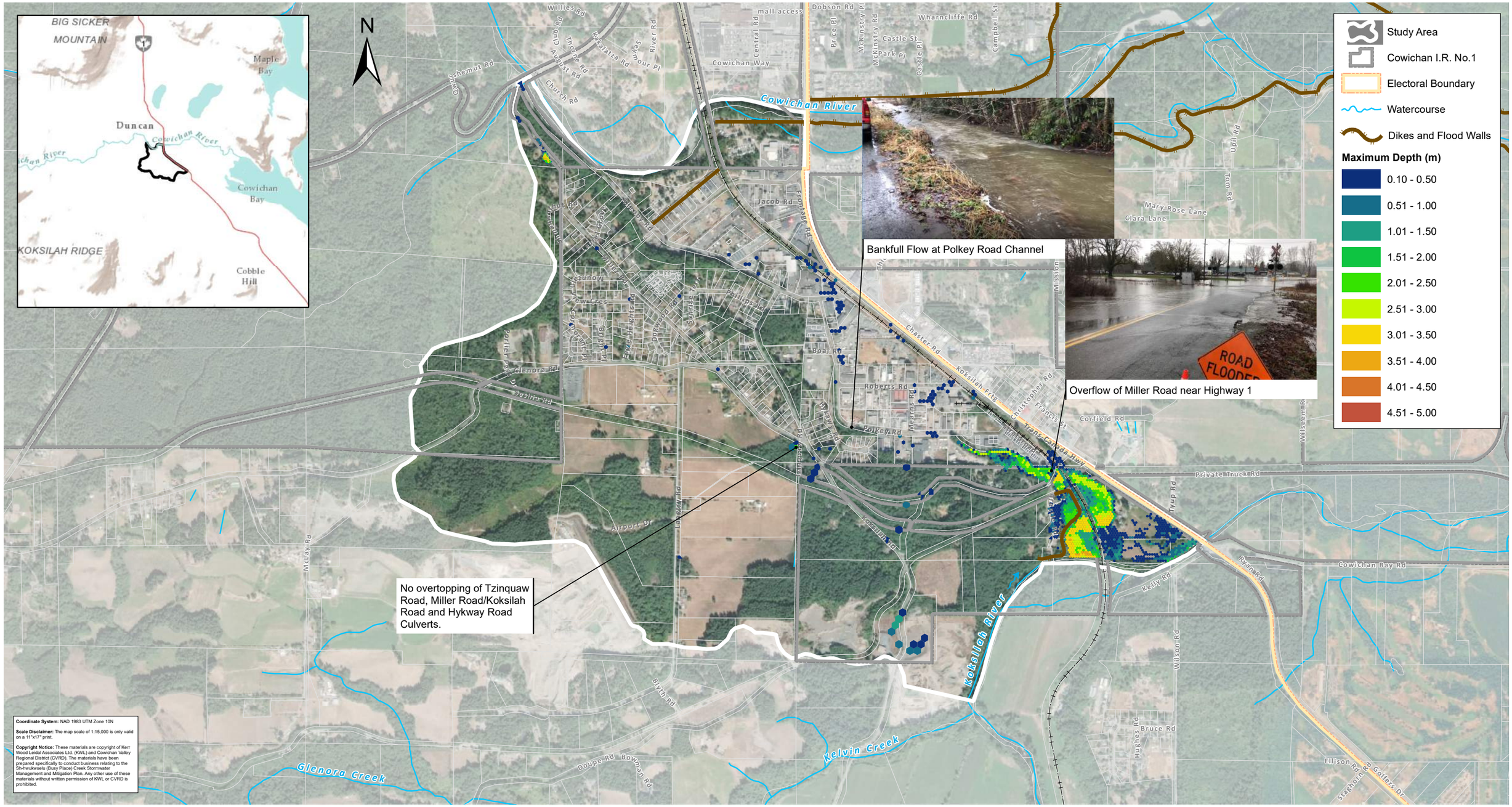
Cowichan Valley Regional District

Sh-hwuykwselu (Busy Place) Creek Stormwater Management and Mitigation Plan

KERR WOOD LEIDAL consulting engineers



Coordinate System: NAD 1983 UTM Zone 10N

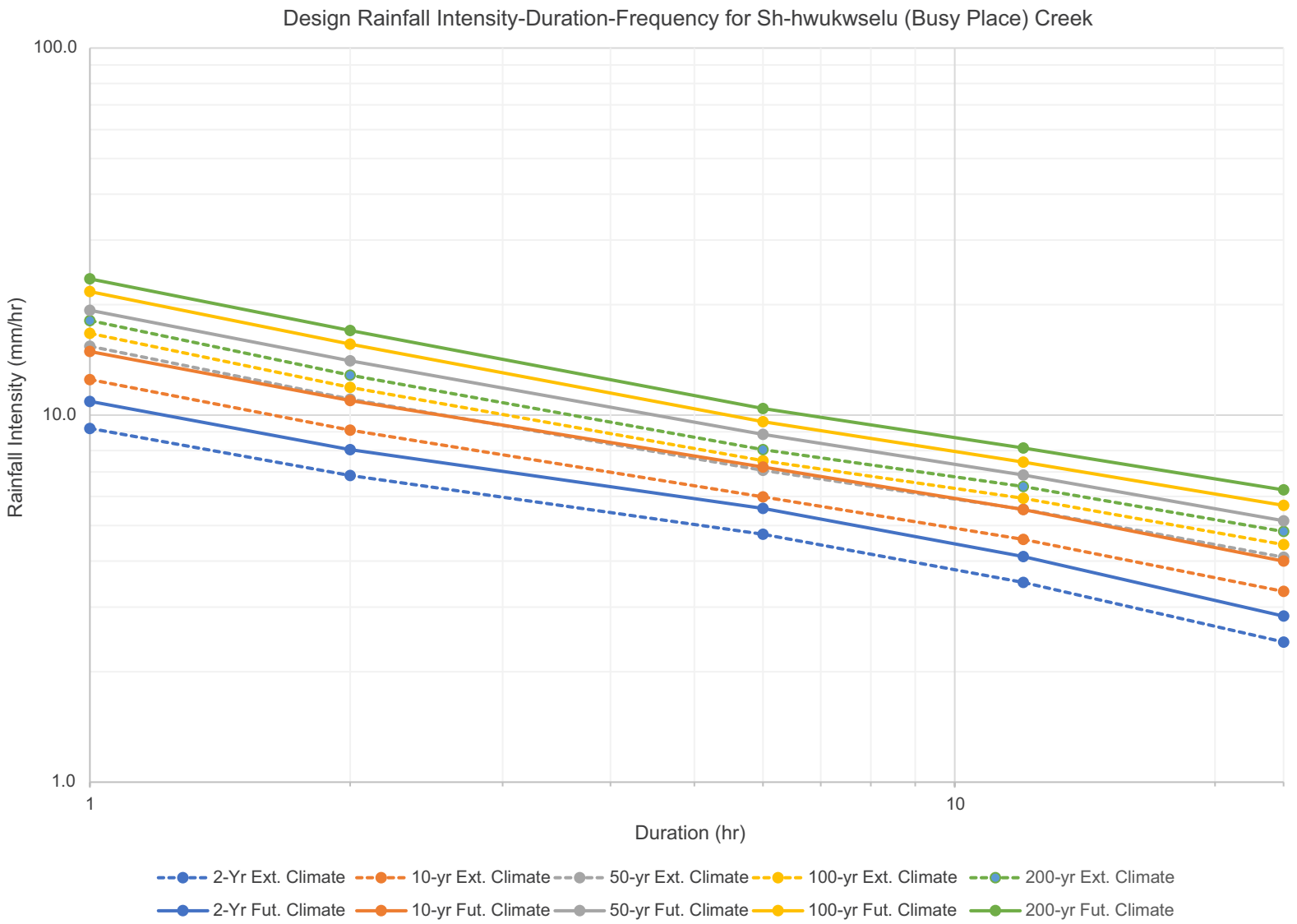
Scale Disclaimer: The map scale of 1:15,000 is only valid on a 11"x17" print.

Project No.	2212.071
Date	March 2019
Scale	1:15,000

200 100 0 200 m

Model Comparison with Observed Conditions (January 29 2018)

Figure 5-1



Project No.	2212.071
Date	March 2019
Scale	Not to Scale

IDF Curves for Existing Climate and Future (2050s) Climate Conditions

Figure 5-2

Cowichan Valley Regional District

Sh-hwuykwselu (Busy Place) Creek Stormwater Management and Mitigation Plan

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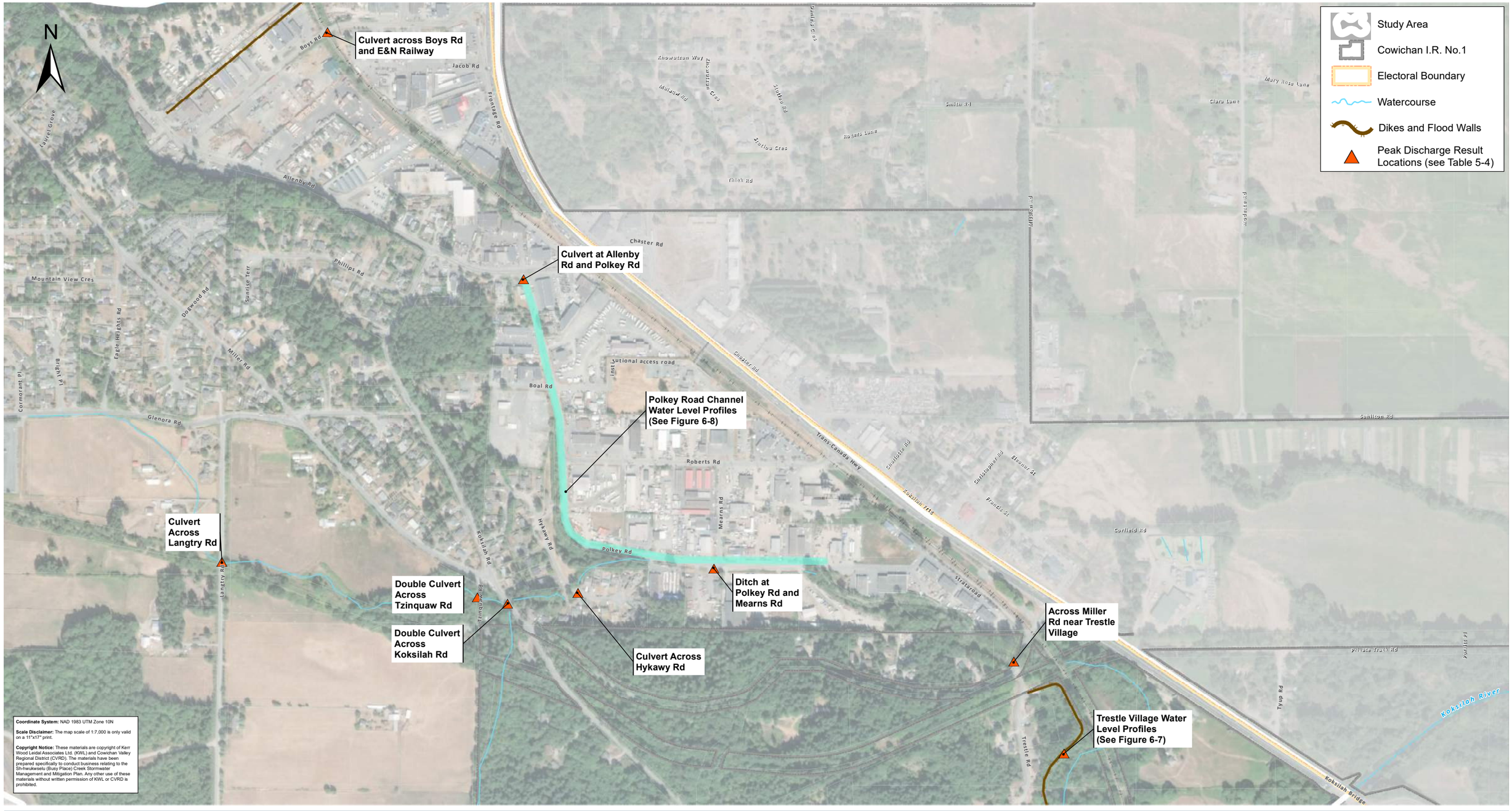

Coordinate System: NAD 1983 UTM Zone 10N

Scale Disclaimer: The map scale of 1:7,000 is only valid on a 11"x17" print.

Project No. 2212.071

Date March 2019

Scale 1:7,000

50 25 0 50 m

Location of Key Peak Discharge and Water Level Results

Figure 5-3

6. Drainage Assessment

6.1 Introduction

The baseline flooding for existing conditions for the watershed was carried out for both current land-use and climate conditions as well as for future climate and land use conditions, described previously in Section 2. The assumptions used in the modelling for the current and future conditions are outlined in the Technical Memorandum #1 included in Appendix D.

Maps showing the maximum depth of flooding for the 10-year, 100-year, and 200-year flood for existing conditions are shown in Figure 6-1 to Figure 6-3.

Maps showing the increase in flooding depth for the 10-year, 100-year, and 200-year flood for future conditions are shown in Figure 6-4 to Figure 6-6.

Twin 450 mm diameter culverts under E&N Railway

Hydrological and Hydraulic Drivers of Floods

Flood in the Sh-hwuykwselu (Busy Place) Creek is typically the result of a combination of:

1. Wet saturated soil conditions and/or accumulation of wet snow across the watershed;
2. Warm air temperatures; and
3. High-intensity rainfall.

These conditions most often occur during frontal storms blowing in westerly or south-westerly from the Pacific Ocean known as Atmospheric Rivers or 'Pineapple Express'. These conditions can pull warm and moist air all the way from the tropical Pacific waters near Hawaii north towards Vancouver Island and the Pacific Northwest coast.

Peak water levels along Sh-hwuykwselu (Busy Place) Creek are not only the result of high discharges along the upper reaches of Sh-hwuykwselu (Busy Place) Creek watershed but also a result of backwatering from high water levels in Koksilah River along the lower reaches of Sh-hwuykwselu (Busy Place) Creek. The culverts at Miller Road near Trestle Village are the transition between peak discharges driving floods in the upper reaches of the creek to flood levels being driven by peak water levels in Koksilah River along the lower reaches of the creek.

6.2 Existing Drainage System Capacity

The following sections summarize the key findings of the existing condition drainage assessment.

Major Road Culvert Capacities

The results of the hydrological/hydraulic model have been used to assess capacities of the existing major road crossing culverts along Sh-hwuykwselu (Busy Place) Creek. The assessment has been used to confirm if the existing culverts have sufficient capacity to pass peak 100-year return period flood discharge without overtopping of the road. A summary of the baseline drainage conditions at the major road crossings is included in Table 6-1. The locations of the major road crossings are shown in Figure 6-7.

Table 6-1: Summary of Baseline Drainage Conditions at Major Road Crossings and Channels

Location[1]	Does culvert have sufficient capacity to prevent overtopping of the road?					
	10-year Return Period (10% Chance of Occurring in any Given Year)		100-Year Return Period (1% Chance of Occurring in any Given Year)		200-Year Return Period (0.5 % Chance of Occurring in any Given Year)	
	Existing Condition[2]	Future Condition[3]	Existing Condition[2]	Future Condition[3]	Existing Condition[2]	Future Condition[3]
Langtry Road	YES	YES	YES	NO	YES	NO
Tzinquaw Road	NO	NO	NO	NO	NO	NO
Koksilah/Miller Road	YES	YES	YES	YES	YES	YES
Hykawy Road	YES	YES	YES	NO	YES	NO
Polkey Road Channel at Polkey Road and Mearns Road	YES	NO	NO	NO	NO	NO
Miller Road at Trestle Village	NO	NO	NO	NO	NO	NO

Notes
1 - Locations of major road crossings shown in Figure 5-3.
2 – Existing condition include current climate conditions plus an existing percentage of impervious area based on zoning maps and review of aerial photography.
3 – Future condition includes future (the 2050s) climate condition plus assumed percentage of impervious area based on 1994 Area E Official Community Plan (OCP) full build-out and future land use plans provided by Cowichan Tribes.

Koksilah Industrial Park Overland Flow and Pooling

The model indicates pooling of water during the 100-year and 200-year return period in properties at:

- the corner of Allenby Road and Boys Road (3025 Boys Road);
- the back of the properties at 2979 and 3001 Allenby Road;
- the property at 2921 and 2925 Allenby Road;
- near Allenby Road and the Trans-Canada Highway (2890 and 2905 Allenby Road);
- at the back side of the property at the Vancouver Island University Trades Campus (5265 Boal Road);
- at the corner of Roberts Road and Trans-Canada Highway (2801 Roberts Road); and

- the corner of Mearns Road and Roberts Road (2810 Roberts Road).

Figure 6-2 and Figure 6-3 indicate that for existing conditions there is no significant change in the area of inundation between the 100-year return period or 200-year return period within the Koksilah Industrial Park upstream of Miller Road. In addition, the extent of inundation does not change significantly between existing conditions and future conditions. This result indicates that the local drainage system likely has enough capacity and is not 'backing' up the increased stormwater runoff into the properties. Rather, it is likely that these ponding areas are the result of local depressions which fill from local rainfall and then overflow into the drainage system.

Drainage Downstream of Miller Road

As outlined previously in Section 6.1, during extreme flood conditions such as the 100-year return period and 200-year return period floods, peak flood levels in Sh-hwuykwselu (Busy Place) Creek downstream of Miller Road near Trestle Village are primarily controlled by peak water levels on the Koksilah River and not flows in Sh-hwuykwselu (Busy Place) Creek.

The culverts which allow Sh-hwuykwselu (Busy Place) Creek to flow past the E&N railway embankment downstream of Miller Road are undersized in comparison to the flow of the creek. However, during high water in Koksilah River, the undersized culverts may provide a benefit in that they reduce the ability of the water to flow upstream from the Koksilah River to Miller Road during high flood levels in the Koksilah River. The model indicates that at peak 200-year return period conditions, the peak water levels at Miller Road are about 10 cm lower than the peak water levels at Koksilah River.

Trestle Village Drainage

Water levels in Trestle Village rise to the same level as the 200-year return period peak water levels in the Koksilah River floodplain due to blockage of the existing flood box culvert. The modelled peak water levels in Trestle Village for existing and future conditions are outlined in Table 6-2. Hydrographs showing water levels on upstream and downstream sides of the existing culvert through the Trestle Village dike for existing conditions and unmitigated future conditions are shown in Figure 6-7.

Table 6-2: Maximum Water Levels in Trestle Village

Design Flood	Existing Conditions	Future Conditions
10-Year return period	2.2 m	2.4 m
100-year return period	2.5 m	3.1 m
200-year return period	2.8 m	4.0 m
Water levels are shown in metres above geodetic datum		

Polkey Road Drainage

As outlined above the channel and culverts along Polkey Road have sufficient capacity to safely pass the 10-year return period flood. For the 100-year and 200-year return period floods, the water levels in the ditches overtop Polkey Road. However, the water levels are only marginally above the road crest and do not result in any significant flooding in the properties along Polkey Road opposite the channel. Figure 6-8 shows water level and road profile along the Polkey Road ditch.

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Cowichan Valley Regional District

Sh-hwuykwselu (Busy Place) Creek Stormwater Management and Mitigation Plan

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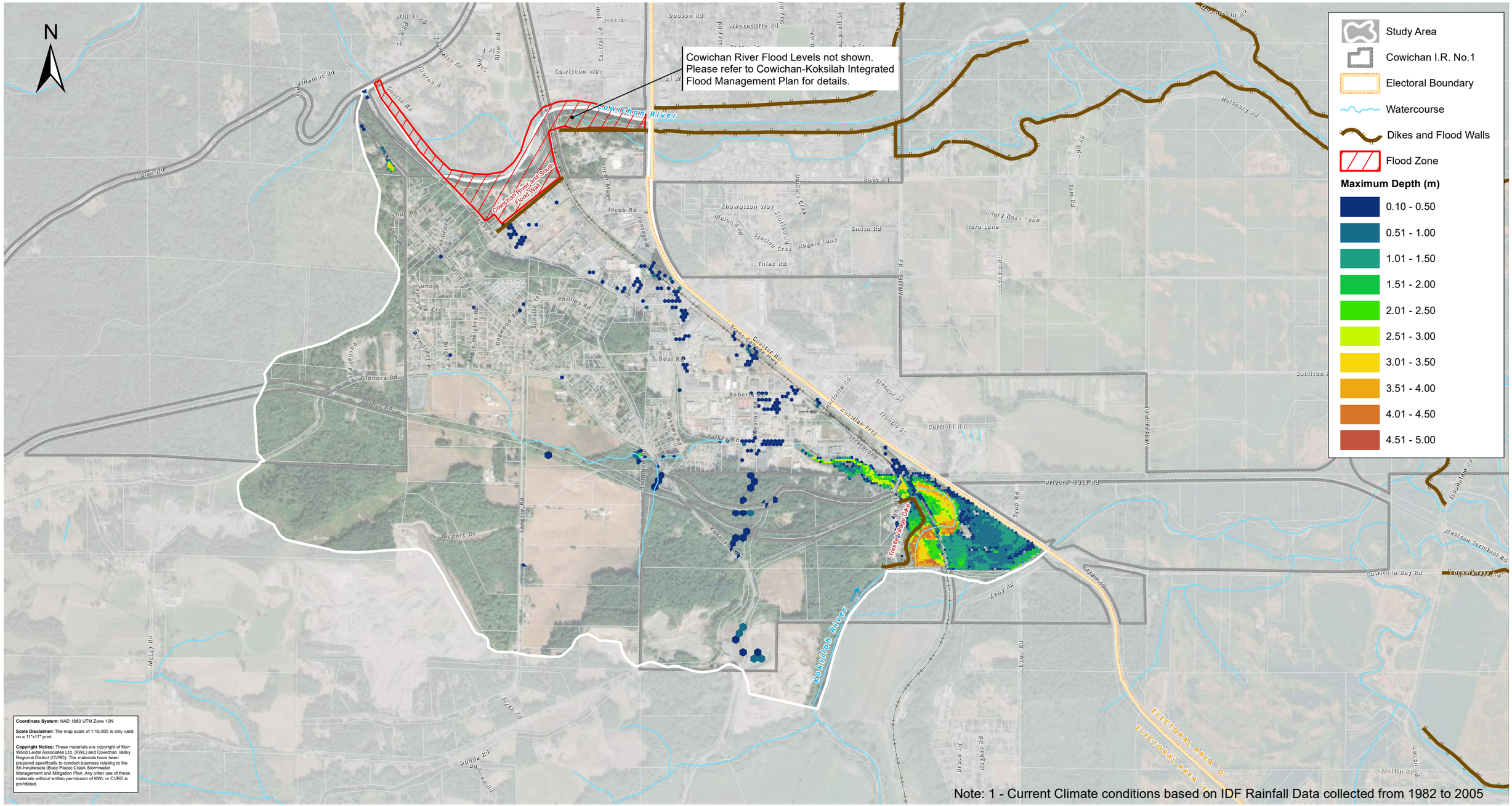

Note: 1 - Current Climate conditions based on IDF Rainfall Data collected from 1982 to 2005

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10-Year Return Period Flooding Depth for Existing Drainage, Land Use, and Climate$_1$

Figure 6-1

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Sh-hwuykwselu (Busy Place) Creek Stormwater Management and Mitigation Plan

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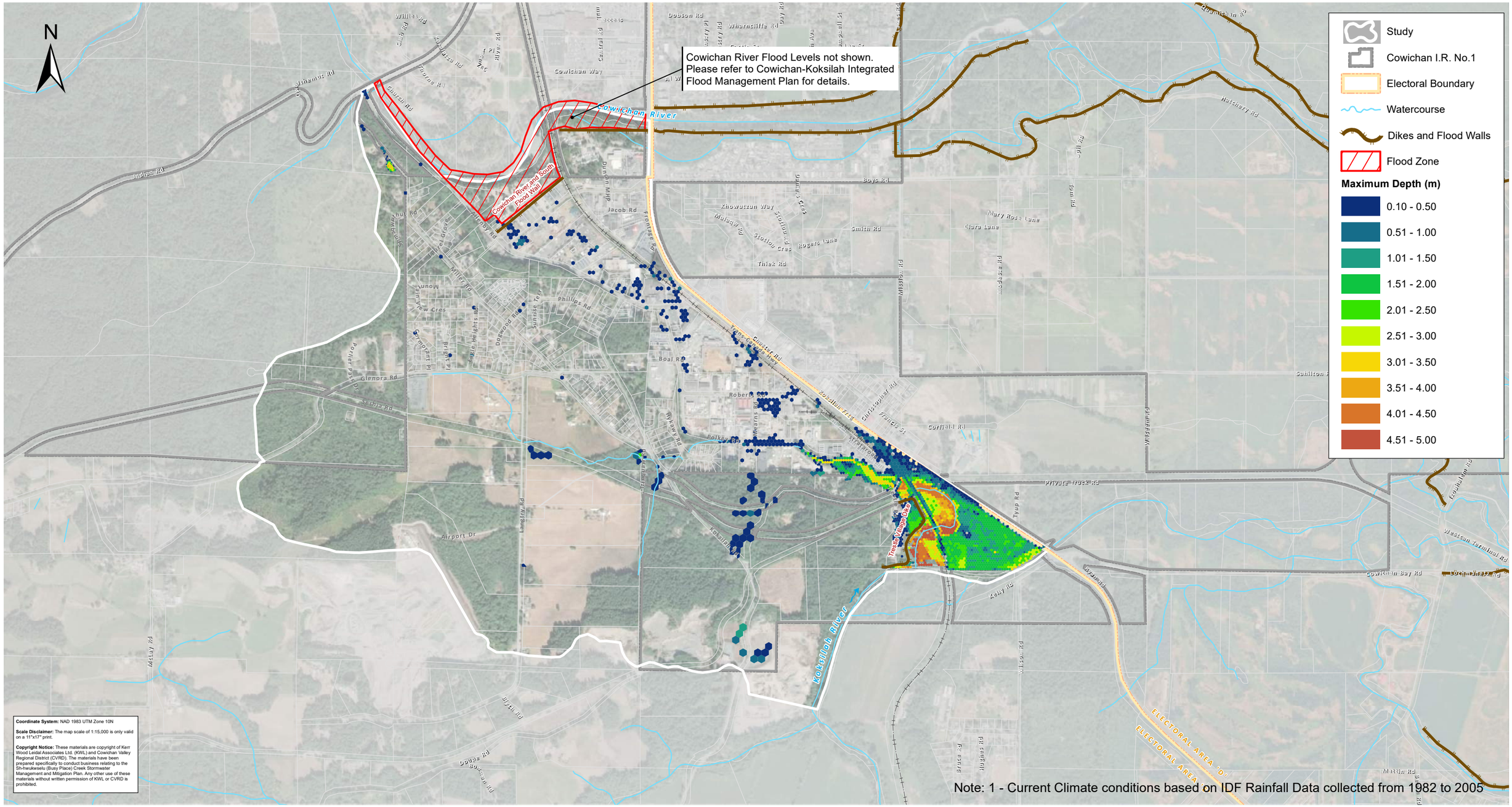

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100-Year Return Period Flooding Depth for Existing Drainage, Land Use, and Climate$_1$

Figure 6-2

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Cowichan Valley Regional District

Sh-hwuykwselu (Busy Place) Creek Stormwater Management and Mitigation Plan

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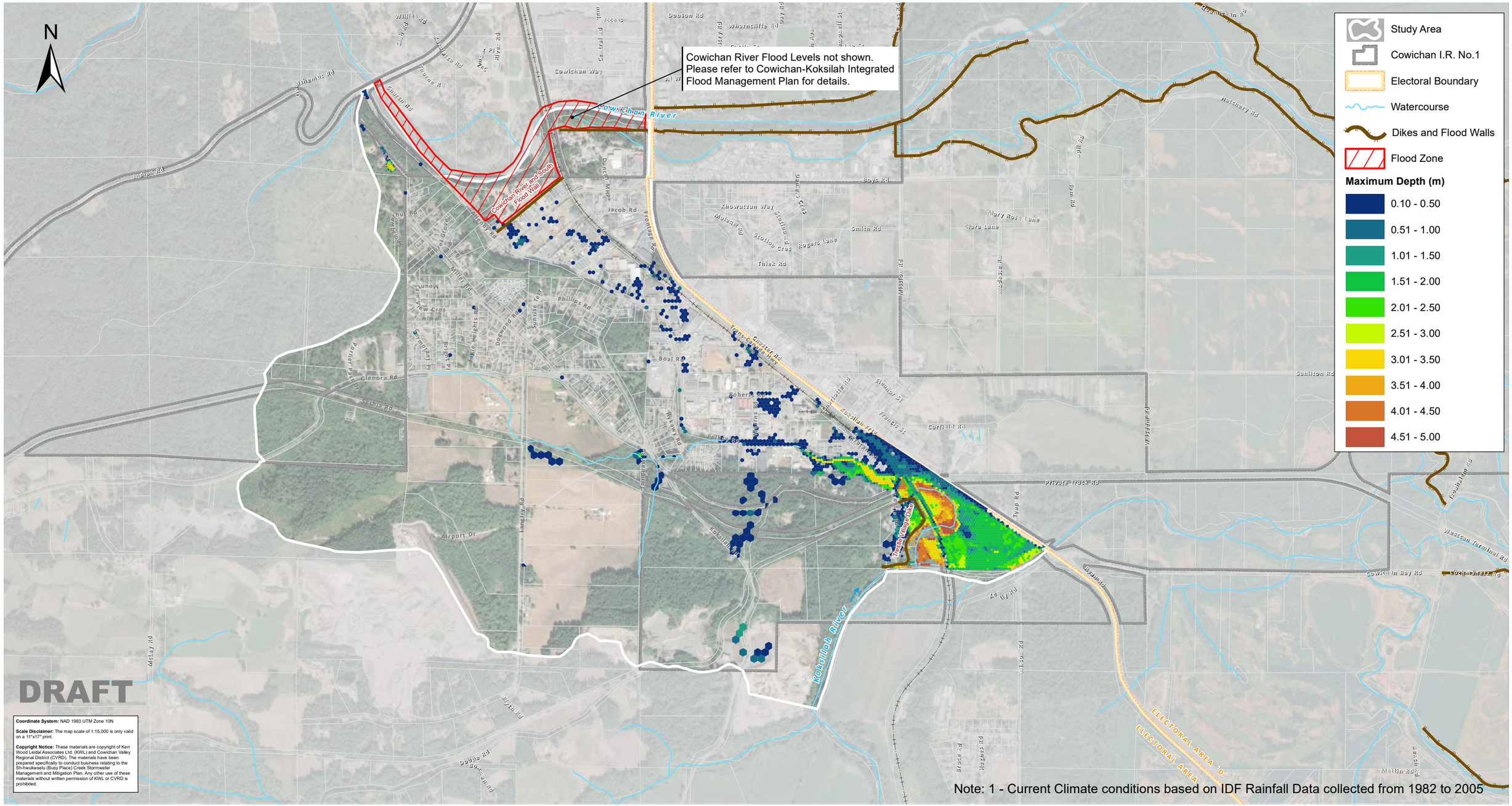

Coordinate System: NAD 1983 UTM Zone 10N

Scale Disclaimer: The map scale of 1:15,000 is only valid on a 11"x17" print.

Note: 1 - Current Climate conditions based on IDF Rainfall Data collected from 1982 to 2005

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200 100 0 200 m

200-Year Return Period Flooding Depth for Existing Drainage, Land Use and Climate$_1$

Figure 6-3

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Cowichan Valley Regional District

Sh-hwuykwselu (Busy Place) Creek Stormwater Management and Mitigation Plan

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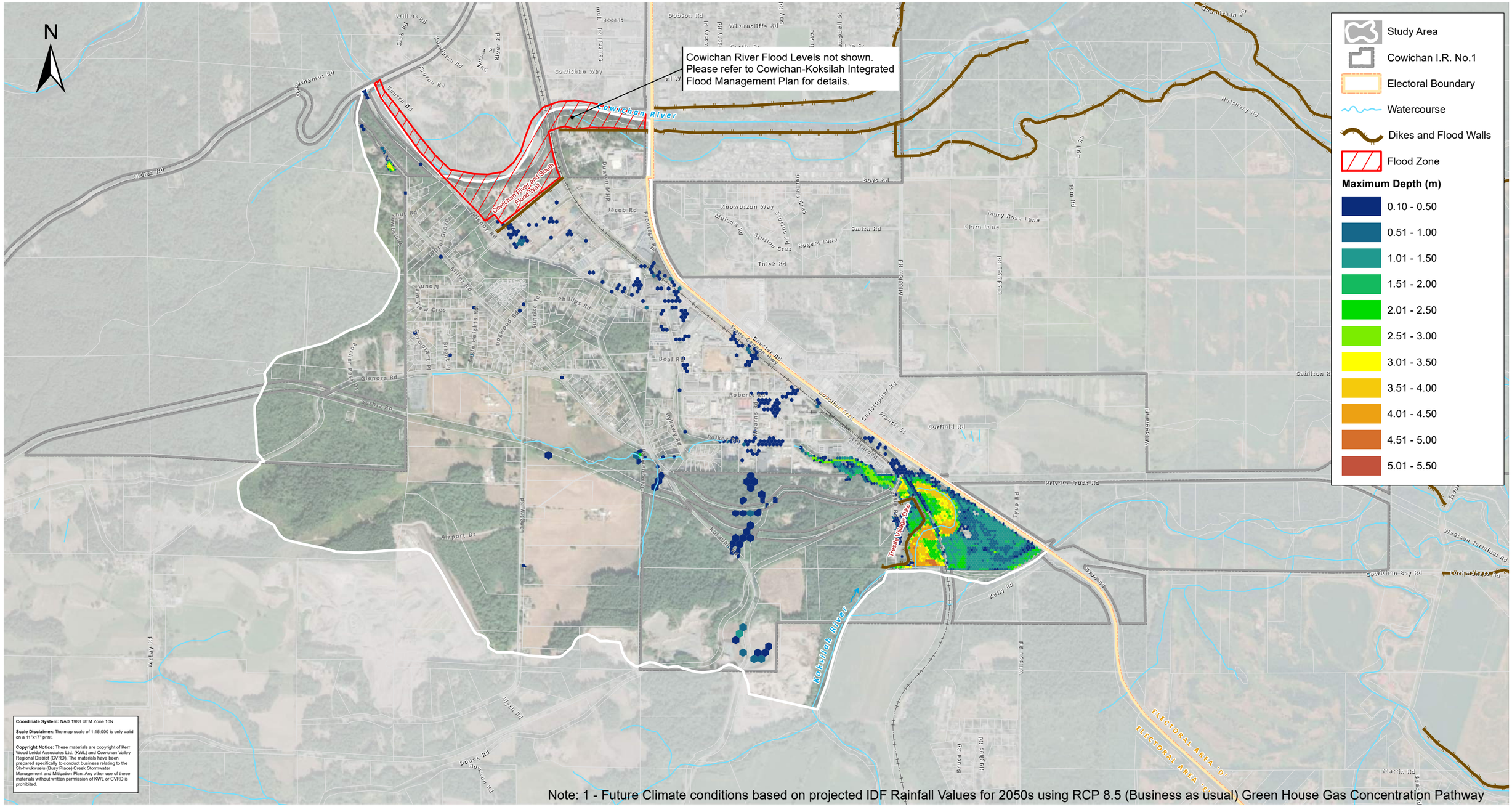

Note: 1 - Future Climate conditions based on projected IDF Rainfall Values for 2050s using RCP 8.5 (Business as usual) Green House Gas Concentration Pathway

Project No. 2212.071

Date March 2019

Scale 1:15,000

200 100 0 200 m

10-Year Return Period Flooding Depth for Existing Drainage Conditions, Future Land Use and Future Climate$_1$ (2050s)

Figure 6-4

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Sh-hwuykwselu (Busy Place) Creek Stormwater Management and Mitigation Plan

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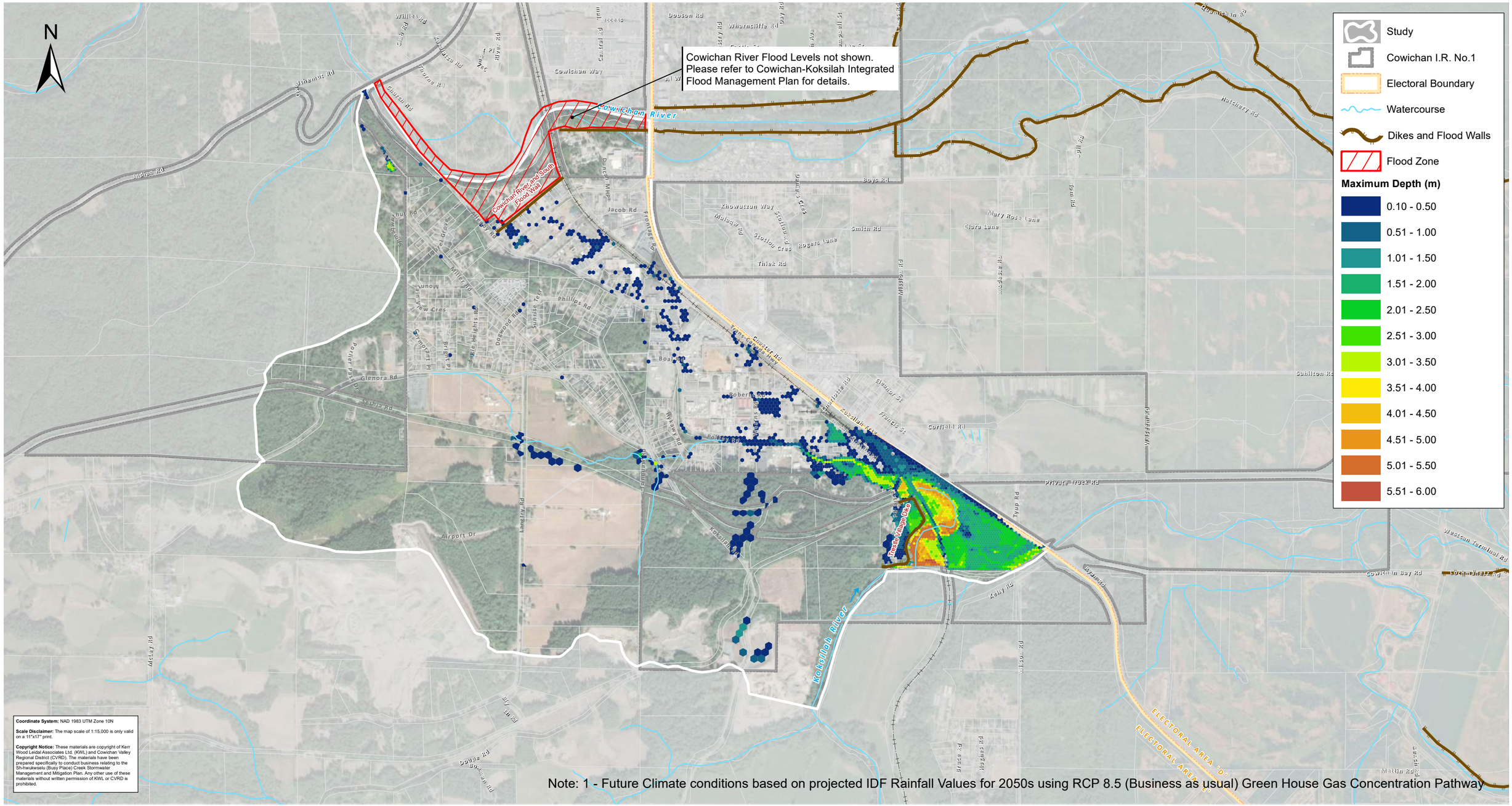

Note: 1 - Future Climate conditions based on projected IDF Rainfall Values for 2050s using RCP 8.5 (Business as usual) Green House Gas Concentration Pathway

Project No. 2212.071

Date March 2019

Scale 1:15,000

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100-Year Return Period Flooding Depth for Existing Drainage Conditions, Future Land Use and Future Climate$_1$ (2050s)

Figure 6-5

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Cowichan Valley Regional District

Sh-hwuykwselu (Busy Place) Creek Stormwater Management and Mitigation Plan

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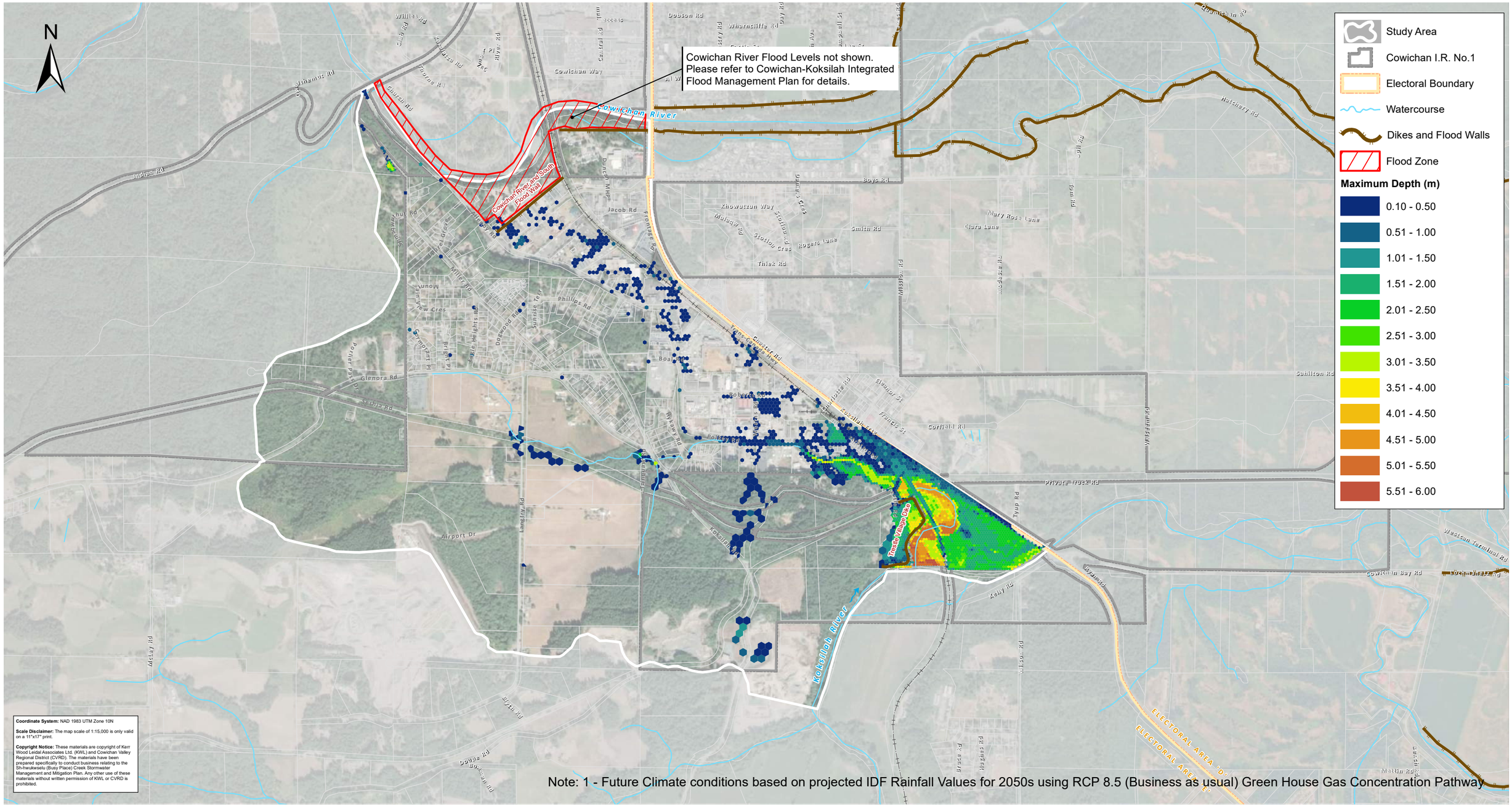


Coordinate System: NAD 1983 UTM Zone 10N

Scale Disclaimer: The map scale of 1:15,000 is only valid on a 11"x17" print.

Note: 1 - Future Climate conditions based on projected IDF Rainfall Values for 2050s using RCP 8.5 (Business as usual) Green House Gas Concentration Pathway

Project No. 2212.071

Date March 2019

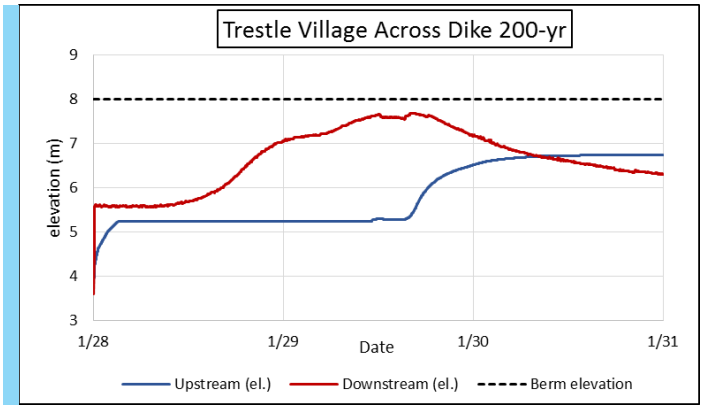
Scale 1:15,000

200 100 0 200 m

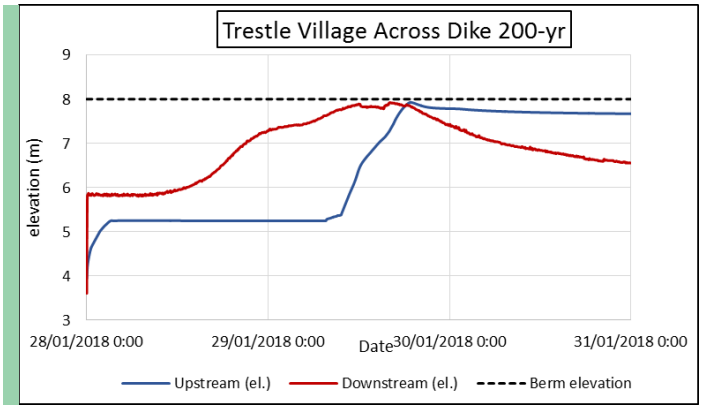
200-Year Return Period Flooding Depth for Existing Drainage Conditions, Future Land Use and Future Climate$_1$ (2050s)

Figure 6-6

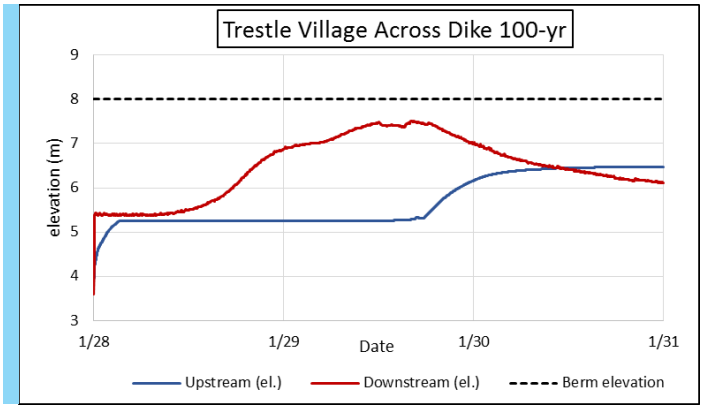
Existing Condition Design Storm Water Level Hydrographs for Trestle Village

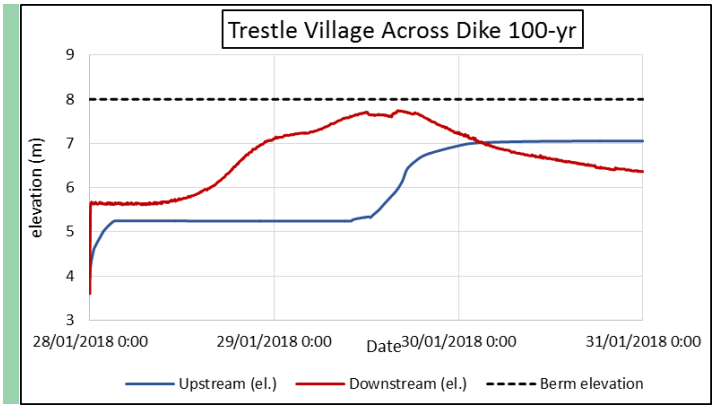


Future Condition Design Storm Water Level Hydrographs for Trestle Village

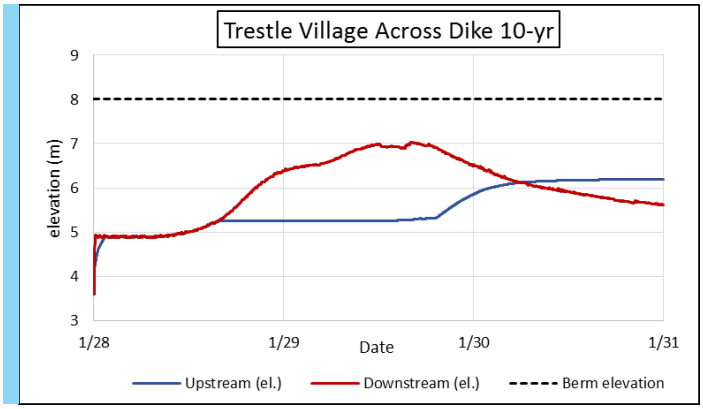


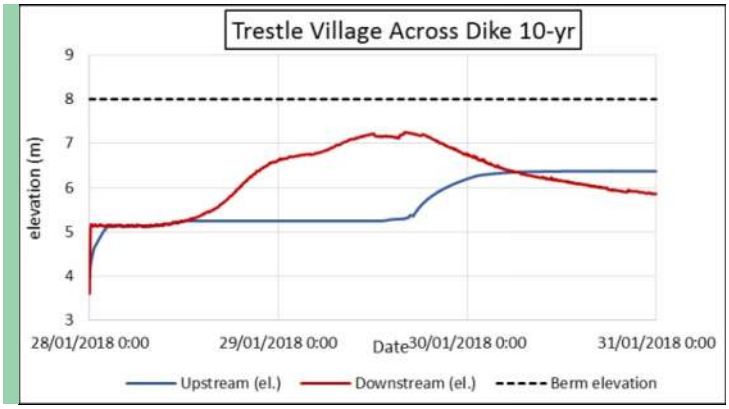
Water Level Hydrographs at Trestle Village - 200-Year Return Period





Water Level Hydrographs at Trestle Village - 100-Year Return Period



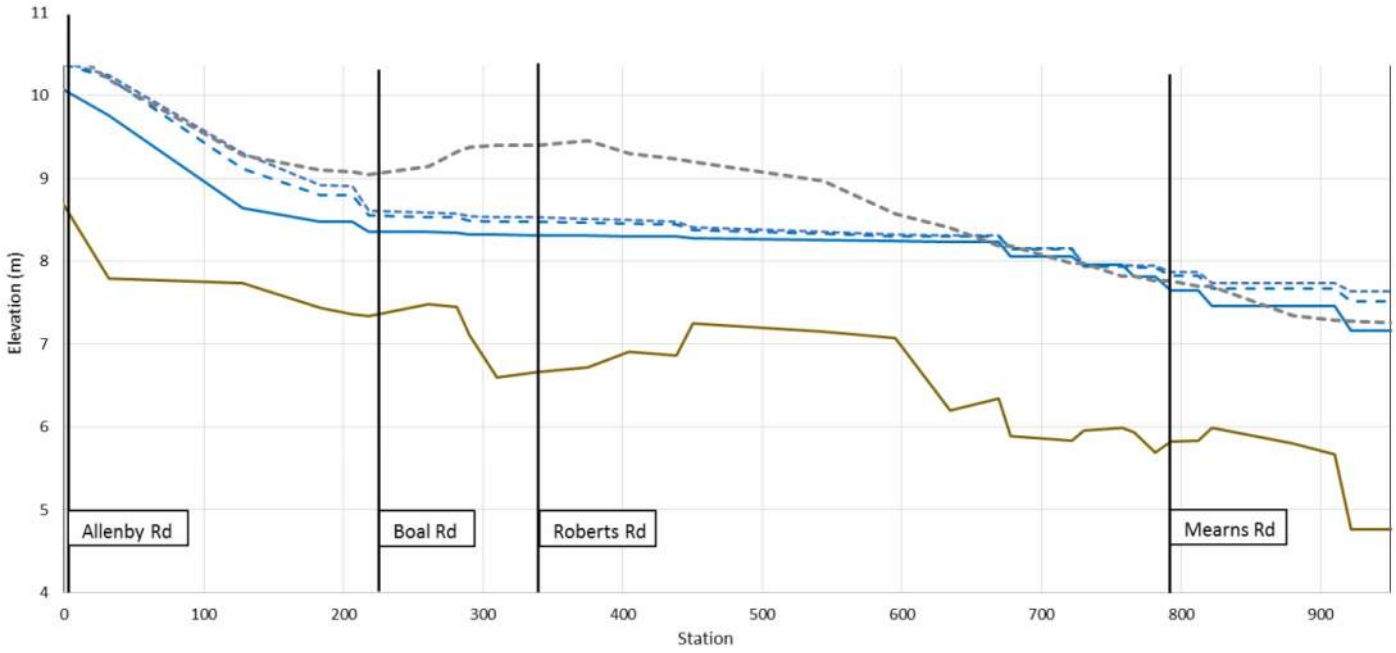


Water Level Hydrographs at Trestle Village - 10-Year Return Period

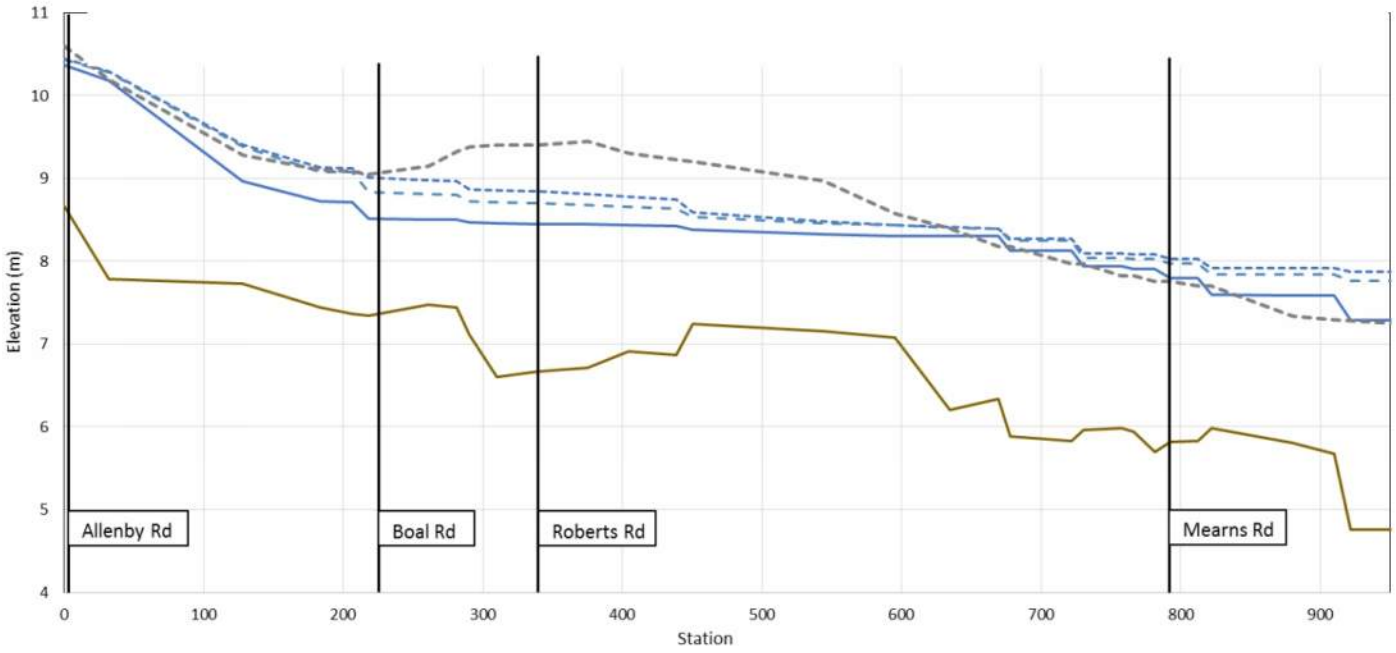
Project No.	2212.071
Date	March 2019
Scale	Not to Scale

Existing and Future Condition Design Storm Water Level Hydrographs for Trestle Village

Figure 6-7



Existing Flood Profiles along Polkey Road



10-Year Future Flood Profiles along Polkey Road

- 200-Year Return Period Peak Water Level
- 100-Year Return Period Peak Water Level
- 10-Year Return Period Peak Water Level
- Polkey Road Crest
- Ditch Invert

Project No.	2212.071
Date	March 2019
Scale	Not to Scale

Polkey Road Water Level Profiles - Existing and Future Climate and Land Use

Figure 6-8

7. Stormwater Improvement Projects

7.1 Potential Stormwater Improvement Projects

Based on the modelling results and discussion with stakeholders, a list of initial potential stormwater improvement projects was developed (see Table 7-1). These potential projects aim to:

1. Mitigate flooding as a result of rare extreme rainfall and/or snowmelt events;
2. Provide stream enhancement opportunities; and/or
3. Provide opportunities to improve water quality.

The locations of the potential drainage improvement projects are shown in Figure 7-1 and Table 7-1 list the potential projects, summarizes the objectives of the potential projects and provides a brief description of the annual maintenance requirements for each.

Stakeholder Feedback on Preliminary Stormwater Improvement Projects

As part of the Phase 2 Engagement, stakeholders were asked to provide input on the potential stormwater improvement projects. General comments included:

1. Ensure recommendations include a communications strategy for communicating the benefits of options to the public.
2. The option that has the greatest potential long-term return on investment or social impacts is likely the preferred option.
3. The level of involvement required for industrial stakeholder's implementation needs to be clear.
4. Further evaluation and discussion with MoTI are needed for those options located within road right-of-way.
5. In general, for any drainage improvement option that results in the construction of a pump station and any other accessory building it may be worth implementing green infrastructure (e.g., roofs).

Comments from the stakeholders on the drainage improvement projects specifically included:

Table 7-1: Summary of Potential Drainage Improvement Projects

Drainage Improvement Project	Intent	Project Objective			Drainage Analysis[1]	On-going Maintenance Considerations
		Drainage/ Flood Risk Reduction	Stream Habitat Enhancement/ Fish Passage	Water Quality		
1A. Keating Farm Detention Pond - (Large Flood Detention Facility)	Provide upland storage to reduce peak flows from the upper watershed to reduce 100-year return period flows such that undersized culverts downstream do not need to be upgraded & reduce 2-year return period flood to reduce channel erosion & provide water quality improvement opportunity.	X	X	X	Requires approximately 20,000 m^3 of storage to reduce peak flows to 1.7 m^3/s (capacity of culverts at Tzinquaw Road). This will require reconstruction of a dam approximately 4 m high at the decommissioned agricultural pond at the Keating Farm property.	This would be considered a dam, therefore formal dam safety inspections, dam maintenance, & other dam safety regulatory requirements will be required. May also require infrequent (~5 to 10 years) removal of sediment accumulation to maintain function.
1B. Keating Farm Detention Pond/Wetland	Provide upland storage to reduce peak flows for 2-year return period flood to reduce channel erosion, improve habitat function, & provide water quality improvement opportunity.		X	X	Requires approximately 14,000 m^3 of storage to reduce 2-year 24-hr event reduce to 1.45 m^3/s.	The storage volume & the height of the berm at the pond outlet would be small enough not to trigger dam safety requirements. Therefore, limited on-going maintenance would be required.
2. Langtry/ Tzinquaw/Koksilah/ Hykway Road/ Polkey Road Driveway Culvert Upgrades & Fish Passage Improvements	Replace major road crossing of main creek channel & driveway culvert crossings along Polkey Road to provide sufficient capacity to safely pass the 200-year return period flood and improve fish passage.	X	X		Drainage analysis results showing recommended minimum culvert sizes for hydraulic capacity are shown in Table 6-3 in the report. Culverts will need to be further sized to provide fish passage by designing culverts such that peak flow velocities are maintained below maximum recommended for fish species & low flow water depths are maintained above minimum recommendations with preference for culverts with natural channel substrate (ie: arch culverts, open bottom culverts or box culverts with fish baffles) .	Annual clearing of debris from the culverts & culvert condition inspection every 10 years
3. Hykawy Park Diversion	Provide low flow diversion from Sh-hwuykwselu (Busy Place) Creek to provide fish passage upstream of Hykway Road and to reduce flood potential at Hykway Road Culvert .	X	X		Requires a diversion channel & culverts for the road crossing to carry approximately 2.0 m^3/s. This is equivalent to a trapezoidal channel with 2:1 side slope & a 1 m bottom width having a depth of flow of 0.5 m (assuming channel slope of 2%)	Maintenance of the channel & riparian vegetation through the park.
4. Polkey Road Channel Floodplain/ Riparian Improvements	Reduce Polkey Road to one lane/ one-way road & use space to naturalize floodplain area. Polkey Road could also be raised to reduce the potential for overland flooding.	X	X	X	Results baseline 200-year return period conditions indicate minimum overtopping of Polkey Road at the peak 200-year Return Period flood. Therefore, Polkey Road would only be required to be raised about 300 mm to provide freeboard above the 200-year return period flood level.	Riparian maintenance
5. Raise Miller Road & Upgrade Existing Culverts	Raise Miller Road & upgrade existing culverts to safely pass the 200-year return period flood to provide emergency access along Miller Road to Highway 1.	X			Results indicate that Miller Road would have to be raised by about 0.5 m with existing culverts upgraded to minimum 1.2 m x 2.5 m box culvert (or equivalent). A different culvert geometry may be required to meet fish passage peak velocity & minimum depth requirements, which will be determined during detailed design.	Culvert and Riparian maintenance
6. Trestle Village Floodbox	Upgrade the Trestle Village flood box to replace the existing culvert. The flood box would include two pipes (a lower & upper-level pipe to assist with drainage of the Trestle Village Area) & proper functioning flap gates to prevent backflow. No additional improvements to the dike are proposed with this project (see project 8.).	X			Initial results during the 200-year flood event indicate that peak water levels in the Trestle Village Area are approximately equal to the peak water levels in the Koksilah River. This indicates that there is insufficient area to store water in the Trestle Village area during periods of high water in the Koksilah River when the flap gate would be closed.	Annual clearing of debris from the floodbox, 5- to 10-year flushing & inspections. Should also be included as part of annual dike inspections.
7. Trestle Village Pump Station	Includes a pump station to transfer water from the Trestle Village drainage system into the Koksilah River during periods of high water (up to 200-year flood event). The pump station will consist of a portable pump which can be brought to the site & run when required. Can be stored & maintained off-site when not required.	X			Should the flood box alone not be sufficient to maintain water levels below habitable floor levels in Trestle Village during periods of high water in Koksilah River.	The pump station would require annual regular maintenance/testing, upgrading of controls/electrical every 10-years, likely replacement of pumps at the 25-year mark.

Drainage Improvement Project	Intent	Project Objective			Drainage Analysis[1]	On-going Maintenance Considerations
		Drainage/ Flood Risk Reduction	Stream Habitat Enhancement/ Fish Passage	Water Quality		
8. Trestle Village Dike Replacement	Replace existing Trestle Village Dike. This would entail removal of the existing dike & full reconstruction of the Trestle Village Dike to acceptable standards. This could be combined with the flood box (Project 7) & a pump station (Project 8).	X			Dike crest would be raised to 200-year return period flood construction level (based on future climate conditions).	Dike would require periodic maintenance/removal of vegetation. Annual dike inspections.
9. Trestle Village Upland flow diversion	Another potential option for management of flood risk at Trestle Village may be to collect & divert runoff (up to 200-year return period flood) from the upland area to the west of Trestle Village & divert around the Trestle Village dike.	X			This option would reduce the volume of water flowing into the Trestle Village area & thus eliminate the need for a pump station.	Limited channel clearing/vegetation clearing
10. Headwaters Channel & Riparian Restoration	Rehabilitate natural function of mainstem of Sh-hwuykwselu (Busy Place) Creek near the headwaters of the watershed. This will help improve water quality for downstream & will also provide opportunity for additional fish habitat in the system after restoration of fish access.		X	X	Drainage analysis not required for this option. Channel design to be carried out at detailed design to carry & be stable at design flows. Restoration will involve rehabilitation of channel, placement of instream habitat structures, riparian planting & fencing within the agricultural lands to protect stream & riparian zone from livestock & other farming activities.	Initial riparian vegetation maintenance & riparian fence maintenance.
11. Lower Sh-hwuykwselu Creek Channel Realignment	Currently, the lower reaches of the creek channel cross from the west to east of the E&N railway embankment & then back from east to west through two separate sets of culverts. The proposed channel diversion would carry water directly to the Koksilah River along the east side of the E&N railway embankment to discharge on the downstream side of the E&N Railway bridge.	X	X		As the water levels on the downstream side of the E&N railway are about 0.5 m lower than the water levels at the confluence of the Koksilah River & Sh-hwuykwselu Creek. This option will not be reviewed further due to concerns of the landholder of potential for flooding or erosion of land adjacent to realignment. PROJECT NOT CARRIED FORWARD FOR COSTING.	May require periodic channel & vegetation clearing.
12. Sh-hwuykwselu (Busy Place) Creek Miller Road/Trans-Canada Highway Diversion	Divert peak flows from the upper Sh-hwuykwselu (Busy Place) Creek watershed around the lower reaches of the creek channel by constructing a large diameter diversion pipe from the upstream side of Miller Road along Highway 1 to the downstream side of the Koksilah Road Bridge.	X			Initial modelling results indicate an insignificant change in peak water levels downstream of Miller Road for the rare extreme flood events (100-year & 200-year return periods) as the water levels in Koksilah River control water levels downstream of Miller Road at these flood levels. PROJECT NOT CARRIED FORWARD FOR COSTING.	Storm drain flushing & inspection every 5 to 10 years
13. E&N Railway & Highway 1 Bridge Conveyance Improvements	The Cowichan-Koksilah Integrated Flood Management Plan modelling indicates approximately 0.5 m drops in water level from upstream to downstream of each of the bridges (a total of 1.0 m from downstream of the Highway Bridge to Upstream of the E&N Highway Bridge)	X			Upgrades of the E&N & Cowichan-Koksilah Bridges could be carried out to improve conveyance of flood discharges in the Koksilah River & lower peak flood levels by up to 1 m on the upstream side of the E&N railway. Detailed analysis of these options is beyond the scope of this study but will be recommended as part of future Koksilah River flood management strategy.	Depending on the solution, this option may require periodic clearing of gravel & debris at bridge crossings to maintain capacity.
14. Gravel Management, Logjam Removal & Side Channel Maintenance on Koksilah River	Development of gravel management & logjam removal plan for the Koksilah River should be carried out. This plan could address maintenance of the conveyance within the existing side channel to the south of the Koksilah River. Any proposed works within the Koksilah River is outside the boundary & beyond the scope of the current study but will be recommended to be investigated as part of future Koksilah River flood management plans.	X	X		Will help to maintain channel conveyance & reduce the risk of increased flood levels during large flood events. Gravel management is an on-going maintenance function & as such will require a comprehensive plan to identify appropriate gravel removal sites, provide best management practices to reduce potential impacts to fish & riparian habitat & to identify partners & funding structure to provide long-term & on-going maintenance.	Channel maintenance may be required every one to two years initially reducing 4 to 6 years. Logjam removal may be required every 5 to 10 years.

Note: 1 - Further detailed hydraulic assessment of drainage improvement projects will be required as part of detailed planning and design to confirm final sizing of proposed projects and potential impacts of proposed projects.

Project 1: Keating Farm Wetland and Detention Facility

- Consider if wetland at Keating Farm is a natural wetland as converting it to a detention pond may contravene the *Canada Fisheries Act* and/or *BC Water Act* based on Ministry of Environment's *Develop with Care 2014: Environmental Guidelines for Urban and Rural Development in British Columbia.*
- Consider incorporating silt and pollutant reduction (from entering into streams and groundwater) features/riparian restoration into the stormwater management design.

Potential Location of Keating Farm Detention Pond/Wetland

Project 2: Major Drainage Culvert Replacement and Fish Passage

- Consider incorporating silt and pollutant reduction (from entering into streams and groundwater) features/riparian restoration into the stormwater management design.

Project 3: Hykway Park Diversion

- Consider incorporating silt and pollutant reduction (from entering into streams and groundwater) features/riparian restoration into the stormwater management design.

Project 4: Polkey Road Channel Floodplain/ Riparian Improvements

- Consider reducing the width of Polkey Road and naturalizing the floodplain to reduce the impervious area and allow onsite rainwater infiltration.

Project 5: Raise Miller Road and Upgrade Existing Culverts

- Consider naturalizing the Miller Road ditches to reduce the impervious area, which can allow onsite rainwater infiltration.

Project 6: Trestle Village Floodbox

- Consider upgrading the flood box infrastructure that is already in place.

Project 7: Trestle Village Pump Station

- Consider diverting upland flow to a detention pond to allow for slow infiltration rather than pump station.

Project 8: Trestle Village Dike Replacement

- Existing condition of the dike is unknown and will likely need full replacement. Will need to carefully consider dike alignment as to limit impacts to archeological sites while maintaining potential residential development area.

Project 9: Trestle Village Upland Flow Diversion

- Consider where diverted water will be directed and its impacts as there may not be sufficient storage to store water in the Trestle Village area during periods of high water in the Koksilah River.
- Consider diverting upland flow to a detention pond to allow for slow infiltration.
- Identify where Trestle Village flow could be diverted to and recommend natural practices that help to slowly infiltrate stormwater.

Trestle Village Dike showing mature trees and vegetation growing on dike.

Project 11: Lower Sh-hwuykwselu (Busy Place) Creek Channel Realignment

- Stakeholders support that the Lower Sh-hwuykwselu Creek Channel Realignment should not be further reviewed if there are concerns for flooding or erosion of land adjacent to realignment as flooding and/or erosion of land may contribute to contaminants flowing into other water bodies.

Project 12: Sh-hwuykwselu (Busy Place) Creek Miller Road/Trans-Canada Highway Diversion

- Consider incorporating vegetated swales, infiltration basins, absorbent vegetation, or engineered wetlands etc., as peak flows are diverted from the upstream side of Miller Road along Highway 1 to the downstream side of the Koksilah Road Bridge

General Considerations:

- Important to consider that residential areas at high elevations in the Study area may be able to retrofit their infrastructure to improve the percentage of permeable/pervious surfaces.
- There is support for other techniques and engineered solutions beyond regulations on impervious surfaces that may be more effective and/or publicly supported.

7.2 Stormwater Improvement Project Analysis

Detention Pond Sizing

Initial sizing of the potential detention pond or wetland at Keating Farm to reduce 100-year the return period peak flows for the projected future climate and future land use condition to the safe conveyance capacity of the downstream culverts.

Major Road Culverts

Modelling of the drainage system has been used to develop sizes of culverts and channel for recommended drainage improvements. The future land use with future climate rainfall has been used

to estimate the drainage sizing. The existing and proposed culvert sizes for drainage improvement project 2 are shown in Table 7-2.

Table 7-2: Existing and Proposed Culvert Sizes for Potential Drainage Improvement Project 2

Location	Existing Size (m)	Proposed Size (m)
Langtry Rd.	0.6	1.5
Tzinquaw Rd.	Upper 0.6 Lower 0.6	1.5
Koksilah Rd.	Upper 0.5 Lower 1.0	1.6
5169 Hykawy Rd. Driveway Culvert	1.2	1.8
Across Hykawy Rd.	1.2	1.8
5146 Polkey Rd. Driveway Culvert #1	1.2	1.8
5146 Polkey Rd. Driveway Culvert #2	1.2	1.8
5136 Polkey Rd. Driveway Culvert	1.2	1.8
5130 Polkey Rd. Driveway Culvert	1.2	1.8
5120 Polkey Rd. Driveway Culvert #1	1.2	2
5120 Polkey Rd. Driveway Culvert #2	1.2	2
4994 Polkey Rd. Driveway Culvert	2	2
Miller Road Culvert near Trestle Village	770 mm dia. wood 400 mm dia. CSP	Twin 2.1 m culverts
Note: Proposed culvert sizes are selected to safely pass the peak 100-year return period flood conditions under future land use and future (2050s) climate rainfall conditions.		

Trestle Village Drainage Improvements

Assessment of the drainage improvements at Trestle Village indicate that installation of a 300 L/s pump station would reduce peak 100-year return period water levels in the Trestle Village area to about El. 5.37 m. This elevation is about 1 m below the Trestle Road crest elevation. The results also indicate that outflow from the pump station would have no significant impact on water levels to the east of Trestle Village Dike within Sh-hwuykwselu (Busy Place) Creek channel.

7.3 Stormwater Improvement Project Costs

Order of Magnitude (Class 5) costs for construction and on-going maintenance costs have been estimated for the proposed stormwater improvement projects. The order of magnitude costs are suitable for relative comparison of options and for long term planning. They are not intended to be accurate enough for annual budgeting purposes or for construction.

Further detailed planning and design will be required to provide more detailed substantive cost estimates. The order of magnitude costs is based on limited development of project details (0 per cent to 2 per cent in terms of percent complete) using typical unit costs of major components with assumed mark-up for additional components. A contingency of 50 per cent has then been added to the cost to account for uncertainty in the concept designs, inflation, and additional project unidentified project costs. This contingency does not reflect the accuracy of the estimate, rather it is a factor added to the costs that would be expected to be spent on implementation of the project. The costs are considered to have an accuracy of an order of magnitude (-30 per cent to +50 per cent). In order to estimate life-cycle

costs, average annual maintenance costs have been estimated and multiplied by 25 to calculate 25-year life cycle costs. The costs are assumed to be in 2018 dollars with no allowance for inflation.

A summary of the estimated project costs is shown in Table 7-3. The cost estimate basis for the indicative class 5 cost estimate is included in Appendix E

Table 7-3: Drainage Improvement Project Indicative (Class 5) Cost Estimates

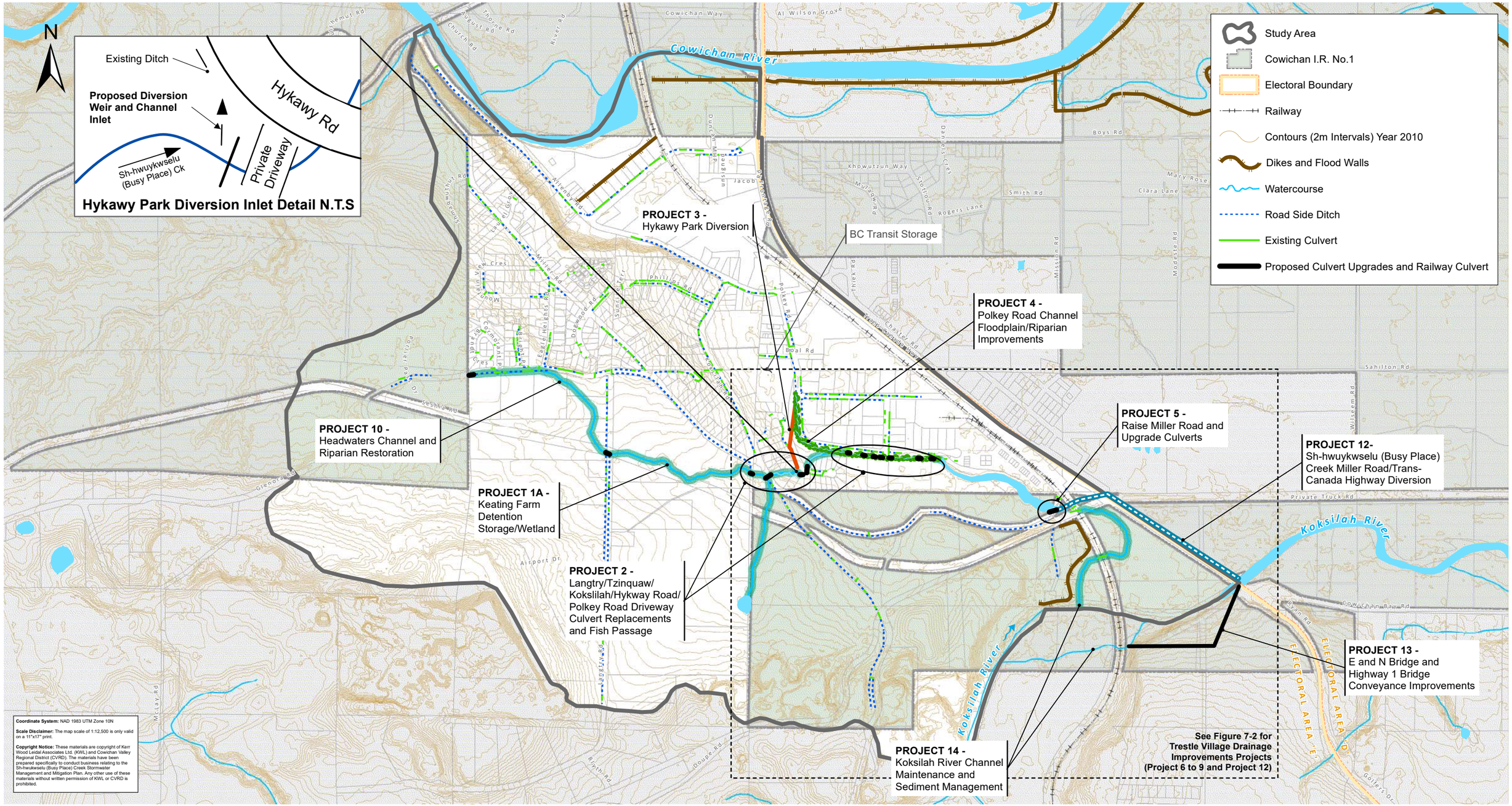
Drainage Improvement Project	Capital Construction Cost[1]	On-going Operation & Maintenance[2] (average annual cost)	Total 25-year project cost[3]
1a. Keating Farm Detention Pond	$525,000	$30,000	$1,275,000
1b. Keating Farm Wetland	$315,000	$10,000	$565,000
2. Tzinquaw Road/ Koksilah Road/ Hykway Road Culvert Replacements	$1,500,000	$10,000	$1,750,000
3. Hykawy Park Diversion	$430,000	$10,000	$680,000
4. Polkey Road Channel Floodplain/Riparian Improvements	$4,600,000	$20,000	$5,100,000
5. Raise Miller Road / Install New Culverts	$670,000	$10,000	$920,000
6. Trestle Village Floodbox	$350,000	$10,000	$600,000
7. Trestle Village Pump Station	$1,600,000	$50,000	$2,900,000
8. Trestle Village Dike Replacement	$2,700,000	$10,000	$3,000,000
9. Trestle Village Upland Flow Diversion	$340,000	$10,000	$590,000
10. Upstream Reaches Channel and Riparian Restoration	$570,000	$5,000	$695,000
11. Lower Sh-hwuykwselu Creek Channel Realignment	Cost not developed as the project was not considered for further analysis based on feedback from stakeholders		
12. Sh-hwuykwselu (Busy Place) Creek Miller Road/Trans-Canada Highway Diversion	Cost not developed as the project was not considered for further analysis based on drainage assessment results showing the project is not effective at reducing flood levels upstream.		
13. E&N Railway and Highway 1 Bridge Conveyance Improvements	Cost not developed as further study required to determine the best approach to increase flow conveyance at bridges and further discussion with bridge owners will be required.		
14. Koksilah River Gravel Management, Logjam Removal & Side Channel Maintenance	Cost not developed as further study and planning required to determine the best locations and frequency of gravel removal.		

Notes:
1- Capital construction cost includes final detailed design, environmental monitoring, construction inspection, procurement of materials and equipment, construction costs and first year warranty period maintenance (for riparian planting). The cost does not include any unforeseen field investigation costs such as archeology, detailed geotechnical investigations, contaminated site mitigation or other unforeseen site conditions.
2- On-going maintenance and operation costs provide best estimate of average annual maintenance and operation costs over the first 25-years of operation. No future discounting or inflation has been included in the costs. These costs do not include staff time or other indirect costs associated with managing the maintenance of the structures.
3- Includes capital and maintenance costs over 25-years with no allowance inflation.

Cowichan Valley Regional District

Sh-hwuykwselu (Busy Place) Creek Stormwater Management and Mitigation Plan

KERR WOOD LEIDAL consulting engineers



Project No. 2212.071

Date March 2019

Scale 1:12,500

200 100 0 200 m

Location of Potential Stormwater Improvement Projects

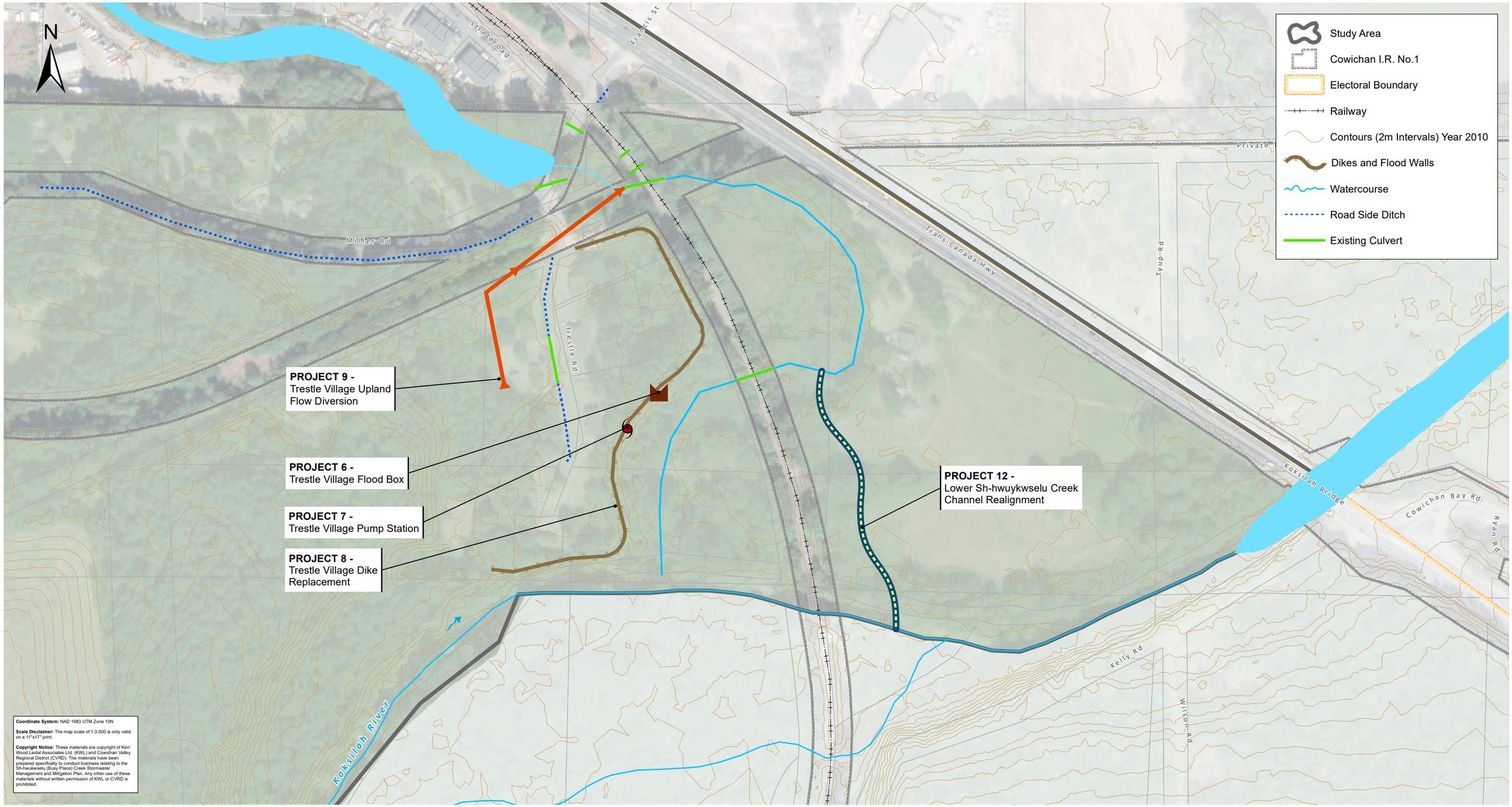
Figure 7-1

Path: Q:\2200-2299\2212-071\430-GIS\MXD-Rp\Report_Figure\2212071_Fig7-2_WatershedManagement-DrainageOptions.mxd Date Saved: 2019-02-28 3:29:43 PM | Author: GOConnell

Cowichan Valley Regional District

Sh-hwuykwselu (Busy Place) Creek Stormwater Management and Mitigation Plan

KERR WOOD LEIDAL consulting engineers



Coordinate System: NAD 1983 UTM Zone 10N

Scale Disclaimer: The map scale of 1:3,000 is only valid on a 11"x17" print.

Project No. 2212.071

Date March 2019

Scale 1:3,000

50 25 0 m 50

Trestle Village Area Potential Stormwater Improvement Projects

Figure 7-2

8. Mitigation of Future Development Impacts

8.1 Mitigating Stormwater Impacts from Changes in Land Cover and Climate Change

Low Impact Development

There is both a threat and an opportunity for the watershed as land use change occurs in both the Electoral Area and Cowichan Tribes:

- Under a 'business as usual' scenario, land use change could lead to cumulative increases in the impervious area (roof and pavement), and reduction pervious area (area of soil and vegetation which acts similar to a 'sponge' to retain storm water). Modelling indicates these changes would increase the frequency, volume, and area of flooding in lower parts of the watershed. Increased flows in creek channels could trigger greater rates of instream erosion on steep parts of the creek, with sediment deposition and reduced flood storage or conveyance in flatter creek bottomlands.

Raingarden/infiltration swale at Cowichan Recreation Center Parking Lot.

- Alternatively, if low impact development techniques, such as the stormwater at-source control best practices introduced in Appendix F, were integrated with new development, there is an opportunity to reduce the 'effective' impervious area when existing industrial sites are redeveloped. When additional housing is developed, less impervious area per person is created when land use forms with compact development (generally multi-family) are complemented by areas of existing woods and soils left in their natural, absorbent state.
- In existing housing and industrial areas, limits on the permissible amount of un-mitigated impervious area can encourage owners to avoid paving or hardening excessive amounts of the lot area unless they balance that impervious area with at-source stormwater controls.
- At-source stormwater controls that infiltrate surface runoff from parking or paved yard areas also improve the quality of urban runoff before it enters groundwater or watercourses. Heavy metals (from brake linings) or petroleum hydrocarbons (from vehicles) are filtered out in the soil or rock layers. Vegetation cover in rain gardens or infiltration swales provides erosion control and keeps the surface of the soil permeable.

The combination of compact growth with integrated stormwater source control best practices can lead to reduced impacts of development, even as the population of the watershed increases.

Implementing low impact development requires a combination of clear targets and understanding of benefits, public awareness, technical capacity building, updates to engineering standards and bylaws, and an attitude of continuous improvement and of monitoring progress.

8.2 Setting Low Impact Development Stormwater Management Targets

Using low impact development practices to better manage stormwater can provide a means of reducing impacts of stormwater runoff on a lot by lot basis. However, it is difficult to understand how implementing lot scale controls improves stormwater management and health of stream habitat at a watershed scale. This makes it difficult to set clear targets which can be used to effectively implement low impact development across the watershed.

One tool that can be used to help guide the implementation of at-source LID controls is the watershed health tracking system. This system was recommended by Metro Vancouver as part of the Integrated Stormwater Management Plan Template (Metro Vancouver, 2005).

The advantages of this system are that it:

1. Does not require detailed hydrological modelling or analysis;
2. Is based on mapping analysis with which can be undertaken using GIS analysis; and
3. Provides a quick way of tracking and updating the relative change in watershed health over-time.

Watershed Health Tracking System

The watershed health tracking system uses two watershed health indicators: (1) riparian forest; and (2) watershed imperviousness to provide an indication of watershed health.

Importance of Imperviousness (Indicator #1)

Research shows a strong relationship between the impervious area in the watershed and a stream's health (based on its fish and benthic insect community) as outlined in Table 8-1.

Table 8-1: Stream Health Relative to Impervious Area

Health	Total Impervious Area (% TIA)
Stressed (minor changes to watershed health)	1 - 10%
Impacted (moderate changes to watershed health)	11 - 25%
Degraded (severe changes to watershed health)	26 - 100%
The Importance of Imperviousness, (Schueler, 1994)	

The level of existing development within the Sh-hwuykwselu watershed is approximately 36 per cent TIA with future development increasing it to 42 per cent (from Table 2-1).

Importance of Riparian Forest Integrity (Indicator #2)

Riparian areas are those adjacent to watercourses that may be subject to temporary, frequent, or seasonal inundation, and which support plant life typical of the wetter soil conditions. These riparian areas provide natural features, functions, and conditions that support a productive fish community, such as:

- multi-canopied forest and ground cover that:
  - moderates water temperature,
  - provides a source of food, nutrients, and organic matter,
  - stabilizes the soil with root systems, thereby minimizing erosion,
  - filters sedimentation and pollution;

- sources of large woody debris;
- active floodplain areas;
- side channels, intermittent streams; and
- infiltration that can aid in sustaining baseflows.[1]

Figure 7-1 shows the Riparian Forest Integrity (RFI) assessment areas on the permanent watercourses with approximately 60 per cent vegetated with trees and shrubs, 20 with grass, and 20 unvegetated.

Sh-hwuykwselu (Busy Place) Creek Existing and Future Watershed Health Indicators

The two watershed health indicators (EIA and RFI) were used to quantify predicted changes between existing and future conditions.

Figure 8-2 provides a graphical representation of Watershed Health Tracking System (WHTS) showing existing conditions and future conditions assuming no mitigation is carried out. This shows how increasing imperviousness and decreasing the riparian area negatively impacts watershed health from fair health to poor health.

Setting Effective Impervious Area Target for Sh-hwuykwselu (Busy Place) Creek Watershed

A clear target for low impact development should be set to develop effective policy and guidance for the design and implementation of at-source stormwater management controls. In addition to indicating the potential impacts of unmitigated development within the watershed, the WHTS can also be used to determine targets for EIA and RFI to achieve watershed health objectives.

Given that improving watershed health is one of the objectives of the Plan and one of the stated priorities of the TAG and stakeholders, improving watershed health from the current 'fair' to 'good' condition is considered to be a reasonable target to achieve improved watershed health.

There are many potential combinations of improvements to RFI and reduction in EIA which could achieve the 'good' watershed health target. However, these are bounded by the following two paths:

1. Maintain existing RFI by protecting existing riparian areas and significantly reducing the EIA within the watershed; or
2. Improving the RFI by enhancing riparian areas and only slightly reducing the EIA within the watershed.

These two paths are also shown in Figure 8-3.

A summary of RFI and EIA targets to improve watershed health for the two potential pathways is shown in Table 8-2.

Table 8-2: Riparian Forest Index and Effective Impervious Area Potential Targets

Pathway	Riparian Forest Integrity	Effective Impervious Area
Existing Conditions	60%	36%
Maintain RFI and Reduce EIA	60%	10%
Enhance RFI[1] and Reduce EIA	80%	20%
1. Assumes all undeveloped riparian area (forested and grass) is enhanced and protected		

[1] Jan 2001, Streamside Protection Regulation

At a minimum, the watershed health should be maintained by implementing at-source stormwater management controls as part of new development to help maintain overall watershed EIA at 36 per cent.

8.3 At-Source Stormwater Management Examples

The Sh-hwuykwselu watershed contains significant areas of light industrial, residential, and agricultural development (Figure 2-4 and Figure 2-5). New housing development is planned within Cowichan Tribes areas, and some redevelopment planned in Electoral Area industrial and residential areas. In order to achieve the low impact development targets outlined in the previous section, the implementation of at-source stormwater management techniques will be necessary.

The illustrations are shown in Figure 8-4 through Figure 8-6 show examples of how low impact development could be implemented when development or redevelopment occurs. The sizing of the example at-source stormwater controls is based on the sizing methodology MV Stormwater Source Control Design Guidelines (Metro Vancouver, 2012) using local design rainfall intensities, minimum available areas for at-source controls based on zoning bylaws and typical infiltration rates.

Although these illustrations indicate that the targets are achievable using assumed conditions, the sizing and design of at-source stormwater management controls are dependants on site-specific conditions soil infiltration rates and ground slopes that will need to be assessed during detailed design of land development.

Light Industrial/Commercial Business Park Area Redevelopment Opportunities

Figure 8-4 shows a plan view of two typical parcels in the existing I-1 Light Industrial Zone in the Electoral Area.

Key Existing Zoning Requirements include:

1. Front Yard Setback 4.5 m
2. Side Yard Setback 0.0 m
3. Rear Yard Setback 0.0 m

The recent Electoral Area OCP process has revealed a desire in the community to upgrade the appearance of the neighbourhood as it redevelops.

Typical existing light industrial/commercial business park property with paved driveways, parking area and road side ditches

Key proposed features in the plan view (Figure 8-4) include:

1. A target of 15 per cent minimum of the lot area as green stormwater source controls, which would also be soft landscape area (absorbent topsoil, grass and trees at a minimum, shrubs, and groundcover, if desired).
2. A front yard rain garden for the depth of the setback (4.5 m) minimum, except where driveways cross the front yard. This front yard landscape would be designed to meet both aesthetic and stormwater purposes.
3. Additional rain garden or infiltration swale areas (see Appendix F) located at edges or convenient locations where roof and pavement drainage may be directed to the rain gardens.

4. Rain gardens areas would be shallow depressed areas within the landscape, with approximately 500 mm depth of growing medium. An overflow catch basin with domed grate would restrict short-term ponding in the gardens to a maximum 100 mm depth. An overflow pipe would be required to direct excess overflow to the public drainage system (roadside swale or ditches).
5. Paved areas where pollutant and/or nutrient loads may be high and where discharge into rain gardens and infiltration swales could increase the risk of pollution of vulnerable unconfined aquifers, would be serviced by engineered water quality treatment structures (e.g., oil/water/grit interceptors).
6. To meet targets and mitigate runoff from the fronting road and roadside, driveway crossings (up to 9 m wide for truck turning movements) would be pervious paving. Rather than have pervious paving in the road right of way, an alternate location could be provided on the private parcel, either as pervious paving or as a landscaped rain garden or infiltration swale.

Residential Area Redevelopment Opportunities

Figure 8-5 shows a similar set of principles applied to a compact housing development, either in the Electoral Area or Cowichan Tribes. The sketch plan reflects the CVRD RM 2 Zone, with key existing requirements including:

1. Front Yard Setback – 7.5 m;
2. Side Yard Setback – 3.5 m;
3. Rear Yard Setback – 7.5 m;
4. Maximum Building Coverage – 50 per cent; and
5. Maximum Impervious Area – 55 per cent.

There may be potential for more developments at this density where sewer and water infrastructure could support it.

Typical existing residential area properties with curb gutter, paved driveways and lawns

Key proposed features in the plan view (Figure 8-5) are in parallel with the industrial example above, and include:

1. A target of 15 per cent minimum of the lot area as green stormwater source controls, which would also be soft landscape area (grass and trees at a minimum, shrubs, and groundcover if desired).
2. A front yard rain garden for the depth of the setback (7.5 m) minimum, except where driveways cross the front yard. This front yard landscape would be designed to meet both aesthetic and stormwater purposes.
3. Additional rain garden or infiltration swale areas (see Appendix F) located at edges or convenient locations where roof and pavement drainage may be directed to the rain gardens.
4. Rain gardens areas would be shallow depressed areas within the landscape, with approximately 500 mm depth of growing medium. These housing sites may be away from the open aquifer, in areas with slower draining subsoils. In such areas, a drain rock reservoir under the rain garden of approximately 300 mm depth would store stormwater until it could soak in. An overflow catch basin with domed grate would restrict ponding in the gardens to a maximum 100 mm depth. An

overflow pipe would be required to direct excess overflow to the public drainage system (roadside swale or ditches).

5. Impervious areas where pollutant and/or nutrient loads may be high and where discharge into rain gardens and infiltration swales could increase the risk of pollution of vulnerable unconfined aquifers, would be serviced by engineered water quality treatment structures (e.g., oil/water/grit interceptors).
6. To meet targets and mitigate runoff from the fronting road and roadside, driveway crossings (7.5 m wide for residential) would be pervious paving. Rather than have pervious paving in the road right of way, an alternate location could be provided on the private parcel, either as pervious paving or as a landscaped rain garden or infiltration swale.

Roadside Area Redevelopment Opportunities

Opportunities to lower development impacts also are possible as new roads are developed, or redevelopment of roads is undertaken by frontage works triggered by private redevelopment or by MOTI road improvements.

Figure 8-6 shows a roadside within the Ministry of Transportation and Infrastructure (MOTI) jurisdiction. The example shown is fronting an Industrial site, but similar principles could apply to a housing location in Electoral Area or Cowichan Tribes. The sketch plan reflects MOTI Supplement to TAC Geometric Design Guide, Section 430 Cross Section Elements, with key existing requirements including:

1. Travel Lane – 3.6 m wide.
2. Paved Walk/Bikeway Shoulder – 1.5 m wide plus 0.5 m gravel.
3. Fill Slope – 4:1 desirable from the roadway to the ditch invert.
4. Ditch backslope – 3:1 from the invert to the property line.

On the adjacent redevelopment lot, the building elevation is shown to conceptually reflect a Flood Construction Level to reduce flood risk from a Cowichan River dike overtopping. The driveway could be pervious paving. In the front yard setback, a rain garden is proposed, including:

1. The Rain Garden base elevation could be intermediate between the raised building and the roadway ditch.
2. A low berm parallel with the property line would provide 100 mm of short term ponding in the rain garden.
3. An overflow catch basin with domed grate restricts ponding to 100 mm maximum and directs overflow to the roadside swale.
4. 500 mm of soil is continuous in both the private property rain garden and the roadside swale. Erosion protection until grass establishment may be required.
5. The surfacing in the road right of way would be mown grass. A similar surfacing of grass would survive the short -term ponding in the rain garden area. Tree and shrub planting would be desirable in the front yard rain garden for appearance and would be optional in interior lot rain gardens, where a mowed grass surface would be acceptable.

Polkey Road/Creek Area Redevelopment Opportunities

Figure 8-7 shows Polkey Road and adjacent roadsides. This section is in concept for the section of Polkey Road between Mearnes and Roberts. The concept is that a one-way alignment in this block

could be accessed from two-way roads on Roberts and Mearns. The sketch plan reflects MOTI Supplement to TAC Geometric Design Guide, Section 430 Cross Section Elements, with key existing requirements including:

1. Travel Lane – 3.6 m wide (one side only);
2. Centre paved median – 1.8 m wide with low C.R.B concrete barrier set back 1.0 m from the travel lane;
3. Paved Walk/Bikeway Shoulder – 1.5 m wide plus 0.5 m gravel;
4. Fill slope – 4:1 desirable from the roadway to the ditch invert; and
5. Ditch backslope – 3:1 from the invert to the property line.

The Polkey Road one-way road is set back as far as possible from Sh-hwuykwselu Creek. The section shows the opportunities this presents to reduce flood risk and to provide space for riparian enhancement and instream complexing of the creek. Of note are:

1. Polkey Road, as well as adjacent buildings, are shown elevated to a Flood Construction Level associated with the risk of a Cowichan River dike overtopping;
2. Within the MOTI right of way, the creek bank is a variable slope and is restored with native trees, shrubs, and ground covers; and
3. In the front yard of the fronting private lot, when redeveloped, the setback area required by the Riparian Area Regulation is also restored with native trees, shrubs, and groundcovers.

Cumulatively, these changes create an improved habitat and flood conveyance corridor along this important section of the lower creek watershed.

These opportunities to develop or redevelop with a lower impact are integrated into the options and recommendations that follow.

8.4 Wide Distribution of Infiltration/Retention Systems

Infiltration and retention to control runoff volumes and peak flows are needed throughout the watershed. It is generally preferred to have a wide distribution of infiltration systems introducing water into different areas and material types, rather than a few concentrated areas discharging into one material type. This will reduce the potential for water table mounding, and in some areas, the potential for slope instability. Infiltration systems should be designed to have sufficient storage to control the required volumes, but during larger storm events, after that capacity is reached, the infiltration system should be bypassed, and the excess volume discharged to the storm sewer system.

8.5 Cost and Maintenance of Stormwater Source Controls

Given the multijurisdictional nature of the stormwater management in the watershed, the responsibility for the implementation cost and maintenance costs of stormwater source controls depends on where the source controls are located.

Private Land

In the proposed approach, the costs and maintenance of most stormwater source controls are associated with private land and would be paid for by private land owners. CVRD may have to prepared guidance to private property owners for the guidance of ongoing maintenance of stormwater

source controls. For any case where stormwater source controls are not provided on private land, a mechanism should be developed to provide funds for downstream mitigation by the CVRD.

Cowichan Tribes Land

For CT lands, the construction of source controls could be funded through capital project funding by Indigenous Services Canada, previously Indigenous and Northern Affairs Canada. However, on-going maintenance will be the responsibility of CT. Therefore, CT will have to develop the capacity to operate and maintain these facilities.

Road Rights-of-Way

The exception to this is installations on roads and lanes which are the responsibility of MoTI. The current MoTI engineering design standards do not provide guidance on source controls within MoTI right-of-way. Therefore, CVRD may consider partnering with MoTI to use Busy Place Creek as a pilot to develop and test at-source stormwater controls within MoTI right of way. The on-going maintenance of these facilities may be funded either through a MoTI maintenance contract or through a CVRD local service area.

8.6 Groundwater Protection Measures

As described previously in Section 2.3, the eastern portion of the watershed is underlain by Aquifer 186 which has been defined as being vulnerable to contamination from activities on the surface and is also an important source of drinking water for the area. Runoff from paved surfaces can contain contaminants such as metals, oil/grease, sanding, and road salt. Therefore, runoff from areas exposed to vehicle traffic or areas where industrial/commercial chemicals are used needs treatment before discharging into the ground. At-source stormwater management facilities will have to carefully consider water quality treatment prior to infiltration in order to protect the groundwater quality.

Proposed at-source stormwater facilities should be designed to remove contaminants under normal conditions prior to infiltration into the ground. However, spills or other unforeseen conditions could overwhelm treatment systems. It is recommended that commercial/industrial activities have spill control measures to prevent contaminated runoff or accidental spills from entering the stormwater system and groundwater. In addition, commercial/industrial operations should limit the use and/or require appropriate storage and handling of toxic chemicals and other potential contaminants.

8.7 Meeting Effective Impervious Area Targets and Groundwater Quality Protection through Policy, Bylaws Guidelines and Incentives

To realize the low impact development opportunities and to meet targets for watershed health and effective impervious area, priority should be given to on-going public education and awareness and technical capacity building.

At the same time, there is a role for upgrades to bylaws, guidelines, policies, and incentives to expedite implementation as new development or redevelopment takes place.

Key changes are likely to include the following:

1. Review existing bylaws and policies to determine if there are barriers to implementation of low impact development and stormwater source controls (e.g., requirements that roof leaders or paved areas be connected directly to piped storm systems).

2. Update subdivision bylaws and engineering standards to include technical information that guides design, typical details, and specifications for stormwater source controls. Precedents exist in the Metro Vancouver Stormwater Source Control Design Guidelines, the City of Campbell River Engineering Standards, and the City of Victoria Rainwater Management Standards.
3. Promote capacity development in key approval staff in agencies. Also, encourage training through professional and contractor groups to increase understanding of these best practices. Demonstration projects integrated with training have many practical benefits.
4. Once public education and training are sufficiently advanced, gradually bring bylaw requirements into a force to trigger use of the best practices. This might be phased to address larger projects such as multi-family development first, with a gradual widening of adoption requirements as capacity and experience develop.
5. While the engineering standards is the main technical resource, there may be related changes to zoning bylaws (maximum coverage and impervious area requirements, landscape buffering requirements), building bylaws/codes (triggering frontage works including stormwater source controls), and OCP Development Permits (requiring use of the engineering standards and embedded stormwater source controls and riparian restoration).
6. Public works or parks policies may also be updated to use stormwater source controls and riparian restoration on public lands and projects.

A Policy and Planning Action Plan is proposed to provide an orderly transition from current practice to low impact best practice.

8.8 Public Education and Awareness

In addition to infrastructure, land use planning and policies, and ecological restoration activities, public education and awareness play an important role in the success of implementation of the Plan. Through public education and awareness, a sense of pride and ownership of the watershed can be instilled in those who live, work, and recreate in the watershed. This, in turn, will lead to consideration of the watershed as a value to be protected rather than a resource to be exploited. Public Education and awareness is a high priority item which can be implemented relatively easily with minimal resources. In addition, engaging public through education and awareness should ease potential public concerns regarding implementation of changes to stormwater bylaws and standards.

Some examples of public education and awareness activities can include:

1. Information and interpretation boards installed as part of infrastructure improvements or ecological restoration projects;
2. Integration of recreation opportunities as part of infrastructure planning such as parks or trails;
3. Water stewardship awards which recognize residents or business leaders in the watershed who make contributions to watershed protection;
4. Incorporation of watershed education into the curriculum at local schools; and
5. Supporting local stewardship groups to help promote and protect watershed health.

8.9 Mitigation of Development Impacts

The intent of stormwater management mitigation options is to limit the negative impact of development through the implementation of stormwater source control practices. The purpose of these stormwater

source controls is to capture and retain stormwater on-site to reduce peak runoff discharge and overall discharge volume from the site. The source controls mimic and replace natural hydrological processes which reduce runoff such as soil storage, infiltration, and evapotranspiration.

Some examples of on-site or single lot source control practices include promoting thick topsoil layers as part of landscaping, bioswales, rain gardens, and rainwater capture for irrigation. At a neighbourhood scale, other source control practices can be included in subdivision development such as detention ponds or tanks, infiltration galleries, and wetlands.

The impacts of unmitigated development were outlined in Section 2.4 previously. They showed that future land development in accordance with the OCP and Cowichan Land Use Framework without including stormwater management source controls would increase impervious area from about 35 per cent to about 42 per cent. According to the WHTS, this would reduce watershed health indicator from a fair condition to a fair/poor condition. Therefore, in order to mitigate impacts, it is recommended that source controls be implemented as part of future development.

Effective Impervious Area Targets – Maintain Watershed Health

One way of determining the required effectiveness of source controls is through a metric known as Effective Impervious Area (EIA). The EIA is the amount of impervious area that is directly contributing to runoff during rainfall events. An example of how to apply EIA would be to consider runoff from a roof and a paved driveway surface that is both directly connected to the storm drain system. Under this condition, the entire roof and driveway would be considered as part of EIA. If under another situation the roof drains were to be directed into a stormwater source control rather than directly to the storm drain, then only the driveway would be considered part of the EIA.

In order to maintain current watershed health, the overall watershed EIA should be maintained at or below 35 per cent. Recognizing the variation in costs for implementing on-site source controls for various land use types, source control targets based on existing land use impervious cover are proposed. These targets have been selected to be reasonable goals that achieve an overall watershed EIA target of 35 per cent. The targets are shown in Table 8-3.

Table 8-3: Effective Impervious Area Targets to Maintain Watershed Health

Land Use Type	Existing Impervious Area	EIA Target
Agricultural, Meadow and Open Spaces	10%	10%
Campground/Recreational	20%	20%
Forests, Natural Areas or Undeveloped	5%	5%
Commercial/Industrial	90%	90%
Industrial - Gravel Pits	10%	10%
Institutional, Schools	50%	50%
Residential - Low Density (Acreage)	10%	10%
Residential - Single Family	50%	35%
Residential - High Density (Medium Density, Multi-Dwelling)	70%	50%
Transportation	90%	90%
Comprehensive	50%	50%

These targets can be achieved through maintaining lower density development, limiting lot impervious coverage, and implementation of simple source control measures such as bioswales to collect runoff from parking lots and disconnected roof rain leaders diverted to lawn areas with thick topsoil.

Effective Impervious Area Targets – Improve Watershed Health

In order to improve watershed health such that the watershed moves toward a 'good' condition, with only minor impacts, the target for all land use types would be to limit the effective impervious area to less than 10 per cent. This would require aggressive implementation of source controls with efficient infiltration to divert the runoff from all impervious surfaces into infiltration or slow release storage.

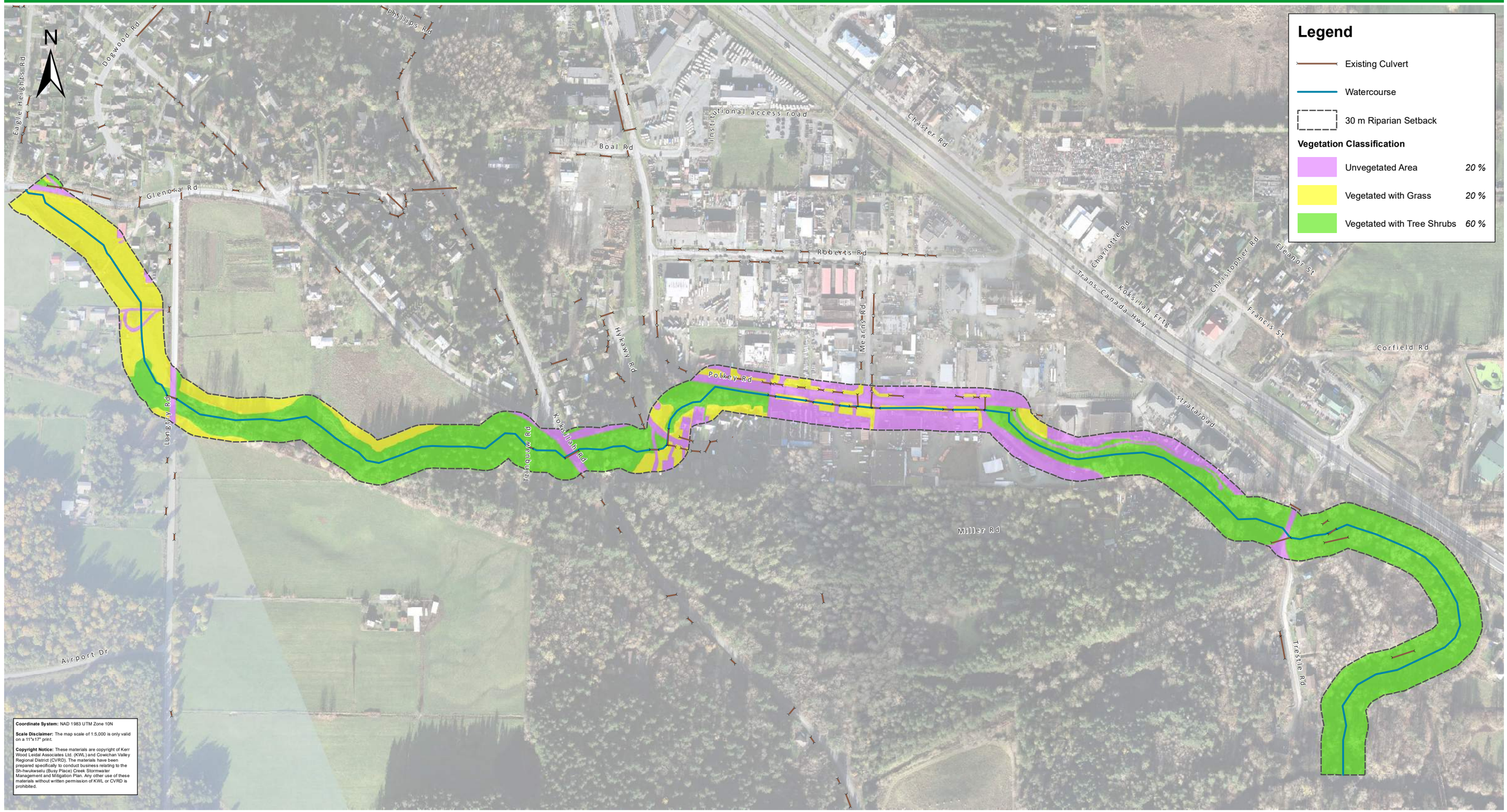
Figure 6-8 shows the effectiveness of the aggressive effective impervious area targets at improving watershed health is.

Path: Q:\2200-2299\2212-071\430-GIS\MXD-Rp\Report_Figure\2212071_Fig8-1_RiparianForestIntegrity.mxd Date Saved: 2019-02-22 2:46:55 PM | Author: GOConnell

Cowichan Valley Regional District

Sh-hwuykwselu (Busy Place) Creek Stormwater Management and Mitigation Plan

KERR WOOD LEIDAL consulting engineers



Coordinate System: NAD 1983 UTM Zone 10N

Scale Disclaimer: The map scale of 1:5,000 is only valid on a 11"x17" print.

Project No. 2212.071

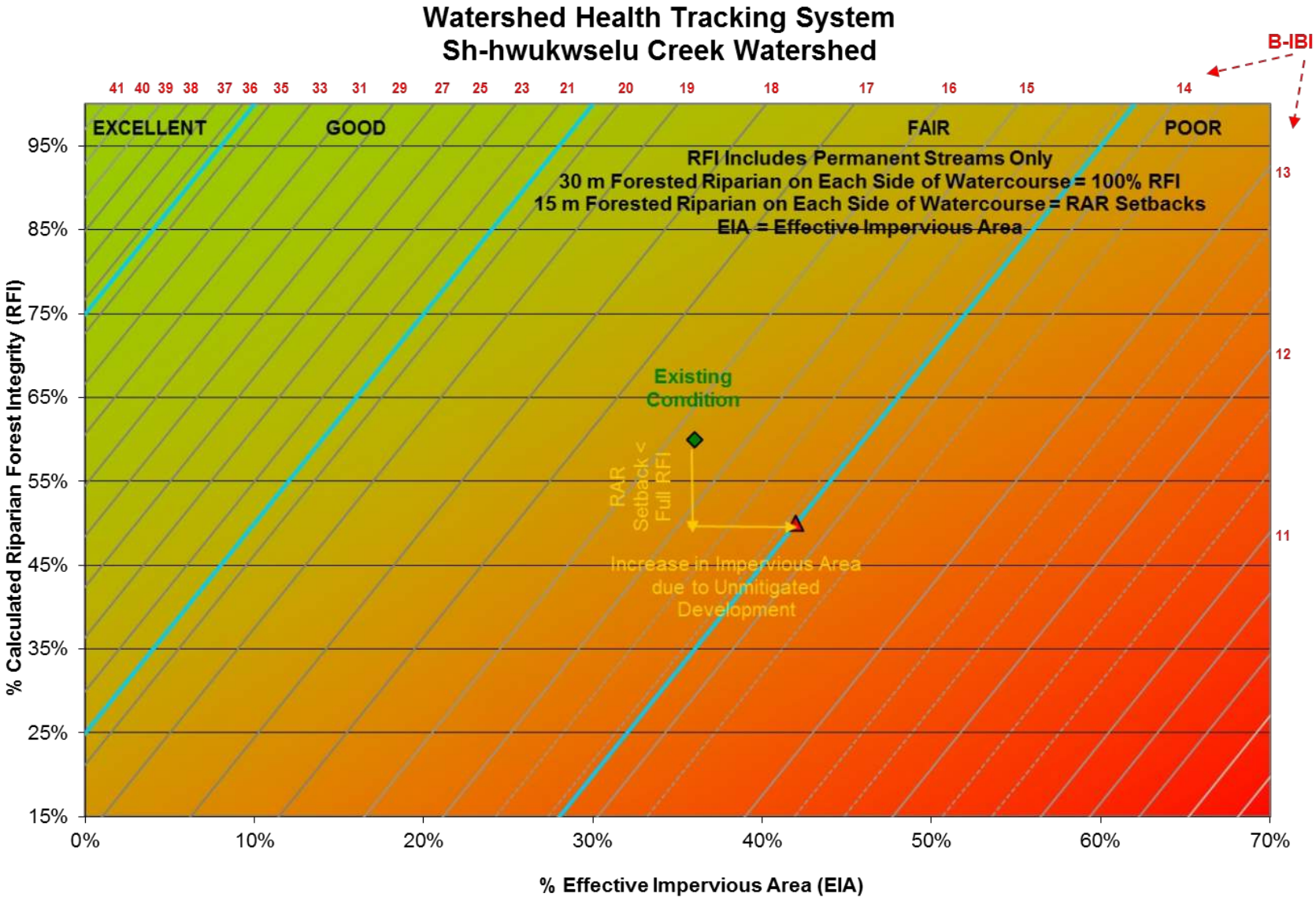
Date March 2019

Scale 1:5,000

50 25 0 50 m

Map of Riparian Forest Integrity

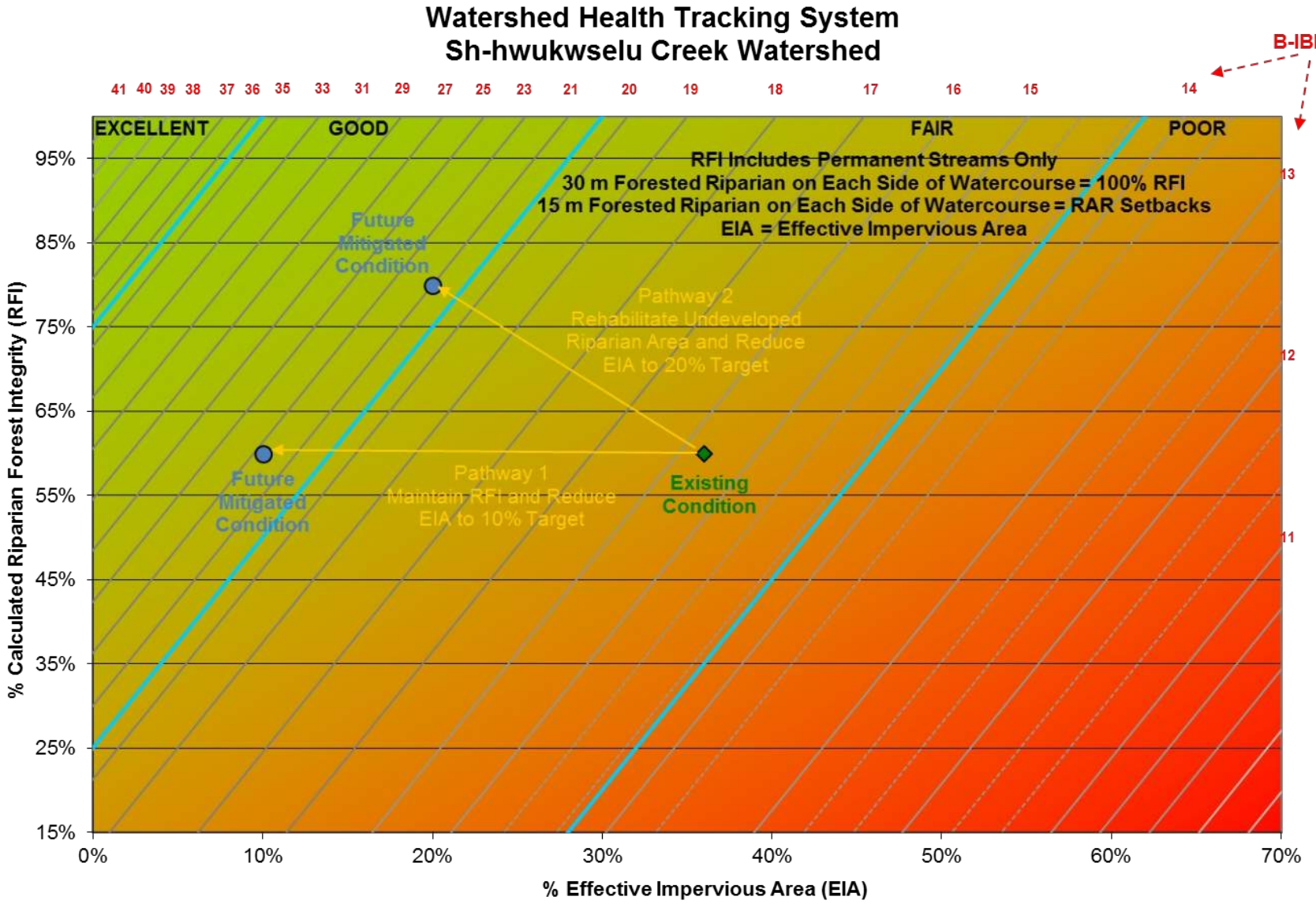
Figure 8-1



Project No.	2212.071
Date	March 2019
Scale	Not to Scale

Watershed Health Tracking for Existing Conditions and Future Unmitigated Condition

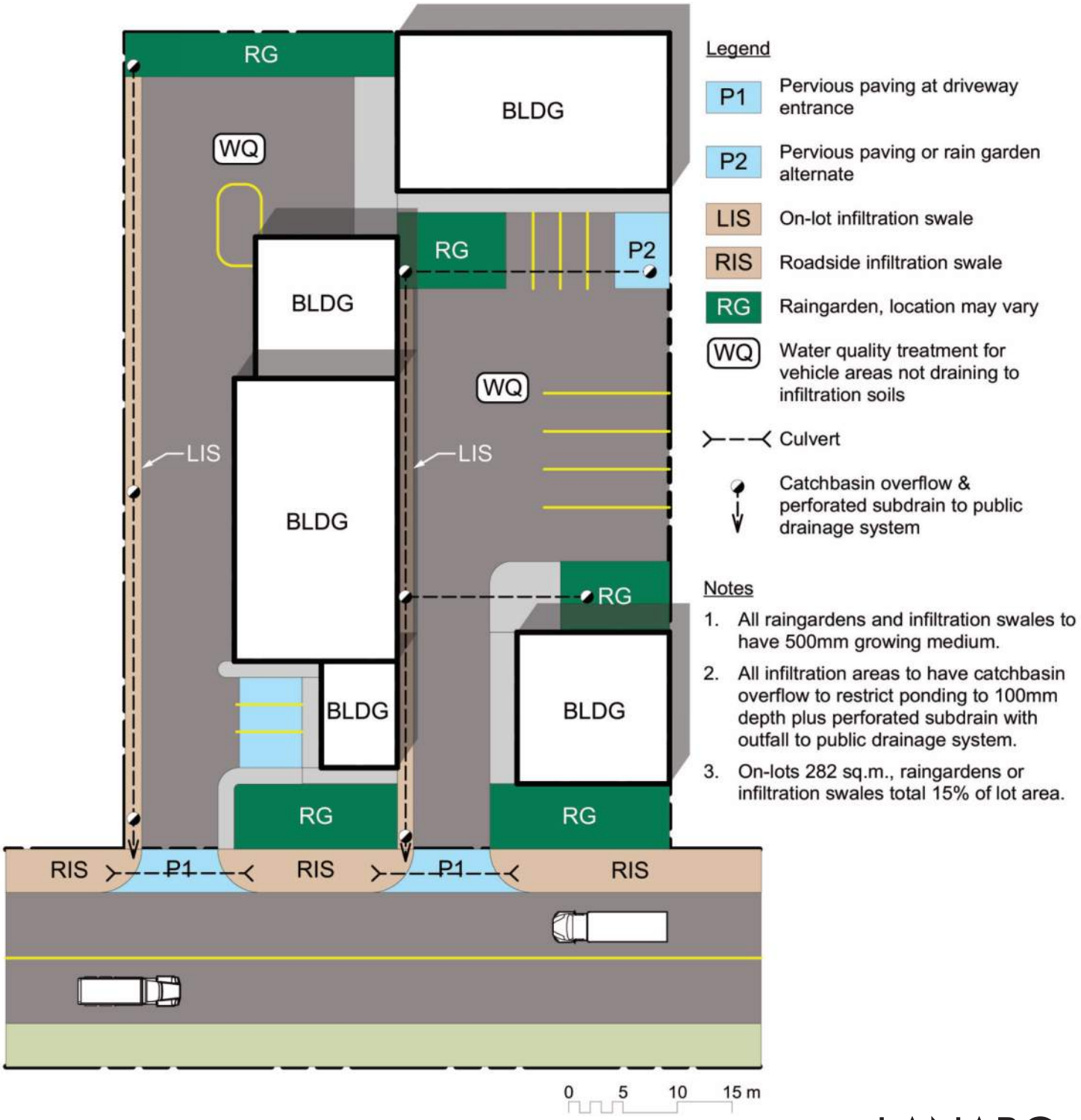
Figure 8-2



Project No.	2212.071
Date	March 2019
Scale	Not to Scale

Watershed Health Tracking for Existing Conditions and Pathways to Future Mitigated Condition

Figure 8-3



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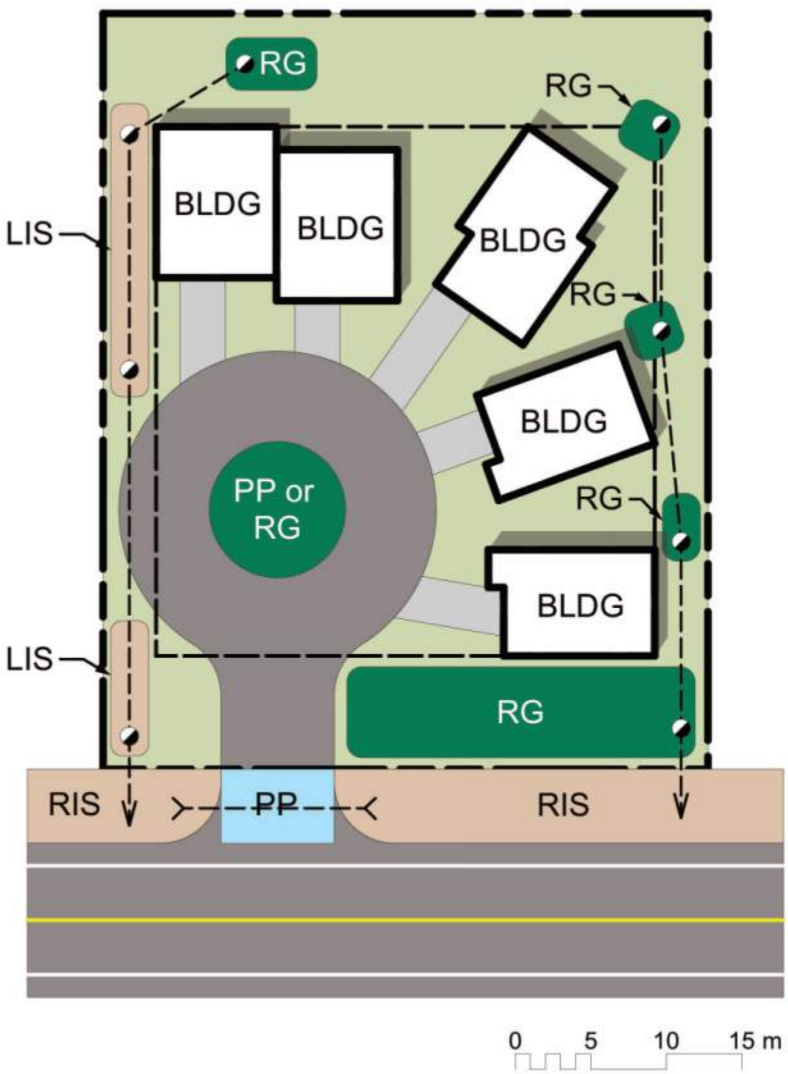
Project No.	2212.071
Date	March 2019
Scale	As Shown

Example of At-Source Stormwater Management for Industrial Areas

Figure 8-4



PLAN
TYPICAL RESIDENTIAL RM2

Legend

PP	Pervious paving or rain garden alternate
LIS	On-lot infiltration swale
RIS	Roadside infiltration swale
RG	Raingarden, location may vary
≻––≺	Culvert
	Catchbasin overflow & perforated subdrain to public drainage system

Existing RM2 Zoning

1. Coverage 50% max.
2. Impervious areas 55% max.
3. 2000 sq.m. min. parcel for multi-family.

Notes

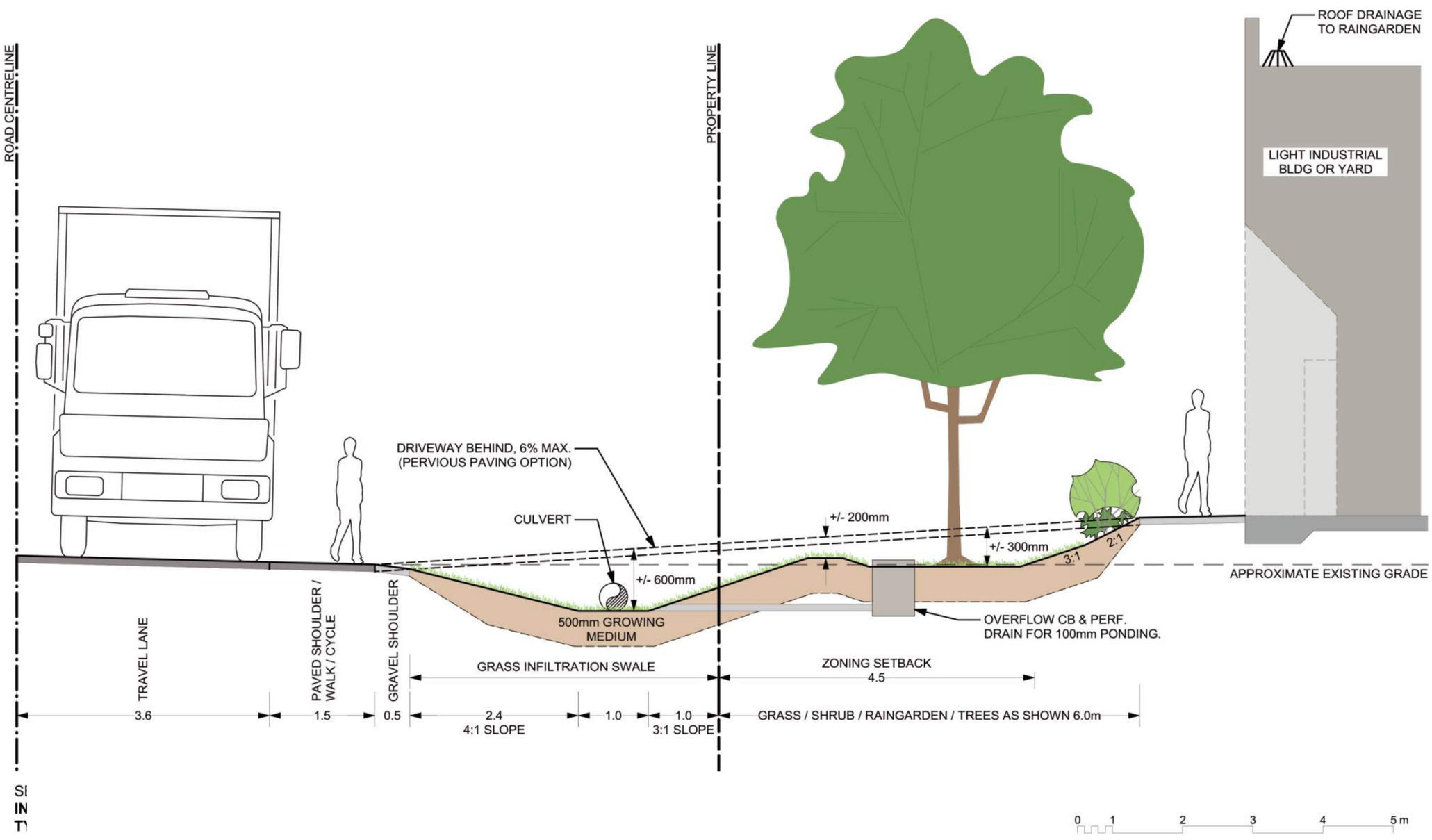
1. Road frontage driveway 40 sq.m. pervious paving or equal on-lot pervious paving or raingarden or on-lot infiltration swale.
2. All raingardens and infiltration swales to have 500mm growing medium over 300mm drain rock.
3. All infiltration areas to have catchbasin overflow to restrict ponding to 100mm depth plus perforated subdrain with outfall to public drainage system.
4. On-lots 300 sq.m., raingardens or infiltration swales total 15% of lot area. All raingardens and infiltration swales to have min. 500mm growing medium.

LANARC

Project No.	2212.071
Date	March 2019
Scale	As Shown

Example of At-Source Stormwater Management for Residential Area

Figure 8-5

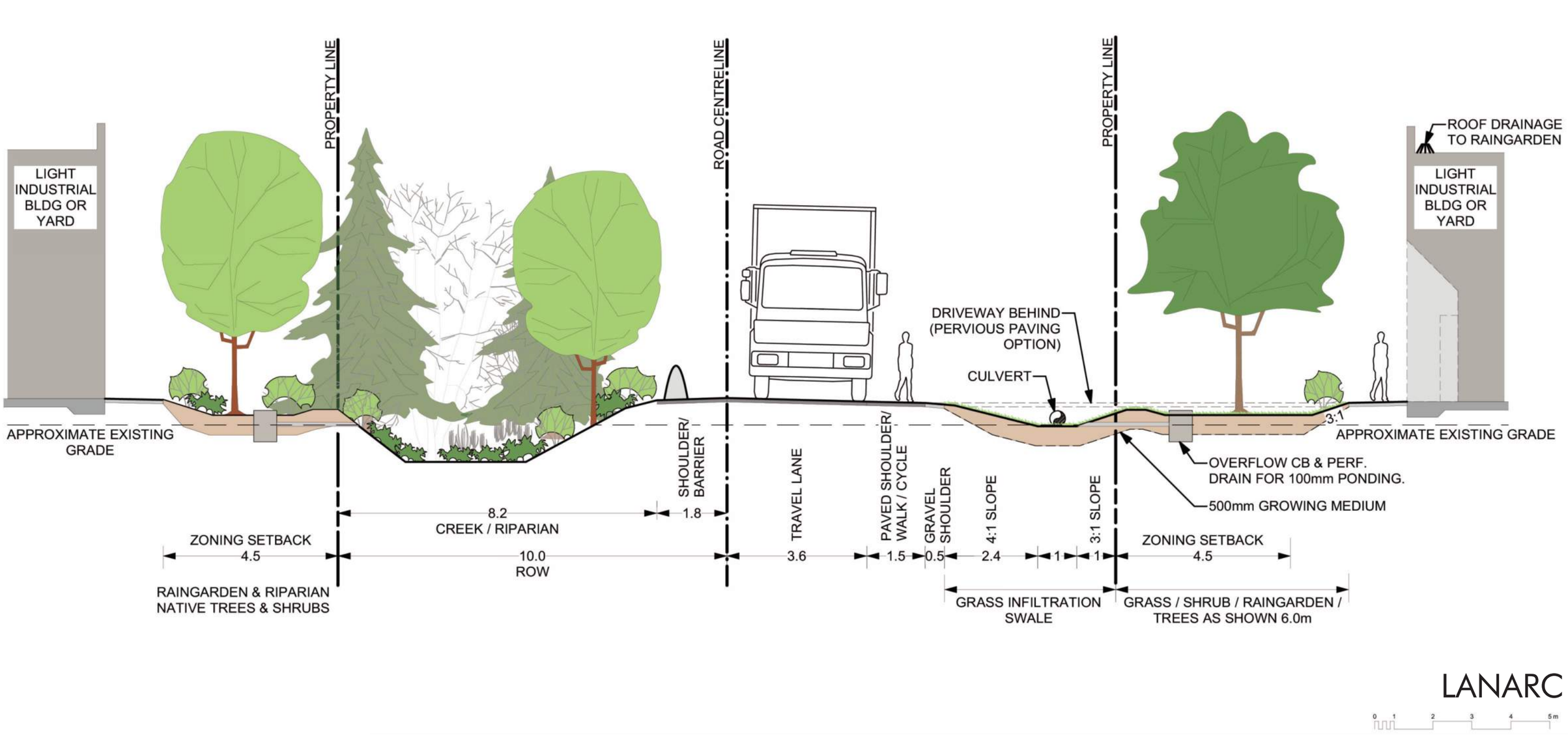


LANARC

Project No.	2212.071
Date	March 2019
Scale	As Shown

Example of Typical Roadside Stormwater Treatment

Figure 8-6



Project No.	2212.071
Date	March 2019
Scale	As Shown

Polkey Road Channel Improvements and Riparian Setback

Figure 8-7

9. Options Evaluation

9.1 Development of Options

The planning process identified several different objectives. However, the two main themes are:

1. Reducing flood risk; and
2. Managing watershed health.

Other values are involved in meeting these objectives – questions of the balance between public and private funding and responsibility for flood mitigation, and equitable relationships among the project partners, including the CVRD and Cowichan Tribes. It is worthwhile to consider Options that illustrate a range of approaches to flood mitigation, watershed health, and mixes of the two that allow a choice of priorities for public investment.

Sh-hwuykwselu (Busy Place) Ck channel downstream of Koksilah Rd

Three proposed suites of mitigation solutions have been developed for comparison.

1. Option A: Flood Management with Minimum Community Intervention, Minor Decline in Watershed Health;
2. Option B: Flood Management with Extensive Community Intervention, Major Gain in Watershed Health; and
3. Option C: Balanced Flood Management Intervention with No Net Loss in Watershed Health.

These options combine some of the potential stormwater management projects identified in Section 7 with potential stormwater land use and impervious targets for evaluation. Description of the three options is included in Table 9-1 with maps of the three options shown in Figure 9-1 to Figure 9-3.

The intent is to compare 'business as usual' options with others that are more creative.

The choice of an option or set of solutions will need to balance a range of values that are important to the partners. As initial priorities are implemented, additional public engagement, as well as senior government fundraising, may be warranted prior to finalizing the longer-term strategy.

9.2 Evaluation Methodology

The options have been evaluated using Multiple Accounts Evaluation (MAE) framework which was developed as a planning framework by the Province of BC in 1992. The MAE framework compares options through a selection of a set of evaluation criteria by which the options can be compared and selected based on the values of the decision makers. Unlike cost-benefit analysis which uses only monetary values to weight the costs and benefits of options, the MAE framework recognizes that not all the benefits and costs of options can be expressed in dollar terms.

Rather than solely using monetary values to compare each of the options, each option is compared by quantifying values of selected evaluation criteria. The performance measures selected for each evaluation criteria can be a qualitative comparison (i.e., better, the same, or worse), a ranking (i.e., 1, 2,

3, etc.), a measure against a target (i.e., meets or does not meet target), and where appropriate can be monetary cost or value.

The evaluation criteria used for the MAE are based on feedback from the TAG committee. The criteria selected for comparison of the options include the following major values categories:

1. **People** which provides a relative comparison of the number of people and homes protected from flooding as a result of the implementation of the Plan.
2. **Economy** which provides a relative comparison of the benefits of options to provide sustained employment opportunities and housing by not restricting development opportunities.
3. **Environment** which compares options based on the ability of the option to provide a sustained long-term improvement to environmental quality in the watershed.
4. **Social** which compares options based on the ability of options to provide fairness and equity of land use and cost sharing between partners.
5. **Infrastructure** which compares options based on function and sustainability of proposed infrastructure improvements.

In addition to the values categories, the options are also compared based on cost criteria including:

1. Initial capital costs;
2. On-going maintenance costs;
3. Joint operation and maintenance effort;
4. Cost/convenience to private sector/FN; and
5. Partnership potential.

A copy of the MAE tables comparing the stormwater management projects is outlined in Appendix G.

9.3 Options Evaluation Summary

The summary of the evaluation of the options is shown in Table 9-1.

Table 9-1: Outline of Potential Stormwater Management and Mitigation Options

	Option A: Flood Management with Minimum Community Intervention, Minor Decline in Watershed Health	Option B: Flood Management with Extensive Community Intervention, Major Gain in Watershed Health	Option C: Balanced Flood Management Intervention with No Net Loss in Watershed Health
Integrated Actions All Areas			
Require culvert upsizing if necessary, at **time** of redevelopment. Review pollutant source control bylaw to protect the **aquifer**. Refer to Environmental Canada standards. Provide public education on the **role** of riparian areas & impervious areas. Update engineering standards in CVRD & CT regulations to remove **barriers** to provide performance guidelines & standard details/specs of common source control best management practices like infiltration swales, rain gardens, pervious paving, roof rainwater infiltration, constructed wetlands/detention ponds. Incorporate flood & watershed health best management practices for new development into approving authority bylaws & requirements (e.g., subdivision bylaw, building bylaw, frontage works & services, development permits, equivalent FN land codes).			
Flood Management Objectives	Protect Trestle Village from building flooding. Reduce overtopping of Miller Road to 1:10 return period Accept risk of limited flooding in Industrial Areas	Protect all urban areas from surface flooding for the 1:10 return period & protect buildings for the 1:200-year return period (other than dike overtopping flooding from the Cowichan River)	Protect urban areas from overland flooding originating from Sh-hwuykwselu (Busy Place) Creek channels. Accept some localized site flooding from on-site rainfall.
Flood Management Actions			
Miller Road / TCH / Koksilah Area	Enlarge culvert under & raise Miller Road, but not for fish passage. Start a discussion with E&N concerning raised railroad or temporary flood barrier at Miller Road	Enlarge culvert under & raise Miller Road & design for fish passage. Start a discussion with E&N concerning raised railroad or temporary flood barrier at Miller Road. Increase flood flow under E&N & MOTI bridges, subject to downstream studies.	Enlarge culvert under & raise Miller Road, but not for fish passage. Start a discussion with E&N concerning raised railroad or temporary flood barrier at Miller Road.
Trestle Village Area	Replace culvert at existing dike with new low & high culvert pair. Include seepage collar & flood box. Ponding at village same level as today. New Housing to be at flood construction level above Koksilah influence. Store/divert upslope drainage away from Trestle Village.	Rebuild dike to meet current standards. Add pump station & improved storage pond to protect existing & future buildings. Replace culvert at existing dike for gravity drainage & stop backflow with new flood box & seepage collar. New Housing to be at flood construction level above Koksilah influence. Store/divert upslope drainage away from Trestle Village.	Improve maintenance of existing dike & pursue replacement in long term. Replace culvert at existing dike with new low & high culvert pair. Include seepage collar & food box. Ponding at village same level as today. New Housing to be at flood construction level above Koksilah influence. Store/divert upslope drainage away from Trestle Village.

	Option A: Flood Management with Minimum Community Intervention, Minor Decline in Watershed Health	Option B: Flood Management with Extensive Community Intervention, Major Gain in Watershed Health	Option C: Balanced Flood Management Intervention with No Net Loss in Watershed Health
Industrial Area	Policies as exist	Implement tank or pond detention storage to relieve flooding near Boys Road & Allenby Road, near the BC Transit facility, & at other concentrated new development. Require new buildings to be above a flood construction level driven by overtopping of dikes at the Cowichan River (separate study).	Implement tank or pond detention storage to relieve flooding near Boys Road & Allenby Road, near the BC Transit facility, & at other concentrated new development. Plan an integrated stormwater drainage/site infiltration & landscape improvement system at road frontages. Implement at redevelopment or by local improvement finance.
CVRD Residential Areas	Policies as exist	Implement tank detention storage (no infiltration) above Allenby bluffs. Implement surface detention wetlands at all other concentrated new development.	Implement tank detention storage (no infiltration) above Allenby bluffs. Implement surface detention wetlands at all other concentrated new development. Enlarge culverts at key road crossings (Koksilah, Tzinquaw, Hykawy).
Other FN Residential Areas	Policies as exist	Implement constructed wetland/detention storage above Koksilah Road & at all concentrated new development.	Implement surface detention wetlands at all concentrated new development.
Agriculture Areas	Policies as exist	Implement constructed wetland/detention storage at Keating Farm Upper Reaches Channel & Riparian Restoration	Policies as exist

9.4 Priority Drainage Improvement Options

As outlined in Table 9-2, one of the key objectives of the plan is to protect the public and private property from flooding during extreme rainfall events. The drainage assessment outlined in Section 6.2, indicates that some of the culverts along the watercourse are too small to safely pass the design flood event. Therefore, upgrades are required to reduce the risk of flooding.

Miller Road near Trestle Village

The first priority drainage improvement project identified is the replacement of the Miller Road near Trestle Village culvert and raising of Miller Road. This area was identified as been regularly flooded (at least once a year on average) through discussion with local stakeholders. Modelling also indicates that Miller Road overtops during the design flood event. Therefore, this is considered a top priority for upgrades.

Sh-hwuykwselu (Busy Place) Pond upstream of Miller Road Culverts

Undersized Culverts

The second priority for drainage upgrades is the undersized culverts identified as part of modelling outlined in Section 6.2. There are two potential solutions to reducing the likelihood that floodwater overtops the roads at the undersized culverts including:

1. Upgrading the size of the culverts (Project 2); or
2. Providing detention storage at Keating Farm pond sufficient to reduce peak flows such that flow at culverts does not overtop the roads (Project 1A).

As outlined in Section 0, the capital cost of upgrading the culverts ($1.5 million) is much greater than the capital cost for constructing detention storage at Keating Farm ($525,000). However, there are several potential barriers to construction of detention storage at Keating Farm including:

1. The project is located on private land which will require negotiation and agreement to gain access for construction and on-going maintenance;
2. Environmental approvals for construction of in-line pond on mainstem of creek channel could be challenging;
3. On-going maintenance and reporting requirements under the Dam Safety regulation; and
4. Additional liability of ownership of a dam.

Given the significant cost difference, further review of these two potential approaches is warranted through discussion with landowner, regulatory agencies, etc. However, for the purposes of development of the Plan, the option of upgrading the culverts has been carried forward for further development of the implementation plan.

Overland Flow Ponding

The final priority identified for drainage upgrades are the areas of ponding identified within the Koksilah Business Park area. As discussed in Section, modelling results indicate that these areas are likely the result of water pooling in shallow depressions within private properties and not the result of water backing up into properties as the result of undersized drainage. In short term, these ponding areas can be addressed by improving private lot drainage through site grading or improved private drainage systems. In the long term, these ponding areas can be eliminated through the raising of land within properties up to the minimum building elevations defined by the Cowichan River overland flow flood construction level.

9.5 Preferred Options

The options evaluation outlined above indicates that compared to other options developed, Option B would provide the most benefit in the reduction of flood risks, watershed health and social benefits. However, this option has the highest estimated 24-year life-cycle cost at nearly $14 million.

Option C provides a similar benefit of reduction in flood risk as Option B and protects existing watershed health through no-net-loss. The total 25-year life cycle cost for Option C is less than 25 per cent of the total 25-year life-cycle cost of Option B.

Given the benefits and costs of the options, as well as the priorities identified by the stakeholders, Option C should be considered as a minimum for future implementation. However, given the focus on improvement in watershed health with Option B, this should be the ultimate desirable outcome as funding becomes available to support watershed health gains.

In summary, the recommendation is to proceed with the projects and programs in Option B on a priority basis, with the aspiration to implement Option C in the long term and as funding or opportunities allow.

Table 9-2: Evaluation of Stormwater Management Options
Sh-hwuykwselu (Busy Place) Creek Stormwater Management and Mitigation Plan

	Baseline – No Adaptation	Option A Minimum Intervention / Minor Watershed Health Decline	Option B Extensive Intervention / Major Watershed Health Gain	Option C Balanced Intervention / No Net Loss Watershed Health
Values Criteria				
People Highest # protected	MODERATELY WORSE	SLIGHTLY BETTER	FAR BETTER	MODERATELY BETTER
Economy Sustained job and housing opportunities	MODERATELY WORSE	SLIGHTLY BETTER	FAR BETTER	MODERATELY BETTER
Environment Sustained/improved long term	MODERATELY WORSE	SLIGHTLY WORSE	FAR BETTER	NO CHANGE
Social Fairness/cost equity for land uses/partners	NO CHANGE	SLIGHTLY WORSE	FAR BETTER	MODERATELY BETTER
Infrastructure Road / emergency / utility function	MODERATELY WORSE	SLIGHTLY WORSE	FAR BETTER	MODERATELY BETTER
Impact and Risk of Failure				
Overall Risk	VERY HIGH	HIGH	LOW	MODERATE
Cost Criteria				
Joint Project Budget Initial		$3.9 million	$21.1 million	$4.4 million
Includes drainage improvement projects		2, 5, 6 and 9	1a, 3, 4, 5, 6, 7, 8 and 10	1b, 2, 5, 6, and 9
Joint Operation and Maintenance Effort		SLIGHTLY HIGHER	HIGHER	SLIGHTLY HIGHER
Cost/Inconvenience to Private Sector / FN Members		MODERATELY LOW	MODERATELY HIGH	MODERATE
Partnership Potential (co-fund)		LOW	MODERATE	HIGH
Future Long-term Climate Adaptation Cost		HIGH	LOW	MODERATE

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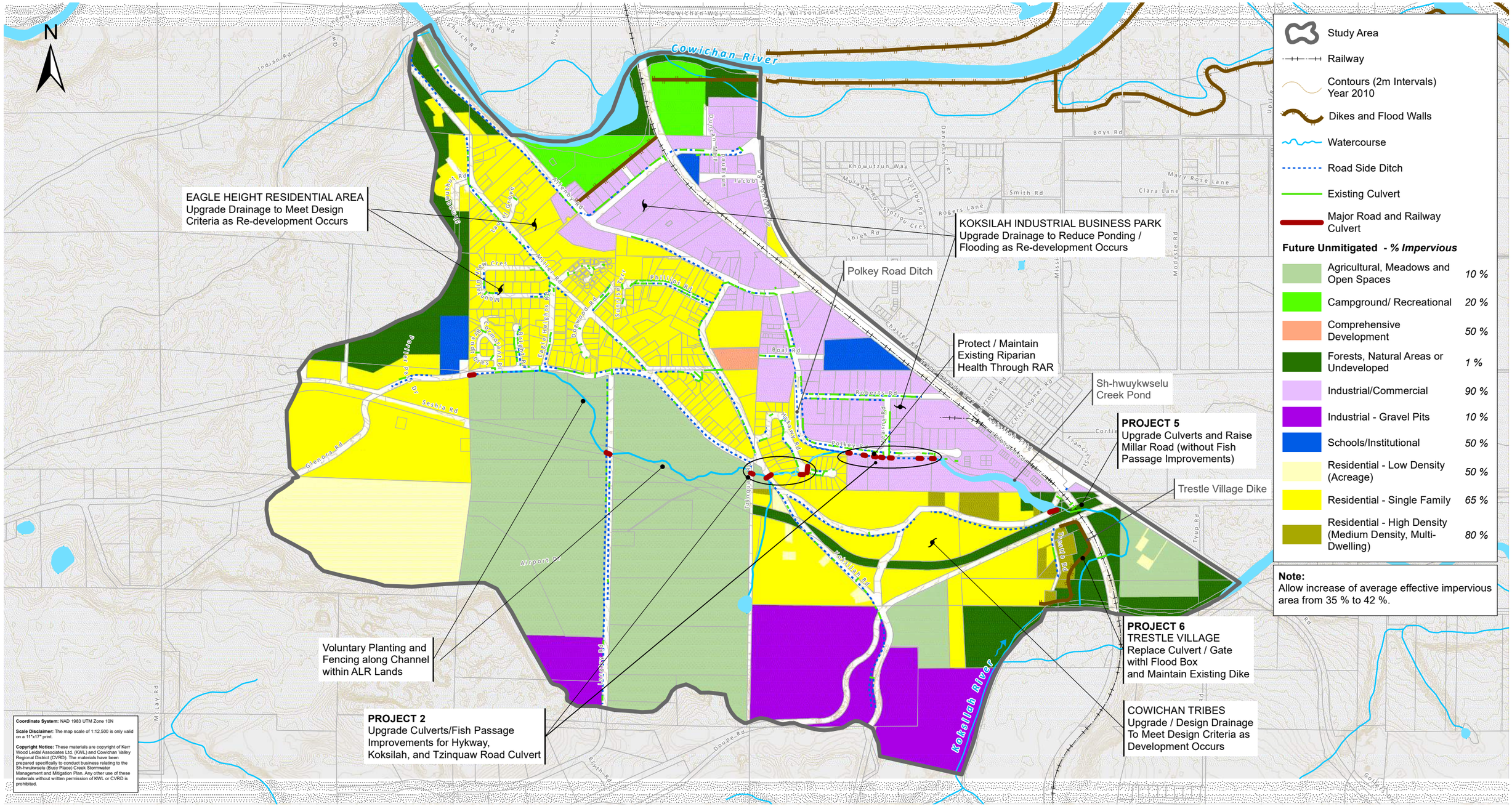
Cowichan Valley Regional District

Sh-hwuykwselu (Busy Place) Creek Stormwater Management and Mitigation Plan

KERR WOOD LEIDAL consulting engineers



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Date March 2019

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Stormwater Management and Mitigation Option A

Figure 9-1

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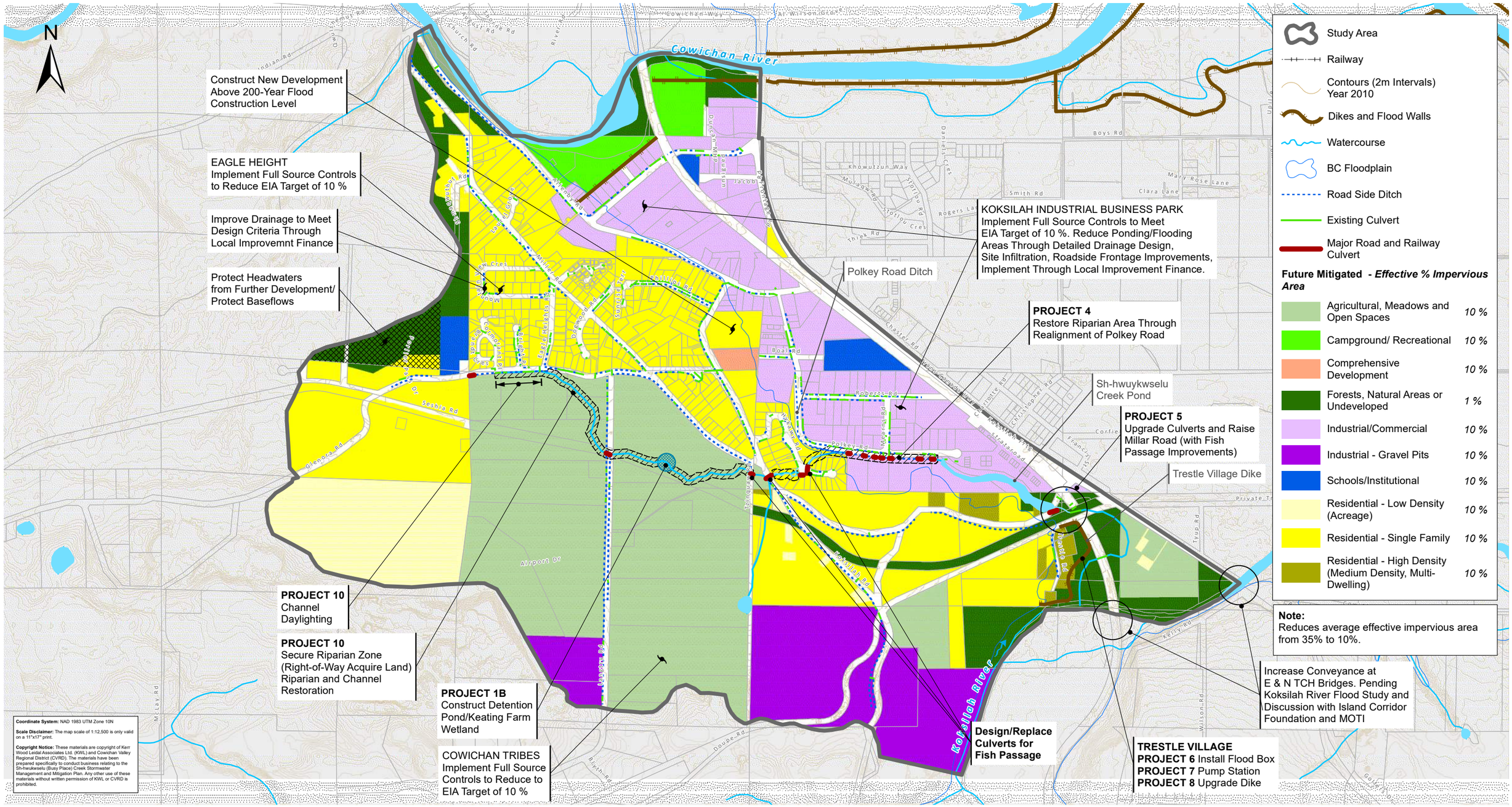
Cowichan Valley Regional District

Sh-hwuykwselu (Busy Place) Creek Stormwater Management and Mitigation Plan

KERR WOOD LEIDAL consulting engineers



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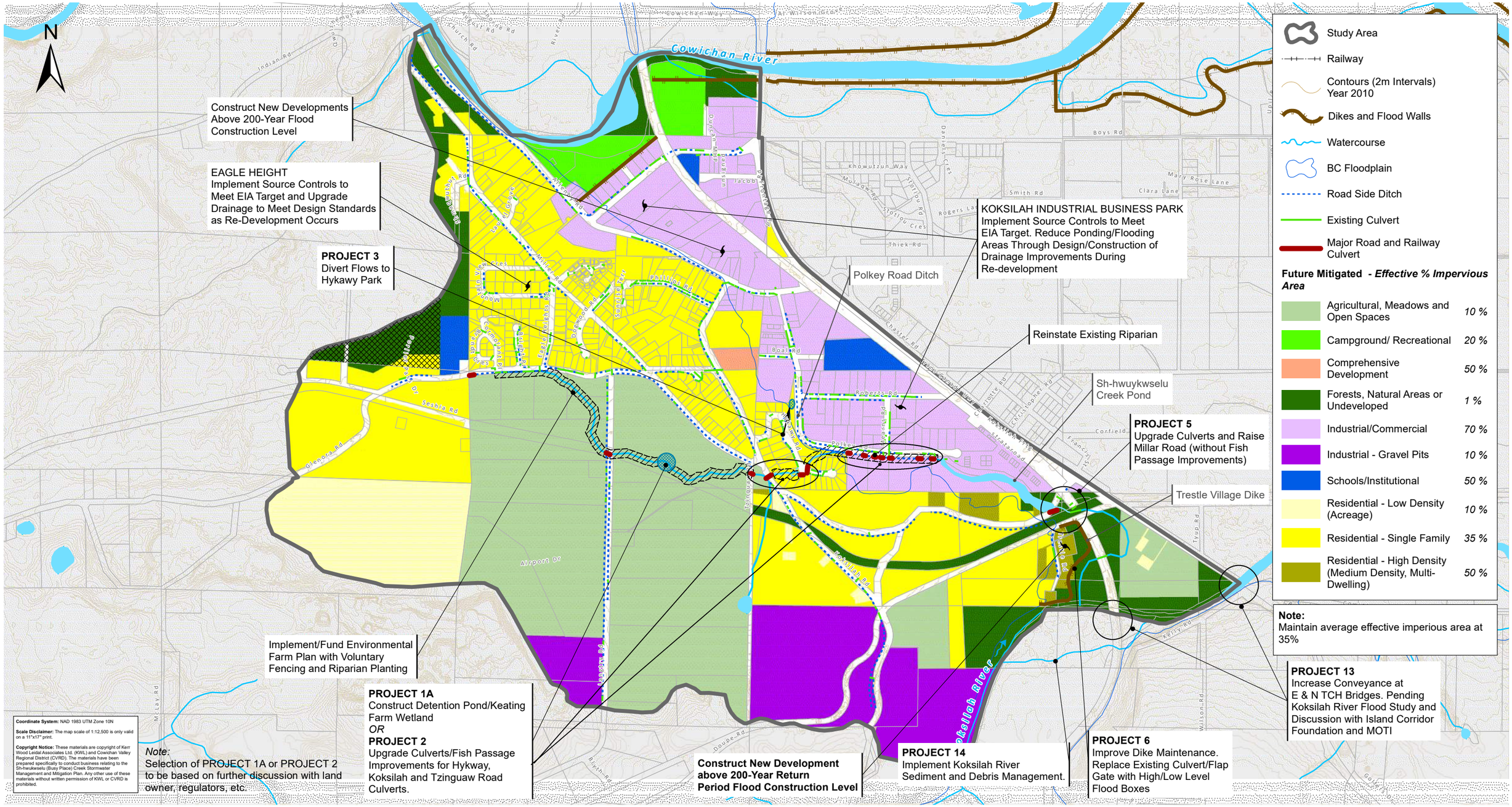
Stormwater Management and Mitigation Option B

Figure 9-2

Cowichan Valley Regional District

Sh-hwuykwselu (Busy Place) Creek Stormwater Management and Mitigation Plan

KERR WOOD LEIDAL consulting engineers



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Stormwater Management and Mitigation Option C

Figure 9-3

10. Stormwater Management and Mitigation Plan

10.1 Stormwater Management and Mitigation Plan Summary

Section 7 and Section 8 above outlined potential approaches for drainage improvements, environmental enhancement and policy and guidelines to help mitigate impacts resulting from future climate change and proposed future land development. These approaches have been combined into packages and presented as three potential options in Section 9, with the outcome being to implement actions which reduce flood protection and at a minimum maintain watershed health. Where opportunities arise, then actions to enhance watershed health should be taken.

A summary of the Plan, including actions to be taken to achieve these objectives, is provided in Table 10-1. The following sections outline the steps required to implement the Plan. Proposed phasing of the plan is outlined in Sections 10.5 and Section 10.6 below and shown in Figure 10-2.

10.2 Everyone Plays a Role – Public and Private Sectors

Meeting the objectives and targets to protect the watershed health and flood management requires cooperation from all land uses and land managers in the watershed area. Gradual redevelopment of the Industrial Park area provides opportunities for improvement. Even single family and low-density land use, and local streets, need to play a role, as they represent a large proportion of the land area in the watershed.

The role of private lands during land development or redevelopment are illustrated in Section 6 and Appendix F At-Source Stormwater Management Controls.

Infrastructure improvements to reduce flood risk and to improve watershed health will also be necessary on public lands – whether in streets (Ministry of Transportation and Infrastructure) or Regional Parks (CVRD) or Cowichan Tribes common lands.

These infrastructure improvement projects are described and compared in Section 7 with a detailed comparison of infrastructure improvement projects using MAE in Appendix G.

10.3 Introduction to Implementation Action Plans

Implementation of the entire Plan may seem daunting if it is assumed all aspects would be accomplished at once. To move forward, it is necessary to break down implementation into a series of manageable steps. An orderly and coordinated set of actions is required.

Proposed actions are divided into four themes:

1. Filling of information gaps identified during the development of the Plan through additional studies;
2. Drainage Infrastructure Projects that improve stormwater and flood control facilities to reduce flood risk across the watershed;
3. Environmental enhancement projects that improve watershed health, some of which are combined with drainage improvement options; and
4. Policy and Program Actions including public awareness (explaining the why and how of watershed health and flood management improvement), demonstration projects and technical capacity building, updates to engineering standards and land use / development permit regulations that

guide private development, and a phased introduction of requirements for green infrastructure in development or redevelopment projects in the private/FN housing sectors.

10.4 Information Gaps and Recommended Additional Studies

As part of the implementation of the Pan, additional studies will be required to fill the information gaps to achieve goals identified during the development of the Plan. A summary of the goals, the information gaps and recommended additional studies are shown in Table 10-1.

10.6 Recommended Flood Management Actions

Table 10-1 provides prioritized lists of actions that should be taken to implement drainage improvement projects to reduce flood risk in the Sh-hwuykselu (Busy Place) Creek watershed. The project locations are shown in Figure 10-1. The table includes the action, the objectives of the action, identify landowner or land manager, the estimated costs of the actions and the approximate timing of the action.

Further planning and design will be required prior to construction such as:

1. Negotiation with landowner/manager for access rights to construct and maintain the stormwater management facility;
2. Additional studies or investigations required for project planning and design including environmental assessments, geotechnical investigations, archeological investigations, etc.;
3. Preparation of environmental and other permitting applications for approval by agencies;
4. Preparation of preliminary design of stormwater infrastructure for review by landowners, stakeholders and approval agencies;
5. Preparation of detailed design of stormwater infrastructure for cost estimating, tendering, and construction; and
6. Procurements and Tendering.

Given the need for these additional planning steps, sufficient lead time will be required between initiating implementation of the action and construction of the infrastructure.

The priority of the implementation of stormwater infrastructure improvement actions has been grouped into three phases as follows.

Phase A: Immediate and Ongoing

The first phase of implementation of drainage infrastructure actions involves the implementation of additional studies to fill information gaps in order to better understand the implications of implementation of the actions. Table 10-1 provides a list of the additional recommended studies.

Phase B: Protect

The second phase of implementation of stormwater infrastructure actions provides flood risk reduction for public and properties with least effort and cost. The stormwater infrastructure improvement projects identified are:

1. Replacement of the Miller Road culverts near Trestle Village (Project 5) which will improve flow conveyance, lower flood levels upstream of Miller Road and reduce the potential for overtopping of Miller Road during floods;
2. Replacement of the flood box at Trestle Village dike to improve drainage from the Trestle Village area;
3. Construction of diversion channel upslope from Trestle Village to divert overland flow away from the low-lying area in Trestle village and reduce the volume of water flowing into the Trestle Village area.
4. Implement the recommended actions in the Koksilah River Debris and Sediment Management Plan developed as part of Phase A.

The locations of the Phase B projects are shown in Figure 10-2.

Phase C: Improve

The third phase of implementation of stormwater infrastructure actions is intended to further reduce flood risk to properties and public while also improving stream habitat. These projects are higher costs and have additional implementation barriers than Phase B actions. These actions include:

1. Replacement of remaining undersized culverts at major road crossings (Project 2) OR construction of flood control pond at Keating Farm (Project 1A); and
2. Construction of Trestle Village drainage pump station.

The locations of the Phase C projects are shown in Figure 10-3.

Phase D: Enhance

The final phase of implementation of drainage improvement actions is intended to lower flood levels along the Koksilah River near the confluence of Koksilah River and Sh-hwuykwselu (Busy Place) Creek. However, this will require further study as outlined below:

1. E&N Railway and Bridge Flow Conveyance Upgrades depending on the outcome of the Koksilah IFMP identified as one of the additional studies.

The locations of the Phase D projects are shown in Figure 10-4.

10.7 Recommended Environmental Enhancement

Maintaining and improving watershed and stream health is an important goal of the stormwater management and mitigation plan. Some of the drainage actions outlined above include environmental enhancement features such as:

1. Fish passage improvements for culvert upgrades;
2. Construction of habitat features as part of the Koksilah River sediment and debris management plan;
3. Construction of habitat features as part of Trestle Village dike or pump station upgrades; and
4. Construction of habitat features as part of the E&N and/or Highway 1 Flow Conveyance Upgrades.

Other actions identified for the are more focused on environmental enhancement and these actions include construction of:

1. Keating Farm wetland (Project 1B);

2. Hykway Park diversion channel (Project 3);
3. Polkey Road Realignment and Raising (Project 4); and
4. Headwaters Channel Daylighting and Riparian Protection (Project 10)

The phasing of the environmental enhancement projects is shown in Figure 10-2 to Figure 10-4.

10.8 Recommended Low Impact Development Actions

The Low Impact Development Actions in Table 10-1 suggests that a four-phase effort may be necessary to 'start-up and phase-in' the implementation of proposed changes.

The proposed targets will bring new players, new roles, and a need for new understanding and training as a precedent to on-the-ground action. There are likely to be both education and awareness steps, as well as refined or new regulations and financing mechanisms that need to be put in place.

Phase A: Immediate and On Going

1. Complete detail design of programs, and related financial planning. Confirm support from Cowichan Tribes Council and from CVRD Board. Create and staff a new Stormwater Management Implementation Team.
2. Work with MoTI to supplement existing street, culvert, catch basin cleaning, and water quality programs.
3. Add detailed stormwater management plans and low impact development as a requirement for select types of rezoning and development permits.
4. Increase the implementation of Low Impact Development demonstration and learning in current projects.

Phase B: Remove Barriers, Build Capacity

1. Create Low Impact Development (LID) capacity-building materials like video and web materials that explain, in plain English, the why what and how of stormwater management.
2. Develop awards incentive program which recognizes developments or companies which integrate stormwater management best practices into their organizations.
3. Identify priorities for LID demonstration projects and start off-street implementation. One potential opportunity identified during the development of the Plan is to investigate potential to partner with Vancouver Island University (VIU) for low impact development demonstration project at VIU trades school campus.
4. Update Engineering Standards to include typical details and design guidelines that ease implementation of stormwater and low impact best practices. Although MOTI), CVRD and CT may have separate implementing regulations and administration of LID engineering standards, there are efficiencies in developing the core elements of engineering standards in a joint effort.
5. Plan for Watershed Health Monitoring Program. Again, this should be a joint effort to plan the monitoring program, while monitoring of individual elements may be by each agency.

Phase C: Expand Low Impact Development (LID) into New Non-SF Projects

1. Review options for financial incentive programs.
2. Require LID application in new non-single-family projects on private land.
3. Upscale the amount of LID installations in local streets, parks, common lands, and Government/CT projects like public housing or office complexes.
4. Continue with public awareness programs and demonstration/capacity building.

Phase D: Expand Low Impact Development to New One/Two Family Housing and Retrofits

1. Expand public information and homeowner/small contractor training to facilitate implementation.
2. Provide SF-specific demonstration and public awareness programs.
3. Expand LID application to new One/Two Family Housing and Lane Housing, with the familiarity and standards gained in the above three phases now used to expand application to Low Impact best practices into new construction in low-density residential redevelopment.
4. Expand the application to retrofits, in recognition that implementing water quality improvements will need to address problems in existing surface parking and building sites.
5. Incentive programs, financed by fees on the untreated impervious area, are to be considered to speed adoption for retrofits.

Beyond Phase D, the programs would be fully active. Continuous improvement to the watershed stormwater management is envisioned as a permanent objective, in recognition that full implementation will be achieved only over a building/street asset life cycle, which is in the range of 50 to 100 years (average 75 years).

10.9 LID Policy and Program Action Details

The sections below provide additional concepts and details on key Actions to implement Low Impact Development throughout the watershed – on both CVRD and Cowichan Tribes land areas.

Culvert/Drain/Catch Basin Cleaning Action / Awareness and Water Quality Action/Awareness

A fundamental issue in pollution abatement is on-going management of the ammount of nutrients and bacteria that flow from the stormwater system to receiving waters - as well as sediment, oil and heavy metals that can flow with runoff from surface parking areas.

To minimize these risks, programs for culvert/drain/catch-basin/sump cleaning and other water quality measures like checking for cross connections from sanitary sewers to the storm drainage system should be implemented. This will require support from CVRD, MoTI, CT, private landowners and businesses.

Street Cleaning

The ongoing program of street sweeping, and shoulder/sidewalk maintenance should continue and be enhanced, to remove sediments and litter from public spaces. A renewed focus should be placed on fall

leaf and water quality cleanup, including citizen programs to encourage timely removal of leaf litter from roadsides, and avoiding the placement of tree or lawn leaf litter on street surfaces or swales/ditches where it blocks catch basins and adds excess nutrients to runoff.

Culvert/Catch Basin Cleaning

Catch basin sumps on streets and parking areas function to remove coarse sediment from runoff before water enters the storm drain pipe or ditch. However, when leaves or organic debris and soil accumulate in the catch basins, bacteria can grow and can contribute to bacterial pollution downstream.

Agencies and the private sector should continue and increase maintenance and regular catch basin cleaning by a vacuum truck. It should also continue to remove sediment and oils from 'structural' best practices, like oil/water separators or detention tanks, or culverts, and require this maintenance on the private property.

Oil and Grit Separators

Oil and grit separators or similar water quality structures should continue to be incorporated in new developments with paved parking areas that do not drain to approved infiltration facilities. This will be mandatory in areas where contaminants could infiltrate into vulnerable aquifers in the watershed.

Sewer Cross-Connection Elimination Program

There a potentially cases on private property where sanitary sewage is running undetected into storm drainage systems, and from there to Sh-hwuykwselu (Busy Place) Creek.

This is against regulations and health best practice. The agencies should cooperate with private landowners on an on-going investigation and elimination of cross-connections between the storm and sanitary systems within buildings or on private land.

Major Developments Stormwater Management and Low Impact Development

Major rezoning applications should be required to meet detention and water quality criteria established by the approving agencies. This policy should be reviewed and updated to ensure that it meets the requirements of the Plan.

The partner agencies may have upcoming projects that provide opportunities to showcase the design and implementation of stormwater management/low impact development on the ground.

Stormwater Management and Lid Public Awareness Program (Phased)

The Stormwater Management and Low Impact Development (LID) Public Awareness Program would recognize that urban design and green infrastructure implementation, in the watershed, has a direct relationship to the health of the ecosystem of its receiving waters, and on the health of the watershed itself.

The quality of water that is delivered, and to a certain extent its quantity, influence the ability of the watershed and receiving waters to support life and ecosystems – benthic invertebrates (bugs) and insects that are food for aquatic species; support for the life ecosystems of salmon, trout, other fishes, heron, eagles, other birds, and mammals that prey on the bounty of the streams and ponds.

The purpose of the Stormwater Management and Low Impact Development (LID) Public Awareness Program is to:

1. Raise awareness among the public, business, agencies, and staff of the relationship of stormwater and watersheds to local ecosystems and life;
2. Provide a vehicle for interested stakeholders within each watershed basin to focus their efforts;
3. Support communication and training among watershed stakeholders and sharing of green infrastructure and other best practices;
4. Undertake communications and outreach, including multi-media and live training and awareness programs. The focus of these communications would be to help the public, landowners, and stakeholders understand the relationship of their actions to watershed and salmon/ watershed health;
5. Provide a constituency in support of applications for outside funding for watershed improvements;
6. Allow a role for 'citizen-science' in combination with agency-funded science and testing, and a focus for monitoring and adaptive management of the watershed;
7. Build a bridge between and support for both the Plan and the stakeholders other environmental programs; and
8. Share resources among departments and with other local governments and CT to implement adaptive management improvements to improve watershed health.

The agencies may phase in this 'Watersheds' Program gradually and expand its depth and breadth in each phase of implementation.

An early priority in selected areas should be to create one or more visible 'water focal points' in each jurisdiction or special area – places where the quality and quantity of water, and the life it supports, can be seen (and monitored/improved). Existing and potential locations for water focal points will be determined on a balance of public land and resources available, potential private sector contributions, community/stakeholder interest, and the potential for the projects to increase community awareness and support.

As well as the environmental benefits, the Watersheds Program is also another means to the community and social development in public, school and neighbourhood groups.

Demonstration Projects and Capacity–Building

Implementation of the Stormwater Management Plan (SWMP) will require technical knowledge and confidence around design, construction and maintenance of new best practices and technologies. The Capacity-Building Program for Stormwater Management would support:

1. Pilot and demonstration projects – these projects provide excellent opportunities to make training and results 'hands-on'. Pilot projects build comfort and confidence among staff and contractors and the skills to implement properly.
2. Capacity-building should include a review of implementation and enforcement of existing standards and regulations (e.g., construction site erosion and sediment control).

Updated Engineering and Building Standards

The agencies should bring regulations and procedures into alignment with the SWMP recommendations. Some older regulations may require exclusive use of 'grey' infrastructure and require an update. The agencies should add green infrastructure 'engineering standards' for a typical

design, sizing and specifications that are well vetted and accepted. Results of pilot projects should inform these new standards.

Updated Maintenance Standards and Roles

1. All infrastructure – whether green or grey – requires on-going maintenance. Some parts of the street (notably landscape boulevards and swales) have been maintained by adjacent landowners;
2. As green infrastructure is contemplated in streets, common areas and parks, the agencies should review their maintenance standards and roles, including the role of adjacent properties and the private sector at larger developments. New standards for maintenance and roles should be developed, and funding allocated for the agency portion of maintenance responsibilities; and
3. A review of the potential 'social development' opportunities for green infrastructure maintenance should be a part of the review.

Updated Development Approval and Inspection Processes

Like all infrastructure, green infrastructure should function well if properly designed, installed, and maintained, and may fail if poorly implemented. The agency approval and inspection processes should encourage proper design and installation of green infrastructure. Implementing requires careful allocation of people and process to create an efficient and effective development and implementation approval system. The intent should be to fully incorporate green infrastructure reviews into existing review procedures, rather than inventing new administrative systems.

Technical Training and Staff Development

Both agency staff and external contractors have ongoing needs for technical training on green infrastructure. Related training activities should include:

1. Reassigning existing staff roles, or perhaps recruiting new staff (engineering, landscape architecture, planning, and engagement) into a Stormwater Management Implementation Team;
2. Internal technical and training materials and staff development;
3. External training materials – aimed at increasing the capacity for proper Green Infrastructure and other BMP design and installation on private lands, aimed at the consulting design community, and in contracting installation and maintenance firms, as well as small property owners and homeowners;
4. Implementation should also include training of staff that review applications and that provide referrals or informal guidance to applicants; and
5. Training should also reinforce enforcement of sediment and erosion control during construction on public and private sites.

Organizational Development for Funding and Implementation

Many aspects of implementing the SWMP should be accommodated as adjustments to existing budgeting, funding, and staffing programs. There are, however, some key changes that would benefit from an organizational development approach, including:

1. Creation of a Stormwater Management implementation team as a focal point for the program;

2. Identification of functions that may be accommodated in existing budgets;
3. Identification of new service functions that should require allocations of budget and staffing for effective delivery; and
4. Clarity on roles of MoTI, CVRD and CT departments, staff and consultants/contractors in on-going implementation.

Awards and Incentive Program

The agencies should integrate Low Impact Development/Green Infrastructure recognition into Annual Awards programs to recognize noteworthy investments and awareness-building activities that meet the objectives of the SWMP.

Absorbent Sites Program

Significant parts of the land area in the Sh-hwuykwselu Creek Watershed is covered by residential and business land uses and the adjacent local streets. These neighbourhoods occur in two widespread types – low-density one- and two-family homes, and moderate density industrial/commercial. The quality and volume of water entering the stormwater system and receiving waters are directly related to the design and maintenance of these places that we live and work.

The Absorbent Sites Program provides guidance for stormwater-sensitive (low-impact) site development for private residential/commercial lands. The local streets and surface parking concerns are addressed below by the Surface Parking Treatment Program.

The issues with at-grade drainage from housing and business areas are excess nutrients from over-fertilization, nutrients and bacteria from pet waste, petroleum hydrocarbons and heavy metals from driveways or other surface parking areas, and potential erosion and sediment transport to stormwater from gardening activities, and in particular from construction sites.

The Absorbent Sites Program primary objective is that normal rainfall that lands on the at-grade portion of residential or business landscapes should be absorbed into the underlying subsoils, and heavy rainfall should be filtered through surface soils. It is recognized that large and extreme storms (above the water quality storm) may create some runoff to drain inlets or the fronting ditch and street, and provisions for positive drainage for these extreme events should still be made in site and utility planning.

Absorbent Sites can be readily achieved by use of the practices in Appendix F: At-Source Stormwater Management Control Examples. These were adapted from stormwater management guidelines by the consulting team in various Coastal BC municipalities. More detailed information may be found in the Metro Vancouver Stormwater Source Controls (Metro Vancouver, 2012).

Requirements for Absorbent Sites would be established by design guideline policy or bylaw and administered at the time of redevelopment through the development or building permit processes.

Single- and two-family zones, as well as low-density business commercial, should be encouraged (subject to an approval process) to either harvest roof stormwater for re-use or disconnect roof stormwater leaders and distribute the roof water to absorbent landscape areas, with an overflow from these absorbent areas for major storm events to the street or piped stormwater system. Agency exceptions to this requirement should be identified, including areas without foundation drains, or other areas at risk based on hydrogeological investigations. Where landowners otherwise wish an exception to the requirement, approval of the exception should be based on a detailed application form and established criteria.

Medium and High-Density residential and mixed-use developments are also required to meet the Absorbent Sites Program requirements. It is anticipated that most of these developments would use the performance application process and that these requirements would be generally complementary to current best practices such as those encouraged by LEED certification.

Surface Parking Treatment Program

Surface Parking is one of the major contributors in watershed environments to water quality pollution of receiving waters. The parking areas (even recently paved) show visible droppings of petroleum hydrocarbons, which flow with stormwater into pipes and ditches and show up as a sheen on surface waters. What is not as visible are heavy metals from brake linings, sediments that are carried into the drains by stormwater, bacteria, and other pollutants.

In Sh-hwuykwselu watershed, there are two areas of surface parking: on-street, and off-street. All surface parking, whether public or private, contributes to watershed water quality issues.

On Street and Roadside Surface Parking Treatment

The Surface Parking Treatment Program would support an inter-agency focus to implement water quality treatment on all on-street parking areas. Priority would be given to streets where drainage is now or soon to be flowing into storm sewer pipes and to receiving waters.

Where road and roadside parking is draining into large areas of absorbent landscape, including properly design absorbent swales and ditches, it is likely there is effective treatment of most pollutants, provided that the runoff is allowed to soak into the soil layer and does not rapidly convey to receiving stream waters, bypassing the treatment of the soil.

Use of water quality structures to treat local streets is discouraged but may be the only option in certain conditions.

Off Street Surface Parking Treatment

Off-street parking areas exist in the study area, in particular in business and industrial areas, and in higher-density housing areas.

Although this section is intended to address staff parking areas at business/industrial sites, it should not be applied to industrial yards – which should have their own pollution abatement program.

The preference for treatments of off-street surface parking is similar to that for on-street, although the site plan configuration varies. All BMP tools should be considered for treating water quality from surface parking. However, the program envisions the general allocation of tools to be similar to the examples illustrated in Figure 8-4 through Figure 8-7 of this report.

Which of these approaches are chosen for a given off-street parking area is to be determined at the time of development application, or if there is a rezoning application, at the rezoning stage. The development permit process may require landscaped area and tree cover for other purposes, and this requirement, as well as site configuration and space available, should lead to site-specific choices.

Use of water quality structures to treat off-street surface parking is discouraged but may be the only option in certain conditions. Water quality structures (e.g., pre-treatment and membrane filtration system) may be appropriate in retrofit surface parking situations where no redevelopment is anticipated for some time, but there is a desire to provide basic water quality treatment.

Where surface parking is an open roof of a parking garage, if these were to occur in the watershed, treatment shall be to a similar performance standard to that provided by the above. Where space is limited, this might be by a water quality structure.

As redevelopment progresses, existing off-street parking areas may be connected to new storm sewers that will outfall to sensitive receiving waters. In addition to installing BMPs with new construction, it is therefore important to encourage water quality BMP retrofit of existing off-street surface parking areas. A proposed Surface Parking Treatment Incentive Program could provide a charge on un-treated surface parking areas, with these charges reduced or eliminated as treatment BMPs are installed. A related grants program could provide incentives to early adopters.

10.10 Stormwater Management Implementation Team

Governments at all levels will need to play a leadership role. An on-going co-operative watershed governance arrangement is necessary to coordinate implementation actions. Key agencies will be CVRD, CT and Ministry of Transportation and Highways. Other provincial agencies and non-government organizations may play a supporting role in some actions.

Both CVRD and CT also have opportunities for co-funding from senior government grants – each with their own key funding agencies.

A gradual, sustained and coordinated effort will be required to fully implement the Plan.

A key first step is the adoption of the Plan by the elected bodies of CVRD and CT.

A key second step is the organization of a joint implementation task force that draws from CVRD, CT and MoTI to coordinate and expedite project implementation and fund-raising.

Many actions may be implemented by individual partners. For example, each partner agency may adopt and enforce their own regulations for lands and projects where they currently have jurisdiction.

There are also opportunities in working together for the efficiency of scale and reduced redundancy of effort, in such tasks as:

1. Public education and awareness programs;
2. Background materials to support funding applications;
3. Staff Technical Capacity Training and Demonstration Projects;
4. Development of Low Impact Development (Stormwater Source Control Best Practice) Design Guidelines for Development Permits;
5. Production of Technical Engineering Specifications, Typical Details, and Engineering Design Criteria documents for Stormwater Source Controls;
6. Potential co-funding, including senior government grants and/or provision of land, for select projects that have benefits in common; and
7. Monitoring programs for Watershed Health, Water Quality, and associated adjustments to action priorities.

In establishing an on-going watershed governance arrangement, the founding premise should be to not duplicate or contradict existing policies, regulations or staffing roles of the partners. There may be many aspects of implementation that may be managed by existing staff, given proper training and development of supporting technical materials. There may also be a need for a part-time or term

watershed coordinator position with a defined term of reference to organize early steps and provide capacity building/training to both other agency staff and leaders/contractors in the private sector so that there is a deep and available pool of technical knowledge and skills to allow cost-efficient implementation.

The Action Plans in Section 10 introduces the Actions and Priorities to get started on effective implementation.

Some Actions are ongoing and may continue with renewed commitment and focus of City staff. Other actions are new and will benefit from on-going community engagement, including stewardship groups, the real estate and development community, homeowners, and tenants.

Public awareness and outreach programs should be a perennial part of the implementation of the SWMP.

10.11 Funding Sources

For the plan to be successful, the stakeholders and project partners will have to secure funding for implementation of the project. Table 10-2 provides a list of funding sources that could be pursued to secure capital funding for project implementation. Further details on funding opportunities can be reviewed through the grant database on the CivicInfo BC website (https://www.civicinfo.bc.ca/grants).

Any on-going operation and maintenance funding will have to be secured either through existing or future local service areas within CVRD, maintenance contractor budgets for MoTI and operation budgets for CT.

10.12 Monitoring Success

On-going monitoring of the success of the implementing of the plan is key to:

1. Monitor progress of implementation for working group;
2. Provide feedback to the planning process as part of on-going adaptation; and
3. Communicating success to the broader community.

Key indices used to monitor the success of the monitoring program could include:

1. WHTS monitoring (updated every 5 years as redevelopment and riparian rehabilitation progress)
2. Water Quality Monitoring (every year during winter, summer and ‘fall flush’ period as recommended in the Cowichan Watershed Water Quality Monitoring study – 2013 and 2014);
3. Tracking project implementation and costs;
4. Tracking progress of guidelines and bylaw development; and
5. Tracking number of “watershed stewardship award” recipients.

The progress of the plan implementation should be communicated to the public through the preparation of regular stormwater management or state of the watershed reports.

Table 10-1: Summary of Sh-hwuykwselu (Busy Place) Creek Stormwater Management and Mitigation Plan & Implementation Strategy

Phase (Priority)	Proposed SMMP	Prerequisite Actions	Type of Action					Land Manager/ Owner	Capital Cost[1]	Average Annual O&M Cost	Total Life Cycle Cost[2]
			Further Study/ Planning	Education, Engagement & Demonstration	Develop/ Implement Policy & Planning Guidelines	Capital Infrastructure	O&M or Monitoring				
Flood Management Actions											
A (1st Priority)	Improve ditch cleaning/catch basin clearing maintenance						X				
	Initiate Koksilah River Flood Management Plan	None	X								
	Assess Koksilah Business Park 200-Year Flood Construction Levels (FCL)	None	X								
	Carry out additional geotechnical investigation of steep slopes along Alenby Road		X								
	Prepare Koksilah Rive Debris and Gravel Management Plan (Project 13)	None	X								
B (2nd Priority)	Upgrade Miller Road near Highway 1 Culverts (Project 5)					X		MoTI	$670,000	$10,000	$920,000
	Design/Install Trestle Village Floodbox (Project 6)					X		CT	$350,000	$10,000	$600,000
	Design/Construct Trestle Village Upland Diversion (Project 9)					X		CT	$340,000	$10,000	$590,000
	Implement Koksilah River Debris and Gravel Management (Project 13)						X	CT/ MFLNRORD/ CVRD	TBD[3]	TBD[3]	TBD[3]
	Establish special development permit area for properties above and below steep slopes on Alenby Road	Geotechnical Investigation			X						
	Establish Minimum Building Elevationfor Koksilah Business Park (bylaw)	Koksilah Business Park FCL			X						
C (3rd Priority)	Design/Upgrade Culverts/Fish Passage Improvements for Hykway, Koksilah & Tzinquaw Road Culverts (Project 2) OR Construct of Keating Farm Detention Storage (Project 1A)[4]	Assess feasibility				X		MoTI	$1,500,000	$10,000	$1,750,000
	Design/Upgrade Trestle Village Dike and Design/Construct Pump Station (Project 7 and 8)					X		CT	$4,300,000	$60,000	$5,800,000
D (4th Priority)	Upgrade E&N Railway and Bridge Flow Conveyance (Project 14)	Koksilah Flood Management Plan				X					
Erosion Management Actions											
C (3rd Priority)	Construct Keating Farm Wetland (Project 1B) (Assuming Culvert Upgrades in Phase C)					X		Private Land	$525,000	$30,000	$1,280,000
Water Quality Protection Actions											
A (1st Priority)	Require water quality pre-treatment for development and redevelopment occurring over vulnerable aquifer. Develop guidance document and / or bylaw.				X						
Environmental Enhancement Projects											
A (1st Priority)	Conduct Detailed Habitat Assessment		X								
D (4th Priority)	Design/Construct Hykway Park Diversion (Project 3)					X		CVRD	$430,000	$10,000	$680,000
	Design/Construct Polkey Road Realignment and Floodplain Riparian Improvements (Project 4)					X		MoTI	$4,600,000	$20,000	$5,100,000
	Design/construct Headwaters Channel Daylighting and Protect Riparian Areas(Project 10)					X		MoTI/Private CT/ CVRD	$570,000	$5,000	$695,000

Phase (Priority)	Proposed SMMP	Prerequisite Actions	Type of Action					Land Manager/ Owner	Capital Cost[1]	Average Annual O&M Cost	Total Life Cycle Cost[2]
			Further Study/ Planning	Education, Engagement & Demonstration	Develop/ Implement Policy & Planning Guidelines	Capital Infrastructure	O&M or Monitoring				
Low Impact Development Actions[5]											
A (1st Priority)	Seek SMMP Support from CT Council and CVRD Board			X							
	Organize SM Implementation Team with staff / coordinator			X							
	Conduct Culvert/drain/catch basin cleaning action / awareness			X							
	Water quality control action / awareness			X							
	Require Stormwater LID in large rezoning				X						
	Integrate LID demonstration/learning in current projects			X							
B (2nd Priority)	SM/LID public awareness 1.0			X							
	Identify priority areas for LID demonstration & implementation on common lands			X							
	Update Engineering standards to include SM and LID				X						
	Design Watershed Health Tracking System				X						
C (3rd Priority)	Review financial incentive program options				X						
	Require SM / LID in new MF ICI projects (update regs)				X						
	Street block SM and LID demo / monitoring projects			X							
	Parks/Common Land site SM, LID and biodiversity demo / monitoring projects			X							
	CVRD/CT Off-Street Property SM demo / monitoring projects			X							
	SM/LID public awareness 2.0			X							
D (4th Priority)	SM/LID public awareness 3.0 focused on single family/small projects			X							
	Private SF SM/LID demo / monitoring projects			X							
	Require SM/LID in new SF/Duplex projects (update regs)				X						
	Private surface parking SM/LID demo / monitoring projects			X							
	Launch charges/incentives for SM/LID in ex private surface parking or retrofits				X						
	Regulation changes to require/encourage/support SM/LID retrofits				X						
	On-going Watershed Health Tracking System				x						

Notes:
1. Order of Magnitude (Class 5) cost estimate for capital works including planning, design, environmental, construction and contingency. Does not include property/access acquisitions, staff co-ordination costs, further consultation costs, detailed geotechnical or archeological investigations. Detailed basis of cost estimate provided in Appendix E.
2. Total life cycle costs assume 25-year project life.
3. Cost to be determined as part of detailed Koksilah Gravel and Debris Management Plan
4. Construct detention pond or upgrade culvets depending on outcome of additional planning/discussions regarding the proposed detention pond including dam safety requirements, private property access/acquisition, etc.
5. The highlighted cells refer to the steps of LID implementation: Public Awareness/Outreach/Engagement, demonstration projects and regulation updates/full implementation of LID during development

Abbreviations

SMMP – Stormwater Management and Mitigation Plan
SM – Stormwater Management
LID – Low Impact Development
MF ICI – Multi-family, Industrial, Commercial and Institutional
SF – Single family
CT – Cowichan Tribes
CVRD – Cowichan Valley Regional District
MFLNRORD - Ministry of Forests, Lands, Natural Resource Operations and Rural Development

Table 10-2: List of Funding Sources

Name	Agency	Cost Share	Amount
Infrastructure			
Disaster Mitigation and Adaptation Fund	Infrastructure Canada	Regional District Up to 40% Province Up to 50%	Varies
Gas Tax Fund	Infrastructure Canada	Varies	Varies
Investing in Canada Infrastructure Program - British Columbia - Rural and Northern Communities Infrastructure	Infrastructure Canada	Senior Government 90% 10% local government	Varies
Green Municipal Fund	Union of BC Municipalities	Up to 80%	Loan up to $5 million with grant 15% of total
Plans			
Building Canada Fund	Infrastructure Canada	Varies	Varies
Municipalities for Climate Innovation	Federation of Canadian Municipalities	Varies	Varies
Environmental Enhancement/Awareness			
EcoAction Community Funding Program	Environment Canada	For non-governmental agencies with up to 50% funding from EC	Minimum $25,000 Maximum $100,00
School Ground Greening Grant	Evergreen	Varies	Varies
Enhancement Grants	Habitat Trust Conservation Fund	Varies	Varies

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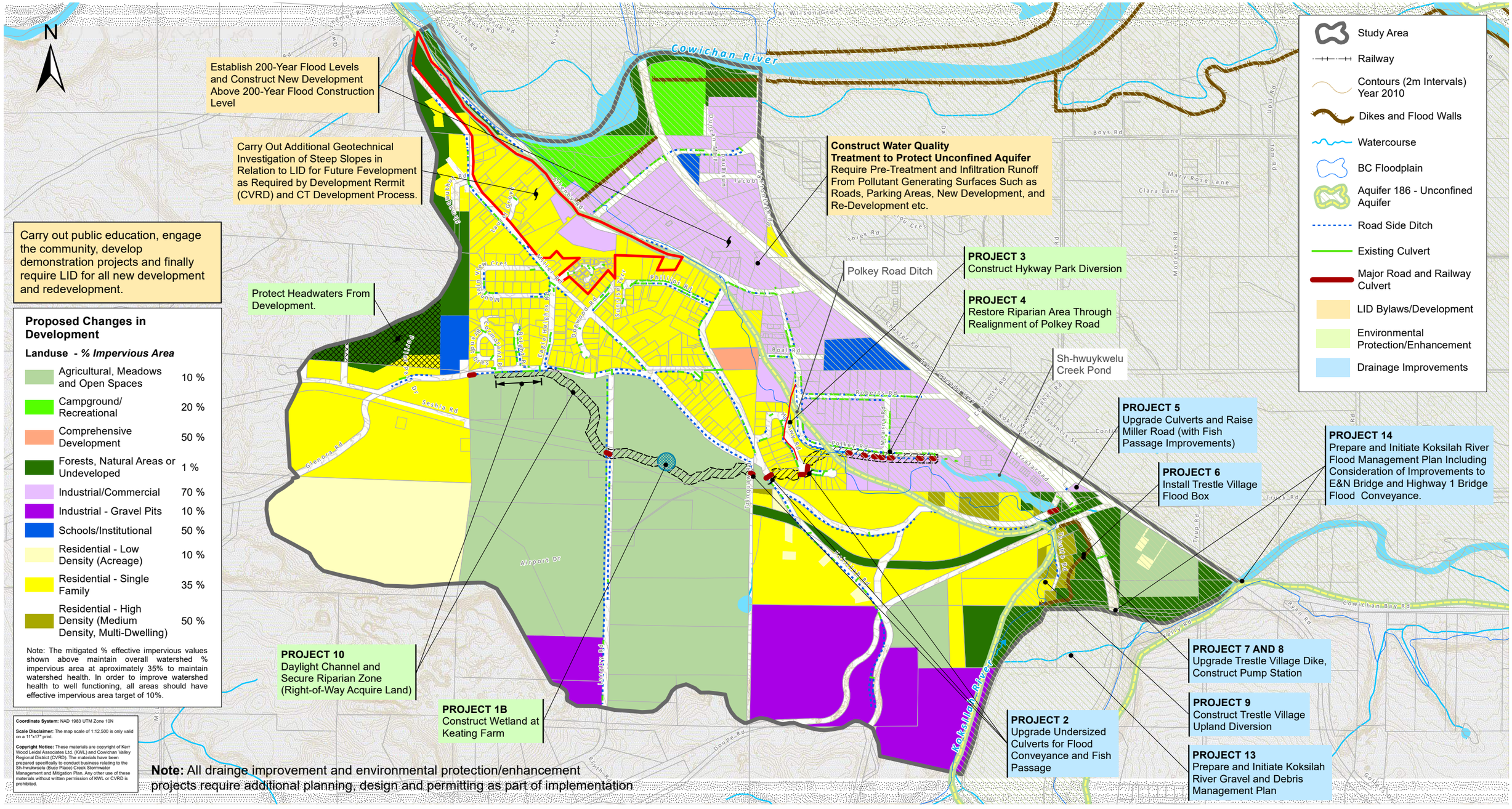
Cowichan Valley Regional District

Sh-hwuykwselu (Busy Place) Creek Stormwater Management and Mitigation Plan

KERR WOOD LEIDAL consulting engineers



Proposed Changes in Development

Landuse - *% Impervious Area*

Agricultural, Meadows and Open Spaces	10 %
Campground/ Recreational	20 %
Comprehensive Development	50 %
Forests, Natural Areas or Undeveloped	1 %
Industrial/Commercial	70 %
Industrial - Gravel Pits	10 %
Schools/Institutional	50 %
Residential - Low Density (Acreage)	10 %
Residential - Single Family	35 %
Residential - High Density (Medium Density, Multi-Dwelling)	50 %

Note: The mitigated % effective impervious values shown above maintain overall watershed % impervious area at aproximately 35% to maintain watershed health. In order to improve watershed health to well functioning, all areas should have effective impervious area target of 10%.

Note: All drainge improvement and environmental protection/enhancement projects require additional planning, design and permitting as part of implementation

Project No. 2212.071

Date March 2019

Scale 1:12,500

200 100 0 200 m

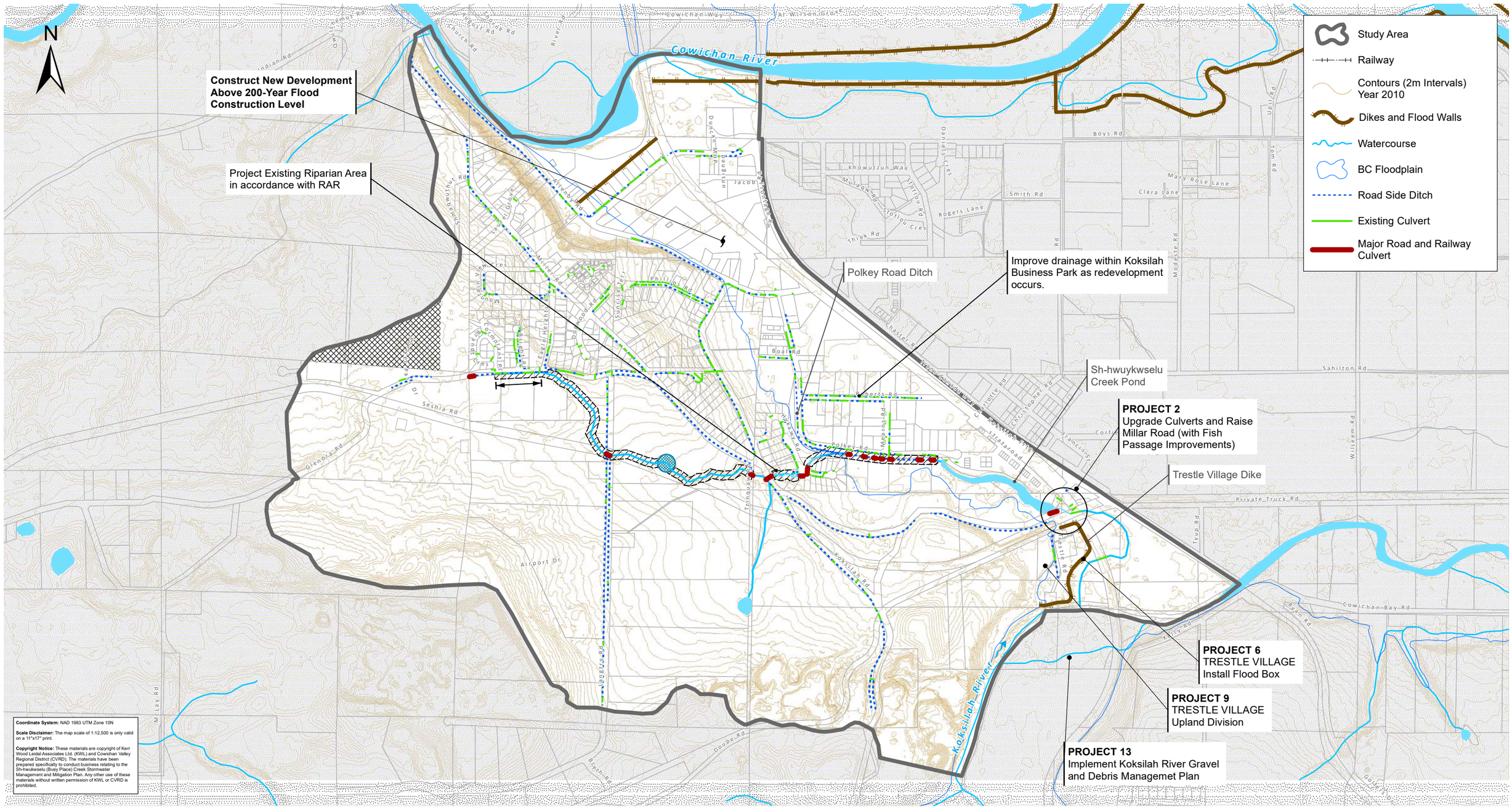
Sh-hwuykwselu (Busy Place) Creek Stormwater Management and Mitigation Plan

Figure 10-1

Cowichan Valley Regional District

Sh-hwuykwselu (Busy Place) Creek Stormwater Management and Mitigation Plan

KERR WOOD LEIDAL consulting engineers



Coordinate System: NAD 1983 UTM Zone 10N

Scale Disclaimer: The map scale of 1:12,500 is only valid on a 11"x17" print.

Project No. 2212.071

Date March 2019

Scale 1:12,500

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Stormwater Infrastructure Improvement Projects - Phase B Projects - Protect

Figure 10-2

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Cowichan Valley Regional District

Sh-hwuykwselu (Busy Place) Creek Stormwater Management and Mitigation Plan

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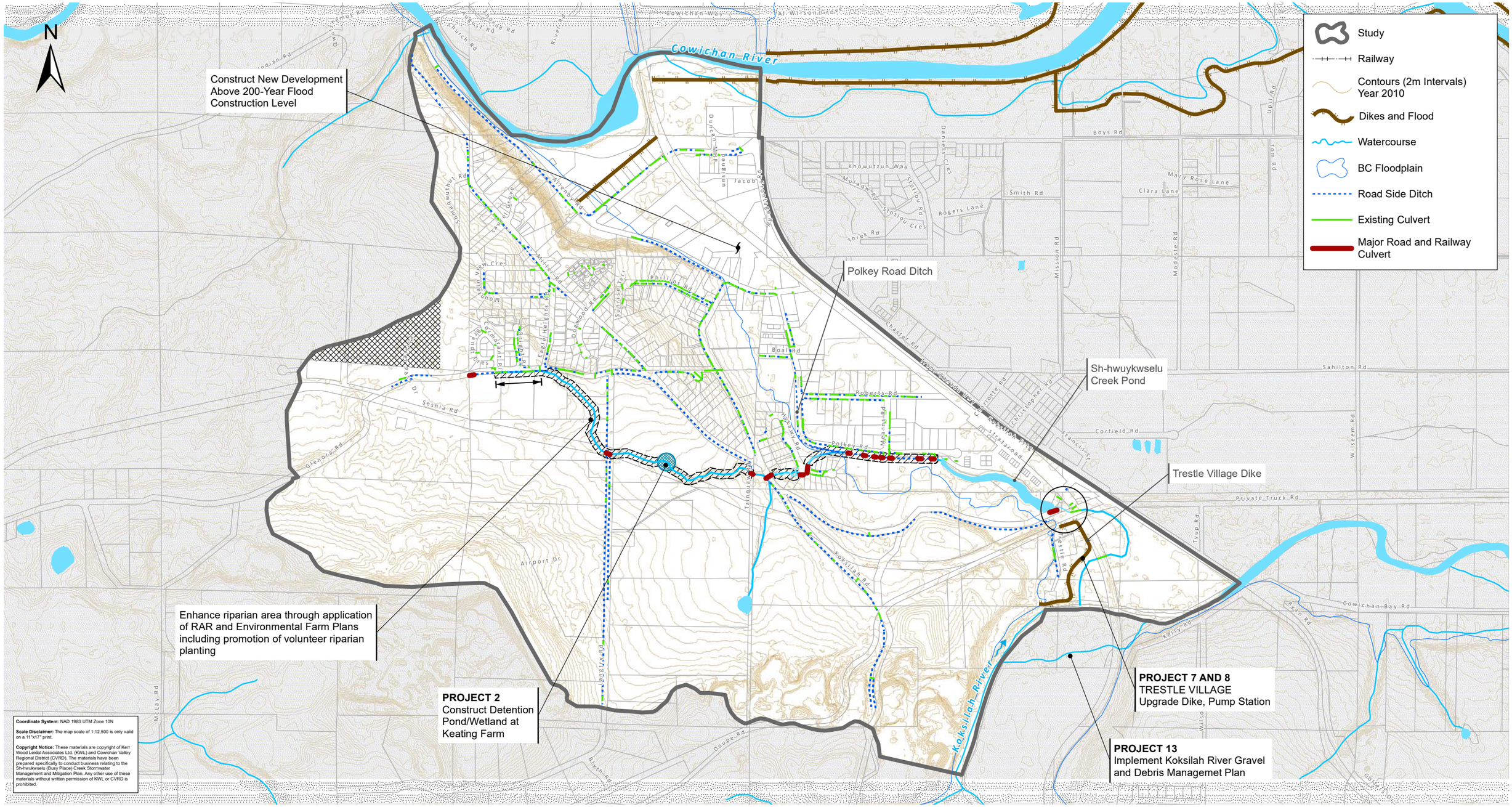

Coordinate System: NAD 1983 UTM Zone 10N

Scale Disclaimer: The map scale of 1:12,500 is only valid on a 11"x17" print.

Project No. 2212.071

Date March 2019

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Stormwater Infrastructure Improvement Projects - Phase C Projects - Improve

Figure 10-3

Cowichan Valley Regional District

Sh-hwuykwselu (Busy Place) Creek Stormwater Management and Mitigation Plan

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N

Construct New Development Above 200-Year Flood Construction Level

PROJECT 3
Hykway Park Diversion

Polkey Road Ditch

PROJECT 4
Restore Riparian Area Through Realignment of Polka Road

Sh-hwuykwelu Creek Pond

PROJECT 10
Channel Daylighting

PROJECT 10
Secure Riparian Zone (Right-of-Way Acquire Land) Riparian and Channel Restoration

PROJECT 2
Design/replace Culverts for Fish Passage

- Study Area
- Railway
- Contours (2m Intervals) Year 2010
- Dikes and Flood Walls
- Watercourse
- BC Floodplain
- Road Side Ditch
- Existing Culvert
- Major Road and Railway Culvert

Project No. 2212.071
Date March 2019
Scale 1:12,500

200 100 0 200 m

Stormwater Infrastructure Improvement Projects - Phase D Projects - Enhance

Figure 10-4

11. Recommendations

Based on the outcome of the Sh-hwuykwselu (Busy Place) Creek Stormwater Management and Mitigation Plan, it recommend that CVRD and CT:

1. Seek support from CVRD Board and CT Chief and Council for the Plan;
2. Form a Sh-hwuykwselu (Busy Place) Creek Stormwater Management Implementation Team (see Section 10.10 for a description of the role and potential members) to coordinate efforts of the various partners and stakeholders, review potential governance structures and funding opportunities for implementation of the Plan;
3. Prepare and implement a public education and engagement plan to promote awareness of stormwater issues within the watershed and to educate residents with regard to potential revisions to policies, land use bylaws, and engineering standards that may impact development or redevelopment of properties (see Section 10.6 for potential public education and engagement initiatives);
4. Carry out further studies to provide additional information to help guide the implementation of the plan (see Table 10-1) including Koksilah River Flood Assessment Study, Koksilah River Sediment, and Debris Management Plan, Koksilah Business Park Flood Construction Levels study and geotechnical slope stability study of the steeper slopes in the study area;
5. Develop/update and implement stormwater management policies, design guidelines and incentives following the priorities provided in the Table 10-1 action plan;
6. Implement stormwater infrastructure improvement projects following the priorities provided in the Table 10-1 action plan for major capital works; and
7. Monitor progress and success of the Sh-hwuykwselu (Busy Place) Creek Stormwater Management and Mitigation Plan (see Section 10.12 for potential monitoring indices) and report through the preparation of regular State of the Watershed reports prepared by the Sh-hwuykwselu (Busy Place) Creek Stormwater Management Implementation Team.

12. Report Submission

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Revision History

Revision #	Date	Status	Revision	Author
0	March 27, 2019	FINAL	Issued as Final	CS