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REPORT

District of Summerland

Eneas Creek Assessment

April 2019

ASSOCIATED ENGINEERING

QUALITY MANAGEMENT SIGN-OFF

Signature: _____

Date: APRIL 12/19

Executive Summary

Eneas Creek is a 15-km watercourse that originates from the outfall at Garnet Lake Dam and flows through Garnet Valley and the District of Summerland before spilling into Okanagan Lake. Agricultural and residential development in the District has confined and redirected the natural flow path of the creek. These actions have impacted the overall capacity and resiliency of the creek to safely manage flows during years of high runoff. During the 2018 freshet period, high discharge from the dam led to areas of flooding, bank erosion, and sediment accumulation. Associated Engineering completed an assessment of Eneas Creek in response to the high streamflows and flooding that caused damage to both private and public property. The assessment involved a review of the characteristics and capacity of the creek, identification of hazard areas, and development of mitigation and remediation options to increase resiliency of the creek.

A field review of the creek identified hazard areas where remediation or mitigation works are required. The hazards identified have been classified by types, such as fallen trees, debris, erosion, or culvert related. Some hazards are localized, such as bank erosion. Other hazards, such as the general confinement of the creek, are more general and apply to a larger area. All hazards have been addressed as part of the recommended projects that follow.

The purpose of the assessment is to identify areas along the creek where remediation or mitigation works are required to restore and improve the function of the creek during future high flow events, and to help inform decision-making and priority setting for proposed improvements. A list of recommended improvement projects is provided, with general descriptions of works and associated costs. A brief risk-cost analysis of each improvement has been completed to help provide understanding of the potential damages that may be offset by each improvement. The risk comparison indicates which projects should be prioritized in the short and long term.

Maps are provided for the entire length of the creek and detail the hazard areas, surveyed cross section locations, and recommended project locations.

Table of Contents

List of Tables

List of Figures

1 Introduction

1.1 PROJECT BACKGROUND

The District of Summerland (the "District") has retained Associated Engineering to complete an assessment of Eneas Creek between Garnet Lake and Okanagan Lake. This assessment is in response to the high streamflows during the 2018 freshet period, which caused flooding and damage to both private and public property.

The high flows in Eneas Creek caused numerous issues including bank erosion, localized flooding, tree fall, debris buildup, and sediment accumulation. Emergency works were completed in several areas in response to flooding and erosion. Temporary emergency measures (e.g., lock blocks, sandbags, soil berms, and gabion baskets) must be removed and replaced with permanent protective solutions.

This assessment involved a review of the characteristics and capacity of the creek, identification of hazard areas, and development of mitigation and remediation options to increase resiliency of the creek.

1.2 PROJECT LOCATION

Summerland is located on the west side of Okanagan Lake, approximately 35 km southwest of Kelowna, BC, and 20 km north of Penticton, BC. Located in the Okanagan Basin, Summerland has a semi-arid climate with generally warm and dry weather. Eneas Creek connects Garnet Lake to Okanagan Lake, and flows through Summerland (Figure 1-1).

1.3 RELEVANT INFORMATION

The assessment involved the review of the following documents, information, and data has been received and reviewed as part of the Eneas Creek Assessment:

- District of Summerland. September 2018. RFP-2018-18 Eneas Creek Assessment and Addendum #1
- EGBC. August 2018. Legislated flood assessments in a changing climate in BC (V2.1)
- District of Summerland. 2018. Emergency Management BC, EOC Expenditure Authorization Form forms from 2018 flooding events
- APEGBC. January 2017. APEGBC Professional Practice Guidelines: Flood Mapping in BC (V1.0)
- Agua Consulting Inc. April 2013. Garnet Reservoir Flood Inundation Study
- Thurber Consultants Ltd. January 1974. Eneas Creek Flood Control Study
- Garnet Valley Water Allocation Spreadsheet

In addition, the District and local residents provided the following information to inform this assessment:

- Locations of localized flooding during the 2018 freshet event
- Points where additional flow enter Eneas Creek downstream of Garnet Lake
- History of recent forest fires in the upper watershed

1.4 OBJECTIVE

The objective of the assessment is to identify hazards and areas along Eneas Creek where remediation or mitigation works are required to restore and improve the function and resiliency of the creek during future high flow events, and to help inform decision-making and priority setting for proposed improvements.

In general, resiliency is the ability to reduce the magnitude and/or duration of disruptive events. A fully resilient system considers four key abilities (USDHS, 2010):

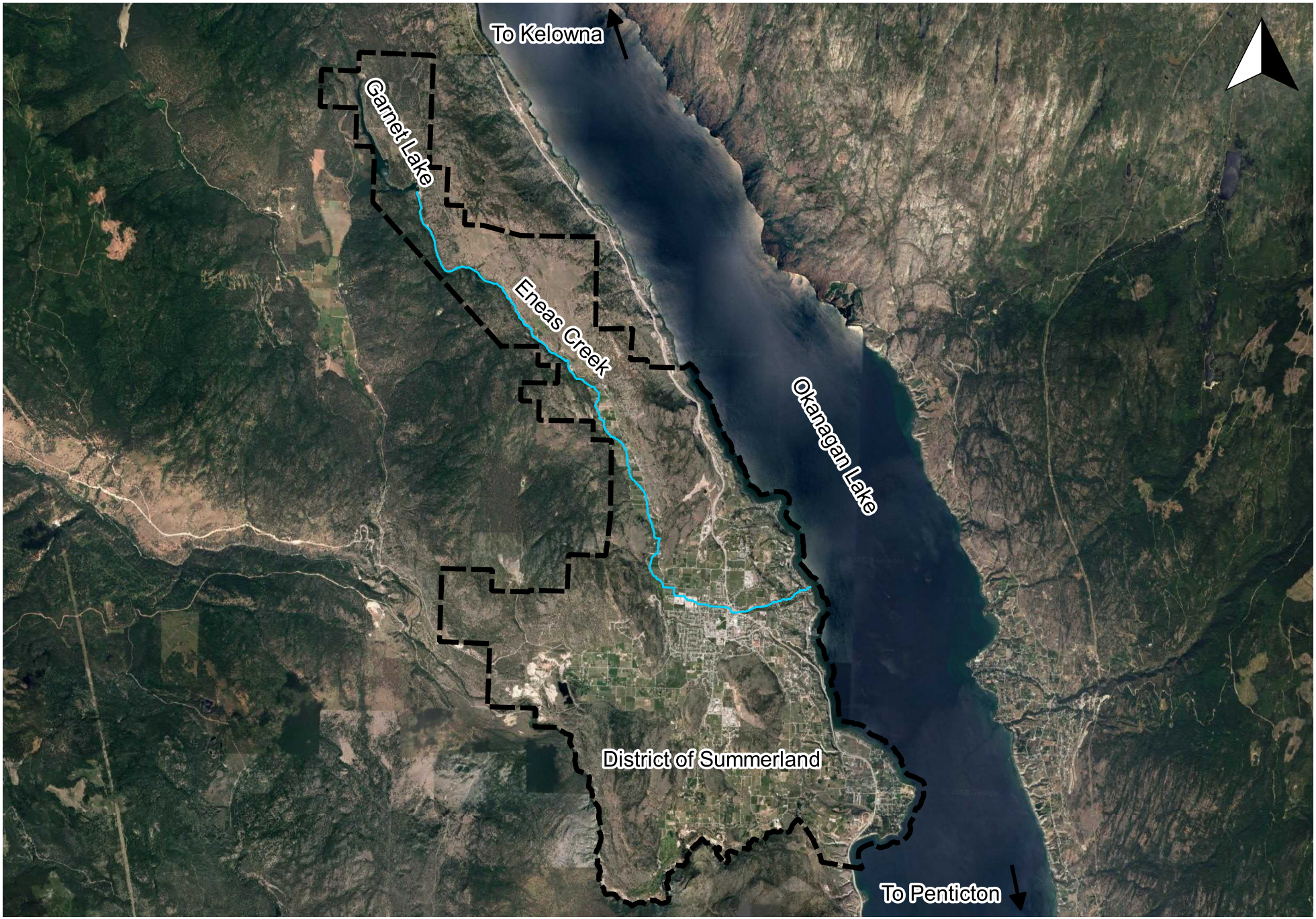
- Robustness—the ability to absorb shocks and continue operating (Flood plain flood attenation);
- Resourcefulness—the ability to skillfully manage a crisis as it unfolds (plans in place for how to react to emergencies);
- Rapid Recovery—the ability to get services back as quickly as possible (protecting critical infrastructure from serious damage); and
- Adaptability—the ability to incorporate lessons learned from past events to improve (incorporating past events and critical areas into future planning).

The resiliency of the creek system has been compromised due to human-caused alterations and lack of riparian area around the creek.

Resiliency improvements of Eneas Creek should consider:

- Re-establishing a natural corridor;
- Decreasing the amount of creek that is ditched;
- Improving inlet capacity on culverts; and
- Establishing overflow or high flow channels/oxbows.

The proposed improvements are intended to prevent or mitigate most failures. The most effective measures for mitigating failures are provided herein. This includes future impacts due to climate change.



Map Data: Google, Digital Globe

Figure 1-1
Project Location

Associated Engineering

2 Eneas Creek Assessment

2.1 ENEAS CREEK AND WATERSHED INFORMATION

Eneas Creek is a 15-km watercourse between the Garnet Lake Dam and Okanagan Lake. The creek is a flow-regulated channel that passes through undeveloped, agricultural, and urban areas. In several locations, the creek channel has been modified or relocated by property owners and farmers to follow property lines. Additionally, there are approximately 64 creek crossings, primarily bridges or culverts of varying dimension and capacity.

Eneas Creek is flow-regulated most of the year and originates at the outfall of Garnet Lake Dam. Flows are released into Eneas Creek through the outlet at the dam face. Occasionally, at peak lake levels, water crests the dam spillway and enters the creek channel. The discharge through the outlet and over the spillway make up the base flow of the creek. Garnet Lake is a reservoir for the District domestic and irrigation water supply. An inlet at the dam conveys water to the distribution system.

The headwaters of the Eneas Creek watershed are located in the hills to the north of Summerland. The total watershed area is approximately 9,250 hectares (ha), with 5,780 ha located upstream of Garnet Lake. Several creeks, including Eneas Creek, Lapsley Creek, and Findlay Creek, convey flows from the upper reaches of the watershed to Garnet Lake. Downstream of the dam, Eneas Creek is the only major defined channel with consistent flow throughout the year. Runoff and snowmelt from the watershed area below the dam also contribute flows to the creek.

2.2 REACH DEFINITION

Eneas Creek begins as a natural stream channel at Garnet Lake before transitioning to a more defined and influenced channel through farmland, then through residential land, and finally through a steep ravine section before draining into Okanagan Lake. The four reaches of the creek each display common stream characteristics, described below.

2.2.1 Reach 1 – Highway 97 to Okanagan Lake to Highway 97

In this reach, the creek flows through a culvert at Highway 97 and continues through a steep ravine section along Peach Orchard Road. There are four culverted road crossings and several private crossings, and the creek flows through many residential properties as it nears Okanagan Lake.

The extents of Reach 4 are between Sta. 14+100 and Sta. 15+900, and the average channel grade is 6.61%. Refer to drawing C-002 in Appendix B.

2.2.2 Reach 1 – Garnet Avenue to Highway 97

Generally, as the creek enters the more developed area of Summerland, the channel banks are steeper, and the alignment is constrained along and between properties. At the top end of this reach, the creek is

routed through an orchard and several 90° bends. Further downstream, the creek passes through commercial and residential properties with very little setback and four culverts at road crossings. At the low end of the reach, the creek enters a steep ravine section immediately upstream of the Highway 97 crossing.

The extents of Reach 3 are between Sta. 12+000 and Sta. 14+100, and the average channel grade is 0.80% (not including the steep ravine section immediately upstream of Highway 97). Refer to drawing C-003 in Appendix B.

2.2.3 Reach 3 – Cattleguard on Garnet Valley Road to Garnet Avenue

In this reach, the creek passes through agricultural properties as it continues along Garnet Valley. There are several locations where the creek channel has been modified or redirected to increase usable land area. Additionally, there are many culvert and bridge crossings on private land.

The extents of Reach 2 are between Sta. 3+300 and Sta. 12+000, and the average channel grade is 1.0%. Refer to drawing C-004 in Appendix B.

2.2.4 Reach 4 – Garnet Lake to Cattleguard on Garnet Valley Road

Downstream from the dam outlet, the creek follows a natural path along the valley bottom. Garnet Valley Road, which provides vehicle access to the dam, is located above the creek's left bank. The riparian area of the creek is characterized by heavy vegetation and trees. There are no developed properties along the creek within this reach.

The extents of Reach 1 are between Sta. 0+000 and Sta. 3+300, and the average channel grade is 1.2%. Refer to drawing C-005 in Appendix B.

2.3 FIELD VISIT

Michael Owen, P.Eng., of Associated Engineering, attended the projection initiation meeting with Maarten Stam and Dave Sandrelli, of the District, on October 23, 2018. The meeting included a walk-through of key hazard areas that were impacted by the 2018 flooding.

Michael Owen performed inspections along the length of the creek on October 30 and 31, 2018. Photographs were taken of culverts, bridges, crossings, erosion areas, debris, and other areas of note. Cross sections at key areas were surveyed for assessing the hydraulic capacity of the channel.

Michael Owen and Carrie Nadeau (of Associated Environmental) inspected the creek on November 21, 2018 and discussed potential mitigation options and best management practices.

2.4 PUBLIC CONSULTATION

A public consultation meeting was held in Summerland on November 20, 2018 and was attended by approximately 100 residents, District staff, Michael Owen, and officials from the Ministry of Forest, Lands, Natural Resources, Operations and Rural Development (FLNRORD) and Emergency Management BC (EMBC). Key discussion points were about creek management and emergency operations.

2.5 HAZARD IDENTIFICATION

A total of 73 hazards were identified and photographed during the site visit. These areas are marked on the Flood Risk mapping in Appendix B and correspond to the list of hazards areas in Appendix A. The hazards were classified by type, such as fallen trees, debris, erosion, or culvert related.

Some hazards are location-specific, such as bank erosion, and other hazards are more general and occur in multiple areas, such as vegetation overgrowth and downed trees. The list of hazard areas provides locations of observed hazards, but there may be additional areas that require mitigation. See Sections 3 and 4 for discussion on mapping and remediation/mitigation measures relating to these hazards.

2.6 HYDROLOGY

The hydrology of the Eneas Creek watershed has been assessed during previous projects and studies, as summarized below. The current assessment of the creek takes into account these preceding studies for determination of peak flows as they relate to the assessed capacity of the creek. We have performed a regional analysis based on the nearby Camp Creek hydrometric station to estimate peak flows for the 2-year through 200-year events.

2.6.1 Eneas Creek Flood Control Study, Thurber Consultants Ltd., 1974

Thurber conducted a flood control study in response to a major flood event in 1972. Thurber estimated the peak creek flow to be 1.93 m^3/s during the flood event. The creek and its structures were surveyed and assessed for hydraulic capacity and compared to various selected flows to determine areas that require upgrades. The upper limit of flows assessed, 2.55 m^3/s, was found to exceed the capacity of many structures and a large extent of the creek channel. Table 2-1 lists the flows at various return periods estimated by Thurber.

Table 2-1 Eneas flows at various return periods

Return Period	Flow	Data Source
1:25	1.2 m^3/s (50 cfs)	Thurber - 1974
1:30	2.0 m^3/s (70 cfs)	Thurber - 1974
1:40	2.55 m^3/s (90 cfs)	Thurber - 1974
1:200	6.6 m^3/s (233 cfs)	Thurber - 1974

2.6.2 Garnet Reservoir Flood Inundation Study, Agua Consulting Inc., 2013

Agua conducted a flood inundation study as part of the dam's Emergency Preparedness Plan required under the *Dam Safety Regulation*. As part of the study, Agua completed hydrological modelling to determine the peak inflow into Garnet Lake. Including attenuation effects by the reservoir, the 1:1000 year rainfall event would result in a 58 m³/s peak inflow into Garnet Lake. The lake can attenuate this flow to an outflow of 43 m³/s over the spillway. The spillway was assessed to have an existing capacity of 38 m³/s but could be upgraded to 43 m³/s with bank improvements. For comparison, the Peak Maximum Flood inflow was calculated to be 85 m³/s.

The study also assessed the maximum capacity of sections of the creek downstream, as it related to the operation of the dam. The critical section was determined to be the 400 m section along residential lots between Victoria Road North and Rosedale Avenue. The maximum capacity of the channel in this section was determined to be 1.20 m³/s based on HEC-RAS modelling.

2.6.3 Regional Analysis

The Water Survey of Canada (WSC) monitored streamflows of Eneas Creek (WSC Station – Eneas Creek near Summerland; 08NM228) in 1974 and 1975. For the available period of record, the peak maximum daily streamflows recorded were 1.47 m^3/s (1974) and 0.762 m^3/s (1975). The location of the WSC Station was approximately 1 km downstream from Garnet Lake Dam.

To support further hydraulic channel capacity assessments, a regional analysis approach was used to estimate selected peak streamflow return periods. A nearby WSC station on Camp Creek (WSC Station – Camp Creek at the mouth near Thirsk; 08NM134) was selected as the most representative station for estimating peak streamflows within Eneas Creek watershed. Camp Creek is located to the west of Eneas Creek watershed (within the Trout Creek watershed).

From the available records on Camp Creek, selected mean daily peak unit discharge return periods were estimated. Four distribution types (Pearson Type III, Log Pearson Type III, Log Normal, and Gumbel) were fitted to the data using the BC Ministry of Environment, Lands, and Parks (MELP) Flood Frequency Analysis Program (version 1.1). The general procedure for estimating a return period using the MELP program involves assessing the goodness-of-fit for each distribution, with poor fits excluded. The assessment indicated that all distribution types fitted the data reasonably well; therefore, the results for all four distributions were averaged and used in calculating the average value (and 95% confidence limits).

The results of the flood frequency analysis for Camp Creek are provided in Table 2-2. Note that the streamflows are reported in a maximum daily unit discharge value ($L/s/km^2$). Also included in Table 2-2 are estimated mean daily and instantaneous peak streamflows of Eneas Creek at Garnet Valley Road (i.e., drainage area = 88.5 km^2). The Eneas Creek peak streamflow estimates assume that Garnet Lake is full and spilling during flood conditions.

Table 2-2 Estimated peak streamflows of Eneas Creek

Peak Flow Return Period	Camp Creek at WSC Station 08NM134	Eneas Creek at Garnet Valley Road	Eneas Creek at Garnet Valley Road
	Maximum Daily ($L/s/km^2$)	Maximum Daily (m^3/s)	Instantaneous[1] (m^3/s)
2-year	36.5	3.23	3.68
5-year	52.9	4.68	5.34
10-year	62.9	5.57	6.35
25-year	75.0	6.64	7.57
50-year	83.5	7.39	8.42
100-year	91.5	8.10	9.23
200-year	99.3	8.79	10.0

Note:

1. Instantaneous values were calculated using the average instantaneous to daily (I/D) peak streamflow ratio (i.e., 1.14) calculated for WSC Station 08NM134. It is assumed that the I/D ratio is consistent for all return periods.

Although Table 2-1 provides estimated peak streamflows for Eneas Creek, Thurber (1974) noted that the hydrologic regimes of Camp and Eneas Creeks may not be comparable due to the lower elevation of the Eneas Creek watershed. The median elevation of Camp Creek (at WSC Station 08NM134) is 1456 m, while the median elevation of Eneas Creek (at Garnet Valley Road) is 881 m. It is likely that the Eneas Creek peak streamflows are overestimated in Table 2-1 and as a result should be used with caution. When compared to the Thurber (1974) estimates, the 25-year and 200-year instantaneous peak flows estimated using the regional analysis are 630% and 150% greater, respectively, if more accurate results are desired in the future a flow measuring station is recommended to accurately measure flows and to be able to relate that to impacts though out the community.

2.7 DESIGN FLOW

The creek has been unnaturally constrained to the point where the capacity to manage extreme event flows is not possible without flooding. Current design standards dictate that any crossings or improvements should be designed to accommodate the 100 – 200 year event. Remediating the creek to convey this magnitude of capacity would require extensive works to the majority of the creek channel and crossings, which would have major impacts on the adjacent properties.

Instead, the recommended remediation and mitigation works in Section 4 focus on remediating critical areas that sustained damage in recent floods, removing temporary emergency works, and building resiliency into the creek system so the system can manage higher flows with minimal sustained damage.

2.8 HYDRAULIC CALCULATIONS

2.8.1 Eneas Creek Cross Sections

Intermittent cross section surveys were completed along the length of the creek, which focused on the areas that experienced flooding during 2018. The cross sections were used to assess the hydraulic capacity of the channel at different locations.

For each cross section assessed, channel dimensions from an upstream and downstream cross section were used to determine an approximate hydraulic capacity based on the bed slope between the points. Manning's formula for open channel flow was used for this purpose. Manning's roughness values are based on field observations and literature by Chow (1959). Capacity is based on the elevation at the surveyed top of bank. No allowance for freeboard is included in these calculations.

Table 2-3 presents a summary of the creek channel hydraulic capacity of each section assessed. The full calculation datasheet is provided in Appendix D.

Table 2-3 Creek channel hydraulic capacity

Section	Reach	Approx. Address	U/S Station	U/S Elevation	D/S Station	D/S Elevation	Local Slope (%)	U/S Capacity (m^3/s)	D/S Capacity (m^3/s)
1	2	24438 Garnet Valley Road	6+706	538.83	6+730	538.58	1.51	3.3	4.1
2	2	24402 Garnet Valley Road	6+961	537.43	6+969	537.23	3.20	5.5	7.8
3	2	15707 Handley Street	7+521	530.72	7+578		3.40	2.2	
4	2	19402 Garnet Valley Road	9+548	513.86	9+750	513.50	0.17	2.7	19.3
5	2	17304 Garnet Valley Road	10+794	501.99	10+817	501.75	0.64	3.5	8.2
6	3	15014 Garnet Ave	12+169	491.19			0.25	1.3	
12	3	15014 Garnet Ave	12+413	490.71	12+420	489.60	1.50	3.7	4.2
7	3	10716 Richie Street	13+151	483.80	13+294	483.14	0.56	3.7	3.3
8	3	14218 Rosedale Ave	13+715	479.45	13+747	478.97	1.39	4.8	5.1
9	3	14205 Rosedale Ave	13+836	476.68	13+890	475.75	1.72	6.5	11.5
10	4	6711 Peach Orchard Road	15+142	382.35	15+146	382.11	6.94	12.5	13.9
11	4	15407 Lakeshore Road	15+872	343.15			0.87	3.5	

Notes:

U/S and D/S refer to upstream and downstream cross sections, respectively.

For section 3, not enough channel information was available for defining the downstream cross section.

Section 11 is based on a single cross section at the concrete channel.

Section 7 was determined based on an overall slope and typical cross section, Agua and Thurber noted much lower capacities for this section (approximately 1.2 cu.m/s). It is expected that there are some critical pinch points along this channel that are more limited on capacity than this estimate.

2.8.2 Eneas Creek Road and Driveway Crossings

Inlet elevations and diameters for several culverts crossing driveways and roads were surveyed during the field assessment. The culverts along Eneas Creek are assumed to operate under inlet control conditions (represented in Figure 2-1). Estimated capacity for inlet-controlled structures was estimated using a nomograph[1] for inlet control CSP[2] culverts. Table 2-3 presents a summary of the surveyed culvert capacities.

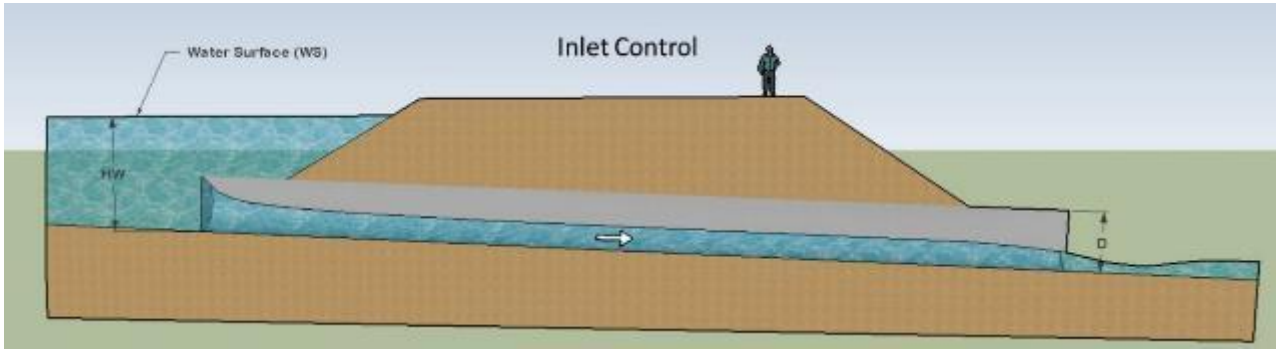


Figure 2-1 – Inlet control pipe representation

Table 2-4 Surveyed culvert capacity

Crossing #	Approx. Sta.	Approximate Address	Diameter (mm)	Material	Surveyed Slope (%)	Inlet Control Capacity[2] (m^3/s)	Inlet Control Capacity[3] (m^3/s)
1	3+970	28412 Garnet Valley Road	1200	CSP	7.5	1.8	3.5
2[1]	8+215	Gallagher Road	See Note 1	Concrete	1.7	0.8	1.3
3	10+915	17304 Garnet Valley Road	1200	CSP	3.9	1.8	3.5
4	10+998	17216 Garnet Valley Road	1400	CSP	2.5	3.2	6.0
5	11+920	15408 Garnet Valley Road	1200	CSP	4.5	1.8	3.5
6	14+000	Peach Orchard Road/Highway 97	1350	Concrete	6.0 (Assumed)	2.8	4.5
7	15+250	Blewett Road	1200	CSP	4.1	1.8	3.5

1. Crossing #2 comprises 1 x 750 mm and 2 x 450 mm concrete pipes. The capacity shown is based on the sum of the three pipe capacities.
2. Inlet Control Calculations based on a depth of water at the inlet equivalent to the diameter of the pipe.
3. Inlet Control Calculations based on a depth of water at the inlet equivalent to 2 times the diameter of the pipe.

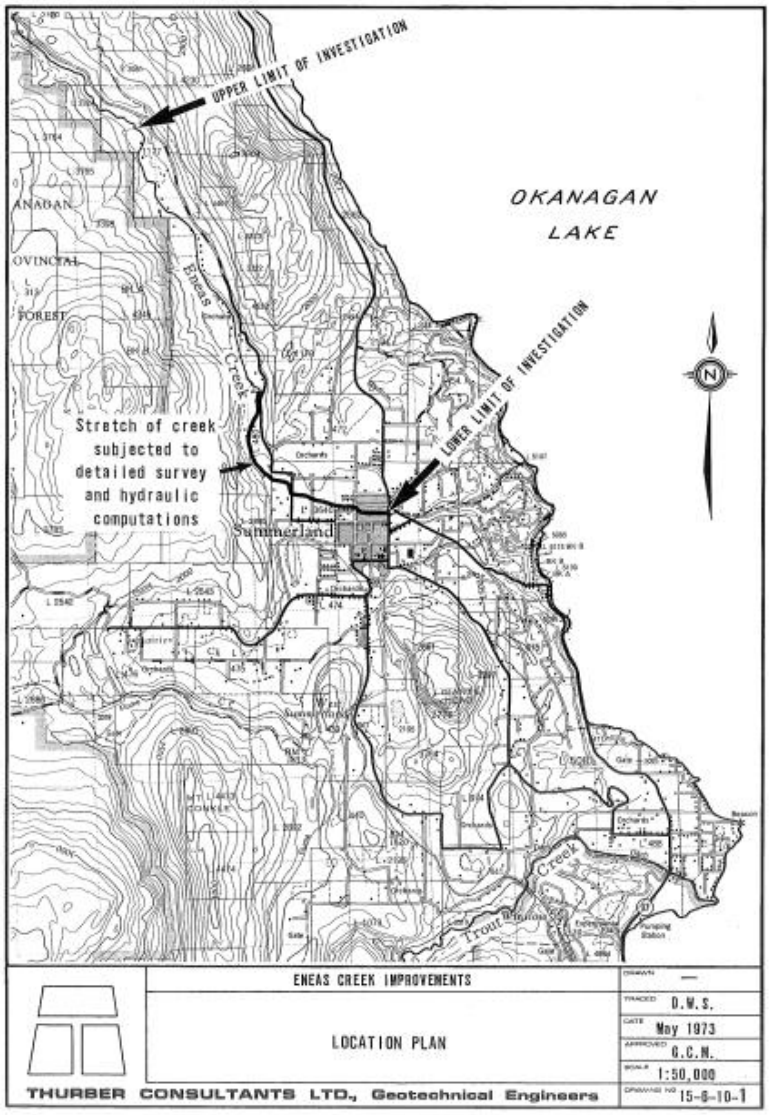
[1] Inlet Control Headwater Depth, Handbook of Steel Drainage & Highway Construction Products, Canadian Steel Pipe Institute (Canadian Edition, 2007)
[2] CSP is corrugated steel pipe

Based on the calculated capacities, compared to the estimated flows from the 1974 Thurber Report, the current driveway culverts have a capacity similar to the 1:25 to 1:30 year event and the culvert below Peach Orchard and Highway 97 just over the 1:40 year event, and appears as though when upstream ponding occurs the capacity of this crossing could increase to pass the 1:200 year event.

2.8.3 Eneas Creek Flood Control Study, Thurber Consultants Ltd., 1974

The report by Thurber was completed for a section of the creek from Rosedale Road to the entrance to Garnet Valley, with an additional length of the creek considered a high level.

Figure 2-2 – Thurber 1974 Investigation Limits



The report stated that upgrading the creek channel and structures to meet the 6.5 m³/s capacity would require changing the character of the creek extensively, as well as carrying a high cost. The authors recommended upgrading the channel and structures to meet a 2.55 m³/s design target, which was equated to be equivalent to the flows expended during a 1:40 year event at that time. Climate change effects have likely already decreased the return period of the suggested works.

Based on a review of the recommendations from this report, many of the areas noted for improvements are still areas of concern with the current creek alignment. This report indicated that sections of the channel need to be cleaned out and widened, and culverts need to be upgraded to manage the flows of the 1:40 year event. The typical channel size recommendations ranged from widening the channel from between 1 ft and 14 ft, and replacing culverts and bridges with arch culverts with dimensions of approximately 2000 mm x 1250 mm. See attached maps and figure below from the 1974 Thurber Report.

Figure 2-3 – Thurber 1974 Recommendations

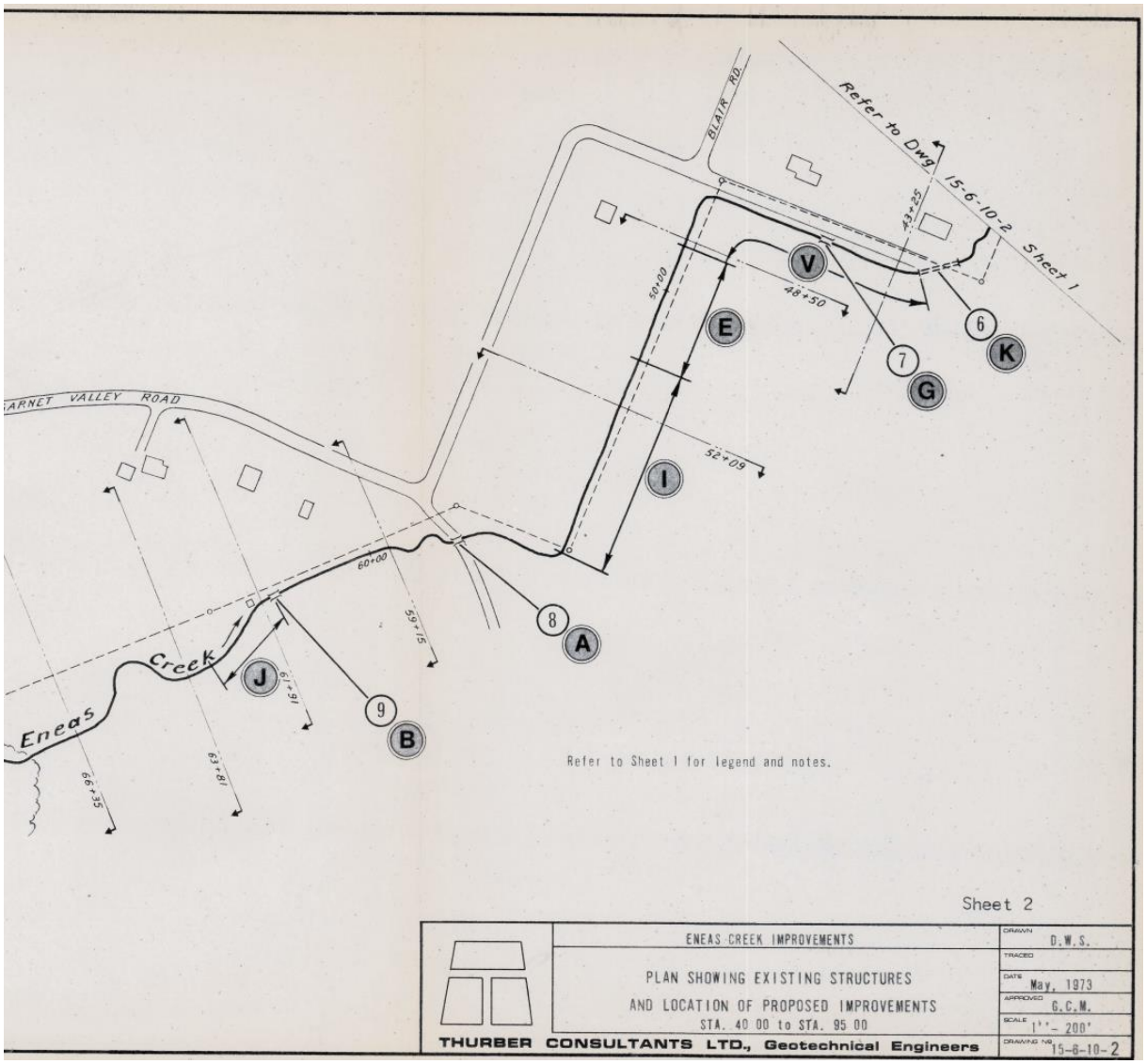
Improvement	50 cfs	70 cfs	90 cfs
A	Provide channel of width 5.5', depth 2.5'	Provide channel of width 6', depth 3'	Provide channel of width 7', depth 3'
B	Provide channel of width 5.5', depth 2.5'	Provide channel of width 6', depth 3'	Provide channel of width 7', depth 3'
C	Provide channel of width 5.5', depth 2.5'	Provide channel of width 6', depth 3'	Provide channel of width 7.5', d. 3'
D	Widen existing creek bottom by 4'	Widen existing creek bottom by 7'	Widen existing creek bottom by 10'
E	Widen existing creek bottom by 5'	Widen existing creek bottom by 9'	Widen existing creek bottom by 14'
F	Use 58" x 36" CMP culvert	Use 65" x 40" CMP culvert	Use 72" x 44" CMP culvert
G	Provide channel of width 5', depth 2.5'	Provide channel of width 6.5', d.2.5'	Provide channel of width 8', d. 2.5'
H	Widen existing creek bottom by 1.5'	Widen existing creek bottom by 3.5'	Widen existing creek bottom by 6'
I	Widen existing creek bottom by 1'	Widen existing creek bottom by 3'	Widen existing creek bottom by 5'
J	Widen existing creek bottom by 1'	Widen existing creek bottom by 3'	Widen existing creek bottom by 6'
K	-	Use 72" x 44" CMP culvert	Use 79" x 49" CMP culvert
L	-	Use 65" x 40" CMP culvert	Use 72" x 44" CMP culvert
M	-	Widen existing creek bottom by 1'	Widen existing creek bottom by 3'
N	-	Widen existing creek bottom by 2'	Widen existing creek bottom by 5'
O	-	Widen existing creek bottom by 2'	Widen existing creek bottom by 4'
P	-	Use 72" x 44" CMP culvert	Use 79" x 49" CMP culvert
Q	-	Widen existing creek by 1'	Widen existing creek bottom by 2'
R	-	-	Use 72" x 44" CMP culvert
S	-	-	Widen existing creek bottom by 2'
T	-	-	Increase side wall height to 3'
U	-	-	Widen existing creek bottom by 1'
V	-	-	Widen existing creek bottom by 1'
W	-	-	Widen existing creek bottom by 1'

A few examples of the recommendations that are still applicable are:

1. Projects D and E shown above recommend widening the existing channel by 10 ft and 14 ft respectively. Project D is between Victoria and Rosedale, and Project E is near Garnet Ave and Tingley. These areas are still of concern and are recommended to have improvements.
2. Thurber recommended significant widening and replacement of crossings around Garnet Ave and Tingley. One bridge which was recommended to be replaced to provide hydraulic capacity for less than the 25-year event still appears to be the same bridge in place today (Number 7, Project G in the Figure below). Another bridge seems to have been replaced, but not with one of recommended capacity, as a 1050 mm diameter structural steel pipe is currently in place and the recommendation in the Thurber Report was for 1800 mm x 1100 mm or 2000 mm x 1250 mm CSP arch culvert.

3. Additionally, it was recommended that the sharp curve at 17304 Garnet Valley Road be softened to allow for better hydraulic flow conditions. This bend still exists and this location is where the resident constructed a berm next to the creek to contain the flows, and prevent property flooding.

Figure 2-4 – Excerpt Map from Thurber Report - 1974



2.8.4 Low-Level Outlet and Spillway Capacity

The low-level outlet of the dam releases flows into Eneas Creek. The approximate maximum flow through the outlet at full volume is 0.182 m³/s, based on the dam operator's daily readings from the V-notch weir during the flood events of May 2018. The low-level outlet contributes the only outflow from the dam until the water level of the lake reaches the spillway crest elevation, at which point any flow over the spillway

contributes to Eneas Creek flows. This commonly occurs during spring freshet, but varies year to year on the amount and length of time spilling occurs.

The spillway at the dam has a crest elevation of 632.76 m, and the capacity of the spillway is 38 m³/s. With upgrades to the spillway bank protection, the capacity could be upgraded to the 1:1000 year peak flow of 43 m³/s. The Garnet Reservoir Flood Inundation study included a Stage-Discharge table for the spillway, which has been reproduced as Table 2-4.

Table 2-5 Garnet Dam spillway stage - discharge

Stage (m)	Height (m)	Flow (m³/s)
632.76	0	0
632.87	0.11	1
632.92	0.16	2
633.00	0.24	4
633.06	0.30	6
633.12	0.36	8
633.18	0.42	10
633.23	0.47	12
633.27	0.51	14
633.33	0.57	16
633.37	0.61	18
633.41	0.65	20

Note: Height refers to the water depth above the spillway elevation of 632.76 m

With channel capacity restricted to 2-3 m³/s in some areas and inlet control culvert capacity (without significant surcharging) limited to 1.5-3.5 m³/s, there is significant concern about lack of carrying capacity throughout the system.

2.9 CLIMATE CHANGE

Based on available information from the Pacific Climate Impacts Consortium (PCIC)[1], the following general climate and hydrologic trends predicted for the Regional District of Okanagan-Similkameen (RDOS) are applicable to the Eneas Creek watershed:

- The climate in the RDOS is predicted to warm, and annual precipitation is predicted to increase. Summer precipitation is likely to decrease, and winter precipitation is likely to increase.

[1] https://www.pacificclimate.org/

- Snowpacks are predicted to decrease in both winter and spring.
- Increased rain-on-snow events may occur due to increased rainfall expected during winter months. Thus, snowmelt runoff is expected to decrease.
- Late fall, winter, and early spring streamflows are projected to be greater; while late spring, summer, and early fall streamflows are projected to be smaller.
- Warmer temperatures in winter may cause mid-winter thawing, increasing the risk of ice jams and subsequent flooding.
- Low flows could occur earlier and last for a longer period of time, increasing the risk of drought throughout the RDOS.
- The magnitude of extreme peak flows is projected to increase, and this could cause an increase in flood and natural hazards within the RDOS.

In addition to the information available from PCIC, Western University has developed a tool to estimate future changes in Intensity-Duration-Frequency (IDF) of rainfall events (i.e., IDF-CC Tool)[2]. The IDF-CC Tool is commonly used to help support the selection of effective climate change adaptation options at the local level, advancing the decision-making capabilities of municipalities, watershed management authorities and other key stakeholders. It has commonly been used in BC to consider projected climate change on IDF curves.

To provide an approximate idea of future changes to IDF values within or near the Eneas Creek watershed, future climate conditions were considered using the Relative Concentration Pathway (RCP) 8.5 greenhouse gas (GHG) concentration scenario. RCP scenarios consider the possible range of radiative forcing values in the year 2100 relative to pre-industrial times. The RCP8.5 scenario (selected for discussion purposes here) represents the highest warming GHG concentration scenario with GHG emissions projected to rise to the year 2100. The RCP8.5 scenario is typically used in climate change studies as a worst-case scenario for planning.

The IDF-CC Tool output (under the RCP8.5 scenario) from as many climate models as possible was used to generate estimates for future IDF values for the Summerland IDF curve (available from Environment and Climate Change Canada). The IDF-CC Tool uses output from nine climate models. No attempt was made to determine which of the relevant models worked better than others; the median (i.e., 50th percentile) output was only considered. The results were summarized for two future 50-year time periods centering on the 2030s (2011-2060) and 2070s (2051-2100). A summary of the projected changes to the Summerland IDF curve is provided in Tables 2-5 and 2-6.

[2] http://www.idf-cc-uwo.ca/

Table 2-6 Projected changes to IDF values for Summerland

Parameter	Projected Change Relative to 1981-2010 Baseline Period[1]	
	2030s	2070s
Intensity-Duration-Frequency	10-25%	30-35%

Note:

1. Approximate projected changes in rainfall intensity values for the Summerland IDF curve for all return periods based on 50th percentile output from nine climate models under the RCP8.5 scenario. A positive value indicates a projected intensity increase (in percent).

Table 2-7 Rainfall Intensity – Penticton Intensity Duration Frequency Data

Time Horizon	Rainfall Intensity 1 hour Storm at a Given Return Period (mm/hr)					
	2-year	5-year	10-year	25-year	50-year	100-year
2013	9.0	14.0	16.0	19.0	21.0	25.0
2030	10-11	15.0-17.5	17.5-20.0	21-24	23-26	27.5-31.0
2070	12.0	18.5	21.5	25.5	38.0	33.0

As can be noted in Table 2-7, the future rainfall predicted due to climate change increases in severity so that the 2013 1:25 year event could become the 1:5 year event and the 1:100 year event could become the 1:25 year event by the 2070s. Based on this it is recommended that channels be designed for increasingly frequent runoff events, and that these systems be designed to be increasingly resilient to increased flows while not causing significant damage or hardship.

3 Flood Risk Mapping

3.1 BACKGROUND MAP DATA

The District provided the following background shapefiles and data for use in mapping:

- Water Infrastructure Shapefiles
- Sanitary Infrastructure Shapefiles
- Storm Infrastructure Shapefiles
- Legal Shapefiles
- 1m 2012 Contour Shapefile
- Infrastructure Record Drawing (AutoCAD format).
- Orthographic Photos, April 2017

Additional resources accessed online, and used under appropriate usage rights, include the following:

- Open Street Map Imagery
- Google Imagery (Digital Globe)
- BC Freshwater Atlas Stream Network (WMS)
- BC Freshwater Atlas Watersheds (WMS)

3.2 FLOOD RISK MAPS

A significant part of the creek assessment was to investigate and document hazard areas. Hazard areas include locations with erosion, fallen trees, debris or blockage, structure damage, low freeboard, or flooding. Without mitigation, these areas may be subject to subsequent flooding or property damage due to future high streamflow events. The severity of the risk and damage is discussed in Section 4.

A list of hazard areas is provided in Appendix A, and each hazard has a unique ID and description for tracking purposes. Mitigation and remediation projects to address these hazards are detailed in Section 4 and Appendix C.

The project locations are identified on the flood risk maps in Appendix B. The maps are set at scale 1:2000 and cover the entire length of Eneas Creek from Garnet Lake to Okanagan Lake. The following additional information is displayed on the maps:

- Locations of surveyed cross sections with hydraulic calculations completed (refer to Section 2.8).
- Locations of surveyed crossings (culverts/bridges).

3.3 AT-RISK INFRASTRUCTURE

The Garnet Reservoir Flood Inundation Study (Agua, 2013, p.22) identified critical infrastructure at risk during a full dam breach scenario. The consequences of a dam breach are much greater than a high flow event, but the impact assessment is useful for identifying potential risks to critical infrastructure.

3.3.1 Municipal Roads

Eneas Creek crosses the following at-risk municipal roads:

- Garnet Valley Road (Sta. 0+120). The creek crosses the road at the immediate downstream end of the dam spillway. Washout of the road and culvert would cut off access to the dam controls.
- Gallaugher St. (Sta. 8+210). The creek crosses a small road that provides access to one property. The crossing comprises 1 x 750 mm and 2 x 450 mm concrete pipes.
- Garnet Ave. (Sta. 12+500). The creek crosses the road through a 1400 mm CSP culvert. Upstream of the crossing, the creek parallels the road embankment. During the 2018 flood event, the creek spilled its banks and flooded Garnet Ave. The installed emergency soil berm and Gabion baskets are still in place.
- Washington Ave. (Sta. 12+730). The creek crosses the road through a 1200 mm x 1000 m concrete box culvert.
- Victoria Road N (Sta. 13+340). The creek crosses the road through a 1200 mm x 1000 mm concrete box culvert.
- Rosedale Ave. and Verity St. (Sta. 13+780). The creek crosses under both roads through a 1400 mm concrete pipe.
- Highway 97 and Peach Orchard Road (Sta. 14+080). The creek crosses under both roads through a 1400 mm concrete pipe.
- Peach Orchard Road (Sta. 14+890). The creek crosses the road through a 1200 mm CSP culvert.
- Peach Orchard Road (Sta. 15+060). The creek crosses the road through a 1200 mm CSP culvert.
- Peach Orchard Road (Sta. 15+590). The creek crosses the road through a 1200 mm CSP culvert.
- Pohlman Ave. (Sta. 15+710). The creek crosses the road through a 1200 mm CSP culvert.
- Lakeshore Dr. N. (Sta. 15+840). The creek crosses the road through a 1200 mm CSP culvert.

Flood inundation of roads may cause localized damage to nearby properties, and road washout would require extensive remediation. In the event of road closure, alternate roads may be used for emergency vehicle access and for residential traffic. The exception to this is Garnet Valley Road, which has no permanent access to the dam from the north. If this road was closed, vehicle access to the dam would be difficult.

3.3.2 Critical Services

From a strategic level assessment, no hospitals, emergency services (fire and police), schools, and utility buildings would be directly damaged or isolated due to high streamflow events.

3.3.3 Buried Infrastructure

The District owns and maintains water, sewer, storm, and electrical utilities in the area. The creek crosses the following buried infrastructure which may be at risk if road washout were to occur:

- Water system:
  - 450 mm CL pipe at Garnet Valley Road near the dam
  - 100 mm PVC pipe at private driveway (Sta. 10+212)

- 100 mm CI pipe at Garnet Ave. (Sta. 12+486)
- 300 mm AC pipe at Garnet Ave. (Sta. 12+494)
- 150 mm AC pipe at Washington Ave. (Sta. 12+770)
- 100 mm CI pipe at Victoria Road N (Sta. 13+350)
- 750 mm PCCP pipe at Rosedale Ave. (Sta. 13+775)
- 100 mm BB pipe at Rosedale Ave. (Sta. 13+775)
- 200 mm AC pipe at Peach Orchard Road (Sta. 15+070)
- 150 mm BB pipe at Peach Orchard Road (Sta. 15+605)
- 150 mm PVC pipe at Pohlman Ave. (Sta. 15+710)
- 150 mm PVC pipe at Lakeshore Dr. N (Sta. 15+845)

- Sanitary system
  - 200 mm PVC pipe at Rosedale Ave. (Sta. 13+775)
  - 200 mm PVC pipe at Peach Orchard Road (Sta. 15+245)
  - 200 mm PVC pipe at Peach Orchard Road (Sta. 15+605)
  - 200 mm PVC pipe at Pohlman Ave. (Sta. 15+710)
  - 100 mm PVC Forcemain at Lakeshore Dr. N (Sta. 15+845)
  - 75 mm PVC pipe at Lakeshore Dr. N (Sta. 15+845)
- Stormwater system
  - 300 mm CSP pipe at Peach Orchard Road (Sta. 14+050)
- Electrical system
  - Size #2 (x2) and 350 U/G Conductors at Rosedale Ave. (Sta. 13+775).

Services and private connections have not been assessed. Station values refer to the chainage along Eneas Creek as per the mapping in Appendix A. All pipe sizes and materials have been referenced from the District GIS database.

4 Mitigation and Remediation

The recommended remediation and mitigation projects are identified below in Tables 4-1 to 4-5, with Class D Cost Estimates. Detailed project sheets are included in Appendix C.

We have categorized the projects into the following:

- Mitigation (M) projects focus on increasing the capacity of the creek to prevent future damage. Project examples include removing existing obstructions, installing erosion protection, and providing controlled overflow paths.
- Planning (P) projects encompass the entire creek system and are intended to improve the nature of development along the creek to protect and improve riparian areas.
- Remediation (R) projects are recommended to repair damage to the system caused by previous high flow events.
- Temporary Works Removal (T) are required to remove the risk of failure, as these defences are generally placed in emergency scenarios and not intended for long term use.
- Operations and Maintenance (O) activities are crucial in ensuring the system is functioning well, and to monitor the creek for hazards which may lead to future flooding or erosion.

4.1 GENERAL RECOMMENDATIONS

General recommendations include the improvement of guidelines for development in District bylaws to protect riparian areas from future development, in accordance with the *Riparian Areas Regulation* (Appendix E). This regulation, in general, stipulates that any activity that could impact a watershed within 30 m of the highwater mark of a stream, creek, river or lake needs to be assessed by a Qualified Environmental Professional (QEP) to determine appropriate setback limits to maintain the riparian area. In addition, it is recommended that the District protects its natural assets, such as flood plains, wetlands, ponds, or riparian areas, which are of enormous benefit to managing flooding in more urban areas. These areas include privately owned land; therefore, a review by a QEP will assist in regulating development in these areas. The District could acquire or work with a non-profit organization to acquire some of these areas to protect them in the future. These natural assets provide significant value. If these areas are removed, downstream flows can increase which causes additional erosion and flood damage, which either costs more to mitigate the high flows or costs more in repairs, recovery or insurance payouts. Additionally, a brief annual inspection of all culverts before freshet would be beneficial in identifying any potential hazards along the creek that may cause issues as flows increase.

Table 4-1 Recommended Projects – General

Descriptor	General Projects	Cost Estimate
P	Project 0.1: Riparian Setback Guidelines	$14,000
P	Project 0.2a: Natural Asset Development/Protection - Guidelines	$12,500
P	Project 0.2b: Natural Asset Development/Protection - Acquisition per Acre	$12,500
O	Project 0.3: Inspect and Maintain Private Crossings	$4,500
O	Project 0.4: Inspect and Maintain Public Crossings	$4,500

Notes: M – Mitigation, P - Planning, R – Remediation, T – Temporary Works Removal, O – Operations and Maintenance

4.2 REACH 1 RECOMMENDATIONS

Reach 1 consists of high velocity, erosive flows as the creek flows down a steep ravine before passing through residential properties and spilling into Okanagan Lake. While other reaches typically have a concern with flooding and water inundation, this reach has a greater general concern of erosion. Recommended projects include erosion remediation, danger tree assessment and removals, channel and culvert improvements to protect infrastructure, dredging, and future property acquisition at constricted areas and the lake outlet.

Table 4-2 Recommended Projects – Reach 1

Descriptor	Reach 1 Projects	Cost Estimate
R/M	Project 1.1: Remediate Trail Section	$192,000
R	Project 1.2: Remove Lock Blocks and Restore Bank Stability	$23,300
R/M	Project 1.3: Remediate Creek Banks – Campground Area	$37,300
M	Project 1.4: Improve Concrete Channel – Peach Orchard Rd. Crossing	$61,000
M	Project 1.5: Property Redevelopment – Peach Orchard Rd. Crossing	$313,000
M	Project 1.6: Replace Culvert - Pohlman Rd. Crossing	$110,100
R	Project 1.7: Remediate Erosion	$21,100
M	Project 1.8: Short Term - Lake Outlet - Dredging	$104,000
M	Project 1.9: Long Term - Lake Outlet – Property Redevelopment	$230,000

Notes: M – Mitigation, P - Planning, R – Remediation, T – Temporary Works Removal, O – Operations and Maintenance

4.3 REACH 2 RECOMMENDATIONS

Reach 2 is characterized by an urban, typically denser residential development along Eneas Creek which can constrain creek flows. The general concern with this section is the proximity of the properties and structures to the creek. Many structures are within 30 m of the creek banks, which is the buffer area that requires assessment by a QEP under the *Riparian Areas Regulation* (Appendix E). To reduce concerns of flooding and erosion in residential areas, the channel should be widened to reduce flow depth and velocity. As the channel grade gets steeper towards Highway 97, measures should be taken to decrease flow velocity to decrease potential future erosion. The erosion that has occurred along the slope in this location must be remediated to prevent further slope failure and potential loss of a structure. As Highway 97 and Peach Orchard Road are critical transportation links, we recommend that the culvert beneath the highway overpass be inspected, and that the inlet to the crossing be improved, including the construction of an access for emergency equipment to keep this clear from blockage in the future.

Table 4-3 Recommended Projects – Reach 2

Descriptor	Reach 2 Projects	Cost Estimate
M	Project 2.1: Improve Flow Conditions – Washington Ave. to Victoria Rd. N (100m Phases)	$108,000
M	Project 2.2: Prevent or Manage Scour/Erosion	$75,000
R	Project 2.3: Remediate Erosion at Garage at Peach Orchard Rd.	$45,100
M	Project 2.4: Inspect Pipe Crossing under Peach Orchard Rd. and Highway 97	$5,600
M	Project 2.5a: Inlet Access - Peach Orchard Rd. and Highway 97	$14,000
M	Project 2.5b: Inlet Improvements - Peach Orchard Rd. and Highway 97	$26,100

Notes: M – Mitigation, P - Planning, R – Remediation, T – Temporary Works Removal, O – Operations and Maintenance

4.4 REACH 3 RECOMMENDATIONS

The creek meanders through many agricultural properties in Reach 3. Issues along this stretch typically are related to flood inundation, driveway crossing restrictions, vegetation overgrowth, and channel capacity due to past human influence. The recommendations in this reach are intended to allow the creek to naturally manage high and low flows. Generally, confining a creek increases water surface elevations, increases velocities and therefore increases erosion potential and risk of failure. If creeks are allowed to naturally meander and spread out during high flow events, velocities and water surface elevations will be lower than in a confined channel configuration. General recommendations along this reach are to:

- Increase culvert size and adjust alignments to have greater hydraulic capacity,
- Construct overflow routes across driveways, or around structures where overflow is expected,
- Remove obstructions in the channel that choke the flow causing inundation upstream,

- Remove the temporary works/permanent works that act as berms/dykes and have significant risk of failure and consequence if failure is not managed properly,
- Modify temporary works that were placed in 2018 to allow for increased flow and protection of infrastructure, and
- Consider long-term solutions along this reach including realigning/naturalizing the creek in areas where it has been constructed as a ditch-style cross section.

Table 4-4 Recommended Projects – Reach 3

Descriptor	Reach 3 Projects	Cost Estimate
O	Project 3.1a: Maintenance Removal of Weir – Garnet Valley Road	$150
M	Project 3.1b: Construct Overflow Spillway – Numerous Locations Garnet Valley Road	$5,600
M	Project 3.1c: Improve Culvert Capacity – Numerous Locations Garnet Valley Road	$19,000
M	Project 3.2a: Re-align Culverts along Creek – Numerous Locations Garnet Valley Road	$28,900
M	Project 3.2b: Remove Hazards Caused by Culverts – Numerous Locations Garnet Valley Road	$9,900
M	Project 3.3: Produce Natural Drainage and Overflow Routes - Numerous Locations Garnet Valley Road	$28,000
M	Project 3.4: Remove Obstructions in Channel - 19804 Garnet Valley for Example	$26,100
T/R	Project 3.5: Remove Temporary or Permanent Berms	$89,000
M	Project 3.6: Re-align Creek to Natural Flow Route	$141,250
T/R	Project 3.7: Short Term - Improve Capacity - Garnet Ave. and Tingley St.	$120,700
M	Project 3.8: Long Term - Re-align Creek to Natural Flow Route – Garnet Ave. and Tingley St.	$304,000

Notes: M – Mitigation, P - Planning, R – Remediation, T – Temporary Works Removal, O – Operations and Maintenance

4.5 REACH 4 RECOMMENDATIONS

Recommendations in Reach 4 relate to maintaining access to the dam, preserving the natural characteristics of the creek, and maintaining this natural asset. There has been significant beaver activity in this area and, while beavers can appear to be a nuisance, they are beneficial in mitigating downstream flooding; however, their activity and numbers should be managed. The trees along the road slopes should be protected from beaver damage to avoid weakening the slope and making it susceptible to erosion. Their numbers should be managed to prevent the population from increasing and taking up residence in areas

where their activities could have more public impact. Their activities should be monitored pre-winter and pre-freshet to determine if mitigation measures are required to improve drainage out of this area during high flow events and protect the road from inundation. A mitigation option would be to raise the section of the road that has minimal freeboard by approximately 300 mm to decrease the inundation potential. To address tree harvesting (i.e., for firewood) near the creek, a public education program is recommended reminding the public that harvesting trees near the creek is against the law and harvesting for firewood is only allowed with dead or dead standing trees more than 30 m away from a watercourse.

Table 4-5 Recommended Projects – Reach 4

Descriptor	Reach 4 Projects	Cost Estimate
O	Project 4.1: Beaver Management – Dam Access Road	$28,700
M	Project 4.2: Increase Elevation of the Road – Dam Access Road	$252,000
P	Project 4.3: Public Education – Dam Access Road	$5,000

Notes: M – Mitigation, P - Planning, R – Remediation, T – Temporary Works Removal, O – Operations and Maintenance

4.6 PROJECT PRIORITY RATINGS

See below for priority rating of the projects. The projects have been separated into public (District) projects and private projects.

Table 4-6
Projects Priority Rating Rubric

General Ranking Scale	1	is the least concern for an attribute/hardest to construct
	10	is the most concern for an attribute/easiest to construct
Capacity Ranking Scale	1	is the least concern due to high flows
	10	is the most concern due to high flows
Ranking score	**7.5+**	Should proceed with this project within one year
	6 to 7.4	Should proceed with this project within two-five years
	4 to 5.9	Should proceed with this project within five to ten years
	1 to > 4	Proceed depending on a specific project basis

Table 4-7
Public Projects Priority Rating

Public	Descriptor	Public Projects	Cost Estimate	Life Safety Risk	Infrastructure Risk	Environmental Risk/Reward	Climate Change/Channel Capacity Risk	Construction Complexity	Economic Risk	Total
				35%	25%	15%	10%	7.5%	7.5%	100%
Public	M	Project 2.4: Inspect Pipe Crossing under Peach Orchard Rd. and Highway 97	$ 5,600	9	9	5	7	8	9	8.8
Public	M	Project 2.5a: Inlet Access - Peach Orchard Rd. and Highway 97	$ 14,000	9	9	5	7	8	9	8.8
Public	M	Project 2.5b: Inlet Improvements - Peach Orchard Rd. and Highway 97	$ 26,100	9	9	5	3	8	9	8.4
Public	R/M	Project 1.1: Remediate Trail Section	$ 192,000	7	8	8	10	5	5	7.78
Public	O	Project 4.1: Beaver Management – Dam Access Road	$ 28,700	8	8	8	8	8	3	7.85
Public/Private	O	Project 0.3: Inspect and Maintain Private Crossings	$ 4,500	7	8	3	7	10	4	6.95
Public	O	Project 0.4: Inspect and Maintain Public Crossings	$ 4,500	7	8	3	7	10	4	6.95
Public	M	Project 1.6: Replace Culvert - Pohlman Rd. Crossing	$ 110,100	8	5	7	7	5	4	6.78
Public	T/R	Project 3.7: Short Term - Improve Capacity - Garnet Ave. and Tingley St.	$ 120,700	3	7	8	10	3	8	6.43
Public	P	Project 0.1: Riparian Setback Guidelines	$ 14,000	6	3	8	10	10	3	6.25
Public	R	Project 1.2: Remove Lock Blocks and Restore Bank Stability	$ 23,300	3	8	5	9	9	5	6.13
Public/Private	P	Project 4.3: Public Education – Dam Access Road	$ 5,000	5	5	8	4	8	3	5.65
Public	R/M	Project 1.3: Remediate Creek Banks – Campground Area	$ 37,300	3	4	8	7	8	5	5.3
Public	P	Project 0.2a: Natural Asset Development/Protection - Guidelines	$ 12,500	3	4	8	10	10	2	5.3
Public	P	Project 0.2b: Natural Asset Development/Protection - Acquisition per Acre	$ 12,500	3	4	8	10	10	2	5.3
Public	M	Project 4.2: Increase Elevation of the Road – Dam Access Road	$ 252,000	5	8	2	8	4	3	5.6
Public	M	Project 2.2: Prevent or Manage Scour/Erosion	$ 75,000	6	5	5	4	6	2	5.25
Public	M	Project 2.1: Improve Flow Conditions – Washington Ave. to Victoria Rd. N (100m Phases)	$ 108,000	2	2	7	9	4	6	4.35

Table 4-8
Private Project Priority Rating

Private	Descriptor	General Projects	Cost Estimate	Life Safety Risk	Infrastructure Risk	Environmental Risk/Reward	Climate Change/Channel Capacity Risk	Construction Complexity	Economic Risk	Total
				35%	25%	15%	10%	7.5%	7.5%	100%
Private	R	Project 2.3: Remediate Erosion at Garage at Peach Orchard Rd.	$ 45,100	8	8	5	9	7	6	7.88
Private	M	Project 3.8: Long Term - Re-align Creek to Natural Flow Route – Garnet Ave. and Tingley St.	$ 304,000	4	8	10	10	2	7	7.1
Private	O	Project 3.1a: Removal of Weir – Garnet Valley Road	$ 150	8	4	4	8	8	4	6.4
Private	M	Project 3.1b: Construct Overflow Spillway – Numerous Locations Garnet Valley Road	$ 5,600	8	4	4	8	7	4	6.33
Private	M	Project 1.4: Improve Concrete Channel – Peach Orchard Rd.	$ 61,000	8	3	7	5	2	6	6.15
Private	M	Project 3.6: Re-align Creek to Natural Flow Route	$ 141,250	4	7	8	5	2	7	6.05
Private	M	Project 1.5: Property Redevelopment – Peach Orchard Rd. Crossing	$ 313,000	8	3	4	5	2	3	5.25
Private	T/R	Project 3.5: Remove Temporary or Permanent Berms	$ 89,000	4	6	6	5	2	5	5.2
Private	M	Project 3.2b: Remove Hazards Caused by Culverts – Numerous Locations Garnet Valley Road	$ 9,900	8	2	2	6	6	2	4.95
Private	M	Project 3.1c: Improve Culvert Capacity – Numerous Locations Garnet Valley Road	$ 19,000	4	5	4	8	4	4	4.95
Private	M	Project 3.3: Produce Natural Drainage and Overflow Routes - Numerous Locations Garnet Valley Road	$ 28,000	3	2	5	9	7	5	4.48
Private	M	Project 3.4: Remove Obstructions in Channel - 19804 Garnet Valley for Example	$ 26,100	3	5	5	5	3	4	4.38
Private	M	Project 3.2a: Re-align Culverts along Creek – Numerous Locations Garnet Valley Road	$ 28,900	4	4	4	6	2	4	4.35
Private	M	Project 1.9: Long Term - Lake Outlet – Property Redevelopment	$ 230,000	2	2	8	10	2	4	4.15
Private	R	Project 1.7: Remediate Erosion	$ 21,100	2	2	5	7	6	3	3.55
Private	M	Project 1.8: Short Term - Lake Outlet - Dredging	$ 104,000	2	2	2	10	7	3	3.48

4.7 POTENTIAL FUNDING AVAILABLE

In areas where the damage from the 2017 or 2018 is being remediated to prevent future problems, there is the ability to apply for 80% of the funding for remediation through the EMBC program, and the District can work with EMBC to determine if any of the improvement costs could also be covered under that program. Areas where works are to remove temporary works funded through EMBC qualify for 100% funding for the removals. In addition, there are funding streams available for bio-engineering and restoration solutions like these. See Table 5-1 for potential sources.

Table 4-9
Funding Streams

Funding Source	Funding Information	Qualifying Bodies
Provincial		
Ministry of Municipal Affairs and Housing Infrastructure Planning Grant Program	Grants up to $10,000 are available to help improve or develop long-term comprehensive plans that include: capital asset management plans, integrated stormwater management plans, water master plans and liquid waste management plans. Grants can be used for a range of activities related to assessing the technical, environmental and/or economic feasibility of municipal infrastructure projects.	Local government
Ministry of Municipal Affairs and Housing Asset Management Planning Program	The intent of the program is to assist local governments in delivering sustainable services by extending and deepening asset management practices within their organizations. Since 2015, 142 grants have been awarded to 100 local governments.	Local government
Union of British Columbia Municipalities Community Emergency Preparedness Fund	The Community Emergency Preparedness Fund (CEPF) is a suite of funding programs intended to enhance the resiliency of local governments and their residents in responding to emergencies. Funding is	Local government

Funding Source	Funding Information	Qualifying Bodies
	provided by the Province of BC and is administered by UBCM. CEPF was announced as part of an $80 million announcement from the Ministry of Transportation & Infrastructure.	
Habitat Conservation Trust Foundation Multiple Grants	The Habitat Conservation Trust Foundation has provided over $160 million dollars in grant money to more than 2,500 conservation projects in BC. They fund a variety of conservation work including: •Projects that restore, maintain, or enhance native freshwater fish and wildlife populations and habitats; •Environmental education and stewardship projects; •Projects that acquire land or interests in land to secure the value of these areas for conservation purposes.	Various
Federal		
Federation of Canadian Municipalities Municipal Asset Management Program	The Municipal Asset Management Program is a five-year, $50-million program that will support Canadian cities and communities to make informed decisions about infrastructure, such as the planning and construction of roads, recreational facilities, and water and wastewater systems.	Local government
Federation of Canadian Municipalities Municipalities for Climate Innovation Program	The Municipalities for Climate Innovation Program provides funding, training and resources to help municipalities adapt to the impacts of climate change and reduce greenhouse gas (GHG) emissions.	Local government

Funding Source	Funding Information	Qualifying Bodies
Federation of Canadian Municipalities Green Municipal Fund	The Green Municipal Fund provides funding for plans, feasibility studies, pilot projects and capital projects.	Local government
Environment Canada Habitat Stewardship Program (HSP) for Species at Risk	The overall goals of the HSP are to "contribute to the recovery of endangered, threatened, and other species at risk, and to prevent other species from becoming a conservation concern, by engaging Canadians from all walks of life in conservation actions to benefit wildlife." The HSP allocates approximately $12.2 million per year to projects that both conserve and protect species at risk and their habitats and to those that prevent other species from becoming a conservation concern.	Various
Environment Canada National Wetland Conservation Fund (NWCF)	The NWCF supports on-the-ground activities to restore and enhance wetlands in Canada. Some objectives of the fund are to: •Restore degraded or lost wetlands on working and settled landscapes to achieve a net gain in wetland habitat area; •Enhance the ecological functions of existing degraded wetlands; and •Encourage the stewardship of Canada's wetlands by industry and the stewardship and enjoyment of wetlands by the public.	Various
Environment Canada Environmental Damages Fund (EDF)	The EDF is a specified-purpose account to manage funds received as compensation for environmental damage. The EDF primarily supports the restoration of natural resources and environment, and wildlife conservation	Various

Funding Source	Funding Information	Qualifying Bodies
	projects in the same geographic area where the damage originally occurred. The EDF also supports research and development on environmental damage assessment and restoration, and education on pollution prevention and the restoration of natural resources.	
Environment Canada EcoAction Community Funding Program	The EcoAction Community Funding Program funds projects across Canada to encourage Canadians to take action to address clean air, clean water, climate change and nature issues, and to build the capacity of communities to sustain these activities into the future. Clean water eligible projects focus on reducing or diverting substances that negatively affect water quality or focus on water-use efficiency and conservation (e.g., reduction of nutrient load, contaminants or toxics in waterbodies).	Various

5 Conclusions and Recommendations

Eneas Creek flows from Garnet Lake to Okanagan Lake, a distance of approximately 15 km. From the dam on Garnet Lake, Eneas creek flows downstream with minimal human impact for the first 5 km. The creek then enters Garnet Valley where there are numerous small acreages in which impacts to the creek, and creek impacts to the community, are observed and noted. The creek then flows through town in a “ditched” channel close to numerous structures, followed by a steep downhill section before reaching Okanagan lake at its mouth. Eneas Creek flooded in spring of 2017 and 2018. The estimated return period of the 2018 event around the Okanagan Valley has been estimated at approximately 1:150 years, though each catchment would have undergone different flows dependent on watershed elevations and flow controls for example.

The primary focus of work along this creek should be in areas where flooding or impacts of failure would be the most widespread, to maximize the benefits from the work. For this reason, it is recommended that most of the initial work is focused on the final reach between town and Okanagan Lake since failure or issues in this area would have quick and compounding effects. Areas further upstream will have fewer properties or structures impacted, and the velocities are anticipated to be significantly lower, allowing more time to react to rising water levels.

In the future, it is recommended that the District should consider resiliency of the creek system and how to co-exist with these systems to limit human impact on the creek and to limit the creek’s impact on the community. Based on this assessment there are a number of projects that should be addressed immediately, while there are other projects which will take some additional planning and consideration prior to moving forward with.

Certification Page

This assessment of Eneas Creek was prepared for the District of Summerland to identify areas along the creek where remediation or mitigation works are recommended to reduce risk to the community. We trust the results of this study will aid the District in planning efforts to improve the resiliency of the Creek.

The services provided by Associated Engineering (B.C.) Ltd. in the preparation of this report were conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions. No other warranty expressed or implied is made.

Respectfully submitted,
Associated Engineering (B.C.) Ltd.

Prepared by:

2019-04-12

Chris Duncan, EIT
Water Resources Engineer-in-Training

Michael Owen, P.Eng.
Civil Engineer

CD/MO/lw

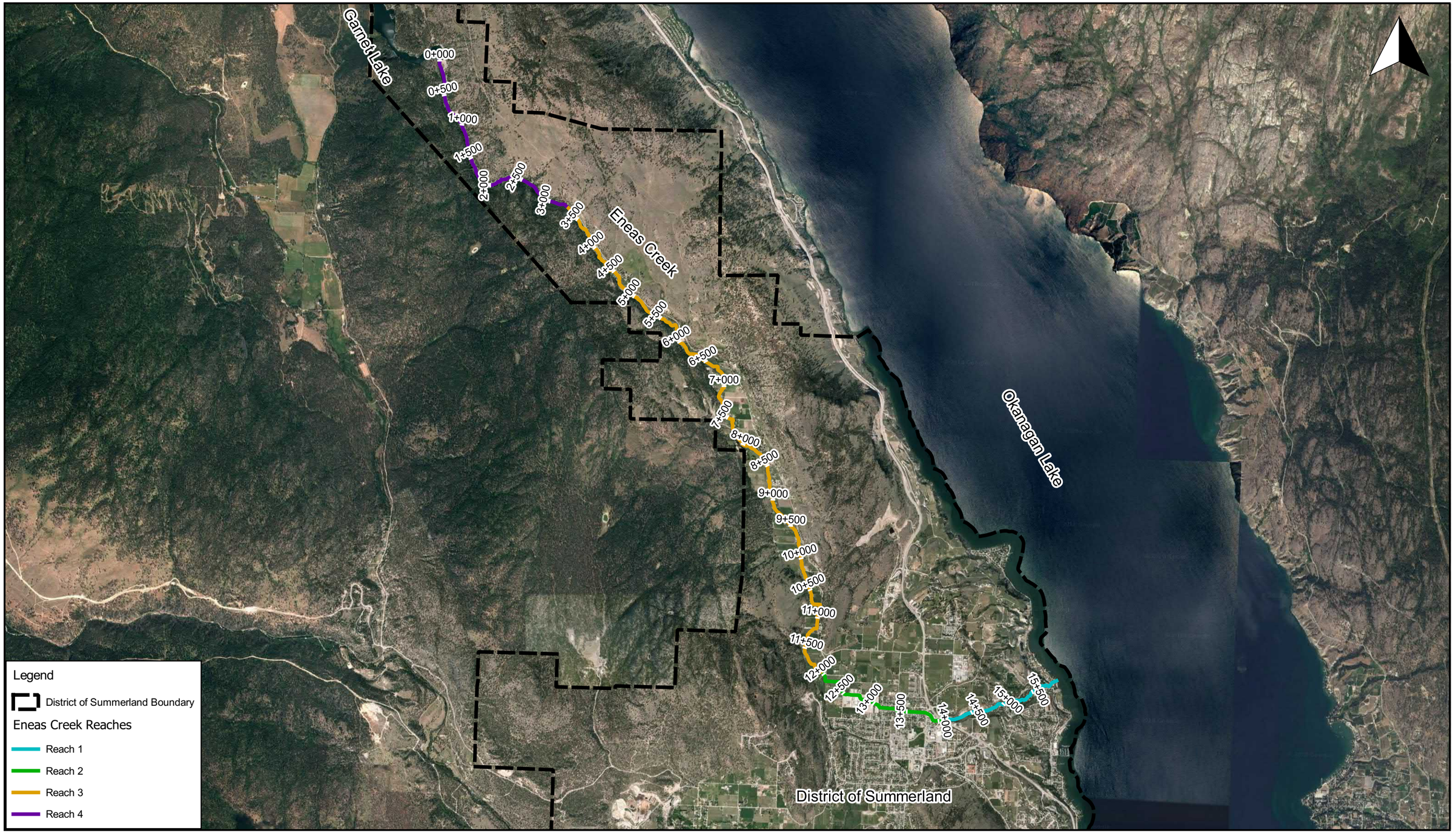
Appendix A – List of Hazard Areas

ID	Hazard Type	Station	Description
1	Fallen trees	0+245	Fallen trees in and across channel.
2	Vegetation	0+257	Vegetation growing in channel.
3	Fallen trees	0+323	Fallen trees in and across channel.
4	Fallen trees	0+708	Fallen trees in and across channel.
5	Channel	2+362	Pond elevation close to road.
6	Flood	2+368	Pond resulting from beaver activity.
7	Erosion	3+157	Significant bank erosion.
8	Fallen trees	3+177	Fallen trees in and across channel.
9	Vegetation	3+723	Vegetation overgrown at 1200 CSP culvert inlet.
10	Culvert	3+781	Exposed rods blocking inlet/outlet of 1050 steel pipe.
11	Culvert	3+961	Inlet partially blocked (manmade weir at pond outlet.
12	Channel	4+033	No defined channel, water flowing over land.
13	Erosion	4+706	Residents reported land slide on slope during spring 2018.
14	Channel	4+783	Low freeboard (300 mm at time of survey) observed here. 2500 mm wide and 500 mm deep measured.
15	Erosion	4+794	Large willow tree being undermined.
16	Culvert	4+825	Culvert seems offset from main channel. Vegetation at inlet.
17	Channel	4+840	Culvert outlet directed at tree, undermining.
18	Flood	5+311	Field floods in past events, can be seen on aerial imagery.
19	Vegetation	5+757	Dense brush, overgrown creek channel.
20	Bridge	6+984	1600w x 1500h driveway bridge. Possible undermining of abutments.
21	Bridge	7+092	1700w x 900h bridge. Resident has PVC pipe running beneath the bridge deck.
22	Channel	7+429	Flat area, channel does not follow low path to pond.
23	Inflow	7+444	Resident noted a spring in this location.
24	Erosion	7+525	Trees very close to edge of channel. Fence dangling over channel.
25	Channel	7+575	The creek alignment does not follow the natural contours. This is the local low area - flood hazaRoad
26	Culvert	8+224	1 x 750, 2 x 450 concrete pipes. Low capacity and small opening.
27	Flood	8+370	Area flooded in spring 2018.
28	Flood	9+373	Typical wetland area, floods in spring.
29	Vegetation	9+561	Dense brush along channel.
30	Channel	9+744	Concrete abutment in channel.
31	Wall	10+837	Temporary berm still in place along road.
32	Flood	10+881	Flooding in orchard occurred in 2018.

ID	Hazard Type	Station	Description
33	Vegetation	11+076	Dense brush along channel.
34	Inflow	11+454	Residents report flows from this direction, locally known as Carcajou creek.
35	Vegetation	11+985	Dense brush along channel.
36	Wall	12+137	Gabion wall (south) and temporary berms (north) still in place.
37	Wall	12+354	Temporary berm still in place along road.
38	Flood	12+454	Water flowed over the road in Spring 2018.
39	Culvert	12+640	Mapping shows 45°, but this is a 90° bend in the culvert.
40	Wall	13+216	Concrete wall in channel.
41	Channel	13+279	Tight corridor, some erosion/undermining. Trees close to channel banks.
42	Wall	13+372	Curved wall impinges flow at a tight radius. Wall damage and/or breach may cause residential floods.
43	Channel	13+424	Narrow corridor.
44	Wall	13+485	Temporary works (sandbags) remain in place.
45	Ice	13+660	Ice buildup issues at culvert.
46	Wall	13+710	Temporary works (sandbags) still in place and supporting asphalt in parking lot.
47	Erosion	13+842	Trees undermined.
48	Erosion	13+925	Bank erosion, trees near channel being undermined.
49	Fallen Trees	13+983	Fallen trees and erosion along bank and existing trees.
50	Erosion	13+985	Major bank erosion and instability. Garage is close to top edge of bank.
51	Culvert	14+001	Inlet grizzly rack has clogged with debris in the past. There is no machinery access to the inlet.
52	Erosion	14+112	Erosion from road runoff.
53	Erosion	14+178	Bank erosion. Trees near channel edge being undermined. Foot path bridge risk of erosion.
54	Fallen trees	14+180	Trees down across channel.
55	Channel	14+229	Flow has broken from main channel and impinging on a tree.
56	Vegetation	14+236	Thick brush and trees along channel.
57	Erosion	14+264	Major bank erosion and instability.
58	Erosion	14+316	Bank erosion along road embankment.
59	Erosion	14+425	Bank erosion and instability. Slope failure along walking trail.
60	Fallen trees	14+820	Fallen trees across channel.
61	Debris	14+924	Wood and debris in channel
62	Erosion	15+156	Bank Instability and slope failure. Temporary lock blocks still in place.

ID	Hazard Type	Station	Description
63	Bridge	15+184	Potential undermining of clear span driveway bridge.
64	Channel	15+235	A side channel exists through this area.
65	Wall	15+239	Temporary (sandbag) channel wall remains in place alongside of home.
66	Flood	15+412	One campsite was lost during 2018 floods.
67	Erosion	15+584	Some bank erosion observed.
68	Wall	15+622	Erosion and undermining of wall. A sinkhole has formed behind the wall.
69	Fallen trees	15+702	Fallen trees, bank erosion, and tree fall danger.
70	Culvert	15+710	Culvert shows major deflection along the profile.
71	Wall	15+881	Creek water level is above ground elevation. A concrete and rock wall retains flow. House at risk.
72	Bridge	15+901	Little clearance beneath bridge.
73	Debris	15+920	Significant sedimentation at creek delta.

Appendix B – Flood Risk Mapping



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NO.	DATE	ENG	BY	SUBJECT
B	2019/01/18	M.O.	C.D.	ISSUED FOR DRAFT REPORT
A	2018/12/05	M.O.	C.D.	ISSUED FOR REVIEW

REVISIONS

Notes:
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Data Sources
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DISTRICT OF SUMMERLAND

Associated Engineering

Project No.	20182441-00
Scale:	1:50,000
Drawn:	C. DUNCAN
Approved:	M. OWEN
Projection:	UTM ZONE 11N
Date:	2018/10/31

ENEAS CREEK ASSESSMENT FLOOD RISK MAPPING OVERVIEW MAP

DISTRICT OF SUMMERLAND

DRAWING	REV NO.	SHEET
2441-00-C-001	B	1 / 23

File: \\S-van-fs-01\projects\20182441\00_Eneas_Creek_Assmt\Working_Dwgs\010_GIS\map_eneas_creek_assmt_20181029_cd.qgs
Date: 2019-01-22T15:18:06

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NO.	DATE	ENG	BY	SUBJECT
B	2019/01/18	M.O.	C.D.	ISSUED FOR DRAFT REPORT
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Project No.	20182441-00
Scale:	1:5000
Drawn:	C. DUNCAN
Approved:	M. OWEN
Projection:	UTM ZONE 11N
Date:	2018/10/31

ENEAS CREEK ASSESSMENT FLOOD RISK MAPPING REACH 1

DISTRICT OF SUMMERLAND

DRAWING	REV NO.	SHEET
2441-00-C-002	B	2 / 23

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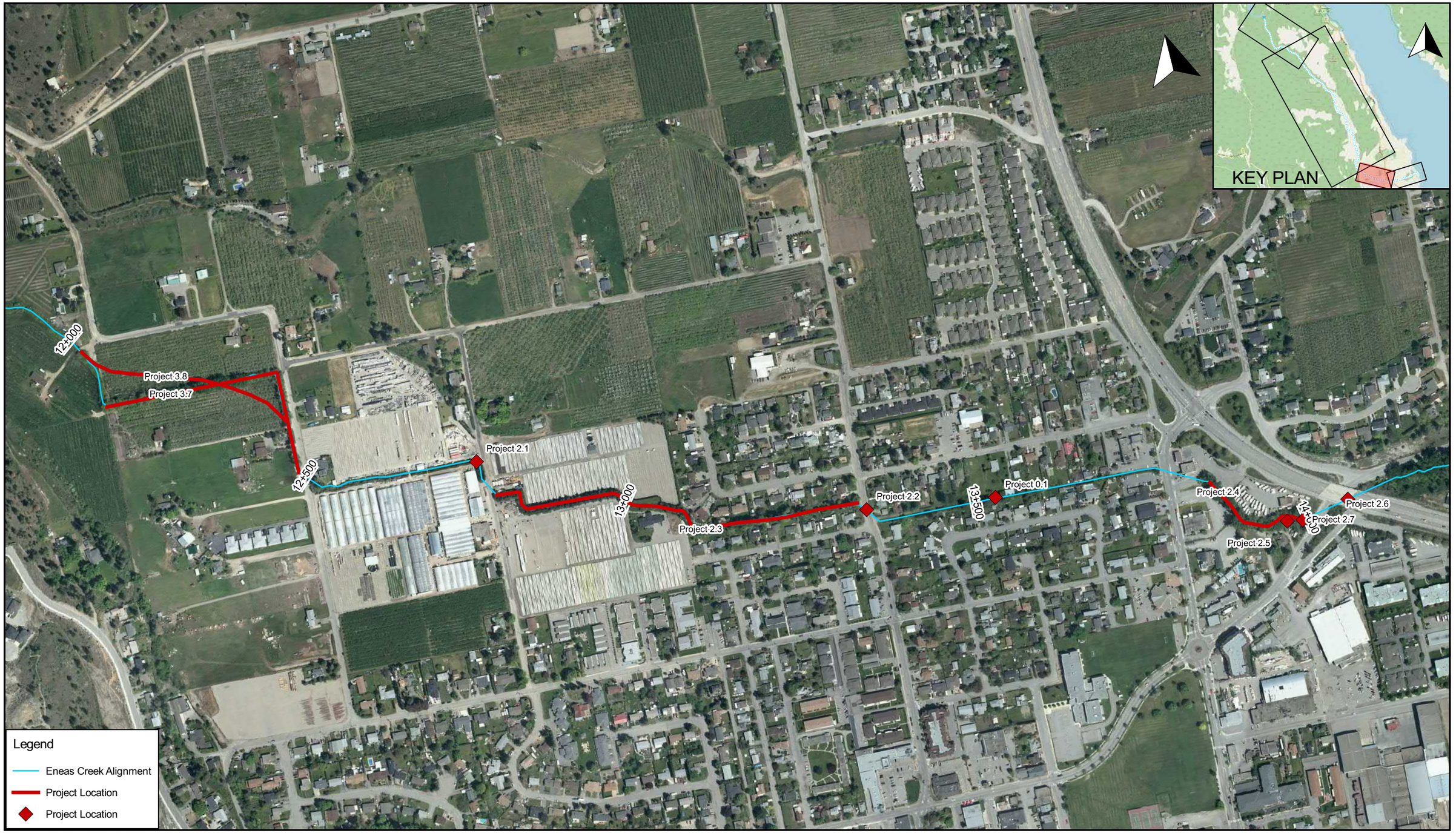

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NO.	DATE	ENG	BY	SUBJECT
B	2019/01/18	M.O.	C.D.	ISSUED FOR DRAFT REPORT
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Scale:	1:5000
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Approved:	M. OWEN
Projection:	UTM ZONE 11N
Date:	2018/10/31

ENEAS CREEK ASSESSMENT FLOOD RISK MAPPING REACH 2

DISTRICT OF SUMMERLAND

DRAWING	REV NO.	SHEET
2441-00-C-003	B	3 / 23

File: \\S-van-fs-01\projects\20182441\00_Eneas_Creek_Assmt\Working_Dwgs\010_GIS\map_eneas_creek_assmt_20181029_cd.qgs
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NO.	DATE	ENG	BY	SUBJECT
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Projection:	UTM ZONE 11N
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ENEAS CREEK ASSESSMENT FLOOD RISK MAPPING REACH 3

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DRAWING	REV NO.	SHEET
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NO.	DATE	ENG	BY	SUBJECT
B	2019/01/18	M.O.	C.D.	ISSUED FOR DRAFT REPORT
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Project No.	20182441-00
Scale:	1:10000
Drawn:	C. DUNCAN
Approved:	M. OWEN
Projection:	UTM ZONE 11N
Date:	2018/10/31

ENEAS CREEK ASSESSMENT FLOOD RISK MAPPING REACH 4

DISTRICT OF SUMMERLAND

DRAWING	REV NO.	SHEET
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NO.	DATE	ENG	BY	SUBJECT
B	2019/01/18	M.O.	C.D.	ISSUED FOR DRAFT REPORT
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Projection:	UTM ZONE 11N
Date:	2018/10/31

ENEAS CREEK ASSESSMENT
FLOOD RISK MAPPING

DISTRICT OF SUMMERLAND

DRAWING	REV NO.	SHEET
2441-00-C-101	B	6 / 23

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Date: 2019-01-21T10:44:03

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NO.	DATE	ENG	BY	SUBJECT
B	2019/01/18	M.O.	C.D.	ISSUED FOR DRAFT REPORT
A	2018/11/27	M.O.	C.D.	ISSUED FOR REVIEW

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ENEAS CREEK ASSESSMENT FLOOD RISK MAPPING

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DRAWING	REV NO.	SHEET
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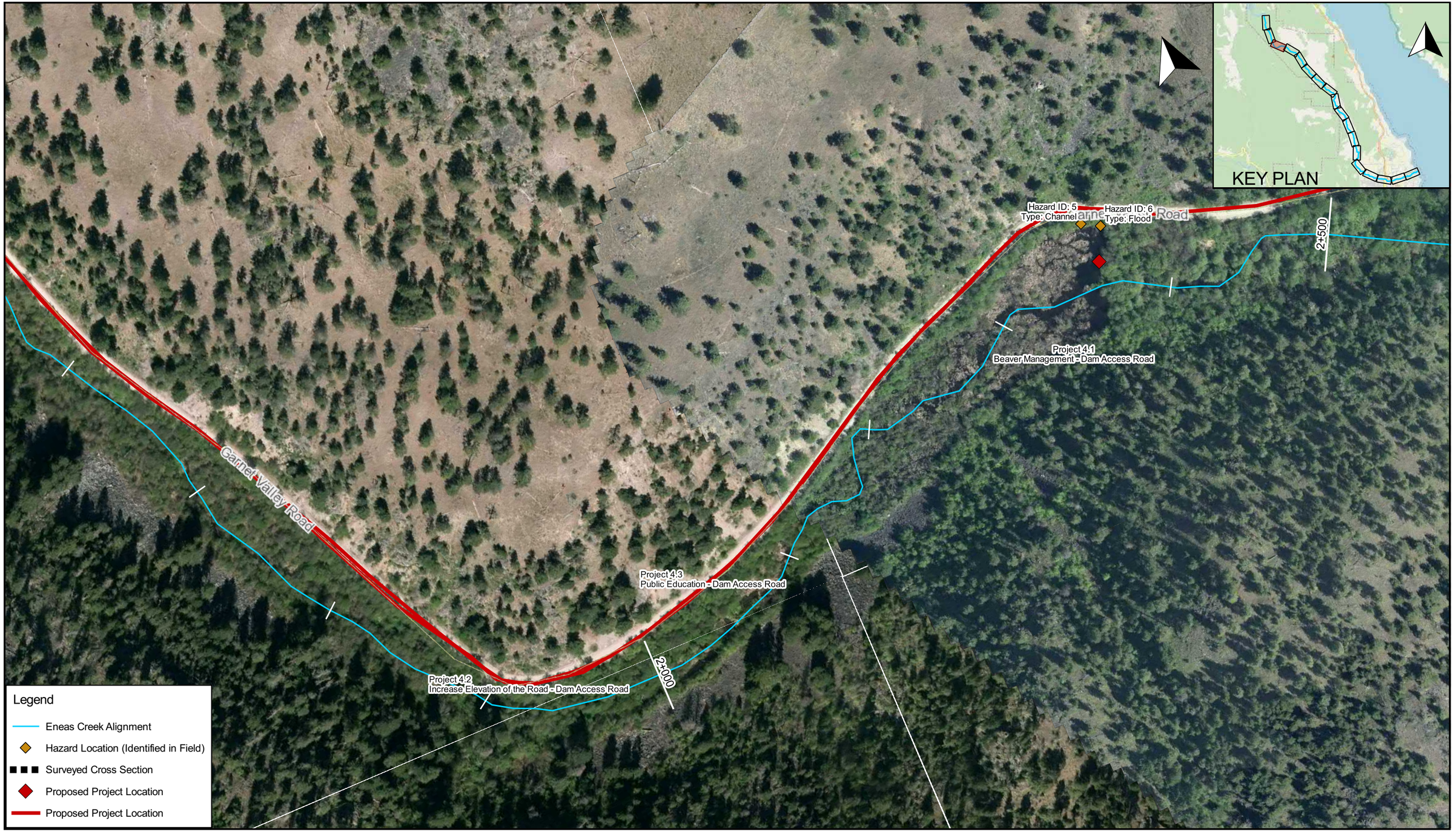

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ENEAS CREEK ASSESSMENT
FLOOD RISK MAPPING

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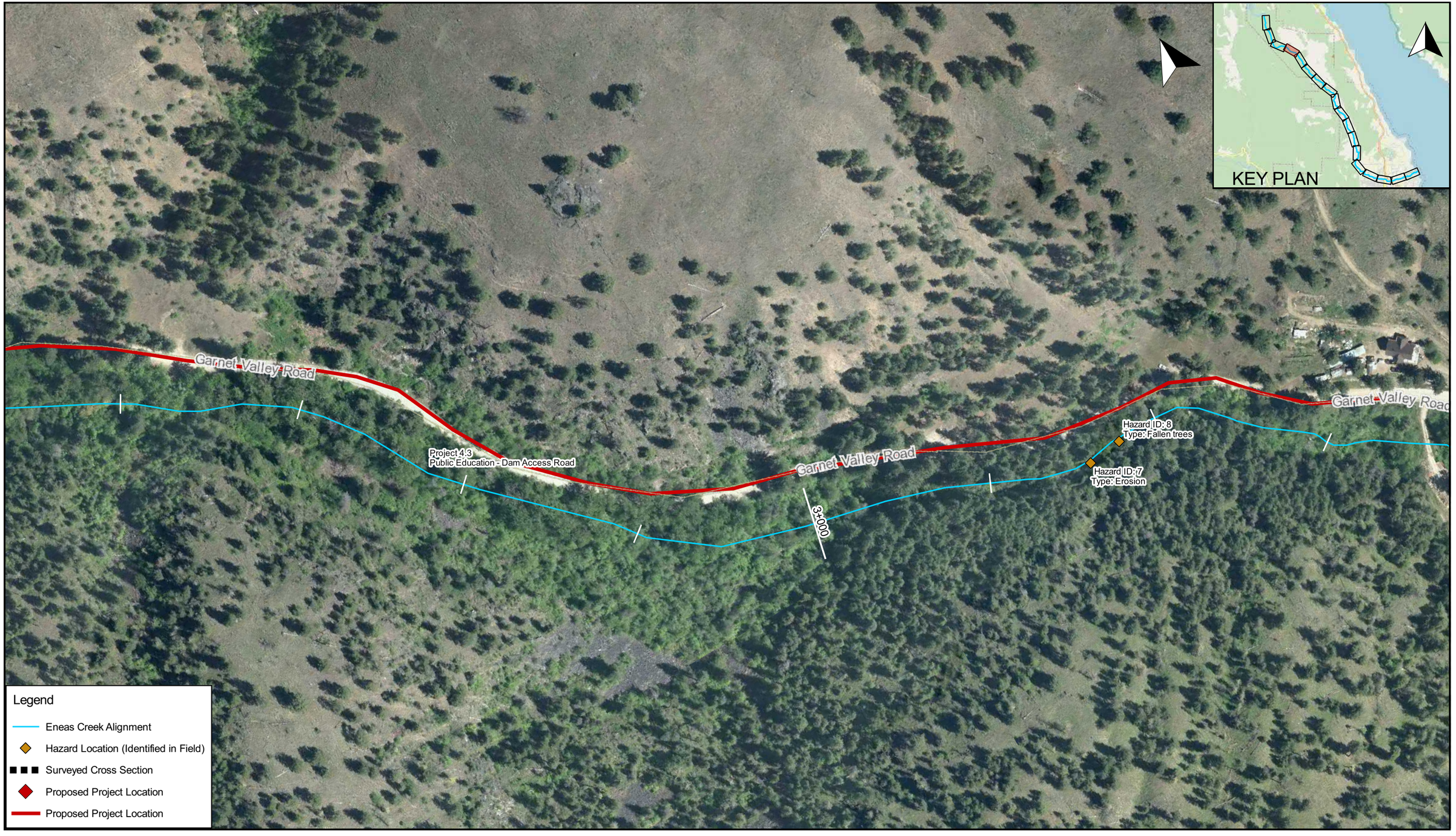

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ENEAS CREEK ASSESSMENT FLOOD RISK MAPPING

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DRAWING	REV NO.	SHEET
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NO.	DATE	ENG	BY	SUBJECT
B	2019/01/18	M.O.	C.D.	ISSUED FOR DRAFT REPORT
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Projection:	UTM ZONE 11N
Date:	2018/10/31

ENEAS CREEK ASSESSMENT
FLOOD RISK MAPPING

DISTRICT OF SUMMERLAND

DRAWING	REV NO.	SHEET
2441-00-C-105	B	10 / 23

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NO.	DATE	ENG	BY	SUBJECT
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Project No.	20182441-00
Scale:	1:2000
Drawn:	C. DUNCAN
Approved:	M. OWEN
Projection:	UTM ZONE 11N
Date:	2018/10/31

ENEAS CREEK ASSESSMENT FLOOD RISK MAPPING

DISTRICT OF SUMMERLAND

DRAWING	REV NO.	SHEET
2441-00-C-106	B	11 / 23

File: \\S-van-fs-01\projects\20182441\00_Eneas_Creek_Assmt\Working_Dwgs\010_GIS\map_eneas_creek_assmt_20181029_cd.qgs
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NO.	DATE	ENG	BY	SUBJECT
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Date:	2018/10/31

ENEAS CREEK ASSESSMENT FLOOD RISK MAPPING

DISTRICT OF SUMMERLAND

DRAWING	REV NO.	SHEET
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NO.	DATE	ENG	BY	SUBJECT
B	2019/01/18	M.O.	C.D.	ISSUED FOR DRAFT REPORT
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Disclaimer:
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DISTRICT OF SUMMERLAND

Associated Engineering

Project No.	20182441-00
Scale:	1:2000
Drawn:	C. DUNCAN
Approved:	M. OWEN
Projection:	UTM ZONE 11N
Date:	2018/10/31

ENEAS CREEK ASSESSMENT FLOOD RISK MAPPING

DISTRICT OF SUMMERLAND

DRAWING	REV NO.	SHEET
2441-00-C-108	B	13/23

File: \\S-van-fs-01\projects\20182441\00_Eneas_Creek_Asmt\Working_Dwgs\010_GIS\map_eneas_creek_assmt_20181029_cd.qgs
Date: 2019-01-21T10:48:31

Garnet Valley Road

Handley St

KEY PLAN

Hazard ID: 20
Type: Bridge

6+960.68
6+986.68
7+000

Hazard ID: 21
Type: Bridge

Hazard ID: 25
Type: Channel

Project 3.3
Produce Natural Drainage and Overflow Routes

7+520.95
7+500

Hazard ID: 24
Type: Erosion

Hazard ID: 22
Type: Channel

Hazard ID: 23
Type: Inflow

Legend

- Eneas Creek Alignment
- Hazard Location (Identified in Field)
- Surveyed Cross Section
- Proposed Project Location
- Proposed Project Location

50 0 50 100 150 m

NO.	DATE	ENG	BY	SUBJECT
B	2019/01/18	M.O.	C.D.	ISSUED FOR DRAFT REPORT
A	2018/11/27	M.O.	C.D.	ISSUED FOR REVIEW

REVISIONS

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DISTRICT OF SUMMERLAND

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Drawn:	C. DUNCAN
Approved:	M. OWEN
Projection:	UTM ZONE 11N
Date:	2018/10/31

ENEAS CREEK ASSESSMENT FLOOD RISK MAPPING

DISTRICT OF SUMMERLAND

DRAWING	REV NO.	SHEET
2441-00-C-109	B	14 / 23

File: \\S-van-fs-01\projects\20182441\00_Eneas_Creek_Assmt\Working_Dwgs\010_GIS\map_eneas_creek_assmt_20181029_cd.qgs
Date: 2019-01-21T10:49:03

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NO.	DATE	ENG	BY	SUBJECT
B	2019/01/18	M.O.	C.D.	ISSUED FOR DRAFT REPORT
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Approved:	M. OWEN
Projection:	UTM ZONE 11N
Date:	2018/10/31

ENEAS CREEK ASSESSMENT FLOOD RISK MAPPING

DISTRICT OF SUMMERLAND

DRAWING	REV NO.	SHEET
2441-00-C-110	B	15 / 23

File: \\S-van-fs-01\projects\20182441\00_Eneas_Creek_Assmt\Working_Dwgs\010_GIS\map_eneas_creek_assmt_20181029_cd.qgs
Date: 2019-01-21T10:49:47

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NO.	DATE	ENG	BY	SUBJECT
B	2019/01/18	M.O.	C.D.	ISSUED FOR DRAFT REPORT
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Projection:	UTM ZONE 11N
Date:	2018/10/31

ENEAS CREEK ASSESSMENT FLOOD RISK MAPPING

DISTRICT OF SUMMERLAND

DRAWING	REV NO.	SHEET
2441-00-C-111	B	16 / 23

File: \\S-van-fs-01\projects\20182441\00_Eneas_Creek_Assmt\Working_Dwgs\010_GIS\map_eneas_creek_assmt_20181029_cd.qgs
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NO.	DATE	ENG	BY	SUBJECT
B	2019/01/18	M.O.	C.D.	ISSUED FOR DRAFT REPORT
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Scale:	1:2000
Drawn:	C. DUNCAN
Approved:	M. OWEN
Projection:	UTM ZONE 11N
Date:	2018/10/31

ENEAS CREEK ASSESSMENT FLOOD RISK MAPPING

DISTRICT OF SUMMERLAND

DRAWING	REV NO.	SHEET
2441-00-C-112	B	17 / 23

File: \\S-van-fs-01\projects\20182441\00_Eneas_Creek_Assmt\Working_Dwgs\010_GIS\map_eneas_creek_assmt_20181029_cd.qgs
Date: 2019-01-21T10:51:04

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NO.	DATE	ENG	BY	SUBJECT
B	2019/01/18	M.O.	C.D.	ISSUED FOR DRAFT REPORT
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DISTRICT OF SUMMERLAND

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Drawn:	C. DUNCAN
Approved:	M. OWEN
Projection:	UTM ZONE 11N
Date:	2018/10/31

ENEAS CREEK ASSESSMENT FLOOD RISK MAPPING

DISTRICT OF SUMMERLAND

DRAWING	REV NO.	SHEET
2441-00-C-113	B	18 / 23

File: \\S-van-fs-01\projects\20182441\00_Eneas_Creek_Assmt\Working_Dwgs\010_GIS\map_eneas_creek_assmt_20181029_cd.qgs
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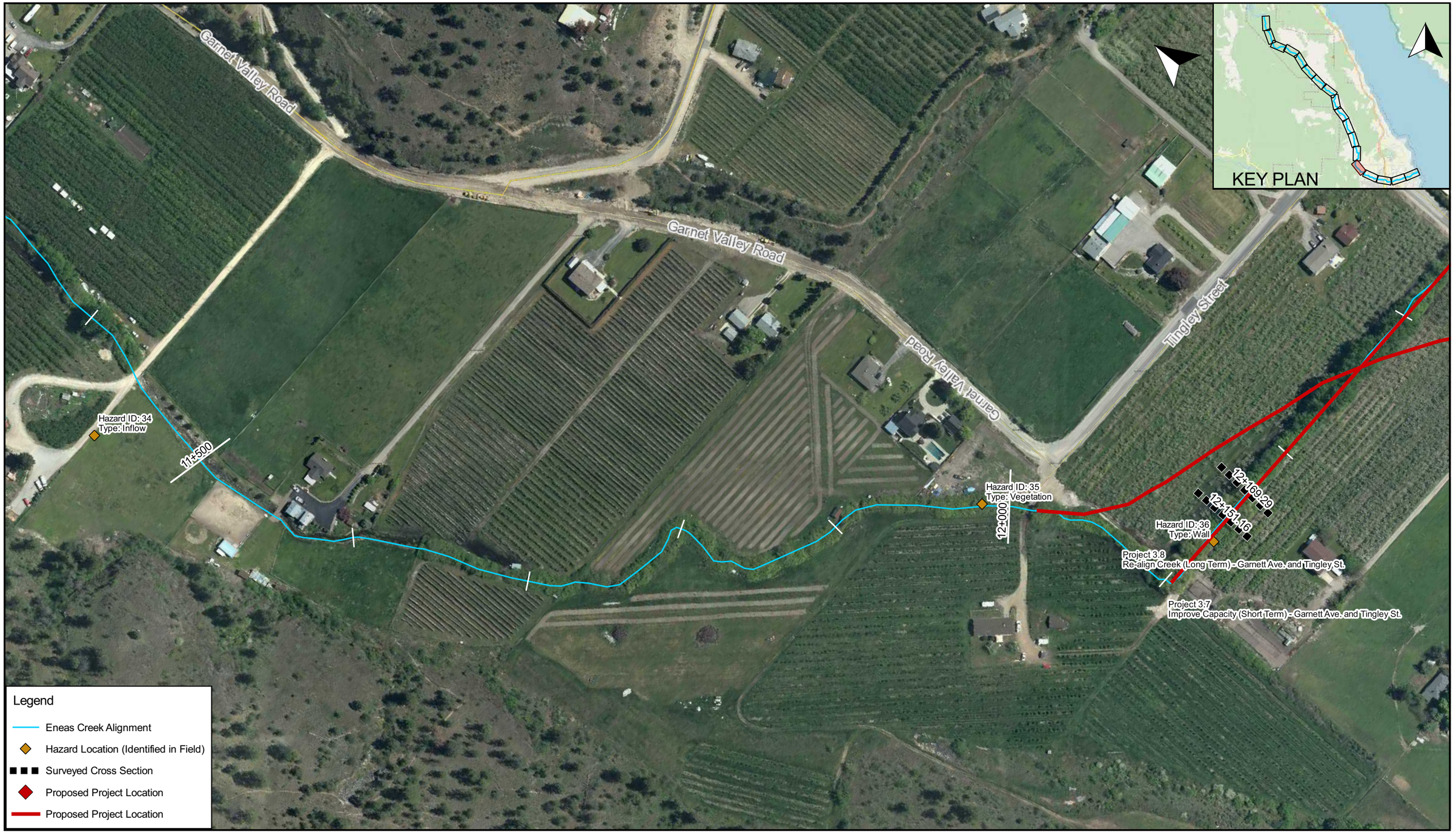

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DISTRICT OF SUMMERLAND

Associated Engineering

Project No.	20182441-00
Scale:	1:2000
Drawn:	C. DUNCAN
Approved:	M. OWEN
Projection:	UTM ZONE 11N
Date:	2018/10/31

ENEAS CREEK ASSESSMENT FLOOD RISK MAPPING

DISTRICT OF SUMMERLAND

DRAWING	REV NO.	SHEET
2441-00-C-114	B	19 / 23

File: \\S-van-fs-01\projects\20182441\00_Eneas_Creek_AssmtWorking_Dwgs\010_GIS\map_eneas_creek_assmt_20181029_cd.qgs
Date: 2019-01-21T10:52:14

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NO.	DATE	ENG	BY	SUBJECT
B	2019/01/18	M.O.	C.D.	ISSUED FOR DRAFT REPORT
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DISTRICT OF SUMMERLAND

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Drawn:	C. DUNCAN
Approved:	M. OWEN
Projection:	UTM ZONE 11N
Date:	2018/10/31

ENEAS CREEK ASSESSMENT FLOOD RISK MAPPING

DISTRICT OF SUMMERLAND

DRAWING	REV NO.	SHEET
2441-00-C-115	B	20 / 23

File: \\S-van-fs-01\projects\20182441\00_Eneas_Creek_Assmt\Working_Dwgs\010_GIS\map_eneas_creek_assmt_20181029_cd.qgs
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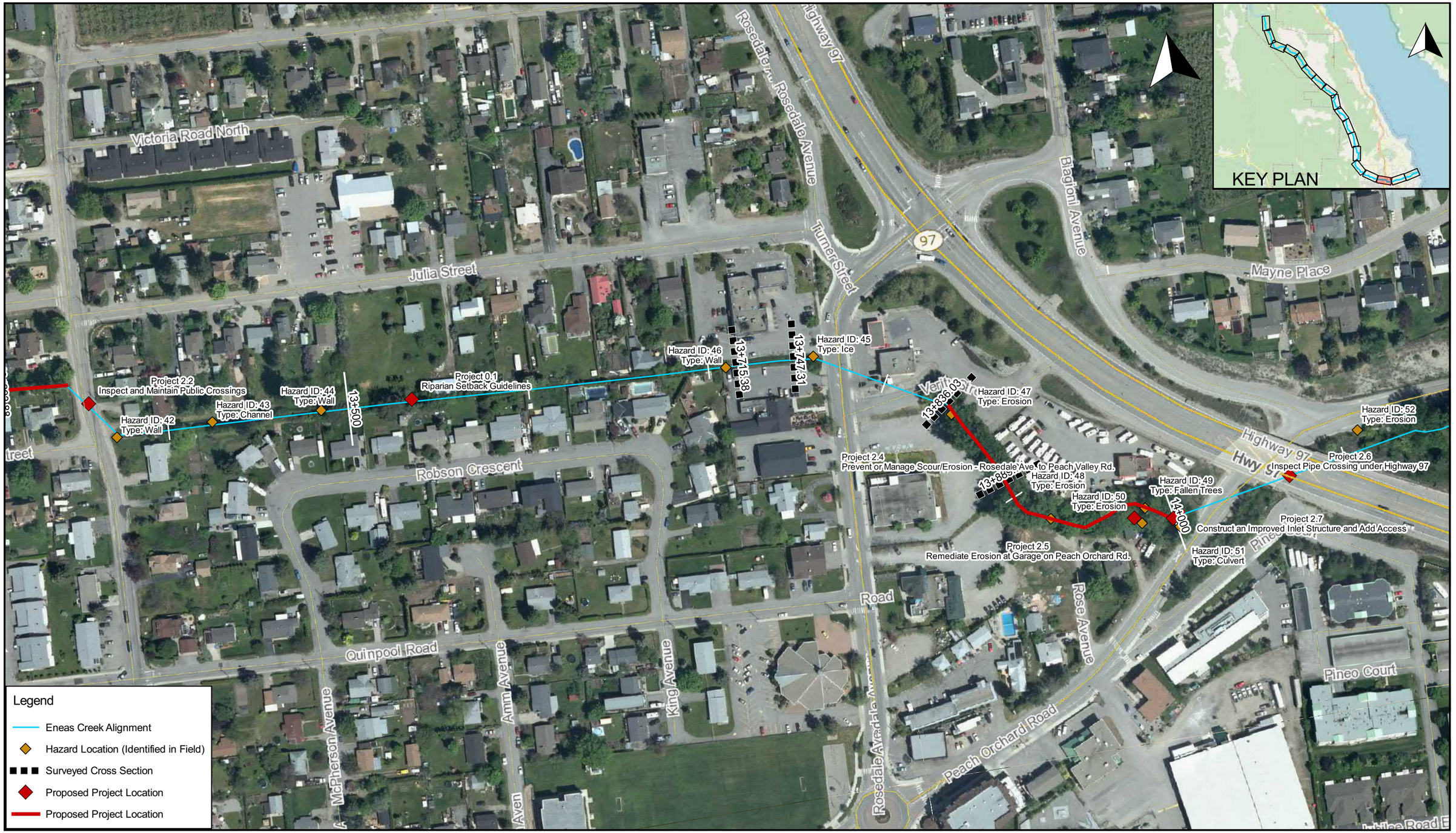

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NO.	DATE	ENG	BY	SUBJECT
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Drawn:	C. DUNCAN
Approved:	M. OWEN
Projection:	UTM ZONE 11N
Date:	2018/10/31

ENEAS CREEK ASSESSMENT FLOOD RISK MAPPING

DISTRICT OF SUMMERLAND

DRAWING	REV NO.	SHEET
2441-00-C-116	B	21 / 23

File: \\S-van-fs-01\projects\20182441\00_Eneas_Creek_Assmt\Working_Dwgs\010_GIS\map_eneas_creek_assmt_20181029_cd.qgs
Date: 2019-01-21T10:53:28

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NO.	DATE	ENG	BY	SUBJECT
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Approved:	M. OWEN
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ENEAS CREEK ASSESSMENT FLOOD RISK MAPPING

DISTRICT OF SUMMERLAND

DRAWING	REV NO.	SHEET
2441-00-C-117	B	22 / 23

File: \\S-van-fs-01\projects\20182441\00_Eneas_Creek_Asmt\Working_Dwgs\010_GIS\map_eneas_creek_assmt_20181029_cd.qgs
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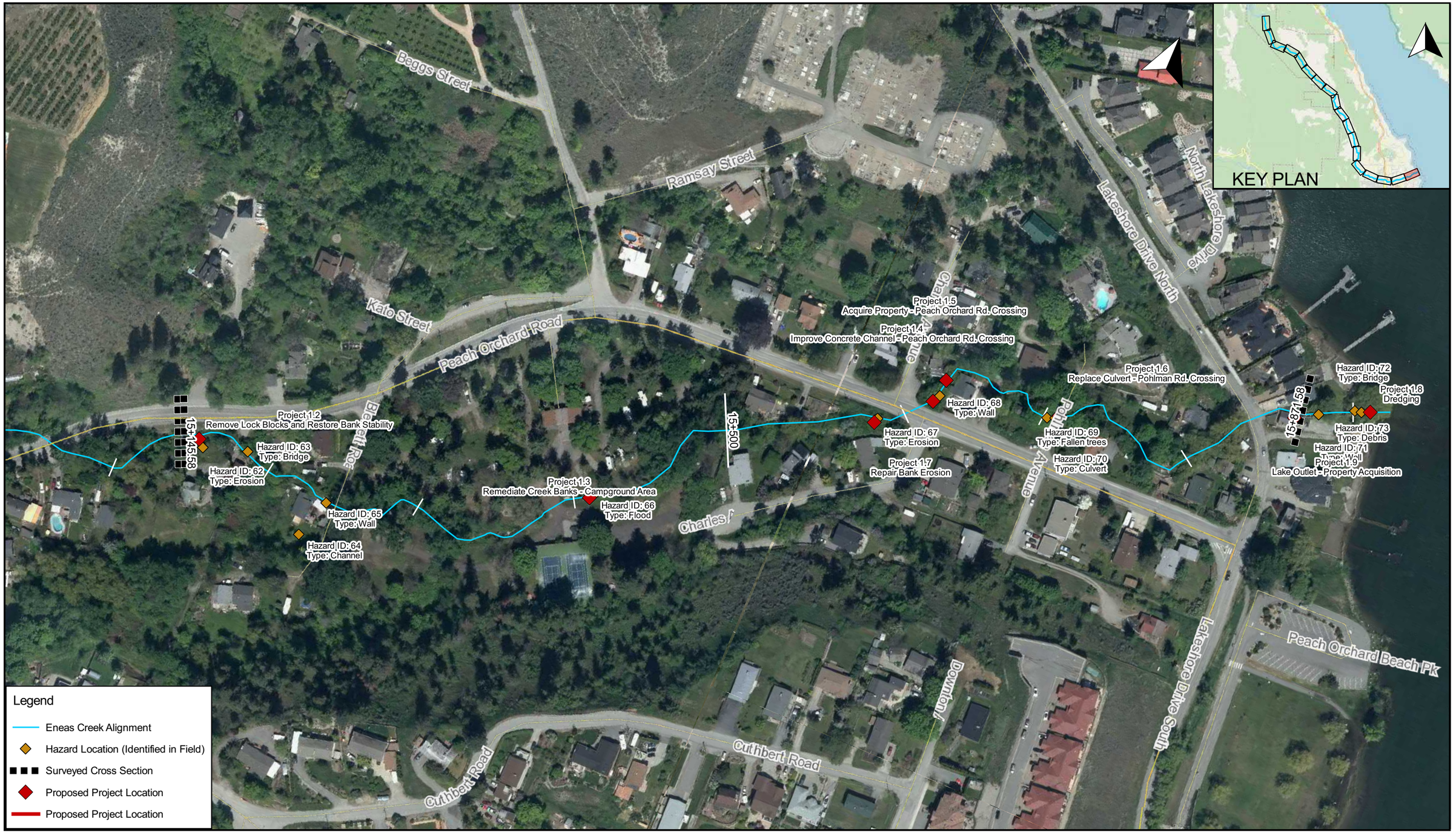

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Drawn:	C. DUNCAN
Approved:	M. OWEN
Projection:	UTM ZONE 11N
Date:	2018/10/31

ENEAS CREEK ASSESSMENT FLOOD RISK MAPPING

DISTRICT OF SUMMERLAND

DRAWING	REV NO.	SHEET
2441-00-C-118	B	23 / 23

File: \\S-van-fs-01\projects\20182441\00_Eneas_Creek_Asmt\Working_Dwgs\010_GIS\map_eneas_creek_assmt_20181029_cd.qgs
Date: 2019-01-21T10:54:50

Appendix C – Project Sheets

C.0 – General Project Sheets

Project 0.1: Riparian Setback Guidelines

Location Map - 30m Riparian Assessment Zone Representation along Eneas Creek

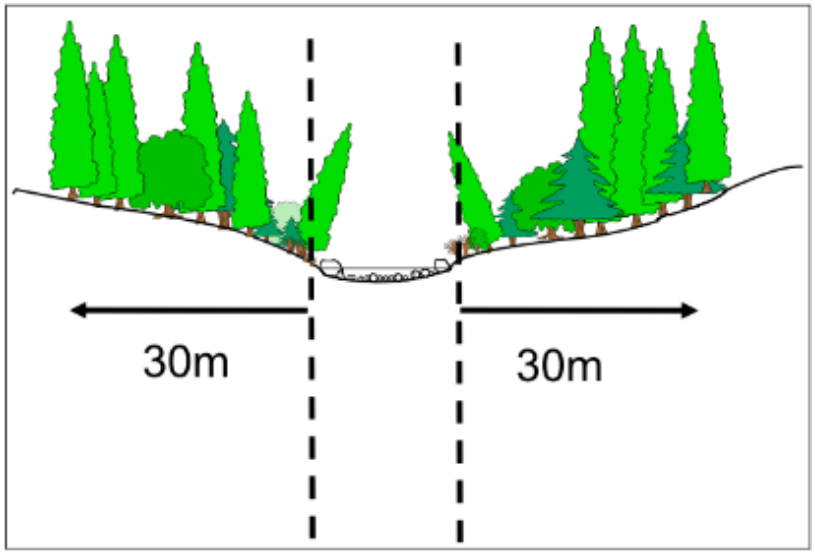


Figure - 30m Riparian Assessment Zone – From FLNRORD RAR Assessment Methods

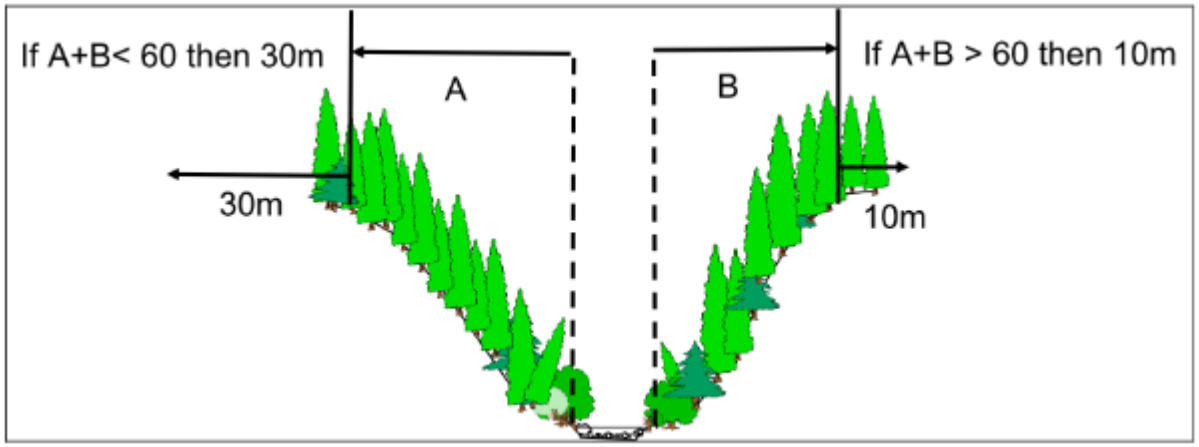


Figure – Assessment Area for Ravines – From FLNRORD RAR Assessment Methods

Location Chainage: Entire length of creek (Channel at Sta. 13+500 shown)

Proposed Works: Further establish bylaws or guidelines about development around a waterbody. Bylaws should cover all activities that could impact the waterbody (i.e. excavation, structures, driveways, etc.)

Implementation:

- Develop guidelines based on FLNRORD regulations with respect to activities within the 30m setback zone from high water mark requiring an Assessment Report from a Qualified Environmental Professional. Refer to Appendix E.

Concern:

- By constructing too close to the creek high water mark and encroaching on the riparian area then capacity may be reduced, erosion potential increased, and structures become at risk of flooding or being compromised.

Cost Estimate:

Project 0.1: Riparian Setback Guidelines

Description	Unit	Quantity	Unit Price	Total
Bylaw Revision	LS	1	$10,000	$10,000
			Subtotal	$10,000
Contingency (25%)				$2,500
Engineering (15%)				$1,500
			Project Total	$14,000

Project 0.2: Natural Asset Development/Protection

Location Map – Natural Floodplain/Wetland

Location Chainage: Entire length of creek (floodplain at Sta. 9+400 shown, 19806 Garnet Valley Road)

Proposed Works: Establish bylaw, or guidelines about development around protection of the natural flood plain and riparian area, and/or acquire lands to maintain the natural asset of the creek

Implementation:

- Develop guides to limit development within the flood plain, and to encourage protection of the natural asset. For example, limit the proximity of farming activity close to the creek, and limit filling in or import of material into the natural flood plain.
- Acquire lands, or work with trust organizations that acquire land to maintain its natural state and to protect as natural flood protection and habitat.

Concern:

- These natural assets decrease the flooding damage down stream by attenuating stream flows and provide valuable habitat along the creek.
    - These areas can prevent the need to more costly attenuation products or increasing culverts downstream.

Cost Estimate:

Project 0.2: Natural Asset Development/Protection

Description	Unit	Quantity	Unit Price	Total
Bylaw Implementation	LS	1	$10,000	$10,000
			Subtotal	$10,000
Contingency (25%)				$2,500
			Project Total	$12,500

Description	Unit	Quantity	Unit Price	Total
Land Acquisition	acre	1	$10,000	$10,000
			Subtotal	$10,000
Contingency (25%)				$2,500
			Project Total	$12,500

Note: Land Values based on Assessment Values not actual purchase value

Project 0.3: Inspect and Maintain Private Crossings

Location Map – Private Crossings

Figure – Private Culvert

Location Chainage: Multiple locations along entire creek length (Sta. 12+740 shown)

Proposed Works: Regular Inspections of Culverts and bridges is recommended to pre-emptively manage potential issues.

Implementation:

- Start/continue an inspection program on all culverts along the creek, remove potential blockages
- Inspect for potential culvert failures.
- Inspect for erosion upstream and down stream of the crossings.
- Inspect existing walls along creek banks as these are critical protection measures that need ot be maintained.

Concerns:

- If private bridges or crossings fail, they can have compounding issues.
- As issues are determined, the District should to have a way to either replace private culverts or to get private residents to act quickly to prevent future issues.

Cost Estimate:

Project 0.3: Inspect and Maintain Private Crossings

Description	Unit	Quantity	Unit Price	Total
Annual Inspection	Hrs	16	$200	$3,200
			Subtotal	$3,200
Contingency (25%)				$800
Engineering (15%)				$500
			Project Total	$4,500

Project 0.4: Inspect and Maintain Public Crossings

Location Map – Public Crossings

Figure – Public Crossing (Victoria Rd. N Culvert Outlet, and Garnet Ave Inlet)

Location Chainage: Multiple locations along entire creek length (Victoria Rd. N crossing at Sta. 13+350 shown)

Proposed Works: Regular Inspections of Culverts is recommended to pre-emptively manage potential issues.

Implementation:

- Start/continue an inspection program on all culverts along the creek, remove potential blockages
- Inspect for potential culvert failures
- Inspect for erosion upstream and down stream of the crossings

Concerns:

- Long crossings under roads can have access issues on failure, or significant public impact if roads need to be closed.

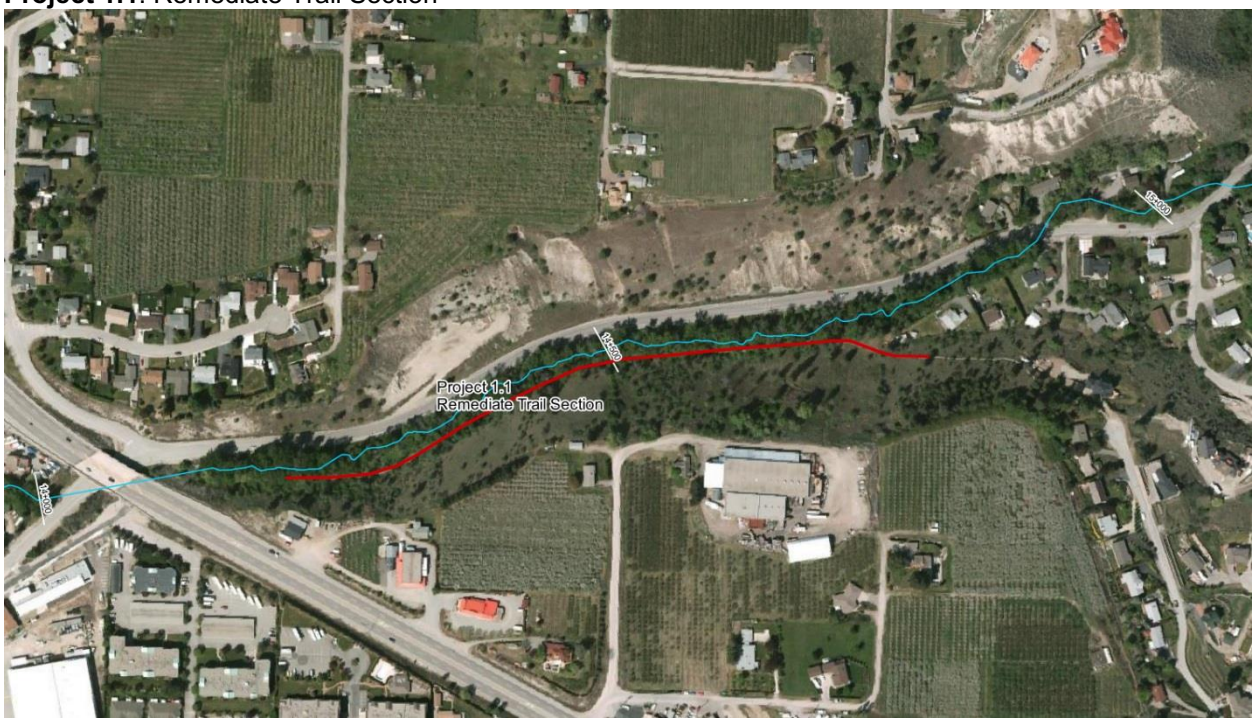
Cost Estimate:

Project 0.4: Inspect and Maintain Public Crossings

Description	Unit	Quantity	Unit Price	Total
Annual Inspection	Hrs	16	$200	$3,200
			Subtotal	$3,200
Contingency (25%)				$800
Engineering (15%)				$500
			Project Total	$4,500

C.1 – Reach 1 Project Sheets

Project 1.1: Remediate Trail Section



Location Map – Centennial Trail

Figures – Trail Washout, Danger Trees

Location Chainage: Sta. 14+000 to 14+750

Proposed Works: Clean up creek section to prevent further erosion, and protect infrastructure, long term stabilization to potentially be able to reconstruct the trail along this section. Removal of danger trees in or around the creek to prevent scour due to debris jams and root wad movement, and creek re-direction.

Implementation:

- Complete a hazard/danger tree assessment and clear the trees that pose a risk to creek change, and infrastructure. Trees and jams to be identified during construction by a Certified Riparian Danger Tree Assessor and Engineer.
- Riprap and fill steep banks towards Peach Orchard Road, where bio-engineering and planting solutions are not feasible due to risk and steep slopes.
- Bio-engineer with live staking or other methods or riprap other erosion points towards road or south bank.
- Future
    - Re-establish bridges and trail after creek has stabilized.

Concerns:

- Due to the steepness of this section and erosive capabilities it is recommended to stabilize the corners that could impact the road so the creek doesn't keep encroaching towards the road.

Cost Estimate:

Project 1.1: Remediate Trail Section

Description	Unit	Quantity	Unit Price	Total
Danger Tree Assessment	LS	1	$5,000	$5,000
Riprap Bank Sections	ea	3	$20,000	$60,000
Bio-engineer Bank Sections	ea	2	$20,000	$40,000
Remove Danger Trees	LS	1	$25,000	$25,000
			Subtotal	$130,000
Environmental Application/Monitoring				$10,000
Contingency (25%)				$32,500
Engineering (15%)				$19,500
			Project Total	$192,000

Project 1.2: Remove Lock Blocks and Restore Bank Stability

Location Map – Bank Erosion

Figure – Lock Blocks and Bank Erosion

Location Chainage: Sta. 15+150

Proposed Works: Remove lock blocks and replace with riprap and planting where possible. Outlet drain pipes out of the slope to prevent future saturation of the bank and sluffing. These pipes are drain pipes that appear to be installed to mitigate an old slide section across Peach Orchard Road.

Implementation:

- Remove danger woody debris in the creek
- Rebuild fill slope
- Armour fill slope with riprap and planting where possible.

Concerns:

- This section needs some mitigation to prevent further encroachment towards the road, and to make this area safer for all users.
- Due to the steepness of this section, velocity of the water, and potential erosive capabilities it is recommended to remove the temporary works and permanently stabilize the corner.

Cost Estimate:

Project 1.2: Remove Lock Blocks and Restore Bank Stability

Description	Unit	Quantity	Unit Price	Total
Remove Debris	LS	1	$2,500	$2,500
Rebuild Fill Slope	m³	60	$75	$4,500
Install Riprap	m³	30	$200	$6,000
			Subtotal	$13,000
Environmental Application/Monitoring				$5,000
Contingency (25%)				$3,300
Engineering (15%)				$2,000
			Project Total	$23,300

Project 1.3: Remediate Creek Banks – Campground Area

Location Map – Campground

Figure – Creek Through Campground

Location Chainage: Multiple locations through campground (Sta. 15+400 shown)

Proposed Works: Armour areas with Riprap and fill to build up slopes behind riprap, restore areas for habitat where available.

Implementation:

- Remove danger woody debris in the creek
- Rebuild fill slope
- Armour fill slope with Riprap.
- Restore creek, and install natural attenuation potential through bio engineering

Concerns:

- There is the potential for the erosive ability of the creek to continue trying to move to a path straight through the municipal campground

Cost Estimate:

Project 1.3: Remediate Creek Banks – Campground Area

Description	Unit	Quantity	Unit Price	Total
Remove Debris	LS	1	$2,500	$2,500
Rebuild Fill Slope	m³	60	$75	$4,500
Install Riprap	m³	30	$200	$6,000
Bio-engineered Protection	ea	1	$10,000	$10,000
			Subtotal	$23,000
Environmental Application/Monitoring				$5,000
Contingency (25%)				$5,800
Engineering (15%)				$3,500
			Project Total	$37,300

Project 1.4: Improve Concrete Channel – Peach Orchard Rd. Crossing

Location Map – Sinkhole and Wall Undermining

Figure – Sinkhole and Wall Undermining

Location Chainage: Sta. 15+650

Proposed Works: Currently the downstream wall is being undermined, and further erosion/material loss is expected. Flows in this stretch should be slowed if possible,

Implementation:

- Install Energy dissipaters to slow flows.
- Slow culvert flows.

Concerns:

- If the velocities stay high the erosive force will continue and the potential for wall failure is high and due to the proximity of the 2 houses there is a high risk of the creek encroaching on the structures.

Cost Estimate:

Project 1.4: Improve Concrete Channel – Peach Orchard Rd. Crossing

Description	Unit	Quantity	Unit Price	Total
Energy Dissipaters	LS	2	$10,000	$20,000
Rebuild Wall / Widen Channel	m²	10	$2,000	$20,000
			Subtotal	$40,000
Environmental Application/Monitoring				$5,000
Contingency (25%)				$10,000
Engineering (15%)				$6,000
			Project Total	$61,000

Project 1.5: Acquire Property – Peach Orchard Rd. Crossing

Location Map – Acquire Property

Figure – Constrained Channel

Location Chainage: Sta. 15+650

Proposed Works: The position of the creek and the 2 adjacent houses and properties suggest that both structures were constructed too close to the creek for safety and for the creek to have any room to move or grow during a flood event.

Implementation:

- Remove structures and rehabilitate the creek

Concerns:

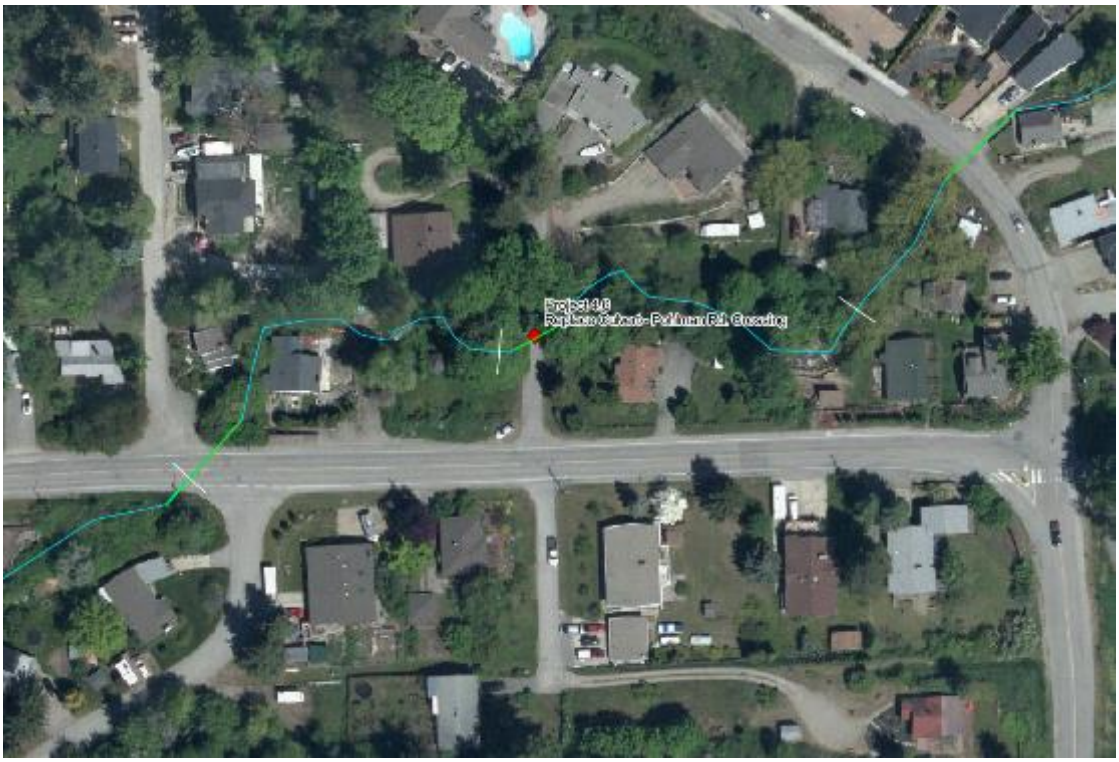
- If the velocities stay high the erosive force will continue and the potential for wall failure is high and due to the proximity of the 2 houses there is a high risk of the creek encroaching on the structures.

Cost Estimate:

Project 1.5: Property Redevelopment – Peach Orchard Rd. Crossing

Description	Unit	Quantity	Unit Price	Total
Demolitions	ea	2	$100,000	$200,000
Rehabilitation	LS	1	$20,000	$20,000
			Subtotal	$220,000
Environmental Application/Monitoring				$5,000
Contingency (25%)				$55,000
Engineering (15%)				$33,000
			Project Total	$313,000

Project 1.6: Replace Culvert - Pohlman Rd. Crossing



Location Map – Pohlman Road

Figure – Pohlman Road Culvert

Location Chainage: Sta. 15+710

Proposed Works: Replace deformed culvert.

Implementation:

- Replace Culvert

Concerns:

- It is unknown if this culvert was installed like this but it is concerning and the risk of failure could be significant to the properties downstream.

Cost Estimate:

Project 1.6: Replace Culvert - Pohlman Rd. Crossing

Description	Unit	Quantity	Unit Price	Total
Replace Culvert	lin.m	15	$1,000	$15,000
Install Headwalls	ea	2	$10,000	$20,000
Rebuild Road	m²	200	$200	$40,000
			Subtotal	$75,000
Environmental Application/Monitoring				$5,000
Contingency (25%)				$18,800
Engineering (15%)				$11,300
			Project Total	$110,100

Project 1.7: Remediate Erosion

Location Map – Erosion

Figure – Bank Erosion near Road Embankment

Location Chainage: Multiple locations (Sta. 15+580 shown)

Proposed Works: Armour areas with Riprap and fill to build up slopes behind riprap

Implementation:

- Remove danger woody debris in the creek
- Rebuild fill slope
- Armour fill slope with Riprap.

Concerns:

- Due to the steepness of this section and erosive capabilities it is recommended to stabilize the corner so the creek doesn't keep encroaching towards the road.

Cost Estimate:

Project 1.7: Remediate Erosion

Description	Unit	Quantity	Unit Price	Total
Remove Debris	LS	1	$2,500	$2,500
Rebuild Fill Slope	m³	60	$50	$3,000
Install Riprap	m³	30	$200	$6,000
			Subtotal	$11,500
Environmental Application/Monitoring				$5,000
Contingency (25%)				$2,900
Engineering (15%)				$1,700
			Project Total	$21,100

Project 1.8: Lake Outlet – Removal of Deposited Materials

Location Map – Outlet

Figure – Outlet to Okanagan Lake (Fall 2018)

Figure – Outlet to Okanagan Lake (approximate date 2013)

Location Chainage: Sta. 15+430

Proposed Works: Remove recently deposited materials from the creek and the lake area to provide freeboard to flows entering the lake. This section has filled in significantly in the past couple years, as can be seen in the photos above, creek freeboard has been compromised due to the downstream transport of eroded material and deposition when the grade decreases and lake effects slow the flows. Lake deposition apparent from comparing past years ortho photos to the current situation. Current level of freeboard in this section suggests that flooding issues are likely if no actions are taken.

Implementation:

- Excavate the channel and the lake removing the material that plugged this section up in the past few years. Haul material away since material source is unknown due to the flooding and erosion extent in 2018.

Concerns:

- Due to the sedimentation the outlet to the lake has increased in elevation threatening the neighboring properties, if nothing is done, flooding damage is expected.

Cost Estimate:

Project 1.8: Short Term - Lake Outlet - Dredging

Description	Unit	Quantity	Unit Price	Total
Dredge Creek	m²	100	$200	$20,000
Dredge Lake	m²	200	$200	$40,000
			Subtotal	$60,000
Environmental Application/Monitoring				$20,000
Contingency (25%)				$15,000
Engineering (15%)				$9,000
			Project Total	$104,000

Project 1.9: Lake Outlet – Property Redevelopment

Location Map – Outlet

Figure – Channel between Lakefront Properties

Location Chainage: Sta. 15+870

Proposed Works: Long term solution is to complete property acquisitions to remove the risk of properties occurring so close to the creek

Implementation:

- Remove structures constructed too close to the creek and restore habitat

Concerns:

- Due to the sedimentation the outlet to the lake has increased in elevation threatening the neighboring properties, if nothing is done, flooding damage is expected.

Cost Estimate:

Project 1.9: Long Term - Lake Outlet – Property Redevelopment

Description	Unit	Quantity	Unit Price	Total
Demolition	ea	1	$100,000	$100,000
Rehabilitation	ea	1	$50,000	$50,000
			Subtotal	$150,000
Environmental Application/Monitoring				$20,000
Contingency (25%)				$37,500
Engineering (15%)				$22,500
			Project Total	$230,000

C.2 – Reach 2 Project Sheets

Project 2.1: Improve Flow Conditions – Washington Ave. to Victoria Rd. N

Location Map – Washington Ave. to Victoria Rd. N

Figure – Existing Channel

Location Chainage: Sta. 12+800 to 13+330

Proposed Works: Produce a wider overflow channel or oxbows in this area to increase flow capacity, slow flows and improve habitat.

Implementation:

- Widen channel, while supporting tree growth and habitat. This will allow flows to meander or for a secondary flood channel to develop so that high flows widen, have less depth and less velocity, therefore cause less flooding and erosion concerns.
- Maintain Access or access agreements through private lots
- Recommend a phased approach to start this, as 2km of creek is too much to address in one project. Phase in 100 – 500m sections.

Concerns:

- Without a secondary flood channel available high flows will continue to have increased elevation and velocity, which increases the risk to properties and structures.

Cost Estimate:

Project 2.1: Improve Flow Conditions – Washington Ave. to Victoria Rd. N (100m Phases)

Description	Unit	Quantity	Unit Price	Total
Widen Channel	lin.m	100	$500	$50,000
Planting	lin.m	200	$100	$20,000
			Subtotal	$70,000
Environmental Application/Monitoring				$10,000
Contingency (25%)				$17,500
Engineering (15%)				$10,500
			Project Total	$108,000

Project 2.2: Prevent or Manage Scour/Erosion between Rosedale Ave. and Peach Orchard Rd.

Location Map – Rosedale Ave. to Peach Orchard Rd.

Figure – Channel Erosion

Location Chainage: Sta. 13+840 to 14+000

Proposed Works: Manage the velocities and erosion that has occurred where the slopes increase.

Implementation:

- Increase and improve bank vegetation growth
- Improve armouring of sensitive areas.
- Length of Concern 200m

Concerns:

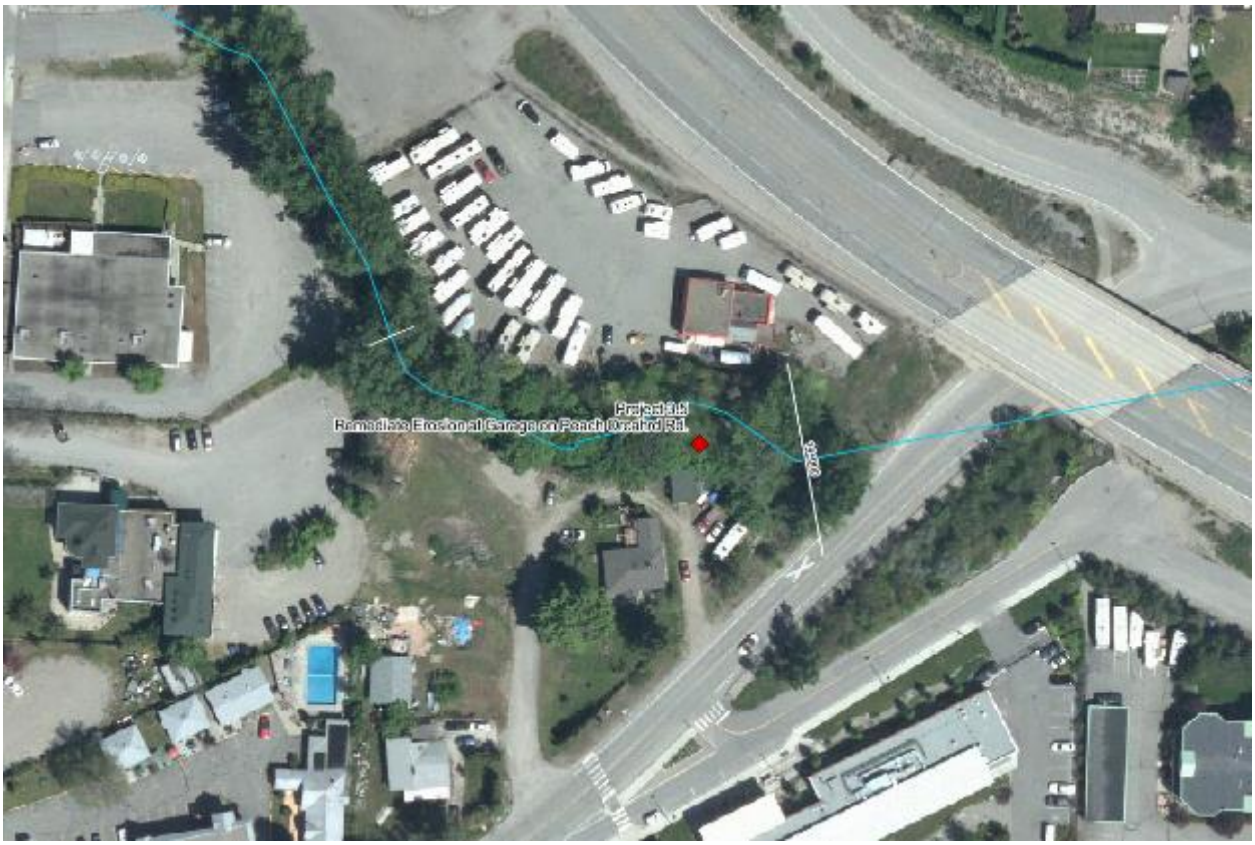
- As this section erodes, material is transported downstream potentially causing issued at the road crossings and when the flows slow and the sediment drops.

Cost Estimate:

Project 2.2: Prevent or Manage Scour/Erosion

Description	Unit	Quantity	Unit Price	Total
Planting	lin.m	400	$100	$40,000
Riprap	cu.m	50	$200	$10,000
			Subtotal	$50,000
Environmental Application/Monitoring				$5,000
Contingency (25%)				$12,500
Engineering (15%)				$7,500
			Project Total	$75,000

Project 2.3: Remediate Erosion at Garage at Peach Orchard Rd.



Location Map – Slope Failure

Figure – Slope Failure

Location Chainage: Sta. 13+980

Proposed Works: Rebuild eroded slope behind garage to prevent further slope failure and loss of the structure into the creek, and therefore mitigate risk of the downstream culvert.

Implementation:

- Remove danger woody debris in the creek that is impeding the flows.
- Rebuild fill slope
- Armour fill slope with Riprap.

Cost Estimate:

Project 2.3: Remediate Erosion at Garage at Peach Orchard Rd.

Description	Unit	Quantity	Unit Price	Total
Fill	m^3	200	$50	$10,000
Riprap	m^3	75	$200	$15,000
			Subtotal	$25,000
Environmental Application/Monitoring				$10,000
Contingency (25%)				$6,300
Engineering (15%)				$3,800
			Project Total	$45,100

Project 2.4: Inspect Pipe Crossing under Peach Orchard Rd. and Highway 97

Location Map

Figure – Inlet and Outlet

Location Chainage: 14+000 to 14+140

Proposed Works: Inspection of a critical culvert crossing such as this is important to ensure its continued service, and prepare for any repairs or maintenance that may be required

Implementation:

- Compete a camera inspection of the inside of the pipe to check for deterioration, or excessive erosion.

Concerns:

- There are concerns that due to the high risk nature and age of this pipe that it should be video inspected to confirm its integrity as the pipe ages.
- If replacement or rehabilitation is needed several options are available including replacement, sliplining, pipe bursting, and other lining options.

Cost Estimate:

Project 2.4: Inspect Pipe Crossing under Peach Orchard Rd. and Highway 97

Description	Unit	Quantity	Unit Price	Total
Inspection	ea	1	$4,000	$4,000
			Subtotal	$4,000
Contingency (25%)				$1,000
Engineering (15%)				$600
			Project Total	$5,600

Project 2.5: Inlet Access and Inlet Improvements - Peach Orchard Rd. and Highway 97

Location Map – Culvert under Hwy 97

Figure – Culvert under Hwy 97 Inlet

Location Chainage: Sta. 14+000

Proposed Works: Construct an improved inlet structure, and create maintenance access to the inlet to maintain

Implementation:

- Improve inlet conditions, install a pre-headwall grizzly to capture most of the debris upstream keeping the headwall clear.
- Create better maintenance access by constructing a road close to the inlet to allow the grizzly to be maintained and kept clear of debris

Concerns:

- Due to the high risk nature of this crossings the district should be able to access this inlet easily in an emergency so access should be constructed and inlet should be improved so back water doesn't occur as frequently

Cost Estimate:

Project 2.5a: Inlet Access - Peach Orchard Rd. and Highway 97

Description	Unit	Quantity	Unit Price	Total
Access Point	LS	1	$10,000	$10,000
			Subtotal	$10,000
Environmental Application/Monitoring				
Contingency (25%)				$2,500
Engineering (15%)				$1,500
			Project Total	$14,000

Project 2.5b: Inlet Improvements - Peach Orchard Rd. and Highway 97

Description	Unit	Quantity	Unit Price	Total
Improve Inlet Conditions	LS	1	$15,000	$15,000
			Subtotal	$15,000
Environmental Application/Monitoring				$5,000
Contingency (25%)				$3,800
Engineering (15%)				$2,300
			Project Total	$26,100

C.3 – Reach 3 Project Sheets

Project 3.1: Improve Inlet Capacity or Construct Overflow Spillway (Private Works) – Garnet Valley Road

Location Map - Private Pond

Figure – Culvert Inlet

Location Chainage: Sta. 3+970, 28412 Garnet Valley Road

Proposed Works: Increase Culvert Capacity during high flows and allow for a safe overflow route in the event of overtopping.

Implementation:

- Increase inlet capacity, by removing manmade weir prior to high flows,
- Increasing capacity by improving inlet conditions by constructing a headwall and tapering culvert to the slope or a suitable slope of ~2:1.
- Add rocked section of road at overflow point to create a high level spillway to allow a safe release of water instead of sandbagging

Concerns:

- Pond capacity is a valuable asset, and if the attenuation is removed here it may push a problem elsewhere, but the potential overflow, and capacity of the culvert should be managed to safely pass increased flows during freshet.

Cost Estimate:

Project 3.1a: Maintenance Removal of Weir – Garnet Valley Road

Description	Unit	Quantity	Unit Price	Total
Remove Weir Annually	LS	1	$150	$150
			Subtotal	$150
Contingency (25%)				$0
Engineering (15%)				$0
			Project Total	$150

Project 3.1b: Construct Overflow Spillway – Numerous Locations Garnet Valley Road

Description	Unit	Quantity	Unit Price	Total
Overflow Channel across Driveway	m^2	40	$100	$4,000
			Subtotal	$4,000
Contingency (25%)				$1,000
Engineering (15%)				$600
			Project Total	$5,600

Project 3.1c: Improve Culvert Capacity – Numerous Locations Garnet Valley Road

Description	Unit	Quantity	Unit Price	Total
Improve inlet Capacity	LS	1	$10,000	$10,000
			Subtotal	$10,000
Environmental Application/Monitoring[1]				$5,000
Contingency (25%)				$2,500
Engineering (15%)				$1,500
			Project Total	$19,000

[1]Assume multiple projects ongoing at one time sharing environmental expectations and costs.

Project 3.2: Re-align Culverts along Creek – Garnet Valley Road

Location Map – Culvert Realignment

Figure – Culvert Inlet

Location Chainage: Sta. 4+830, 27088 Garnet Valley Road shown

Proposed Works: Increase culvert capacity, improve flow conditions and decrease erosion downstream

Implementation:

- Re-align culverts that are currently off line from the creek flow to make the shortest crossing possible.
- Alternate solution
    - Monitor the concerning trees or manage the release from these culverts, may be a more effecting solution for culverts currently in place.
    - Future culverts should be installed through consultation with a QEP, maintaining a natural stream flow.

Concern:

- By constructing culverts off line this can cause abnormal bends to the creek that can lead to additional erosion.

Cost Estimate:

Project 3.2a: Re-align Culverts along Creek – Numerous Locations Garnet Valley Road

Description	Unit	Quantity	Unit Price	Total
Culvert Replacement	lin.m	10	$1,000	$10,000
			Subtotal	$10,000
Environmental Application/Monitoring				$5,000
Contingency (25%)				$2,500
Engineering (15%)				$1,500
			Project Total	$19,000

Project 3.2b: Remove Hazards Caused by Culverts – Numerous Locations Garnet Valley Road

Description	Unit	Quantity	Unit Price	Total
Hazard Removal	ea	1	$1,000	$1,000
Armouring/Protection	ea	1	$2,500	$2,500
			Subtotal	$3,500
Environmental Application/Monitoring				$5,000
Contingency (25%)				$900
Engineering (15%)				$500
			Project Total	$9,900

Project 3.3: Produce Natural Drainage and Overflow Routes – 15704 Handley St Shown

Location Map – Drainage Route

Figure – Natural Overflow Route

Location Chainage: Sta. 7+440

C-46

Proposed Works: Regrade lots at areas of potential overtopping to allow a safe route back to the creek downstream. Improve riparian areas by reintroducing natural plants to encourage flows to slow outside the main channel, reducing erosion

Implementation:

- General site grading to encourage flows to flow away from structures or other critical infrastructure.
- Re-establish riparian area around creek channel

Concern:

- By allowing a safe overflow, structures can be protected, and the creek can be allowed to react naturally to changes in flows.

Cost Estimate:

Project 3.3: Produce Natural Drainage and Overflow Routes - Numerous Locations
Garnet Valley Road

Description	Unit	Quantity	Unit Price	Total
Site Grading	LS	1	$10,000	$10,000
Planting	LS	1	$10,000	$10,000
			Subtotal	$20,000
Contingency (25%)				$5,000
Engineering (15%)				$3,000
			Project Total	$28,000

Project 3.4: Remove Obstructions in Channel – 19804 Garnet Valley Road Shown

Location Map – Obstruction at 19804 Garnet Valley Rd.

Figure – Creek Obstruction

Figure– Creek Build Out Confining Creek

Location Chainage: Sta. 9+750

Proposed Works: Remove in channel obstructions and obstructions in the secondary channel

Implementation:

- Remove Concrete Confining Creek Flows
- Remove buildout into the secondary flood channel and limit future construction around the creek.

Concerns:

- Confinements such as these cause flows to back up causing additional water levels upstream.

Cost Estimate:

Project 3.4: Remove Obstructions in Channel - 19804 Garnet Valley for Example

Description	Unit	Quantity	Unit Price	Total
Concrete Removals	ea	1	$5,000	$5,000
Secondary Channel Grading	m^3	50	$100	$5,000
Planting	ea	1	$5,000	$5,000
			Subtotal	$15,000
Environmental Application/Monitoring				$5,000
Contingency (25%)				$3,800
Engineering (15%)				$2,300
			Project Total	$26,100

Project 3.5: Remove Temporary or Permanent Berms next to Creek – 17304 Garnet Valley Road Shown

Location Map – Remove Berms

Figure – Creek Berm

Location Chainage: Sta. 10+700 to 11+000

Proposed Works: Remove Private Berms building up creek banks, as there is risk that these will fail and cause additional damage down stream since they trap the flood waters behind and may not have a safe route back to the channel and may affect neighboring properties or neighboring structures. These if they are being constructed should be built set back from the channel and only protect a single property.

Implementation:

- Remove Berms
- Open up Channel to provide a secondary channel for higher flows.

Concern:

- Concerns exist if these fail, then the creek flows may cause increased damage, above a natural flooding state, since the water can't get back into the creek safely, or since flows are deeper and more sudden.
- Concerns with structures like these also exist, since these deepen the water in the channel, and increase the creek impacts to both banks.
- These can also lead to increased sediment into the creek and cause future water levels to increase due to the creek bed being filled in.

Cost Estimate:

Project 3.5: Remove Temporary or Permanent Berms

Description	Unit	Quantity	Unit Price	Total
Widening overflow Channel Construction	lin.m	200	$100	$20,000
Planting	sqm	400	$100	$40,000
			Subtotal	$60,000
Environmental Application/Monitoring				$5,000
Contingency (25%)				$15,000
Engineering (15%)				$9,000
			Project Total	$89,000

Project 3.6: Re-align Creek to Natural Flow Route – 17304 Garnet Valley Road Shown

Location Map – Creek Realignment

Figure– Creek Realignment

Location Chainage: Sta. 10+750

Proposed Works: Remove current "ditched" creek sections with natural course with meanders, bends and riparian zone around creek to allow water level rise and fall with minimal impact to development

Implementation:

- Property Owner Agreement
- Construct new channel
- Planting or riparian areas
- Rerouting creek
- Removing old creek ditch line

Concern:

- The current "ditched" type of creek channel provides little room for increased flows to be managed without increasing water velocities and erosion potential, which occurs immediately next to Garnet Valley Road

Cost Estimate:

Project 3.6: Re-align Creek to Natural Flow Route

Description	Unit	Quantity	Unit Price	Total
New Channel Construction	lin.m	200	$200	$40,000
Property	acre	1	$10,000	$10,000
Removing Old Channel	lin.m	150	$25	$3,750
Planting	lin.m	400	$100	$40,000
			Subtotal	$93,750
Environmental Application/Monitoring				$10,000
Contingency (25%)				$23,400
Engineering (15%)				$14,100
			Project Total	$141,250

Note: Land Values based on Assessment Values not actual purchase value

Project 3.7: Improve Capacity (Short Term Solution) - Garnet Ave. and Tingley St.

Location Map – Improve Creek Capacity

Figure – Debris and Vegetation and Gabions

Location Chainage: Sta. 11+900 to 12+500

Proposed Works: In the short term, improve capacity and resilience along this section, by removing sediment deposited in this section, clear growth or debris that restricts flows, improve driveway crossings to remove the restrictions, and re-arrange temporary works to allow for better flow conditions.

Implementation:

- Pull temporary works back if possible from the creek to allow for creek expansion, and/or rework banks to prevent sediment transport from temporary works into creek bed.
- Clear debris that restricts/slows flows
- Remove deposited material that has removed freeboard
- Increase capacity of 2 downstream driveway crossings.
- Improve inlet capacity of culvert crossing Garnet Ave

Concerns:

- Current channel has minimal to no freeboard to natural ground, and the temporary works are retaining water. In the event that these fail the repercussions would be difficult to keep the creek in its current alignment, and not severely impacting the neighboring properties or community at large.
- The current water level in this section is approximately 0.3m above the neighboring agricultural land, and less than 0.3m freeboard to the road next to the creek.
- Clearing deposited material instream will be difficult around the large trees, to make sure the trees aren't compromised.

Cost Estimate:

Project 3.7: Short Term - Improve Capacity - Garnet Ave. and Tingley St.

Description	Unit	Quantity	Unit Price	Total
Pull Back Temporary Works	LS	1	$15,000	$15,000
Clear Channel of Woody debris	LS	1	$4,000	$4,000
Clear Deposited Material	LS	1	$15,000	$15,000
Replace 2 Crossings DS	ea	2	$20,000	$40,000
Improve Inlet Capacity at Garnet Ave	ea	1	$5,000	$5,000
			Subtotal	$79,000
Environmental Application/Monitoring				$10,000
Contingency (25%)				$19,800
Engineering (15%)				$11,900
			Project Total	$120,700
Excavator @ 200 per hour plus labourer @50 per hour				

Project 3.8: Re-align Creek to Natural Flow Route (Long Term) – Garnet Ave. and Tingley St.

Location Map – Re-align Creek to Natural Flow Route

Location Chainage: Sta. 12+000 to 12+400

Proposed Works: Remove current "ditched" creek sections with natural course with meanders, bends and riparian zone around creek to allow water level rise and fall with minimal impact to development

Implementation:

- Property trade, or reallocation.
- Construct new channel
- Planting or riparian areas
- Rerouting creek
- Removing old creek ditch line

Concerns:

- Restore a natural channel ability to meander and rise and fall with changing flow levels to prevent future flooding events from having such a significant impact.
- This section of creek has been noted as having issues for decades and is likely to continue having issues if some significant changes aren't completed

Cost Estimate:

Project 3.8: Long Term - Re-align Creek to Natural Flow Route – Garnet Ave. and Tingley St.

Description	Unit	Quantity	Unit Price	Total
Property	acre	4	$10,000	$40,000
New Channel Construction	lin.m	400	$200	$80,000
Removing Old Channel	lin.m	400	$25	$10,000
Planting	lin.m	800	$100	$80,000
			Subtotal	$210,000
Environmental Application/Monitoring				$10,000
Contingency (25%)				$52,500
Engineering (15%)				$31,500
			Project Total	$304,000

C.4 – Reach 4 Project Sheets

Project 4.1: Beaver Management – Dam Access Road

Location Map - Beaver Activity Area

Figure – Beaver Dam

Location Chainage: Sta. 2+400

Proposed Works: Protect trees along banks, that are helping to prevent erosion and protecting the road. Remove beaver dams and other blockages caused by downed trees and debris regularly, especially prior to freeze up and freshet. This work is considered to me a maintenance activity that should be completed and inspected regularly as needed.

Implementation:

- Wrap trees along bank line in beaver guard to prevent beavers from harvesting the trees along the road. Remove blockages prior to high flow events or freeze up

Concern:

- Beavers can maintain an important wetland/pond on the system that can attenuate flows, settle out sediment and provide valuable habitat, but it is important to maintain the growth along the road edge to prevent against erosion, and maintain absorbing capacity.

Cost Estimate:

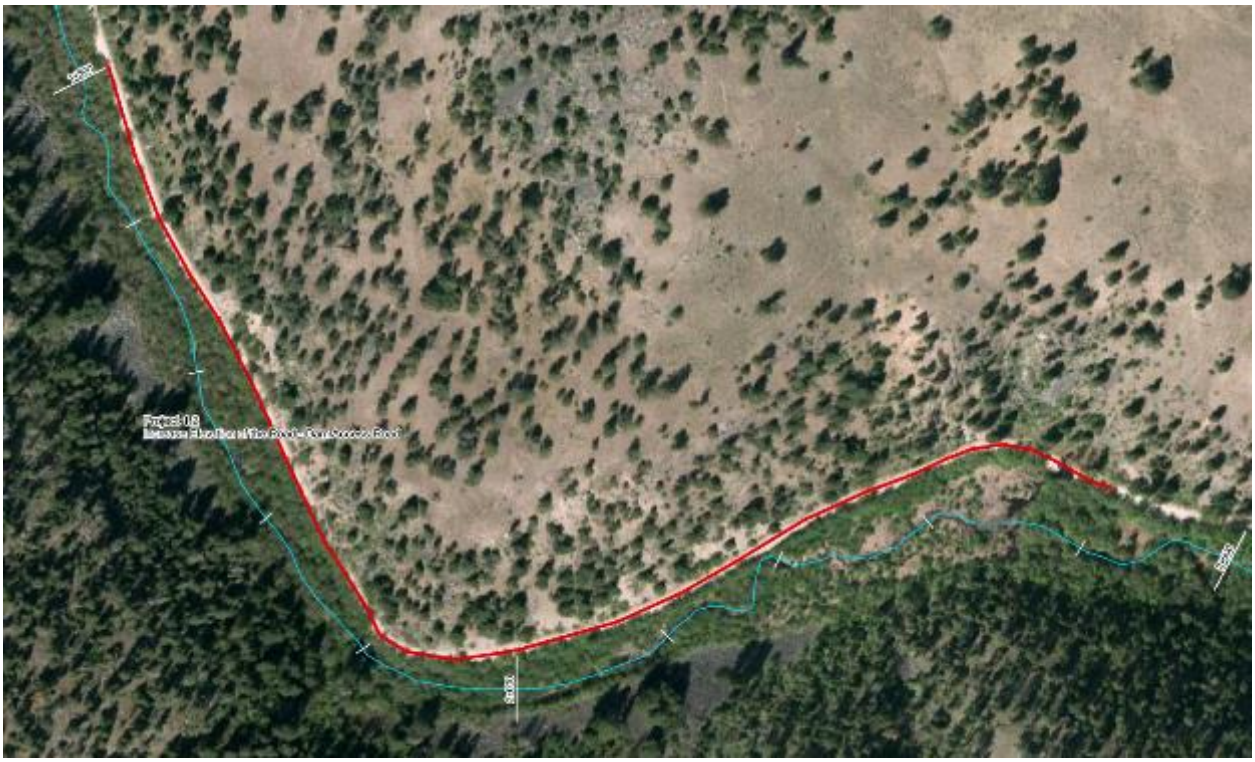
Project 4.1a: Beaver Management – Dam Access Road

Description	Unit	Quantity	Unit Price	Total
Beaver Guard	lin.m	500	$25	$12,500
Installation	Hrs	40	$100	$4,000
			Subtotal	$16,500
Contingency (25%)				$4,100
Engineering (15%)				$2,500
			Project Total	$23,100

Project 4.1b: Beaver Management – Dam Access Road

Description	Unit	Quantity	Unit Price	Total
Annual Maintenance	Hrs	40	$100	$4,000
			Subtotal	$4,000
Contingency (25%)				$1,000
Engineering (15%)				$600
			Project Total	$5,600

Project 4.2: Increase Elevation of the Road – Dam Access Road



Location Map – Dam Access Road

Location Chainage: Sta. 1+500 to 2+400
Proposed Works: Increase the elevation of the road in low lying areas near the creek to allow for increase freeboard and less risk of erosion or inundation when high streamflow events occur.

Implementation:

- Add ~300mm of material along Garnet Valley Road from Station 1+500 to Station 2+400 to increase the amount of freeboard available to increasing water levels.

Concern:

- The current road has minimal freeboard to the water level so minimal increases to water level can cause either water inundation onto the road or saturation of the road structure causing road deterioration.
- If the road isn't raised and water levels increase then a temporary berm or tiger dam, or windrow from a grader may be effective to maintain a single lane of access through this section.
- This is something that could be done slowly as the road is graded each year a bit of material is added, therefore phasing this cost.

Cost Estimate:

Project 4.2: Increase Elevation of the Road – Dam Access Road

Description	Unit	Quantity	Unit Price	Total
Base Gravel (7m wide road surface)	lin.m	900	$200	$180,000
			Subtotal	$180,000
Contingency (25%)				$45,000
Engineering (15%)				$27,000
			Project Total	$252,000
Gravels based on $29 per sqm				

Project 4.3: Public Education – Dam Access Road

Location Map – Dam Access Road

Figure – Tree Harvesting next to Creek

Location Chainage: Sta. 0+000 to 3+300

Proposed Works: Conduct a public information program reminding residents that activities around the creek are limited and that firewood harvesting within 30m of the creek is against the regulations and can adversely affect the creek slopes. And that live standing trees are prohibited from being harvested.

Implementation:

- Install signage and produce a public awareness campaign.

Concern:

- This vegetation provides valuable erosion control and absorption so removing the vegetation can make the system more vulnerable to erosion and additional flows

Cost Estimate:

Project 4.3: Public Education – Dam Access Road

Description	Unit	Quantity	Unit Price	Total
Notification	LS	1	$4,000	$4,000
			Subtotal	$4,000
Contingency (25%)				$1,000
			Project Total	$5,000

Appendix D – Hydraulic Calculations

Section	End (U/S or D/S)	Sta.	Invert	Slope (%)	Channel Bottom		Left Cross Section Slope Dimensions								Right Cross Section Slope Dimensions								Overtopping Depth (m)	Channel Capacity at Overtopping Depth (m^3/s)
							Channel Bank		1st Floodplain Dimensions			2nd FloodPlain Dimensions			Channel Bank		1st Floodplain Dimensions			2nd FloodPlain Dimensions				
					Manning 'n'	Bottom width (m)	Side Slope (h/v)	Rise (m)	Manning 'n'	Side Slope (h/v)	Rise (m)	Manning 'n'	Side Slope (h/v)	Rise (m)	Side Slope (h/v)	Rise (m)	Manning 'n'	Side Slope (h/v)	Rise (m)	Manning 'n'	Side Slope (h/v)	Rise (m)		
1	U/S	6+706	538.8	1.5%	0.045	1.34	1.58	0.36	0.1	1.98	0.75				0.93	0.36	0.1	1.62	0.43				0.79	3.4
1	D/S	6+730	538.6	1.5%	0.045	1.07	1.4	0.53	0.1	5.4	0.53				0.34	0.44	0.1	2.23	0.55				0.99	4.1
2	U/S	6+960	537.4	3.2%	0.05	0.38	2	0.26	0.13	6.9	0.72				2.55	0.18	0.13	1.64	1.21				0.98	5.5
2	D/S	6+969	537.2	3.2%	0.05	1.21	1.78	0.33	0.13	1.39	0.75				1.1	0.33	0.13	1.33	0.87				1.08	7.8
3	U/S	7+520	530.7	3.4%	0.045	0.39	1.44	0.39	0.06	3.91	0.23				2.64	0.35	0.06	0.89	0.57				0.62	2.2
4	U/S	9+548	513.9	0.2%	0.05	1.99	1.39	0.62	0.1	0.98	0.54				0.73	0.62	0.1	0.81	0.68				1.16	2.7
4	D/S	9+750	513.5	6.3%	0.05	0.89	1.47	0.25	0.1	1.46	2.06				0.68	0.25	0.1	0.68	1.47				1.72	19.3
5	U/S	10+794	502.0	0.6%	0.05	2.54	0.89	0.47	0.06	3.88	0.36				1.29	0.47	0.06	1.29	0.25	0.06	6.29	0.59	0.83	3.5
5	D/S	10+817	501.8	0.6%	0.05	1.44	0.87	0.49	0.06	2.17	1.55				0.67	0.49	0.06	5.01	0.99				1.48	8.2
6	U/S	12+151	491.2	0.3%	0.07	2.17	1.42	0.52	0.1	3.71	0.5				2.02	0.52	0.1	2.86	1.16				1.02	2.4
6	D/S	12+169	491.2	0.3%	0.07	2.71	3.29	0.31	0.1	2.52	0.73				1.13	0.31	0.1	7.59	0.34				0.65	1.3
7	U/S	13+151	483.8	0.6%	0.045	2.0	1.2	0.4	0.06	4.73	1.19				0.52	0.4	0.06	0.52	0.54				0.94	3.7
7	D/S	13+294	483.1	0.6%	0.045	1.0	2.87	0.23	0.06	1.13	0.84				1.57	0.23	0.06	1.57	0.75				0.98	3.3
8	U/S	13+715	479.5	1.4%	0.035	1.9	0.75	0.53	0.035	2.05	0.73				0.41	0.65	0.035	6.94	0.18				0.83	4.8
8	D/S	13+747	479.0	1.4%	0.035	1.39	0.48	0.18	0.035	0.57	0.29	0.035	2.17	0.99	0.67	0.34	0.035	1.89	0.57	0.035	11.94	0.007	0.92	5.1
9	U/S	13+836	476.7	1.7%	0.045	1.33	1.46	0.32	0.04	1.21	1.66				2.77	0.32	0.04	2.57	0.6				0.92	6.5
9	D/S	13+890	475.8	1.7%	0.045	1.21	5.69	0.17	0.04	0.32	0.49	0.04	3.84	0.79	0.34	0.64	0.04	1.69	0.7				1.34	11.5
10	U/S	15+142	382.4	6.9%	0.04	2.05	1.56	0.09	0.06	1.56	2.8				0.27	0.1	0.06	0.28	0.78				0.88	12.5
10	D/S	15+146	382.1	6.9%	0.04	1.78	1.22	0.17	0.06	1.22	2.22				1.05	0.17	0.06	1.05	0.79				0.96	13.9
11	U/S	15+872	343.2	0.9%	0.03	1.4	3.78	0.23	0.05	1.17	0.46				1		0.02	0.35	0.77				0.69	3.5
12	U/S	12+413	490.7	1.5%	0.05	0.83	1.36	0.47	0.1	2.31	0.42				2.85	0.46	0.1	6.54	0.39				0.85	3.7
12	D/S	12+420	489.6	1.5%	0.05	0.61	1.62	0.5	0.1	5	0.54				1.33	0.61	0.1	3.18	0.45				1.04	4.2

Appendix E – Riparian Areas Regulation

The *Riparian Areas Regulation* including all up-to-date amendments may be accessed from BC Laws: http://www.bclaws.ca/civix/document/id/complete/statreg/376_2004

Included in this Appendix are a Riparian Areas Regulation brochure, an information note published by the Province of BC, and the Riparian Areas Regulation Assessment Methods document.

Information Note #1:

Introduction to the Riparian Areas Regulation

This Information Note is a guide only. It is not a substitute for the federal Fisheries Act, the provincial Riparian Areas Regulation, or local government bylaws.

What are riparian areas and why are they important?

Riparian areas[1] are the areas adjacent to ditches, streams, lakes and wetlands. These areas, found in all regions of the province, support a unique mixture of vegetation, from trees and shrubs to emergent and herbaceous plants. The vegetation in riparian areas directly influences and provides important fish habitat. It builds and stabilizes stream banks and channels, provides cool water through shade, and provides shelter for fish. The leaves and insects that fall into the water are a source of food for fish[2]. Although they account for only a small portion of British Columbia's landbase, riparian areas are often more productive than the adjoining upland and are a critical component of the Province's biodiversity.

Good quality riparian habitat ensures healthy fish populations (see Figure 1). The protection of riparian areas is a vital component of an integrated fisheries protection program. The integrity of a riparian area depends on, and is influenced by, the upland area as well as the upstream environment. British Columbia has lost hundreds of kilometres of riparian habitat in the past decades in the Lower Mainland alone. To reverse this trend Section 12 of the *Fish Protection Act* was established to guide and facilitate urban development that exhibits high standards of environmental stewardship, while protecting and restoring riparian fish habitat.

Preventing damage to riparian fish habitat is simpler than restoring it once damage has occurred. Addressing riparian areas through watershed planning integrates a broad approach that ensures all aspects of the watershed are considered, including environmentally sensitive areas, stormwater management and riparian areas.

Does the Riparian Areas Regulation apply?

- Yes, to all streams, rivers, creeks, ditches, ponds, lakes, springs and wetlands connected by surface flow to a waterbody that provides fish habitat.
- No, not to marine or estuarine shorelines. These fish habitats are still subject to the federal *Fisheries Act*.
- No, not to watercourses that are disconnected from fish habitats.

[1] *Riparian area* is defined in section 1(1) of the Regulation as a streamside protection and enhancement area (SPEA).

[2] *Fish* is defined in section 1(1) of the Regulation as being all life stages of (a) salmonids, (b) game fish and (c) regional significant fish.

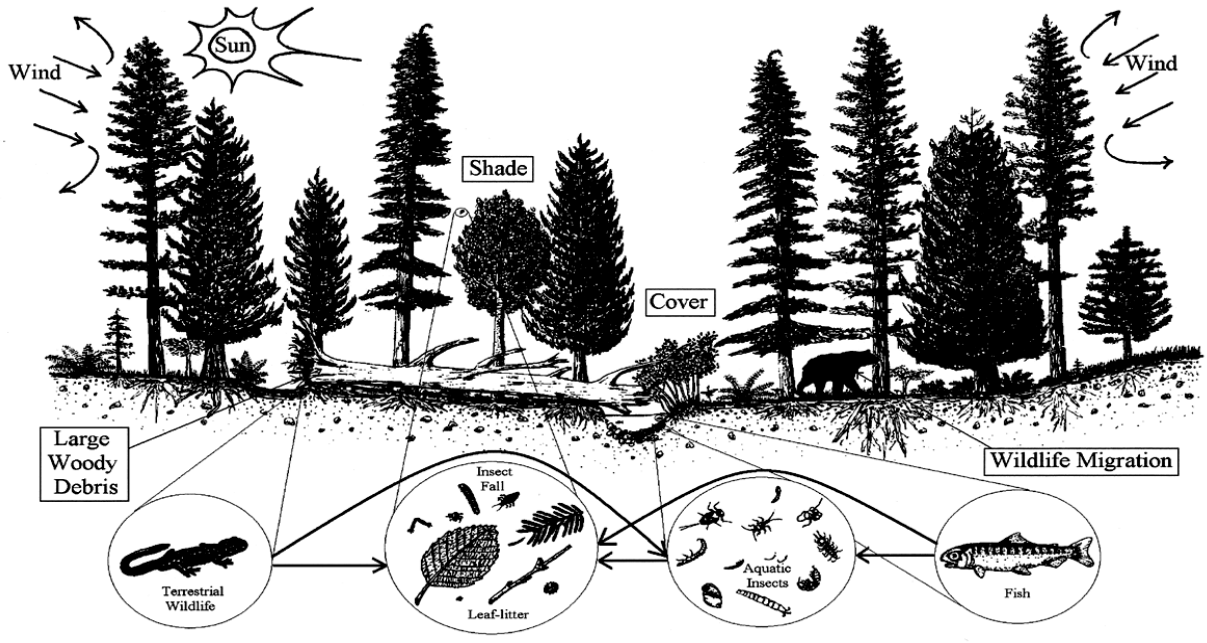


Figure 1. Ways in which healthy riparian areas help to ensure healthy fish populations.

> *Fish habitat* is defined as spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly in order to carry out their life processes. *Fish* under the Regulation include salmonids, game fish and "regionally significant" fish.

What is the Riparian Areas Regulation?

The provincial government passed the *Fish Protection Act* in July 1997 to help ensure fish have sufficient water and habitat as British Columbia continues to grow and develop. Section 12 of the Act authorizes the Province to establish "policy directives regarding the protection and enhancement of riparian areas that the Lieutenant Governor in Council considers may be subject to residential, commercial or industrial development." These policy directives are intended for local governments (municipalities and regional districts), which are the primary bodies responsible for planning and regulating these forms of development.

The Riparian Areas Regulation, enabled by the *Fish Protection Act*, provides the legislated direction needed by local governments to achieve improved protection of fish and fish habitat. The Regulation applies to riparian fish habitat *only in association with new residential, commercial and industrial development*[3] *on land under local government jurisdiction*.

[3] *Development* is defined in section 1(1) of the Regulation as being any of the following associated with or resulting from the local government regulation or approval of residential, commercial, or industrial activities or ancillary to the extent that they are subject to local government powers under Part 26 of the

This includes private land and the private use of the provincial Crown land.

Key components of the Regulation

- Under the Regulation, local governments may allow development within 30 m of the high water mark[4] of a stream or top of a ravine bank[5] – provided the prescribed riparian assessment methods have been followed.
- The riparian assessment method requires a Qualified Environmental Professional[6] (QEP) to provide an opinion – in an Assessment Report – that the development will not result in a harmful alteration to the natural features, functions, and conditions that support fish life processes . The QEP can help plan any new development so that it will avoid any such impacts. The Assessment Report also identifies measures that will be required to maintain the integrity of the riparian area in the development project.
- The assessment methodology in the Schedule of the Regulation ensures that an assessment has been conducted to a standard level and that the standard reporting format is followed. The Assessment Report, submitted electronically to provincial and federal governments, facilitates monitoring and compliance. Based on a detailed assessment of the development area, the

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Local Government Act: (a) removal, alteration, disruption, or destruction of vegetation; (b) disturbance of soils; (c) construction or erection of buildings and structures; (d) creation of nonstructural impervious or semi-impervious surfaces; (e) flood protection works; (f) construction of roads, trails, docks, wharves, and bridges; (g) provision and maintenance of sewer and water services; (h) development of drainage systems; (i) development of utility corridors; (j) subdivision as defined in section 872 of the *Local Government Act*.

[4] *High water mark* is defined in section 1(1) of the Regulation as being the visible high water mark of a stream where the presence and action of the water are so common and usual and so long continued in all ordinary years, as to mark on the soil of the bed of the stream a character distinct form that of its banks, in vegetation, as well as in the nature of the soil itself, and includes the active floodplain.

[5] *Top of a ravine bank* is defined in section 1(1) of the Regulation as being the first significant break in a ravine slope where the break occurs such that the grade beyond the break is flatter then 3:1 for a minimum distance of 15 m measured perpendicularly from the break and the break does not include a bench within the ravine that could be developed.

[6] *Qualified Environmental Professional* (QEP) is defined in section 1(1) of the Regulation as being an applied scientist or technologist, acting alone or together with another QEP. He or she must be registered and in good standing in British Columbia with an appropriate professional organization constituted under an Act, acting under that association's code of ethics and subject to disciplinary action by that association. The applicable professionals include Professional Biologists, Geoscientists, Foresters, and Agrologists. To be able to certify that they are qualified to conduct the assessment methodology, the individual's area of expertise must be recognized in the assessment methods as one that is acceptable for the purpose of providing all or part of an Assessment Report in respect of the particular development proposal that is being assessed. The individual is considered a QEP only for that portion of the assessment that is within their area of expertise, as identified in the assessment methodology.

Regulation provides a mechanism for allowing site-specific determination of appropriate levels of protection.

- The Regulation is based on current science regarding fish habitat, while recognizing the challenges in achieving science-based standards in an urban environment.
- It is recommended that prior to any development, as defined in the Regulation, the local government responsible for land use decisions be contacted to determine what specific legislative requirements are in place.

Where does the Riparian Areas Regulation apply?

The Riparian Areas Regulation currently applies only to municipalities and regional districts in the Lower Mainland, on much of Vancouver Island, in the Islands Trust area, and in parts of the Southern Interior, as these are the regions of greatest population growth and development. The following regional districts and all municipalities within them are affected by the Regulation:

- Capital (except the City of Victoria and Town of Esquimalt)
- Central Okanagan
- Columbia-Shuswap
- Comox
- Strathcona
- Cowichan Valley
- Fraser Valley
- Greater Vancouver (except the City of Vancouver)
- Nanaimo
- North Okanagan
- Okanagan-Similkameen
- Powell River
- Squamish-Lillooet
- Sunshine Coast
- Thompson-Nicola
- the trust area under the *Islands Trust Act*

The Regulation may be phased in elsewhere in the province as the need arises. Other local governments outside these areas can use the approach set out in the Regulation as a way to prevent riparian disruption or disturbance. See also *Develop with Care* (sections 4 - 8) for guidelines on working in riparian areas: http://www.env.gov.bc.ca/wld/documents/bmp/devwithcare/index.html

What types of development does the Regulation apply to?

As noted above, the Regulation applies to local government regulation or approval of residential, commercial or industrial activities or ancillary activities under Part 26 of the *Local Government Act* as "development" along streams.

That means:

- **activities**:
  - construction or erection of buildings and structures;
  - creation of nonstructural impervious or semi-impervious surfaces; and
  - subdivision, as defined in section 872 of the *Local Government Act;* and
- **ancillary activities that are done in a association with residential, commercial or industrial development**:
  - removal, alteration, disruption or destruction of vegetation;
  - disturbance of soils;
  - flood protection works;
  - construction of roads, trails, docks, wharves and bridges;
  - provision and maintenance of sewer and water services;
  - development of drainage systems; and
  - development of utility corridors.

What types of development does the Regulation NOT apply to?

The Regulation does not apply to activities that are NOT residential, commercial or industrial activities or ancillary activities regulated or approved by local government under Part 26 of the *Local Government Act*. The Regulation does not apply to the following:

- ***A development permit or development variance permit*** issued only for the purpose of enabling reconstruction or repair of a permanent structure described in section 911 (8) of the Local Government Act if the structure remains on its existing foundation. Section 911 (8) states: "If a building or other structure, the use of which does not conform to the provisions of a bylaw under this Division is damaged or destroyed to the extent of 75% or more of its value above its foundations, as determined by the building inspector, it must not be repaired or reconstructed except for a conforming use in accordance with the bylaw."
- ***Existing permanent structures, roads and other development*** within riparian protection areas are "grand parented." Landowners can continue to use their property as they always have even if a streamside protection and enhancement area is designated on it. The

Regulation also has no effect on any repair, renovation, or reconstruction of a permanent structure on its existing foundation. Only if the existing foundation is moved or extended into a streamside protection and enhancement area (SPEA) would the Regulation apply.

- ***Developments that have been approved*** but not yet built are honoured. Requests for changes to the approved development may, however, trigger a review with reference to the Regulation, depending on the significance of the proposed change (e.g., a request for a new zone, different land use, or larger structure than the one approved).
- ***Farming activities*** are not subject to the Regulation. Most of them are subject to the *Farm Practices Protection (Right to Farm) Act* or other provincial legislation or guidelines. A Farm Practices Guide is being developed that will address stream setbacks for farming activities. However, while the Regulation does not apply to some farming activities themselves,[7] it does apply to non-farming activities on lands that may otherwise be used, designated, or zoned for agriculture. For instance, construction of non-farming-related building or development of a golf course on Agricultural Land Reserve land would be regulated by local government bylaws and subject to the Regulation.
- ***Mining activities, hydroelectric facilities and forestry (logging) activities*** are also not subject to the Regulation, as these land uses are regulated by other provincial and federal legislation and not by local governments. However, a local government can regulate how and where mineral or forest products may be processed. For instance,

[7] The *Farm Practices Protection Act* defines "farm operation" as "any of the following activities involved in carrying on a farm business:
(a) growing, producing, raising or keeping animals or plants, including mushrooms, or the primary products of those plants or animals;
(b) clearing, draining, irrigating or cultivating land;
(c) using farm machinery, equipment, devices, materials and structures;
(d) applying fertilizers, manure, pesticides and biological control agents, including by ground and aerial spraying;
(e) conducting any other agricultural activity on, in or over agricultural land;
and includes
(f) intensively cultivating in plantations, any (i) specialty wood crops, or (ii) specialty fibre crops prescribed by the minister;
(g) conducting turf production (i) outside of an agricultural land reserve, or (ii) in an agricultural land reserve with the approval under the *Agricultural Land Reserve Act* of the Land Reserve Commission;
(h) aquaculture as defined in the *Fisheries Act* if carried on by a person licensed, under Part 3 of that Act, to carry on the business of aquaculture;
(i) raising or keeping game, within the meaning of the *Game Farm Act,* by a person licensed to do so under that Act;
(j) raising or keeping fur bearing animals, within the meaning of the *Fur Farm Act,* by a person licensed to do so under that Act;
(k) processing or direct marketing by a farmer of one or both of (i) the products of a farm owned or operated by the farmer, and (ii) within limits prescribed by the minister, products not of that farm, to the extent that the processing or marketing of those products is conducted on the farmer's farm;
but does not include
(l) an activity, other than grazing or hay cutting, if the activity constitutes a forest practice as defined in the *Forest Practices Code of British Columbia Act;*
(m) breeding pets or operating a kennel;
(n) growing, producing, raising or keeping exotic animals, except types of exotic animals prescribed by the minister".

processing activities are usually considered as industrial for the purposes of a zoning bylaw and thus fall within the definition of development that can be regulated under the Regulation. As for these resource extraction activities, the bottom line is that all such land uses are still subject to the federal *Fisheries Act*.

- ***Federal lands and First Nations reserve lands*** would be exempt from the Regulation but only to the extent that they are already exempt from local government bylaws. However, activities on these lands are still subject to the federal *Fisheries Act*. With regard to treaty Settlement Lands, compliance with the Regulation and local government bylaws will be negotiated in each treaty.
- ***Parks and parkland*** are subject to other legislation and may, in some cases, be exempt from the Regulation. In other cases, activities such as commercial development within them may still be subject to the Regulation. As well as activities that are ancillary to residential, commercial, or industrial development may be subject to the regulation. For example if as part of a residential development an area was designated as park, then a trail within the park would be subject to the regulation as it is ancillary to the residential development. In all cases it will depend on the individual circumstances. Therefore, review on a case by case basis would be necessary.
- ***Institutional developments*** are exempt from the RAR, but are subject to the Federal Fisheries Act and Provincial Water Act. Where an institutional development includes development activities within the riparian area, it is recommended that the developer seek advice from a qualified environmental professional(s) and secure the necessary approvals for meeting applicable regulatory requirements.

Activities Permitted within a SPEA

The vegetation in the SPEA provides the natural features, functions and conditions that support fish life processes. In this regard, the vegetation in the SPEA must be left in a natural, undisturbed state and activities that have the potential to damage it are not permitted in the SPEA. Where a SPEA has been previously disturbed by development activities the objective is to allow regeneration of the vegetation either naturally or through enhancement efforts.

Instream works

Often, in undertaking instream works such as pipeline crossings, road crossings, foot bridges, bank repairs and stormwater outfalls, a proponent

is required to enter a SPEA or make some modification to a SPEA. These works and their impact on riparian vegetation are to be considered together in the context of instream works.

Fish habitat enhancement works

Fish habitat enhancement activities, including riparian planting, are an acceptable practice within SPEAs if they are done to an appropriate standard. Removal of invasive plant species and garbage is also acceptable as long as care is taken to minimize impacts on the fish habitat and creation of sediment. These are activities that a QEP can provide an opinion on as per section 4(2)(a)(i) of the Regulation. While the involvement of a QEP in planning and overseeing these activities is preferred, the need to involve a QEP will depend on the nature and extent of enhancement works being proposed. For example, planting of native plants by a Streamkeeper group can be undertaken without a QEP but activities that require large machinery to work within the SPEA should involve a QEP or other suitably qualified professional.

Siting of Small Out-buildings

As stated above, the goal for SPEAs that have been previously disturbed by development activity is to restore the vegetation that would naturally occur on the site, either actively by planting or passively by natural recruitment processes. Some local governments review proposals for the construction of small structures (defined as a maximum of 100 square feet) such as sheds. Every effort should be made to locate these structures outside the SPEA. However, where this type of structure must be located in a historically damaged SPEA, the local government may approve it as long as the structure has no permanent foundation, no native vegetation will be damaged during construction, and the structure is located as far from the watercourse as possible. For Greenfield development sites, these structures cannot be located within the SPEA.

Activities not permitted within a SPEA

Development as defined in the RAR is not allowed within SPEAs except as described above. The following activities that have historically occurred within SPEAs are no longer allowed.

Trails

The construction of formal trail networks within the SPEA are not supported as the construction and maintenance of such a trail systems often causes erosion, compaction of root systems, loss of trees and understory plants. In addition, trail development requires a high standard of hazard tree mitigation all of which significantly

impact the form and function of the SPEA. However, some passive activities are compatible with protection of the SPEA including: hiking; nature viewing; access to water, and fishing.

Landscaping

Activities such as landscaping (to create lawns and formal gardens, for example) are not acceptable within a SPEA. Where historic damage to SPEAs has occurred though landscaping or other means, education programs should be considered for landowners. The goal is to provide awareness of the importance of riparian vegetation to fish, and to provide suggestions for replanting the areas to appropriate standards. Local environmental groups can assist or provide these education programs to the community and to link to current replanting and other enhancement initiatives. When planning any landscaping works within the SPEA it is essential that only native plant species specific to the region are selected for use.

Sources of information for planning successful riparian planting projects include:

- *Living by Water* - www.livingbywater.ca
- *Revegetation Guidelines for Brownfield Sites* – (https://www2.gov.bc.ca/gov/topic.page?id=FB284A0570084959BEBF55B9D4D4AEC2)

Stormwater management

Stormwater treatments ponds and wetlands cannot not be located within SPEAs.

Schedule

Riparian Areas Regulation
Assessment Methods

Table of Contents

Figures

Tables

1. Introduction to the RAR Assessment Methods

The Riparian Areas Regulation, enabled by the *Fish Protection Act*, came into effect on March 31, 2005. This assessment methodology is attached as a Schedule of the Regulation and ensures that assessments are conducted to a standard level and that the standard reporting format is followed.

This methodology requires a Qualified Environmental Professional (QEP) to provide an opinion in an Assessment Report that the development will not result in a harmful alteration of riparian fish habitat. Through this report the QEP helps to plan any new development so that it will avoid impacting fish habitat. The Assessment Report, submitted electronically to provincial and federal governments, facilitates monitoring and compliance

Prior to conducting an assessment QEPs should be also be familiar with the Riparian Areas Regulation process which can be found in the Riparian Areas Regulation Implementation Guidebook and with the science rationale for this methodology, both of which are available on the MOE website. The Regulation is based on current science regarding fish habitat, while recognizing the challenges in achieving science-based standards in an urban environment. These supporting documents provide context and principles of the regulation and should be reviewed by QEPs prior to preparing an Assessment Report.

This methodology provides the intended technical interpretation of several definitions found within the Fish Protection Act and the Riparian Areas Regulation; QEPs should ensure they are familiar with these interpretations prior to preparing an Assessment Report.

1.0 The Assessment Methods

This methodology has been developed to provide direction to Qualified Environmental Professionals (QEPs) on how to develop an Assessment Report to meet the provisions of the Riparian Areas Regulation (RAR).

RIPARIAN AREAS REGULATION definition – qualified environmental professional "means an applied scientist or technologist, acting alone or together with another qualified environmental professional, if:

(a) the individual is registered and in good standing in British Columbia with an appropriate professional organization constituted under and Act, acting under that association's code of ethics and subject to disciplinary action by that association,

(b) the individual's area of expertise is recognized in the assessment methods as one that is acceptable for the purpose of providing all or part of an assessment report in respect of that development proposal, and

(c) the individual is acting within that individual's area of expertise "

RIPARIAN AREAS REGULATION definition – assessment report "means a report prepared in accordance with the assessment methods to assess the potential impact of a proposed development in a riparian assessment area and which is certified for the purposes of this regulation by a qualified environmental professional

1.1 Preparing an Assessment Report

An Assessment Report contains the results of a Riparian Assessment. Two assessments options **may**[1] be available to the proponent to determine the applicable Streamside Protection and Enhancement Area (SPEA) width. They are as follows:

1. The Simple Assessment considers whether the stream is fish-bearing, the nature of stream flows and the status of streamside vegetation in determining the SPEA width.
2. The Detailed Assessment requires an evaluation of stream width, reach breaks, potential vegetation type and channel type and then applies formulas to determine the SPEA width and then an assessment of measures to protect the integrity of the SPEA.

RIPARIAN AREAS REGULATION definition - streamside protection and enhancement area "means an area

(a) adjacent to a stream that links aquatic to terrestrial ecosystems and includes

both existing and potential riparian vegetation and existing and potential

adjacent upland vegetation that exerts an influence on the stream, and

(b) the size of which is determined according to this regulation on the basis of an

assessment report provided by a qualified environmental professional in

respect of a development proposal;"

An Assessment Report specifies the appropriate SPEA width following the applicable methodology and outlines the measures required to maintain the integrity of the SPEA if the detailed assessment is used. Proponents must provide an Assessment Report in support of their development application to the appropriate Local Government if they are proposing development within the Riparian Assessment Area.

RIPARIAN AREAS REGULATION definition - riparian assessment area "means

(a) for a stream, the 30 meter strip on both sides of the stream, measured from the high water mark,

(b) for a ravine less than 60 meters wide, a strip on both sides of the stream measured from the high water mark to a point that is 30 meters beyond the top of the ravine bank, and

(c) for a ravine 60 meters wide or greater, a strip on both sides of the stream measured from the high water mark to a point that is 10 meters beyond the top of the ravine bank"

RIPARIAN AREAS REGULATION definition- high water mark 'means the visible high water mark of a stream where the presence and action of the water are so common and usual, and so long continued in all ordinary years, as to mark on the soil of the bed of the stream a character distinct from that of its banks, in vegetation, as well as in the nature of the soil itself, and includes the active floodplain"

[1] Where a Local Government has in place a "meet or beat" approach to the RAR, proponents may limit the options to use the RAR. The proponent or QEP should investigate this prior to undertaking an assessment using the Assessment Methods. Additional information on this can be found in the RAR Implementation Guidebook.

Determining the Riparian Assessment Area (RAA)

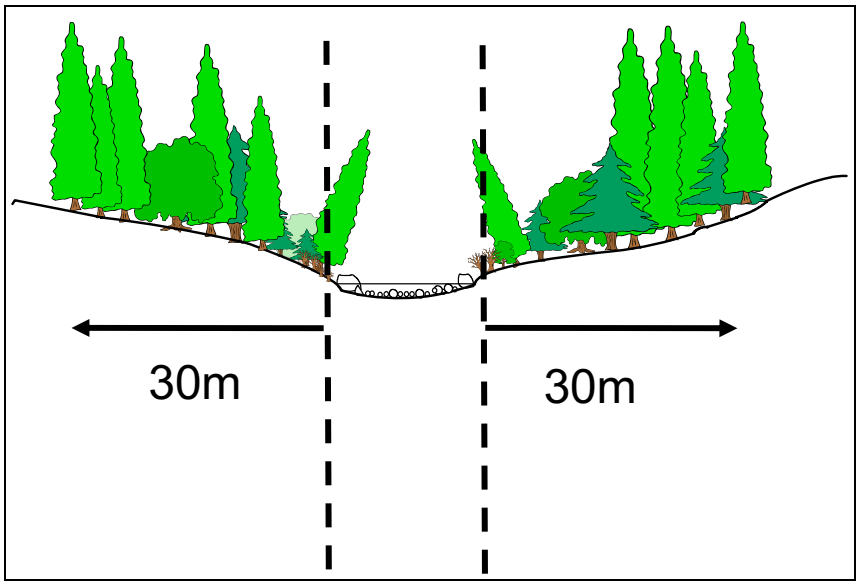


Figure 1-1: Assessment Area

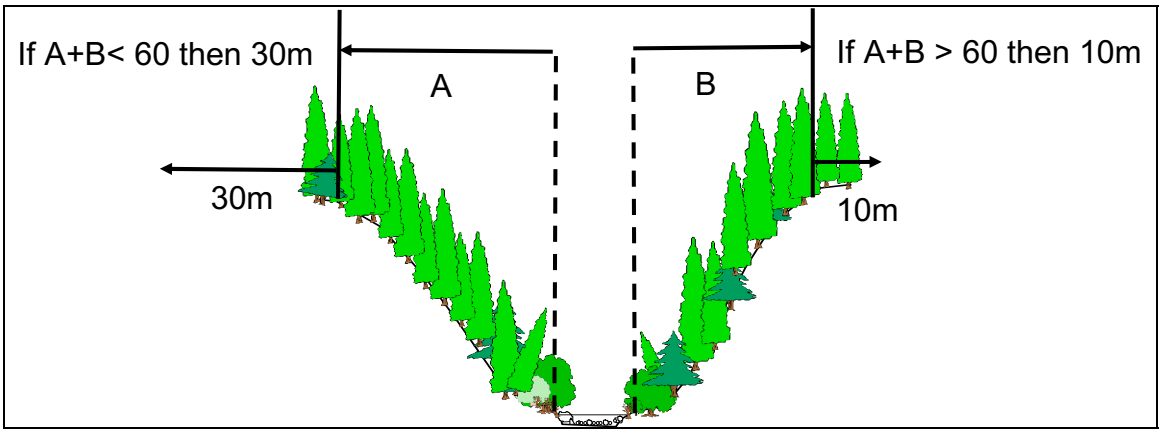


Figure 1-2: Assessment Area for ravines

RIPARIAN AREAS REGULATION definition- ravine "means**'** a narrow, steep-sided valley that is commonly eroded by running water and has a slope grade greater than 3:1"

RIPARIAN AREAS REGULATION definition – top of ravine bank "means the first significant break in a ravine slope where the break occurs such that the grade beyond the break is flatter than 3:1 for a minimum distance of 15 meters measured perpendicularly from the break, and the break does not include a bench within the ravine that could be developed;

All Assessment Reports must be prepared by a Qualified Environmental Professional (QEP) with skill sets appropriate to the evaluation being performed (See Appendix 2). Specialized QEPs may be required to provide their expert advice where site characteristics include indicators of problems or concerns. For example, highly unstable channels require an assessment by a fluvial geomorphologist to help define the appropriate SPEA and recommend measures that will assist in maintaining the features, functions and conditions of the riparian area, a fisheries biologist is required to determine fish absence and a geotechnical engineer is required to evaluate unstable slopes. It is the responsibility of the primary QEP for the project to ensure that specialized QEPs are consulted where appropriate.

1.2 Contents of an Assessment Report

The Assessment Report has been designed to be commensurate with the nature of the site conditions and the development proposed. Its contents will permit monitoring and auditing by regulatory agencies to determine compliance with these Assessment Methods and compliance of the developer with the recommendations by the QEP. It will also allow for a determination of those features, functions and conditions that are deficient and targets for potential compensation proposals, and/or goals for restoration.

The Assessment Report must be filed electronically in PDF format to MOE via http://slkapps1.idir.bcgov/apps/rar/. Information filed must include the following:

1. Completed Assessment Form which contains the information outlined in the Assessment (Appendix 1).
2. An appropriately labeled air/orthophoto as outlined in the methodology if the Simple Assessment is followed (see page 15 for details)
3. Site plan showing width of all Zones of Sensitivity and resulting SPEA (see section 2.5.4 for details)

The Assessment Report must include the following sections:

1.2.1 Description of Fisheries Resources and Riparian Condition

A summary of the species that frequent the waterbody, types of fish habitat present (e.g. spawning, rearing, over-wintering, or migration) and a description of the present riparian vegetation condition must be provided. This information should be used by the QEP to determine appropriate measures to protect the integrity of the SPEA and fish habitat (e.g. sediment control measures during construction or assessing potentially hazard trees within the SPEA) Values of areas tenuously connected to fish habitat and assessments of barriers to fish movement should be described here. Where connectivity between a waterbody and areas of fish use is debatable, a description of the spatial and temporal connection and value for fish of food and nutrients derived from the waterbody should be discussed here with sufficient justification and validation.

1.2.2 Results of the Riparian Assessment Methods

The results of the Riparian Assessment using ether the Simple or Detailed Assessment methodology must be provided in this section. Where the Simple Assessment is used, an air/orthophoto must be scanned and submitted as outlined in section 2.1 along with the measurements and calculations used to determine the SPEA width. Where the Detailed Methodology is used the measurements and calculations for each Zone of Sensitivity must be provided as well as the resultant SPEA width and the associated "Measures" to protect and maintain the integrity of the SPEA.

1.2.3 Site Plan

A site plan showing topographic features must be included. The site plan must be of the appropriate size and scale to show the locations of the top of bank, high water mark, SPEAs, Zones of Sensitivity and measures to maintain the integrity to the SPEAs

If the application to local government includes a specific development proposal then the site plan must show the proposed development. This includes both primary development (e.g. buildings) and all supporting infrastructure (e.g., servicing, walls, roads, trails, docks). Site plans will vary in their complexity, according to the scale of the development. In general, local government will have requirements for site plan development and the proponent should check with them to ensure the appropriate scale is selected. The site plan must be at a sufficient resolution to be reproduced at the original scale submitted to local government for approval. **The site plan must show the width of the various zones of sensitivity (ZOS) and the resulting SPEA width, including setbacks from the either the Top of Bank or Top of Ravine Bank (Simple Assessment) or the High Water Mark (Detailed Assessment) depending on which method of assessment has been used.**

1.2.4 Measures to Protect and Maintain the SPEA (Detailed Methodology Only)

A description of all "Measures" (actions and contingencies) that will be taken to maintain and protect the SPEA from development outside of the SPEA must be included in the Assessment Report if the Detailed Assessment is used. The measures that must be considered include: assessment and treatment of danger trees, windthrow, slope stability, tree protection during construction, encroachment and sediment and erosion control. The only measure permitted within the SPEA is the treatment of hazard trees. Some measures will result in areas beyond the SPEA being identified as areas requiring special protection or limited activity to protect and maintain the SPEA. For example, addressing windthrow will require the creation of a wind firm edge outside of the SPEA.

Addressing some of these measures may require retaining other QEPs with specialized expertise relevant to the skill sets identified in Appendix 2. Not all sites will require an assessment for all measures; the primary QEP is responsible for identifying if the site conditions indicate a particular problem or issue. For example, where the watercourse is in a ravine the primary QEP should seek advice from a secondary QEP who is a geotechnical engineer on slope stability measures required to prevent any failure of the ravine slope both during and post-development. Where the development site has been previously disturbed and the SPEA is currently lawn the

primary QEP does not need to consider hazard trees, windthrow or tree protection during construction. All QEPs must provide advice only within their area of expertise.

Information regarding specific measures is found in Section 3.7 and must be referred to when developing applicable measures. Additional solutions to some of these issues may be found in the document entitled "Best Management Practices for Urban and Rural Land Development". This document can be found at the Ministry of Environment website http://www.env.gov.bc.ca/wld/BMP/bmpintro.html.

1.2.5 Environmental Monitoring

This section identifies the actions that will be taken to ensure all proposed activities are completed as described. It will include a monitoring schedule and process for resolving any non-compliance on the site. A communication plan for site workers is strongly recommended. The appropriate level of knowledge, training and experience for all site environmental monitors should be specified.

1.2.6 Photos

QEPs are encouraged to provide as many photos as necessary to illustrate the nature of the riparian area and any significant fish habitat features.

1.2.7 Professional Opinion

The QEP(s) will certify in the Assessment Report for that proposal that

1. **he or she is qualified to carry out the assessment,**
2. **that the assessment methods have been followed, and provides their professional opinion that:**

(i) if the development is implemented as proposed there will be no harmful alteration, disruption or destruction of natural features, functions and conditions that support fish life processes in the riparian assessment area, or

(ii) if the streamside protection and enhancement areas identified in the report are protected from the development and the measures identified in the report as necessary to protect the integrity of those areas from the effects of the development are implemented by the developer, there will be no harmful alteration, disruption or destruction of natural features, functions and conditions that support fish life processes in the riparian assessment area.

Where a Local Government (following the direction in the Implementation Guidebook http://www.env.gov.bc.ca/habitat/fish_protection_act/riparian/riparian_areas.html) or DFO has provided a letter allowing a divergence from the Detailed Assessment Methods the QEP provides opinion (i) along with the agency letter(s).

Where the Assessment Report fully adheres to the Assessment Methods the QEP provides opinion (ii).

1.3 Sign-off and Submitting an Assessment Report

The Assessment Report must be prepared and signed by all the QEPs that contributed to and share responsibility for the report at all points indicated in the report template for those components of the assessment for which they were the QEP. The primary QEP must retain on file at their normal place of work a signed hardcopy of the Assessment Report. The Assessment Report is captured in a form (Appendix 1) which is submitted electronically on the Ministry of Environment website. The Assessment Report, once submitted, is used by the proponent to support their development application to Local Government. When Assessment Reports are submitted notification is sent automatically to the Ministry of Environment, Department of Fisheries and Oceans and the relevant Local Government.

An Assessment Report may only be submitted where the QEP can make the certifications and provide one of the two opinions on harmful alteration, disruption or destruction of natural features, functions and conditions that support fish life processes in the riparian assessment area. If the development cannot accommodate the prescribed Detailed Assessment SPEA width and measures consult the processes outlined in the RAR Implementation Guide (http://www.env.gov.bc.ca/habitat/fish_protection_act/riparian/riparian_areas.html) to address these situations and where an agency has provided authority to diverge from the Assessment Methods their letter is referenced and the QEP gives opinion "(i) if the development is implemented as proposed there will be no harmful alteration, disruption or destruction of natural features, functions and conditions that support fish life processes in the riparian assessment area.

1.4 Does the RAR Apply to the Proposal

1.4.1 Types of Development

RIPARIAN AREAS REGULATION definition - development "means any of the following associated with or resulting from the local government regulation or approval of residential, commercial or industrial activities or ancillary activities to the extent that they are subject to local government powers under Part 26 of the *Local Government Act:*

a) removal, alteration, disruption of destruction of vegetation;

b) disturbance of soils;

c) construction or erection of buildings and structures;

d) creation of nonstructural impervious or semi-impervious surfaces;

e) flood protection works;

f) construction of roads, trails, docks, wharves and bridges;

g) provision and maintenance of sewer and water services

h) development of drainage systems;

i) development of utility corridors;

j) subdivision as defined in section 872 of the *Local Government Act*;"

The Regulation applies to local government regulation or approval of residential, commercial or industrial activities or ancillary activities under Part 26 of the *Local Government Act* as "development" along streams.

The Riparian Areas Regulation does not apply to:

• A development permit or development variance permit issued only for the purpose of enabling reconstruction or repair of a permanent structure described in section 911 (8) of the Local Government Act if the structure remains on its existing foundation.

• Existing permanent structures, roads and other development within riparian protection areas are "grand parented." Landowners can continue to use their property as they always have even if a streamside protection and enhancement area is designated on it. The Regulation also has no effect on any repair or reconstruction of a permanent structure on its existing foundation. Only if the existing foundation is moved or extended into a streamside protection and enhancement area (SPEA) would the Regulation apply.

• Developments that have been approved but not yet built are honoured. Requests for changes to the approved development may, however, trigger a review with reference to the Regulation, depending on the significance of the proposed change (e.g., a request for a new zone, different land use, or larger structure than the one approved).

• Farming activities are not subject to the Regulation. Most of them are subject to the Farm Practices Protection (Right to Farm) Act or other provincial legislation or guidelines. A Farm Practices Guide is being developed that will address stream setbacks for farming activities. However, while the Regulation does not apply to some farming activities themselves, it does apply to non-farming activities on lands that may otherwise be used, designated, or zoned for agriculture. For instance, construction of non-farming-related building or development of a golf course on Agricultural Land Reserve land would be regulated by local government bylaws and subject to the Regulation.

• Mining activities, hydroelectric facilities and forestry (logging) activities are also not subject to the Regulation, as these land uses are regulated by other provincial and federal legislation and not by local governments. However, a local government can regulate how and where mineral or forest products may be processed. For instance, processing activities are usually considered as industrial for the purposes of a zoning bylaw and thus fall within the definition of development that can be regulated under the Regulation. As for these resource extraction activities, the bottom line is that all such land uses are still subject to the federal Fisheries Act.

• Federal lands and First Nations reserve lands would be exempt from the Regulation but only to the extent that they are already exempt from local government bylaws. However, activities on these lands are still subject to the federal Fisheries Act. With regard to treaty Settlement Lands, compliance with the Regulation and local government bylaws will be negotiated in each treaty. The policy of the MOE is to seek to include the standards set out in the Regulation in treaties.

• Parks and parkland are subject to other legislation and may, in some cases, be exempt from the Regulation. In other cases, activities such as commercial development within them may still be subject to the Regulation. As well as activities that are ancillary to residential, commercial, or industrial development may be subject to the regulation. For example if as part of a residential development an area was designated as park, then a trail within the park would be subject to the

regulation as it is ancillary to the residential development. In all cases it will depend on the individual circumstances. Therefore, review on a case by case basis would be necessary.

•Institutional developments are exempt form the RAR, but are subject to the Federal Fisheries Act and Provincial Water Act. Where an institutional development includes development activities within the riparian area, it is recommended that the developer seek advice from a qualified environmental professional(s) and secure the necessary approvals for meeting applicable regulatory requirements.

1.4.2 Streams under the Riparian Areas Regulation

The Riparian Areas Regulation defines a stream as any watercourse – natural or human-made – that provides fish habitat that contains water on a perennial or seasonal basis, is scoured by water or contains observable deposits of mineral alluvium, or has a continuous channel bed including a watercourse that is obscured by overhanging or bridging vegetation or soil mats. A watercourse may not itself be inhabited by fish, but may provide water, food and nutrients to streams that do support fish.

RIPARIAN AREAS REGULATION definition - stream "includes any of the following that provides fish habitat:

(a) a watercourse, whether it usually contains water or not;

(b) a pond, lake, river, creek, brook;

(c) a ditch, spring or wetland that is connected by surface flow to something referred to in paragraph (a) or (b);"

Side channels, intermittent streams, seasonally wetted contiguous areas are included by the definition of a stream which includes active floodplains and wetlands connected to streams.

Fish are defined under the Riparian Areas Regulation. Game fish are defined federally and include: trout, char, whitefish, bass, kokanee, arctic grayling, burbot, white sturgeon, black crappie, northern pike, yellow perch, walleye, goldeye, inconnu and crayfish. Regionally significant fish will be determined by MOE. Aquatic species that are endangered or threatened either provincially or nationally may have requirements in excess of the level of protection identified under the Riparian Areas Regulations. QEPs should review Species Recovery Plans or contact agency staff in MOE or DFO regarding the specific needs of these species.

RIPARIAN AREAS REGULATION definition - fish "means all life stages of

(a) salmonids,

(b) game fish, and

(c) regionally significant fish;"

The Riparian Areas Regulation does not apply to marine or estuarine shorelines; these waters are still considered fish habitat under the Fisheries Act and DFO should be contacted regarding appropriate setback widths to ensure that development activities do not result in a harmful alteration, disruption or destruction of fish habitat. The boundary between freshwater habitats and estuarine habitats is considered the upstream extent of tidal influence. Streams that do not contain fish and that flow directly to the ocean may have high fish utilization of their estuary; contact DFO staff regarding the level of riparian protection required on these watercourses.

This definition of stream is broad but is consistent with the definition of fish habitat under the federal *Fisheries Act***.** As such this definition provides the basis for harmonizing municipal, provincial and federal statutory requirements. It also ensures consistency in application and interpretation of streamside protection requirements across the three levels of government.

When is a watercourse not a stream under the Riparian Areas Regulation? When it does not support fish or drain into a watercourse that supports fish; e.g., an isolated wetland that is not connected to a stream system; or a roadside ditch that is not directly connected to a fish-bearing stream. Note, however, that these 'non-fish' watercourses may still provide important functions as habitat to other aquatic organisms, food, water and migration corridors for birds and wildlife, water storage and cleansing, and greenway and aesthetic values for people. The fact that the Riparian Areas Regulation focuses on fish streams does not prevent governments from regulating development around these other watercourses in the interests of protecting a wider range of values.

The key question in determining if a watercourse is a stream is whether it connected by surface flow to a stream that provides fish habitat. If so, then it **is** a stream under the Riparian Areas Regulation. Surface flow means that the water is moving above the bed of the stream; water flowing through a culvert does not constitute subsurface flow. Where a stream periodically flows subsurface but flows above the surface part of the year would constitute a stream under the Riparian Areas Regulation.

This means that many "ditches" will be considered streams under the Riparian Areas Regulation and will require an Assessment Report to be prepared. However, under the Detailed Assessment ditches are considered differently than natural or channelized streams because it is recognized that not all ditches are created equal. Some convey only local surface drainage while others are natural streams that have been channelized and the Detailed Assessment identifies the appropriate level of riparian protection that should be afforded to each of these situations.

1.4.3 Day-Lighting of Streams

There is interest in some urban areas to open up culverted and buried stream channels and bring them back above ground. However, there is also a perception that such day-lighted streams would immediately be subject to the RAR standards. Having to meet these standards on a day-lighting project where there is often limited room to re-establish the stream channel could cause many day-lighting projects to be discarded. In this regard, MOE and DFO staff are able to negotiate specific riparian protection standards to enable these positive projects to proceed.

2.0 Conducting a Simple Assessment

The Simple Assessment originates from the repealed Streamside Protection Regulation and is one of two options available to establishing the associated SPEA width. The Simple Assessment sets out widths for SPEAs based on certain stream characteristics – fish-bearing, nature of stream flows and the status of streamside vegetation. These widths have been defined for the protection of fish habitat, tempered by the feasibility of applying these widths in previously developed areas. All "permanent structures" legally constructed within the 30 meter riparian area are grandfathered (i.e. they are able to remain provided they remain on the same foundation). Table 2-3 provides guidance on permanent structures.

Determining the SPEA using the Simple Assessment

Determining a SPEA using the Simple Assessment requires answering the following key questions:

1. What is the width and status of the ***existing and potential streamside vegetation***?
2. Is the stream currently or potentially ***fish-bearing***? Or is it tributary to a fish-bearing stream?
3. (For a few, limited situations) is the stream flow ***permanent*** or ***non permanent***?

The QEP has the option of assuming defaults as outlined below in Table 2.1 for each question and then applying the 30 m buffer width listed in Table 2-4 as outlined in section 2.4

Table 2.1 30m default

Question	Default
What is the width and status of the ***existing and potential streamside vegetation****?*	Category 1
Is the stream currently or potentially ***fish-bearing****?*	Yes
Is the stream ***permanent*** or ***non permanent****?*	Permanent

2.1 Determining the Status of Existing and Potential Vegetation

The vegetation category is assessed within a 30m wide area starting from the middle of the subject site and going 200m both upstream and downstream on the bank(s) where the development will occur on. An air photo can be used to undertake this measurement providing it is of a scale and resolution sufficient to determine the type of structures and the QEP confirms by a site visit that no changes have occurred to the area since the date that the air photo was taken. Where adequate air photo coverage is unavailable, ground transects should be used, provided permission to access to upstream and downstream properties can be obtained. Below are the directions on how to calculate the vegetation category:

1. Draw on the air photo the 30m and 200m assessment boundaries.
2. Mark all permanent structures in this area. **For this evaluation permanent structures only include buildings with foundations.** Table 2-3 found later in this chapter provides guidance on permanent structures for the purpose of grandfathering structures in the SPEA. Field checking an aerial or orthophoto interpretation is particularly important where land uses have changed or structures and clearings are difficult to interpret
3. At a minimum of every 40 metres, beginning at the midpoint of the lot, measure the distance from the TOB (at right angles to the stream) to the first permanent structure. Road crossings should not be included in assessments - move further upstream or downstream to account for a loss of linear length in assessment area. Record each distance.
4. Add all these distances and determine the average potential riparian width and apply formula in Table 2-2.

Table 2-2 Average Potential Riparian Width and Vegetation Category for the Simple Assessment

Category	Average Potential Riparian Width
1	greater than 15m
2	10 - 15m
3	less than 10m

Figure 2-1 on page 16 illustrates this method with the resulting average potential riparian width of 28 m results in Vegetation Category 1.

Figure 2-1: Example of determining of vegetation category for Simple Assessment

Note that a previously developed streamside site could become "potential" vegetation if redevelopment is proposed that involves removing one or more permanent structures. In that case, reclaiming and restoring a streamside area to a vegetated state could form part of the subsequent development approval. Table 2-3 provides guidance on what is a 'permanent structures" for the purpose of determining potential vegetation. It can also be used to provide guidance on "permanent structures" for the purpose of both the Simple and the Detailed Assessments. When using the Simple Assessment there are some situations where the location of the permanent structure will influence the location of the SPEA (see section 2-4 and 2-5).

Field check: Field checking an aerial or orthophoto interpretation is particularly important where land uses have changed or structures and clearings are difficult to interpret.

Table 2-3: Examples of permanent structures

Structure	
Building	**Permanent** if constructed and compliant with permits, approvals and standards required at the time of construction; this includes buildings that pre-date current permitting processes but which are considered "legal" whether or not they conform to current zoning or building standards.
Public road	**Permanent** if the road alignment is consistent with a current transportation plan and can not be changed.
Private road	**Permanent** if it is required as access for an existing use that is not subject to change (i.e., not subject to redevelopment, rezoning or subdivision wherein road alignment could change).
Temporary access	**Temporary** if an alternative, permanent access will be developed as part of site development.
Parking area	**Permanent** if it is associated with a permitted structure and is required to meet minimum local government parking standards for the existing use (i.e., parking area can not be reduced, altered, moved or relocated). **Temporary** if the area is subject to new development, redevelopment, rezoning or subdivision, is not associated with a permanent structure, and/or the parking area can be reduced, or reasonably altered, or relocated.
Landscaped area	**Temporary** if it could be modified over time to provide more natural riparian conditions
Playing field, playground or golf course	**Permanent -** however, there may be room and opportunity to relocate structures or allow streamside areas to be 'naturalized' without compromising the recreational use. **Temporary** if the land is being used in this capacity in the short term, while being held for another recreational or other purpose.
Trail	**Permanent** if it is an integral part of an existing or approved trail network, has been in use for an extended period of time and/or there is no room or opportunity to relocate it. **Temporary** if it does not have structures (i.e.: boardwalks, viewing platforms, access control structures, bridges) associated with it or there is room or opportunity to relocate the trail, especially portions that are degrading streambanks and riparian vegetation.
Outdoor storage associated with a commercial, industrial or utility operation	**Permanent** if it is associated with a permitted structure, the existing use of which is to be retained, storage use is in compliance with all other appropriate legislation, and storage area can not be reduced, altered, moved or relocated. **Temporary** if the existing property use will not be retained; the site is subject to new development, redevelopment, rezoning or subdivision; the storage facility would not be considered a permitted structure; and/or the storage area can be reduced altered, moved or relocated.
Utility works and	**Permanent** if it is an authorized use in compliance with all other appropriate legislation.

services	Where the utility is underground for which a right of way exists for servicing purposes, the right of way within the streamside area should be naturalized or revegetated with minimum vegetation clearing to allow service vehicle access to the area.
Dykes, levees	**Permanent** if the structure is provincially or federally approved, and intended to provide long-term flood protection to associated properties. **Temporary** if the structure is not intended to provide long term protection, may be feasibly moved back or realigned, or is planned to be decommissioned as part of an infrastructure renewal program.

2.2 Determining if the Stream is Fish-Bearing

Fish-bearing streams are ones in which fish are present or *potentially* present if introduced obstructions could be made passable. The definition of Fish under the Riparian Areas Regulation was provided in Chapter 1. The QEP may use the default position and assume that fish are present and use the applicable SPEA standard for a fish-bearing stream.

2.2.1 Information Sources to Confirm Fish Presence

If it is not known whether a stream supports fish, there are a few resources to check to see if others have found fish in that system. These sources cannot be used to determine fish absence (see section 2.2.2 below).

The Fisheries Information Summary System (FISS) is maintained by the Ministry of Environment and Fisheries and Oceans Canada and can be accessed through their websites (Box 2-1). It provides maps of streams indicating fish presence and habitat value. However, at a scale of 1:20,000, the FISS misses many small streams that may contain fish in urban and rural areas.

The Community Mapping Network has fish presence information and other thematic maps at a 1:5,000 scale for the Georgia Basin and Central Okanagan (see Box 2-1).

Box 2-1: Fisheries Information Sources

Fisheries Information Summary System (FISS):

Ministry of Sustainable Resource Management

FISS Data Manager
Resource Information Branch
395 Waterfront Cres.
Victoria, BC V8W 9M2
Phone: (250) 387-9588 Fax: (250) 356-1202
http://www.bcfisheries.gov.bc.ca/fishinv/fishinfobc.html>.

Department of Fisheries and Oceans
http://www-heb.pac.dfo-mpo.gc.ca/maps/maps-data_e.htm

Salmon Habitat Inventory and Mapping - Community Mapping Network
http://www.shim.bc.ca

Resources Inventory Committee (RIC*)*:
standards for aquatic ecosystems -
http://www.for.gov.bc.ca/ric/PUBS/AQUATIC/index.htm
LINK DOES NOT WORK

Local Government Offices

- Staff at regional Ministry of Environment and Fisheries and Oceans offices or local government environmental staff may have data on fish presence in local streams.
- Stewardship groups or local residents may also be sources of documented or anecdotal information. Though the information may be anecdotal, it can still provide the basis for choosing whether to conduct a field assessment.

2.2.2 Determining Fish Absence

Fish Absence can be affirmed using the three methods outlined below

1. Using stream gradient (Section 2.2.2.1)

2. Evaluating man made barriers to fish passage (Section 2.2.2.2)

3. Undertaking sampling to confirm fish absence (Section 2.2.2.3)

As described below the QEP may need to employ more than one of these methods to confirm fish are absent from the area of concern.

Non-fish-bearing streams are still protected under the Riparian Areas Regulation if they provide water, food or nutrients to a fish-bearing stream. The only watercourses that are exempt from the Riparian Areas Regulation are those that are clearly isolated from a fish-bearing system.

2.2.2.1 Fish Absence Based on Stream Gradient

Stream reaches with a stream slope greater than 20% are not considered fish-bearing for the purposes of applying the Simple Assessment methodology. However, fish such as cutthroat trout, bull trout, Dolly Varden char and sometimes rainbow trout have been observed to occur in very steep streams, well in excess of 20% slope. Where a reach has a stream gradient >20% and a stepped-pool profile and (or) where a lake occurs at the head of the drainage, or there is perennial fish habitat above a barrier the methodology found in Appendix 3 must be employed to determine fish presence/absence. Impassible conditions or barriers where no reasonable potential for fish presence can be expected include:

- Natural impassable barriers such as falls or steep cascades that are too high even in high flow periods for fish to jump.
- Human made permanent barriers that cannot be reasonably modified to allow fish passage; e.g., large weirs or dams, or extensive enclosed or channelized reaches.

Very low or no flows during critical life history stages that preclude migration and upstream access.

When the proponent identifies a situation where an accessible and (or) lake-headed stepped-pool reach of ≥ 20% grade occurs in the upper parts of a fish-bearing stream, the proponent is encouraged in the interests of fish population conservation to contact and consult with the Ministry of Environment regional office, and if necessary, the local Fisheries and Oceans office in order to establish whether the reach might be surveyed for fish.

When fish are found in a given reach; that reach is to be identified, classified and managed as a fish-bearing stream reach regardless of its slope.

2.2.2.2 Man Made Barriers to Fish Passage

It may be necessary to conduct an assessment of man made barriers to fish passage. Where these circumstances exist the QEP must provide sufficient documentation in the Assessment Report to confirm the existence of a "permanent" man made barrier. This should include providing measurements of the barrier, calculations of flows where this is identified as the problem, and confirmation from responsible authorities that a man made barrier cannot be reasonably modified or replaced with a passable structure. If the man made barrier can be made accessible then the stream is to be considered fish bearing. Depending on the situation, there may also be a need to conduct an assessment upstream of the barrier following the methodology in Appendix 3 to confirm that resident fish populations do not exist (i.e. there is year round flow or a lake above the barrier).

2.2.2.3 Methodology to Confirm Fish Absence

To confirm fish absence where stream gradient or a barrier are not factors, the methodology found in the Appendix 3 must be employed to determine fish presence/absence. Documentation of the methods employed to determine fish absence is required on the electronic Assessment Report submitted to the Ministry of Environment. As noted in the above sections, there may be a need to undertake this assessment in association with stream gradient and barrier situations.

2.3 Determining Stream Permanence

Assessment methods definition - permanent stream "means a stream that typically contains continuous surface waters or flows for periods more than 6 months in duration

Assessment methods definition - non-permanent stream "means a stream that typically contains continuous surface waters or flows for a period less than 6 months in duration" and does not contain fish

Stream flow permanence is a factor only in determining a SPEA on non fish - bearing streams with existing or potential vegetation greater than 30 m in width. Here, the minimum SPEA width is either 15 or 30 m depending on whether the stream is permanent or not. Hence, this characteristic will need to be determined on a more limited basis than the other SPEA factors.

Some streams have flow records and these can be referenced to determine stream permanence. It is important to keep in mind that the default value is permanent. The QEP must adequately document that a stream is non-permanent and provide the rationale in the Assessment Report which should include flow records over multiple years.

In the definitions, surface flow means flow that is not below the bed of the stream; flow contained within a culvert is considered surface flow. Lakes and wetlands are always considered to have permanent flow; if they are non-fish bearing then the RAR does not apply to them.

2.4 Calculating the SPEA for the Simple Assessment

Once answers to the key questions are determined the SPEA can be determined from Table 2-4., except for Ravines greater than 60 meters in width where the SPEA is 10 meters beyond the top of the ravine bank (Section 2.5.4.1). For three combinations there are multiple outcomes that are based on the location of permanent structures (Figures 2-2 and 2-3).

<table>
<tr><th rowspan="3">Vegetation Category</th><th rowspan="3">Existing or potential streamside vegetation conditions</th><th colspan="3">Streamside Protection and Enhancement Area Width*</th></tr>
<tr><th rowspan="2">Fish bearing</th><th colspan="2">Non-Fish bearing</th></tr>
<tr><th>Permanent</th><th>Non Permanent</th></tr>
<tr><td>1</td><td>Continuous areas ≥30 m or discontinuous but occasionally > 30 m to 50 m</td><td colspan="2">30 m</td><td>Minimum 15 m
Maximum 30m
Refer to Figure 2-2</td></tr>
<tr><td>2</td><td>Narrow but continuous areas = 15 m or discontinuous but occasionally > 15 m to 30 m</td><td>Minimum 15
Maximum 30
Refer to Figure 2-2</td><td colspan="2">15 m</td></tr>
<tr><td>3</td><td>Very narrow but continuous areas up to 5 m or discontinuous but occasionally > 5 m to 15 m</td><td>15 m</td><td colspan="2">Minimum 5m
Maximum 15 m
Refer to Figure 2-3</td></tr>
</table>

Table 2-4: Streamside Protection and Enhancement Area Widths for the Simple Assessment

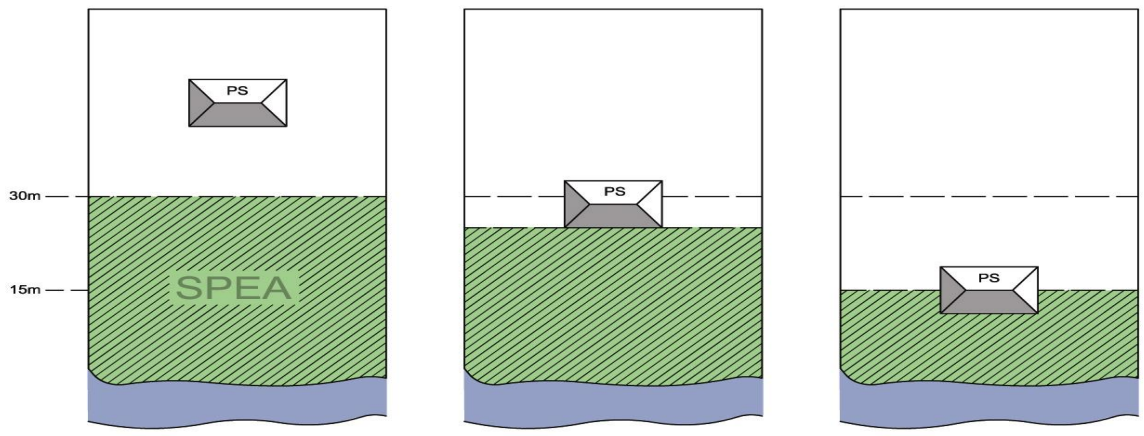
***SPEA is measured from Top of Bank or Top of Ravine Bank.**

Assessment methods definition - top of bank "″ means

(a) the point closest to the boundary of the active floodplain of a stream where a break in the slope of the land occurs such that the grade beyond the break is flatter than 3:1 at any point for a minimum distance of 15 metres measured perpendicularly from the break, and

(b) for a floodplain area not contained in a ravine, the edge of the active floodplain of a stream where the slope of the land beyond the edge is flatter than 3:1 at any point for a minimum distance of 15 metres measured perpendicularly from the edge.

Figure 2-2 Determining SPEA width for Vegetation Category 1/non-fish bearing/non permanent and Vegetation Category 2/Fish bearing.

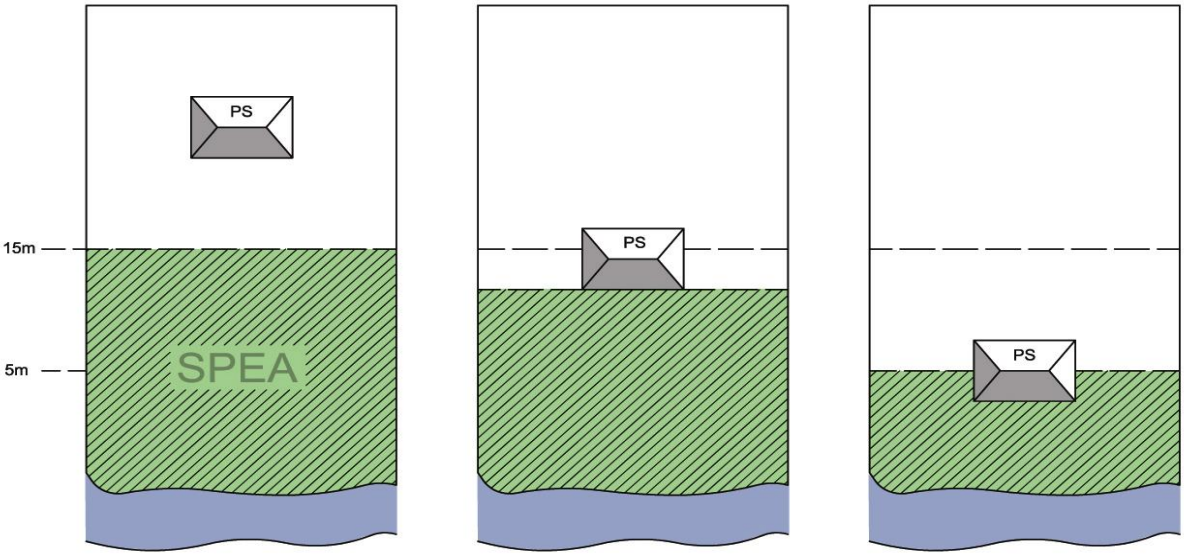


No Permanent Structures (PS) within 30m of TOB.
SPEA = 30m from TOB

PS between 15-30 m from TOB.
SPEA = distance from TOB to the closest point of PS

PS < 15m from TOB.
SPEA = 15m from TOB

Figure 2-3 Determining SPEA width for Vegetation Category 3/non-fish bearing



No Permanent Structures (PS) within 15m of TOB.
SPEA = 15m from TOB

PS between 5-15 m from TOB.
SPEA = distance from TOB to the closest point of PS

PS < 5m from TOB.
SPEA = 5m from TOB

2.5 Laying out the SPEA Under the Simple Assessment

2.5.1 Permanent Structures

Note that a previously developed streamside site could become "potential" vegetation if redevelopment is proposed that involves removing one or more permanent structures. In that case, reclaiming and restoring a streamside area to a vegetated state could form part of the subsequent development approval. Table 2-3 provides guidance on grandfathering "permanent structures" for the purpose of both the Simple and the Detailed Assessments. When using the Simple Assessment there are some situations where the location of the permanent structure will influence the location of the SPEA.

2.5.2 Wide Lots

Using the Simple Assessment there are some situations where the location of the permanent structure will influence the location of the SPEA. Where the property can be subdivided and the structure is located only on a small portion of the property, the SPEA determined based on the presence of a permanent structure will apply only to the portion of the property where the structure continues to exist. For example, if a property was subdivided into five lots and only one of those lots contained the permanent structure, the one lot with the permanent structure will have the SPEA based on the location of the permanent structure and the other four lots will have the maximum SPEA width from Table 2-2.

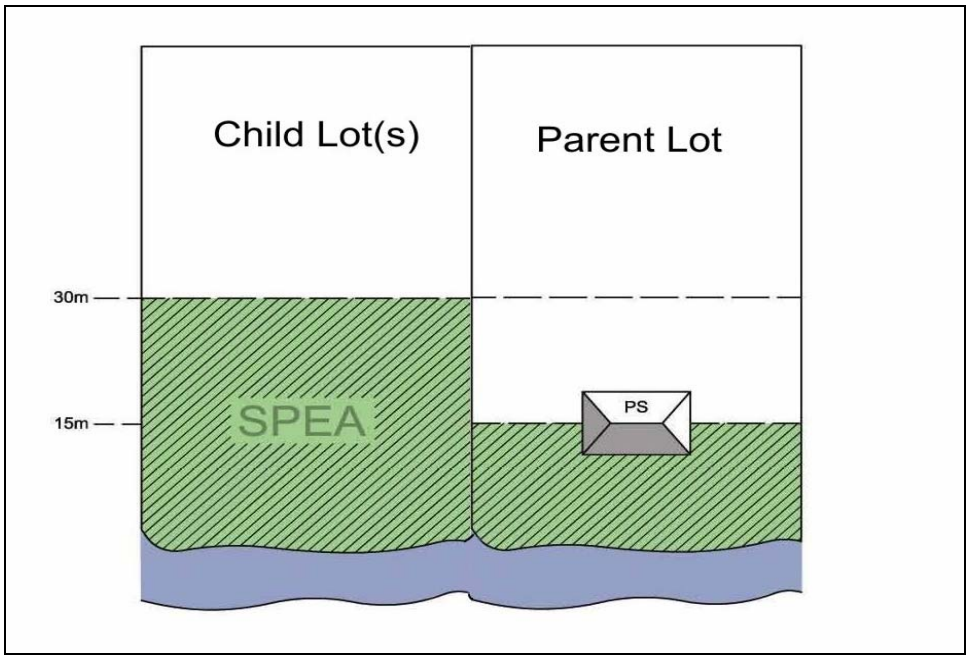


Figure 2-4 Example of Wide Lot Scenario. The SPEA is reduced on the Parent Lot where the Permanent Structure will remain but all Child lots where there are no permanent structures have the maximum SPEA width for their Vegetation Category/Fish Bearing Status.

2.5.3 Roads

Where a road is located between the subject property and the stream the SPEA should still be provided for on the other side of the road. In many cases trees on the other side of the road will still provide valuable shade and litter fall and insect drop to the stream. Clearly, the provision of Large Woody Debris (LWD) to the stream will be limited due to safety requirements for the road.

2.5.4 Establishing the SPEA on the ground

Prior to construction commencing and for subsequent monitoring, the appropriate SPEA width must be located on the ground. For the Simple Assessment the SPEA width is measured perpendicularly from the "**top of bank**" unless the stream is located within a ravine in which case the SPEA is measured from the "**top of ravine bank**". The SPEA width is always measured by horizontal distance.

2.5.4.1 Top of Bank

The top of the bank (TOB) needs to be determined as the starting point for measuring the SPEA. Where stream channels and their banks are distinct, this may be fairly easy. In flatter areas, identifying the TOB based on riparian vegetation in the active floodplain can be more challenging. The TOB should be identified and flagged by a BCLS.

The TOB is defined as

1. The point closest to the boundary of the active floodplain of a stream where a break in the slope of the land occurs such that the grade beyond the break is flatter than 3:1 at any point for a minimum distance of 15 meters[2] measured perpendicularly from the break, and
2. For a floodplain area not contained in a ravine, the edge of the active floodplain of a stream where the slope of the land beyond the edge is flatter than 3:1 at any point for a minimum distance of 15 meters measured perpendicularly from the edge.

On streams located within ravines, it is important to locate the top of ravine bank, as the SPEA width is measured from where the slope breaks (becomes less than 3:1). For ravines that are greater than 60 m in width (from the top of one ravine bank to the other, excluding the wetted stream width), the SPEA is established by measuring 10 m from the top of ravine bank. Streams that are in ravines of lesser width receive a SPEA width as per the Table 2-2, measured from the top of the ravine bank. A ravine must have two steep sides; a steep slope on only one side does not qualify as a ravine. The ravine scenarios can not be applied to lakes and wetlands.

[2] Any slope change greater than 3:1 must result in greater than a 1.0 meter elevation gain between the points where the slope is less than 3:1.

3.0 Conducting a Detailed Assessment

The RIPARIAN AREAS REGULATION provides a second option to determine the appropriate SPEA width. A "Detailed Assessment" is conducted by a qualified environmental professional(s) (QEP) to determine the "Zone of Sensitivity" for the Features, Functions and Conditions (FFC) of the riparian assessment area through a series of assessments. The Detailed Assessment determines the "Zone of Sensitivity" for the features, functions and conditions of the riparian assessment area through a series of assessments. The SPEA width is then the largest "Zone of Sensitivity" resulting from an individual assessment. It is also critical that the QEP evaluates "measures" to protect the integrity of the SPEA and applies them both within and beyond the SPEA boundary. Figure 3-1 illustrates this concept.

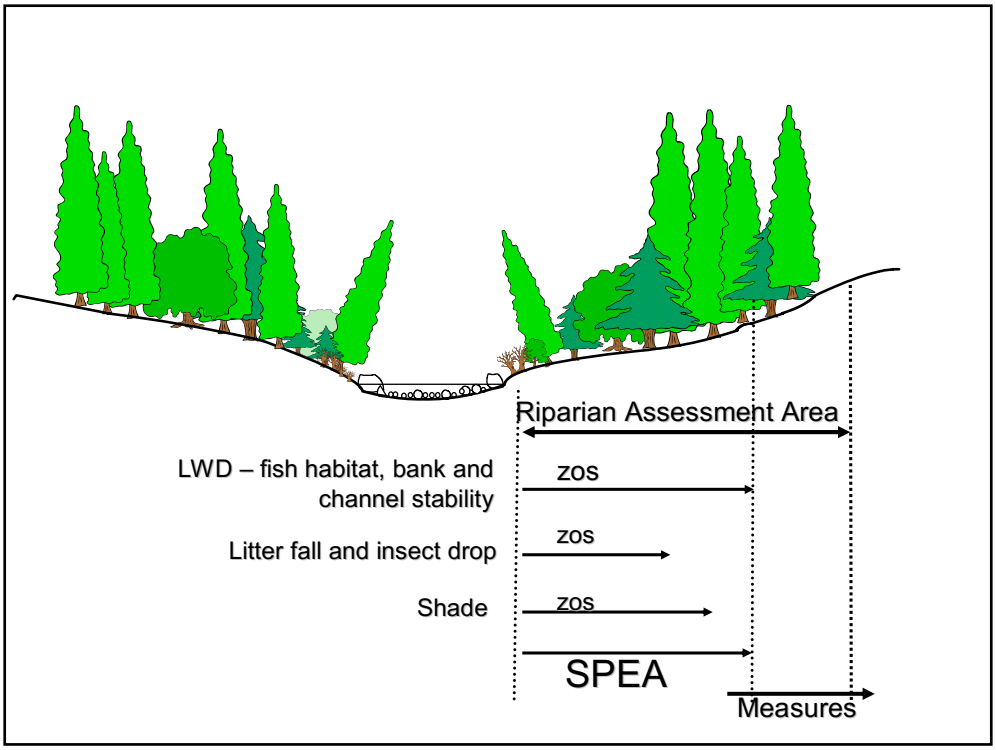


Figure 3-1. Illustration of the Riparian Assessment Area, Zones of Sensitivity (ZOS), Stream Protection and Enhancement Area (SPEA) and Measures under the Detailed Assessment.

The five main FFCs that this assessment addresses are as follows:

1. Large Woody Debris (LWD) for fish habitat and the maintenance of channel morphology
2. Area for localized bank stability
3. Area for channel movement (larger floodplains will be addressed through "Measures")
4. Shade
5. Litter fall and insect drop

All of the assessments and measurements outlined below are carried out for streams while only some are required for lakes and wetlands. It is recognized that lakes and wetlands perform different functions (e.g. biogeochemical relating to improving water quality, hydrologic related to maintaining the water regime) than streams; however, the focus of the Riparian Areas Regulation is on riparian vegetation and its functional role in maintaining fish habitat.

To establish the ZOS for the five main FFCs the following will have to be determined:

1. Reach breaks (streams only)
2. Average channel width (streams only)
3. Average channel slope (streams only)
4. Channel Type (streams only)
5. Site Potential Vegetation Type (streams, lakes and wetlands)

Once the ZOSs and resulting SPEA(s) has been determined the QEP must then consider "measures to protect the integrity of the SPEA". These measures can be found in Section 3.7. QEPs are expected to evaluate which of these concerns exist on the site and to bring in additional expertise where required. This is a required section of the Assessment Report (see Chapter 1) and failure to adequately consider and address these concerns will significantly reduce a QEP's due diligence with respect to using the Assessment Methods to meet the provisions of the Federal Fisheries Act.

3.1 Step 1 Determining Reach Breaks

The basic unit employed to determine the ZOS for a stream is the stream reach. For small developments, given that a reach has a minimum length of 100 meters, it is likely that the stream associated with the subject parcel will contain one homogeneous reach. However, the QEP must verify that the stream conditions associated with the subject parcel are homogeneous enough to classify the associated stream as one reach and that a reach break does not occur within or adjacent to the subject parcel.

Streams may consist of a single reach, but more commonly are composed of a sequence of different reaches extending from the headwaters to the stream mouth. A reach is defined as a length of a watercourse having similar channel morphology, channel dimension and slope. For this purpose, the identifiable features characterizing channel morphology are the presence or absence of a continuous channel bed plus evidence of either scour or mineral alluvial deposits. The minimum length of a reach (to warrant reach breaks) must be greater than 100 m to prevent the division of streams into unmanageably small portions that may be little more than individual habitat units such as riffles, pools or glides.

Uniform channel morphology, channel dimension (and thus width and discharge), and slope are primary attributes of reaches that encompass a number of component physical characteristics including channel pattern, confinement, and streambed and streambank

materials. Together, these features are used to identify reach types in the field for the purpose of the Riparian Areas Regulation.

Reaches do not change gradually or along a continuum of features. Reaches are distinct and changes occur at clearly identifiable boundaries which occur at any of the following locations:

1. where the watercourse ceases to have a continuous channel bed;
2. where a major change in channel morphology occurs, for example, as from a single channel to braided, multiple channels, or from a confined canyon to a wide floodplain, or from one channel morphological type to another (i.e. riffle-pool to cascade pool);
3. where the change in mean channel width is abrupt, for example, at the junctions with major tributaries, from a canyon to an unconfined channel, or where a major change in channel morphology type occurs;
4. where changes occur in the size and composition of streambed or streambank materials (in association with the changes in slope, discharge, and morphology type), and
5. where natural barriers to fish distribution occur and no fish occur upstream of the barrier (e.g., known from existing inventories or proven by the methodology outlined in Appendix 3.).

QEPs should note that **c**ulverts and other artificial features that have become barriers to fish passage are not necessarily reach breaks – it is important to consider whether the channel features change upstream and downstream of the feature. Each reach must be given a unique number on the site plan.

3.2 Step 2 Measuring Channel Width

The "average channel width" is used in the Detailed Assessment to determine the various Zones of Sensitivity and ultimately the SPEA width. It is not used for ZOS and SPEA determination in lakes and wetlands. It must be determined for all reaches within the subject parcel.

Assessment Methods definition-average channel width is the horizontal distance between the stream-banks on opposite sides of the stream measured at right angles to the general orientation of the banks. The border from which the width is measured is the normal bank-full width

Assessment Methods definition- bank-full width for streams means where the presence and action of the water are so common and usual, and so long continued in all ordinary years, as to mark on the soil of the bed and banks of the stream a character distinct from that of its banks, in vegetation, as well in the nature of the soil itself

The point on each bank from which width is measured is usually indicated by a definite change in vegetation and sediment texture. This border is the "normal" bank-full width of the stream and is sometimes shown by the edges of rooted terrestrial vegetation. Above

this border, the soils and terrestrial plants appear undisturbed by recent stream erosion. Below this border, the banks typically show signs of both scouring and sediment deposition. The definition for **bank-full width** is very similar to the definition for **high water mark** except it does not include the active flood plain. In the majority of situations the bank-full width and the high water mark will be the same point. In some low gradient channel types the active flood plain will extend past the edge of rooted vegetation, and the high water mark will extend past the bank- full width

In the case of highly-modified channels where natural indicators are not present to determine bankfull width the methodology outlined in section 3.6.5 should be followed. QEPs should recognize that some species, such as canary reedgrass (Phalaris arundinacea), are tolerant to moderate flow velocities and may exist below the bank-full width and that in these instances additional indicators such as rafted debris should be used to determine the location of the bank-full width.

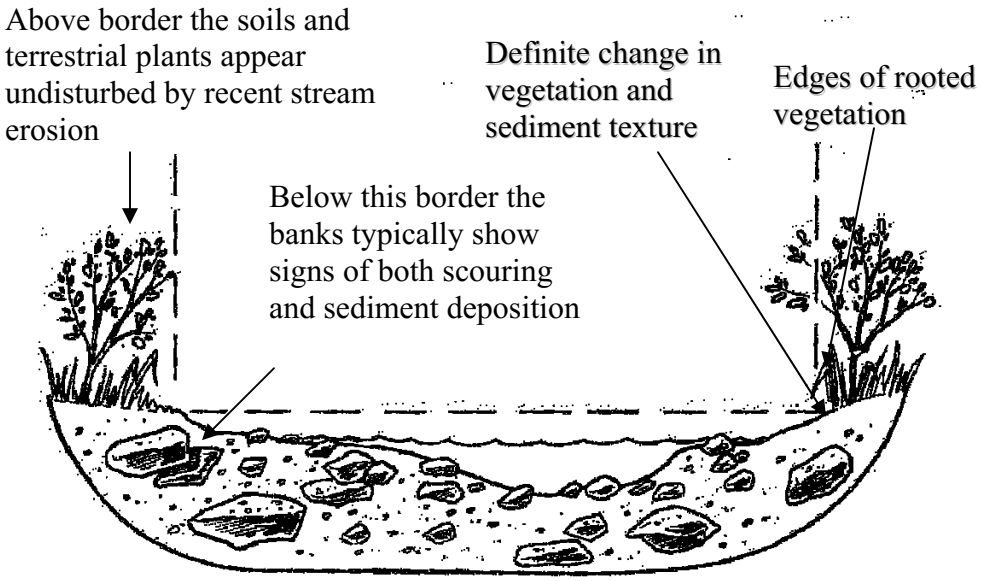


Figure 3-2. Indicators of Bank-full Width for Streams

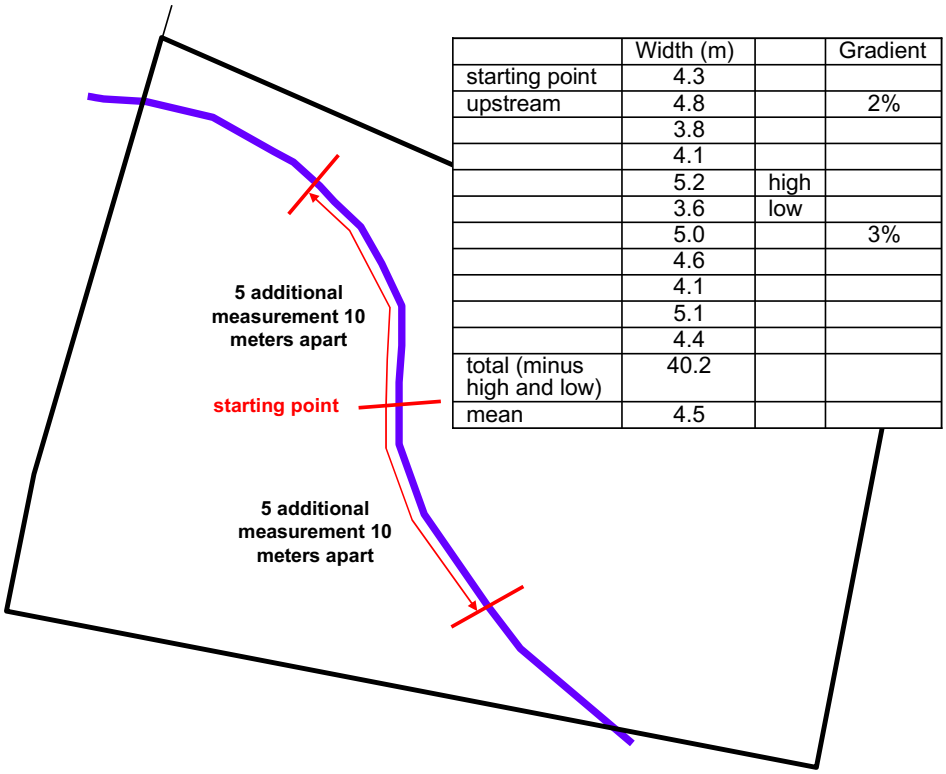
Stream width measurements should not be made near (e.g. within 20 m) of stream crossings, at unusually wide or narrow points, or in areas of atypically low slope such as marshy or swampy areas, beaver ponds or other impoundments. Avoid measuring channel width in disturbed areas unless the entire reach is in altered state. "Normal" channel widths can be increased greatly by both natural and human-caused disturbances.

To determine the mean reach width of a stream channel:

a) Include all unvegetated gravel bars in the measurement (these usually show signs of recent scouring or deposition). Gravel bars with herbaceous stems or grasses that are tolerant of periodic high water should be considered unvegetated.

b) Where multiple channels are separated by one or more vegetated islands (having woody stems), the width is the sum of all the separate channel widths. The islands are excluded from the measurement.

c) The average width of the stream reach is calculated by taking a total of eleven separate width measurements spaced 10 m apart. The starting point for the measurements is the center of the reach within the subject parcel as shown in Figure 3-3. The lowest and highest measurement is then discarded and the remaining 9 measurements are averaged.



	Width (m)		Gradient
starting point	4.3		
upstream	4.8		2%
	3.8		
	4.1		
	5.2	high	
	3.6	low	
	5.0		3%
	4.6		
	4.1		
	5.1		
	4.4		
total (minus high and low)	40.2		
mean	4.5		

Figure 3-3: Calculating average channel width and channel slope

3.3 Step 3 Measuring Stream Slope

Average slope is calculated by taking two measurements using a clinometer. Slope is measured between the starting point and the furthest point upstream and the furthest point downstream that channel width is measured. If these points are not visible from each other then the nearest visible point upstream and downstream from the starting point is used.

3.4 Step 4 Determining Channel Type

	Width (perpendicular from HWM)	***Length (along HWM)***
Assessment Area:	n/a	Each reach
Required for	Streams	
Default:	Riffle-pool	
ZOS	LWD, bank and channel stability	

Channel type is used in determining the ZOS LWD (fish habitat and the maintenance of channel morphology) and bank and channel stability, for streams. For the purposes of this methodology, there are three channel types possible – riffle-pool, cascade-pool and step-pool. These three classic channel morphological types are relatively easy to distinguish in undisturbed channels but it becomes more difficult to determine channel types when some form of disturbance is at play, i.e. changes in streamflow discharge and sediment/debris loads. This is often the case with urban streams that have been altered or disturbed. Figure 3-4 is to be used to determine channel type using a surrogate for stream power (channel width and slope) in these situations, and can be used to confirm the channel type in less disturbed channels. Stream calculations resulting in a point falling on the line must default to the lower channel type (i.e. line between pool-riffle and cascade-pool defaults to pool-riffle). Small anomalies in channel type within a reach (e.g. a small Cascade-Pool section in a Riffle-Pool reach) should simply be given the same classification of the overall reach. Alluvial fans are discussed under "measures" in section in 3.7.

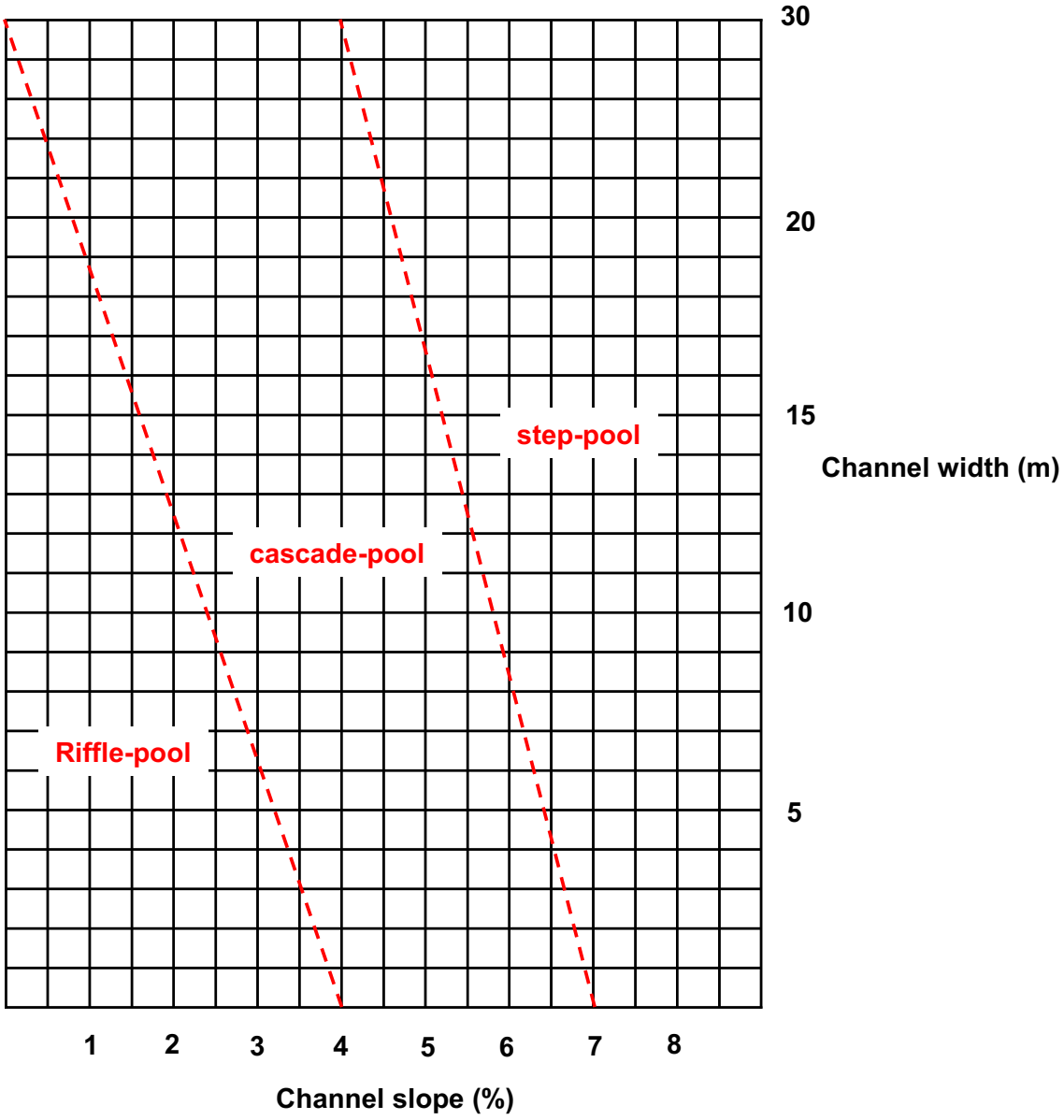


Figure 3-4: Determining Channel type

3.5 Step 5 Determining Site Potential Vegetation Type (SPVT)

	Width (perpendicular from HWM)	*Length (along HWM)*
Assessment Area:	30 m	Subject parcel
Required for	Streams, Lakes and Wetlands	
Default:	Deciduous or Coniferous Cover (TR)	
ZOS	all	

Determining the site potential vegetation type (SPVT) establishes the *capability* (potential) of the vegetation versus the *suitability* (current) of the vegetation. Table 3-1 outlines the three major categories for SPVT. These SPVTs are used to determine the Zone of Sensitivity for the various features, functions and conditions later in the assessment. The SPVT categories are based on approximate vegetation heights. LC has a height of approximately 1 metre and does not include woody stemmed plants, SH includes woody stemmed plants up to a height of 5 metres and any vegetation that reaches a height of greater than 5 metres should be considered TR.

It is important to remember that the default SPVT is TR. However, five approaches are presented below that can be used to confirm a SPVT other than TR. The first approach is preferred, being rigorous and sufficient in justifying an alternate SPVT. The other approaches are much less rigorous and the QEP is cautioned in relying on only one of the other approaches in isolation. The QEP must document in the Assessment Report which methodology was used to determine an SPVT that is not TR.

1. Ministry of Forests field guides for site identification and interpretation in forest region http://www.for.gov.bc.ca/hre/sibec/Index.htm
2. Adjacent undisturbed riparian areas with similar ecological characteristics
3. Historical air photographs
4. Vegetation and/or soils mapping
5. Local vegetation ecologists

Site Potential Vegetation Type (SPVT)	*Vegetation Code*
Low ground cover (i.e. grass/sedge)	LC
Deciduous or coniferous Shrub	SH
Deciduous or coniferous Tree	TR

Table 3-1: **Site Potential Vegetation Type**

Some riparian sites may have an SPVT of SH or LC due to some form of natural disturbance or limitation. Large bedrock outcrops may be identified as LC if they do not support any significant vegetation. In determining the SPVT around a wetland or lake it is important to first identify the outer edge of the wetland or lake (see Section 3.8) and then map the SPVT immediately beyond that boundary.

It is important to remember that the SPVT is the future potential for the site and that human impacts (such as parking lots or old septic fields) do not influence the outcome. Sites where cattle grazing has limited vegetation to grasses do not arrive at a LC SPVT unless, if left to recover, they would never achieve a SH or TR type. Sites that contain a tree layer must be considered TR even if trees are sporadic (e.g. PP generally has open parkland with a Ponderosa Pine canopy) and consideration must be given to the type of vegetation typical in a riparian area (e.g. for BG riparian sites tend to have shrubs so they should not be classified as LC). Polygons of bedrock should be considered low cover (LC).

3.5.1 Creating Polygons for SPVTs

Larger, more diverse sites may warrant stratifying into smaller homogeneous units. If the QEP wishes to stratify the site into polygons of various SPVTs, then the following methodology should be undertaken. The polygon should meet the minimum polygon size outlined in step 2 below and illustrated in Figure 3-4. Different Zones of Sensitivity may have to be calculated for each polygon with a different SPVT. This may ultimately result in a variable width SPEA within the development.

Using air photos or ground surveys stratify the area into the various polygons of uniform vegetation. The site plan map produced for the development can be used as base map and the SPVT polygons shown as an overlay. Polygons identified through air photos should be ground-truthed.

1. The minimum length of the radius from the geometric center of a polygon should be 15 m (see Figure 3-5).
2. The vegetation polygon must contain no more than 20% of another (or combination of) SPVT by area. Any polygon with a TR component must be treated as TR for the purposes of establishing the Zones of Sensitivity.

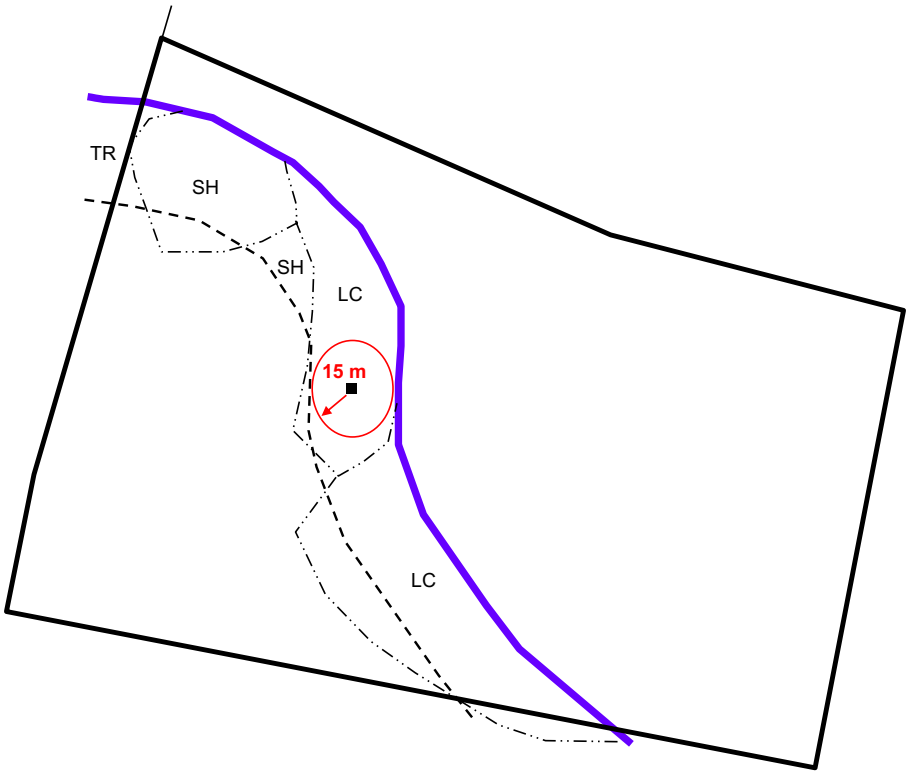


Figure 3-5: Creating Vegetation Polygons

3. Once the polygons are established lines are drawn at right angles to separate the individual polygons in segments as shown in Figure 3-6.
4. Each segment must be given a unique number for recording on the Assessment Report. In the event that a reach break occurs within a vegetation segment the reach break should be moved to the nearest segment boundary in the direction of the wider average channel width.
5. Each of the segments created by the lines is then labeled and given an overall SPVT, defaulting to the SPVT that has the highest potential height, i.e. if there is a SH component along with a LC then the segment gets a SH designation. This is illustrated in Figure 3-6

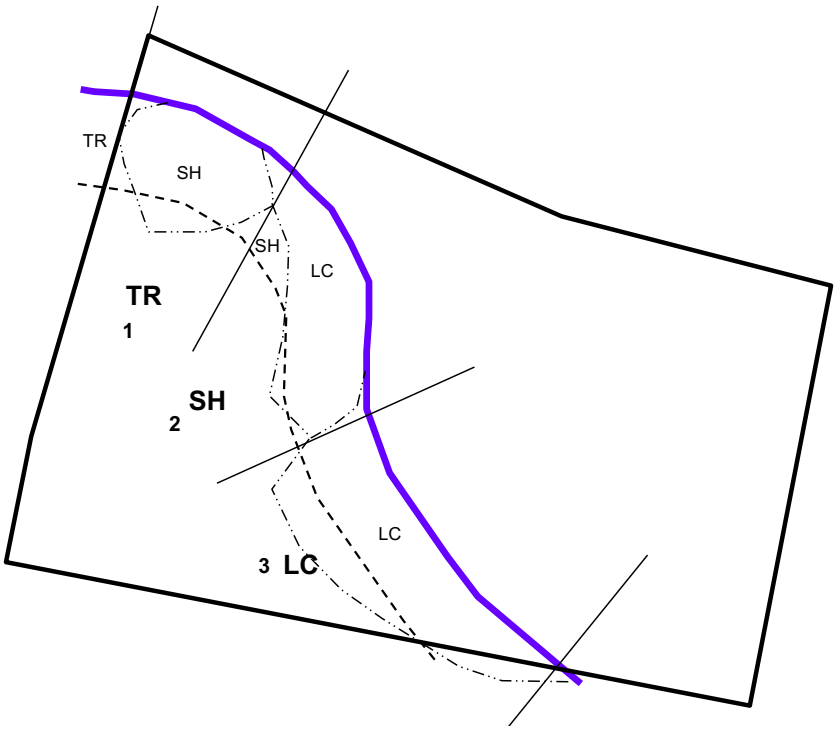


Figure 3-6: Overall SPVT segment designations

3.6 Determining the Zones of Sensitivity

This methodology involves determining three Zones of Sensitivity (ZOS) for the following features functions and conditions of riparian areas.

1. Large Woody Debris (LWD) for fish habitat and the maintenance of channel morphology
2. Area for localized bank stability
3. Area for channel movement
4. Shade
5. Litter fall and insect drop

The first three have been combined as they are related to an individual morphological channel type. The ZOS for the remaining two will be derived at separately.

3.6.1 Large Woody Debris, Bank and Channel Stability for Streams

Table 3-2: Zone of sensitivity for channel and bank stability based on channel type, Channel width, and SPVT

	SPVT		
Channel Type	***LC***	***SH***	***TR***
Riffle-pool	3 times channel width		
	max. of 5 m	max. of 20 m	max. of 30 m (min of 10 m)
Cascade-pool	2 times channel width		
	max. of 5 m	max. of 10 m	max. of 15 m (min of 10 m)
Step-pool	1 times channel width		
	max. of 5 m	max. of 10 m	10 m

In using table 3-2 first multiply the channel width determined in **Step 2** (Section 3.2) by the appropriate factor for the channel type determined in **Step 4** (Section 3.4) and the SPVT determined in **Step 5** (Section 3.5) and then adjust based on the minimums and maximums identified for each category.

In addition, for TR SPVT types natural landslide areas that are coupled to the stream and are within the RAA are obvious sources of large wood to the stream channel that are not captured by the ZOS for LWD in the above table. The QEP must assess whether any of the slope stability triggers identified in the slope stability measures assessment (3.7.3) are present within the RAA. If slope stability triggers are present a slope stability measure assessment must be conducted to determine if there are any unstable slopes linked to the stream channel. These linked unstable areas are then to be included within the LWD ZOS and the resultant SPEA, and slope stability measures developed to ensure the development does not destabilize the slope and put the integrity of the SPEA at risk.

Figure 3-7 shows an example ZOS for a Cascade-pool channel type with a SPVT of TR. This example has a channel width of 6.2 m and a resulting ZOS for LWD, bank and channel stability of 12.4 m.

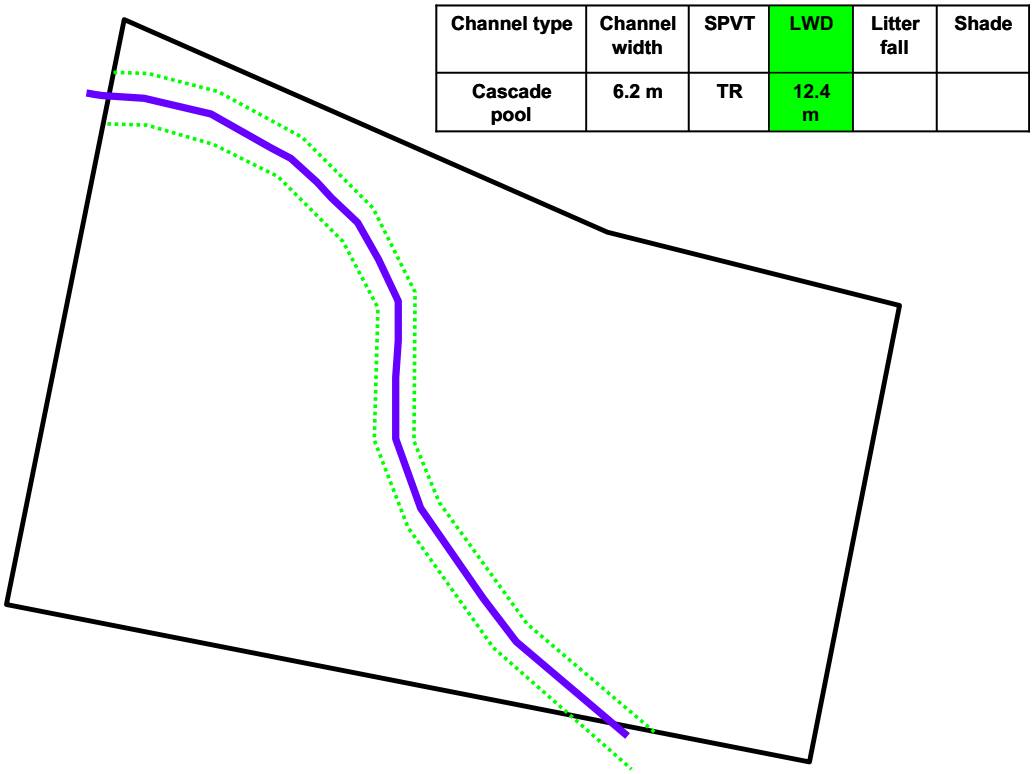


Figure 3-7: Layout of LWD, bank and channel stability ZOS

3.6.1.1 Large Woody Debris for Lakes and Wetlands

The riparian zone of lakes and wetlands often contains large wood which provides important long-term woody cover for protection of smaller species and fry and juvenile fish, when it falls into the water. Because their decay rates are slow, especially for conifer species, fallen trunks can provide habitat structure over a long period of time. Further, the vegetation within the riparian zone of a lake provides natural protection from erosion. The riparian zone, adjacent to small and seepage lakes and wetlands, is particularly important, where it may be the only source of LWD. The streams that enter these features do not have the power to move LWD to the feature itself. Foreshore fish habitat in lakes and wetlands often suffers when riparian owners remove aquatic vegetation for pier construction, boat access, swimming, or aesthetic reasons. Populations of fry and juvenile fish have been significantly reduced along developed shorelines.

The LWD ZOS for lakes and wetland (Table 3-3) is therefore related to the height of the site potential vegetation type. Although both LC and SH contribute little if any LWD to a lake or wetland, a minimum width is provided for bank protection.

SPVT	*Zone of Sensitivity*
LC	5 m
SH	5 m
TR	15 m

Table 3-3: Lakes and Wetlands ZOS to provide LWD and bank stability

3.6.2 Litter Fall and Insect Drop for Streams, Wetlands and Lakes

The ZOS for litter fall and insect drop is determined by the Site Potential Vegetation Type determined in **Step 5** and the size of the stream or wetland.

SPVT	*Zone of Sensitivity*	*Streams*		*Lakes and Wetlands*
		Min.	*Max.*	
LC	5 m	5 m	5 m	5 m
SH	2 x width	5 m	15 m	10
TR	3 x width	10 m	15 m	15

Table 3-4: Determination of Zone of Sensitivity for Litter fall and Insect Drop for streams, lakes and wetlands

Figure 3-8 illustrates the ZOS for the previous example of a Cascade-pool channel type with a SPVT of TR. Here the ZOS for litter fall and insect drop would be 3 times the channel width to a maximum of 15 m, or in this specific case 15 m.

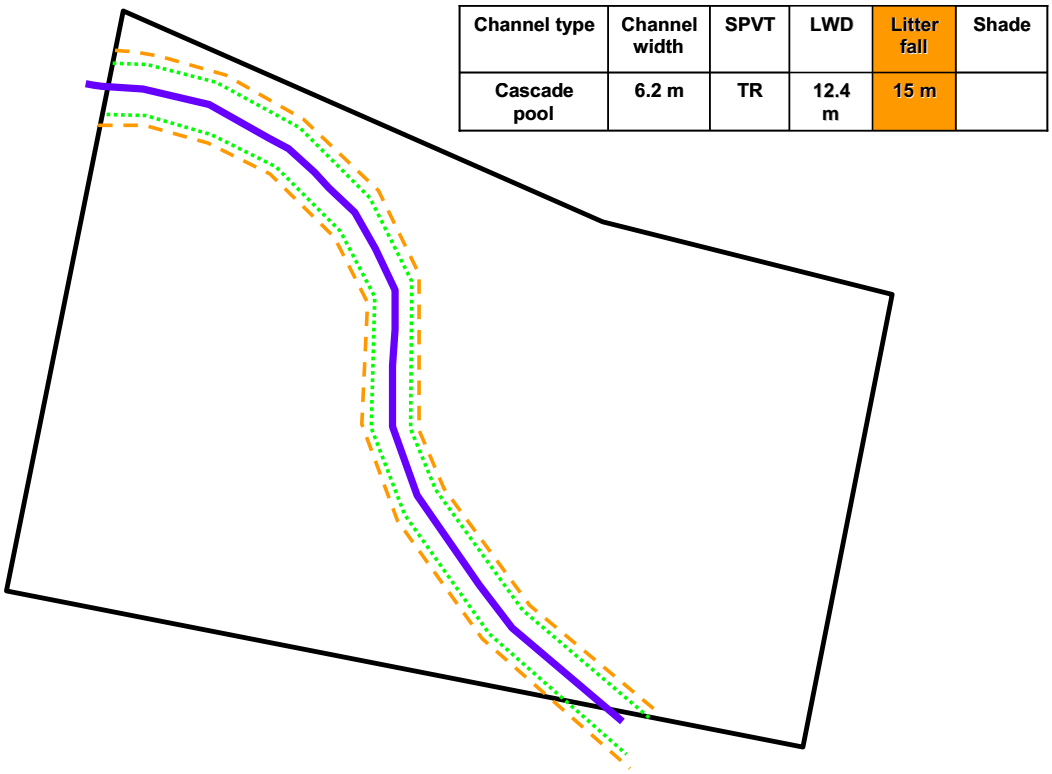


Figure 3-8: ZOS for Litter Fall and Insect Drop

3.6.3 Shade for Streams, Lakes and Wetlands

The **relative** ability of vegetation to influence stream temperature (shade) depends on many factors, such as quality of shade, angle of sun, degree of cloud cover, leaf angle, aspect and orientation of watershed, time of year, stream volume, volume of subsurface flows, width and depth of water column, and height, density and species of vegetation.

Solar angle, geographic stream orientation, stream width, the surface-to-volume ratio (width-to-depth ratio) of the stream and the height of the natural vegetation are all factors that determine the importance of shade to a particular stream reach. The following methodology has been adapted from using solar angle, stream aspect and the height of the natural vegetation to calculate the width of riparian buffer required to maintain shading to the stream.

The first step is to open a layout file in your mapping or drawing program and place a line on top of the high water mark of the subject stream To establish the zone of sensitivity for shade for streams with a SPVT of TR you drag the line 3X the channel width (to a max of 30 meters) due south. For streams with a SPVT of SH the multiplier is 2X to a max of 5 meters. As LC does not provide shade no ZOS is calculated. The respective shift for each feature is shown on Table 3-5.

It is important to note that for “temperature sensitive streams” the width modifier is not used and the maximum distance based on the SPVT is employed for the south bank. Temperature sensitive streams will be designated by MOE.

SPVT	*Streams*	*Wetlands, Lakes*
LC	n/a	n/a
SH	2 x width (max 5 m)	5
TR	3 x width (max 30 m)	30

Table 3-5: Zone of Sensitivity for Shade for Streams, Lakes and Wetlands

Figure 3-9 shows the ZOS calculation for shade on a stream with a SPVT of TR. As the example illustrates a riparian area with a ZOS of TR the multiplier is 3X so the overlaid line is dragged 18.6 m south since the channel type is Cascade Pool.

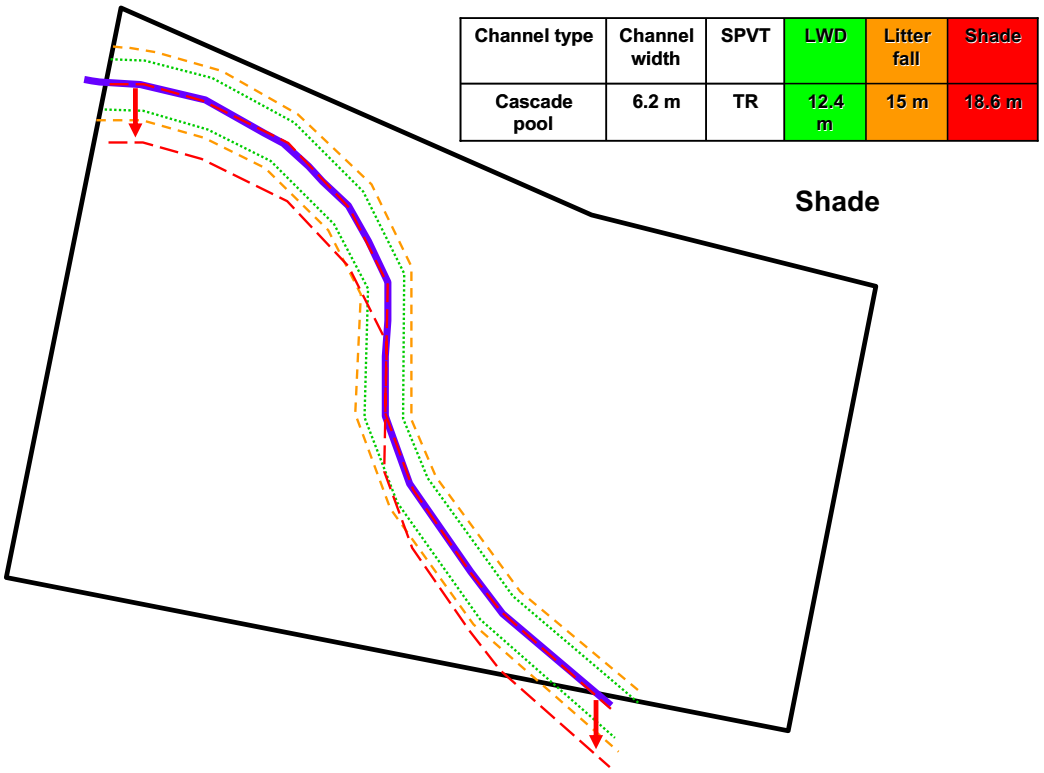


Figure 3-9: Zones of Sensitivity for Shade

3.6.4 Calculating the SPEA Width using the Detailed Assessment

Once all the Zones of Sensitivity have been calculated the SPEA is determined by using the widest ZOS. The QEP will flag the HWM and provide a surveyor with the SPEA width(s) to be defined on the ground.

As shown in Figure 3-10, the resultant SPEA may have a width that varies based on which ZOS was widest at which point on the stream. In this example the SPEA on the south side of the stream varies between 15 m and 18.6 m in width driven by litter fall (15m) and shade (18.6 in some locations). The SPEA on the north side will be a consistent 15 meters from the HWM.

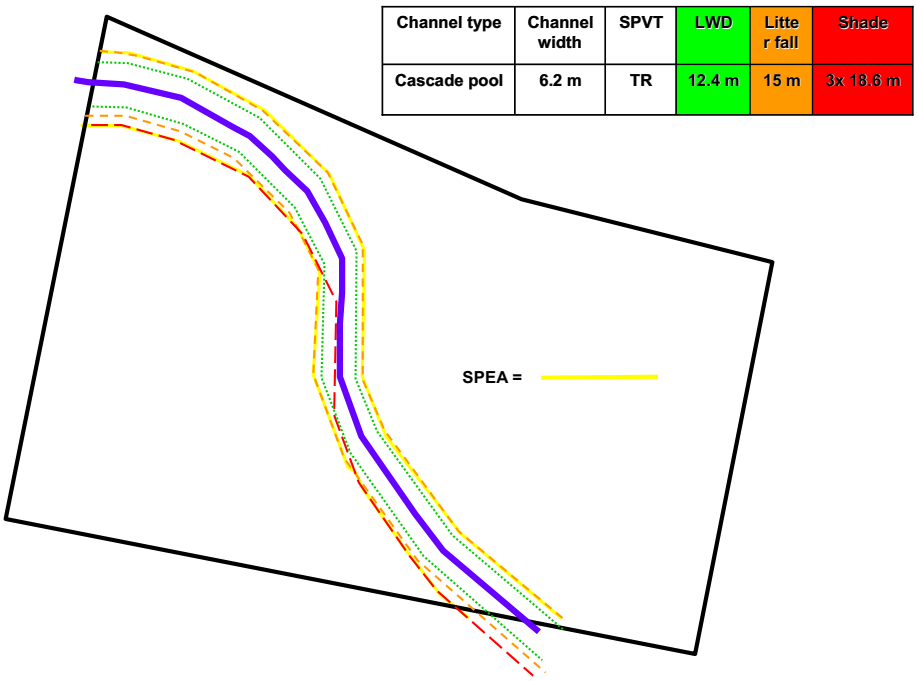


Figure 3-10: Determining the Resulting SPEA

On larger developments, riparian vegetation may be stratified into various different types See creating polygons in section 3.5.1. This makes calculating the resultant SPEA somewhat more complex as the various ZOS are determined for each segment. Where the development encompasses both sides of a stream, then each side would be considered a separate segment. Using the example from this section, the ZOS are calculated for each segment in the same fashion as a stream with only one SPVT. The resulting SPEA is then determined by following the outermost ZOS. The QEP uses their knowledge of the site and their best judgment when the ZOS changes from one segment to another to smooth out the resulting SPEA. This is done by drawing the SPEA by linking each segment with varying ZOS by a line drawn at 45 degree as shown by the green line in Figure 3-11.

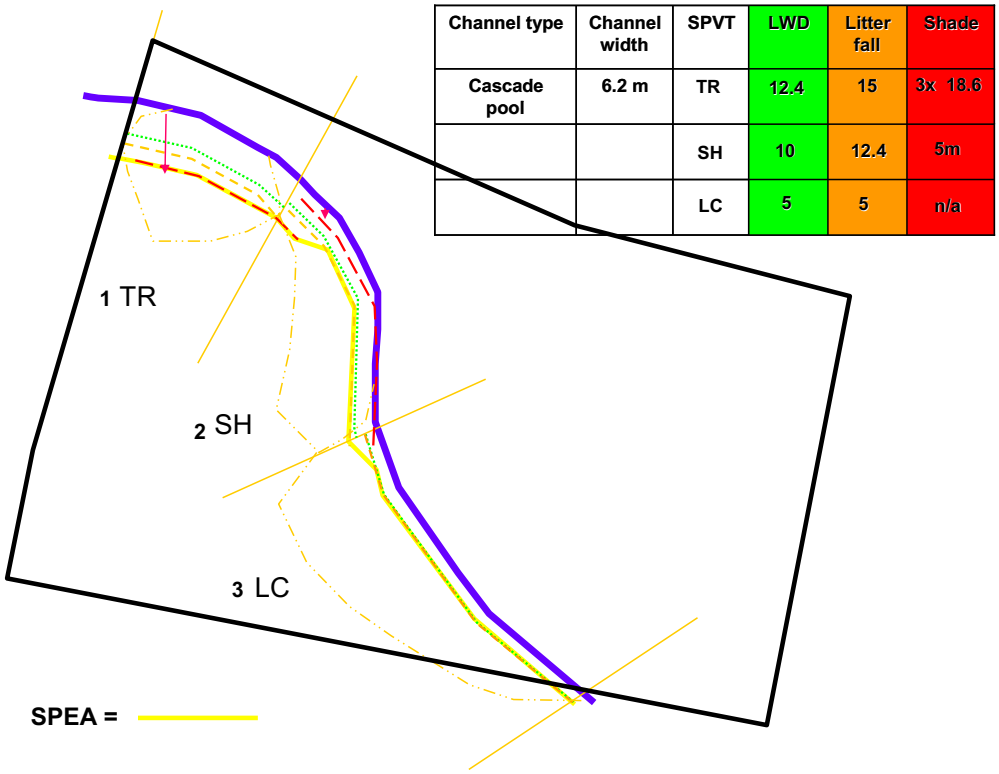


Figure 3-11: Determining the SPEA for a stream with various SPVTs

A method similar to streams is used to determine the SPEA around lakes, ponds and wetlands. The first step is to stratify the SPVT around the feature in a manner similar to streams (Figure 3-12). Next the respective ZOS for LWD and bank stability, litter fall and insect drop and shade are applied to each segment of the lake (segments are determined by SPVTs). Each segment is labeled with a unique number. The SPEA will follow the largest determined ZOS. This is illustrated in Figure 3-13.

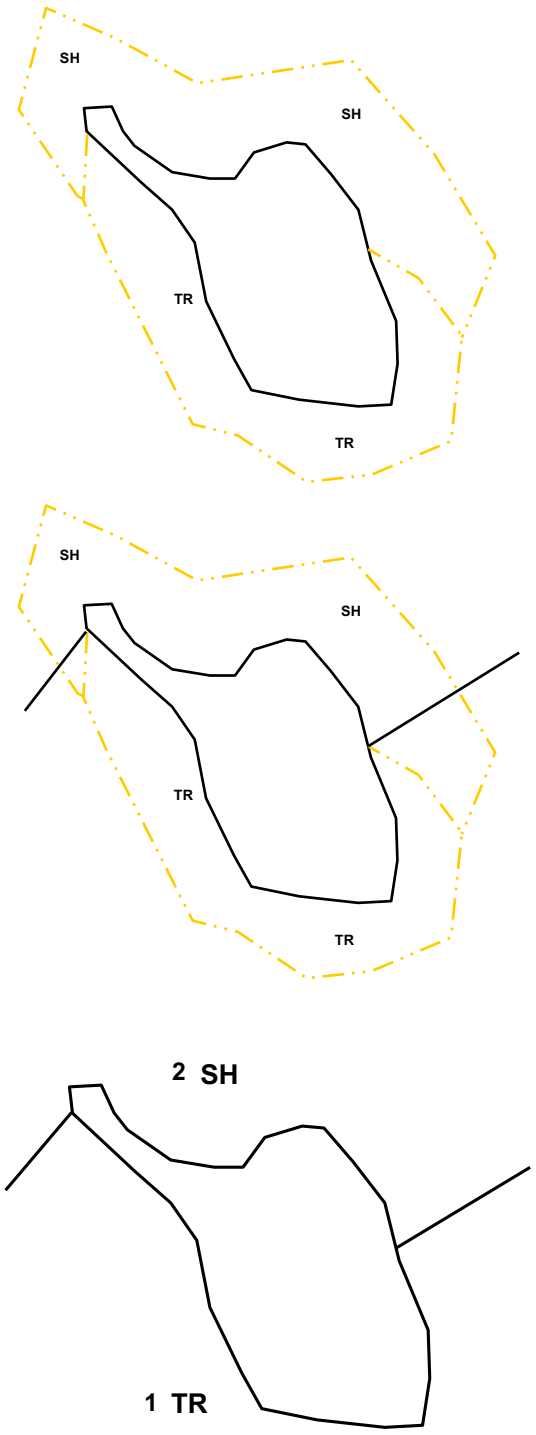


Figure 3-12: Stratify SPVT around Perimeter of Feature

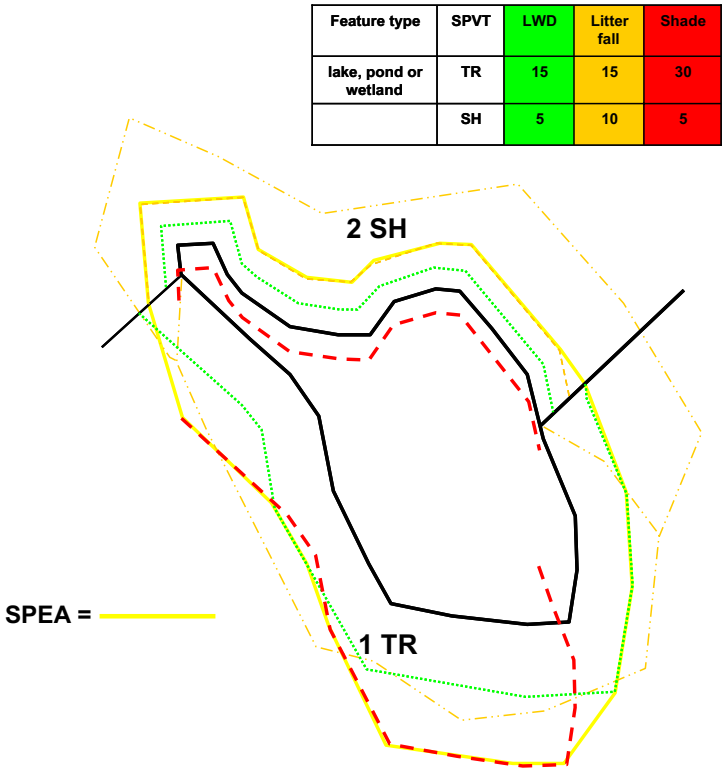


Figure 3-13: SPEA determination around Lakes, Ponds and Wetlands

3.6.5 Ditches

Where ditches are connected to fish habitat they are considered streams under the Riparian Areas Regulation and require an assessment and SPEA determination. Ditches are characterized as being manmade and straight with no significant headwaters or springs. They were constructed to drain property (they often form property boundaries) or roadways and while connected to natural streams they are not part of the natural historic drainage pattern. They are often diked with regulated or seasonal flows. If a QEP is uncertain as to whether the stream they are dealing with is a ditch they should default to a stream. Some local governments have watercourse maps identifying ditches. In addition, Table 3-6 offers some distinguishing characteristics of a ditch versus a channelized stream.

Under the Detailed Assessment, ditches receive either a 2 or 5 m SPEA depending on whether the ditch contains fish or not (Table 3-7). To determine the SPEA for ditches

utilize the channel width information collected in Section 3.2 and direction in Section 2.2 as to whether the stream is fish bearing or not.

Table 3-6: Characteristics of Channelized streams and Ditches

Feature	Channelized Stream	Ditch
Distinguishing Characteristics	Flows most if not all year round. Forms part of historic natural drainage pattern. Larger intact headwaters or significant sources of groundwater. Depending on degree of channelization, natural segments of channel remain.	Flow is seasonal. Entirely manmade and straight with a no significant headwaters or springs. Often diked with regulated flows.
Large Woody Debris	Needed for fish habitat and may be needed to maintain channel morphology (as per natural channels)	Required only when fish present
Bank Stability	Depending on degree and nature of channelization, rooted vegetation may be required to maintain bank stability. However, requirement to provide for channel migration (or future restoration of) will accommodate requirement for bank stability	Depending on nature of channelization, rooted vegetation may be required to maintain bank stability
Lateral Channel Movement	Suitable area needs to provided for lateral channel stability or options maintained for restoration as per natural channels	Lateral movement is confined and stable. Often forms property or field boundary or is aligned and constrained by a permanent roadway.
Shade	Should be provided for as per natural channels	Should be provided for at slightly reduced levels
Litter fall and Insect Drop		

Table 3-7: SPEA widths for ditches

<table>
<tr><th rowspan="2">Function</th><th colspan="2">Constructed Ditch</th></tr>
<tr><th>Fish</th><th>No Fish</th></tr>
<tr><td>LWD for maintenance of channel morphology and provision of fish habitat</td><td rowspan="2">2 times channel width
max 10 m
min 5 m</td><td>n/a</td></tr>
<tr><td>Vegetation to assist in controlling localized erosion</td><td>2 m</td></tr>
<tr><td>Suitable area to allow for lateral channel movement</td><td>n/a</td><td>n/a</td></tr>
<tr><td>Litter Fall and Insect Drop</td><td rowspan="2">2 times channel width
max 10 m
min 5 m</td><td rowspan="2">2 m</td></tr>
<tr><td>Shade</td></tr>
</table>

3.6.6 Dikes

There are situations where the development is separated from the watercourse by a dike. The characteristics of the dike often determine the value of riparian areas landward of the crest of the dike to the stream. Where the dike is very high and wide, the potential value of riparian areas landward of the crest of the dike may be limited. For smaller dikes, riparian vegetation landward of the dike crest is often still interlinked with the stream and must be maintained. When dealing with this type of situation QEPs must contact DFO or MOE for a determination of whether riparian vegetation landward of the dike crest is contributing to the watercourse and the SPEA as determined by the Assessment Methods must be provided or if the riparian vegetation landward of the dike crest is so disconnected from the watercourse that a SPEA is not required beyond the dike crest.

3.7 Measures to protect the Integrity of the SPEA

When the Detailed Assessment is used, the QEP must consider "measures to protect the integrity of the SPEA". QEPs are expected to evaluate which of these concerns exist on the site and to bring in additional expertise where required. This is a required section of the Assessment Report (see Chapter 1) and failure to adequately consider and address these concerns will significantly reduce a QEP's due diligence with respect to using the Assessment Methods to meet the provisions of the Federal Fisheries Act.

A description of all "Measures" (actions and contingencies) that will be taken to maintain and protect the SPEA from development outside of the SPEA must be included in the Assessment Report if the Detailed Assessment is used. The measures that must be considered include: assessment and treatment of danger trees, windthrow, slope stability, tree protection during construction, encroachment and sediment and erosion control. The only measure permitted within the SPEA is the treatment of hazard trees. Some measures will result in areas beyond the SPEA being identified as areas requiring special protection or limited activity. For example, addressing windthrow will require the creation of a windfirm edge outside of the SPEA. Site maps must reflect measures to be incorporated.

Addressing some of these measures may require retaining other QEPs with specialized expertise relevant to the skill sets identified in Appendix 2. Not all sites will require an assessment for all measures; the primary QEP is responsible for identifying if the site conditions indicate a particular problem or issue. For example, where the watercourse is in a ravine the primary QEP should seek advice from a geotechnical engineer on slope stability measures required to prevent any failure of the ravine slope both during and post-development. Where the development site has been previously disturbed and the SPEA is currently lawn the primary QEP does not need to consider hazard trees, windthrow or tree protection during construction. It is very important that QEPs provide advice only within their area of expertise.

For projects at the subdivision stage where detailed site plans do not yet exist it can be difficult to provide specific advice on measures. In these instances the QEP should provide advice on what environmental monitoring and measures may need to be considered when another Assessment is undertaken at the building stage if development is proposed in the Riparian Assessment Area. It should be recognized that the preliminary assessment at the subdivision stage provides a SPEA distance but that the measures may place additional restrictions on the development (e.g. geotechnical stability) at the next approval stage.

3.7.1 Addressing Danger Trees in the SPEA

Danger trees located within the SPEA should be assessed by a QEP with appropriate training to determine if they pose a high risk to the adjacent development. These include standing dead trees that are vertical or lean towards the work area, as well as some live trees with large dead branches or tops. To determine whether to remove a danger tree, an assessment should be completed by a qualified professional who is a qualified danger tree assessor. If a tree is determined to be unsafe, there are options available to reduce or eliminate the threat to safety. Trees felled within a SPEA are to be left as coarse woody debris. The following reference, though prepared for use in parks, will be of assistance when conducting a danger tree assessment http://www.for.gov.bc.ca/hfp/training/00016/index.htm . A training course is now available through the Pacific Northwest Chapter of the International Society of Aboriculture on Tree Risk Assessment in Urban Areas and the Urban/Rural Interface. Membership in the ISA is not considered qualification as a QEP under the RAR but some

individuals may have membership in the ISA and other associations that are recognized under the RAR.

Any trees that are felled should be replaced according to provincial criteria http://srmwww.gov.bc.ca/sry/csd/downloads/forms/vegetation_riparian/treereplcrit.pdf.

3.7.2 Windthrow

Windthrow can be an issue where new developments remove part of a forest, leaving the remaining trees more exposed to high velocity winds. Wind damage can break tree trunks near the top or the base of the tree or uproot them. Windthrow is an issue because it places people and property in danger as well as removing riparian vegetation important to streams. In situations where forest clearing may result in windthrow developers are advised to retain the services of a professional forester. An RPF will be able to assess the windthrow hazard of the trees on the property using the "Windthrow Handbook for British Columbia Forests" produced in 1994 by the Ministry of Forests and recommend mitigation measures to reduce windthrow hazard such as locating tree removal boundaries and feathering of stand edges http://www.for.gov.bc.ca/hfd/pubs/Docs/Wp/Wp01.htm. Stable falling boundaries and feathering must be performed to preserve trees in the SPEA and should not be undertaken within it if the integrity of the SPEA is compromised.

3.7.3 Slope stability

One of the major areas of concern that a QEP must address is the issue of slope stability, within and adjacent to the SPEA. Measures must be developed to address slope stability concerns that may have an impact on the SPEA. Table 3.8 contains a list of field indicators that would suggest slope stability concerns. Developing appropriate measures to address slope stability will likely involve consulting a geotechnical engineer if the primary QEP involved lacks the necessary skills (refer to the skill set matrix in Appendix 2). It is important to remember that each QEP must sign off each particular area of the Assessment Report that they were responsible for. Where only one QEP is engaged, they accept the responsibility for the overall report.

Table 3-8 Slope Instability Indicators

Field indicators	Potential landslide type
• recent landslide scars • revegetated landslide scars • old bank protection works	high likelihood of landslides of the same type and size
• partially revegetated strips (may also be snow avalanche tracks) • jack-strawed trees (trees tilted in various directions) • linear strips of even-aged timber • landslide debris piled on lower slopes • soil and rocks piled on the upslope side of trees • curved or sweeping trees (may also indicate snow creep) • mixed or buried soil profiles • poorly developed soils relative to other comparable slopes • tension fractures • poorly drained or gullied, fine-textured materials <3 m deep on slopes >50% • poorly drained or gullied coarse-textured materials on slopes >50% • wet site vegetation on slopes >50% • shallow, linear depressions • shallow, wet, organic soils on slopes >40%	debris avalanches debris flows Debris slides
• recently scoured gullies* • exposed soil on gully sides* • debris piles at the mouths of gullies* • vegetation in gully much younger than the adjacent forest • poorly developed soils on gully sides relative to adjacent slopes (repeated shallow failures continually remove the developed soil profile)	debris flows Debris slides
• tension fractures • curved depressions • numerous springs at toe of slope, sag ponds • step-like benches or small scarps • bulges in road • displaced stream channels • jack-strawed trees (trees tilted in various directions), split trees • poorly drained medium- to fine-textured materials (e.g., till, lacustrine, marine and some glaciofluvial deposits) >3 m deep • mixed or buried soil profiles • ridged marine deposits	slumps
• talus or scattered boulders at base of slope • steeply dipping, bedrock discontinuities (bedding planes, joints or fracture surfaces, faults) that parallel the slope • bedrock joint or fracture surface intersections that dip	rock slides or rock fall (can be induced by excavation and blasting for roads)

steeply out of the slope	

3.7.4 Protection of Trees in the SPEA

Homes constructed near riparian areas have the advantage of the aesthetic and environmental values of large trees. However, trees can become a concern in residential settings where they may endanger people and property if they are considered "hazardous".

In residential settings the most common causes of hazardous trees is damage that occurs during site clearing and construction. Severing of roots, changing the grade of the ground, and other root zone incursions often lead to the decline and death of mature trees. Construction can injure the tree branches, tear bark, and/or wound the trunk of the tree. Digging and trenching can often sever a portion of the roots. Roots of a mature tree typically extend from 1-3 times the height of the tree from the tree's trunk (i.e. far beyond the drip line). A common misconception is that trees have deep taproots - most trees do not. The majority of the roots are found within the upper 12-15 inches of the soil. Physical injury of the structural roots increases the risk of complete tree failure. Roots are also critical in anchoring a tree; if they are cut on one side of the tree the tree may fall or blow over.

Heavy equipment used in construction will compact the soil and can inhibit root growth and decrease oxygen in the soil that is essential to the growth and function of roots.

Construction "Do Not's" for Protection of Trees in SPEA:

- Do not trench through the root zone of a tree
- Do not pave around trees
- Do not change the ground level around the tree
- Do not allow any parking under trees
- Do not allow concrete washout or other pollutants to contaminate the soil around trees

Construction Do's for Protection of Trees in SPEA:

- A physical barrier should be erected to protect trees. The location of this barrier will vary based on the size and location of the trees on the site but it should provide for the majority of the tree's root system to be undisturbed by the construction activities.
- Communicate tree protection plans to everyone involved in the project. Write damage clauses into any service contract to provide financial penalties to any contractors who damage trees.

- Monitor the impacts of construction activities. If roots have been cut make sure they weren't shattered by a backhoe or other equipment. Broken roots should be cut cleanly with a saw.
- Mulch about the base of trees to retain moisture.
- Vertical mulching may be necessary where roots have been severely impacted by machinery or fill.
- Prune any broken limbs with clean cuts.
- It is strongly recommended that an ISA Certified Arborist is retained to provide advice on the rooting zone for SPEA trees, to oversee installation of the physical barrier, and to undertake any corrective actions required.

3.7.5 Preventing Encroachment in the SPEA

Direct human impact to streams most often consists of refuse dumping, trampling of vegetation, bank erosion and noise. Plant loss due to the trampling of vegetation near a stream increases silting of spawning gravels and reduces aquatic invertebrates that are important fish food sources. Encroachment pressures on urban wetland buffers in Washington indicated that 76% of buffers were disturbed by dumping of yard wastes, 100% had some conversion of natural vegetation into lawn or turf, 50% had trees removed, and 29% had unofficial trails in the buffer. 43% of buffers were severely altered to the point that the buffer was not protecting the adjacent wetland.

A major cause of riparian loss and stream degradation continues to be encroachment by adjacent land owners. Easements or restrictive covenants alone are only lines on paper which have proven to be ineffective against encroachment. Visual barriers such as fences or signs appear to be the most effective tool to stop encroachment. Local governments are strongly encouraged to make permanent fencing of SPEAs a mandatory element of developments by watercourses.

Fences should be installed to demarcate SPEAs for future land owners and occupiers. The height of the fence and material it is made from should be complementary to the nature of the development. High chain-link fences are be appropriate in industrial and commercial settings, low split rail fences may be functional in park settings, and medium height wooden fences may be appropriate adjacent to residential yards.

The QEP will evaluate the severity of encroachment expected on the site both during and post construction and will provide recommendations for the type of barrier that would be most effective to the situation. Guidance on selecting appropriate barriers for the nature of the adjacent development can be found in Chapter 7 of "Access near Aquatic Areas: a guide to sensitive planning, design and management" part of the Stewardship Series and available at http://www-heb.pac.dfo-mpo.gc.ca/publications/publications_e.htm.

3.7.6 Sediment and Erosion control during Construction

As part of the site design, a sediment and erosion control plan should be developed to prevent the discharge of sediment laden water into the SPEA or any watercourse. The SPEA should not be used to filter sediment laden water prior to discharging into a watercourse and SPEA widths were not designed for this function. The QEP is expected to be familiar with the sediment and erosion control plan and to monitor its installation, effectiveness and maintenance. Links to sediment and erosion control planning can be found in the document entitled "Best Management Practices for Urban and Rural Land Development" http://www.env.gov.bc.ca/wld/BMP/bmpintro.html. At the subdivision stage, general guidance regarding site clearing may be provided with detailed plans being a requirement at the construction stage.

3.7.7 Stormwater Management

Stormwater resulting from development within the assessment area should be returned to natural hydrologic pathways. The key to runoff volume reduction and water quality improvement is capturing the small storm runoff (less than 50% of the rainfall event that occurs once per year, on average) from these rooftops and impervious surfaces. The goal is to capture runoff from rooftops, driveways, parking and other impervious areas for infiltration, vapor-transpiration and/or reuse. The RAR is only able to address development within the Riparian Assessment Area but stormwater management is an issue for the entire development site and watershed. For all Detailed Assessments, the QEP must include in their Assessment Report a plan to capture the small storm runoff event from the Riparian Assessment Area.

The requirements identified here under the RAR should not be considered sufficient to achieving stormwater objectives for the entire development. The provincial government document entitled Stormwater Planning: A Guide for British Columbia, May, 2002 provides a very good reference for this topic and provides examples on how to develop measures to achieve this goal. This document is available on the web at *http://www.env.gov.bc.ca/epd/epdpa/mpp/stormwater/stormwater.html* or

www.waterbalance.ca

3.7.8 Floodplain Concerns

Flooding is a common hazard in British Columbia as a result of heavy rainfall (flash floods), snowmelt (spring freshets) or ice jams. The RAR Detailed Assessment considers the active floodplain and ensures that the SPEA starts at the edge of this feature but on very dynamic channels this may not be sufficient to protect the SPEA or the development from flood hazards and damage.

Where these issues are applicable, the QEP should identify issues related to the maintenance of the SPEA and larger floodplains and ensure that a professional, qualified in floodplain issues has been consulted. Developments occurring on large floodplains (greater than the active floodplain) and alluvial fans can result in requests for diking,

bank revetment and stream channelization, all of which can negatively affect the proper functioning condition of the riparian ecosystem. The goal in any proposed changes should be to maintain the natural movement of the stream channel. Any proposed channel alterations will require approval by DFO and MOE under the Water Act and cannot be included in an RAR Assessment Report until this approval has been obtained.

Often this issue is one that local governments have enacted Bylaws or Development Permit Areas to address. See http://www.env.gov.bc.ca/wat/flood/index.html for further information relative to floodplain issues.

3.8 Establishing the SPEA on the Ground

Prior to construction commencing and for subsequent monitoring, the appropriate SPEA width must be located on the ground.

Once all the Zones of Sensitivity have been calculated the SPEA is determined by using the widest ZOS and is measured horizontally from the edge of the High Water Mark (HWM). This boundary should be identified and flagged by a QEP before being surveyed by a land surveyor or GPS technician.

3.8.1 High Water Mark

On site, the high water mark is determined based on these site characteristics. For flowing watercourses, it is indicated by a distinct change in vegetation and sediment texture. Above the high water mark, the soils and terrestrial plants appear undisturbed by recent stream erosion. Bank areas below the top of the bank typically have freshly moved sediment (e.g., clean sands, gravels and cobbles) and show signs of both sediment deposition and scouring. Where stream channels and their banks are distinct, this may be fairly easy. However, in flatter areas, identifying the high water mark based on riparian vegetation in the active floodplain can be more challenging.

High Water Mark (HWM) means the visible high water mark of a stream where the presence and action of the water are so common and usual, and so long continued in all ordinary years, as to mark on the soil of the bed of the stream a character distinct from that of its banks, in vegetation, as well as the nature of the soil itself, and includes the active floodplain;

Active Floodplain means and area of land that supports floodplain plant species and is

(a) adjacent to a stream that may be subject to temporary, frequent or seasonal inundation, or

(b) within a boundary that is indicated by the visible high water mark;

Clues to identify the active floodplain for areas flooded more frequently than once in five years on average include:

1. Flood periodicity (areas flooded by stream water once in five years, on average)

2. Indicators of past flood levels (channels free of terrestrial vegetation, the location of rafted debris or fluvial sediments that were recently deposited on the surface of the

forest floor or suspended on trees or vegetation, or recent scarring of trees by material moved by flood waters).

For the Detailed Assessment the SPEA begins from the HWM. Remember that seasonally inundated channels (e.g. backchannels and side-channels) are included in the Active Floodplain so the SPEA starts on the outside edge of these features.

3.8.1.1 Outer Edge of Wetlands

From an ecological perspective, either an abundance of hydrophytes or hydric soil conditions is generally sufficient to indicate a wetland ecosystem. The boundary or HWM of the wetland is identified by changes in vegetation structure, loss of obligate hydrophytes, and absence of wetland soil characteristics. For a list of obligate hydrophytes see Wetlands of British Columbia, A Guide to Identification (BC Ministry of Forests, Land Management Handbook No. 52)
http://www.for.gov.bc.ca/hfd/pubs/Docs/Lmh/Lmh52.htm

Wetland soils are subhydric or hydric and have one or more of the following features that reflect anaerobic soil conditions:

- Peaty organic soil horizons greater than 40 cm thick
- Non-sandy soils with blue-grey gleying within 30 cm of the surface
- Sandy soils with predominant mottles within 30 cm of the surface or blue-grey matrix.
- Hydrogen sulphide (rotten egg smell) in upper 30 cm

3.8.1.2 High Water Mark for Lakes

For ungauged lakes the high water mark is where the presence and action of annual flood waters area so common and usual and so long continued in all ordinary years, as to mark on the soil of the bed of the body of water a character distinct from that of its banks, in vegetation, as well as in the nature of the soil itself and includes areas that are seasonally inundated by floodwaters.

Where a lake is gauged and agencies have agreed on a calculated lake level, this value may be used as the HWM. The QEP needs to ensure that this agreed level includes those areas that are seasonally inundated more frequently than once in five years on average.

For reservoirs, full pool is considered the HWM.

The term “natural boundary” is used in surveys of lakeshores. The natural boundary does not always match the levels identified above for HWM for lakes and in some instances the surveys of natural boundary are out of date such that this line is below current water levels during much of the year. The definitions for HWM are provided such that a QEP can use these indicators to determine a more appropriate starting point for the SPEA on lakes.

3.8.2 Ditches

SPEAs for ditches, as determined by section 3.6.5 are laid out in the following fashion as illustrated in Figure 3-14.

1. The channel width is determined by the width of the ditch at the midpoint between the ditch invert and the top of the ditch bank
2. The SPEA setback is then outward from the top of the ditch bank

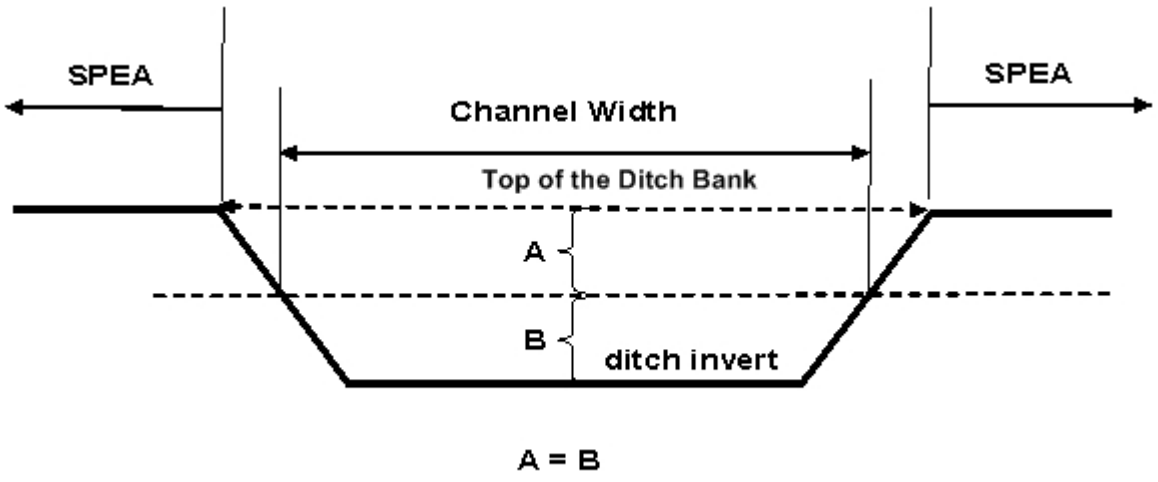


Figure 3-14: Determining Channel width for a Constructed Ditch

Appendix 1: Electronic Submission

For the current version of the:

1. The electronic notification system for filing an "Assessment Report"
2. The Guide for using the electronic notification system
3. "Assessment Report" templates *
4. Guidelines for assembling an "Assessment Report" using the templates

http://wlapwww.gov.bc.ca/habitat/fish_protection_act/riparian/riparian_areas.html

* Note: An "Assessment Report" **must** utilize the report templates.

Appendix 2: QEP Skill Sets

Regulation requirement	General Focus	General experience overview	Skill set required to undertake the work	Likely Designation
Determining SPEA width				
Simple Assessment	Non-Fish Bearing	Completed courses at Post Secondary level in Aquatic and/or Biological Sciences / Technical courses on fish species identification and aquatic ecosystem inventory field techniques / minimum of two years completing fish stream inventories and/or assessments/ One year of experience working within British Columbia	Ability to evaluate previous sample efforts and determine if additional sampling required to confirm no fish, experience evaluating potential fish barriers, ability to develop site specific sampling program (using appropriate methods and effort) to confirm fish absence, knowledge of species habitat preferences and seasonal habitat characteristics. Ability to identify barriers to fish passage, connectivity to known fish-bearing streams; skills in database and literature searches, liaison with local experts; Requirement: A good background in Ichthyology, animal physiology, knowledge of aquatic ecology and aquatic taxonomy;	RPBio, ACT, RPF, P.Ag
	Permanent Structures and Potential Vegetation	Airphoto Interpretation		RPBio; PGeo; PEng; PAg; RPF; ASTTBC

Regulation requirement	General Focus	General experience overview	Skill set required to undertake the work	Likely Designation
Detailed Assessment	Reach breaks	Technical courses on stream fluvial processes and aquatic ecosystem inventory field techniques / minimum of two years completing fish stream inventories and/or planning and completing assessments / One year of experience working within British Columbia	Experience identifying significant changes in stream channel morphology and ability to use maps and air photos to pinpoint probable reach break locations	RPBio, PGeo, PEng, RPF, ACT, P.Ag,
	Site Potential Vegetation Type other than Treed	experience/training in Biogeoclimatic classification (site series) or TEM mapping	local knowledge of vegetation species and typical vegetation community types, knowledge related to effect of site conditions on vegetation community establishment, ability to identify invasive species that may inhibit or alter vegetation community development; thorough knowledge of forest/riparian ecology; expertise in plant ID; thorough knowledge of riparian functions. Requirement: Advanced education in plant taxonomy and ecology. experience - 5 years relevant job experience with 2 years as field crew leader in inventory or stream classification or similar work.	RPBio, RPF, PAg, ASTTBC

Regulation requirement	General Focus	General experience overview	Skill set required to undertake the work	Likely Designation
	Average channel width	Technical courses aquatic ecosystem inventory field techniques / minimum of two years completing fish stream inventories and/or planning and completing assessments / One year of experience working within British Columbia	Follow directions in assessment methodology after determining HWM	RPBio, PGeo, PEng, RPF, ASTTBC, P.Ag,
	Average channel slope	Technical courses aquatic ecosystem inventory field techniques / minimum of two years completing fish stream inventories and/or planning and completing assessments / One year of experience working within British Columbia	Experience using measuring devices (clinometer, Abney level etc), ability to select appropriate sections of channel to accurately determine gradient for a particular section of the stream.	RPBio, PGeo, PEng, RPF, ASTTBC, P.Ag,
	Channel Type		Combine Stream width and Channel slope to determine channel type in chart. Training in the Channel Assessment Procedure	RPBio, PGeo, PEng, RPF, ASTTBC, P.Ag,

Regulation requirement	General Focus	General experience overview	Skill set required to undertake the work	Likely Designation
	Determining the Zones of Sensitivity	QEP having completed RAR training course or a designated professional who has read the RAR procedures and understands how they are to be applied. Skills are a function of all measurements required under Detailed Assessment		RPBio, PGeo, PEng, RPF, ASTTBC, P.Ag,
Determining Measures	Danger tree Assessment	Danger Tree Assessor Course		RPBio, PGeo, PEng, RPF, ASTTBC, P.Ag,
	Windthrow Assessment	Windthrow Assessment Course		RPBio, PGeo, PEng, RPF, ASTTBC, P.Ag,
	Slope stability - determining indicators	Familiarity with slope stability analysis and recognition of slope stability indicators. Resources include "Management of Landslide Prone Terrain" Guidelines for Terrain Stability Assessments in the Forest Sector", and "Mapping and Terrain Stability Guidebook"	Assess site for slope stability indicators. When in doubt consult professional. Terrain Course recommended to enhance ability to recognize slope stability indicators or familiarity with the following references "Management of Landslide Prone Terrain" Guidelines for Terrain Stability Assessments in the Forest Sector", and "Mapping and Terrain Stability Guidebook"	RPBio, PGeo, PEng, RPF, ASTTBC, P.Ag,
	Slope stability - determining measures	A terrain stability professional and recognized by PEng, PGeo association		PGeo or PEng

Regulation requirement	General Focus	General experience overview	Skill set required to undertake the work	Likely Designation
	Drip zone and rooting strength	Completed courses at Post Secondary level in Biological Sciences / Technical courses on botany		RPBio, RPF, PAg, ASTTBC
	Encroachment	Two years experience in urban riparian protection; understanding of interactions between land use and riparian areas	Apply BMPs based on adjacent use of land	RPBio; RPF; PAg, ASTTBC
	Sediment and erosion control measures	experience appropriate to scale of project; Engineer; technical courses on sediment and erosion control; maintain currency;	The Urban Rural Land Development Guidebook by the Ministry of Environment provides guidance on developing sediment and erosion control measures.	RPBio, PEng, PGeo; possibly RPF, PAg; technologist only as supervised by professional
	Floodplain concerns - determining measures	appropriate knowledge, training and experience in the assessment of flood hazards and the prescription of appropriate mitigative measures	Ability to identify floodplain boundaries, evidence of past flood impacts, knowledge of suitable mitigation techniques determined by site characteristics. Experience - minimum 5 years of relevant experience	RPBio (possibly PAg), sometimes with PEng, PGeo
	On-site stormwater management	Appropriate knowledge, training and experience in the design of stormwater management facilities (water quantity and quality)	Provide input to Engineer and/or Hydrologist during SMP design (i.e. appropriate locations for outflow locations into watercourses) based on advanced knowledge in aquatic ecology; Hydrologist or engineer with minimum of 5 years relevant experience in storm sewer engineering.	RPBio, PGeo, PEng, RPF, ASTTBC, P.Ag,

Regulation requirement	General Focus	General experience overview	Skill set required to undertake the work	Likely Designation
Laying out the SPEA	Determining the High Water Mark for Lotic Waters	Completed courses at Post Secondary level in Aquatic and/or Biological Sciences / Technical courses on stream fluvial processes, stream ecology and aquatic ecosystem inventory field techniques / minimum of two years completing fish stream inventories and/or assessments/ One year of experience working within British Columbia		RPBio, PGeo, PEng, RPF, ASTTBC, P.Ag,
	Determining High Water Mark for Lakes and Wetlands	Completed courses at Post Secondary level in Aquatic and/or Biological Sciences / Technical courses on lake and wetland ecology and aquatic ecosystem inventory field techniques or plant taxonomy and ecology / One year of experience working within British Columbia	Experience in identifying plant species and soil characteristics	RPBio, PGeo, PEng, RPF, ASTTBC, P.Ag,
	Determining the Top of Bank for Simple Assessment and Top of Ravine Bank for both Methodologies	Surveyor		BCLS to assist QEP for the purpose of laying out the SPEA on the ground

Regulation requirement	General Focus	General experience overview	Skill set required to undertake the work	Likely Designation
	Determining the upslope boundary of the SPEA	Surveyor	Follows HWM flagged by QEP and uses SPEA distance determined by QEP	BCLS to assist QEP for the purpose of laying out the SPEA on the ground
	Determining if it is a stream under RAR	Completed courses at Post Secondary level in Aquatic and/or Biological Sciences / Technical courses on fish species identification and aquatic ecosystem inventory field techniques / minimum of two years completing fish stream inventories and/or assessments/ One year of experience working within British Columbia		RPBio, PGeo, PEng, RPF, ASTTBC, P.Ag,
	Determination of a ditch	Completed courses at Post Secondary level in Aquatic and/or Biological Sciences / Technical courses on fish species identification and aquatic ecosystem inventory field techniques / minimum of two years completing fish stream inventories and/or assessments/ One year of experience working within British Columbia		RPBio, PGeo, PEng, RPF, ASTTBC, P.Ag,

Regulation requirement	General Focus	General experience overview	Skill set required to undertake the work	Likely Designation
	Enhancement of the SPEA	Completed courses at Post Secondary level in Aquatic and/or Biological Sciences / Technical courses on fish species identification and aquatic ecosystem inventory field techniques / minimum of two years completing fish stream inventories and/or assessments/ One year of experience working within British Columbia	Familiarity and experience in conducting and developing restoration prescriptions using the WRP Restoration Techniques (See the WRP technical circulars)	RPBio, RPF, ASTTBC, P.Ag,
	monitoring - develop plan	Experience in developing construction monitoring plans	during construction only - looking urban rural BMPs?	RPBio, RPF, ASTTBC, P.Ag,
	conducting monitoring		during construction only - looking urban rural BMPs?	RPBio, RPF, ASTTBC, P.Ag,

Appendix 3: Fish Sampling Methodology

One of the two alternative methods detailed below in the subsection "Acceptable survey methods." Either the *systematic-sample method* (Option 1) or the *first-fish-captured method* (Option 2) must be employed to demonstrate fish absence in reaches of < 20% slope.

Fish collection permits and the requirements discussed previously under "Qualifications and training" are also mandatory. RIC standard data forms, recording and data management are recommended but not mandatory for the purpose of determining whether or not a stream is fish-bearing.

The following protocols should be followed in order to conduct an acceptable survey to confirm the absence of fish from stream reaches if the decision has been made to undertake a fish sampling program. Fish presence can be determined by a number of acceptable techniques that cover a range of efficiency and sampling intensity. The simplest technique might be sufficient to determine fish presence. Fish presence is confirmed once an individual specimen of the appropriate species is properly identified. Sampling information and results are then recorded and kept on file.

Determination of the absence of fish from a body of water is much more difficult. While no fish may be captured at successively greater levels of sampling intensity, the ultimate "proof" of absence must be associated with the most intensive and efficient procedure appropriate for the species, life stage and time of year. For example, when sampling for quantitative purposes, baited traps are ideally set over 24 hours for juvenile fish, or two-trial electrofishing is performed. It is recognized that these levels of effort are sometimes difficult to achieve.

In order to establish absence acceptably, a reasonable balance between sampling effort and risk of error must be achieved to produce satisfactory results consistent with the intent of this guidebook.

Sampling effort must include a significant portion of the stream reach and be applied in the seasons appropriate for the geographical area and habitat types present (main channel, off-channel, seasonal). The proper equipment must be used under appropriate environmental conditions. For example, electrofishing will be much less effective in cold water (i.e., < 5°C) or where electrical conductivity is low.

It is recommended that sampling be done in a systematic and repeatable way so that results can be accepted with confidence. This guidebook presents a series of sampling techniques and gear types that generally reflect intensity levels. The intent of this guidebook is ***not*** to identify electrofishing as the only acceptable and final "technique of choice," although this gear type has become singularly advocated to determine fish presence or absence for fish-stream identification. Biologists and technicians conducting fish surveys must be aware that alternative techniques and gear are available, and in many cases may be more appropriate to the habitats, environmental conditions and species present.

Ultimately, an acceptable survey has been performed when there is, in total, sufficient evidence to support the conclusion that fish do not occur in a given stream reach. The evidence must include, ***in addition to fish capture results:***

1. any known information on fish presence upstream and downstream of the reach sampled
2. type and location of obstructions to fish migrations
3. sampling conditions including stream flow, temperature and conductivity
4. sampling methods and effort (include gear selection sample timing)
5. judgment of seasonal habitat availability
6. evaluation of seasonal fish use of stream and off-channel habitats.

Evidence that justifies the designation of a stream reach as non-fish bearing is signed off by the QEP indicating the method of inventory that was used or the source of information. This brief summary may include results of any acceptable fish inventory already conducted in the watershed. It is recommended that fish sampling results and methods used be recorded in the field on standard fish collection forms. Contractors that have the capability to enter the information into the FDIS database management system are encouraged to do so. These data standards will ensure data are captured and available for future uses including the review of the stream classifications.

Sampling Techniques and Gear

Several fish sampling techniques are available including: visual sightings of readily identifiable species, angling, pole seining, trapping and electrofishing.

Visual sightings are particularly useful for surveying adult salmonids during spawning periods. The seasonal timing of surveys is critical. For example, anadromous salmon spawn most frequently from mid-July (e.g., some interior sockeye stocks) to December (e.g., some coastal coho and chum stocks). Other salmonids such as steelhead trout have different populations that collectively spawn at times that include virtually the entire year. Consult with MINISTRY OF ENVIRONMENT regional offices and FISHERIES AND OCEANS CANADA divisional offices for normal salmonid migration times and spawning periods within the region of concern.

Visual surveys conducted while snorkeling can frequently be employed in both large and small streams to locate and identify adult and juvenile fishes. Use portable lights to inspect areas frequented by stream fish such as overhanging banks, tree-root masses and logjams. Visual survey results are not appropriate to use as evidence of fish absence. Apart from viewing fish, the simplest methods are angling and trapping. These methods employ light-weight equipment and have the advantages of being relatively cheap and safe.

Angling is straightforward and effective for older juvenile fish and larger specimens. It may not be effective for catching fry. A collapsible rod which can fit in a cruiser vest is convenient gear. An angling license is required for each person who uses this method. Again, angling surveys are not appropriate to use as evidence of fish absence.

Pole seines are most effective in relatively small, shallow and slow-moving streams with relatively few obstructions. This equipment is most frequently used for collecting juvenile fishes (e.g., salmonid fry, parr and smolts). Larger, fast-swimming fish are more

difficult to catch. Seining is also ineffective and difficult where water is > 1.5 m deep, stream velocities exceed about 0.8 m/s, banks are deeply undercut, and in areas with large amounts of small organic debris, tree root masses, and tree branches embedded in the stream substrate.

Pole seines about 3 m long and 1.5 m deep are frequently employed for sampling fish in streams. For most stream work, larger nets are difficult to transport and awkward to use. Because of their disadvantages, pole seines are usually used in combination with other techniques such as electrofishing.

Before seining, use a pair of barrier nets to enclose a habitat unit (e.g., a pool or riffle) to prevent fish from escaping the site. Employ two fishing trials per site. If no fish are captured in the first trial, a second trial might succeed. Fish are often easily caught in the second pass if the stream becomes cloudy and disorients the fish due to reduced visibility. Some fishes such as young coho salmon are attracted to suspended sediments because invertebrate prey is also stirred up from the steam bottom by the first seining effort.

Baited Gee-type traps (commonly known as minnow or fry traps) will not catch fish too large to enter the trap but will catch fry, parr, smolts and other juvenile fishes easily.

1. To use the trap, open it, put in some bait (e.g., salted fish roe or pierced cans of either shrimp or sardines), add a small rock for ballast, and close the trap.
2. Attach a long tether string and drop the trap into the stream. Make sure the trap is in water deep enough to be sufficiently submerged. Tie off the tether string so that the trap is secured to the stream bank, and mark the site with a piece of high-visibility flagging tape. Take care to select locations where trap recovery will be easy.
3. Gee traps work well in stream pools or in the quieter water downstream of boulders or debris, but tend to roll around too much if placed in a fast current, and therefore, will not fish effectively. If possible, orient the trap lengthwise into the flow (the apertures will then be in line with the flow).

Gee traps should be set during daylight hours on one day and ideally left to fish overnight at minimum, preferably for 24 h. This requirement may be logistically difficult when crews are attempting to cover many reaches in the quickest possible time. However, try to set traps so that fishing occurs during a period including either dawn or dusk. Fish are usually the most active at these times. In most cases, fish are caught within a few hours after the traps have been set.

If this method is employed, sufficient traps should be obtained to cover a significant part of a stream reach. Trap number and spacing will depend upon professional judgment. As a guide, try to achieve a trapping density of at least one trap per 10 lineal metres of stream, or place traps in the following key sites, especially when the features occur within high-slope reaches containing fast-flowing water and stepped pools. These features represent prime habitats for stream fishes: •

- main channel pools, especially those on the downstream edge of large boulders or those downstream of stable, large woody debris •
- off-channel pools near woody debris or overhanging banks •
- logjam pools •
- undercut banks •

- riffle-pool junctions, especially under the cover of banks.

Observe the pools for awhile to see if there are larger fish present that are too big to enter the traps. Also check the stream margins for the presence of small fry because these sites are too shallow to be fished effectively with Gee traps.

Be sure to make every reasonable effort to recover all traps because they will continue to catch fish if they are not taken out of the stream. If any trap cannot be recovered, the trap location and reasons why recovery was not possible should be reported.

Electrofishing is a relatively complex procedure that requires training and technical certification to high standards by the Workers' Compensation Board. This procedure is not discussed in detail here. (See the RIC inventory manual *Fish Collection Methods and Standards*, Version 4.0) The same key habitats discussed under fish trapping should be covered when electrofishing is undertaken. Electrofishing is advantageous because entire stream reaches can usually be covered relatively quickly within one day. Unlike trapping, no overnight or sampling is required. Use a small barrier net when electrofishing in streams, especially fast-flowing ones. Place the net just downstream of the riffle or pool being sampled so that any shocked fish collect against the net. In some steep stream reaches, shocked fish may be difficult to detect at the site where the probe is used because of turbulent water. The effectiveness of electrofishing varies not only with environmental conditions and the species and size of fish, but also with the voltage, electric pulse frequency, and the experience of the electrofishing operator. If a single fishing trial fails to capture any fish, consider adjusting the frequency or voltage settings for a second trial.

Survey Timing

Fisheries resource agencies usually sample for fish during mid-summer periods of low flows (July–August). This period is also recommended for surveys of fish presence or absence because (a) low flows may concentrate fish in stream pools at this time, and (b) juveniles of most species will be present in streams, lakes and wetlands. Exceptions in coastal streams include the fry of pink and chum salmon. These fry migrate downstream almost immediately after they emerge from the stream gravels in spring. However, both pink and chum occur most frequently in relatively low slope reaches where the probability of anadromous and game fish presence is very high.

If seasonally flooded channels, wetlands, and other off-channel sites are to be confirmed for fish absence, an additional survey will be required (a) for the fall or spring in interior watersheds when water bodies are free of ice but contain seasonally elevated volumes, and (b) in the fall or winter in coastal drainages. Channels that are dry during summer, but flooded at these other times of the year, are potential fish habitats if the adjacent main channel contains fish. These sites must be checked at the times noted here for extent and duration of flooding, fish access and fish presence or absence.

Acceptable Survey Methods

The two alternative procedures detailed below will satisfy the requirements for an acceptable fish inventory as legally referenced in paragraph (b) of the fish-bearing definition.

For sampling stream reaches and off-channel sites to determine fish presence or absence, it is recommended that sampling be done in a systematic and repeatable manner. Be sure to cover the best of the available habitat within a stream reach. Studies have shown that to establish the presence of certain species such as bull trout in some high-slope, high-elevation reaches, as much as 1.2 km of stream coverage is necessary. Because of this pattern of distribution, the recommended sampling method for fish-bearing identification has required the coverage of as much as 500 m to 1 km of stream to confirm the absence of species such as bull trout. This procedure, which involves fishing until the first caught is retained, is one of two alternate survey methods recommended for fish-stream identification.

To reduce the costs and simplify the logistics associated with the **"first-fish captured"** method, an alternative **"systematic-sample method"** is recommended that involves sampling the entire length of a representative portion of a stream reach. This portion surveyed will be 100 m long or have a length equivalent to 10 bankfull channel widths (whichever is greater). The entire length of the selected segment does not have to be sampled if fish are captured in abundance, even within the first few metres of coverage (see below).

The systematic-sample method offers important advantages. First, the total length of stream that needs to be covered within each survey will be substantially reduced in most cases. For example, the results of a single-trial systematic survey performed competently in the sample site will be acceptable if:

1. the sample site selected represents the available habitat in the reach
2. the site is sampled thoroughly at the right time of year by using gear suitable for the season, habitat, species and life stage
3. observations on habitat quality and accessibility to fish support the fish survey results.

Second, the results of the systematic survey generate useful data on the **probabilities** of fish presence or absence in streams of given size, slope and location within a watershed. These data can be added to the base of knowledge from reconnaissance fish and fish habitat inventories. Systematic-survey results are even more important in areas where no reconnaissance inventories are available. Information accumulated from systematic surveys can be used to predict the likelihood of fish presence in similar streams in unsurveyed areas of a watershed.

Regardless of the method adopted, the first step is to determine the likelihood of fish presence from a review of the existing knowledge on fish distribution for the specific areas to be affected by development. If no information is available, then fish surveys must be conducted in reaches < 20% slope to confirm fish absence.

When known information is reviewed, look for information on the potential occurrence of bull trout or other very rare (i.e., low density) fish for the sites that will be sampled.

Fish are more difficult to detect if they are at very low population densities. If the data review suggests this is probable, a more rigorous sampling intensity is justified (see step 5 in the systematic method below).

One of the two sequences detailed below may be employed in the season most appropriate for fish presence considering the type of available habitat, species and life stage.

Option 1: Systematic-Sample Method

1. The first site recommended to be sampled is a representative length within the uppermost reach included in the affected area. Fish distributions downstream of the reach, taking barriers and other features into account, can be assumed from the results of this survey.
2. The length of the selected site will be equal to 10 bankfull channel widths, or 100 lineal metres (whichever is greater). The entire length of the site is sampled for fish. Sampling must systematically cover all available habitat types and employ techniques appropriate to the anticipated species and habitats present. Use the technique most appropriate for the season and physical conditions.

   If no fish are caught in the first trial, but there are doubts about sampling efficiency, sample again with a second method. Sampling methods and results are recorded on the standard fish collection forms.

   If electrofishing is employed and fish are caught in abundance, even within the first few metres of coverage, stop sampling. For example, if 10 to 20 specimens are captured within the first 5 to 10 metres, the reach clearly supports fish in abundance.
3. If no fish are captured in the initial sample site, the biologist or field technician must make a professional judgment as to whether and how much further fish sampling should be conducted.

   If sampling at a different time of year is warranted due to water temperatures that are too low, or ephemeral habitats that are accessible to fish are present but dry, sampling should be terminated in favor of a follow-up survey at a more appropriate time.
4. Sampling is finished when the surveyor is confident that there is enough evidence to support the conclusion that no fish inhabit the reach. If the evidence to support fish absence is insufficient, then further sampling is required.
5. If no fish are found in the initial sample site, but habitat quality appears good and no barriers to fish access are evident, a second site of a length equal to the first site must be sampled within the same reach, again covering all habitat types. The most appropriate sampling method shall be employed. Sampling methods and results are recorded on the fish collection forms found in the Ministry of Forests Fish Stream Identification Guidebook www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/FISH/FishStream.pdf.
6. In cases where it has been previously determined that populations of fish occur in the area at very low densities, and if no fish have been captured in the initial sampling

site, additional sampling is recommended. Consult with the local MINISTRY OF ENVIRONMENT representative prior to initiating surveys. It is expected that these situations will be relatively uncommon; however, sampling the remainder of the reach might be recommended for reaches < 500 m long. Sampling methods and results are recorded on the standard fish collection forms.

7. Evidence for justification of a non-fish bearing stream reach is reported as a "non-fish-bearing status report" as outlined below. This may include results of any 1:20 000 reconnaissance fish and fish habitat inventory previously conducted in the watershed.

Option 2: First-Fish-Captured Method

1. To sample for fish, begin at the downstream end of the reach and proceed sequentially upstream until a fish is caught and identified as one of the species of concern.
2. If no fish are caught, continue upstream and cover the entire length of reaches up to 500 m long. For reaches 1 km long or longer, surveys focused on the deepest pools and other key habitats noted above are recommended for an additional 500 m. Be sure to cover the available habitat. Studies have shown that to establish the presence of bull trout in some high-slope, high-elevation reaches, as much as 1.2 km of stream coverage is necessary. In order to establish absence, sampling according to the procedures of this guidebook must be thorough enough to produce reliable results that minimize the likelihood of error.
3. Document sampling methods and results on the recommended fish collection form (see 5. above).
4. Evidence for justification of a non-fish bearing stream reach is reported as a "non-fish-bearing status report."

Non-Fish-Bearing Status Report

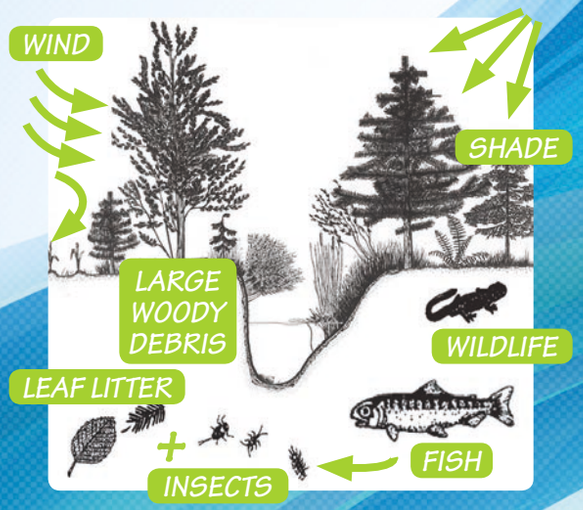
All stream reaches for which non-fish-bearing status is proposed require a short, concise, written justification for this designation. This non-fish-bearing status report contains information that, in the professional opinion of the person responsible for the survey, provides sufficient evidence to support the conclusion that fish do not occur in the stream reach in question. Information that should be provided includes:

1. date and time of sampling events, including initial and any follow-up sampling efforts;
2. fish sampling methods and effort employed:
   - capture methods used (e.g., electrofisher; Gee traps; use of barrier nets at either downstream limit, upstream limit, or at both ends of the sampled site)
   - sampling area covered (number, length and area of sample site)
   - sampling effort (e.g., number of traps, electrofishing seconds)

3. stream conditions during sampling (e.g., specific conductance; flow stage of high, medium or low; temperature; turbidity)
4. supporting evidence:
   - known fish species presence both upstream and downstream
   - type and location of obstructions to fish migrations
   - seasonal habitat availability
   - seasonal fish use of stream and off-channel habitats
   - results of any 1:20 000 reconnaissance fish and fish habitat inventory conducted in the watershed.

What is a Riparian Area?

Riparian areas are the areas bordering on streams, lakes, and wetlands that link water to land. The blend of streambed, water, trees, shrubs and grasses directly influences and provides fish habitat.



The Riparian Area is Fish Habitat

Riparian areas provide shade and shelter from predators, as well as a home and food for the insects that are food for fish. These areas provide wood to the stream that in turn provides shelter and nutrients. A healthy riparian area acts as a buffer to changes in weather, temperature, flooding and pollution. This resilience is critical to the survival of fish in a developing landscape.

Protecting Riparian Areas is Important

Preventing damage to riparian fish habitat is easier than restoring it if damage has occurred. Waterfront land owners have a direct role to play in ensuring the health of their local watercourse. For example, land owners can contribute to the restoration of riparian areas by allowing natural re-vegetation to take its course and re-establishing native plants.

Value for Fish & Your Community

A healthy riparian area has both economical and ecological benefits. Protected natural areas make neighbourhoods desirable and can have a positive impact on your property values.

Protected riparian areas mean:

- Improved water quality
- Decreased flood hazard
- Lower stormwater management costs
- Higher aesthetic values
- Increased shoreline stability
- Decreased heating and cooling costs
- Better air quality

It will take all of us working cooperatively in our communities and with all levels of government to keep riparian areas healthy.

For More Information

Consult your local government to learn about the permit and approval process for developments in your riparian area.

Visit the provincial Riparian Areas Regulation website for more information.

Riparian areas are highly productive ecosystems and are a critical source of British Columbia's biodiversity.

Quick Guide for Waterfront Land Owners & Developers

If you have a stream, lake, wetland or ditch on or beside your property, there are things you need to know.

Provincial and, or Federal legislation may apply to you. This brochure is intended to assist land owners & property developers who are planning development activities in riparian areas adjacent to streams or other water bodies.

This pamphlet is a guide only. It is not a substitute for the Federal *Fisheries Act*, the *Riparian Areas Regulation*, or your local government's bylaws.

BRITISH COLUMBIA
Ministry of Forests, Lands and Natural Resource Operations

Standards are in Place to Protect Fish

You need to follow local standards to protect riparian habitat when your development project is near a stream, river, creek, pond, lake, ditch, spring or wetland, if it provides fish habitat or nutrients to fish habitat.

Fish habitats are areas on which fish depend directly or indirectly for a variety of needs including spawning, nursery, rearing, food supply and migration.

If Your Project is…

a residential, commercial or industrial **activity** within 30 metres of a watercourse, even if that watercourse is not on your property,

AND you are planning ANY of the following:

- Removing or altering plants
- Disturbing soils
- Constructing buildings and structures
- Constructing roads, trails, docks, wharves, bridges
- Creating hard surfaces such as decks and pavement
- Installing works for flood protection
- Developing drainage systems and utility corridors
- Servicing sewage and water systems
- Subdivisions

…the Riparian Areas Regulation may apply to your development. The regulation helps you conduct your activities responsibly to avoid degrading valuable riparian fish habitat.

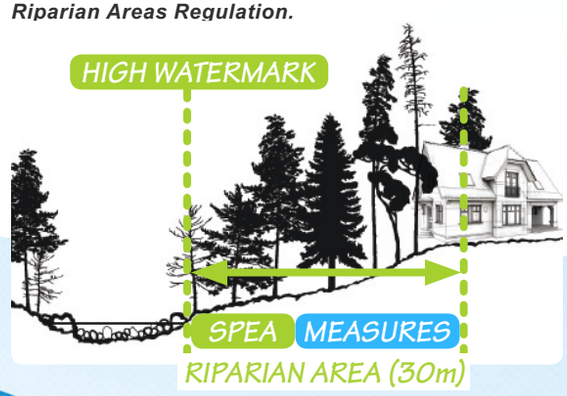
About the Regulation

The Riparian Areas Regulation is **provincial legislation** that requires **local governments** to enact bylaws that protect riparian areas during residential, commercial, and industrial development.

If the Regulation Applies to You

If the Riparian Areas Regulation applies to your development, you may need to have your property assessed by a **Qualified Environmental Professional**. The assessment will determine the width of the **Streamside Protection and Enhancement Area** (SPEA) on your property. Development may be restricted in this area if it has the potential to damage vegetation and/or interfere with the ability of the riparian area to provide fish habitat. Additional measures to maintain riparian habitat such as sediment and erosion control, may be included in the assessment.

DIAGRAM 1: ***Illustration of the 30m Riparian Assessment Area requiring compliance with the Riparian Areas Regulation.***



Qualified Environmental Professionals (QEPs) include agrologists, biologists, foresters, geoscientists, and technologists who are in good standing with their respective professional organizations working in their area of expertise.

How Do I Proceed?

STEP 1

CHECK LOCAL BYLAWS
check with your local government for the rules that apply to developing property within the riparian area (within 30m of a stream, shore or ravine bank *see diagram 1*).

STEP 2B

IF LOCAL BYLAWS DO NOT STIPULATE SETBACKS
you will require an assessment from a Qualified Environmental Professional in order to determine the setbacks and protection measures. It is strongly advised that you conduct this assessment before actual site development.

STEP 2A

ABIDE BY SETBACKS
layed out in local bylaws. Go to Step 6.

STEP 3

USING STANDARD PROCEDURE
the assessment determines which measures must be taken before, during and after development, in order to comply with the Riparian Areas Regulation.

STEP 4

IF THE DEVELOPMENT PROPOSAL DOES NOT COMPLY
with the stipulations in the assessment, the development proposal must be redesigned to occur outside the riparian area.

STEP 5

A RECORD OF THE ASSESSMENT
is reviewed and filed with the provincial government.

STEP 6

AFTER THE ASSESSMENT
the local government may proceed with their approval process.

Consult your local government for bylaws that apply to your development.