Dumont Creek Hydrological Assessment (May 2022)

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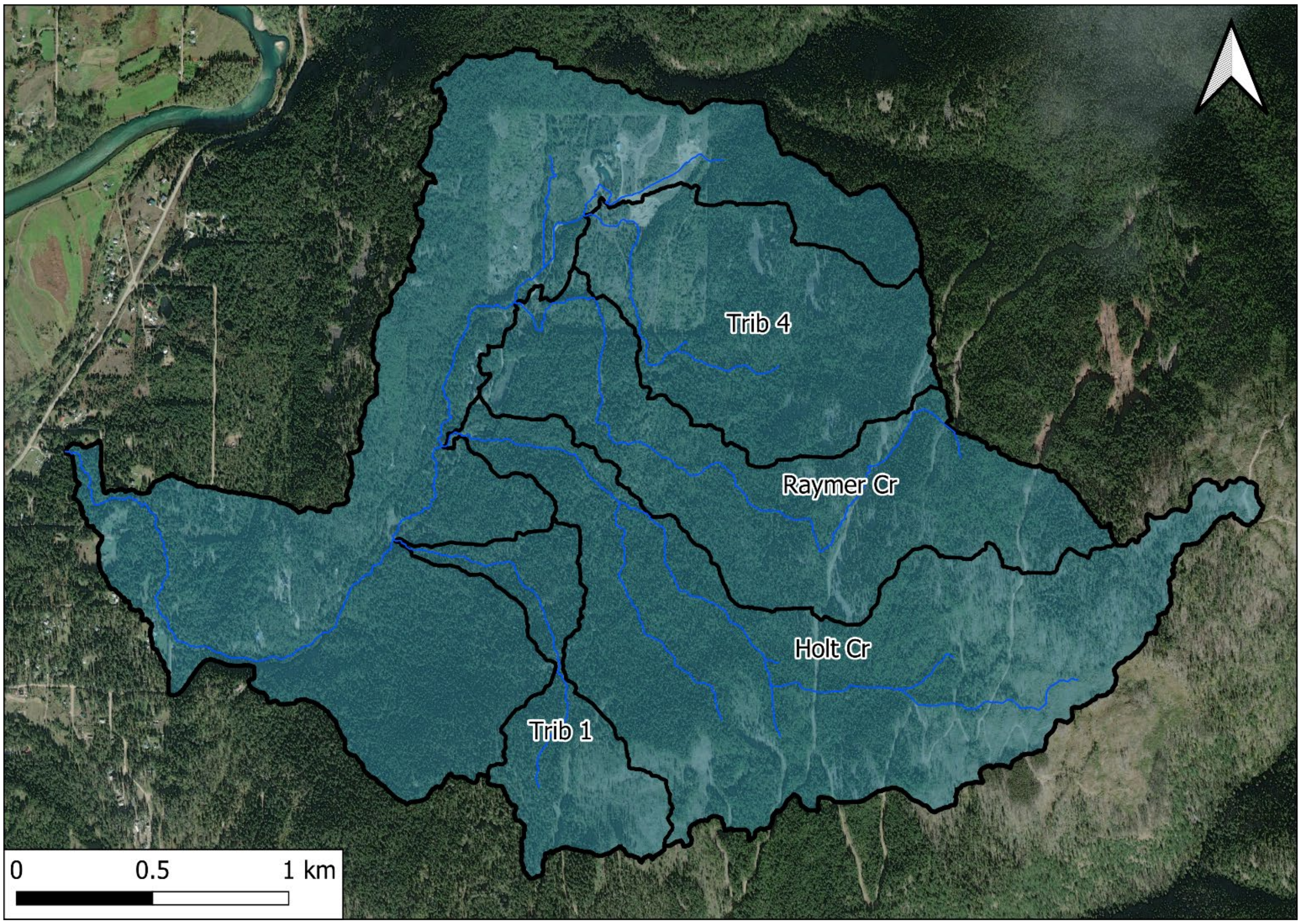

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1. ABSTRACT

The current level of development in Dumont Creek, estimated at just under 18% ECA, represents a Moderate likelihood for increasing the frequency/magnitude of overbank peak flows in Dumont Creek. The planned wildfire interface treatment will not substantially alter this likelihood given that for most years the openings will be snow free prior to peak flows occurring in Dumont Creek. The planned wildfire treatment will not affect the current Low likelihood of increased sediment delivery or the Low likelihood of increased duration of low flows. There is a Moderate likelihood that the frequency/magnitude of peak flow in Holt Creek have increased and a High likelihood the timing of peaks has shifted to earlier in the freshet, effectively prolonging the low flow period in this subbasin. The proposed forest harvesting, situated at low elevations will not alter the existing likelihood.

Climate change is projected to result in increased daily precipitation during the winter and spring months and increased daily temperatures. By 2070 Dumont Creek is projected to be a rainfall dominated watershed. The trend to hotter, drier summers results in an increase in the likelihood of wildfire. Managing forests to reduce the likelihood of wildfire in Dumont Creek could help to mitigate the long-term hydrological impacts of climate change.

2. INTRODUCTION

Tom Bradley, RFT, for Slocan Integral Forestry Cooperative (SIFCo) has retained Apex Geoscience Consultants Ltd (Apex) to undertake a hydrological assessment on Dumont Creek using a method consistent with the Guidelines for Watershed Assessments (https://www.egbc.ca/getmedia/8742bd3b-14d0-47e2-b64d-9ee81c53a81f/EGBC-ABCFP-Watershed-Assessment-V1-0.pdf.aspx). SIFCo is proposing to undertake wildfire interface forest treatments on the lower slopes of the watershed. In the past few decades an extensive mountain pine beetle infestation has resulted in forest disturbance through tree mortality and salvage harvesting in the upper elevations of the watershed. Dumont Creek provides consumptive use water through points of diversion (PODs) on the mainstem channel and Holt Creek (blue dots, Figure 1) as well as a number of springs. In addition, there are several irrigation water licenses (orange dots, Figure 1) and one groundwater well (pink dot, Figure 1).

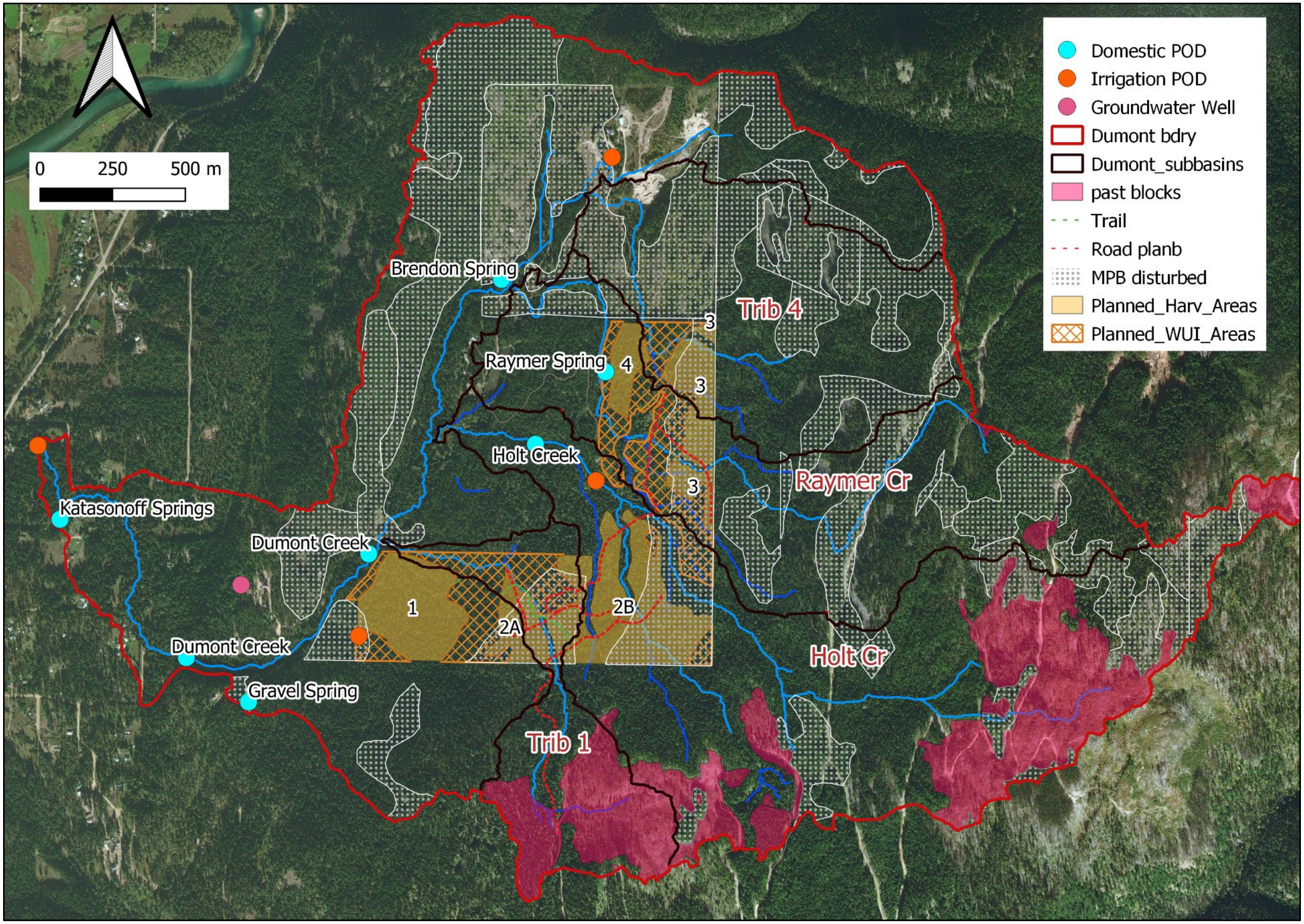

FIGURE 1. DUMONT CREEK NORTH OF WINLAW CREEK. DOMESTIC PODS ARE BLUE AND IRRIGATION PODS ARE ORANGE. THE AREAS IMPACTED BY MOUNTAIN PINE BEETLE ARE STIPPLED IN LIGHT GREY. AREAS HARVESTED IN THE PAST ARE SHOWN IN PINK. AREAS PROPOSED FOR WILDFIRE INTERFACE LOGGING ARE SHOWN IN MUSTARD YELLOW.

The objective of this assessment is to provide an investigation of the cumulative impacts of past logging and beetle mortality on Dumont Creek and subbasin channels and to provide an assessment of likelihood of impacts to water supplies given the planned forest treatment and projected climate change.

For this assessment, the values at risk are water quality, and timing of flows at the Holt Creek, Raymer Creek (spring) and Dumont Creek intakes. The harmful events of concern are;

1. Changes in the frequency/magnitude of peak flows that could impact channel stability,
2. Increases in turbidity above current levels and,
3. Changes in the timing of runoff that could increase the duration of low flow conditions

For this assessment the spring water supplies (Raymer and Brendon) are assumed to include a seasonal snowmelt contribution and are considered the same as surface water streams. The groundwater well is not considered a value at risk. According to Provincial well records this well is 660 feet deep and in bedrock so has no connection to surface runoff in Dumont Creek.

3. METHODS

The hydrological assessment undertaken here considers the hydrological impacts of landcover disturbance over the past several decades. This assessment includes the analysis of the equivalent clearcut area (ECA) which is the area of the watershed contributing to altered hydrological processes but adjusted for forest stand regeneration, a geospatial analysis of watershed physical characteristics of elevation, aspect and slope gradient distribution and a field review of the subbasin channels in Dumont Creek to identify current conditions, channel sensitivity to disturbance and information on past disturbance events and an assessment of likelihood of altered hydrological processes

The ECA analysis and geospatial analysis has been undertaken by Apex Geoscience GIS specialist Cydne Potter GIT with input from Kim Green, PhD., P.Geo. The field investigation of channels was undertaken on October 21, 2021 by Kim Green, PhD., P.Geo. during low flow conditions with the assistance of Will Halleran, P.Geo., L.Eng. A second field investigation of the water courses and terrain conditions at the mid-elevations of the watershed was undertaken by Will Halleran on November 16, 2021.

4. Physical watershed characteristics

Elevation distribution

Dumont Creek is a 674-hectare watershed that ranges in elevation from 1553m at Mt. Conner to 526m at Highway 6 (Figure 2). In this assessment Dumont Creek includes Holt Creek and Raymer Creek tributaries, as well as two other unnamed tributaries which are referred to as Trib 1 and Trib 4 in this assessment. Raymer Creek is named after the licensed spring that occurs within the catchment. The area upstream from the confluence of Dumont Creek and Raymer Creek is considered the headwater reach of Dumont Creek although it is labeled Brendon Spring in Figure 1.

The watershed is characterized by primarily low elevation with 80% of the area below 1000m elevation. A study of the area contributing to hydrograph peaks in mountainous, snowmelt watersheds of the Kootenays has shown that, for most years, the area above the H60, which is the upper 60% of the watershed area is the primary contributor of runoff during the peak period (Gluns, 2001). This is due to more snow accumulating with increasing elevation and the lower slopes often snow free by the time peak flows are occurring. In Dumont Creek the H60 elevation is at 840 meters (Figure 3). The absence of snow on low elevation west aspect slopes by the start of the spring freshet period is confirmed by high resolution satellite imagery (see Section 7)

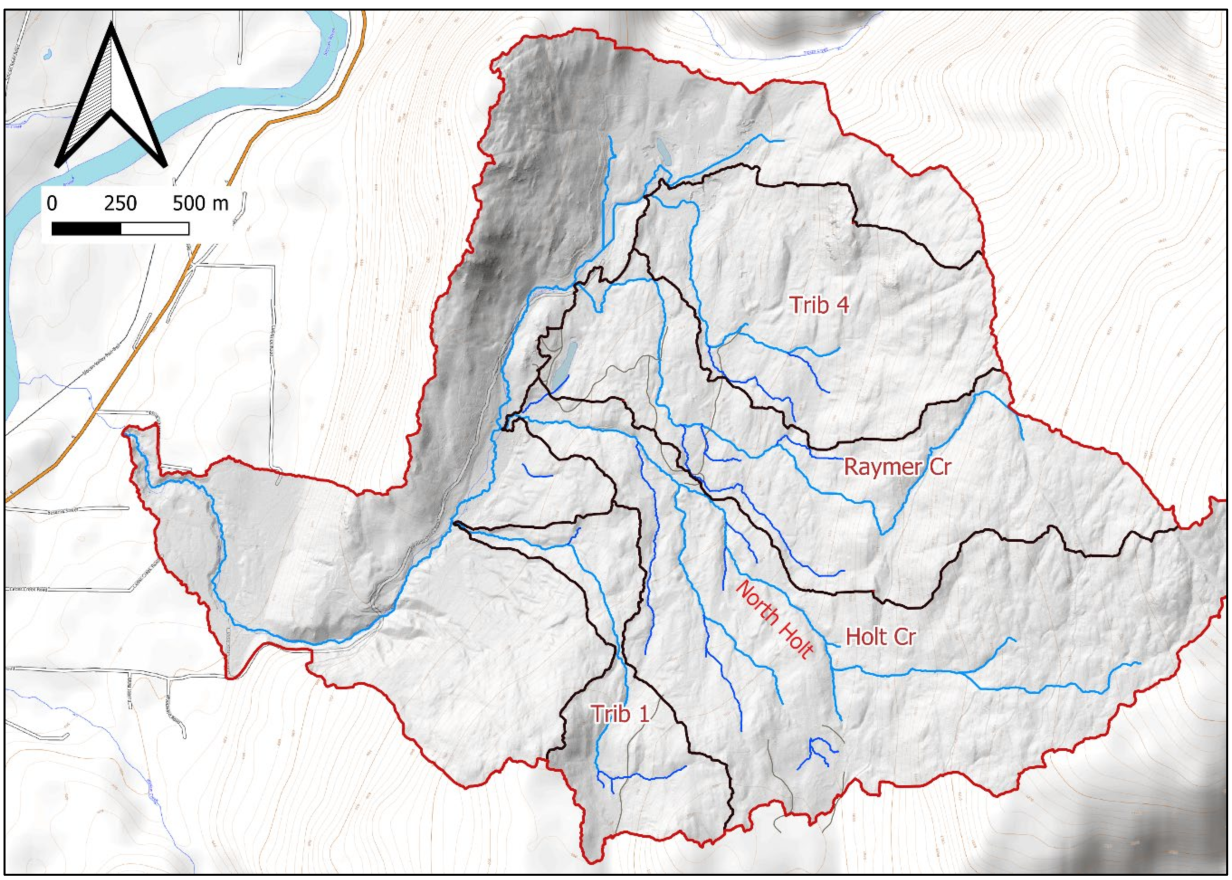

FIGURE 2. NAMES FOR SUBBASINS OF DUMONT CREEK USED IN THIS ASSESSMENT.

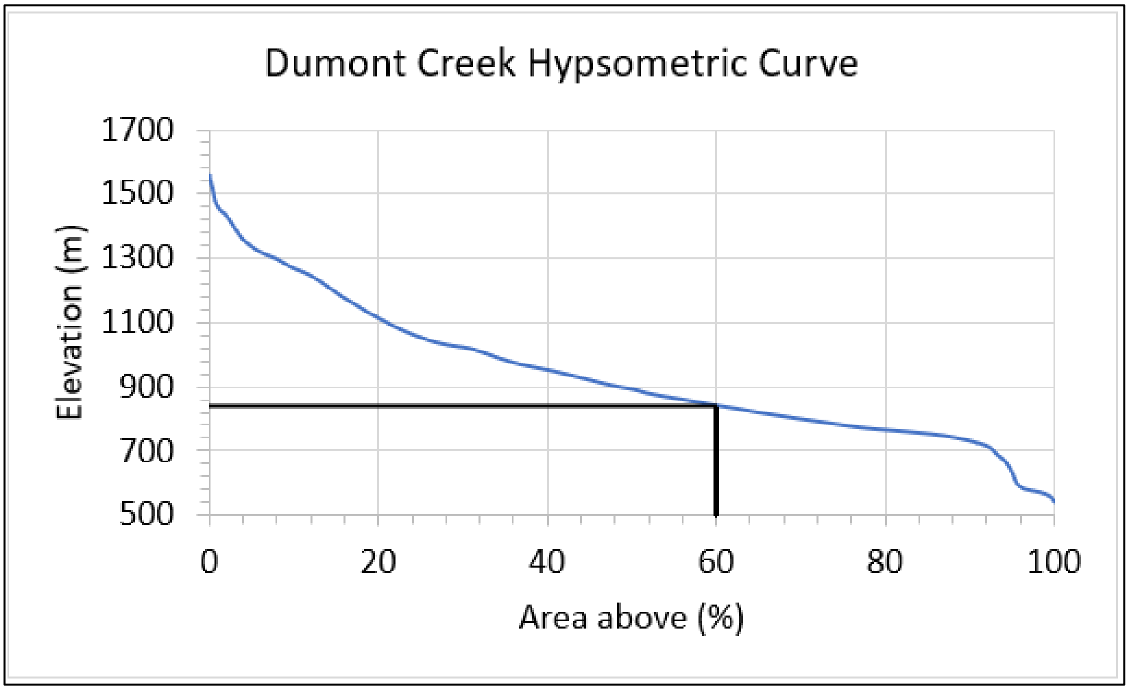

FIGURE 3 HYPSOMETRIC CURVE FOR DUHAMEL CREEK. THE H60 ELEVATION IS AT 840 METERS.

Geology

Geology plays a role in the erodibility of sediment and the texture of sediment in the stream channel. Fine shales and siltstone tend to be very erodible and contribute to fine textured channel beds while coarse grained intrusive rocks are generally more resistant and contribute to blocky channel beds. Dumont Creek is primarily underlain by granodioritic intrusive rocks of the Nelson Batholith. The lower elevations are underlain by granite and alkali feldspar granite intrusive rocks and meta-volcanic rocks of the Sheppard, Tuzo Creek and Shingle Creek group.

Slope Aspect

The aspect of slopes in a watershed (i.e. the direction they face) are one of the primary controls on snowmelt timing and volume. The mainly blue and pink colours of Figure 5 indicates Dumont Creek is characterized as a single-aspect watershed with aspects that are predominantly west to northwest. This is also confirmed in the histogram of slope aspects in Figure 6. Western aspects are highly responsive to forest disturbance in terms of increases in the rate and volume of runoff and advancement of snowmelt relative to the undisturbed forest stand.

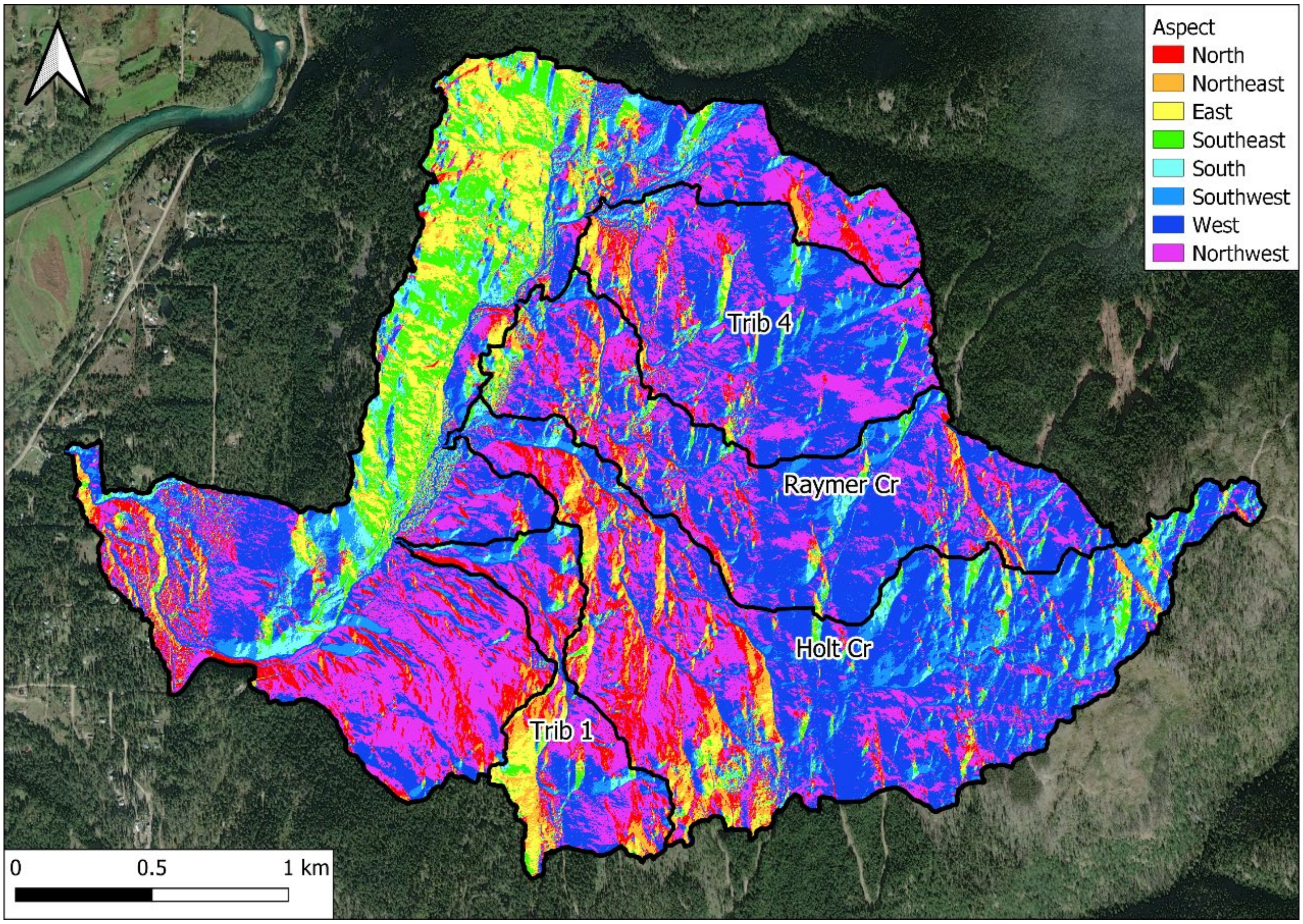

FIGURE 4 DUMONT CREEK ASPECT DISTRIBUTION.

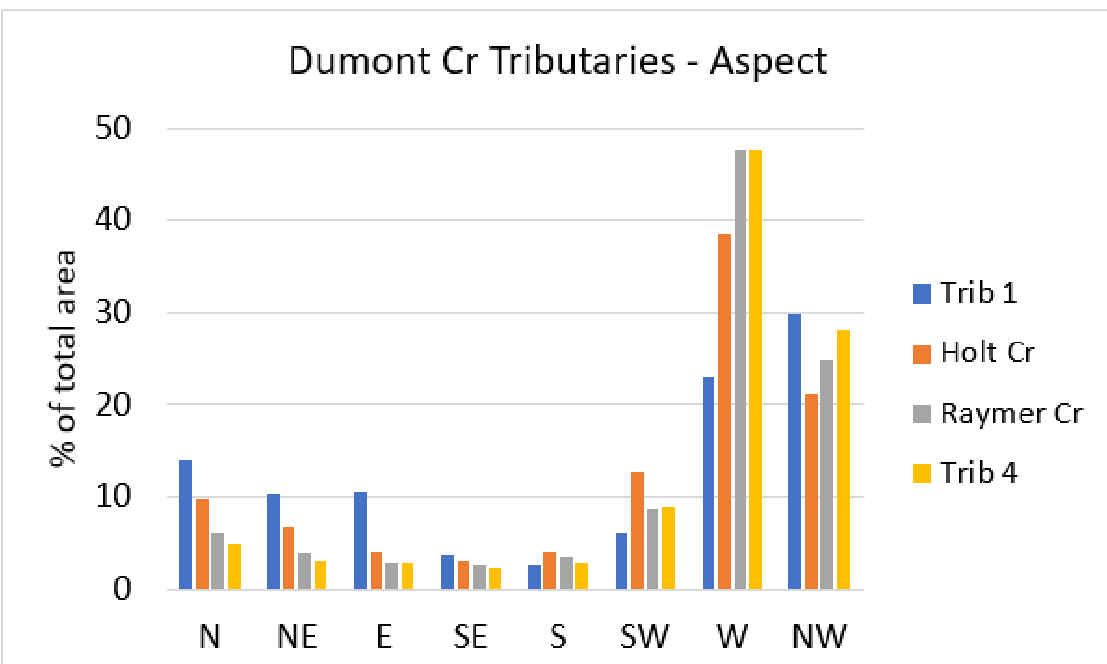

FIGURE 5 ASPECT DISTRIBUTION IN DUMONT CREEK SUBBASINS.

A small component of the slopes, above the confluence with Trib 1, are characterized by east/southeast/south slopes (yellow/green/teal). The histogram of aspect distribution in Dumont Creek (Figure 5) confirms westerly aspect slopes including west, northwest, and southwest slopes account for over 68% of the watershed area.

Slope Gradient

Much of Dumont Creek (78%) is characterized by low to moderate slope gradients below 50%. Steeper gradients are found in the higher elevation regions of Raymer Creek and Trib 4, and, locally, at low elevations below 670 meters. Steep slopes in the upper elevations highlight bedrock bluffs while those at low elevations define the glacial sediment terrace scarps along the Slocan Valley.

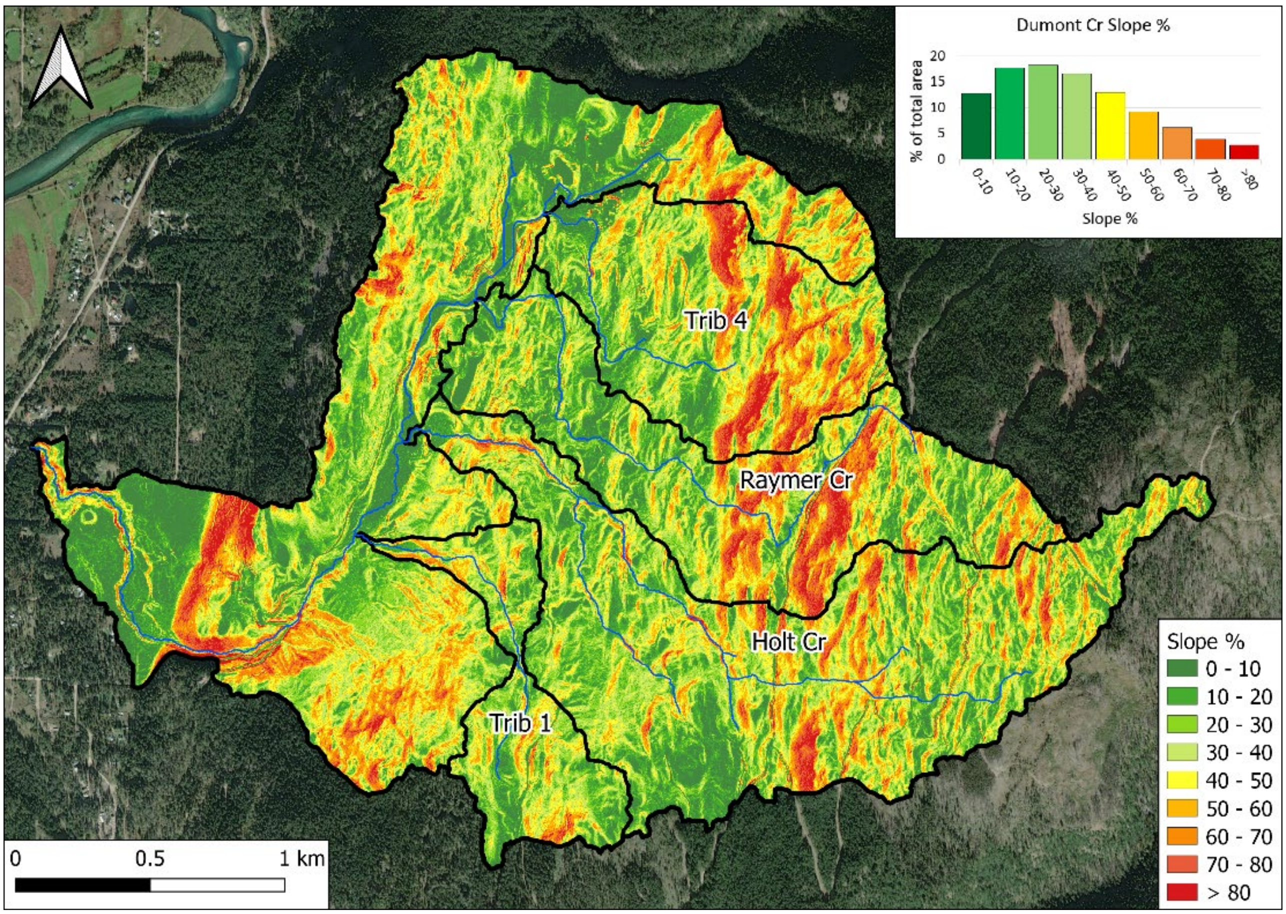

FIGURE 6 SLOPE GRADIENT DISTRIBUTION IN DUMONT CREEK

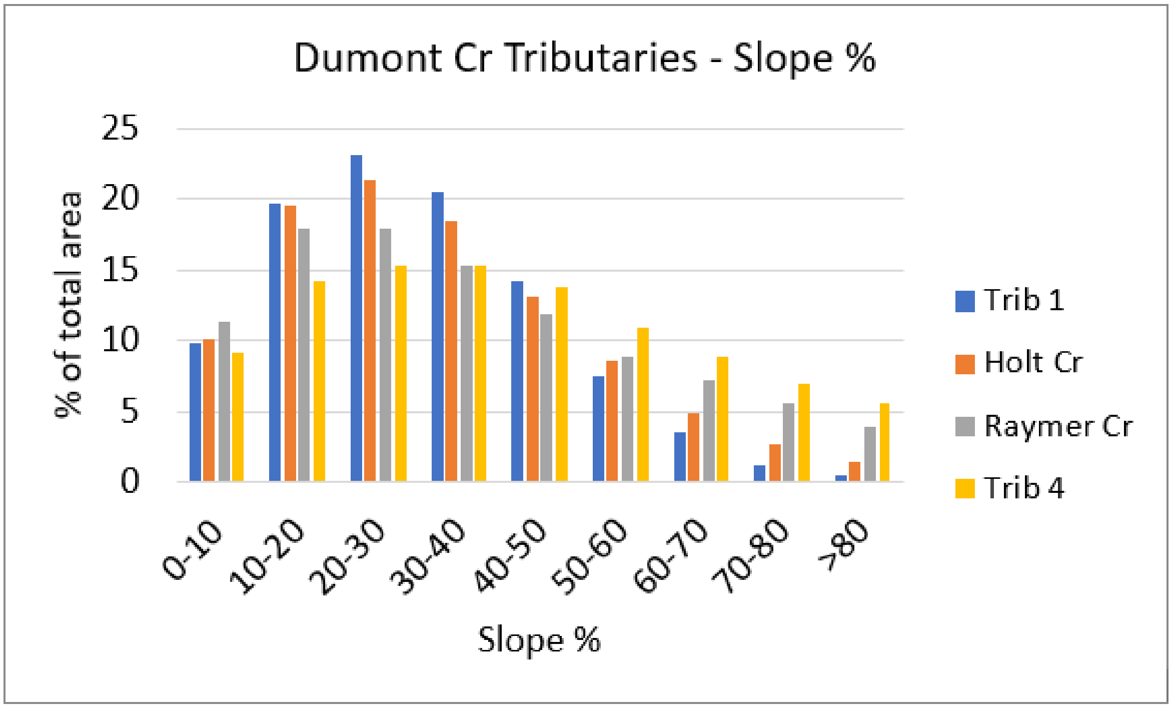

FIGURE 7 SLOPE GRADIENT DISTRIBUTIONS IN DUMONT SUBBASINS.

Stream gradients of Holt Creek and Raymer Creek reflect the steeper gradient terrain in their headwater reaches and moderate gradients through the lower reaches while the channel of Dumont Creek flows across the flat, glacial sediment deposits that underly Paradise Valley (Figure 8)

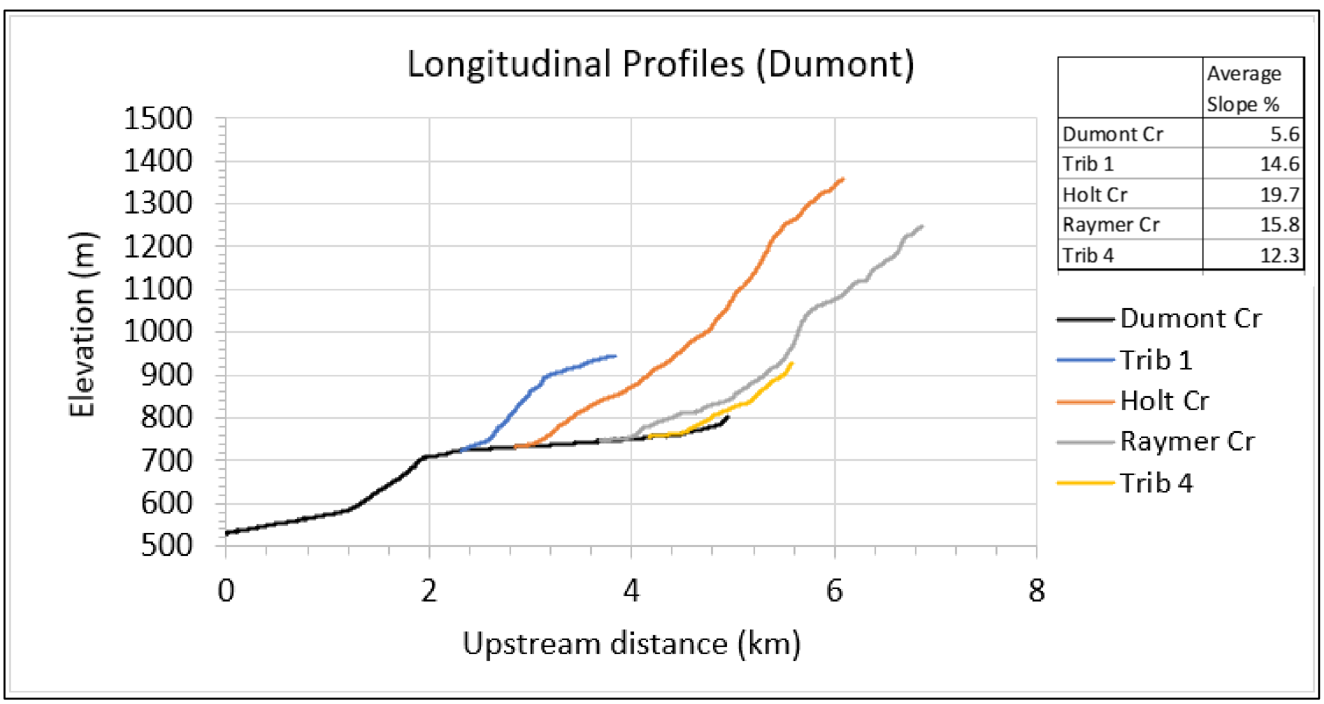

FIGURE 8 CHANNEL GRADIENT PROFILES FOR DUMONT CREEK AND SUBBASIN CHANNELS.

5. Current Forest Disturbance

Over the past two decades, forest disturbance in Dumont Creek has been caused by pest infestation as well as Crown land and private land logging. Google Earth orthophoto images shown in Figure 9 reveal a heavily beetle infested condition in the upper elevations of Dumont Creek in the summer of 2003 (top photo, Figure 9). More recent imagery, in part from the summer of 2020, reveal that, while some salvage harvesting has occurred, most of the area impacted by the beetle infestation is now devoid of trees (Figure 9, lower image). The lower image also indicates that two roads were constructed across the upper watershed and further private land logging has occurred on lower slopes.

FIGURE 9. GOOGLE EARTH ORTHOPHOTO IMAGERY FROM 2003 (ABOVE) AND 2020 (BELOW) SHOWING THE GROWING FOOTPRINT OF DISTURBANCE IN DUMONT CREEK OVER THE LAST TWO DECADES.

ECA ESTIMATION

Equivalent clearcut area is used to estimate the hydrological impact of forest disturbance in a watershed. The method is based on studies that indicate that processes of snow accumulation and melt in a regenerating stand are intermediate to those of a clearcut and the undisturbed, mature forest. Forest attributes of stand height and crown cover are used to estimate the equivalent clearcut area (ECA) of a regenerating stand compared to the clearcut condition.

The information of stand height and canopy closure is estimated using data from the 2020 LiDAR provided by SIFCo and the Province of BC's Vegetation Resource Inventory (2020). To understand the distribution of forest disturbance the ECA is determined for Dumont Creek above Katasonoff Road, and for the 4 main subbasins: Trib 1, Holt Creek, Raymer Creek, and Trib 4.

The location and height of individual trees greater than 3 meters in height were identified from the 2020 LiDAR canopy height model. Growth projection curves developed from a detailed analysis of median stand height and age relationships derived from the 2020 LiDAR were used to project the 2020 LiDAR tree heights in Dumont Creek to 2022 estimated heights. The watershed boundaries used for the ECA calculation were determined using the LiDAR derived digital elevation model (DEM). The location of the watershed boundary assumes that surface runoff is not substantially diverted by roads that traverse the watershed boundary.

HYDROLOGICAL RECOVERY

A study of hydrological recovery in West Kootenay stands has been under way in Rover Creek for the past three winters (2019-2021). This current study through Selkirk College Applied Research and Innovation Center utilizes mobile terrestrial LiDAR together with time lapse cameras and snow surveys to investigate differences in snow accumulation and snow melt across juvenile stands at a range of elevations and aspects. The preliminary outcomes of the Rover Creek study are consistent with other recent studies on the effect of cut blocks on snow accumulation and melt across different aspects which have determined that cut blocks on north and south aspects have very different effects on snow melt dynamics (Ellis et al., 2010). Cutblocks situated on north aspects tend to delay snowmelt while those on south aspects can advance snowmelt by several weeks compared to the forested stand. Preliminary results from the Rover Creek study confirms that snowmelt is substantially delayed in openings on north aspect slopes compared the mature stand and advanced on south and southeast aspect slopes relative to mature stands. However, the Rover Creek study also shows that elevation plays an important role in the extent of the changes in snow accumulation and melt processes. In addition, the Rover Creek study reveals that regenerating stands between about 3 to 5-meter height have very little influence on snow accumulation relative to the clearcut but elevated snowmelt rates compared to the clearcut condition. This means that regenerating stands of between about 3 to 5-

meter height accumulate as much snow as the clearcut but melt that snow much faster than the clearcut effectively resulting in negative hydrological recovery.

The Rover Creek-based recovery curves are provided in Figure 10. These curves differ to some degree from the recovery curve produced by Winkler and Boon (2015) for Thomspon-Okanagan spruce – pine stands. In Rover Creek a stand located on north aspects in the ICH biogeoclimatic (BEC) zone is considered fully mature when it has a height of 27 meters and a LiDAR-derived canopy cover of 75% or greater while a stand located on south aspects in the ICH BEC zone in Rover is considered fully mature when it has reached a height of at least 22 meters and has a LiDAR-derived canopy cover of 55% or greater. A stand located in the ESSFwh BEC subzone is considered fully mature when it has reached a height of at least 20 meters and has a canopy cover of at least 45%. Locally, mature stands in the ESSFwm subzone in Rover creek are similar in height and canopy cover to mature stands in the ESSFwh subzone. Disturbed stands in the ESSFwm subzone in Rover Creek are located immediately adjacent to the ESSFwh subzone and are assigned recovery values based on mature stand characteristics in the ESSFwh subzone.

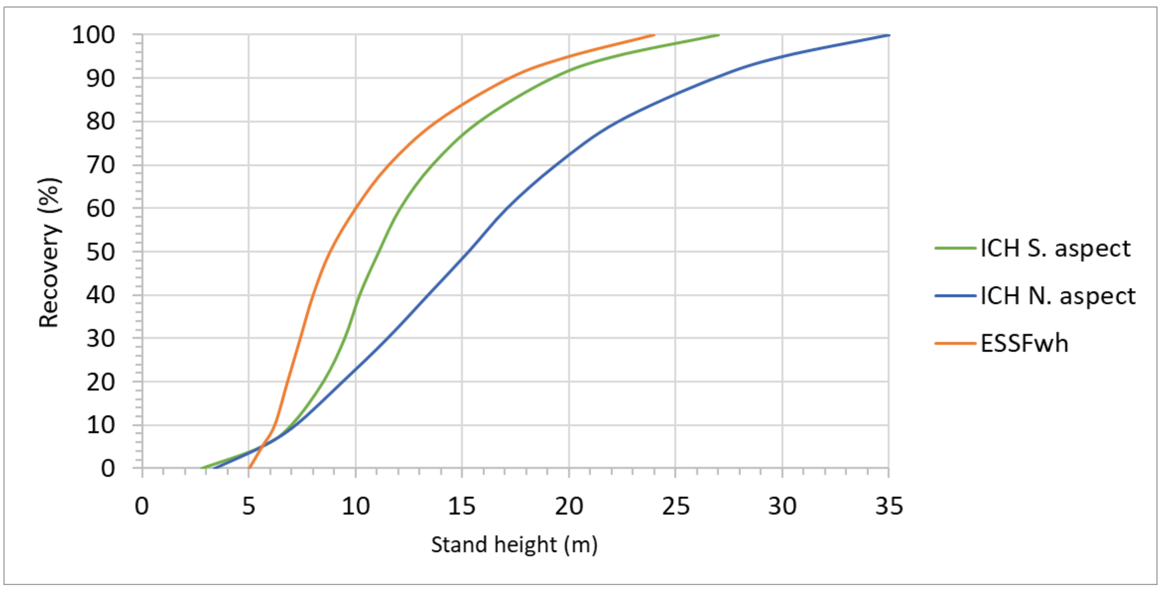

FIGURE 10 PRELIMINARY HYDROLOGICAL RECOVERY CURVES DEVELOPED FROM SNOW SURVEY DATA FROM SELKIRK COLLEGE STUDY.

The height and canopy closure characteristics of mature stands in Dumont Creek (Table 1) were determined by undertaking a geospatial analysis of the LiDAR-derived canopy height model (CHM) for forest cover polygons in the VRI and determining the median values of tree-heights in each of the mature forest polygons located within each BEC subzone. Canopy cover percentages for VRI polygons in Dumont Creek were derived from the 2020 LiDAR. Additionally, field survey information supplied by SIFCo describing recent pest-damage/mortality and the condition of replanted blocks was also considered. The extent of MPB invested stands is identified in Figure 1. The hydrological recovery values are applied regardless of whether it is a harvested block or a polygon with beetle infestation.

TABLE 1. HYDROLOGICAL RECOVERY VALUES ASSIGNED TO STANDS IN DUMONT CREEK

BEC zone	LiDAR median stand ht (m)	LiDAR CrCl (%)	Recovery (%)
ICH	<5m and/or	<20%	0
	≥5 - 9	≥20 - 35	10
	≥5 - 9	>35 - 50	20
	≥5 - 9	>50	30
	>9 - 13	≥20 -35	20
	>9 - 13	>35 - 50	30
	>9 - 13	>50	50
	>13	≥20 - 35	30
	>13	>35 - 65	50
	>13 - 18	>65	70
	>18 - 21	>65 - 75	80
	>21	>65 - 75	90
	>18 - 21	>75	90
	>21 - 26	>75 - 85	90
	>21	>85	100
	>26	>75	100

RESULTS

Currently 129 hectares or 19% of the 674-hectare Dumont Creek watershed upstream from Katasonoff Road is considered in a disturbed condition. When hydrological recovery is applied the current ECA for the watershed is estimated at 118.8 hectares or 17.6% of the total watershed area (Figure 11 and Table 2). Of this, 63ha or 9.3% is situated above the H60 elevation. Besides the private land logging, most of the current forest disturbance is in the headwater regions of Holt Creek and Trib 1 subbasin.

TABLE 2. CURRENT ECA IN DUMONT CREEK AND SUBBASINS

Opening description	**Applied recovery (%)**	**2022 area (ha) with applied hydrological recovery**				
		Dumont Cr	**Trib 1**	**Holt Cr**	**Raymer Cr**	**Trib 4**
Total watershed area (ha)		**673.8**	**43.6**	**183.5**	**109.5**	**87.7**
Recent harvest	0%	12.2	0.0	10.7	1.5	0.0
Road opening	0%	9.6	0.1	5.9	3.1	0.6
Disturbed forest 10% recovered	10%	25.1	0.0	25.1	0.0	0.0
Disturbed forest 20% recovered	20%	16.0	10.4	5.6	0.0	0.0
Disturbed forest 30% recovered	30%	6.4	0.0	6.4	0.0	0.0
Disturbed forest 50% recovered	50%	4.1	0.0	2.8	1.2	0.2
Disturbed forest 70% recovered	70%	1.6	0.0	0.0	0.0	0.0
Disturbed forest 90% recovered	90%	2.8	0.5	0.0	0.9	0.0
Recovered	100%	0.0	0.0	0.0	0.0	0.0
Prvt managed forest 10% recovered	10%	6.4	0.1	0.0	0.0	0.0
Prvt managed forest 20% recovered	20%	1.2	0.0	0.5	0.0	0.0
Prvt managed forest 30% recovered	30%	13.9	0.0	0.7	5.7	0.0
Prvt managed forest 50% recovered	50%	18.3	0.0	0.0	2.0	7.6
Prvt managed forest 70% recovered	70%	1.1	0.0	0.0	0.0	1.0
Total current ECA (ha)		118.8	11.0	57.8	14.5	9.3
Total current ECA (%)		**17.6**	**25.4**	**31.5**	**13.2**	**10.6**
Total ECA with planned harvest (ha)		160.5	16.2	72.6	21.0	13.0
Total ECA with planned harvest (%)		**23.8**	**37.2**	**39.5**	**19.2**	**14.9**

The ECA estimates for the individual subbasins range from over 31% in Holt Creek to less than 11% in Trib 4. Managed private land forest is included in this estimate but the recovery for these areas is estimated based on orthophoto imagery. Permanent residential/developed area was not included in the ECA calculation. Lower recovery values seen in the headwaters of Trib 1, Holt Creek, and Raymer Creek are primarily related to high levels of pest mortality and subsequent salvage harvest. Stands located adjacent to large recovering blocks in the headwaters of Trib 1 and Holt Creek currently have high levels of mortality (SIFCo) which is themed orange and red on Figure 12 and observable as open areas in recent Sentinel satellite imagery.

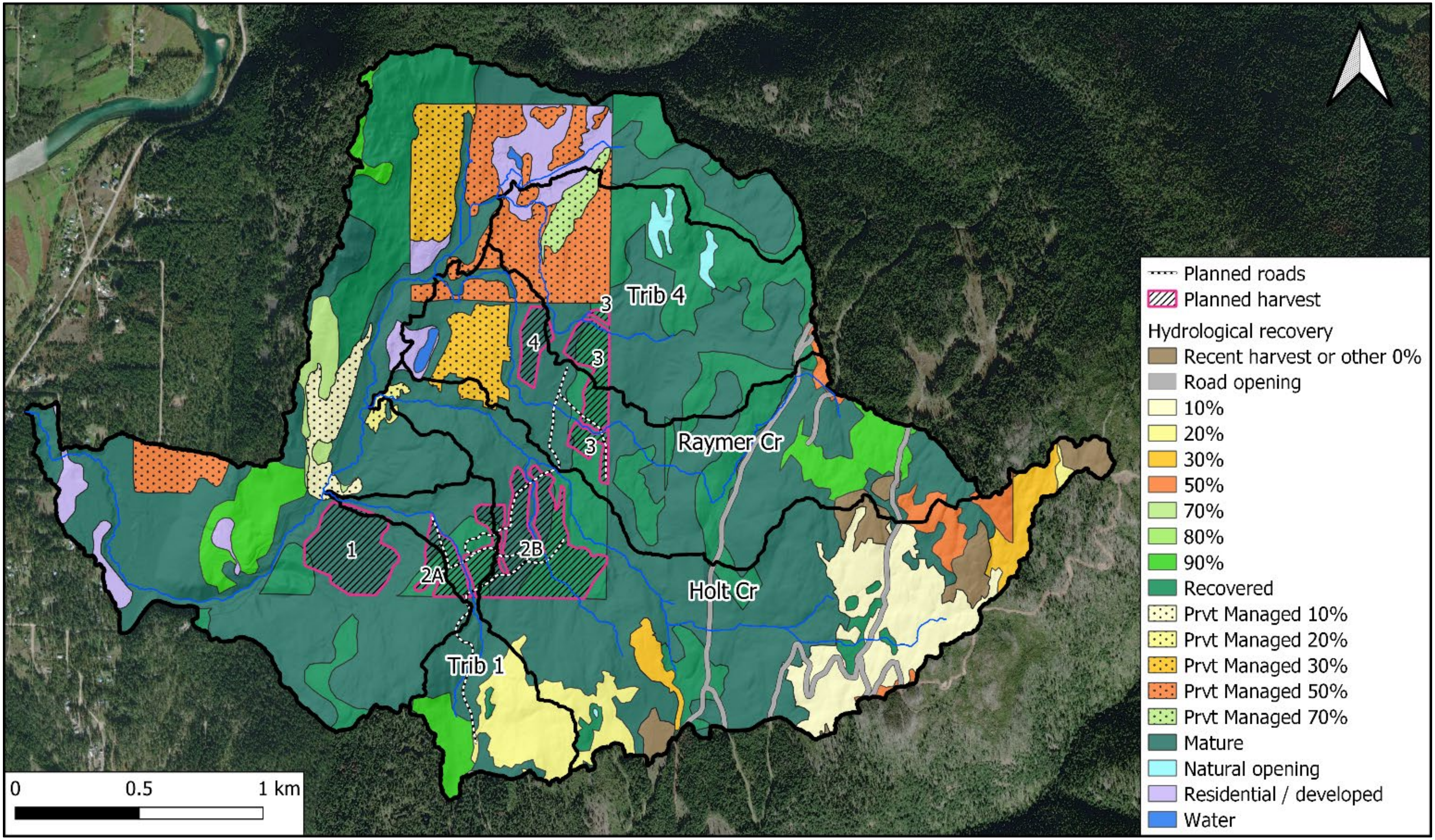

FIGURE 11 CURRENT ESTIMATED HYDROLOGICAL RECOVERY (%) IN DUMONT CREEK FOR THE FULL WATERSHED AREA AND SUBBASINS.

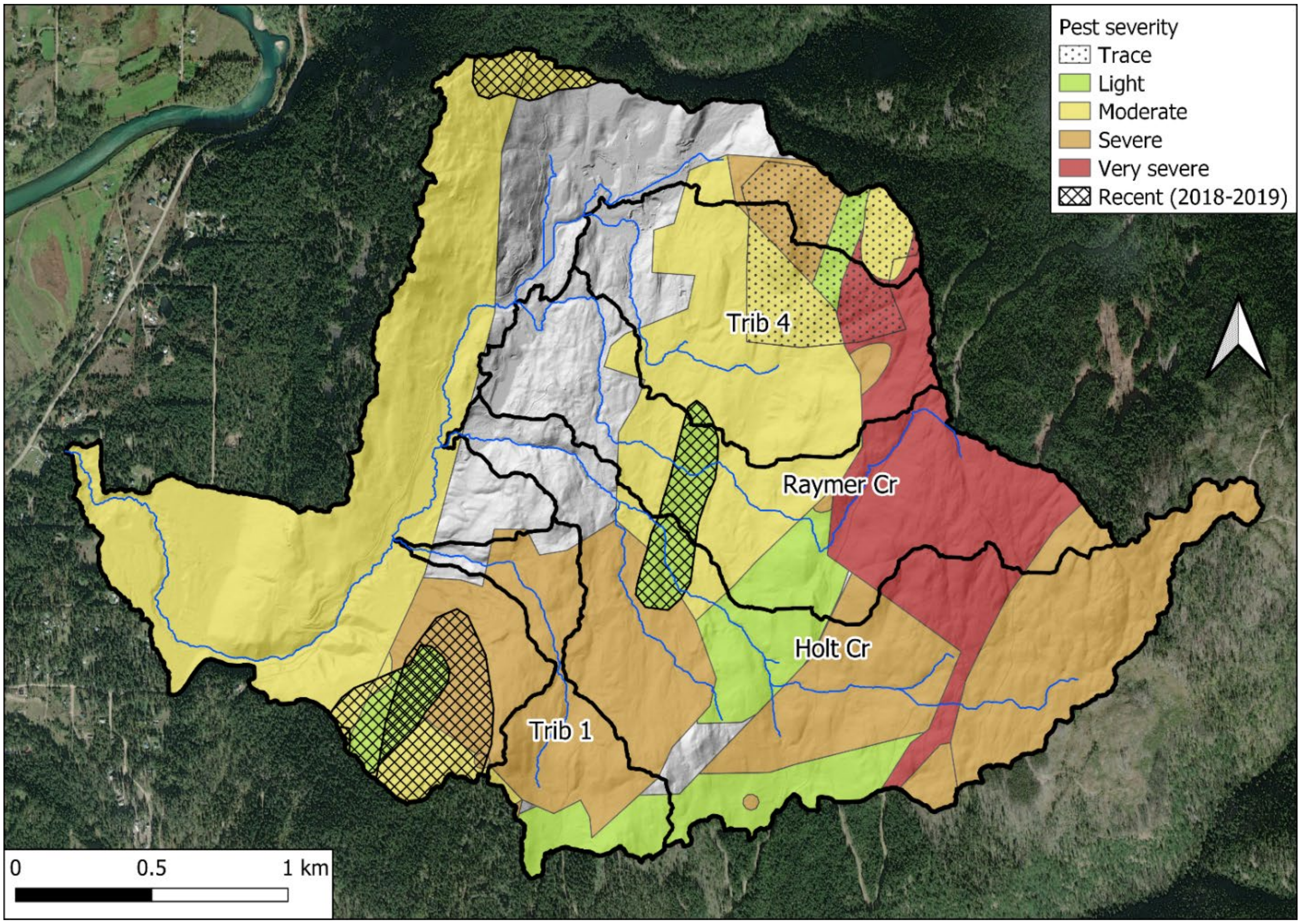

FIGURE 12. PEST INFESTATION POLYGONS FOR DUMONT CREEK SHOWING PEST SEVERITY FROM 1966 – 2019.

PLANNED FOREST HARVEST

The wildfire interface treatments (WUI) proposed by SIFCo include two treatment types. Treatment 1 involves understory management without disturbing the overstory canopy. Treatment 2 involves stand thinning with the retention of a minimum of 35% of the current mature coniferous stand. For the purpose of the ECA assessment, treatment 1 (see brown cross hashing on Figure 1) will have no impact on hydrological processes and is not included in the estimation of ECA or shown on Figure 11. Treatment 2 is assumed to involve substantial opening of the forest stand and for this reason is considered equivalent to a clearcut with 0% hydrological recovery for the purpose of the ECA calculation. The ECA in Dumont Creek with the planned WUI activities increases just over 6% to 160.5 hectares or 23.8% of Dumont Creek above the highway. The ECAs in Trib 1, Holt Creek and Raymer Creek increase to 37.2%, 39.5% and 19.2% respectively while Trib 4 ECA increases to 14.9% (Table 3, last row).

6. Field Observations

The channel of Dumont Creek and three of the subbasin channels were investigated at thirteen sites on October 21st, 2021, which was a dry, cool, snow free day. Access to Dumont Creek and lower reaches of the subbasin channels was provided by the Paradise Valley Road however, the mid- and upper reaches of the tributaries were not investigated as part of this field session. Observations made along the stream channels at the mid-elevations have been provided by Will Halleran PGeo., L.Eng. from his field survey undertaken on November 16, 2021, which was also a dry, snow free day. The location of field sites is shown in Figure 13.

Information collected during the field investigation included morphological description of the channels, evidence of recent and historical channel disturbance, processes of sediment delivery and riparian function. In addition, the specific conductivity of surface flows was recorded at every site with surface water to assist in determining the contribution of deeper groundwater to stream flows. Information from the field survey is presented for Raymer and Holt Creeks and then moving in the downstream direction from site Dt02 to Dt13 on Dumont Creek.

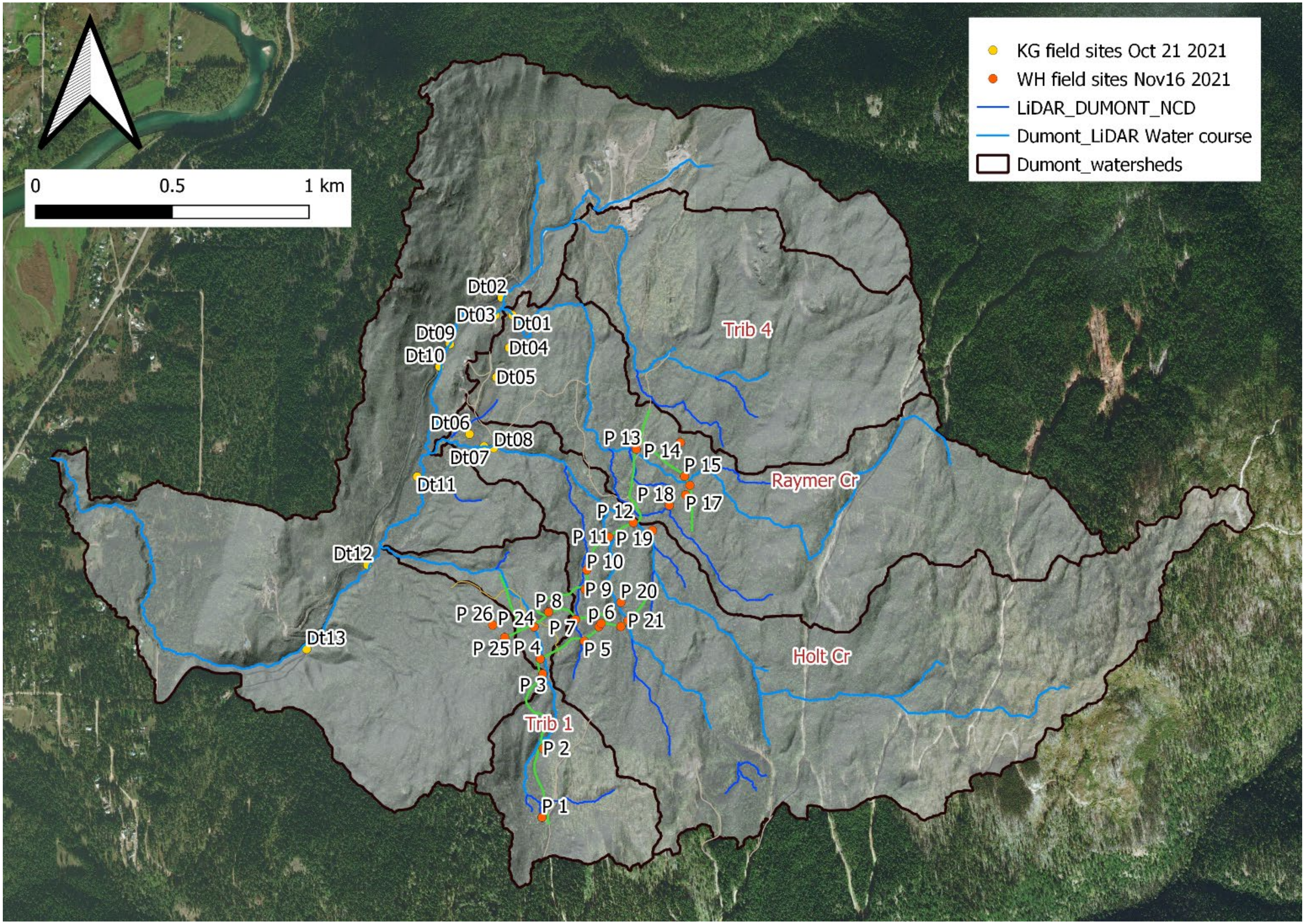

FIGURE 13. LOCATION OF FIELD SITES IN DUMONT WATERSHED

RAYMER CREEK

No perennial flowing water or defined stream channel is present at the mid elevations of this catchment although moist soils were noted at sites P13, P16 and P17. Indication of seasonal surface runoff included washed gravel along an old trail at site P13. In the lower elevations, perennial surface water is present between the shallow pond at Dt05 and the Paradise Valley Road culvert at site Dt01.

Standing water at Dt04 is supplied by subsurface flow from the shallow pond at Dt05 (Photo 1). Old diversion works including an outflow pipe and diversion channel are evident at the southern end of this shallow pond that appears to have been used at one time to divert water into Holt Creek but they are in disrepair and do not appear to have been used recently.

At site Dt01 Raymer Creek is a broad wetland vegetated with sedges and alder to 10 cm diameter. Multiple small channels feed into the culvert at Paradise Valley Road. The largest channel is just under a meter wide and 10 cm deep. There is no mobile bedload other than fine organic material. Seasonally higher flows are evident as side channels and depressions that become ponds during the spring freshet.

PHOTO 1. SHALLOW LAKE AT DT 05 DRAINS SUBSURFACE TO THE NORTH INTO RAYMER CREEK CATCHMENT.

PHOTO 2. PERENNIAL STREAM DRAINING FROM WETLAND AREA ABOVE CULVERT ON RAYMER CR AT SITE DT01.

HOLT CREEK

Below approximately 810 meters elevation Holt Creek flows in a single channel that is confined in a moderate to steep-sided bedrock gully. Above this elevation water drains from the headwaters of the catchment in three main channels, the largest of which is the northern-most channel that can be traced on the LiDAR DEM to the upper elevations of the catchment. Perennial flow was observed in two of the three tributaries during the November 2022 field survey. The southern-most of the three channels is identified on Figure 14 as an NCD (non-classified drainage) channel but contains a small discontinuous channel in the bottom of a broad draw with flowing water as well as standing pools. This southern channel does not display indicators of higher seasonal flow events or a mobile bedload suggesting it is spring-sourced and conveys a near-constant discharge throughout the year. The middle of the three channels was investigated at sites P11 and P20 (Figure 14). Ponded water was present at site P11 but a dry bedrock draw occurs upstream from this point and no indication of surface flows were noted at site P20. Perennial flow was noted in the northern channel at sites P19 and P12. At site P19 the channel is a mossy, colluvial to forced step pool channel. The overhanging banks and high-water marks along the banks indicate that flows increase substantially during the spring freshet period in this channel. The channel at site P19 displays no indication of recent flood disturbance such as increased bed mobility or bank scour. The last large runoff event that occurred in this section of the channel pre-dates the toppling of old burnt trees and possibly occurred shortly after the hillside was burnt at least 70 years or more ago.

PHOTO 3. LOOKING UPSTREAM AT SITE P19 ON THE LARGEST OF THE HEADWATER TRIBUTARIES OF HOLT CREEK. BURNT TREES FROM A MANY DECADES-OLD FIRE HAVE TOPPLED ACROSS THE CHANNEL.

Downstream from this point the channel becomes unconfined and has shifted across a broad swale over the years. The last shift appears to correspond to the ~70-yr old flood event although these old avulsion channels may also carry seasonal runoff at times.

PHOTO 4. ABANDONED CHANNEL OF HOLT CREEK AT SITE P12.

Holt Creek at site P12 appears to have experienced a recent peak flow event that mobilized small cobbles and small woody debris and caused localized bank scour (photo not included).

Below this point Holt Creek becomes confined again in a bedrock gully. The channel was investigated further downstream at site Dt08 where it displays a forced step to colluvial morphology.

At site Dt08 Holt Creek contains mossy angular cobbles and boulders and mossy woody debris in the channel most of which has not been mobilized ever or for many decades. Local bank erosion from a recent high flow event has resulted in mobilization of small cobbles and gravel in the channel below Dt08.

PHOTO 5. LOOKING UPSTREAM AT DT08. CHANNEL CONTAINS A MOSSY FLOOD DEPOSIT FROM A DECADES-OLD FLOOD EVEN AND SMALLER RECENT GRAVEL DEPOSITS FROM A RECENT HIGH FLOW EVENT THAT SCOURED A NEARBY BANK.

PHOTO 6. SAME LOCATION AS PREVIOUS PHOTO. RECENT COBBLE DEPOSIT FROM NEARBY BANK EROSION.

There is no indication such as old flood deposits that Holt Creek has hosted debris floods with any frequency in the past. The last large flood event appears to be at least 70 years old as indicated by deciduous vegetation on colluvial deposits where the channel gradient decreases above the confluence with Dumont Creek. In this location (Dt06, Figure 14) the surface flow of Holt Creek disappears subsurface but appears to contain surface flows during the spring freshet period.

Dumont Creek

Dumont Creek was investigated at several locations from above the confluence of Raymer Creek at site Dt02 to above the culvert on Paradise Valley Road at site Dt13 (Figure 13). Above Raymer Creek confluence, Dumont Creek headwater (identified as Brendon Spring in Figure 1) occupies a broad, low gradient, marshy area like that observed on Raymer Creek above the Paradise Valley Road culvert. Below the confluence of Raymer Creek at site Dt03 Dumont Creek is contained in a small meandering, riffle pool channel with a bankfull width of 1.5 meters and a gradient of between 1% and 2%. In this reach the mobile bedload during peak flows includes organic material and gravel up to 1 cm diameter. Marshy areas and pools are present on the broad valley bottom. The flow in this section of Dumont Creek varies through the year as indicated by the high-water mark along the channel banks that is upwards of 15 cm above the low flow water level.

PHOTO 7. DUMONT CREEK AT DT03 BELOW THE CONFLUENCE RAYMER CREEK.

Downstream from Dt03, Dumont Creek alternates between very low gradient ponded areas with no indication of flow, areas with intermittent surface flow and areas with only subsurface flow. At the point where Paradise Valley Road confines Dumont Creek along the west side of the valley (Site Dt09, Figure 13) the channel displays more continuous surface flows, and the gradient steepens to over 2%.

PHOTO 8. PONDING ALONG DUMONT CREEK AT SITE DT09.

At site Dt10 Dumont Creek is carried in a culvert beneath Paradise Valley Road and discharges into a low gradient ponded area with deciduous shrubs (Photo 9). There is no obvious channel or indication of sediment mobilizing flows in this reach of Dumont Creek.

PHOTO 9. DUMONT CREEK AT SITE DT10 WHERE THE STREAM IS CARRIED TO THE EAST SIDE OF THE VALLEY BENEATH PARADISE VALLEY ROAD.

The channel of Dumont Creek is poorly defined in a low gradient alder and willow-filled swale for roughly 200 to 300 meters below Dt10 and above the confluence of Holt Creek. There is minimal indication of surface flow and no substantial sediment transport through this low gradient section.

At site Dt11 an ephemeral channel that carries seasonal flows during the freshet occurs on a broad, mossy, vegetated valley bottom (Photo 10). At this point the nearly flat valley bottom is roughly 100 meters wide and 600 meters long and appears to have been a post-glacial pond or wetland area.

PHOTO 10. AN EPHEMERAL CHANNEL OF DUMONT CREEK AT SITE DT11.

Below the confluence of Trib 1 (Figure 14), the valley narrows to less than 20 meters and steepens (Figure 7) as Dumont Creek cuts down through fine textured terraced glacial sediments into bedrock. The channel has a woody debris step morphology with an average gradient of 7% and a bankfull width of between 1.6 and 2 meters (Photo 11). Channel banks are vegetated with cedar, moss and deciduous shrubs but locally undercut and eroded due to a number of high flow events in the last decade or more. Cobble accumulations along the active channel and in adjacent abandoned channels indicate the channel has shifted laterally in the recent past. Angular cobbles, and gravel comprises most of the mobile bedload. Cobbles up to about 6cm are moving annually but a recent flood (last 2 years?) moved cobbles up to 12cm and small woody debris.

The bankfull indicators along the channel banks that are roughly 20cm above the low flow stage suggest a substantial increase in discharge during the spring freshet period (Photo 12). A small amount of surface flow (estimated at less than three liters per second) was present in Dumont Creek from this point to site Dt13 at the time of the field investigation in October.

PHOTO 11. DUMONT CREEK BELOW SITE DT12. BANKS ARE VEGETATED WITH CEDAR AND DECIDUOUS SHRUBS. BEDLOAD IS ANGULAR COBBLES AND GRAVEL.


PHOTO 12. DUMONT CREEK BELOW DT12. THE DISCHARGE INCREASES SUBSTANTIALLY THROUGH THE FRESHET PERIOD AND THEN DROPS TO LESS THAN 2 OR 3 LITRE/SEC IN THE FALL AND WINTER MONTHS.

The sandy sediment exposed on the Paradise Valley Road surface and along the ditch line at site Dt13 was the only significant active sediment source to Dumont Creek noted during the October field investigation (Photo 13). The channel of Dumont Creek above this culverted crossing has been modified by human activities and contains many pieces of cut wood. A debris jam over 1meter in height is present immediately upstream from the Paradise Valley culverted crossing.

PHOTO 13. SAND FROM ROAD SURFACE ENTERS DUMONT CREEK AT SITE DT13.

PHOTO 14. DEBRIS JAM CONSISTING OF COBBLES AND BROKEN WOODY DEBRIS IS PERCHED IN THE CHANNEL UPSTREAM FROM THE PARADISE VALLEY ROAD AT SITE DT13.

About 30 to 50 meters upstream from the debris jam, a debris slide from a steep gully below a private driveway appears to have entered Dumont Creek several decades ago (Photo 15). This debris slide deposited woody debris and sediment on the valley bottom along Dumont Creek and may have contributed to the accumulation of debris in the jam above the culvert.

PHOTO 15. DEBRIS FROM DECADES-OLD DEBRIS SLIDE ALONG DUMONT CREEK ABOVE SITE DT13.

TRIB 1 SUBBASIN

Trib 1 subbasin was investigated at several locations through the upper to mid-elevations at sites P1 to P4 and P24 (Figure 13). At the upper elevations the subbasin contains that appear to be seasonally wet areas (Photo 16). A small perennial stream is present further down slope at site P24. No indication of high seasonal flows that have mobilized bed sediment in the past were noted suggesting the stream in this lower channel is fed by groundwater with minimal seasonal runoff contributions. A surface water channel of Trib 1 was not obvious at the confluence of Dumont Creek and may flow subsurface at this point.


PHOTO 16. SEASONALLY WET AREA AT SITE P3 IN UPPER TRIB 1 SUBBASIN

7. Surface water Conductivity and temperature

Electrical conductivity is a measure of the ability of water to pass an electrical current which is affected by the presence of inorganic dissolved solids such as chloride, nitrate, sulfate, and phosphate anions (negative charge ions) or sodium, magnesium, calcium, iron, and aluminum cations (positive charge ions) (Fondriest, 2021). Conductivity increases with increasing water temperature. For this reason, conductivity, when recorded by a calibrated conductivity meter, is normalized to a standard temperature of 25 degrees Celsius. Bedrock geology through which the stream flows is one of the primary influences on conductivity. Streams that run through areas with granite bedrock tend to have lower conductivity because granite is composed of minerals that do not easily ionize. Conversely, streams that run through limestone tend to have higher conductivity due to the dissolution of limestone that releases calcium and carbonate ions. Groundwater has higher conductivity than surface water due to the concentration of dissolved ions in the groundwater. An exception to this is where the surface water flows through an area with substantial inputs of effluent or urine such as an area heavily grazed by cattle (Wetzel, 2001).

Methods

Conductivity and temperature of surface water was measured at each of the survey sites using a Reed SD4307 data logging conductivity meter. Conductivity and temperature readings for each field survey site were collected in the field by placing the probe in the stream flow for a period of time averaging about 10 minutes until the conductivity and temperature values stabilized. Once readings had stabilized the data was recorded in the site data. Conductivity for this study is measured in micro-Siemens per centimeter (uS/cm). Distilled water has a conductivity in the range of 50 uS/cm. The conductivity of streams in Dumont Creek ranged from 62 uS/cm to 183 uS/cm. During the mid-October sampling period the weather was cool and dry with little to no precipitation. Stream flows were near or at low flow stage. The period of sampling extended from about 11:45 am to 2pm on a cool (10^{o}C) overcast day in later October. The change in stream temperature associated with diurnal heating during this period is likely to be minimal so that the steam temperature recorded by the conductivity meter likely represents relative differences in temperature between sample sites.

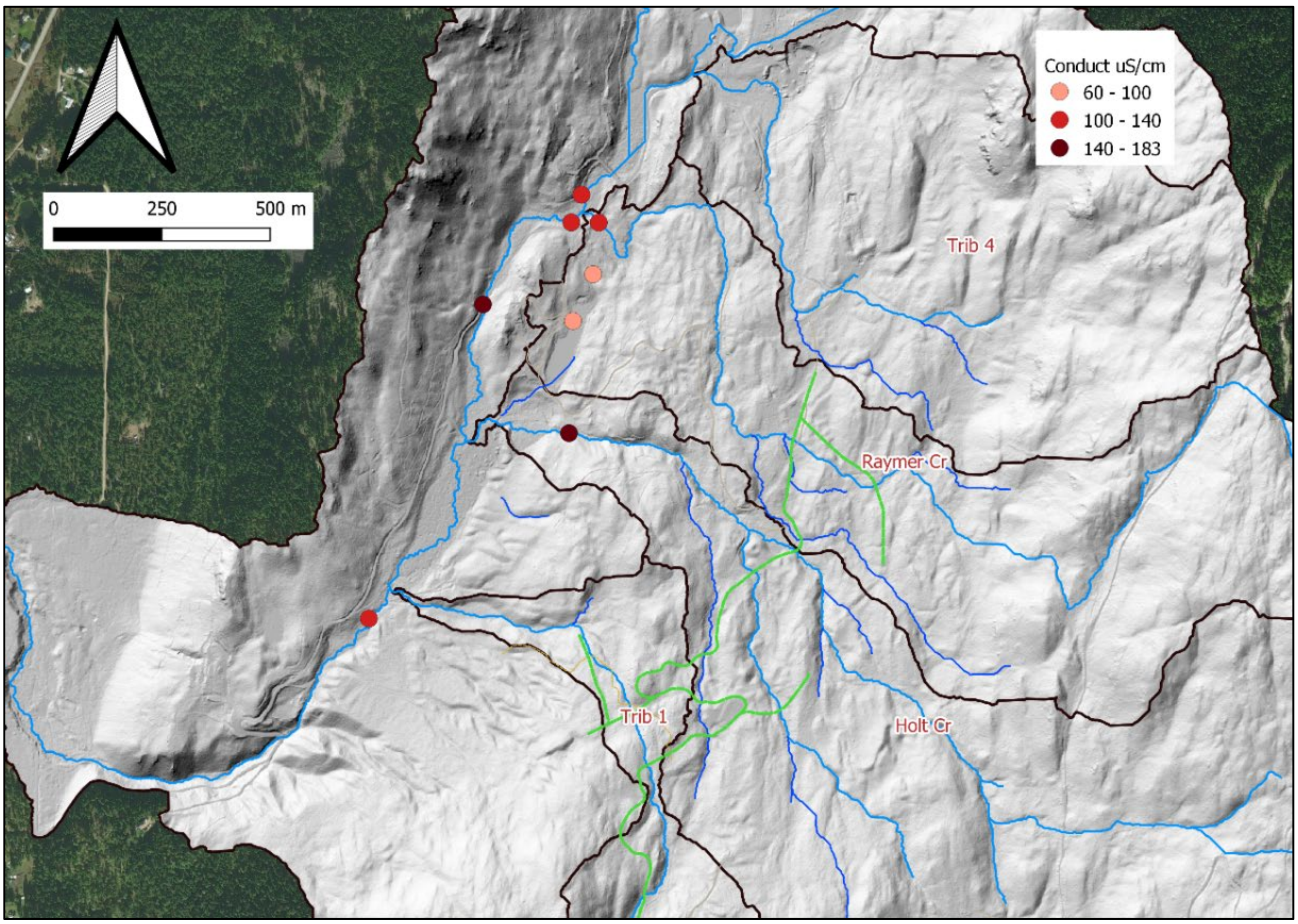

FIGURE 14. CONDUCTIVITY OF SURFACE WATER IN MICRO-SEIMENS PER CM (US/CM).

The surface water conductivity recorded in Dumont Creek indicates groundwater contribution in Holt Creek and the main channel of Dumont Creek below Rayner Creek. The decrease in conductivity in the downstream direction towards site Dt12 suggests input of surface flows into Dumont Creek – possibly from Trib 1 although this stream was not sampled for conductivity during the field investigation. The shallow lake at site Dt05 records a low conductivity of 62 uS/Cm and the low conductivity directly north confirms it drains northward via a subsurface route into the catchment of Rayner Creek.

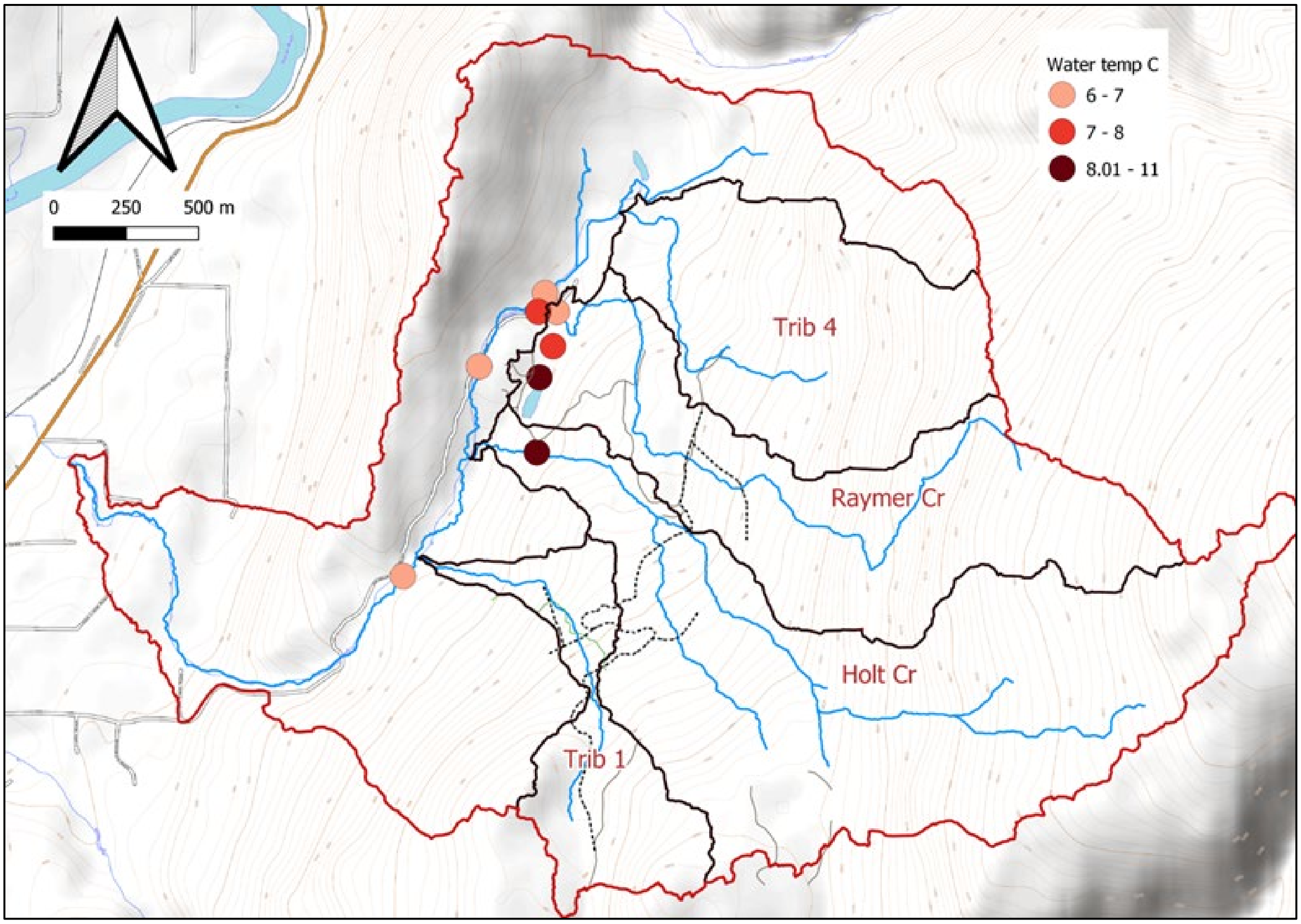

FIGURE 15. STREAM TEMPERATURE RECORDED FOR SURFACE FLOWS IN DUMONT CREEK

The distribution of stream temperature, recorded at the same time as conductivity confirms that Dumont Creek, during the low flow period of October experiences groundwater or hyporheic inflow along the main valley which contributes to cool stream temperatures (light pink, Figure 15). A difference of several degrees exists between Holt Creek and the shallow lake at Dt05 (dark red points, Figure 15) when compared with Dumont Creek mainstem (medium to light pink, Figure 15). Higher temperatures in Holt Creek stem from its steep gradient which creates warmth through turbulent flow and its predominantly west aspect watershed that receives a direct solar radiation throughout the day. Similarly, the shallow lake at Dt05 is heated by direct solar radiation through the day.

Discussion of Field Observations

Information from the field observations and survey data indicate that Holt Creek contributes most of the flow to Dumont Creek, particularly during peak flow months. Raymer Creek (named here for Raymer Spring) contributes roughly the same amount of flow to Dumont Creek as Dumont Creek above Raymer Cr confluence (which is mostly Trib 4). The seasonal variability in these northern tributaries is less than that observed in Holt Creek and in Dumont Creek below Holt Creek. During the low flow period Dumont Creek is supplied by groundwater that enters along the length of Paradise Valley and the lower reach of Raymer Creek as well as surface flows in Holt Creek and Trib 1.

Neither Raymer Creek nor Dumont above Raymer Creek display evidence of large peak flow events that mobilize bedload sediment. Upstream from Trib 1 confluence, much of Dumont Creek flows subsurface through glacial sediments and only carries surface flow during the spring freshet period.

Raymer Creek, although steep enough to host a debris flood in its upper reaches, lacks the volume of discharge necessary to mobilize debris and there is no field evidence that Raymer Creek has carried any floods in past centuries. The northern channel of Holt Creek which drains from the uppermost reaches (see Figure 2), shows indications of a debris-mobilizing flood that occurred at least 70 years ago, and a higher peak flow event in the last few years that scoured banks and mobilized gravel and small cobbles. Evidence of a higher peak flow event in the recent past was also observed as scoured banks and cobble deposits along the lower reach at site Dt08.

Dumont Creek below Dt12 shows evidence of more than one recent large flood event that has mobilized cobble-sized angular bedload and caused channel avulsion and bank erosion.

8. Assessment of Likelihood of harm to watershed values

The assessment of likelihood undertaken here follows the guidance contained in the document; Watershed Assessment and Management of Hydrologic and Geomorphic Risk in the Forest Industry (EGBC – ABCPF Joint Practices Board, January 2020, downloaded from; https://www.egbc.ca/getmedia/8742bd3b-14d0-47e2-b64d-9ee81c53a81f/EGBC-ABCFP-Watershed-Assessment-V1-0.pdf.aspx). The values of concern in Raymer, Holt and Dumont creeks include water quality and quantity at the intakes which are situated throughout Dumont Creek above Katasonoff Road. For this assessment the points of interest (POIs) are (1) the downstream extent of Dumont Creek below Katasonoff Spring, (2) Raymer Creek at the confluence, (3) Holt Creek at the confluence and (4) Trib 1 at the confluence. The harmful events of concern are;

- Changes in the frequency or magnitude of peak flows that could impact water quality,
- Increased sediment delivery that could impact water quality and,
- Increase in the duration of the low flow period.

These harmful events are assessed for current conditions relative to historical forested conditions and for proposed wildfire mitigation treatments relative to current conditions. The compounding effects of climate change are also considered in the assessment of harmful events.

Definition of Probability and Likelihood of an Event

The likelihood of an event that could cause harm to a Value is assigned a qualitative likelihood according to the criteria in Table 3. For this assessment, the likelihood of an event is assessed for current conditions relative to an undisturbed watershed as well as the potential for incremental increases in the likelihood of the event associated with the proposed wildfire treatment.

TABLE 3. QUALITATIVE LIKELIHOOD FOR A HARMFUL EVENT ADAPTED FROM LMH 61.

Qualitative likelihood	Description
Very high	A noticeable change in event is certain to occur
High	A noticeable change in event is likely to occur
Moderate	A noticeable change in event is possible to occur
Low	There is a small possibility of a change in the event but not noticeable
Very Low	There is a very remote possibility of a change in the event occurring

Current Conditions Relative to Fully Forested

Dumont Creek at Katasonoff Road

Changes in the Frequency/Magnitude of Peak Flows That Could Impact Water Quality

Forest disturbance can increase the frequency and magnitude of floods in snowmelt watersheds due to increased snow accumulation and faster snowmelt following removal of a forest canopy. The 'harmful' peak flow is in Dumont Creek assumed to be any overbank peak flow event that erodes channel banks and forest floor creating higher turbidity.

The current ECA in Dumont Creek for the watershed area upstream from Katasonoff Road indicated in Figure 11 is estimated at 118.8 hectares or 17.6% of the 673.8-hectare watershed. Most of the recent forest disturbance, which is due to beetle kill and subsequent harvesting, occurs at the higher elevations of Holt Creek above 1150 meters elevation where there is an estimated ECA of 57.8 hectares (Table 2). The 11-hectare opening in Trib 1 is also related to beetle kill and subsequent harvest. The forest disturbance in Raymer Creek and Trib 4 is primarily at the lower elevations below 850-meter.

Sentinel satellite imagery from 2018 to 2021 shows that for most years in Dumont watershed, the snow is absent from the slopes below about 850 to 900-meter elevation by mid- to late-April (Figure 16). This suggests peak flows are mostly driven by snowmelt runoff from slopes above about 850 metres elevation.

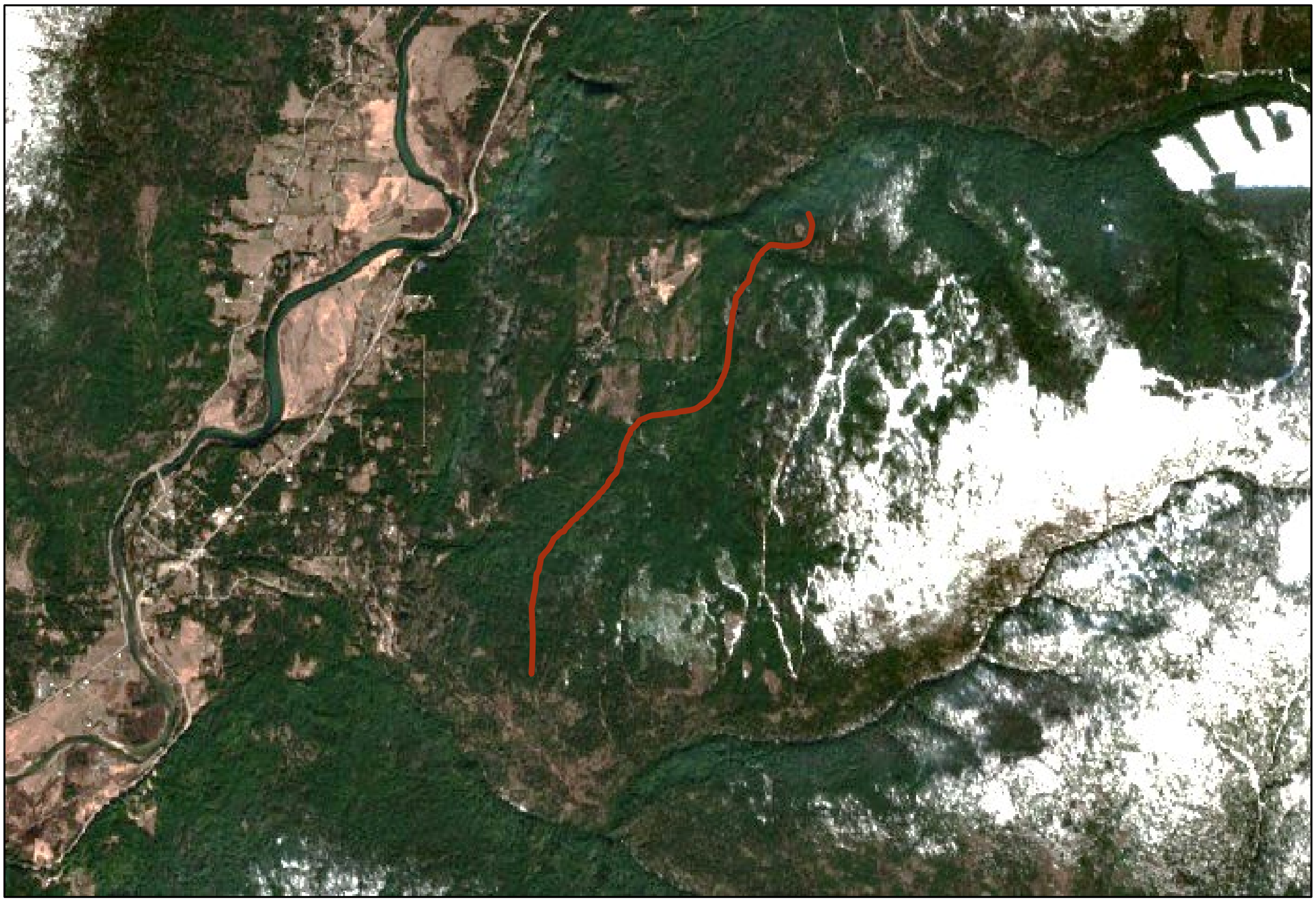

FIGURE 16. SENTINEL PLAYGROUND IMAGE FOR APRIL 14, 2021. SNOW IS ABSENT FROM SLOPES BELOW ABOUT 850M WHICH IS ROUGHLY DELINEATED BY RED LINE.

Holt Creek and Trib 1 subbasin contribute runoff to Dumont Creek immediately upstream from the two licensed PODs. Water quality/quantity issues in these two subbasins have the potential to directly influence water quality/quantity at the PODs. The cumulative ECA for disturbed forest in Holt Cr and Trib 1 is 68.8-hectares or 10.2% of the Dumont Creek watershed area. Most of this disturbance is situated in the upper elevations above 950 meters elevation (Figure 11).

Statistically significant, increases in the magnitude/frequency of overbank peak flows (i.e. return period greater than 2-years) are reported for a small (500 ha) watershed in the Okanagan when forest removal of approximately 20% occurs in the upper elevation regions (Schnorbus and Alila, 2013) however increases are not detectable for a level of disturbance of 10%. The field indicators of several relatively recent flood events in Dumont Creek below Dt12 could reflect the cumulative effects of forest disturbance from beetle kill and salvage harvesting in the upper elevations of Holt

Creek and Trib 1. The current ECA in Dumont Creek above the point of interest at Katasonoff Road is just under 18%. Based on the Schnorbus and Alila (2013) study Dumont Creek is currently assessed as having a Moderate likelihood of increased frequency of peak flows that could affect water quality.

INCREASES IN SEDIMENT DELIVERY THAT COULD IMPACT WATER QUALITY

Currently there is no indication of sedimentation associated with roads or forest disturbance upstream of the upper POD on Dumont Creek (Figure 1, below confluence of Trib 1). The only substantial sediment source noted during the field assessment was at the Paradise Valley Road crossing. The likelihood of increased sediment delivery associated with current forest disturbance in Dumont Creek is assessed as Low.

INCREASE IN THE DURATION OF LOW FLOW PERIOD

Forest openings concentrated on upper elevation, west aspect slopes such as in Dumont Creek can result in the advance of snowmelt runoff by two weeks or more depending on the characteristics of the forest stand. This advancement of runoff results in an earlier return to baseflows and, consequently, an increased duration of low flows. The relative change in the timing of runoff will increase with increasing canopy closure of the pre-disturbance stand. In upper Dumont Creek the forest stand that has been impacted by mountain pine beetle and salvage harvesting was predominantly a lodgepole pine stand that regenerated after early 1900s forest fire. The current area of forest disturbance in upper Dumont Creek is estimated at 63 hectares or 9.3% of the watershed area and the fact that the stand was predominantly lodgepole pine before the beetle infestation occurred, which tends to have a lower canopy closure compared to other conifer species, results in an assessment of a Low likelihood of increased duration of low flows in Dumont Creek.

RAYMER CREEK

CHANGES IN THE FREQUENCY/MAGNITUDE OF PEAK FLOWS THAT COULD IMPACT WATER QUALITY

The current ECA in Raymer Creek is estimated at 14.5 hectares or 13.2% of the 109.5-hectare catchment. The existing forest disturbance is due to beetle kill at the uppermost elevation and private land logging below 840m elevation (Table 2). Field observations showed no indication of high flow events in this catchment at the mid- or lower reaches. The likelihood of changes in the frequency/magnitude of peak flows related to current conditions is assessed as Low.

Increases in sediment delivery that could impact water quality

Currently there is no indication of sedimentation associated with roads or forest disturbance in Raymer Creek. The likelihood of increased sediment delivery at the POD associated with current disturbance is assessed as Low.

Increase in the duration of Low flow period

The limited area of forest disturbance in upper Raymer Creek and the fact that groundwater supplies flows for much of the year in this catchment results in an assessment of a Low likelihood of increased duration of low flows in Raymer Creek.

Holt Creek

Changes in the frequency/magnitude of peak flows that could impact water quality

The current ECA in Holt Creek is estimated at 57.8 hectares or 31.5% of the 183.5-hectare catchment. The existing forest disturbance is due to beetle kill and salvage harvest at the uppermost elevations. Field observations showed no indication of repeated high flow events in this catchment at the mid- or lower reaches. However, given the aspect and elevation distribution of the disturbed area, the likelihood of changes in the frequency/magnitude of peak flows related to current conditions is assessed as Moderate.

Increases in sediment delivery that could impact water quality

Currently there is no indication of sedimentation associated with roads or forest disturbance in Holt Creek. The likelihood of increased sediment delivery at the Holt Creek POD associated with current disturbance is assessed as Low.

Increase in the duration of Low flow period

Based on past studies (Schnorbus and Alila, 2013), the extent of forest disturbance in upper Holt Creek makes it likely that peak flows have advanced relative to pre-beetle disturbance conditions by two weeks or more. An assessment of a High likelihood of increased duration of low flows is applied to Holt Creek.

Trib 1 Subbasin

Changes in the frequency/magnitude of peak flows that could impact water quality

The current ECA in Trib 1 subbasin is estimated at 11 hectares or 25.4% of the 43.6-hectare catchment (Table 2). The existing forest disturbance is due to salvage harvest at the upper elevation of the subbasin. Field observations showed no indication of channel disturbance such as channel scour or a mobile bedload in this catchment. The likelihood of changes in the frequency/magnitude of peak flows related to current conditions is assessed as Low.

Increases in sediment delivery that could impact water quality

Currently there is no indication of sedimentation associated with roads or forest disturbance in Trib 1 channel. The likelihood of increased sediment delivery in Trib 1 associated with current disturbance is assessed as Low.

Increase in the duration of Low flow period

Trib 1 is a small, low elevation catchment in which the timing of snowmelt is likely to be highly variable from year to year. Low flows in Trib 1 appear to be supplied by groundwater. An assessment of a Low likelihood of increased duration of low flows is applied to Trib 1 stream.

Proposed harvested condition relative to current conditions

Dumont Creek at Katasonoff Road

Changes in the frequency/magnitude of peak flows that could impact water quality

Four wildfire interface treatment (WUI) areas are planned in Dumont Creek totaling 41.7 hectares which corresponds to a 6.2% increase in the current ECA to 23.8% or 160.5 hectares of the 673.8-hectare watershed (Table 2). Of the four areas, only openings 2 and 3, which represent slightly more than half of the treatment area (25 ha), are situated at an elevation that could potentially contribute runoff during the peak flow period (Figure 11). Openings 1 and 4 are situated below 850m elevation and are unlikely to contribute snowmelt runoff during peak flows. In most years snowmelt in openings 2 and 3 will also occur in advance of peak flows in Dumont Creek. Exceptions to this would be in years with high snowpacks and delayed spring snowmelt or in years when the peak flow occurs in response to an early season rain-on-snow event. The two WUI treatment areas that may influence peak flows in some years represent an increase in the current ECA in Dumont Creek of approximately 3.7%. An increase of 3.7% in the mid to lower elevation of the watershed is unlikely to affect the current Moderate likelihood of changes in the frequency/magnitude of peak flows that could impact water quality in Dumont Creek.

Increases in sediment delivery that could impact water quality

Information collected during the field survey by Will Halleran, L.Eng., P.Geo., determined that there are no terrain stability concerns associated with the planned WUI treatment areas. WUI treatments will not alter the current Low likelihood of increased sediment delivery assuming measures to limit road surface and ditch line erosion are implemented.

Increase in the duration of Low flow period

The early runoff of snowmelt from the mid to low-elevation wildfire treatment openings has the potential to slightly increase stream flows in Dumont Creek during March and early April but these openings will not influence the timing of the main peak flows which are determined by snowmelt from upper elevation slopes. Consequently, the WUI treatment will not affect the current Low likelihood of increased duration of low flows in Dumont Creek.

Raymer Creek

Changes in the frequency/magnitude of peak flows that could impact water quality

The proposed wildfire treatment increases the area of forest disturbance in Raymer Creek by 6.5 hectares to 19.2% of the catchment area. The logging will occur at elevations below about 950 meters. The WUI treatment will not alter the current Low likelihood of changes in the frequency/magnitude of peak flows in Raymer Creek.

Increases in sediment delivery that could impact water quality

Roads are planned in the Raymer Creek catchment as part of the harvest of block 3 directly upstream from the POD on Raymer Spring. An investigation of terrain conditions by Will Halleran did not identify concerns relating to terrain stability or soil erosion along the proposed road right-of-way. If measures are implemented to avoid intercepting and concentrating surface runoff on road and trail surfaces, the proposed WUI treatment will not affect the current Low likelihood of increased sediment delivery at the POD.

Increase in the duration of Low flow period

The area planned for forest harvesting in Raymer Creek is situated on low elevation slopes that do not contribute snowmelt during the peak runoff period in most years. For this reason the proposed WUI harvesting will not alter the current Low likelihood of increased duration of low flows in Raymer Creek.

Holt Creek

Changes in the frequency/magnitude of peak flows that could impact water quality

The proposed wildfire treatment increases the area of forest disturbance in Holt Creek by 14.8 hectares to 39.5% of the catchment area. The logging will occur at elevations below about 950 meters. The WUI treatment will not increase the current Moderate likelihood of changes in the frequency/magnitude of peak flows in Holt Creek.

Increases in sediment delivery that could impact water quality

Roads are planned in the Holt Creek catchment as part of the harvest of block 2 upstream from the POD on Holt Creek. An investigation of terrain conditions by Will Halleran did not identify concerns relating to terrain stability or soil erosion along the proposed road right-of-way. If measures are implemented to avoid intercepting and concentrating surface runoff on road and trail surfaces, the WUI treatment will not alter the current Low likelihood of increased sediment delivery at the POD.

Increase in the duration of Low flow period

The area planned for forest harvesting in Holt Creek is situated on low elevation slopes that do not contribute snowmelt during the peak runoff period in most years. The proposed WUI treatment will not alter the current High likelihood of increased duration of low flows in Holt Creek.

Trib 1 Subbasin

Changes in the frequency/magnitude of peak flows that could impact water quality

The proposed WUI treatment increases the area of forest disturbance in Trib 1 subbasin by 5.2-hectares to 16.2% of the 43.6-hectare catchment area. The logging will occur at mid-elevations. Low levels of snow accumulation in this watershed and runoff more related to groundwater results in the assessment that the WUI treatment will not increase the current Low likelihood of changes in the frequency/magnitude of peak flows in Trib 1 Subbasin.

Increases in sediment delivery that could impact water quality

Roads are planned in the Trib 1 subbasin as part of the harvest of block 2A. An investigation of terrain conditions by Will Halleran did not identify concerns relating to terrain stability or soil erosion along the proposed road right-of-way. If measures are implemented to avoid intercepting and concentrating surface runoff on road and trail surfaces, the WUI treatment will not alter the current Low likelihood of increased sediment delivery in Trib 1.

Increase in the duration of Low flow period

Low flows in Trib 1 appear to be groundwater sourced. The proposed WUI treatment will not alter the current Low likelihood of increased duration of low flows in Trib 1 subbasin.

Cumulative Effect of climate change on likelihood of harmful events

Downscaled global climate models for the Dumont Creek area were investigated using the PCIC Climate Explorer tool (https://services.pacificclimate.org/pcex/app/#/data/climo/ce_files) . The models for the RCP 8.5W/m^2 (worst-case) scenario suggest that total winter and spring precipitation is likely to increase (right graph, Figure 18) but that daily temperatures during the winter months will also increase by several degrees (left graph, Figure 17). As a result, by roughly 2070 Dumont Creek is projected to have a substantially lower snowpack and be predominantly rainfall dominated.

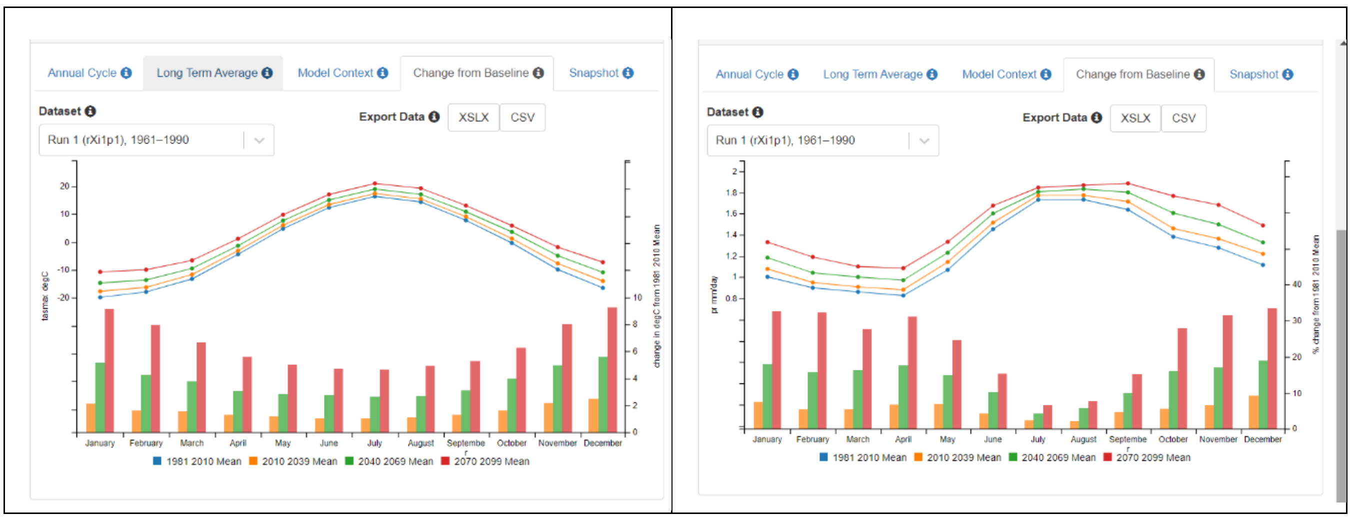

FIGURE 17. PROJECTED MAXIMUM DAILY TEMPERATURE ABOVE GROUND (LEFT) AND PRECIPITATION (RIGHT) FOR DUMONT CR AREA GIVEN RCP8.5 SCENARIO.

The transition to rainfall dominated from snowmelt dominated by 2070 will alter the forest's influence on stream flows in Dumont Creek. Currently forests function to decrease and delay snowmelt runoff compared to non-forested areas in the watershed. In a rainfall dominated system, forests intercept precipitation to a lesser extent. In addition, forests in rainfall areas may reduce annual water yield due to higher rates of evapotranspiration in spring and summer months. However, the trend to hotter drier summers is likely to increase the occurrence of forest fires, especially in Dumont Creek, which is a low elevation, west aspect watershed.

In Dumont Creek and Holt Creek projected climate change could reduce the assessed likelihood of harmful changes to the flow regime associated with forest disturbance at upper elevations but the increased likelihood of wildfire may result in the forests of this watershed burning like it did in the early 1900s which would extensively alter the hydrological processes in the watershed.

SUMMARY

As indicated in the discussion above, the current level of development, estimated at just under 18% ECA, represents a Moderate likelihood for increasing the frequency/magnitude of overbank peak flows in Dumont Creek. The planned wildfire treatment will not substantially alter this likelihood given that for most years the openings will be snow free prior to peak flows occurring in Dumont Creek. The planned wildfire treatment will not affect the current Low likelihood of increased sediment delivery or the Low likelihood of increased duration of low flows. There is a Moderate likelihood that the frequency/magnitude of peak flow in Holt Creek have increased and a High likelihood the timing of peaks has shifted to earlier in the freshet, effectively prolonging the low flow period in this catchment. The proposed forest harvesting, situated at low elevations will not alter the existing likelihood.

Climate change is projected to result in increased daily precipitation during the winter and spring months and increased daily temperatures. By 2070 Dumont Creek is projected to be a rainfall dominated watershed. The trend to hotter, drier summers results in an increase in the likelihood of wildfire. Managing forests to reduce the likelihood of wildfire in Dumont Creek could help to mitigate the long-term hydrological impacts of climate change.

9. LIMITATIONS

The accuracy of information provided in this assessment report is dependent on the accuracy of the data the analyses are based on. The LiDAR data for Dumont Creek is recent and high quality so the ECA analysis has a relatively high level of precision. The field observations are made using a strategic survey system that is meant to cover a range of sites over different scales and across elevations and aspects. In Dumont Creek field sites were focused in areas with stream flow. Historical flow data, that could contribute the information used to inform the assessment of likelihood for Dumont Creek is not available. The impact of activities other than forest harvest on private land were not considered in this assessment.

10. LITERATURE CITED

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HYDROLOGIC ASSESSMENT ASSURANCE STATEMENT – REGISTERED PROFESSIONAL

Note: This Statement is to be read and completed in conjunction with the *Professional Practice Guidelines – Watershed Assessment and Management of Hydrologic and Geomorphic Risk in the Forest Sector* and is to be provided for Watershed Assessments or Hydrologic Assessments.

To: [the client] Date: June 1, 2022

Erik Leslie, RPF

Slocan Integrated Forestry Cooperative

Name and designation

With reference to the following project area: Dumont Creek

Name and location of project area

The undersigned hereby gives assurance that he/she is a Registered Professional:

Name of Registered Professional: Kim C Green

Professional designation: Professional Geoscientist

Professional association: Engineers and Geoscientists of BC

I have signed, sealed and dated the attached

- ☐ Watershed Assessment report, or
- ☑ Hydrologic Assessment report

in general accordance with the Joint Professional Practice Guidelines – Watershed Assessment and Management of Hydrologic and Geomorphic Risk in the Forest Sector.

Kim C Green

Kim Green, P.Geo., PhD