

**MINISTRY OF FORESTS: POST-WILDFIRE NATURAL HAZARD RISK ANALYSIS**  
**ARGENTA CREEK - LEVEL 2 RECONNAISSANCE REPORT**

*NOTE: The results given on this form are reconnaissance in nature and are intended to be a warning of potential hazards and risks. A more detailed report will follow and may alter the conclusions. Please read the appendix of this report for important limitations. Contact the author for more information.*

<b>FIRE NUMBER:</b> N71058 Argenta Creek	<b>FIRE YEAR:</b> 2024	<b>DATE OF REPORT:</b> October 9, 2024
<b>AUTHOR:</b> Sarah Crookshanks, P.Geo., Ministry of Forests		
<b>REPORT PREPARED FOR:</b> Southeast Fire Centre, District Manager		
<b>FIRE SIZE, LOCATION, AND LAND OWNERSHIP:</b> 19,150 ha of provincially managed public land and private land from the Argenta Face north to Glacier Creek		

**VALUES AT RISK:**

1. Private residences
2. Domestic surface water quality and water intakes
3. Secondary roads
4. Forest Service Roads (Duncan FSR and Glacier Creek FSR)
5. Recreation sites
6. Earl Grey Trail (BC Parks)

<b>WATERSHEDS AFFECTED</b>	<b>TOTAL AREA</b> ***Further work may alter watershed and burned areas***	<b>AREA BURNED</b>	<b>BURN SEVERITY</b> (% of watershed area)
Argenta Creek	613 ha	365 ha (60%)	26% H, 26% M
Argenta Face Draw 1	238 ha	209 ha (88%)	40% H, 43% M
Hamill Creek	29,900 ha	6,840 ha (23%)	14% H, 8% M
Glacier Creek	27,900 ha	4,210 ha (19%)	12% H, 6% M

**SUMMARY OF POST-FIRE HAZARD AND RISK**

1. Hazard = P(H), the probability of occurrence of a hazardous event
2. Probability of spatial impact, P(S:H), the probability of a hazard reaching or affecting an element at risk
3. Partial Risk, the probability of a hazard occurring and affecting an element at risk = P(H) x P(S:H)
4. Location with the highest risk rating given; at other locations the risk may be lower

**Debris flow or clearwater flood on Argenta Creek impacting private residences, Argenta Road, secondary roads, and water licence works**

<b>Geohazard Event</b>	<b>Element at risk</b>	<b>Hazard P(H)<sup>1</sup></b>	<b>Probability of spatial impact P(S:H)<sup>2</sup></b>	<b>Partial Risk<sup>3,4</sup></b>
<b>Debris flow</b>	Private residences on the Argenta Bench	High	Low	Moderate
<b>Debris flow</b>	Argenta Road		Moderate	High
<b>Clearwater flood</b>	Argenta Road		High	Very High
<b>Debris flow</b>	Private residences along Argenta Johnsons Landing Rd		Low	Moderate
<b>Clearwater or sediment-laden flood</b>	Private residences along Argenta Johnsons Landing Rd		Moderate	High
<b>Debris flow</b>	Water licence works		High	Very High

Argenta Creek is a steep channel (average gradient of ~ 30%) that is subject to debris flows. The creek drains mountainous terrain on the west side of Mount Willet (>2,700 m). The channel gradient moderates to on average less than 20% as it flows onto an area referred to as the Argenta Bench (between 900 and 680 m elevation). Below the bench the channel steepens to >25% below Argenta Road dropping 120 m down to Kootenay Lake. According to residents, a natural debris slide occurred in the south fork of Argenta Creek in May 1997. The slide transitioned to a debris flow, depositing some of its material ~900 m upstream of Argenta Road where the channel gradient moderates and channel confinement decreases near the uppermost water diversion point. As the channel steepens below this site, a second phase of the initial event was initiated, transporting logs and debris 700 m further downstream and depositing the bulk of this material upstream of the Argenta Road crossing. Some sediment-laden water of this secondary flow was diverted south along an access trail for a water line, flowed through private property, along Wolfe Road, and then Argenta Road before almost reaching the lake at the Argenta Johnsons Landing Road. The debris flow did not impact the lower fan along the lakeshore.

The headwaters of Argenta Creek were burned at mostly high and moderate vegetation burn severity, but the riparian zones and gully sidewalls contain patches of low vegetation burn severity and the southern end of the watershed remains unburned. Given the moderate and high burn severity over the steep terrain in the headwaters, the likelihood of a post-wildfire debris flow in this watershed is rated as high.

Argenta Creek is well-confined through the Argenta Bench as it flows towards the lake. Around 900 m upstream of the road, the channel gradient moderates and it becomes slightly less confined, providing an opportunity for deposition of debris flow material. During the field review, evidence of historical debris flow events, in addition to the 1997 debris flow deposit, were observed at this location. One potential avulsion site is 250 m upstream of Argenta Road along the water line access road that leads to the south. The 1997 debris flow event resulted in sediment-laden water flowing along this access road, impacting private property and two secondary roads. The second potential avulsion site is at the Argenta Road crossing. The creek passes through the road in a 1,200 mm culvert covered with 3 m of fill on the upstream side and 5 m of fill on the downstream side. If a debris flow event reached this crossing, it would be expected to plug the culvert and some of the flow could be diverted down the Argenta Road on the south side of the creek (downhill gradient of 3-4%).

Due to the channel incision and the opportunity for deposition upstream of the Argenta Road, the likelihood of a debris flow spatially impacting a private residence and the secondary road on the Argenta Bench is rated as low and moderate respectively. The water licence works in the channel have a high likelihood of being spatially impacted by a debris flow. If a clearwater flood were to occur, the spatial likelihood of this event reaching Argenta Road is rated as high. The culvert capacity should be reviewed by Ministry of Transportation and Infrastructure, and regular inspection and maintenance undertaken particularly during high risk periods.

Argenta Creek drops from the bench to the lake, ending at a small fan at lake level. According to the Regional District of Central Kootenay (RDCK) mapping, three address points are located on this lower fan and the Argenta Johnsons Landing Road crosses the fan. According to residents, one house is occupied year-round on this fan, one is occupied seasonally, and the other has been abandoned. A debris flow much larger than the 1997 event has the potential to impact these properties; however, because the Argenta Creek channel gradient moderates across the bench allowing for deposition, the spatial probability of a debris flow event directly impacting these houses is rated as low. If a debris flow were to terminate upstream and a sediment laden flow continued downstream, this flow would have a moderate likelihood of impacting these residences. A clearwater flood event would also have a moderate likelihood of impacting these residences.

### ***Debris flow on Argenta Face Draw 1 impacting private residences***

Hazard  $P(H)^1$  = High      Probability of spatial impact  $P(S:H)^2$  = Low      Partial Risk<sup>3,4</sup> = Moderate

The draw to the north of Argenta Creek (*Argenta Face Draw 1* on the attached map) is also steep with an average channel gradient ~30%. While it drains over 200 hectares, no stream channel is visible at the base of the draw suggesting that any surface flow that may occur along this draw is ephemeral. A fan at the outlet of the draw on the Argenta Bench is visible on the lidar hillshade imagery. Evidence of previous debris flow events were observed on this fan in the field, though it is difficult to determine when they occurred. The watershed is almost entirely burned at moderate and high burn severity over steep terrain; therefore, the likelihood of post-wildfire debris flow is rated as high. Several structures on private property are located 200 m downslope from the fan apex, near the downslope fan boundary. Therefore, a geohazard event in this watershed is rated as having a low likelihood impacting private residences.

Field investigation as part of the forthcoming more detailed (level 3) assessment is recommended to better understand the soil burn severity, types of geohazard events that have occurred in the past, and probability of spatial impact to elements at risk.

### ***Debris flow or debris flood on Argenta Face Draws 2 or 3 impacting private residences or Argenta Road***

Hazard  $P(H)^1$  = Moderate to High      Probability of spatial impact  $P(S:H)^2$  = Low  
Partial Risk<sup>3,4</sup> = Low to Moderate

To the north of Argenta Creek Draw 1, two major draws are incised into the Argenta Face (*Argenta Face Draw 2 and 3*). These two draws have steep average gradients (~45%), which decrease to 20-30% as they meet the Argenta Bench. In Argenta Face Draw 2 (to the south) surface flow was observed where the draw crosses the fire guard during the field visit in early October. Evidence of overland flow and sediment transport was also observed in Argenta Face Draw 3 (to the north) as well as at a few other minor draws along this face where they cross the fire guard. Due to the terrain and the patchy burn severity across these face units, the debris flow or debris flood hazard in these draws is rated as moderate to high, pending further investigation.

RDCK mapping indicates several address points on the Argenta Bench downslope of Argenta Face Draw 2, and several more address points downslope of Argenta Face Draw 3. All structures appear to be near the downslope fan boundaries. Field investigation as part of a more detailed (level 3) assessment is recommended to confirm the dominant hazard, as well as the probability of spatial impact to houses and Argenta Road.

### ***Debris flow on Hamill Creek tributary impacting Earl Grey Trail***

Hazard  $P(H)^1$  = High      Probability of spatial impact  $P(S:H)^2$  = High      Partial Risk<sup>3,4</sup> = Very high

The Hamill Creek watershed burned at high burn severity, and numerous steep tributaries are composed of almost 100% high burn severity. In a rainstorm in mid-August debris flows occurred in several of these drainages, contributing debris and logs to the main channel. The Earl Grey trail traverses below terrain that has been severely burned and crosses numerous small debris-flow prone tributary channels to Hamill Creek. The likelihood of a post-wildfire debris flow is rated as high and the probability of spatial impact to the trail is also rated as high, resulting in a very high partial risk.

### ***Log jam flood on Hamill Creek impacting private residences or Forest Service Road***

Hazard  $P(H)^1$  = Moderate      Probability of spatial impact  $P(S:H)^2$  = Moderate      Partial Risk<sup>3,4</sup> = Moderate

A log jam in Hamill Creek has been identified 1.25 km up from the bridge. The log jam appears to have been in place since before the fire due to the condition of the wood at its downstream end, but additional fresh logs have been introduced to the log jam since the fire. The log jam is inaccessible due to its position in a

bedrock canyon. The new logs likely originated from several small debris flows that occurred in Hamill Creek tributaries in mid-August. This log jam has the potential to release suddenly, potentially causing flooding on the Hamill Creek fan. However, log jams such as this one occur frequently in natural systems, and can often be stable for many years. If there is significant ponding of water upstream of the jam, then an outburst flood has the potential to impact houses on the fan, and logs or debris in the flood would increase the risk of avulsion (i.e. the water being re-directed outside of the current channel).

The likelihood of a post-wildfire related log jam flood on Hamill Creek is rated as moderate. The Hamill Creek drainage burned multiple steep tributary drainages at high severity, which increases the likelihood of debris flows and thus the introduction of debris and logs to the Hamill Creek system. Further investigation will occur as part of a more detailed (level 3) assessment to confirm the likelihood of the hazard as well as the probability of spatial impact to private residences.

#### ***Flooding on Hamill Creek impacting private residences or Forest Service Road***

Hazard  $P(H)^1 = \text{Low}$     Probability of spatial impact  $P(S:H)^2 = \text{Moderate}$     Partial Risk<sup>3,4</sup> = Low

Hamill Creek is a flood prone channel that has experienced large floods in the past, most recently during a rainfall-induced flood in June of 2013. During the flood, private property adjacent to the creek sustained damage and the British Columbia Timber Sales bridge along Duncan Forest Service Road (FSR) approaches were washed away leaving the bridge. The Argenta Creek Fire burned 23% of the total watershed area, mostly at high burn severity. Spring peak flow in Hamill Creek occurs as snow is melting from mid and high elevations. The burned area is mostly at lower elevation. Any increase in flow from the burned area will therefore occur early in the melt season, before peak runoff in Hamill Creek. Given that the overall proportion of the watershed that has been burned is less than 30%, the incremental flood risk due to the fire is rated as low.

#### ***Landslide or flooding impacting private property along Glacier Creek FSR***

Hazard  $P(H)^1 = \text{Moderate}$     Probability of spatial impact  $P(S:H)^2 = \text{Moderate}$     Partial Risk<sup>3,4</sup> = Moderate

The slope above the private property at 100 Glacier Creek FSR was burned in the Glacier Creek Fire in 2022 at mostly low burn severity. The 2024 fire has resulted in more patches of moderate burn severity on the slope above the private property, particularly in the drainage area above the main dwelling. Despite base mapping showing several creeks that drain the private property, no stream channels were observed. The landowner confirmed in 2022 that there is no history of pre-wildfire overland flow impacting their private property, even during the spring runoff season. The patches of moderate burn severity above the private property have increased the likelihood of overland flow or instability; however, given the lack of history of surface water runoff at this site, the likelihood of a post-wildfire landslide has been rated as moderate.

#### ***Debris flow or debris flood on a Glacier Creek tributary impacting Glacier Creek FSR***

Hazard  $P(H)^1 = \text{Moderate}$     Probability of spatial impact  $P(S:H)^2 = \text{Moderate}$     Partial Risk<sup>3,4</sup> = Moderate

The Glacier Creek FSR is located on the northwest side of the creek for the first 9.5 km, and several small, ephemeral drainages drain the slopes above the road along this section. The burn severity along the slopes above the first section of the FSR is mostly composed of low and moderate burn severity, with small patches of high. Sections of this slope, particularly towards the intersection with MacBeth FSR, burned at high severity. There will likely be an increased likelihood of small debris flows or flooding along sections of road, particularly during intense rainfall or spring snowmelt.

#### ***Debris flow on a Duncan Lake tributary impacting Duncan FSR***

Hazard  $P(H)^1 = \text{High}$     Probability of spatial impact  $P(S:H)^2 = \text{High}$     Partial Risk<sup>3,4</sup> = Very High

Two steep unnamed drainages on the west side of Mount Lavinia burned almost entirely at 100% high severity. Two debris flows have already occurred on one drainage and impacted the FSR at 7.8 km (*Duncan*

Lake Tributary 1). Due to the high burn severity in these watersheds, the incremental post-wildfire hazard is rated as high. Duncan FSR crosses the fans of both drainages, and has a high probability of spatial impact, resulting in a very high partial risk. Further details on the risk to Duncan FSR will be provided as part of a more detailed (level 3) assessment.

**Flooding on Glacier Creek impacting Glacier Creek Regional Park and Campground**

Hazard P(H)<sup>1</sup> = Low      Probability of spatial impact P(S:H)<sup>2</sup> = Moderate      Partial Risk<sup>3,4</sup> = Low

The 2024 fire burned a small portion (19%) of the Glacier Creek watershed; therefore, the incremental impact of this fire to the flood risk to the campground on the fan is rated as low. The campground is located on the fan, mostly along the lower half of the fan. The probability of spatial impact is rated as moderate, though further field work is recommended to fully evaluate the potential for impact.

**FURTHER ACTIONS**

A more detailed (level 3) assessment for the Argenta Creek fire is recommended to verify the hazard and risk to private residences, infrastructure, roads, licensed water works, and drinking water quality.

Ministry of Transportation should review their infrastructure below the fire, particularly at the Argenta Creek crossing on Argenta Road. Regular inspection and maintenance is recommended, particularly during high risk periods such as during spring melt.

**COMMENTS**

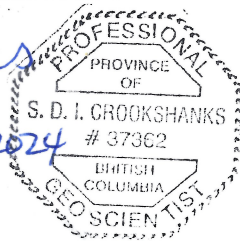
The Argenta Creek fire was discovered on July 18, 2024 and burned 19,150 ha of land between the Argenta Creek Face and the Glacier Creek valley. A helicopter overview of the fire was undertaken on August 7, 2024, and fieldwork in the Argenta area was performed on October 1, 2024.

All members of the public should avoid spending time in debris flow prone creek channels during or immediately after intense rainstorms, or during periods of rapid snowmelt. Further information can be found in the Debris Flow Hazard Awareness brochure, available on the RDCK website.

Episodic water quality impacts to surface domestic water users on sources originating from within the fire perimeter are anticipated. In the event of a debris flow or debris flood, water intake structures in channels have a high likelihood of being impacted. For their own safety, licensed water works users should not repair their intakes until it has been deemed safe to do so by a qualified registered professional. More detail on these risks will be included in the forthcoming more detailed (level 3) report.

**SIGNATURE, SEAL, FIRM PRACTICE #**

*S. Crookshanks*  
*October 19, 2024*



Sarah Crookshanks, P. Geo.  
Ministry of Forests  
Permit to Practice #1003022

Reviewed by: Gareth Wells, P. Geo

**ATTACHMENTS**

See attached map, photos and Appendix

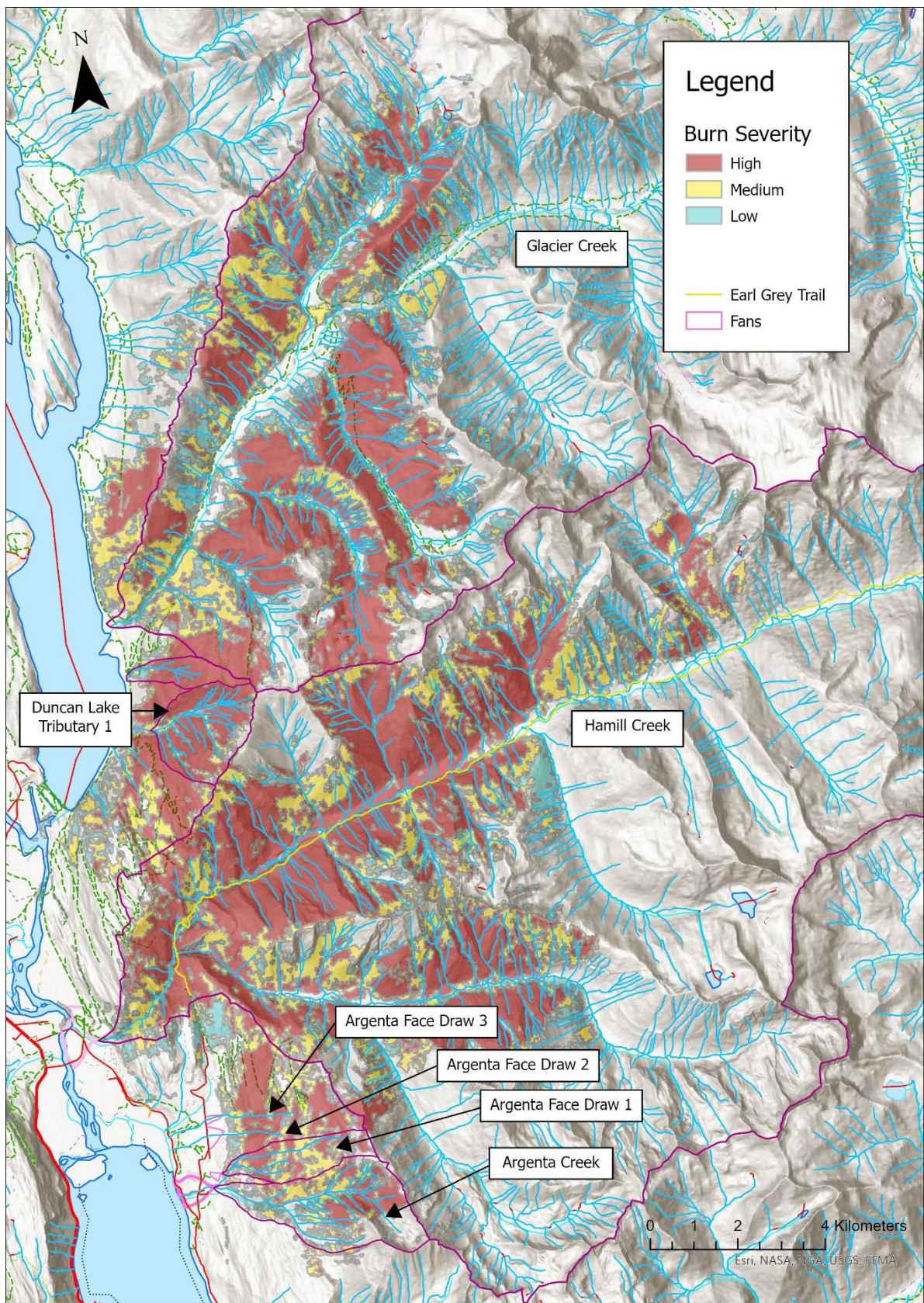


Figure 1. Burn severity map of the Argenta Creek fire showing estimated classes derived from Sentinel-2 imagery (prefire: July 7, 2024; post-fire: September 5, 2024). Further work may alter watershed boundaries and burn severity classes.



*Figure 2. Glacier Creek FSR just downstream of the confluence with Birnam Creek.*



*Figure 3. Argenta Creek and the Argenta Face (photo: Florence Lanouette, Sitkum Consulting Ltd.).*



*Figure 4. Hamill Creek tributary showing evidence of a debris flow from August (photo: Tedd Robertson, Sitkum Consulting Ltd.)*



## **Appendix to PWNHRA Reconnaissance Reports**

### **Scope of Reconnaissance (Level 2) Reports**

Reconnaissance (Level 2) reports are primarily intended to identify whether post-wildfire hazards are likely to occur and need detailed investigation to protect identified elements at risk. Identified elements at risk are generally limited to public safety and infrastructure. Reconnaissance reports may also be used to assess safety conditions for wildfire fighters. In some cases, the MOF District Manager or other MOF personnel may request assessments for non-standard elements at risk or for other reasons.

### **Definitions of Hazard and Risk**

Wildfire may produce conditions conducive to a suite of hazards. Debris flows, debris floods, and floods are often the most important hazards, but other types of landslide hazards including rockfall, debris slides and earthflows can also occur in response to wildfire. Wildfire can also cause snow avalanches and may affect water quality, cause erosion and result in sedimentation. Terrain, watershed, and channel conditions that produce post-wildfire hazards may also produce similar hazards in unburned conditions; these hazards may be mentioned but are not evaluated in this report.

P(H), P(S:H) and partial risk are presented for each identified elements at risk. Multiple types of channel hazards (debris flows, debris floods, floods) may affect an element at risk. These hazards are ranked by severity, with debris flow as the most damaging and destructive and flood as the least damaging and dangerous, and ratings are given for the highest rating hazard that may affect an element at risk. For example, where a channel has the potential for a debris flow and an element at risk may be affected, the lower ranking debris flood and flood hazards are not rated, since discharge and velocity are likely to be less than for a debris flow. These processes may cause erosion or sedimentation that affects the element at risk. Hazards that are unlikely to affect an identified element at risk are not discussed.

Table A1 shows the annual probability ranges for qualitative definitions of P(H). The probability of the hazard occurrence is for the post-wildfire period of elevated hazard, which in many cases may be less than five years, but in some cases may extend for several more years.

**Table A1. Qualitative descriptions of post-wildfire hazard likelihood, hazard criteria, and related quantitative probabilities.**

<b>Post-wildfire hazard rating</b>	<b>Description</b>	<b>Annual Probability Range</b>
Very High	An event is expected to occur. Most of the catchment or face unit has burned with a significant proportion burned at moderate and/or high severity	>0.2
High	An event is probable under adverse conditions. Most of the catchment or face unit has burned with a significant proportion (i.e., >50 %) of terrain conducive to post-wildfire natural hazard initiation burned at moderate or high severity. Existing indicators of pre-fire terrain instability within stream channels, on fans or face units.	0.01 - 0.2
Moderate	An event could occur under adverse conditions. It is not probable but possible over a several year period. More than 20% of the terrain conducive to post-wildfire natural hazards in the catchment or on the face-unit has burned with moderate and/or high severity. Historic geomorphic indicators of instability are present.	0.002 – 0.01
Low	An event could occur under very adverse conditions. It is considered unlikely over a several year period. Only a limited proportion of the catchment or face unit has burned. Few or no signs of pre-fire instability present along stream channels, fans or face units.	0.0004 – 0.002
Very Low	An event will not occur or is conceivable though considered exceptionally unlikely. A limited proportion/none of the catchment was burned. No terrain instability indicators are present	<0.0004

Table A2 defines spatial impact to an element of risk. Post-wildfire event magnitude is considered when rating spatial impact.

**Table A2. Post-wildfire spatial impact.**

<b>Likelihood of spatial impact</b>	<b>Description</b>	<b>Probability range</b>
<b>H</b>	It is probable that the event will impact the element at risk.	>0.5
<b>M</b>	It is possible that the event will impact the element at risk.	0.5 - 0.1
<b>L</b>	It is unlikely that the event will impact the element at risk.	< 0.1.

Table A3 is a matrix which combines the hazard likelihood (Table A1) with the spatial impact likelihood (Table A2) to determine partial risk.

**Table A3. Post-wildfire risk matrix partial risk matrix.**

Hazard Likelihood P(HA) (Table 1)	Spatial Impact Likelihood (P(S:H)) (Table 2)		
	High	Moderate	Low
Very High	Very High	Very High	High
High	Very High	High	Moderate
Moderate	High	Moderate	Low
Low	Moderate	Low	Very Low
Very Low	Low	Very Low	Very Low

### Report Standards

FLNRORD Land Management Handbook 69 is the primary standard followed in this report. LMH 69 describes the process to complete a detailed report. This reconnaissance report uses the framework of LMH 69 but does not follow it where detailed assessment procedures are described.

**[Land Management Handbook 69 Post Wildfire Natural Hazards Risk Analysis in British Columbia 2015](https://www.for.gov.bc.ca/hfd/pubs/Docs/Lmh/Lmh69.htm)**  
<https://www.for.gov.bc.ca/hfd/pubs/Docs/Lmh/Lmh69.htm>

Additional guidance is provided in the MOF SOG for PWNHRA and the 2014 FLNRO Landslide Risk Management Procedure.

Other professional guidance standards that may be used for the preparation of reconnaissance reports are listed below. These guidelines have similar report content to this reconnaissance assessment, but are for different purposes, have different levels of appropriate effort, and do not recognize the potential emergency nature of this reconnaissance assessment. These guidelines include:

**EGBC Guidelines for TSA in the Forest Sector 2010**  
<https://www.egbc.ca/getmedia/684901d7-779e-41dc-8225-05b024beae4f/APEGBC-Guidelines-for-Terrain-Stability-Assessments.pdf.aspx>

**EGBC Guidelines for Legislated Landslide Assessments 2010**  
<https://www.egbc.ca/getmedia/5d8f3362-7ba7-4cf4-a5b6-e8252b2ed76c/APEGBC-Guidelines-for-Legislated-Landslide-Assessments.pdf.aspx>

**Legislated Flood Assessments in a Changing Climate in BC 2018**  
<https://www.egbc.ca/getmedia/f5c2d7e9-26ad-4cb3-b528-940b3aaa9069/Legislated-Flood-Assessments-in-BC.pdf>

**Watershed Assessment and management of hydrologic and geomorphic risk in the Forest Sector**  
<https://www.egbc.ca/app/Practice-Resources/Individual-Practice/Guidelines-Advisories/Document/01525AMW2ATQA5BSODHJAKBAGZDYTRL6FJ/Watershed%20Assessment%20and%20Management%20of%20Hydrologic%20and%20Geomorphic%20Risk%20in%20the%20Forest%20Sect>

Other standards may also apply, depending on the professional qualifications of the writer.

### **Statement of Limitations**

Reconnaissance PWNH Level 2 assessments are typically done in constrained timelines where personnel, resources, data collection, and analysis methods are limited. Post-wildfire hydrogeomorphic hazards in BC are not well understood and therefore hazard and risk assessments are estimates only. While probabilities ranges are given in Tables A1 and A2, the state of the science in BC does not allow for precise assessments, particularly near the borders of classes. Numeric probabilities ranges do not imply precision.

Identification of elements at risk relies on BC government data layers, satellite imagery, and perhaps an overview flight. BCWS and the MOF district office may provide additional information. No further confirmation of elements at risk was conducted.

Comments, conclusions, and suggestions contained in this reconnaissance assessment reflect my experience and judgement considering the information available to me at the time that this report was prepared and are considered appropriate for the reconnaissance nature of the review. The review has been carried out in accordance with generally accepted professional practices. This assessment and its contents are intended for the sole use of post-wildfire hazard management by provincial agencies, First Nation governments and local governments. I do not accept any responsibility for the accuracy of any of the data, the interpretation, or the conclusions contained or referenced in the report when the report is used or relied on for any other purpose than specified. Any such unauthorized use of this report is at the sole risk of the user.