MINISTRY OF FORESTS: POST-WILDFIRE NATURAL HAZARD RISK ANALYSIS

NEMO 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. It is not a detailed risk analysis and further work may alter the conclusions. Please read the appendix of this report for important limitations. Contact the author for more information.

FIRE NUMBER: N51103 Nemo Creek and N51228	**FIRE YEAR: 2024**	**DATE OF REPORT:** December 19, 2024

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REPORT PREPARED FOR: Southeast Fire Centre, District Manager

FIRE SIZE, LOCATION, AND LAND OWNERSHIP: 5980 ha on provincially managed public lands on the west shore of Slocan Lake (N51103). This fire was mostly contained within Valhalla Provincial Park. An additional 234 ha was burned within Valhalla Provincial Park in the Nemo Creek drainage (N51228).

VALUES AT RISK:

1. Private residences
2. BC Parks campsites
3. Domestic surface water quality

WATERSHEDS AFFECTED	**TOTAL AREA**	**AREA BURNED**	**BURN SEVERITY** (% of watershed area)
Wee Sandy Creek	5543 ha	970 ha (17%)	3% High, 7% Moderate
Sharp Creek	1291 ha	117 ha (9%)	0.5% High, 4% Moderate
Nemo Creek	7009 ha	727 ha (10%)	2% High, 5% Moderate
Cove Creek	302 ha	147 ha (49%)	1% High, 27% Moderate

SUMMARY OF TERRAIN CONDITIONS AND THE EFFECTS OF THE FIRE

The Nemo Creek fire was discovered on July 18, 2024, and burned almost 6000 ha of land on the west shore of Slocan Lake extending from Cove Creek north up to Wee Sandy Creek (Figure 1). A second fire in the Nemo Creek drainage (N51228) was discovered the same day and burned 234 ha in that watershed. Helicopter reconnaissance flights were undertaken on August 7 and August 23, followed by field work along the Slocan lakeshore on October 31.

The vegetation burn severity map for N51103 was adjusted based on aerial photos, as the bedrock outcroppings show artificially high burn severity. The breakpoint between moderate and high burn severity classes was lowered, resulting in some high vegetation burn severity areas being adjusted down to moderate. Due to access challenges, no field work was undertaken to evaluate soil burn severity.

The Nemo Creek fire is located between lake level at 550 m up to the alpine (>2000 m). Nemo Creek and Wee Sandy Creek are large (5000-7000 ha) u-shaped valleys that drain alpine terrain within Valhalla Provincial Park. Two smaller (~1000 ha) streams, Hoben Creek and Sharp Creek, also drain alpine terrain. The burned area includes large areas of exposed bedrock overlain in places by a thin veneer of colluvium.

The BC Freshwater Atlas includes several channel and watershed delineation errors for the area west of Slocan Lake. The Atlas shows an unnamed creek adjacent to the Cory's Ranch campsite. No channel or surface expression of flow was identified in the field during the field assessment. A seep along the lakeshore was noted north of the campsite; however, no surficial channel was identified upslope of the spring. The Sharp Creek watershed is also incorrectly delineated. The outlet of the creek was observed in the field several hundred metres to the north of where it is mapped. The watershed area and creek were redrawn in ArcGIS and what is shown in Figure 1 reflects what was observed in the field.

Potential post-wildfire natural hazards include flooding, debris floods, debris flows, landslides, and rockfall. Over the first few years after a fire, hazardous events such as debris floods and flows are typically triggered by short-duration, high intensity (i.e. convective) rainfall threatening elements located on alluvial fans near or in the valley bottom. Debris flows and floods can also occur during spring runoff because of rapid snowmelt in burned areas, or less frequently during fall rain events. Due to changes in snow accumulation and melt processes, elevated flows during spring freshet or summer low flow periods may persist for many years until the forest canopy closure recovers.

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 flood or clearwater flood on Wee Sandy Creek impacting campsites

Geohazard Event	Element at risk	Hazard P(H)[1]	Probability of spatial impact P(S:H)[2]	Partial Risk[3,4]
Debris flood	Campsites	Low	Moderate	Low
Clearwater flood	Campsites	Low	Moderate	Low

Wee Sandy Creek drains extensive areas of alpine terrain up to 2700 m in elevation around Mount Meers and Mount Niord and Mount Denver. The fire extended approximately 7 km up the watershed impacting the lower half of the catchment. The majority of the alpine terrain remained unaffected by the fire. Below 1400 m, the channel gradient of the main channel is 19% and moderates to 6%, before steepening to 13% as the channel drops to lake level over the last 1.5 km. The Melton ratio (watershed relief divided by the square root of the watershed area) has been shown to reasonably predict the dominant hydrogeomorphic hazard; for Wee Sandy Creek, the Melton ratio is 0.07, which suggests that the channel is prone to experiencing clearwater floods. The watershed was 17% burned (10% at high and moderate burn severity). The wildfire area is limited to the lower elevation (eastern) half of the watershed. Any increase in flow from the burned area will therefore occur early in the melt season, before peak runoff in Wee Sandy Creek. Given that the overall proportion of the watershed that has been burned is less than 20%, the incremental clearwater flood risk due to the fire is rated as low.

The watersheds of two potentially debris-flow prone tributaries that drain from the south into Wee Sandy Creek were >50% burned at moderate and high burn severity. It is anticipated that a post-wildfire debris flow from one of these channels will be diluted once it hits the mainstem, potentially transitioning to a debris flood that may affect the campsites on the fan. The distance between where the tributaries enter the mainstem and Slocan Lake is just over 2 km and channel gradients in the mainstem are insufficient for debris flows to be continue to Slocan Lake. Furthermore, no debris flow deposits were observed on the fan. The likelihood of a debris flow in a tributary to Wee Sandy has been rated as moderate, because historical satellite imagery or airphotos do not show a high degree of historical channel activity and the headwaters of these two channels remain unburned. The likelihood that a debris flow from these tributaries will be transported as a debris flood down to the Wee Sandy fan has been rated as low; deposition along the mainstem channel is possible given the channel gradient (<10% steepening to 13%) and the Wee Sandy Creek drainage area is large enough to allow for significant dilution particularly during periods of high flow.

Four tent pads are located on the fan of Wee Sandy Creek. These tent pads are near the channel, though not directly in an avulsion path or immediately adjacent to channel. Therefore, the probability of spatial impact has been rated as moderate.

Two tent pads at the south end of the campground are located below a rock bluff. The rock bluff area has been affected by the fire; therefore, the likelihood of rock detachment may be elevated for the next several years. I recommend not rebuilding these tent pads for several years to discourage camping in this area.

Debris flow on Sharp Creek impacting campground

Hazard P(H)[1] = Low Probability of spatial impact P(S:H)[2] = Moderate Partial Risk[3,4] = Low

Sharp Creek drains a 1300 ha watershed that includes the small (17 ha) New Denver Glacier. The watershed is only 1% glaciated, and glacial melt is assumed to be a minor contributing factor to the creek's annual hydrograph. Sharp Creek appears to be a debris flow prone channel. The fan gradient is 14%, and debris flow lobes and levees were observed on the fan. It is challenging to determine when these events occurred, though none of the deposits appear to be recent (i.e. within the last 100 years). Only 9% of the watershed was burned in the fire, and less than 5% at moderate and high burn severity; therefore, the hazard has been rated as low.

The campground is located south of the channel on the Sharp Creek fan, though none of the sites are located immediately adjacent to the stream channel or within a defined avulsion channel. For these reasons, the probability of spatial impact is rated as moderate.

Debris flood or flooding on Nemo Creek impacting private residences or campsites

Geohazard Event	Element at risk	Hazard P(H)[1]	Probability of spatial impact P(S:H)[2]	Partial Risk[3,4]
Clearwater flooding	Campsites	Low	Low	Very Low
Debris flood	Campsites	Low	Low	Very Low
Clearwater flooding	Cabin	Low	Moderate	Low
Debris flood	Cabin	Low	Moderate	Low

Nemo Creek is a large (>7000 ha) flood-prone creek that drains alpine terrain up to 2600 m. The channel gradient of the mainstem of the creek range from 4-7% until dropping the final 3.5 km to lake level at a gradient of 14%. Only 10% of the watershed area was burned, though the burn is composed mostly of moderate and high burn severity (Figure 2). Given the low proportion of the watershed that was burned, the incremental increase in the likelihood of post wildfire clearwater flooding has been rated as low.

A tributary that could be susceptible to debris-flows drains from the north into Nemo Creek and was burned mostly at high to moderate severity (Figure 3). The distance between where the tributary enters the mainstem and Slocan Lake is 3.5 km. The headwaters of this tributary are composed of unburned bedrock cliffs. If a debris flow were initiated in this drainage, the most likely scenario would be that the flow would be diluted once it converges with Nemo Creek, transitioning to a debris flood. If Nemo Creek discharge was at flood stage near its annual maximum, the debris flow may be further diluted into a clearwater flood. The likelihood of a debris flow event in this tributary has been rated as moderate, because while over 70% of the watershed has been burned at moderate/high severity, the headwaters remain unburned. The likelihood that a debris flow this tributary will be transported as a debris flood down to the Nemo Creek fan has been rated as low; deposition along the mainstem channel is possible and the Nemo Creek drainage area is large enough to allow for significant dilution particularly during periods of high flow.

The campsites at Nemo Creek are located to the north of the channel and a cabin on private property is located on the fan to the south of the channel (Figure 4). The channel through the upper portion of the fan is incised, where the bank height to the north is 6.5 m and to the south is 2 m. Therefore, the probability of an event (flood or debris flood) impacting the cabin or the campsites has been rated as moderate and low, respectively.

Water quality impacts to surface domestic water user on Nemo Creek

Hazard P(H)[1] = Low Probability of spatial impact P(S:H)[2] = High Partial Risk[3,4] = Moderate

There is one domestic water licence on Nemo Creek (Appendix 2). Given the low proportion of watershed burned, the likelihood of water quality impacts has been rated as low. Any water quality impacts are expected to be highly episodic.

Flooding on Cove Creek impacting campsites

Hazard P(H)[1] = Moderate Probability of spatial impact P(S:H)[2] = Low Partial Risk[3,4] = Low

Cove Creek is a small (300 ha) watershed that drains terrain up to 2200 m elevation. The watershed has a Melton ratio of 0.97, which indicates that the terrain may be susceptible to debris flows. However, no evidence of fan formation or debris flow deposits was observed at the creek's outlet. The channel bed is composed of cobbles and gravel where it flows into the lake. Based on field observations at the outlet into Slocan Lake and watershed morphometrics, the creek is likely flood-dominated. Approximately 50% of the watershed was affected by fire, with the majority of the burned area experiencing low to moderate burn severity. Due to the proportion of the watershed that was burned, the incremental increase in the post-wildfire flooding hazard is rated as moderate.

The campsites at Cove Creek are located north of the creek channel. Most are located on an elevated bench above the channel and lake and are not at risk of flooding from Cove Creek. One campsite is located on the beach, but this site is located well north of the channel with no risk of avulsion from Cove Creek. The probability of spatial impact is thus rated as low.

COMMENTS

There are approximately eight seasonal cabins on private land that are located north of Hoben Creek and the Sandy Point campground. These cabins are located below a rock bluff area that was burned at moderate severity. Numerous rocks were observed on the land surrounding the two northernmost cabins (one of which was burned in the fire), which indicates that rockfall has historically impacted the area and likely presents an ongoing hazard (Figure 5). Due to private land access restrictions, it was not possible to assess if any recent rockfall has occurred during or since the fire and no detailed assessment of the spatial distribution of the rockfall was undertaken. Additional lots further to the south may also be at risk. Affected residents may wish to hire a technical specialist to undertake a more detailed assessment to better understand the natural hazards which may impact their properties.

The increase in rockfall hazard after wildfire is typically due to the removal of vegetation or fallen logs that were supporting loose rocks. Thermal expansion and exposure can also make rocks more susceptible to detachment and increase the likelihood of rockfall during and after rainfall or freeze-thaw. The highest frequency of rockfall is typically seen during or immediately after the fire, and declines in subsequent years.

FURTHER ACTIONS

BC Parks may want to consider not-rebuilding or temporarily decommissioning two tent pads near the south end of the Wee Sandy Creek that are located below a rock bluff.

SIGNATURE, SEAL, FIRM PRACTICE #

SCrookshanks
December 19, 2024

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ATTACHMENTS

See attached map, photos and Appendices

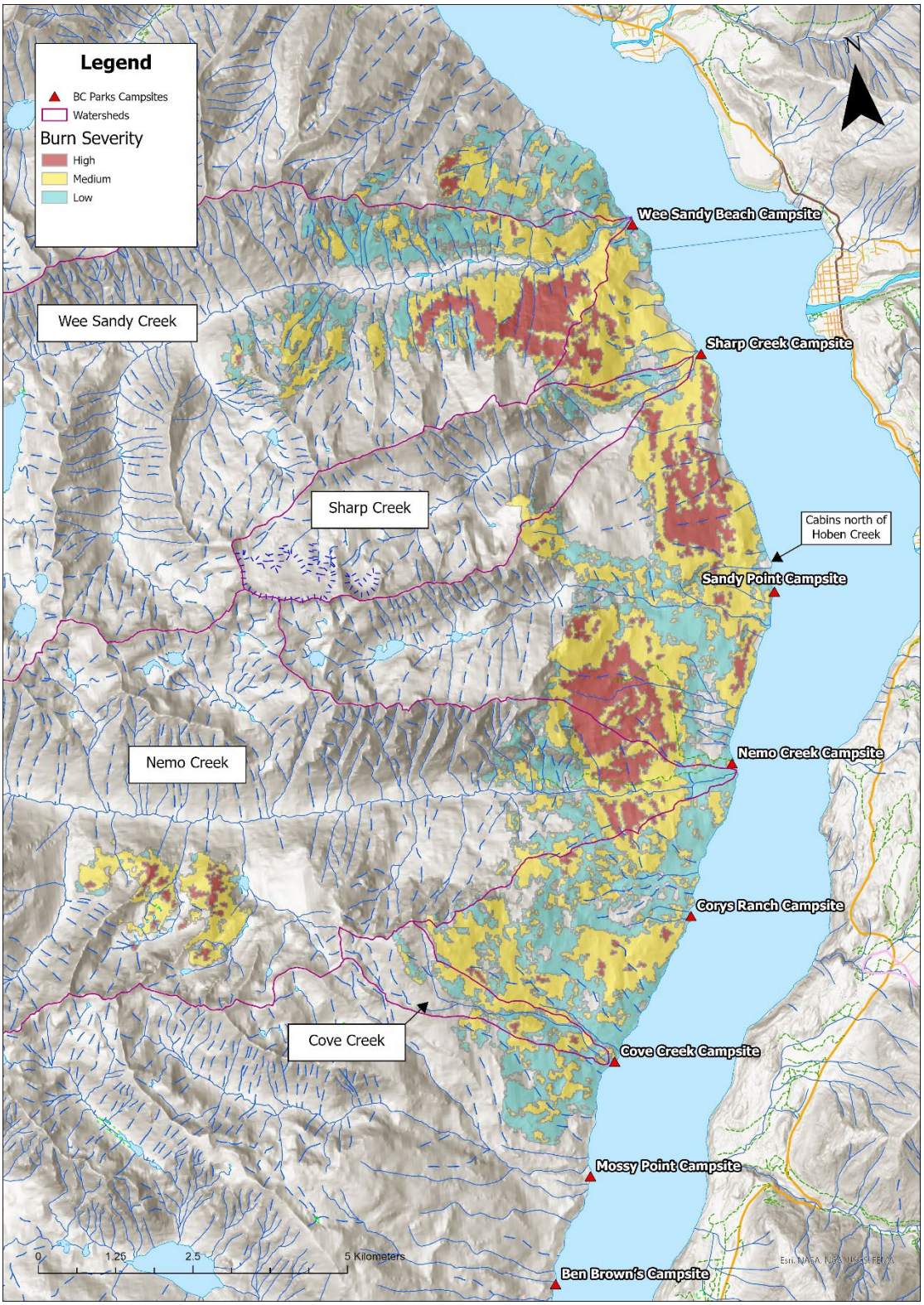

Figure 1 Burn severity map of the Nemo Creek fire showing estimated classes derived from Sentinel-2 imagery (prefire: July 7, 2024; post-fire: September 5, 2024). Burn severity classes were modified based on aerial photographs to correct for the high reflectance from bedrock outcropping areas.

Figure 2. Looking upstream at the Nemo Creek valley.

Figure 3. Potentially debris-flow prone tributary to Nemo Creek.

Figure 4. Nemo Creek fan (Photo: Ryan Williams, SNT Geotechnical)

Figure 5. Private cabins below a rock bluff north of Hoben Creek.

Appendix A 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.

Post-wildfire hazard rating	Description	Annual Probability Range
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.

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

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.

Appendix B Water Licence Holders

Source Name	Licence #	Client Name	Client Address	Purpose Use
Nemo Creek	C51695	LaPointe Fiduciary Management	In Trust, PO Box 4995, Jackson WY 83001, USA	Domestic
Nemo Creek	C51898	LaPointe Fiduciary Management	In Trust, PO Box 4995, Jackson WY 83001, USA	Power (residential)