

MINISTRY OF FORESTS: POST-WILDFIRE NATURAL HAZARD RISK ANALYSIS
MULVEY 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: N51117 Mulvey Creek	FIRE YEAR: 2024	DATE OF REPORT: November 14, 2024	
AUTHOR: Sarah Crookshanks, P.Geo., Ministry of Forests			
REPORT PREPARED FOR: Southeast Fire Centre, District Manager			
FIRE SIZE, LOCATION, AND LAND OWNERSHIP: 2235 hectares of provincially managed public land, mostly within Valhalla Provincial Park, and private land southwest of the Village of Slocan.			
VALUES AT RISK:			
<ol style="list-style-type: none"> 1. Private residences 2. Mulvey Creek Road and Little Slocan Road North 3. Licensed water diversion structures 4. Water quality impacts to the Village of Slocan water supply 5. Evans Creek trail (BC Parks) 			
SUMMARY OF TERRAIN CONDITIONS AND THE EFFECTS OF THE FIRE:			
<p>The Mulvey Creek fire was discovered on July 18, 2024, and burned over 2000 ha of land on the rocky terrain to the west of the Village of Slocan. The fire is located between 540 m and 2000 m and burned an area extending from Mulvey Creek north to Slocan Lake. Both Gwillim and Mulvey Creek are u-shaped valleys that drain alpine terrain within Valhalla Provincial Park. The southeast facing slopes south and north of Mulvey Creek include large areas of exposed bedrock overlain in places by a thin colluvium. Aerial reconnaissance was completed on August 23, 2024, and field work was completed on October 11, 2024.</p> <p>The vegetation burn severity map 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. Given the lack of access above elements at risk, no field work was undertaken to evaluate soil burn severity.</p> <p>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.</p> <p>Wildfire impacts to the pre-existing rockfall hazard above the Village of Slocan waterworks is being assessed separately by the Regional District of Central Kootenay (RDCK).</p>			
WATERSHEDS AFFECTED	TOTAL AREA	AREA BURNED	BURN SEVERITY (% of watershed area)
<i>Gwillim Creek</i>	7895 ha	553 ha (7%)	0.5% H, 3% M
<i>Mulvey Creek</i>	2666 ha	184 ha (7%)	0% H, 4% M
<i>Unnamed Creek 1 (above Mulvey Crk Rd)</i>	339 ha	59 ha (17%)	0% H, 11% M
<i>Unnamed Creek 2 (above Mulvey Crk Rd)</i>	145 ha	88 ha (61%)	0% H, 50% 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 = $P(H) \times P(S:H)$
- 4: Location with the highest risk rating given; at other locations the risk may be lower

Debris flow on Unnamed Creek 2 above Mulvey Creek Road impacting private residences, secondary road or licensed water diversion structure

Geohazard Event	Element at risk	Hazard $P(H)^1$	Probability of spatial impact $P(S:H)^2$	Partial Risk ^{3,4}
Debris flow	Private residences	Moderate	Moderate	Moderate
Debris flow	Mulvey Creek Road		Moderate	Moderate
Debris flow	Water diversion structure		High	High

Multiple small (<0.5 m width) channels drain the slope above Mulvey Creek Road, though not all are mapped in the provincial freshwater atlas. The slope has many bedrock outcroppings, and irregular topography. The unnamed channel that was most affected by the fire (*Unnamed Creek 2 above Mulvey Creek Road* on Figure 1) crosses Mulvey Creek Road several times and flows near several residences located on the Mulvey Creek Land Cooperative lot (PID 023-527-714). The overall proportion of this watershed that burned is 61%, and the headwaters were burned almost entirely at moderate burn severity. The channel gradient is steep (averaging ~ 45%) in the headwaters, and moderates to an average gradient of 17% before reaching any elements at risk. Given the proportion moderate vegetation burn severity in the watershed (50%), the likelihood of a post wildfire debris flow is rated as moderate.

Evidence of historical debris flow deposits (levees, avulsion channels) was observed within Valhalla Provincial Park ~300 m upslope of the private land. 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). In this same area, there were several lower gradient (~10%) unconfined reaches where deposition of a debris flow could occur. A water diversion structure is located 225 m above Mulvey Creek Road. If a debris flow were to occur on this creek, the most likely scenario would be that the bulk of the material would be deposited upslope of Mulvey Creek Road, impacting the water diversion structure. A sediment laden flow could continue downstream, potentially affecting houses and Mulvey Creek Road. As such, the probability of spatial impact to the houses and road is rated as moderate.

Debris flow on Unnamed Creek 1 above Mulvey Creek Road impacting private property

Hazard $P(H)^1$ = low Probability of spatial impact $P(S:H)^2$ = low Partial Risk^{3,4} = very low

The watershed of the *Unnamed Creek 1 above Mulvey Creek Road* (see Figure 1) was 17% burned, mostly at moderate burn severity. Due to the minor proportion of the watershed burned, the likelihood of a debris flow event in this drainage is rated as low. The property at 7613 Little Slokan FSR is the only private lot located near this creek. The building(s) on this lot appear on satellite imagery to be located close to valley bottom. The channel and elements at risk were not assessed in the field due to the private land access limitations. The terrain is similar to the adjacent *Unnamed Creek 2*, where the creek channel gradient gradually flattens approaching valley bottom allowing for deposition of debris flow material, upslope of elements at risk. For this reason, the probability of spatial impact is rated as low.

Water quality impacts to Village of Slokan water supply

Hazard $P(H)^1$ = very low Probability of spatial impact $P(S:H)^2$ = high Partial Risk^{3,4} = low

The Gwillim Creek watershed was only 7% burned; therefore, the likelihood of post-wildfire induced water quality impacts has been rated as very low. One potential source of post-wildfire sediment in the watershed is a patch of high vegetation burn severity on the west side of the creek approximately 3 km upstream from the outlet (Figure 4). This area is located on steep ground, and increased overland flow may be generated

from this slope. The stream channels that drain this patch of high burn severity are rocky with limited sediment availability, reducing the likelihood of sediment bulking contributing to the volume. While channel gradients beneath this area are low (~2%) and substantial sediment deposition is anticipated, the probability of spatial impact is rated as high, particularly for fine sediment in suspension that may be transported considerable distances. Any turbidity effects would be anticipated to be highly episodic in nature.

Rockfall impacting Evans Creek Trail in Valhalla Provincial Park

Hazard P(H)¹ = high Probability of spatial impact P(S:H)² = high Partial Risk^{3,4} = very high

The Evans Creek trail traverses under steep rocky bluffs that were burned in the fire beginning 650 m from the trailhead and ending 1000 m from the trailhead. These bluffs are subject to active rockfall processes, and the ground below is scattered with loose cobbles and boulders. 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. Approximately 10 fresh rockfall incidents that appear to have occurred during or since the fire were noted along the Evans Creek Trail in mid-October. Therefore, the likelihood of rockfall is rated as high. The probability of spatial impact is also rated as high, as the trail is located immediately below the rock bluffs.

Flooding on Mulvey Creek or Gwillim Creek impacting Little Slokan Road North

Hazard P(H)¹ = very low Probability of spatial impact P(S:H)² = moderate Partial Risk^{3,4} = very low

Only 7% of Mulvey and Gwillim Creeks watersheds were burned with limited high burn severity; therefore, the likelihood of increased flood flows due to wildfire effects on both streams is rated as very low. The Mulvey Creek road crossing is a bridge and the Gwillim Creek crossing is an arch (open-bottom) culvert. No hydrological analysis of culvert or bridge capacity has been undertaken given the low likelihood of post-wildfire related flooding on either of these drainages.

Landslide, avalanche or rockfall within the Gwillim Creek valley impacting two cabins

Hazard P(H)¹ = moderate Probability of spatial impact P(S:H)² = moderate Partial Risk^{3,4} = moderate

Two cabins are located in the Gwillim Creek valley, approximately 1.8 km and 2.6 km upstream from the Village of Slokan water intake, respectively. They are both located on the west side of Gwillim Creek along the flat u-shaped valley bottom. A steep (average gradient >60%) and rocky valley wall that has been burned in a patchwork of low, moderate, and high burn severity rises above the cabins to the west. Based on a desktop analysis, the two cabins do not appear to be located on fans of debris-flow prone tributary channels; therefore, it is unlikely that a debris flow will impact these structures. However, the steep burned slope above has an increased likelihood of generating avalanches, landslides, or rockfall after the fire, and it is possible these processes may impact the cabins. For this reason, the probability of spatial impact is rated as moderate. Due to access challenges, these cabins were not assessed in the field.

FURTHER ACTIONS

BC Parks may want to consider installing rockfall warning signs along the Evans Creek trail to warn users of the potential hazard.

Further analysis of post-wildfire natural hazards for this fire is not recommended.

SIGNATURE, SEAL, FIRM PRACTICE #

Sarah Crookshanks
November 14/2024

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



ATTACHMENTS

See attached map, photos and Appendices.

Reviewed by: Gareth Wells, P. Geo

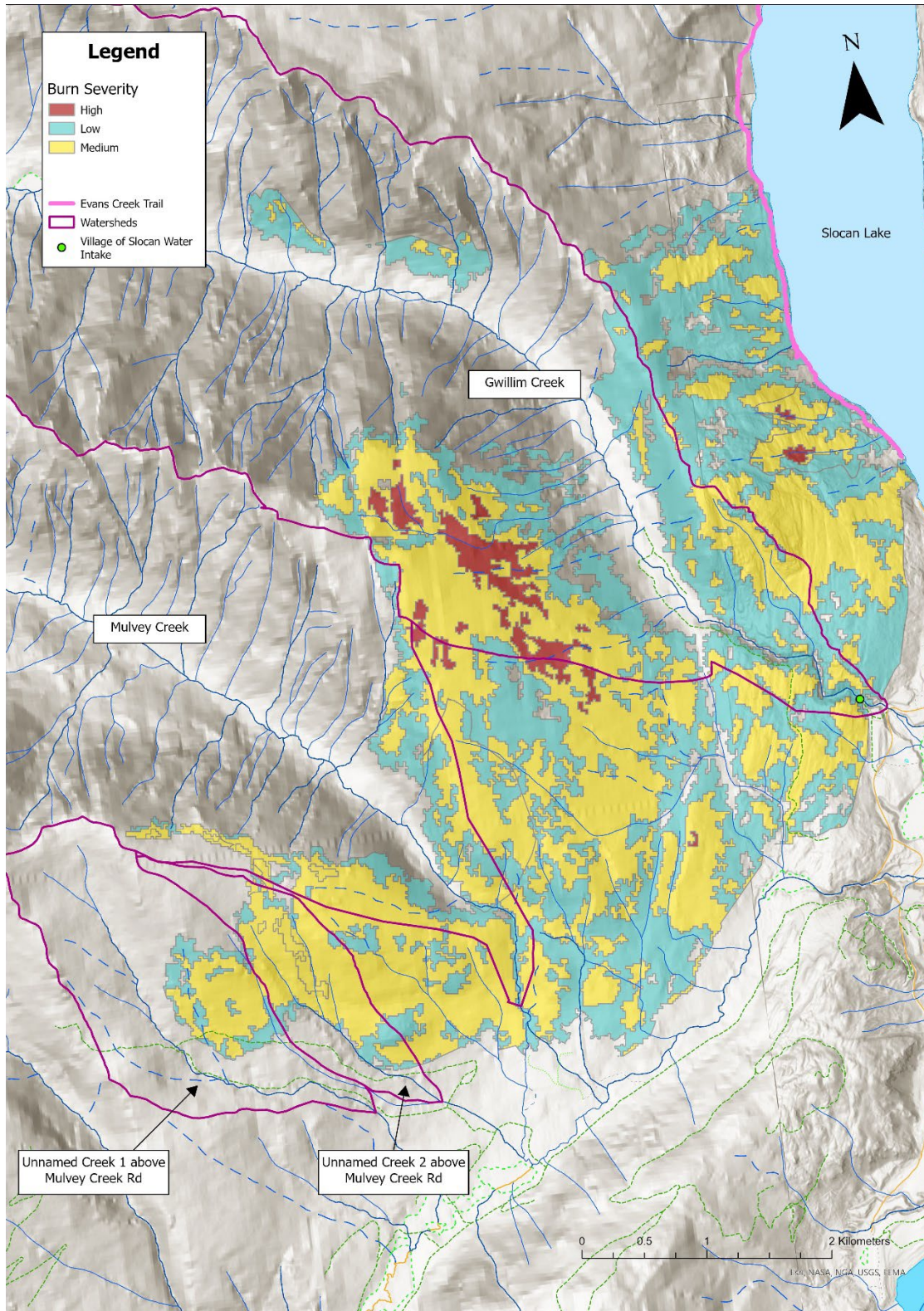


Figure 1. Vegetation burn severity map of the Mulvey Creek fire showing estimated classes derived from Sentinel-2 imagery (prefire: July 7, 2024; post-fire: September 5, 2024). Burn severity classes were modified based on aerial photographs to correct for the high reflectance from bedrock outcropping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



Figure 2. Overview of the Mulvey Creek fire.



Figure 3. Burn severity in the unnamed drainages above Mulvey Creek Road.



Figure 4. High burn severity in a steep tributary to Gwillim Creek.

Appendix A

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)
<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
Backlog Creek	C110612	Mulvey Creek Land Cooperative, CP 1734	PO BOX 286 Little Slocan F.S.R. KM10, Slocan BC V0G 2C0	Domestic
Mulvey Creek	C053927	Alan John Mills and Michael James Mills	PO BOX 156, SLOCAN BC V0G 2C0	Domestic and Irrigation
Mulvey Creek	C111329	Oreamnos Property Co Ltd	PO BOX 1526, BANFF AB T1L 1B4	Domestic
Mulvey Creek	C120262	Oreamnos Property Co Ltd	PO BOX 1526, BANFF AB T1L 1B4	Power and Commercial
Mulvey Creek	C128899	Alan John Mills and Michael James Mills	PO BOX 156, SLOCAN BC V0G 2C0	Domestic and Irrigation
Mulvey Creek	F007880	Hope Mead	PO BOX 199, Slocan BC V0G 2C0	Domestic and Irrigation
Gwillim Creek	C053790	BC Parks - Attn: Rae Busse	Parliament Buildings, 501 Belleville Street, Victoria BC V8V 1X4	Domestic and Irrigation
Gwillim Creek	C055431	Gary Lee Burns	PO BOX 177, Slocan BC V0G 2C0	Irrigation
Gwillim Creek	C056258	Gary L Burns and Heather I Burns	BOX 177, SLOCAN BC V0G 2C0	Domestic and Irrigation
Gwillim Creek	C059989	Gary L Burns and Heather I Burns	BOX 177, SLOCAN BC V0G 2C0	Pond & Aquaculture
Gwillim Creek	C115981	Village of Slocan	BOX 50, SLOCAN BC V0G 2C0	Waterworks: Local Provider