



1516 Robertson Ave.
Nelson BC
V1L 1C6

Date: October 10, 2018 **FILE:** SCL 18-1457

To: Ms. Sarah Crookshanks, P.Geo.
Research Geomorphologist
Ministry of Forests, Lands, and Natural Resource Operations

From: Mr. Tedd Robertson, P.Geo., Eng.L.
Sitkum Consulting Ltd.

Subject: Blazed Creek Fire N72301
Post Wildfire Risk Analysis

At the request of Sarah Crookshanks, P.Geo., Sitkum Consulting Ltd. (SCL) completed a Post Wildfire Risk Analysis for the Blazed Creek fire (N72301) located approximately 20 km northwest of Creston in southeastern B.C. The attached preliminary report form provides the results of this assessment.

Field work was completed by Tedd Robertson, P.Geo Eng.L., and Marc Deschenes, geotechnical specialist and CAA professional member, on September 5, 2018 including a helicopter overview flight and ground assessment along Highway 3. Additional truck and foot traverse field assessments were completed by Tedd Robertson on September 19, 2018. Refer to Figure 1 for field observation site locations.

The burn severity mapping was provided by the Ministry of Forests, Lands, and Natural Resource Operations based on Differenced Normalized Burn Ratio calculations using same year classification satellite imagery. The classification areas shown in this mapping appear to be reasonably accurate for the purposes of this assessment based on field observations by SCL.

The discussions and recommendations presented above are based on a visual site inspection and available background information. Shallow soil pits, road cuts, and failure scarps were examined; no further subsurface investigation was carried out as part of this assessment. Subsurface conditions are inferred from observations and interpretations of surface characteristics, and conditions encountered during excavation may vary. This report has been prepared for use by the Ministry of Forests, Lands, and Natural Resource Operations, which includes distribution as required for purposes for which it was commissioned. The assessment has been carried out in accordance with generally accepted geotechnical practice. Geotechnical judgement has been applied in developing the recommendations in this report. No other warranty is made, either expressed or implied.

We trust that the information above meets your current requirements. If you have any questions, or require further information, please do not hesitate to contact the undersigned.

Respectfully submitted,

Tedd Robertson, P.Geo. Eng.L.
Sitkum Consulting Ltd.



MINISTRY OF FORESTS, LANDS AND NATURAL RESOURCE OPERATIONS, POST-WILDFIRE RISK ANALYSIS – PRELIMINARY REPORT

NOTE: The results given on this form are preliminary in nature and are intended to be a warning of potential hazards and risks. It is not a final risk analysis and further work may alter the conclusions. Please contact the author for more information.

FIRE: Blazed Creek N72301		FIRE YEAR: 2018	DATE OF REPORT: Oct. 10, 2018
AUTHOR: Tedd Robertson, P.Geo. Eng.L., Sitkum Consulting Ltd.			
REPORT PREPARED FOR: South East Fire Centre, Selkirk Resource District			
<p>FIRE SIZE, LOCATION, AND LAND STATUS: Blazed Creek fire N72301 is approximately 6798 ha in size, which includes much unburned area within the fire perimeter. The fire was caused by lightning, and was discovered on August 7th, 2018. It is primarily located within the Summit Creek drainage on the north side of Highway 3, approximately 20 km west northwest of Creston, BC. The majority of the fire is situated on crown land, with a portion of the fire in the northern half situated on the Darkwoods Property, a large private land tract owned by the Nature Conservancy of Canada.</p>			
VALUES AT RISK: Highway 3, BC Hydro high voltage transmission line, existing forest roads			
WATERSHEDS AFFECTED:	TOTAL AREA	AREA BURNED	BURN SEVERITY (% of burned area // % of watershed area)
West Placer Face	165 ha	8 ha (5%)	6% L, 85% M, 9% H // 0% L, 4% M, 0% H
Placer Creek	1102 ha	75 ha (7%)	29% L, 71% M, 0% H // 2% L, 5% M, 0% H
East Placer Face	122 ha	72 ha (60%)	14% L, 73% M, 13% H // 8% L, 44% M, 8% H
Unnamed Creek 1	175 ha	151 ha (86%)	29% L, 52% M, 20% H // 25% L, 45% M, 17% H
Unnamed Creek 2	47 ha	46 ha (98%)	26% L, 63% M, 11% H // 25% L, 62% M, 11% H
West Blazed Face	230 ha	191 ha (83%)	46% L, 45% M, 9% H // 38% L, 38% M, 7% H
Blazed Creek	5399 ha	2465 ha (46%)	14% L, 44% M, 42% H // 6% L, 20% M, 19% H
Blazed-Toby Face	152 ha	118 ha (78%)	44% L, 40% M, 15% H // 34% L, 31% M, 12% H
Toby Creek	1305 ha	816 ha (62%)	27% L, 44% M, 30% H // 17% L, 27% M, 18% H
Toby-Topaz Face	134 ha	92 ha (68%)	46% L, 25% M, 29% H // 32% L, 17% M, 20% H
Topaz Creek	1071 ha	197 ha (18%)	57% L, 33% M, 10% H // 11% L, 6% M, 2% H
<p>The listed watersheds all drain south towards Highway 3 and Summit Creek. Other affected watersheds include Shaw Creek and Next Creek which are located in the Darkwoods Property and drain eastward into Kootenay Lake. These Darkwoods watersheds have not been analyzed due to the small proportion of the watersheds affected and the lack of public or private infrastructure at risk.</p>			

<p>SUMMARY OF HAZARDS AND RISKS³:</p> <p>1. Hazard = P(H), the probability of occurrence of a hazardous event 2. Risk = Partial risk P(HA) = P(H) x the probability of it reaching or affecting an element at risk 3. Rating definitions consistent with Land Management Handbook 69, Post-wildfire Natural Hazards Risk Analysis in British Columbia (Province of British Columbia, 2015)</p> <p><u>Location - Hazard type : Element at Risk</u></p> <p><u>Note:</u> BC Hydro transmission line has not been itemized in risk analysis. In general, towers have been located in positions to avoid risk from natural hazards, and post-wildfire risks to the towers are not estimated to be significantly increased from the pre-fire state.</p>	<p>HAZARD¹</p>	<p>RISK²</p>
<p><u>Shaw Creek and Next Creek – rockfall, debris slides/flows : undeveloped private land</u> <u>Shaw Creek and Next Creek – increased runoff/peak flow : forest road drainage</u></p> <p>These watersheds are in the Darkwoods Property and drain east to Kootenay Lake. No ground based field work was completed in this area to confirm interpretations, but the area was viewed during the reconnaissance helicopter overview flight. No risk analysis has been completed due to lack of public safety concerns or occupied private land at risk.</p> <p>In general, the extent and severity of burn in this area is not sufficient to cause significantly elevated peak flows in the watersheds, but may elevate the likelihood of localized landslide and peak flow runoff events.</p>	<p>N/A N/A</p>	<p>N/A N/A</p>
<p><u>West Placer Face –debris slides/debris flows : highway</u></p> <p>Very limited area of moderate burn severity on broad ridgetop, separated from steeper downslope terrain by more than 500 m. Unlikely to have significant impact on downslope terrain including stream gully. Moderate gradient unburned terrain separates highway from base of steeper slopes and gully.</p>	<p>VL</p>	<p>VL</p>
<p><u>Placer Creek – debris flows/debris floods : highway crossing</u> <u>Placer Creek – increased runoff/peak flows : highway crossing</u></p> <p>Limited area of moderate or high burn severity within watershed. Placer Creek channel and adjacent gully sidewalls remain unburned. Large corrugated steel pipe-arch at highway crossing is unlikely to be affected by small changes to peak flow (refer to Photo 1 and 2). Large basin at arch culvert inlet protects highway from debris flow or debris flood impacts, and smaller events would be accommodated by arch culvert.</p>	<p>L L</p>	<p>L VL</p>
<p><u>East Placer Face – debris slides/rock fall : highway</u> <u>East Placer Face – snow avalanches : highway</u></p> <p>There is some area of moderate burn severity on moderately steep slopes with some minor natural rockfall (refer to Photo 3). The extent and severity of burn will moderately increase likelihood of debris slides and rock fall, but the magnitude of</p>	<p>M M</p>	<p>M L</p>

<p>events are unlikely to reach highway considering the lack of gullies to facilitate longer runout debris flow events. The forest approaching Highway 3 has been harvested in recent years.</p> <p>There is some evidence of old natural snow avalanches in the upper slopes above approximately 1300 m elevation. Some areas of high vegetation burn severity in this area may result in more active snow avalanche start zones, particularly between 1400 m and 1500 m elevation where slope gradients average 75%. There are no significant start zone features in this area, and no downslope gullies to facilitate longer runout, so avalanches are expected to remain in the size 2 to 3 range. However, the average slope gradient from 1500 m elevation to the highway at 1060 m elevation is 62%, therefore there an impact to the highway is possible in the event of a larger magnitude avalanche initiating upslope.</p>		
<p><u>Unnamed Creek 1 - increased runoff/peak flows : highway crossing</u> <u>Unnamed Creek 1 – debris flow : highway</u></p> <p>This unnamed gully system drains under Highway 3 with an 800 mm culvert (refer to Photos 4 and 5). This crossing is likely undersized for large peak flow events regardless of the post-fire conditions, so may be vulnerable to even small increases in runoff. Much of the high burn severity area is in the upper elevation, upslope of an existing forest road which traverses the drainage near 1620 m elevation. This forest road was bladed during firefighting operations to function as a fireguard, and will require deactivation to ensure effective drainage control. Majority of stream channel is unburned. Periodic debris flows are likely a natural process in this gully at a typical frequency ranging from several decades to a few hundred years, and the post-wildfire conditions are estimated to moderately increase the likelihood of debris flows. No recent natural events are apparent.</p>	<p>H</p> <p>M</p>	<p>VH</p> <p>M</p>
<p><u>Unnamed Creek 2 - increased runoff/peak flows : highway crossing</u> <u>Unnamed Creek 2 – debris flow : highway</u></p> <p>This unnamed gully system drains under Highway 3 with a 1200 mm culvert (refer to Photos 6 and 7). This crossing appears to be adequate for large peak flow events in pre-fire conditions, and is likely able to accommodate increased flow in the post-fire environment. While the majority of the watershed has burned, there is limited high burn severity area. Majority of stream channel is unburned. Periodic debris flows are likely a natural process in this gully at a typical frequency ranging from several decades to a few hundred years, and the post-wildfire conditions are estimated to slightly increase the likelihood of debris flows. No recent natural events are apparent.</p>	<p>M</p> <p>L</p>	<p>L</p> <p>L</p>
<p><u>West Blazed Face – rock fall : highway</u></p> <p>Adjacent to the highway is moderately steep slopes with predominantly moderate burn intensity and some high burn intensity. These slopes are likely to be subject to increased raveling and rock fall which could impact the highway due to proximity.</p>	<p>H</p>	<p>VH</p>

<p><u>Blazed Creek - increased runoff/peak flows : highway crossing</u> <u>Blazed Creek – debris flow/flood : highway</u> <u>Blazed Creek – increased runoff : existing forest roads</u> <u>Blazed Creek – debris flows : forest roads</u> <u>Blazed Creek – snow avalanches : forest roads</u></p> <p>Blazed Creek is the largest of the burned watersheds within the Summit Creek drainage (refer to Photo 8 and 9). It also has the largest area of high burn severity which is primarily located on the west aspect slope of the Blazed Creek valley. This area was assessed both from the air and on the ground, and was found to have high vegetation and soil burn severity with evidence of recent overland flow and hydrophobic soils. Blazed Creek is crossed by Highway 3 with a large concrete arch culvert spanning the entire natural channel width (refer to Photo 10), and while the crossing is likely capable of accommodating an increase in flow, it may be susceptible to partial blockage from large woody debris in the event of a debris flow or debris flood reaching the crossing. There is a high incremental increase in the likelihood of debris flows in many of the high burn severity area that are on steep gullied terrain susceptible to debris flows. These debris flows would likely reach Blazed Creek, and could continue downstream as a debris flood depending on event magnitude and stream flow conditions at the time. Several forest roads are situated within Blazed Creek; these roads can be expected to be impacted by increased runoff where situated in or downslope of high burn severity areas, particularly the roads on the west aspect slope of Blazed Creek. Forest roads in the mid to upper elevations may experience significant increases in runoff where the forest has burned to ridgetop upslope, and these roads may also cause drainage diversions if drainage systems are compromised or not capable of accommodating the extra flow. Drainage diversions could result in downslope debris flows capable of reaching valley bottom and Blazed Creek. Forest roads located in the valley bottom are likely to be impacted by debris flow runout where situated downslope of high burn severity areas with steep gullied terrain such as the west aspect slope of Blazed Creek. Some new snow avalanche start zones may also have been created along this west slope, and while there is no risk from avalanches to Highway 3 it could pose a risk to valley bottom forest roads from snow avalanches with long runouts, with implication to public safety for winter backcountry recreational snowmobile users that may not consider the potential for new avalanche terrain.</p>	<p>H H H H H</p>	<p>H H VH VH H</p>
<p><u>Blazed – Toby Face – rock fall : highway</u> <u>Blazed – Toby Face – snow avalanches : highway</u></p> <p>Adjacent to the highway is moderately steep slopes with predominantly low to moderate burn intensity. These slopes are likely to be subject to increased raveling and rock fall which could impact the highway due to proximity.</p> <p>Some high burn intensity area upslope of 1300 m elevation in gully headwall area may result in new snow avalanche start zone.</p>	<p>H M</p>	<p>VH M</p>
<p><u>Toby Creek - increased runoff/peak flows : highway crossing</u> <u>Toby Creek – debris flow : highway</u></p>	<p>H M</p>	<p>H M</p>

<p>Toby Creek is crossed by Highway 3 with a large arch culvert, approximately 4 m to 5 m in width, and 3 m in height (refer to Photo 11). Toby Creek is likely subject to periodic debris flows or debris floods, although none appear to have reached the highway crossing in the recent past. There is an area of steep gullied terrain with some high burn severity approximately 2 km northwest of the highway crossing which is likely to have a moderately increased debris flow hazard. Toby Creek has an average channel gradient of near 20% between this steeper gullied terrain and the highway, and as a result continued debris flow transport is possible under adverse conditions.</p>		
<p><u>Toby-Topaz Face – Snow Avalanches : highway</u> <u>Toby-Topaz Face – debris slides/flows : highway</u></p> <p>High burn severity area in gullied upper elevations of face unit (refer to Photo 12). Gentle basin at toe of slope separates highway from slope, reducing the likelihood of an impact to the highway in the event of an avalanche or landslide initiating upslope. A mid slope bench with unburned to low burn severity forest also separates the higher elevation high burn severity area providing a buffer between the valley bottom and potential snow avalanche start zones in some portions of this face unit.</p>	<p>M M</p>	<p>L L</p>
<p><u>Topaz Creek - increased runoff/peak flows : highway crossing</u> <u>Topaz Creek – debris flow : highway</u></p> <p>Topaz Creek is crossed by Highway 3 with a large arch culvert, approximately 4 m to 5 m in width, and 3 m in height (refer to Photo 13). Topaz Creek is likely subject to periodic debris flows or debris floods, although none appear to have reached the highway crossing in the recent past. There is an area of steep gullied terrain with some high burn severity approximately 1.8 km north of the highway crossing which is likely to have a moderately increased debris flow hazard which could reach Topaz Creek. Topaz Creek has an average stream channel gradient near 20% in the adjacent reach, and would likely be capable of continued debris flow transport and entrainment of material. There is a 500 m long reach with an average 16% gradient approaching the highway crossing where some debris flow deposition may occur, although longer than normal debris flow runout may be possible under adverse conditions due to the continued confinement. A debris flood could also continue downstream from where a debris flow ends.</p>	<p>L M</p>	<p>L M</p>

FURTHER ACTIONS:

No further actions are considered necessary to mitigate risks to the **BC Hydro transmission line**. Tower locations are generally located outside of gullies, where the likelihood of an impact is greatest.

Recommended actions to increase **public safety for highway users** include:

1. Installation of signage to indicate rockfall hazard beneath West Blazed Face and Blazed Toby Face. Temporary signage was in place at the time of assessment, but more permanent signage is recommended as the elevated likelihood of rockfall and landslides can last for several years.
2. Installation of signage to indicate debris flow hazard at Toby Creek and Topaz Creek.
3. Increased ditchline and culvert cleaning maintenance in order to ensure ditches and culverts remain functional in the event of increased runoff and raveling.
4. Increased monitoring of major crossings including Blazed Creek, Toby Creek, and Topaz Creek. These creeks may all experience increased peak flow events, and may be more susceptible to debris flows which could contribute to blockage of crossing structures.

5. Monitoring of potential new snow avalanche start zones in high burn intensity areas of the East Placer Face, Blazed –Toby Face, and Topaz-Toby Face, and any other location where a MoTI avalanche specialist may consider there to be an elevated risk of avalanches. These areas are located upslope of Highway 3 and have some high burn severity areas on sufficiently steep slopes such that they could become new snow avalanche start zones. Monitoring should occur for a period of several years to determine if there is sufficient risk to the highway that may require ongoing monitoring or avalanche control. A separate snow avalanche risk assessment should be completed by MoTI to confirm the extent of monitoring and mitigation works required.
6. Consider upgrading flow capacity at Unnamed Creek 1; this crossing appears to be undersized and is likely to experience elevated peak flows in comparison with pre-fire conditions.

Recommended actions for existing forest roads:

1. Existing forest roads should be reviewed to ensure drainage structures remain functional in burned areas (plastic culverts can burn and melt shut). Road drainage should also be assessed to consider if it is adequate for accommodating potential increases in flow where there is significant burned areas upslope, as there may be a significant increase in runoff at roads combined with a decrease in downslope stability. Increased seasonal deactivation and maintenance measures with an emphasis on drainage control should be implemented in areas of moderate or high burn severity. The roads in the Blazed Creek drainage are most likely to be affected, with effective drainage control very important along the road traversing the west aspect slope of Blazed Creek near 1775 m elevation due to the high likelihood of post-fire debris flows in the down slope gullies. The stacked switchbacks between Blazed Creek and Toby Creek are also important maintaining drainage to avoid redirection of runoff from the ridgetop to adjacent downslope gullies.
2. Blazed Creek FSR should have signage posted to warn snowmobile traffic of potential new snow avalanche terrain due to the high intensity wildfire upslope. This appears to be a common snow mobile access route, and recreational traffic may not be aware of the extent of upslope changes.

Recommended actions for recently constructed fireguards:

1. Deactivate all machine built fire guards with the intent of restoring natural drainage and pulling back any potentially unstable fill slopes which could result in a landslide. Where existing forest roads were modified or bladed for use as fireguards or access, they should also be deactivated for drainage control.

Recommended actions for future forest development:

1. Effects of fire on hillslope hydrology, including equivalent clear cut area (ECA) concepts, should be taken into account when planning future forest development in the affected watersheds, either salvage harvesting or development of non-burned areas. Further hydrological assessment would be required to confirm extent of impacts and possible mitigation measures.

POTENTIAL MITIGATION:

Mitigation measures intended to increase public safety at Highway 3 are recommended above. While landslide, rockfall, and snow avalanche risks to Highway 3 and road users will be elevated in comparison with pre-fire conditions, the risks are not expected to be higher than many other mountain highway sections in the region including Highway 3 on the west side of the Salmo Creston Pass; therefore, no further measures for risk reduction have been recommended.

COMMENTS:

Based on the MoT Kootenay Pass 39100 Avalanche Strip Map there are no monitored avalanche paths impacting Highway 3 from the north side of the highway within the area of fire N72301. There are some areas of high vegetation burn severity upslope of the highway that have the potential to create new avalanche start zones. As noted under Further Actions, these areas should be monitored for several years to determine if they may require ongoing monitoring and or avalanche control to maintain public safety at the highway.

SIGNATURE:



ATTACHMENTS:

See attached photos, Figure 1, and N72301 Burn Severity Mapping page for further details.



Photo 1: Highway culvert at Placer Creek.

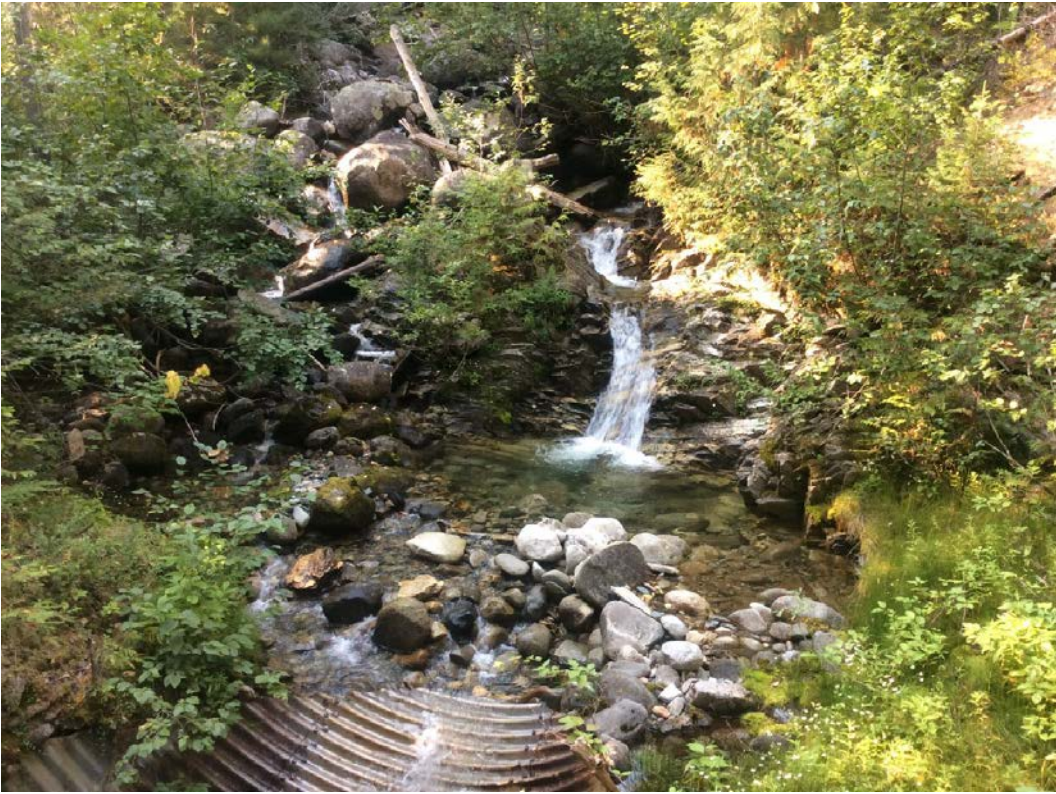


Photo 2: Placer Creek.



Photo 3: East Placer Face. Machine guard visible ascending to left side of photo, with moderate to high burn severity area in mid-upper elevation of face unit.



Photo 4: View of East Placer Face, Unnamed Creek 1, and Unnamed Creek drainage areas.



Photo 5: Highway culvert at Unnamed Creek 1.



Photo 6: Highway culvert at Unnamed Creek 2.



Photo 7: View of a portion of Unnamed Creek 1, Unnamed Creek 2, and West Blazed Face.



Photo 8: View looking upstream in Blazed Creek.



Photo 9: High burn severity along the west aspect slopes of Blazed Creek.



Photo 10: Highway 3 crossing of Blazed Creek.



Photo 11: Highway 3 crossing of Toby Creek.

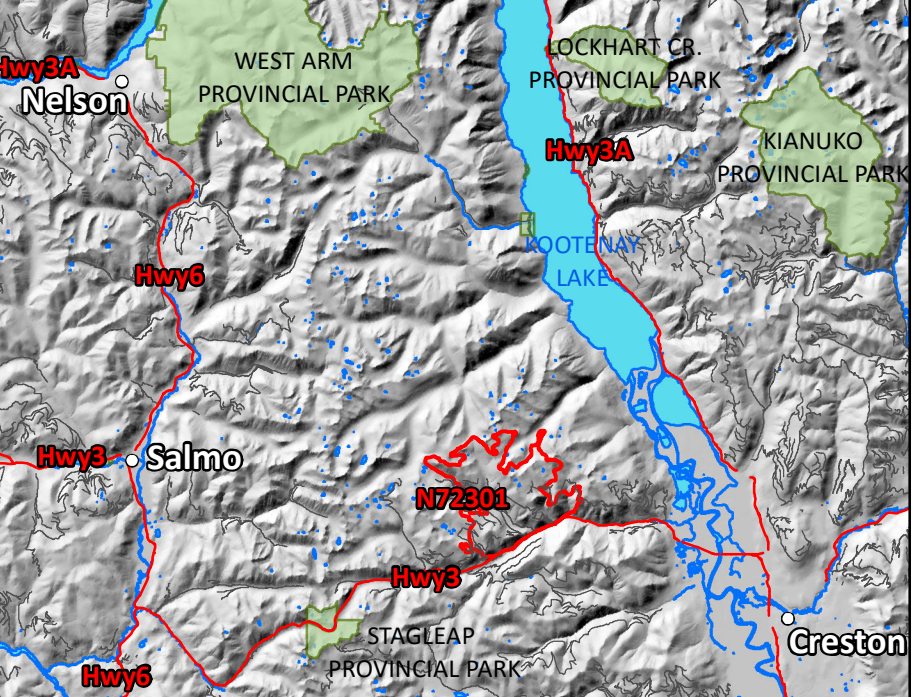
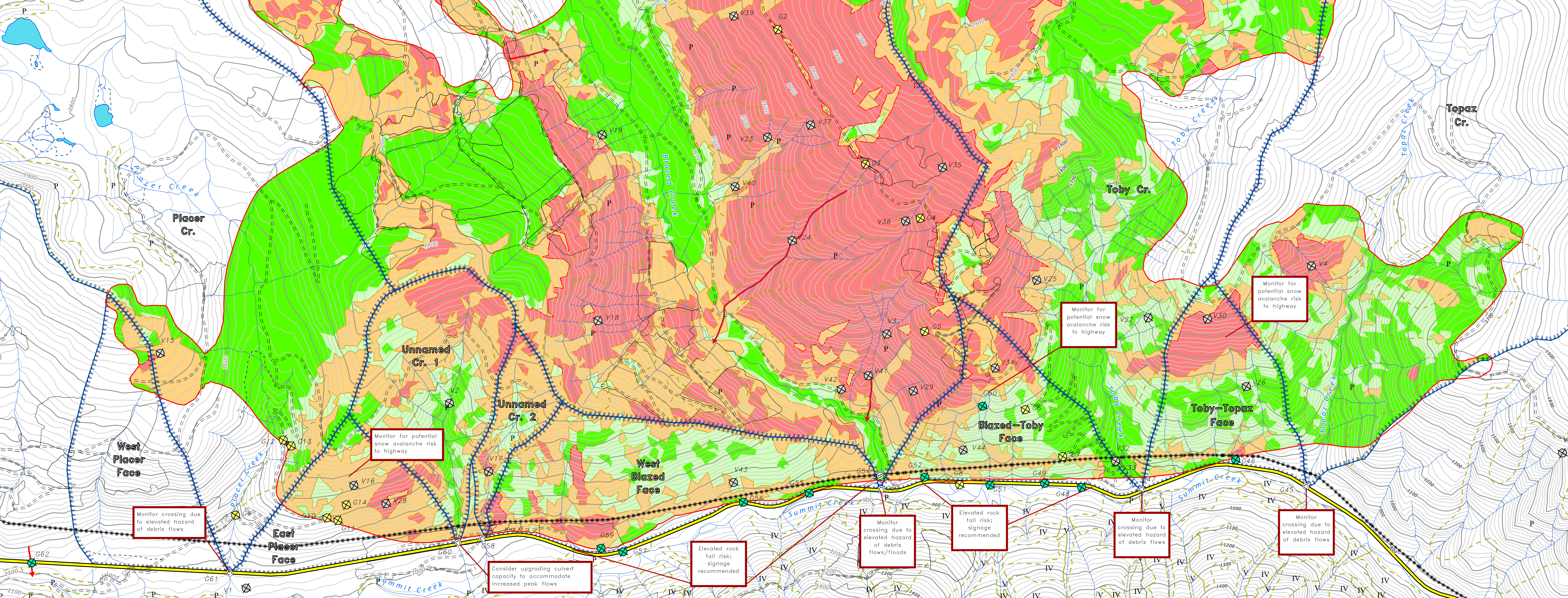


Photo 12: View of Toby-Topaz Face.



Photo 13: Highway 3 crossing of Topaz Creek.

WATERSHED AFFECTED:	TOTAL WATERSHED AREA (ha)	AREA BURNED WITHIN WATERSHED (ha)	AREA BURNED WITHIN WATERSHED (%)	BURN SEVERITY (% of burned area)	BURN SEVERITY (% of total watershed)
West Placer Face	165.4	8.2	5.0	6% L, 85% M, 9% H	0% L, 4% M, 0% H
East Placer Face	121.5	72.3	59.5	14% L, 73% M, 13% H	8% L, 44% M, 8% H
Unnamed Cr. 1	175.2	150.9	86.1	29% L, 52% M, 20% H	25% L, 45% M, 17% H
Unnamed Cr. 2	47.2	46.2	97.8	26% L, 63% M, 11% H	25% L, 62% M, 11% H
West Blazed Face	229.9	191.1	83.1	46% L, 45% M, 9% H	38% L, 38% M, 7% H
Blazed-Toby Face	151.9	118.0	77.7	44% L, 40% M, 15% H	34% L, 31% M, 12% H
Toby-Topaz Face	134.1	91.9	68.5	46% L, 25% M, 29% H	32% L, 17% M, 20% H
Topaz Cr.	1071.0	197.0	18.4	57% L, 33% M, 10% H	11% L, 6% M, 2% H
Toby Cr.	1304.9	815.8	62.5	27% L, 44% M, 30% H	17% L, 27% M, 18% H
Blaze Cr.	5398.8	2465.4	45.7	14% L, 44% M, 42% H	6% L, 20% M, 19% H
Placer Cr.	1102.1	74.7	6.8	29% L, 71% M, 0% H	2% L, 5% M, 0% H



LOCATION INSET MAP
APPROXIMATE SCALE: 1: 1,000,000

Monitor crossing due to elevated hazard of debris flows

Monitor for potential snow avalanche risk to highway

Consider upgrading culvert capacity to accommodate increased peak flows

Elevated rock fall risk; signage recommended

Monitor crossing due to elevated hazard of debris flows/floods

Elevated rock fall risk; signage recommended

Monitor crossing due to elevated hazard of debris flows

Monitor crossing due to elevated hazard of debris flows

Monitor for potential snow avalanche risk to highway

Monitor for potential snow avalanche risk to highway

N72301

Burn Severity Mapping

BC Burn Severity 2018
(Same-Year Classification)

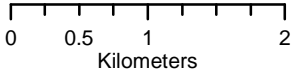
- High
- Medium
- Low
- Unburned

This burn severity mapping is created using a Differenced Normalized Burn Ratio (DNBR) calculation on pre- and post-fire imagery which is classified into four Burned Area Reflectance Classification (BARC) categories. Default breakpoints are used for all timber types across BC and therefore may not accurately reflect field conditions.

"Same-Year Classification" means that the burn severity mapping has been completed the same year the fire occurred (i.e. in summer/fall 2018 for 2018 fires).

Pre-Fire Imagery Date: 20180719
Pre-Fire Scene Identifier: S2B_MSIL1C_20180719T184919_N0206_R113_T11UNQ_20180719T235109

Post-Fire Imagery Date: 20180907
Post-Fire Scene Identifier: S2B_MSIL1C_20180907T184909_N0206_R113_T11UNQ_20180907T24321



Last updated: 2018/09/19
Updated by: camahood
Coordinate System: NAD 1983 BC Environment Albers

