Mount Ida - Haines Creek South FSR (0825.05) Drainage Review

Prepared for:

Ministry of Forests, Lands and Natural Resource Operations
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1 Introduction and Scope

As requested by the Ministry of Forests, Lands and Natural Resource Operations (the Ministry), Westrek Geotechnical Services Ltd. (Westrek) completed a drainage review along the first 6.1 km of the Mount Ida - Haines Creek South Forest Service Road (the FSR) and several other non-status branch roads. The drainage review was requested after a debris flow initiated from the FSR on April 22, 2017, which resulted in a local state of emergency and the evacuation of several properties along the toe of the slope. The objective of the review was to assess the existing drainage conditions along the road network near the landslide, identify possible diversions or issues that might have contributed to the debris flow, and provide recommendations to stabilize the drainage conditions within the road system.

The work was authorized via Work Order 12 under contract number EN17474-002 between the Ministry and Westrek, dated March 23, 2016. The services provided by Westrek are subject to the terms and conditions set out in the contract, and where not specified in that contract, they are subject to the terms and conditions set out in the *Interpretation and Use of Study and Report and Limitations*, which is attached in Appendix A and incorporated herein by reference.

2 Methodology

The following air photos were used for the project:

- BC2619, #102-104 (1959, pre-development);
- BC4034, #73-74 (1961);
- BC7641, #69-73, 159 (1974);
- 30BCC94086, #176-178 (1994)
- 15BCB97024, #268-269 (1997);
- 15BCC01022, #37-38 (2001);
- 15BCC04039, #134-135 (2004); and
- 15BCC07016, #79-80 (2007, low resolution).

The following information was obtained for the project:

- British Columbia Ministry of Forests, Lands and Natural Resource Operations – Thompson Okanagan Region. *Mount Ida – Haines Creek South FSR (0825.05) Landslide Assessment*, dated May 3, 2017.
- Westrek Geotechnical Services Ltd. *Report of Preliminary Findings and Recommendations Haines Creek South FSR Landslide and Flooding Event*, dated April 30, 2017.
- Topographic and Cadastral information: The BC Data Catalogue, retrieved May 1, 2017. [https://catalogue.data.gov.bc.ca/dataset?download_audience=Public].
- Bedrock Geology: Thompson, R. I. et al (2004): *Geology, Salmon Arm, British Columbia*; Geological Survey of Canada, Open File 4380, scale 1:50,000.
- Fulton, R.J., Berti, A.A. and Smith, G.W. (1974): *Surficial geology, Shuswap Lake (west of sixth meridian)*, British Columbia; Geological Survey of Canada, Map 1391A (Salmon Arm). Scale 1:126,720.
- Google Earth™ and Microsoft Bing™ imagery and related applications.

Kevin Turner PEng, who represented Westrek, carried out some preliminary field work on April 22, 2017, during the emergency response. Fieldwork for the drainage study was carried out over multiple days between May 1 and 16, 2017, by Jeffrey Pisio EIT, Simon Gautschi MSc PGeo, and Oliver Talbot, who represented Westrek. The area was flown again on May 10, 2017, by Mr. Turner and Mr. Gautschi, after two additional landslides occurred.

Observation points were referenced to waypoints obtained with a tablet. Their horizontal accuracy is likely 5 to 10 m. Elevations provided in this report are based on TRIM information. Other measurements were made with a handheld clinometer or fibreglass tape. Surficial materials, site drainage, and geomorphological processes were assessed from the road cuts or from air photo interpretation. No subsurface investigation or laboratory testing was undertaken.

Field information is presented on the attached tables, which include co-ordinates, a description of the road or feature and site conditions. For complex sites, the required work is more thoroughly described in following sections in this report. Referenced points are shown on Figure 1 (Tab 1). Symbols on the map summarize the recommended upgrade measures. Most, but not all, of the site locations have been flagged in the field using yellow ribbons. Photographs are attached in Tab 2.

3 Background Information

3.1 Setting and Project Description

The study area lies on a west-facing slope above the Salmon River valley and on the north-facing slope of Haines Creek, which is a tributary stream that drains the upland area to the east (see Figure 2, next page). The study area is about 1.9 km by 3.0 km in size and extends from the Salmon River valley bottom to the summit of the upland area at elevation 1200 m.

Haines Creek is located in a steep, deeply incised valley. It is not a community watershed, but it contains two domestic water intakes (C115352 and C058013). A small creek, known locally as Andrew Brook, also flows off the lower slope of the Salmon River valley immediately south of Haines Creek. Available maps show that Andrew Brook contains two domestic water intakes (C051944 and C067193).

The northeast part of the study area is defined by two prominent gullies that drain into Haines Creek. For the purposes of this report, the gullies and its streams are named A and B and both creeks are assumed to be class S6.

Both the FSR and the Mount Ida - Haines Creek North FSR starts at the end of a short public access road that leads east off Salmon River Road. From the POC, the FSR ascends via 11 switchbacks to the summit of the upland area and eventually intersects the Deep Creek FSR, which ascends the upland area from the Deep Creek valley to the east. The FSR is generally narrow and in many places, has steep grades, with switchbacks that have small radii. Grades are gentler in the upland area.

The area is apparently intensively used by off-road and recreational vehicle enthusiasts. There are trails throughout the area, especially along the terrace and in the lower valley slopes where the trees are widely spaced.

Figure 2: *Annotated oblique view of study area, looking east-southeast. Source imagery from Bing™ overlaid in Google Earth™. Vertical scale is exagerated.*

3.2 Geology

Geological mapping indicates the area is underlain by quartz-feldspar-muscovite-biotite, black carbonaceous, and amphibolitic schist rocks of the Devonian Silver Creek Formation. Minor amounts of micaceous quartzite, marble and amphibolite rocks are also present in this formation. Schist rocks generally have medium to medium-strong strong intact rock strength and exhibit schistocity (parallel arrangement of platy mineral crystals).

The Salmon River floodplain is mapped as modern alluvium, which is comprised of sand, gravel, silt, and minor muck and peat. The terrace formed when the ancestral river stage cut down through collapsed lacustrine deposits, which are comprised of silt, sand, clay and minor gravel that were laid down on underlying ice and subsequently distorted during ablation. The terrace surface lies at elevation 510 to 530 m. The steep slope affronting the terrace is irregular resulting from dissection by surface erosion throughout the post-glacial period.

A small stream terrace is mapped immediately south of the outlet of Haines Creek. This deposit formed during the Fraser glaciation and is comprised of sand and gravel. An old gravel pit is present near the POC. The stream terrace has since been incised by Haines Creek, which has formed a prominent fan on the valley floor. Fan deposits typically contain poorly sorted gravel, sand, silt and clay.

Mapping shows the middle slopes of the valley are shallow bedrock. The upper slopes are mapped as drumlinoid morainal deposits comprised of till, which consists of sand, gravel and silt. Drumlins are streamlined (tear-drop) landforms comprised of till materials that were formed as ice moved over the landscape during glacial periods.

Two large rockslide features present on the south side of the study area (see Figure 2) and are the source of the talus slopes that are present in that area. These likely occurred shortly after de-glaciation. Some of the debris lies on the terrace deposit.

3.3 Development and Landslide History

The earliest available historic air photos (1959) suggest the uplands area was in recovery following a forest fire that cleared much of the uplands within the study area. The FSR appears to have been constructed between 1959 and 1961, to access minor selective logging in the uplands. The alignment originally extended through the gravel pit at the base of the valley. Between 1961 and 1974, the entire valley slope within the study area was completely logged, and a dense network of trails and roads off of the FSR were constructed (Figure 3). The alignment at the start of the FSR was shifted to the present-day location. The Deep Creek FSR was also built in that period to access the uplands area from the Deep Creek valley. Despite the number of roads and trails, no landslides were observed in the historical photos that were reviewed.

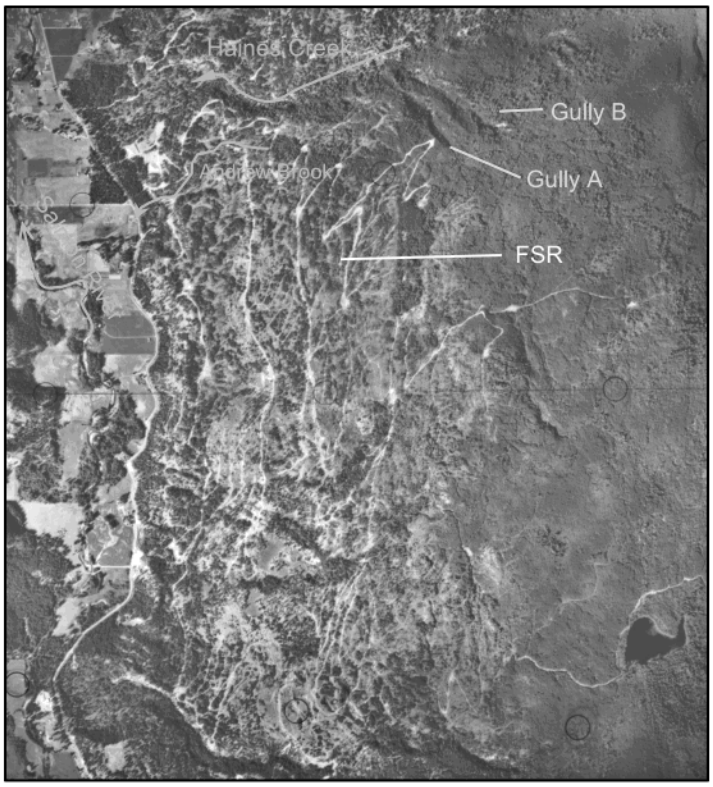


***Figure 3**: 1974 provincial air photograph showing the extensive historical logging in study area.*

The FSR and many of the spur roads in the study area were deactivated several years ago, likely in the mid to late 1990s. No records of the deactivation work have been provided to Westrek.

Minimal logging occurred in the upland area until the late 2000s, when nine blocks were logged. Three more blocks were logged in the 2010s, which are located in the catchment of the Salmon River valley face and Gully A.

Three landslides occurred between April 22, 2017 and May 10, 2017, and are referred to as Landslide 1, 2 and 3 and are shown on Figure 1. They are described in more detail in Section 4.2.

3.4 2016-2017 Weather Synopsis

Conditions leading to the 2017 landslide events in the area were likely affected by the weather trend in the preceding months. The Environment Canada weather data from the Salmon Arm station indicated that, while most of 2016 was much drier than normal, it was followed by a relatively wet autumn (see data table attached in Tab 4). The data shows that September 2016 had about average rainfall, October received about twice the average amount, and November was slightly below average. December was very cold and dry. Very cold temperatures and below normal precipitation occurred in January and February 2017. The precipitation in March

was twice the average, in April it was almost 2.5 times the average, and in early May it was well above average. This pattern likely left high antecedent soil moisture levels, raised groundwater levels, and/or created a frozen land surface, any or all of which may have impacted runoff patterns during freshet.

The snow survey station nearest to the site is Bouleau Lake (2F21, elevation 1190 m). The record is incomplete but it indicates that the snow pack was slightly below normal over most of the winter. At Anglemont (1F02, elevation 1190 m), the snow pack reached a peak near the beginning of April. Depressed average temperatures delayed the lower-elevation snow pack ablation and by May 1 it was slightly above average (see snow survey graphs in Tab E). Snow was present in the upland area (elevation 1200-1300 m) on April 22 and was patchy during the fieldwork in early May.

Following steadily increasing average temperatures, the weather station at Salmon Arm recorded 15.7 mm of rain on April 20. This likely caused a rapid depletion of the snow pack and increased runoff throughout the site. Haines Creek is not gauged but flow in the Salmon River was noted to rapidly rise at Falkland after about April 17 or 18 (see data in Tab E). Landslide 1 occurred on April 21, 2017.

Modest rainy periods followed in the remainder of the month. A period of unsettled weather occurred from May 2 to 3, 2017, and the Salmon Arm weather station recorded 9.9 mm of rain. This was followed by a frontal system that moved inland on May 4, which brought mild temperatures and heavy rain showers. A total of 22.8 mm of rain was recorded at the Salmon Arm weather station[1]. Peak flows occurred in the Salmon River around May 7 or 8. Landslide 2 and 3 likely occurred around this time.

4 Site Conditions

The conditions along the road are listed in the attached Table 1 in Tab 4 and are summarized below. Specific sites including the three landslides and other drainage issues are included in the following sections.

4.1 Steep Ascent to the Terrace

From the valley bottom to the top of terrace, the surficial deposits generally consist of uniform silt and sand. The terrace slope is 60% to 65% and irregular in shape. Grades on the FSR and its spur roads are generally steep, commonly ranging from 10% to 15% (Photo 1, attached). Road cuts along the terrace slope are up to 8 m high and actively ravelling in many places, or actively being eroded by local recreational vehicle traffic. These deposits are highly erodible, and several deep ruts had formed in some places from uncontrolled runoff off the terrace.

The top of the terrace is 100 to 250 m wide and its surface is undulating and imperfectly drained. Slopes range from 10% to 15%, and increase towards the back of the terrace where it meets the steep slope above. Ditches are generally absent or shallow. Water collects on the road surface and few cross-drains are present (Photo 2). Only one culvert was noted (Wpt 11).

[1] Agencies use different start and stop times for their daily summaries, so a direct comparison between data sets for each date requires a review of the actual data, which has not been done at this time.

4.2 Slope above the Terrace

The slope steepens to 50% to 60% in the north half of the study area, above the terrace. A mix of till and ice-contact glacio-fluvial sediments are present in the slopes immediately above the terrace, and in places, the surficial deposits have a high cobble and boulder content. Cobbly sand and gravel was observed within the Landslide 1 scarp and beneath 3 m of sand in an exposure near Wpt 190. Where till is present, it is silty sand with some gravel and occasional cobbles. Road cuts are typically up to 2 to 3 m high with slopes between 1.5H:1V and 1H:1V. Despite the presence of bedrock in the area, rock cuts were uncommon. Consistent with the variable materials and rock types in the slope, the fill slopes are also highly variable. Because of the age of the roads, fill slopes are likely to be very loose and possibly contain buried organic material.

Ditches along the FSR are generally shallow, discontinuous and have not been cleaned out for several years. Many of the cross-ditches and water bars do not have adequate depth, which is likely due to gradual infilling caused by intensive off-road vehicle use. When first reviewed on April 22, water was flowing down the FSR network in many locations.

Several draws and small gullies are present throughout the lower slopes in the study area (Figure 1). Some contain non-classified drainages (NCDs); however, it is not clear if these are natural features or the result of drainage alteration by the road network.

In the south half of the study area, the slope is up to 65% to 90%, where bedrock and talus slopes are more prominent. Two large relict landslides were identified in this area and are shown in Figure 1. The spur roads in this section generally had few drainage structures and shallow or non-existing ditches; however, this area was notably drier with no significant diversions.

4.2.1 Andrew Brook Crossings

The FSR crosses Andrew Brook three times. The lowest crossing (Wpt 1) is a 500 mm corrugated metal culvert (CMP) and the middle crossing (Wpt 201) is a 450 mm CMP. A 200 mm culvert was present in the upper crossing (Wpt 201) but it was removed on April 23 and a cross-ditch was constructed (Photo 3, attached).

The stream source appears to be a prominent zone of groundwater emergence located between Wpt 172 and 307, which lies near elevation 740-750 m (Photo 4, attached). The majority of this water flows to the FSR at Wpt 201. A significant spring at Wpt 172 appears to be related to the same zone, but is diverted by the FSR to a cross-ditch at Wpt 173, where it then likely flowed towards Landslide 1 prior to the installation of the interception ditch between Wpt 188 and 190 on April 22. At present, that interception ditch likely diverts the majority of the flow from Wpt 172 back into the Andrew Brook draw.

4.2.2 Landslide 1

Landslide 1 (Wpt 197) initiated from a fill slope failure at km 2.8 on the FSR (Photo 5). The scarp was about 12 m along the shoulder, but tension cracks and slumped ground extended an additional 18 m and 27 m to the north and south, respectively. Most notably, the crack to the south (uphill) of the scarp opened and dropped about 0.3 m, and about half of the road was lost.

The scarp was 2.0 to 3.5 m high and nearly vertical. Surface water was observed to be flowing into and along tension crack and then into the landslide scarp. A significant portion of this water likely came from the spring at Wpt 172 (Photo 6). In addition, a major spring was observed emerging from the coarse sediments in the base of the scarp which added to the runoff flowing down the landslide.

Debris ran out on a steep slope below the scarp and entered a deep draw. It continued as a small debris flow within the gully. It lost confinement about 95 m downslope and most of the debris arrested on an overgrown branch road just above the FSR, and on the FSR itself. Some fine-grained debris continued down the steep slope below the FSR and into Andrew Brook. The small amount of debris that reached the creek was rapidly diluted and incorporated into other sediment that was entrained in the flood flow. Total sediment was substantial and it impacted the water intake structure(s) downstream, the stream channel where it flows across 1605 Salmon River Road, and the ditch along the Salmon River Road.

Westrek recommended the construction of a ditch between Wpt 188 and Wpt 190 to intercept the flow from the spring (Photo 7) and direct it towards the crossing at Wpt 201 in Andrew Brook. The ditch was constructed later that day. By May 1, surface water was no longer flowing in the tension crack, but moderate seepage was noted to be flowing from the base of the scarp.

4.2.3 Landslide 2

Landslide 2 (Wpt 176b) occurred at km 4.0 km on the FSR (± 745 m elevation) at some time between May 3 and May 6 (Photo 8). The scarp was approximately 11 m wide and 1.5 m high, and was located immediately beneath a slope break that steepened from 25% to 60%. The failure surface was along the interface between sandy colluvium and till, which consisted of silty sand with some gravel and occasional cobbles. The total initiation zone was approximately 250 m^3. Bedrock was present in the landslide track near Wpt 176b.

Landslide 2 can be characterized as a debris avalanche. Debris ran out approximately 110 m and deposited a substantial amount of material at two levels on the FSR (Wpt 176a and 185). We understand that the Ministry removed the debris road prior to Westrek's review. Most of the debris material appeared to have been dumped on the fill slope at each location.

Minor scour from seepage was evident in the initiation zone, but it was dry at the time of the review on May 16. A cross-ditch was located at Wpt 169, directly above the landslide scarp, and it was draining significant ditch flow on May 1 (Photo 9). This flow appeared to be sourced from a seepage zone in the ditch at Wpt 167. By May 16, the cross ditch was almost dry.

4.2.4 Landslide 3

Landslide 3 initiated as a 3 m wide by 3 m deep road fill failure at Wpt 2201 sometime between May 3 and 10, 2017. The failure initiated on a non-status road that leads down from the FSR to the water intakes on Andrew Brook (Photo 10). The road is no longer usable as its entire width has been lost at the scarp. The fill slope was approximately 70% and surface flow from the road was flowing into the scarp. The flow appeared to originate at a two seepage zones (Wpt 2200 & 2200a) approximately 85 m up the road from the slide. The road surface was U-shaped in this section and no drainage structures were present (Photo 11).

4.3 Upland Area Section

The upland area is generally till covered and has slopes that range from 10% to 30%. The area is typically poorly drained, with swamps and pooling water observed near the height of land. A significant stream diversion was present at Wpt 800 and is discussed in further detail below.

4.3.1 Gully / Stream A

Stream A forms near the height of land near Wpt 1303, which is within a cluster of harvest blocks that were logged in 2011. The catchment area for this stream is relatively narrow and based on air photo interpretation, the drainage features are very subtle. These observations and ground truth suggest the provincial watershed boundaries for this gully are inaccurate. The approximate catchment limits based on a limited amount of fieldwork are shown on Figure 1.

Stream A was tracked by GPS and is shown on Figure 1. The channel is poorly confined in several locations in the higher elevations and ponding was common. No obvious diversions were observed until it intersects the FSR near Wpt 800. At this location, the entire stream flow is diverted west by about 90 m to a dip in the FSR at Wpt 810 (Photo 12), at elevation +/- 1190 m.

From there, the stream flows in a draw until it intersects the FSR at Wpt 137 (Photo 13), at elevation +/- 930 m. Westrek understands the culvert at Wpt 137 was removed by the Ministry in early May, but significant erosion in the road surface suggested that the flow had been flowing down to Wpt 139 (Photo 14), possibly because the culvert was not functioning. Prior to culvert removal, the water diverted to Wpt 139 eventually drained to the FSR at Wpt 170, followed the ditch, and then drained through a cross-ditch at Wpt 171. From there it joined the springs below that area and likely contributed to the water flowing to Landslide 1. Following removal of the culvert at Wpt 137, the water was directed towards Wpt 167, which was cross-ditched at Wpt 169 above Landslide 3.

The draw immediately downstream of the diversion point at Wpt 810 was also tracked with GPS and is shown on Figure 1. The drainage path was initially dry, but an NCD was present below Wpt 808. At Wpt 1108 (Photo 15), this NCD appears to be diverted by old logging trails that direct the flow towards the FSR at Wpt 146, where it contributes to the large ditch flow at that location. The ditch flow is cross-drained by a cross ditch at Wpt 147 and ultimately flows into a small draw that drains into Haines Creek instead of Gully A. On May 16, the cross-ditch at Wpt 147 was blocked with rock to direct the flow off the switchback in a take-off ditch and back into Gully A. The take-off ditch was significantly eroded, with near vertical side slopes up to 3 m high (Photo 16). The erosion appeared to have been occurring over a long period of time.

Spur 7 crosses Gully A at +/- 950 m elevation. The gully becomes deeply V-shaped and steep below elevation 920 m.

4.3.2 Gully B

Stream B was partially diverted at a filled in water-bar on Spur 7 road at Wpt 1000 (Photo 17). At the time of the review, the diverted water was flowing down the road to Wpt 1005 and had significantly eroded the road surface (Photo 18). The diverted water flows off the road at Wpt 1005 into a large draw that drains into Gully A.

5 Assessment

The drainage review indicated that a substantial amount of runoff is being diverted out of Gully A and onto the slope face above Andrew Brook. This condition has apparently existed since the FSR was built in the 1960s, but has not been an issue until this past spring when unusual hydrological and hydrogeological (groundwater) conditions developed. These included a combination of above-average rain in the fall of 2016, cold conditions through the winter and early spring that delayed melt, and above-average rain in April and early May. These factors combined to increase both surface runoff and groundwater discharge, which led to significant peak flows in the streams and increased runoff in natural drainage paths throughout the area. It is not clear to what degree the recent harvest blocks in the upland area may have increased runoff by locally increasing the snow pack; however, these blocks would have naturally drained into Gully A and Gully B had not the runoff been diverted by the FSR onto the slopes above Andrew Brook.

The natural drainage patterns in this area have been completely altered by the numerous old roads and trails, and all three landslides were the result of drainage diversion and concentration by them. The cross-ditches and water-bars installed in the area when the roads and trails were deactivated have deteriorated over the years due to very high off-road vehicle use, and they no longer function as intended. The occurrence of Landslide 2 after some minor surface runoff changes were made indicates just how sensitive the slopes were this past spring. The best way to manage runoff on this slope would be to fully deactivate the FSR and spur roads. This would be a costly undertaking and may not be acceptable to the public. In lieu of that, the Ministry could consider a drainage improvement program to restore drainage paths to a more natural condition. On this basis, areas of recommended maintenance are shown on the attached table and as marked on the site plan with an “M”. These structures would have to be maintained as long as the roads and trails are present on the hillside.

The effect of off-road vehicle use is especially noticeable on the steep slope below the terrace where the surficial deposits consist of highly erodible silt and sand. Severe erosion and damage to the FSR has occurred, and in many places uncontrolled off-road vehicle use has eroded ruts in the adjacent forest floor. It would require a considerable effort to restore the FSR section on the steep slope so that erosion is fully curtailed, as outlined in the following section. The Ministry will have to accept that maintenance will be required as long as the FSR is in place, particularly if the use of recreational vehicles is not restricted.

Correction of the major diversion of Stream A and others, and restoration of the function of the road deactivation works already in place, should be carried out as outlined in the following section. Once the major diversions are resolved, the landslide hazard on the slopes above Andrew Brook should diminish. However, it will take several years or even decades for the hydrogeological regime in the slopes to re-adjust to the restored drainage patterns, and since groundwater appears to feed many of the small streams on the hillside, changes in the timing and magnitude of peak flows may occur over time.

6 Recommendations

6.1 Section on Steep Slope below Terrace

It will be very difficult to control runoff on the section leading up the steep slope to the terrace, due to the steep grades and the highly erodible soils. Sections with road surface erosion, particularly between Wpts 5 and 11, should be repaired to reduce runoff along the road surface, as summarized below:

- Repair eroded or rutted areas of road surface and re-grade the section so that the entire section is in-sloped.
- Little opportunity exists for a ditch, so it will have to be shallow and regularly maintained.
- Install cross-drain culverts or cross-ditches at Wpts 5, 8a and 9. Culverts should be armoured and cross-ditches should be fully lined with rock to resist erosion.
- Cap the road surface with a 0.3 m layer of 75 mm minus granular material that contains some fines (10-15%). Angular rockfill material would work best.
- Regular maintenance will be required in this section.

6.2 Andrew Brook Crossings

Given the amount of off-road vehicle traffic on the road and presence of water licenses on Andrew Brook, install an adequately sized culvert at Wpt 201 to replace the stream culvert cross-ditch that was removed and replaced with a cross-ditch during the emergency response. A minimum culvert size of 500 mm is recommended.

6.3 Landslide 1

A 60 m long section of slumped fill remains at Wpt 197 to 197a, which has the potential to initiate another landslide should it become saturated. To reduce this hazard, pull back the slumped fill to the tension crack and flatten the fill slope to no more than 1.5H:1V (67%). The pulled-back material should be end-hauled to an approved spoil location, such as the bowl-shaped area at Wpt 204.

This may result in very little road width. If ATV access is still desired, the road can be extended farther into the cut slope to gain additional width. If pick-up or industrial access is needed, then a more extensive re-alignment would be required, or otherwise the road fill would have to be rebuilt with rockfill, or possibly retained with a fill slope retaining wall.

6.4 Landslide 2

Correcting the diversion of Stream A farther up the slope should reduce much of the runoff that was directed to this location. Therefore, no additional drainage works are needed for this landslide other than upgrading the cross-ditches that are already present.

The landslide debris cleared from the road at Wpt 176a and Wpt 185 and temporarily placed on the fill slope should be removed and hauled to a suitable spoil site. This will reduce the likelihood of a subsequent fill slope failure from the additional loading generated by the stockpiled debris.

6.5 Road to Intake and Landslide 3

This landslide likely initiated as a result of fill slope saturation that was caused by the diversion of drainage along the access road leading down to the intake. Westrek understands this is a non-status road and the person responsible for this road may have to implement the repair. To minimize additional failures from the road, the road fill at the head scarp that is reachable with an excavator should be pulled back to 1.5H:1V (67%) and a cross ditch should be installed in the draw located at Wpt 2200a. A berm should be constructed on both sides of the landslide to prevent access and signs should be posted warning road users of the hazard. Due to the cost of the repair, the person needing the road should consider other access options once the slope above the creek has been stabilized.

6.6 Gully A Diversions

Stream A can be restored to its natural drainage path below the FSR by constructing a ditch and small berm at Wpt 800. The following is recommended:

- The berm should be at least 1 m high, 0.75 m wide at the crest and extend approximately 25 m perpendicular to the road. The toe of the upstream face has been laid out in the field with ribbon as Wpt 800A and 800B. This works will require the removal of seven 0.2 to 0.3 m diameter trees and existing log cribbing in the road fill.
- The berm slopes should be constructed no steeper than 2H:1V and it can be built using the local non-organic materials. Material should be placed in lifts and compacted to a dense state (i.e. 95% Standard proctor density). The new stream channel and the upstream facing berm slope should be armoured with 150-300 mm sized angular rock underlain by a non-woven geotextile. If the road is needed for off-road vehicle traffic, the top of the berm should be at least 1 m wide the entire vehicle path should be armoured. Consider ramping up at flatter angles for ease of use and to reduce erosion.

The natural drainage path should also be restored at Wpt 1108 where it is currently being diverted by an old trail towards the FSR. A +/- 0.5 m deep ditch at this location should be sufficient to direct the flow back into its intended draw. Access at this location is expected to be difficult and if excavator access is not feasible, then a ground crew may be required to dig the ditch by hand. Westrek should be on site to lay out this ditch.

6.7 Gully B Diversions

To remove the diversion of Steam B and restore the natural drainage path, Westrek recommends constructing a 0.5 m cross-ditch at Wpt 1000. This should be armoured with available rock to minimize erosion.

6.8 Spur Roads in the South Area

In general, the spur roads to the south of the FSR do not appear to be an elevated hazard due to the generally dry conditions and the presence of shallow bedrock or rocky colluvium. The existing cross-ditches should be refreshed in accordance with the general guidelines in Section 6.10.

6.9 Spur 3 and Branch Trails

This area was dry due to the well-drained surficial deposits. Based on these observations, the hazard in that area is also considered to be low, and no work is necessary along these old roads.

6.10 General Maintenance and Upgrading

Most of the road drainage system (ditches, cross-ditches, and water-bars) are now beyond service life and require updating or repair. The following general specifications are recommended for upgrading the previously deactivated FSR and spur roads.

- All cross-ditches should be fully excavated into the road surface, rather than cut-and-fill. Excavated fill should be placed in the ditch on the downstream side and bermed up on the inside shoulder to help alert ATV users to their presence. Cross-ditches should have a minimum width of 0.5 to 0.75 m. They should be a minimum 0.5 m deep, and deeper on steep grades. Approach slopes should be no steeper than 2H:1V.
- Ditches should be cleaned out so they are a minimum 0.3 m deep. Where seepage is encountered, the cut slope should be stabilized with rockfill.
- Water-bars should be installed on roads with long sustained grades, whether it is prescribed in the tables or not.
- Cross-ditches for streams should be armoured. Rock armour can be sourced from talus slope located at Wpt 126 with minimal development (Photo 19, attached).
- Where slopes are to be pulled back (see Figure 1), the final slope should be no steeper than 1½H:1V (67%) , unless it is bedrock or otherwise specified.
- Material pulled back from the fill slope should end hauled to an approved spoil location.
- Out-slope the road surface and remove any grader berms where practical.

7 Closure

If there are any questions please contact either of the undersigned.

Westrek Geotechnical Services Ltd.

Jeffrey Pisio EIT
Junior Geotechnical Engineer

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
K. P. TURNER

Kevin Turner PEng
Senior Geotechnical Engineer

Sept 11, 2017

Tab 1

FIGURE 1 - Record of Site Observations and Recommended Upgrade Measures

Mount Ida - Haines Creek South F.S.R. (0825.05) Drainage Review

Prepared For:

BRITISH COLUMBIA

Ministry of Forests, Lands and Natural Resource Operations
Okanagan Shuswap Natural Resource District

758500 759200 759900 760600 761300 762000

5661100 5657400 5657700 5660000

HAINES CREEK
ANDREW BROOK
SALMON RIVER
STREAM A (DIVERTED)
STREAM A (NDP)
STREAM A
STREAM B
GULLY A
GULLY B
0825 050
SPUR 1
SPUR 2
SPUR 3
SPUR 4
SPUR 5
SPUR 6
SPUR 7
SPUR 8
SPUR 9
SPUR 10
Slide 1 April 22, 2017
Slide 2 May 3 - 10, 2017
Slide 3 May 3 - 10, 2017
Bk A
Bk B
Bk C
Sec 32, TP 18, Rge 10
Sec 29, TP 18, Rge 10
DL 1672
PD49998
PD49997
PD49996
PD49993
PD185260
C067193
C051944

Legend

Apex	Water Diversion (Points)	Road - Forest Service
Attention	Slide_p2	Road - Permit
Bedrock Exposure	Slide_p1	Road - Paved
Spring/Seepage	Draw	Road - Non-Status
Swamp	Gully	Trail
Dip	NCD	Bridge
Existing water-bar	S6	PullBack
Install water-bar	Flow	Landslide
Existing cross-drain culvert	Existing Drainage Path	Lake
Install cross-drain culvert	Proposed Drainage Path	River
Existing cross ditch	Natural Drainage Path (dry)	Swamp
Install cross ditch	Creeks (TRIM)	Watershed Sub-Basins
Maintenance required	Contour Index (100m)	Cutblocks
Site observation	Contour Interval (20m)	Private Land

N W E S

0 50 100 200 300 400 500 Meters

Westrek Project No. 017-045
Scale: 1:3,000
Document Name: Haines_Creek_5
Date: 7/27/2017
Projection: NAD 1983 UTM Zone 10N

For the source digital data please refer to the report titled " Mount Ida - Haines Creek South FSR (0825.05) Drainage Review".

Disclaimer: this map is for informational purposes and is not suitable for and was not prepared for legal, engineering or surveying purposes. Users of this information should review or consult the primary data and information sources to ascertain the usability of the information.

WESTREK CERTES

Tab 2

Photo 1 – *Typical section of road.*

Photo 2 – *Surface erosion at Wpt 629.*

Photo 3 – *Cross-drain culvert removed at Wpt 201.*

Photo 4 – *Exfiltration zone is approximately 10 m upslope of Wpt 307 and is the source of Andrew Brook.*

Photo 5 – *Slide 1 (Wpt 197). Photo faces towards the bush.*

Photo 6 – *Large spring at Wpt 172. Photo faces downslope towards town.*

Photo 7 – *Interception ditch between Wpt 188 and 190. Photo faces towards town.*

Photo 8 – *Slide 2. Photo taken May 16th and faces upslope from Wpt 176b towards the headscarp.*

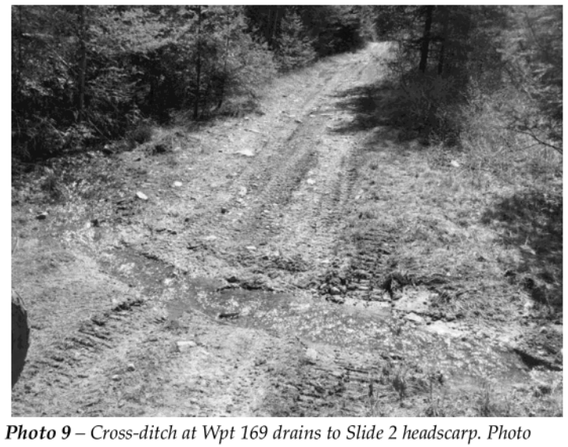


Photo 9 – *Cross-ditch at Wpt 169 drains to Slide 2 headscarp. Photo taken May 1and faces towards town.*

Photo 10 – *Slide 3 (Wpt 2201). Photo faces towards the bush direction.*

Photo 11 – *Seepage flow diverted by trail from Wpt 2200 to Slide 3.*

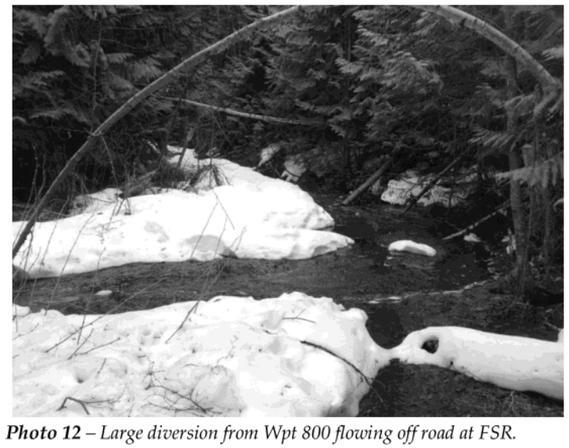


Photo 12 – *Large diversion from Wpt 800 flowing off road at FSR. Photograph faces towards the bush.*

Photo 13 *– Culvert recently removed at Wpt 137. Significant road surface erosion noted towards town.*

Photo 14 *– Road surface erosion between Wpt 137 and 139 suggests drainage was likely diverted along the FSR prior to removal of the culvert at Wpt 137. Photo is located at Wpt 139 and faces towards the bush.*

Photo 15 *– Diversion along old logging trail at Wpt 1108.*

Photo 16 *– Eroded take-off ditch at Wpt 149 drains into Gully A.*

Photo 17 – *Partial diversion of Stream B at Wpt 1000. Photo faces towards town.*

Photo 18 *– Road surface erosion between Wpt 1000 and 1005.*

Photo 19 *– Source of rock for armouring near Wpt 126.*

Tab 3

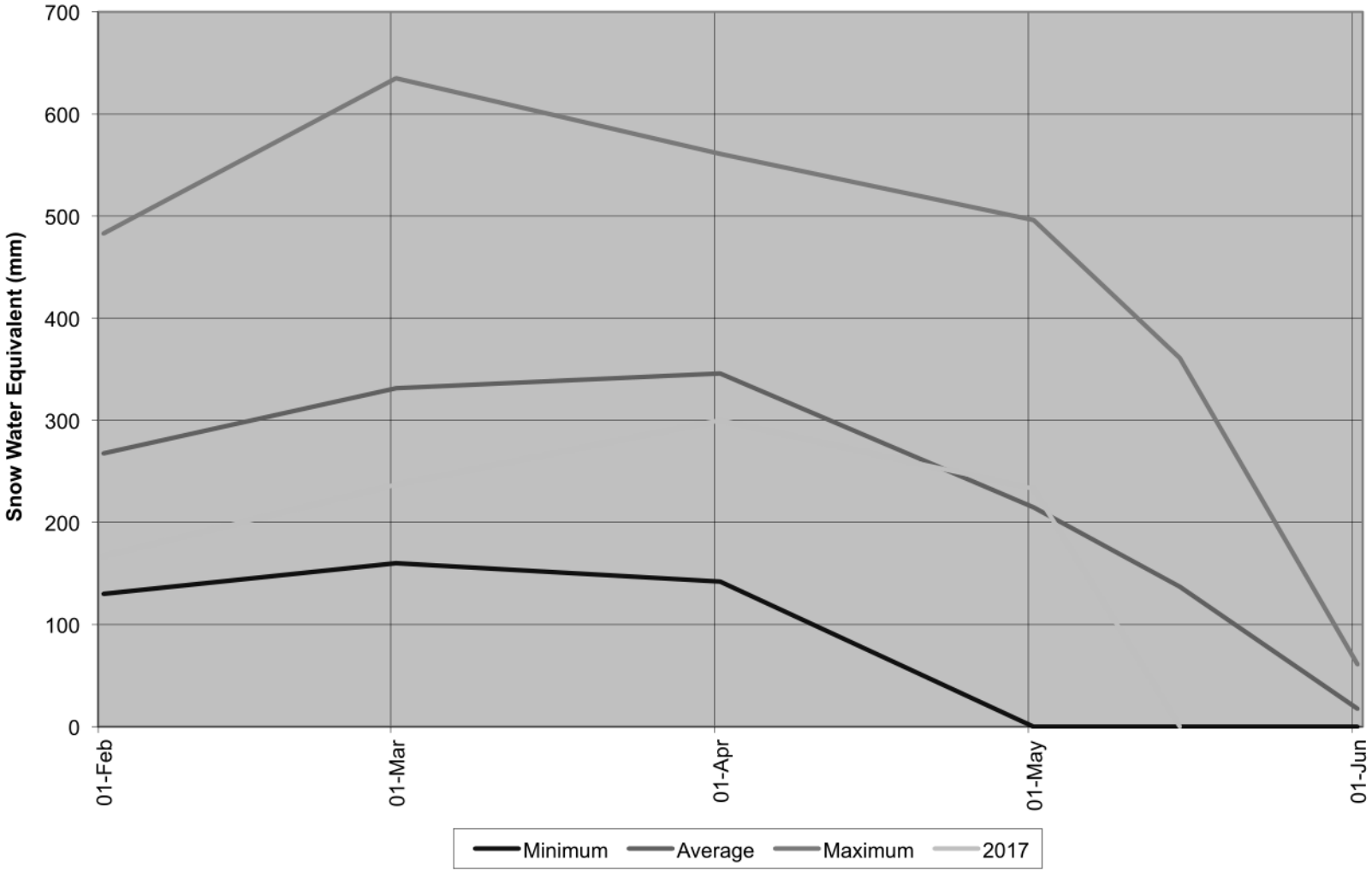
Station	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1166945	1911													
	1912				26.7	9.6	22.1	50.9	71.9	19.0	13.5	53.2	46.5	
	1913	80.0	22.9	13.0	13.2	31.9	69.1	46.5	19.8	44.2	46.7	33.4	19.9	440.6
	1914	91.3	36.8	25.1	22.7	24.4	36.2	19.4	8.1	41.1	30.5	64.9	29.1	429.6
	1915	54.7	11.4	24.4	48.9	89.2	64.7	65.0	12.7	18.5	33.6	29.4	76.2	528.7
	1916	21.5	57.9	39.4	19.4	27.6	48.2	72.8	25.4	8.1	4.8	39.9	57.9	422.9
	1917	92.3	39.4	39.5	60.1	27.6	43.5	1.8	32.9	35.9	35.8	27.3	92.9	529.0
	1918	165.2	46.8	11.2	9.0	15.9	37.1	20.1	71.4	5.3	64.9	52.4	45.6	544.9
	1919	52.1	58.6	43.3	21.6	27.0	16.2	17.8	12.0	39.4	38.3	79.3	71.4	477.0
	1920	61.8	11.7	44.6	41.3	28.6	70.5	9.6	45.1	66.8	71.4	61.0	73.6	586.0
	1921	79.8	56.4	20.4	21.8	27.0	44.5	9.2	21.6	32.1	35.6	85.9	37.3	471.6
	1922	60.2	54.7	50.4	29.3	18.1	1.5	7.5	38.6	52.0	67.3	15.2	81.4	476.2
	1923	77.3	28.3	29.4	20.3	55.9	127.6	19.4	32.8	19.8	25.3	40.6	85.7	562.4
	1924	73.7	24.8	6.6	7.2	7.2	28.0	21.6	54.5	41.3	29.5	53.9	92.5	440.8
	1925	112.1	53.9	15.5	12.4	16.8	23.3	9.4	27.9	10.5	21.8	16.6	77.7	397.9
	1926	82.2	23.5	5.6	10.1	28.9	14.7	1.5	19.4	25.2	22.5	42.9	67.8	344.3
	1927	51.6	35.8	14.0	12.0	53.2	24.9	36.1	68.9	56.4	42.8	78.7	61.5	535.9
	1928	19.1	11.4	44.8	35.1	19.0	54.5	8.6	6.6	1.3	19.4	66.5	27.2	313.5
	1929	30.5	2.6	23.3	47.2	24.5	82.2	14.5	34.1	32.4	39.1	21.8	63.3	415.5
	1930	38.2	60.1	23.2	29.3	51.6	37.1	5.9	17.8	22.9	72.9	51.2	20.0	430.2
	1931	51.2	20.5	30.2	22.3	19.2	73.7	7.4	10.6	46.7	47.1	52.7	70.0	451.6
	1932	48.8	36.8	62.9	53.6	31.7	33.6	25.8	29.5	20.0	57.3	83.9	54.7	538.6
	1933	42.0	33.1	59.6	7.3	38.8	33.6	24.4	15.7	52.6	101.5	37.1	77.7	523.4
	1934	45.1	6.6	57.1	11.9	28.6	13.0	28.3	11.4	88.3	35.6	74.1	77.8	477.8
	1935	95.3	28.7	34.0	19.6	34.3	43.4	108.9	12.6	25.6	47.2	37.4	48.0	535.0
	1936	111.1	69.4	59.4	52.0	25.5	57.8	12.7	23.1	49.5	15.0	17.0	101.2	593.7
	1937	63.2	97.0	19.8	72.0	29.7	62.0	39.4	29.4	12.3	24.1	113.5	70.4	632.8
	1938	44.3	58.3	19.7	10.8	13.9	43.9	36.9	26.8	37.9	32.1	46.8	114.3	485.7
	1939	75.4	39.2	24.5	4.2	42.2	87.2	12.3	5.8	25.7	46.6	22.1	103.5	488.7
	1940	53.5	74.5	113.2	18.9	55.1	14.8	30.2	10.7	13.5	56.6	43.7	59.8	544.5
	1941	37.8	49.6	10.8	12.9	71.9	85.2	46.1	31.9	90.2	31.8	43.9	48.1	560.2
	1942	12.0	10.9	8.2	25.9	78.3	48.4	123.0	29.1	22.3	42.5	11.5	25.0	437.1
	1943	27.6	11.2	16.6	21.0	27.6	49.4	28.3	22.6	8.8	69.9	19.9	57.0	359.9
	1944	40.1	58.0	27.0	38.2	33.9	27.3	25.4	49.9	64.2	35.2	72.4	33.3	504.9
	1945	93.5	42.8	28.4	36.1	15.2	33.4	39.2	26.0	49.0	84.6	79.5	68.8	596.5
	1946	114.2	51.5	21.4	31.4	34.9	67.5	11.5	32.5	36.4	44.2	76.8	57.7	580.0
	1947	60.1	37.5	30.8	31.5	33.0	70.7	49.4	31.2	20.8	96.5	53.6	61.3	576.4
	1948	27.9	72.6	32.2	72.6	99.2	19.7	61.2	68.8	38.4	32.0	68.3	54.6	647.5
	1949	22.1	87.6	26.7	18.1	46.4	49.8	39.5	32.7	17.3	48.2	27.5	92.1	508.0
	1950	42.0	43.9	39.4	37.2	32.1	16.0	37.4	17.1	9.9	78.2	63.1	78.4	494.7
	1951	73.2	75.5	56.9	15.7	21.0	9.2	36.8	31.8	32.2	96.5	45.8	116.0	610.6
	1952	62.3	24.6	15.5	22.7	20.5	59.6	17.1	4.3	8.4	7.3	9.9	106.2	358.4
	1953	42.9	45.2	29.8	46.5	16.5	112.2	24.6	87.6	19.2	33.1	54.3	67.4	579.3
	1954	93.5	28.6	41.6	28.0	70.7	44.5	49.5	86.9	21.2	16.4	107.6	46.4	634.9
	1955	49.5	37.0	27.5	11.4	35.7	41.0	56.0	11.2	23.6	57.2	75.0	82.8	507.9
	1956	77.8	23.1	33.9	9.3	13.1	67.2	31.5	48.8	29.3	58.2	65.0	94.6	551.8
	1957	58.8	26.4	57.3	25.7	41.5	96.1	25.8	82.8	10.2	34.1	36.0	40.7	535.4
	1958	90.7	86.2	37.8	52.2	28.5	46.2	15.7	20.9	64.5	38.1	64.0	64.0	608.8
	1959	64.7	40.7	20.5	13.8	45.1	64.3	25.6	57.4	128.0	63.1	43.2	22.3	588.7
	1960	64.5	52.3	17.3	28.9	73.3	35.2	3.3	73.0	31.0	34.9	42.1	52.7	508.5
	1961	23.2	59.4	36.7	35.1	46.3	44.7	80.2	36.6	30.5	72.9	32.6	62.3	560.5
	1962	59.5	6.9	21.6	32.5	29.8	34.3	34.0	46.3	32.9	49.0	45.8		392.6
	1963	27.2		43.7	70.0	15.5	38.7	33.9	40.6	34.2	19.5	69.5	50.9	443.7
	1964	92.8	29.0	43.2	9.2	32.6	64.1	72.4	62.1	85.1	8.6	45.9	57.4	602.4
	1965	80.1	48.5	9.0	31.5	27.4	29.1	15.2	107.1	28.4	19.1	43.8	68.1	507.3
	1966	79.9	22.2	24.2	36.8	44.2	69.3	66.8	33.6	13.8	32.2	42.6	69.6	535.2
	1967	79.7	18.6	34.1	21.3	20.8	26.7	8.1	15.2	20.2	124.4	36.7	70.0	475.8
	1968	63.9	31.6	37.5	13.5	31.7	33.4	17.1	60.5	33.5	45.8	43.6	97.7	509.8
	1969	110.4	21.7	24.6	47.7	21.4	44.3	39.0	22.9	94.6	32.1	60.2	56.5	575.4
	1970	71.6	15.0	28.0	16.3	26.5	21.5	29.7	24.4	41.1	50.6	66.5	57.6	448.8
	1971	88.5	55.5	47.7	22.9	42.0	73.1	24.5	26.2	26.6	59.4	71.6	153.8	691.8
	1972	78.3	41.2	81.9	38.6	29.7	35.7	65.1	20.2	81.2	25.9	33.4	60.7	591.9
	1973	17.0	80.8	33.4	4.8	17.9	55.9	8.9	12.5	31.3	68.1	93.0	61.0	484.6
	1974	76.2	45.5	54.2	40.3	52.3	13.6	47.5	18.5	10.2	4.9	69.8	101.1	534.1
	1975	94.2	84.1	20.0	15.8	30.0	50.9	21.3	46.6	9.7	86.3	76.4	45.8	581.1
	1976	68.0	20.6	27.2	23.3	44.9	54.8	38.6	142.5	16.1	32.1	13.8	35.1	517.0
	1977	24.5	40.2	28.2	13.3	25.0	30.5	55.9	32.2	45.6	23.0	96.1	106.7	521.2

Data in red was missing and was compiled by averaing previous data for that month.

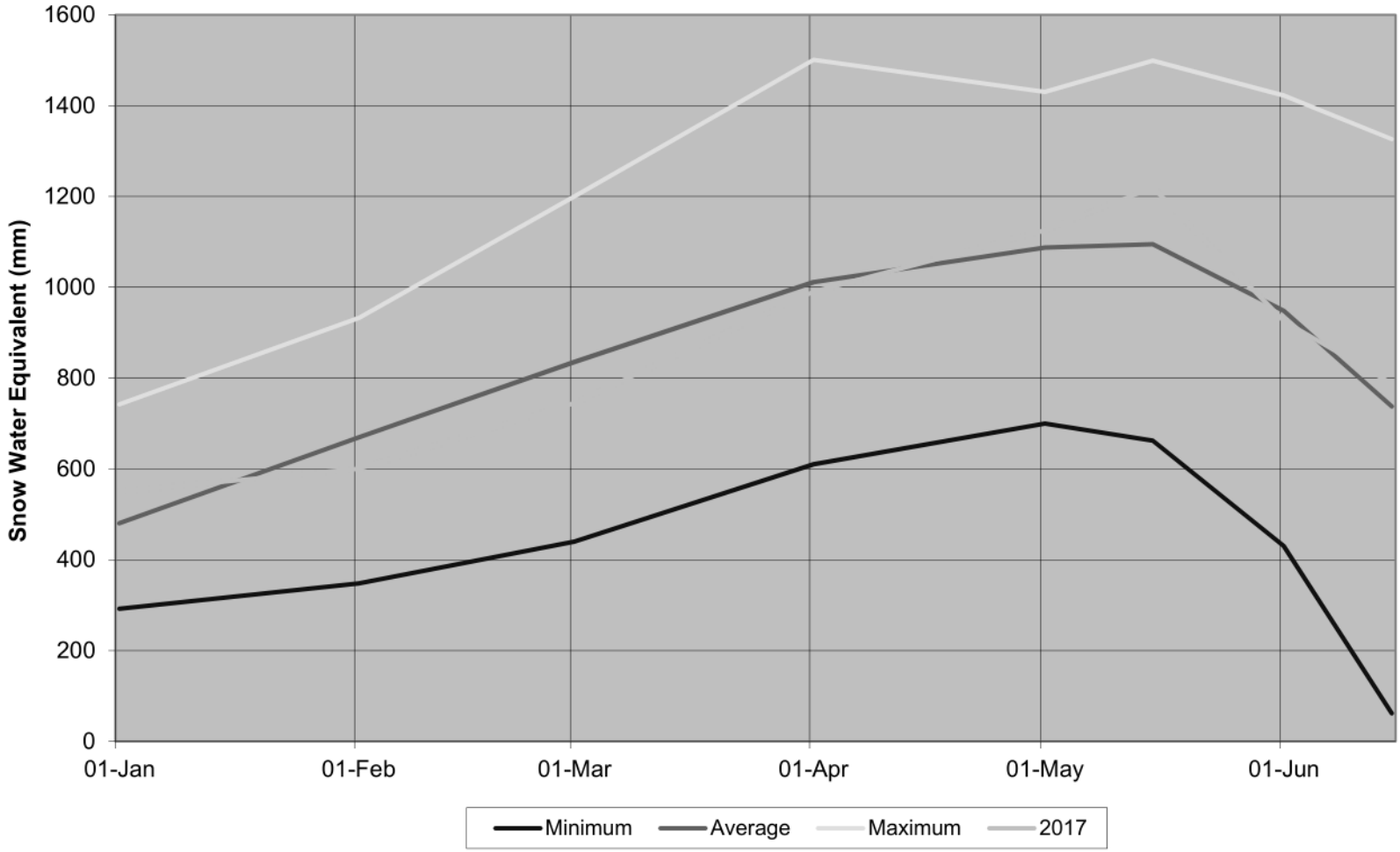
Station	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
	1978	55.6	21.0	21.3	41.7	67.3	31.1	22.9	62.6	71.8	30.5	39.3	19.5	484.6
	1979	30.1	46.6	14.5	39.9	25.8	19.2	13.2	34.4	40.8	55.8	11.2	30.6	362.1
	1980	23.8	46.8	15.8	40.0	58.8	83.6	41.7	35.6	52.4	32.6	63.2	75.0	569.3
	1981	12.8	52.6	14.4	43.7	65.8	70.6	95.0	32.8	47.2	85.8	55.0	69.3	645.0
	1982	125.6	44.2	25.0	24.8	36.4	58.8	93.8	36.5	35.9	32.4	87.7	73.0	674.2
1166R45	1983	73.1	95.3	75.2	56.2	23.3	71.9	127.2	14.0	30.6	30.5	111.0	58.3	766.6
	1984	49.7	19.0	52.4	25.9	85.1	58.1	20.3	28.3	34.3	41.2	102.0	54.0	570.3
	1985	12.0	30.0	12.4	30.2	51.3	41.5	22.8	41.0	67.5	86.3	32.2	49.6	476.8
	1986	43.5	46.4	48.2	60.9	47.9	87.6	69.1	3.8	79.4	21.4	54.6	54.0	616.8
	1987	44.6	29.0	37.6	36.3	26.6	17.9	58.4	34.4	22.2	12.2	52.8	78.1	450.1
	1988	17.0	48.5	40.6	80.8	53.3	87.1	48.5	48.1	87.8	49.2	94.9	51.0	706.8
	1989	43.0	34.0	51.3	28.5	98.7	56.6	50.4	75.9	50.8	46.4	55.4	64.4	655.4
	1990	87.5	27.5	32.2	21.4	73.2	122.4	48.6	82.4	3.8	72.4	85.8	90.4	747.6
	1991	52.0	34.8	25.6	43.4	52.8	43.8	29.8	72.6	13.4	23.6	96.0	15.4	503.2
	1992	115.0	27.6	25.4	43.5	23.8	47.0	49.0	13.8	65.0	47.4	122.8	138.0	718.3
	1993	95.0	6.0	47.4	70.6	51.2	60.6	57.2	30.8	15.4	54.0	55.6	65.6	609.5
	1994	62.3	40.5	32.9	30.5	38.4	49.5	36.6	69.8	21.6	66.0	80.0	72.2	600.3
	1995	96.8	33.8	58.2	48.9	20.0	63.2	33.0	63.2	36.7	84.0	124.1	65.7	727.6
	1996	57.6	51.0	37.6	55.8	119.6	32.6	34.6	31.0	114.2	118.2	156.2	148.2	956.6
	1997	81.0	50.0	51.6	47.0	71.1	69.8	150.0	21.2	97.2	75.2	47.8	58.8	820.7
	1998	95.2	32.4	47.8	36.8	11.6	51.0	7.6	7.2	22.4	61.8	101.0	114.8	589.6
	1999	63.2	40.5	50.2	34.6	71.9	99.4	58.2	60.0	37.0	59.8	87.6	90.7	753.1
	2000	86.0	39.0	89.6	36.8	77.4	61.0	51.3	29.5	24.1	50.2	26.4	89.0	660.3
	2001	42.0	19.0	29.5	39.0	67.2	80.1	61.0	34.9	18.7	83.0	57.3	145.5	677.2
	2002	60.0	37.0	25.0	41.7	87.5	52.2	11.2	9.5	19.6	16.6	46.4	58.6	465.3
	2003	85.3	8.7	42.3	58.0	51.4	83.3	5.9	5.2	41.6	62.8	49.0	54.0	547.5
	2004	87.0	13.0	15.5	28.9	81.3	68.2	21.0	70.5	51.3	40.2	58.0	68.3	603.2
	2005	63.7	39.6	20.6	31.2	54.3	101.9	19.0	25.7	38.9	102.2	55.4	29.2	581.7
	2006	63.5	30.0	22.6	47.0	55.2	54.0	18.3	14.7	37.0	18.5	126.6	74.3	561.7
116FRMN	2007	63.7	39.5	41.2	13.2	19.4	94.6	25.4	59.4	49.0	74.0	58.8	68.1	606.3
	2008	63.7	39.5	22.8	15.8	59.2	28.8	15.6	33.8	12.4	51.6	58.8	68.1	470.1
	2009	63.7	39.5	15.6	16.0	33.0	10.6	20.4	36.5	37.8	48.0	58.8	68.1	447.9
	2010	63.7	39.5	33.7	31.5	46.2	50.6	29.2	28.0	67.0	25.4	15.6	68.1	498.5
	2011	63.7	39.5	33.7	34.2	54.2	57.8	52.0	13.4	15.4	35.2	22.2	19.2	440.5
	2012	27.5	33.6	36.1	33.0	23.3	94.4	30.0	14.0	2.8	44.0	59.3	71.7	469.7
	2013	27.5	8.7	31.1	36.6	50.8	95.3	0.7	21.4	38.2	3.5	55.1	45.2	414.1
	2014	35.4	25.5	47.8	35.7	40.0	31.5	50.9	35.5	42.3	50.3	62.8	69.7	527.4
	2015	86.6	41.1	23.9	9.3	21.8	85.5	27.6	13.4	35.5	30.2	47.7	90.7	513.3
	2016	124.4	47.0	41.1	7.7	35.4	32.0	35.1	15.5	44.8	85.3	59.6	41.9	569.8
	2017	18.3	43.2	68.1	74.2	76.3	12.4							292.5
	Maximum	165.2	97.0	113.2	80.8	119.6	127.6	150.0	142.5	128.0	124.4	156.2	153.8	956.6
	Average	63.1	39.1	34.2	31.5	41.4	51.8	36.3	35.7	37.4	47.1	57.9	67.3	539.9
	Minimum	12.0	2.6	5.6	4.2	7.2	1.5	0.7	3.8	1.3	3.5	9.9	15.4	292.5

Data in red was missing and was compiled by averaing previous data for that month.

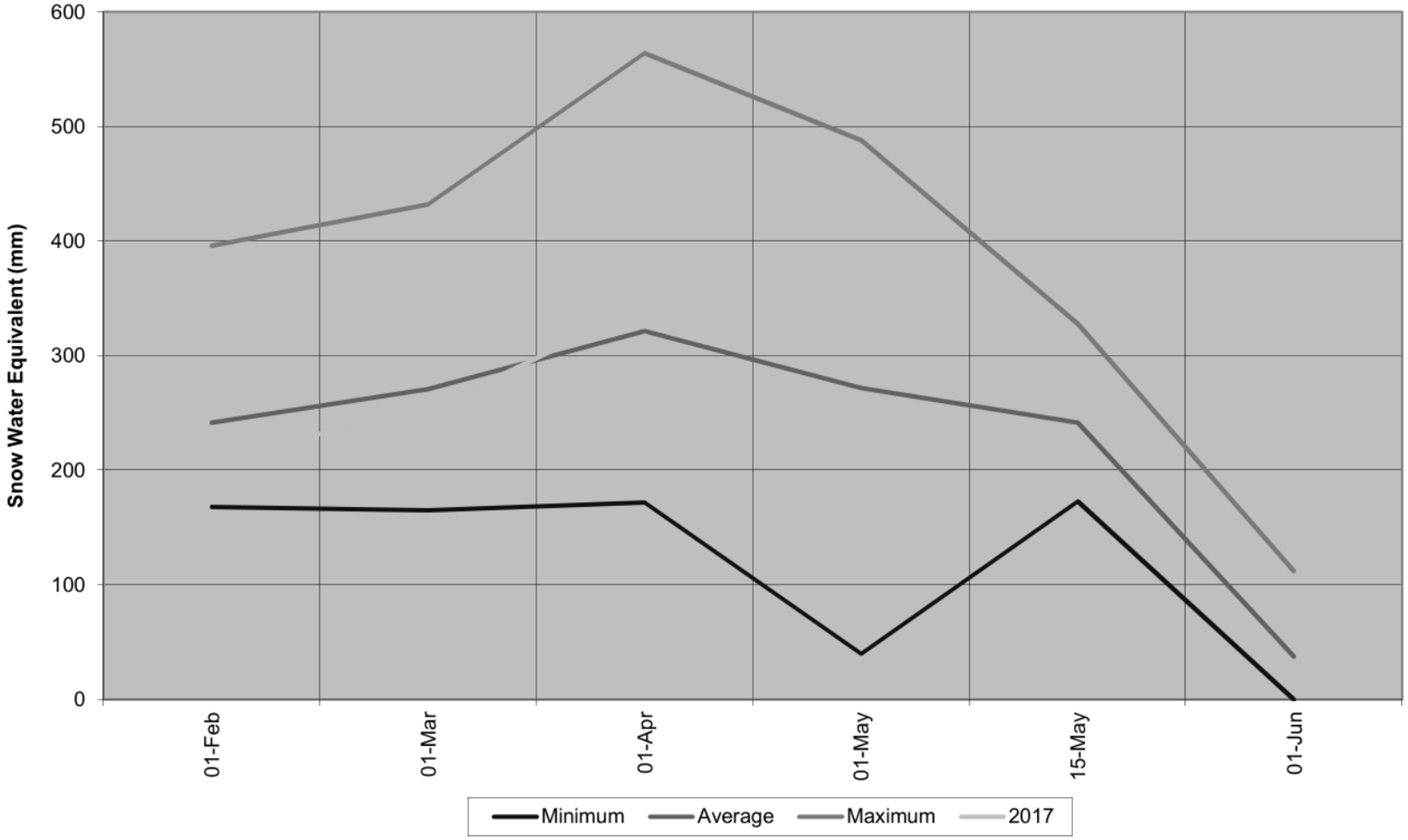
Anglemont (Sta 1F02)
Snow Water Equivalent (1956 to 2017)



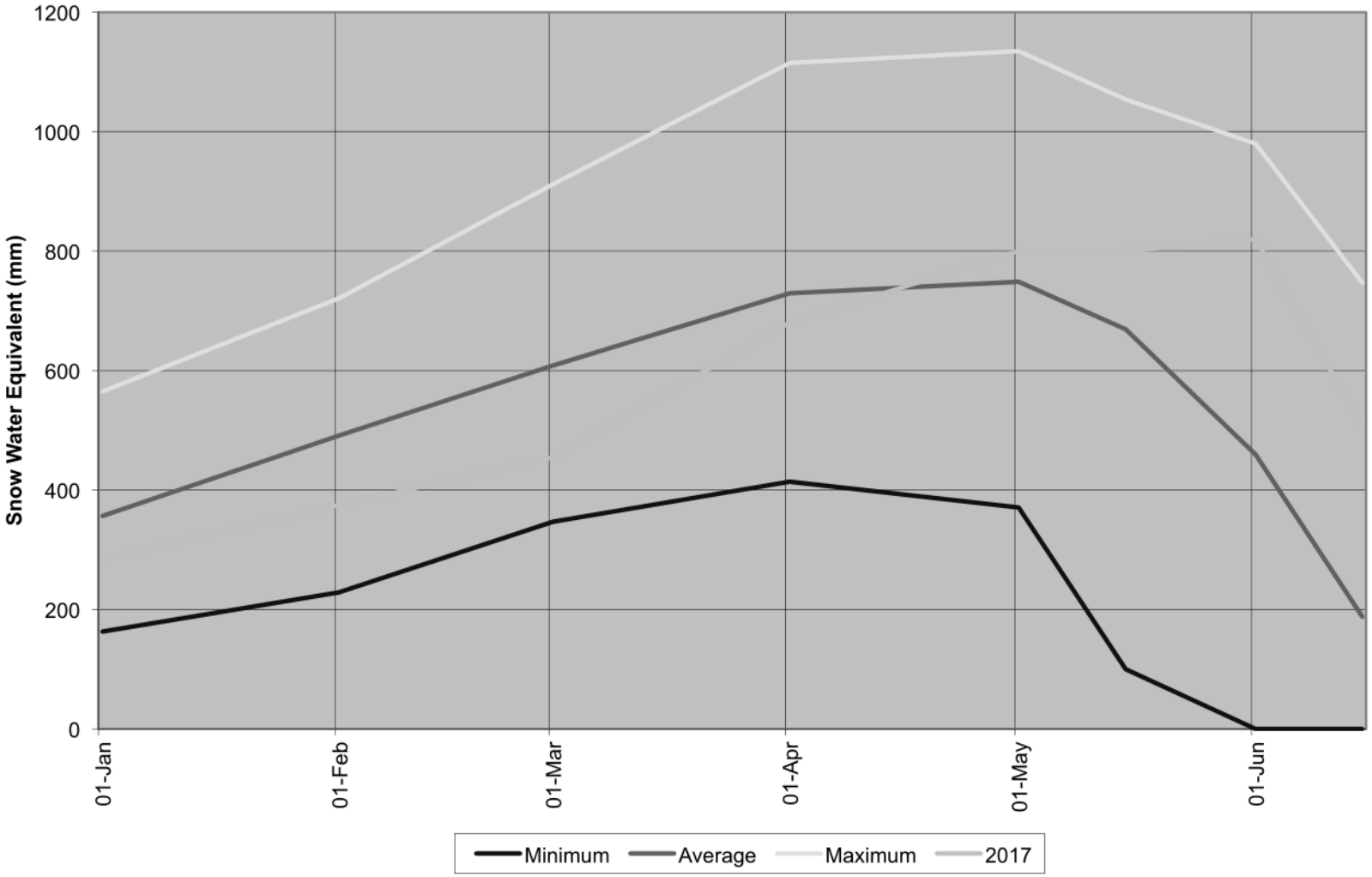
ENDERBY (Snow Course 1F04)
SNOW COURSE HISTORY (1963 to 2017)

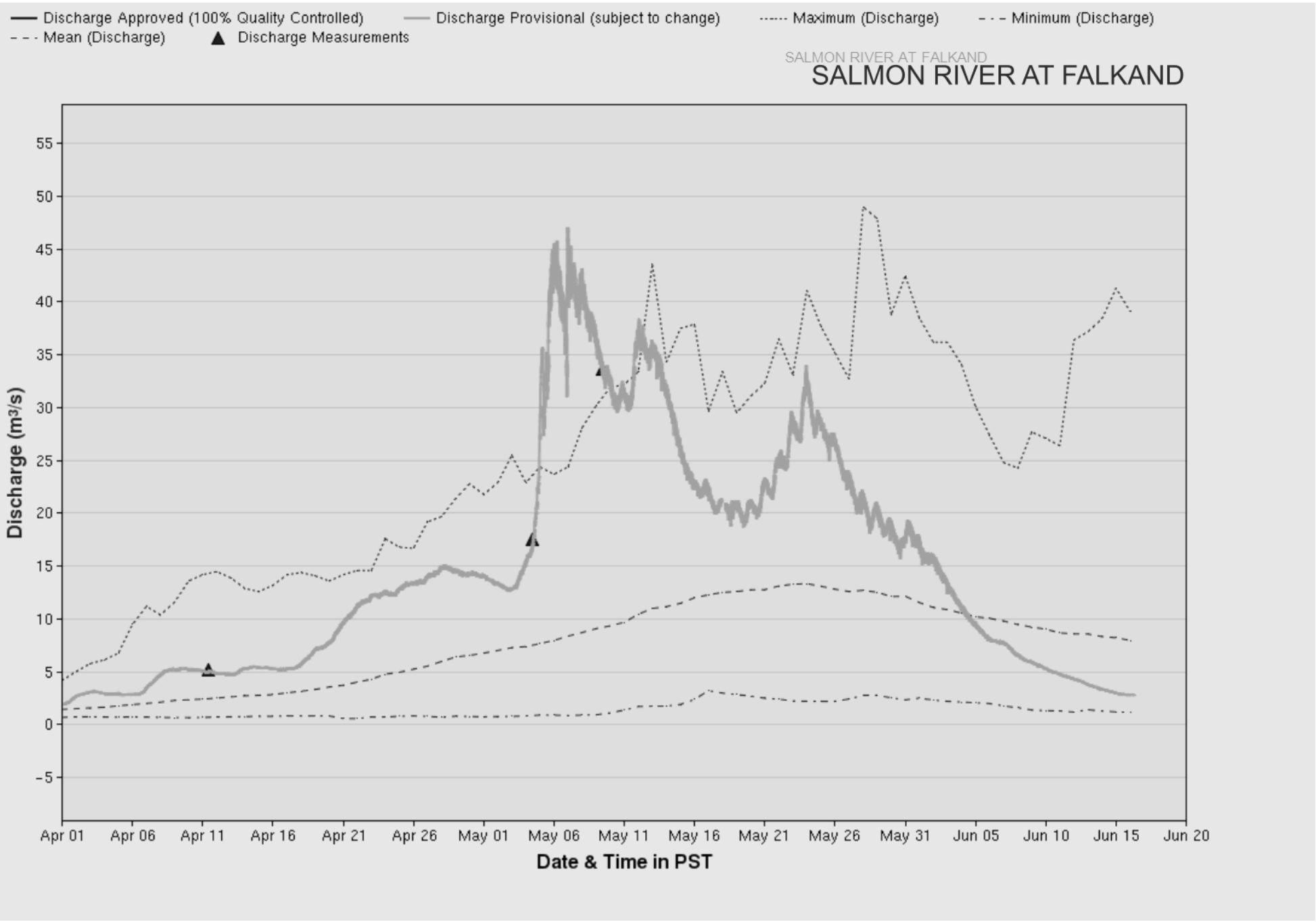


Bouleau Lake (Sta 2F21)
Snow Water Equivalent (1971 to 2017)



Silverstar (Sta 2F10)
Snow Water Equivalent (1959 to 2017)




Discharge Approved (100% Quality Controlled)
Discharge Provisional (subject to change)
Maximum (Discharge)
Minimum (Discharge)
Mean (Discharge)
Discharge Measurements
SALMON RIVER AT FALKAND
SALMON RIVER AT FALKAND
Discharge (m³/s)
55
50
45
40
35
30
25
20
15
10
5
0
-5
Apr 01
Apr 06
Apr 11
Apr 16
Apr 21
Apr 26
May 01
May 06
May 11
May 16
May 21
May 26
May 31
Jun 05
Jun 10
Jun 15
Jun 20
Date & Time in PST

Tab 4

Mount Ida - Haines Creek South FSR

Drainage Review Summary

MoFLRNO

UTM ZONE 10U, NAD83

DRAFT ISSUED FOR REVIEW

From	At	To	Grade	Easting	Northing	Length	Description	Map Symbol	Upgrade Recommendations / Remarks
	1		↑	759014	5607522		S6. 500 CMP stream culvert in gully. Gradient: +10%, -15%. Surficial deposits: silt-fine sand. Grade +10% town.	NDP, ESC	
	2		↑	759020	5607479		Dry draw. Gradient: -40%. Some erosion on road surface.	NDP	
	3		↑	759009	5607440		Seepage zone.	Seep	
	4		↑	759013	5607418		Signs of ponding.	Seep	
	5		↑	759014	5607357		Existing water bar. Draw. Gradient: 40%. Signs of large ditch flow and road surface flow on road. Possibly minor flow from slopes (50%) and trails above the road.	EWB, NDP	Install cross ditch. Maintain road surface.
	6		↑	759091	5607235		Draw. Gradient: -50%.	NDP, M	Maintain road surface.
	7		↑	759053	5607198		Draw. Very steep (120%) cutslope with shallow localized failures. Gradient: -65%. Old 5m wide fill failure 5m wide. Surficial deposits: fine sandy silt. Ditch paritally filled.	NDP, !, M	Clean ditch. Maintain road surface.
	8		↑	759003	5607156		Significant erosion to road surface. Road is in-sloped. Grade: +15% bush.	!, M	Maintain road surface.
	8a		↑	759005	5607177		Existing water bar.	EWB	
	9		↑	759109	5607076		Road surface erosion. Shallow draw. Slope: -15%. Grade: +5% bush.	NDP, IXD	Install cross-ditch. Maintain road surface.
	10		↑	759207	5607239		**Existing water bar.** Significant road surface erosion. Slope: -12%. Grade: +12% bush / -5% town.	EWB, M	Maintain water bar and road surface.
	11		↑	759256	5607335		**Existing 350 mm CMP cross-drain culvert.** Uncertain whether functional. Gradient: 20%, dry. Grade: +10% bush / +2% town.	EXC, EWB, NDP, M	Maintain water bar.
	12		↑	759302	5607394		**Existing water bar.** Slope: -15%. Grade: +12% bush.	EWB, M	Maintain water bar.
	13		↑	759302	5607440		Very shallow draw.	NDP, #, M	Install water bar.
	14		↑	759332	5607484		**Existing water bar.** Grade: +7% bush.	EWB	
	15		↑	759344	5607530		Draw. Slope: -50%. Grade: +10% bush, -5% town.	NDP, IWB, M	Install water bar.
	16		↑	759355	5607598		**Existing water bar**. Signs of recent flow, seeped in within 10m downslope.	EWB	Maintain water bar.
	17		↑	759364	5607633		Existing water bar.	EWB, M	Maintain water bar.
	18		↑	759383	5607683		NCD. Existing water bar. Debris flood deposits on the road and over shoulder. Cut slope failure 5m wide 10m . Grade: +10% bush.	EWB, NCD, !	
	20		↑	759414	5607780		S6 in 450 CMP existing stream culvert in gully. Existing water	ESC, S6, NDP	
	1800		↑	759162	5607995		**Existing water bar.** Filled. Dry. Slope: -80% / +10%.	EWB, M	Maintain water bar.

LEGEND:

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Other codes: CMP = corrugated metal pipe; CPP = corrugated plastic pipe; NCD = non-classified ditch age; POC = point of commencement; POT = point of termination. Slopes: + = above road, - = below road.

Mount Ida - Haines Creek South FSR

Drainage Review Summary

MoFLRNO

UTM ZONE 10U, NAD83

DRAFT **ISSUED FOR REVIEW**

From	At	To	Grade	Easting	Northing	Length	Description	Map Symbol	Upgrade Recommendations / Remarks
	205		↑	759434	5607916		**Existing reverse water bar.** Dry. No ditch. Recent minor flow. Grade: -10%.	EWB	
	204		↑	759502	5607930		**Existing water bar.** Dry. No ditch.	EWB	
	203		↑	759505	5607900		**Existing water bar** in swale. Dry. Slope: -45%. Swale below. Grade: -15%.	EWB, NDP	
	202		↑	759520	5607858		**Existing cross-ditch.** Dry. No ditch.	EXD	
	201		↑				**S6 stream in large draw. Culvert recently removed.** Part of log culvert in stream.	NDP, NCD, EXD, IXC	Install adequately sized stream culvert.
	200		↑	759536	5607798		**Existing cross-ditch.** Large flow from ditch. **Minor seepage. Slope:** -50%. Grade: -10% town.	EXD,Seep	
	199		↑	759541	5607769		**Existing cross-ditch.** Drains minor flow from ditch. **Small NCD** in draw partially diverted onto road. Grade: -10%.	EXD, NCD, NDP	Clean ditch from Wpt 199 to 200.
	198		↑	759542	5607732		**Minor seepage** in ditch. Ditch cleaned from here to Slide 1. Slope: -55%.	NDP, Seep,	
	197a		↑	759521	5607734		**Tension cracks adjacent to Slide 1.**	!	Pull back fill between ribbons 197 and 197a. See report for details.
	197		↑	759548	5607677		**SLIDE 1.**	!	Pull back fill between ribbons 197 and 197a. See report for details.
	196		↑	759588	5607648		**Small NCD through existing cross-ditch in draw.** Road ditch is dry.	NDP, NCD, EXD	
	195		↑	759601	5607597		**Medium NCD.** Drains into ditch to switchback.	NCD,	
	194		↑	759621	5607599		**Existing cross-ditch.** Moderate flow from ditch. Broad draw below. Grade: -15%.	NDP, EXD	
	193		↑	759651	5607655		**Medium NCD** in broad draw. Flows in ditch to Wpt. 193. Slope: -20%. Grade: -15%.	NCD, NDP	Install cross-ditch.
	192		↑	759660	5607681	15m	**Existing cross-ditch. Seepage** in ditch flows onto road. Small draw below.	EXD, Seep, NDP	Clean ditch towards 193 for 15 m.
	191		↑	759698	5607765		**Existing cross-ditch.** Moderate flow. Seepage. Gradient: -25%.	NDP, EXD,	Clean ditch towards 192 for 20 m.
	190		↑	759731	5607790		**Large ditch flow into take off ditch.** Trimmed cut slope failure. **Large seepage** from gravel cobble layer beneath 2.5 m sand, some silt.	Seep, !	
	189		↑	759739	5607745		**Existing cross-ditch** in draw. **Moderate NCD** in draw flows into interception ditch.	NCD, NDP, EXD	
	188		↑	759739	5607702		**Existing interception ditch.** 6x2x5 m cut slope failure. Draw below. Sand some silt exposed in failure. Large NCD.	NDP, !, NCD	
	187		↑	759740	5607674		**Moderate NCD** in draw into new ditch. Moderate ditch flow from further up. Minor flow on road. Grade: -10%.	NCD, NDP	

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Mount Ida - Haines Creek South FSR — **Drainage Review Summary**

MoFLRNO — UTM ZONE 10U, NAD83 — DRAFT ISSUED FOR REVIEW

From	At	To	Grade	Easting	Northing	Length	Description	Map Symbol	Upgrade Recommendations / Remarks
	186		↑	759731	5607639		**Existing cross-ditch with moderate flow in swale. Seepage** in ditch. Minor flow on road.Mmoderate flow in ditch. Grade: -9%.	EXD, Seep, NDP	Clean ditch to Wpt 187.
	185		↑	759729	5607578		Broad draw both sides. +45%. Grade -11%.	NDP	
	184		↑	759727	5607555		**Existing cross-ditch** in draw.	EXD, NDP	
	183		↑	759731	5607520		**Minor seepage** in ditch. Defined draw. Minor flow in ditch to 184.	NDP, Seep	Install cross-ditch.
	182		↑	759703	5607486		**Existing cross-ditch.** Broad draw below. Fill: 1.5 m. Gradient: -45%. Grade -2% town.	NDP	M
181		182					Surface flow on road from 181 to 182.		
	181		↑	759704	5607459		**Large NCD flows onto road.** No ditch. Gully below. Fill is -80% for 7 m.	NCD, NDP, M	Clean ditch to Wpt 182.
	180		↑	759710	5607446		Draw at end of switchback.	, NDP	
	179		↑	759731	5607447		**Existing cross-ditch**. Evidence of previous flow on road.	EXD	Deepen cross-ditch.
	178		↑	759751	5607500		**Large NCD** in draw. Flows in ditch to 179. Gradient: -40%. Bedrock exposed in ditch.	NCD, NDP, bedrock	Install cross-ditch.
	177		↑	759776	5607531		**Existing cross-ditch**. Dry. Shallow ditch. Slope: +50%. Grade: -13%.	NDP, EXD	
	176a		↑	759792	5607563		**SLIDE 2 impacted road** and deposited significant amount of debris. Debris recently cleared and pushed onto fill slope. Bedrock exposed in cut slope. No visible surface flow on track.	!	Pullback loose material from fill slope and end haul to suitable spoil site. See report for details.
	176		↑	759815	5607609		**Existing cross-ditch in swale. Small NCD.** All flow from ditch and road drains here. Recently cleaned.	EXD, NCD, NDP	
	175		↑	759838	5607617		**Large seepage. 8 m wide by 2.5 m high slope failure.** Fractured bedrock exposed in cut. Ditch partially plugged with sediment and trees; diverts flow onto road.	!, Seep	Clean sediment and trees out of ditch. Trim cutslope at failure to 1.5H:1V.
174		176					Ditch flow on road from 174 to 176		
	174		↑	759826	5607620		**Seepage** in ditch. Ditch plugged. Minor to moderate flow in	Seep, NDP	Clean ditch.
	173		↑	759858	5607651		**Existing cross-ditch. Small NCD.** All flow from road and ditch drains here. Large flow through EXD. Broad draw. Grade: -10%.	NDP, NCD, EXD	
	172		↑	759898	5607686		**Seepage zone with high flow.** Substantial flow onto road from here. No ditch. 90% of flow onto road to 173. Ditch starts 10 m down road.	Seep, M	Extend ditch to yellow ribbon to intercept all seepage flow.
	171		↑	759903	5607642		**Existing cross-ditch.** Dry. Slope: +35%. Grade: -10% town.	EXD	
	170		↑	759867	5607554		Draw. Dry. Gradient: -38% . Grade: -8% town.	NDP	

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Mount Ida - Haines Creek South FSR — **Drainage Review Summary**

MoFLRNO — UTM ZONE 10U, NAD83 — DRAFT ISSUED FOR REVIEW

From	At	To	Grade	Easting	Northing	Length	Description	Map Symbol	Upgrade Recommendations / Remarks
	169		↑	759878	5607546		**Large ditch flow into existing cross-ditch.** Broad draw below. Slope: -35%.	EXD, NDP	
	168		↑	759864	5607524		Draw below. Large flow in shallow ditch.	NDP, IXD	Install cross-ditch.
167		169					Moderate to large flow in ditch to wpt 169		
	167		↑	759870	5607502		**Seepage** in ditch. Grade: -9% town.	Seep	
	166		↑	759866	5607484		**Existing cross-ditch.** recently cleaned. **Small NCD** in large gully. Evidence of substantial flow on road surface.	NCD, EXD, NDP	
	165		↑	759855	5607427		**Moderate seepage** in ditch. Flow contained in recently cleaned ditch. Broad draw below. Swale above. Grade: -6% town.	Seep, NDP	Install cross-ditch.
	164		↑	759850	5607420		**Existing cross-ditch.** Recently cleaned. Drains all water on road surface from 163. Swale below. Grade: -8% town.	EXD	
	163		↑	759847	5607373		**Small NCD onto road 8 m from Wpt 159 EXD.** 50% of flow onto road. Grade: -10% town.	NCD, IXD	Install cross-ditch.
	162		↑	759850	5607376		**Existing cross-ditch.** dry.	EXD	
	161		↑	759846	5607343		**Existing cross-ditch.** Moist. Shallow ditch. Slope: +30%. Grade: -10% town.	EXD	
	160		↑	759876	5607326		**Minor seepage,** 1 m wide. Seeps into road. Draw above. 3m high bedrock in cut. No road ditch.	Seep, #, NDP	
	159		↑	759873	5607352		**Existing cross-ditch in swale.** dry. Grade: -18% town.	EXD	
	158		↑	759953	5607427		**Existing cross-ditch in draw.** Dry. Surficial deposits: sand some silt, mixed fragments colluvium. Slope: +30%. Grade: -12% town.	EXD, NDP	Deepen cross-ditch.
	157		↑	759969	5607417		**Existing cross-ditch**. Swale below. Evidence of recent minor flow. Shallow ditch.	EXD, NDP	
	156		↑	760040	5607500		**Existing cross-ditch.** Recently cleaned. Swale below. Evidence of	EXD, NDP	
	155		↑	760054	5607551		Swale below. Very shallow ditch, filled in several locations. Slope: -50%.	NDP	
	154		↑	760078	5607576		**Existing cross-ditch**. Moist. Evidence of minor previous flow. Slope: -35 / +35.	EXD	
	153		↑	760169	5607680		**Existing cross-ditch**. Dry. Very shallow ditch above. No ditch below.	EXD	
	152		↑	760235	5607695		**Existing cross-ditch.** Very shallow ditch. Slope: +55%. Grade: -15%.	EXD	
	151		↑	760248	5607746		**Seepage. Existing water bar** misses seepage. Draw with minor flow. Gradient: +30%. Fill: 1 m fill. No ditch. Minor seepage onto road seeps in road within ~15 m.	EWB, Seep, NDP, IWB	Install water bar.

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Mount Ida - Haines Creek South FSR

Drainage Review Summary

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From	At	To	Grade	Easting	Northing	Length	Description	Map Symbol	Upgrade Recommendations / Remarks
	150		↑	760302	5607781		**Large NCD in draw through existing cross-ditch.** Slope: -40%. Grade: -10% town.	EXD, NDP, NCD	
	149		↑	760374	5607815		**Existing take-off ditch. Large NCD.** Ditch is eroded with near vertical sidewalls up to 3 m high. Gradient -65%.	NCD	
148		149					Large ditch flow.		
	148		↑	760369	5607797		**Moderate NCD** in draw. Drains along ditch to Wpt 149.	NCD, NDP	
	147		↑	760357	5607775		**Existing cross ditch. Large flow.** Slope: -40%. Grade: -5%.	EXD	
	146		↑	760315	5607713		**Seepage zone** in 0.2m deep ditch. Large ditch flow in ditch to 147.	Seep	
	145		↑	760296	5607685		**Existing water bar.** Minor flow. Seepage from draw above. Draw below. Slope: -50% /+35%. Shallow ditch.	Seep, EWB, NDP, M.	Deepen water bar.
	144		↑	760305	5607669		**Existing cross-ditch.** No flow, moist. Slope: -50% / +55%. No ditch. Grade: -5%.	EXD	
	143		↑	760271	5607607		**Existing cross-ditch. Minor seepage** in ditch. Grade: -6%.	EXD, Seep	
	142		↑	760259	5607559		Dry draw. Ditch 0.1m deep. Grade -5% town.	NDP, IXD	Install cross ditch.
	141		↑	760235	5607523		**Existing cross-ditch. Dry.** Ditch from Spur 7 drains here. Very shallow ditch, plugged in several areas. Grade: -7% town.	EXD	
	140		↑	760219	5607486		**Existing cross-ditch. Dry**. Jct with Spur 7. Slope: -40%. Grade: -13% town.	EXD	
	139		↑	760227	5607432		**Existing water bar.** Dry. Evidence of substantial road surface flow to here. Fill 0.5m. Cut 1 m. Slope: +35 /-30%. Grade: -10% town.	EWB	
	138		↑	760229	5607372		**Existing water bar** with take off ditch. Broad swale below.	EWB, NDP	
	137		↑	760243	5607321		**Large NCD through existing cross-ditch.** Old culvert debris. Slope +25% / -35%. Evidence of substantial previous flow on road towards town. Grade -15% town.	EXD	
	136		↑	760250	5607299		Broad swale. Dry. No ditch. Outsloped road. Grade: -5% town.	NDP	
	135		↑	760245	5607203		**Existing water bar.** Dry. No ditch. Slope: 40%. Grade: -5% town.	EWB	
	134		↑	760246	5607177		**Existing water bar.** Dry. No ditch. Bench below. Surficial deposits: sand some silt, mixed fragments colluvium. Cut: 3 m cut, fill: 1.5 m. Grade -9%	EWB	
	133		↑	760252	5607113		Jct with Spur 8. Slope: -25%.		
	132		↑	760266	5607089		**2 m wide seepage zone.** Very shallow ditch toward town.	Seep	
	131		↑	760252	5607070		**Existing water bar.** Dry. No ditch. Grade -11% town.	EWB	

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Mount Ida - Haines Creek South FSR — **Drainage Review Summary**

MoFLRNO — UTM ZONE 10U, NAD83 — DRAFT **ISSUED FOR REVIEW**

From	At	To	Grade	Easting	Northing	Length	Description	Map Symbol	Upgrade Recommendations / Remarks
	130		↑	760244	5606985		**Existing water bar.** Dry. Shallow ditch, discontinuous. Slope: +24%/-35%. Grade -10% town.	EWB	
	129		↑	760246	5606939		**Seepage zone**, 10 m wide. Shallow ditch. Minor flow onto road. Flow seeps into road surface 5 m past seepage zone.	Seep	
	128		↑	760264	5606912		**Existing water bar.** Dry. Drains to take off ditch into draw at end of Switchback. Slope: -20%.	EWB	
	127		↑	760281	5606941		**Existing water bar.** Slope: -20%. Grade -2% town.	EWB, M	Extend water bar past shoulder to drain.
126		127					Minor diversion from station 126 to 127.		
	126		↑	760319	5606941		**2 m wide seepage zone.** Minor flow on road around switchback. Large talus slope above, good rock source. No ditch.	Seep	Good rock source from talus slope.
	125		↑	760308	5606906		**Existing water bar.** Dry. No ditch. Broad swale below. Grade -10% town.	EWB, NDP	
	124		↑	760305	5606886		**Existing water bar.** Dry. No ditch. Slope: +40%.	EWB	
	123		↑	760303	5606850		Water from 122 seeps into road here. No ditch. Grade -13% town.	NCD	
122		123					Water diverted from station 122 to 123		
	122		↑	760286	5606815		**Seepage.** End of ditch, Minor flow from ditch onto road.	Seep	
	121		↑	760285	5606794		**Existing cross-ditch. Moderate flow and shallow. Minor seepage in ditch.** Slope: -47%. Grade: -12 % town.	EXD, Seep, M	Deepen cross ditch.
	120		↑	760279	5606752		**Moderate flow on road.** Dry draw. Start of 0.2 m deep ditch.	NDP, IWB	Install water bar.
119		121	↑				**Minor flow on road to station 121.**		
	119		↑	760281	5606730		10m wide **seepage zone** onto road. Slope: -50%. Grade: -12%	Seep	
	118		↑	760281	5606686		**Existing water bar.** Moist, recent flow.	EWB	
	117		--	760295	5606628		Apex 10 m towards town. Broad swale downslope. No ditch. Slope: +37% / -37%.	NDP, Dip	
	116		↑	760284	5606606		**Existing water bar.** Broad swale below. No ditch. Grade -2% town.	EWB, NDP	
	115		↑	760307	5606564		**Switchback.** Blocky rock in cut and road, fractured, probably rippable. Possible source for rock armour. Bench above for 40 m. Cut is 1.5 m high. No ditch.	Bedrock	
	114		↑	760323	5606629		**Existing water bar.** No ditch. Slope: -31% / +45%. Grade: -11% town.	EWB	

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	113		↑	760381	5606712		**Existing water bar.** Dry. Drains onto bench. Ns -5% for 10, -42%. Sand, some silt, mixed fragments. Colluvium. Grade -9% town.	EWB	
	112		↑	760414	5606753		**Existing water bar with take off ditch. Dry.** Bedrock in road surface for 3 m. Slope: -33%. Grade: -10% town. No ditch.	EWB, #	
	810		--	760659	5606947		**Diverted S6 flows off road.**	NDP, Dip	
800		810					**Large volume of water diverted down road.**		
	800		↑	760759	5606957		**S6 diverted onto trail.** Draw above. Minor flow from further up trail. Gully gradient: -5%. Grade: -5%.	NDP, S6, !	Install berm across road to direct flow into draw. See report for details.
	806		--	760789	5606973		**Seepage.** Pooled water on road with minor flow both ways. No ditch. Grade -2% bush, -5% town.	Seep, Apex	
	805		--	760818	5606972		**Large NCD into well defined gully below.** Broad swale upslope. Gradient -15%.	NCD, NDP, Dip	
	804		↑	760830	5606977		**Seepage.** Moderate flow on trail.	Seep	

LEGEND:

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Mount Ida - Haines Creek South FSR - Spur Roads

Drainage Review Summary

MoFLRNO

UTM ZONE 10U, NAD83

DRAFT ISSUED FOR REVIEW

From	At	To	Grade	Easting	Northing	Length	Description	Map Symbol	Upgrade Recommendations / Remarks
Spur 1									
	629		↑	759103	5607020		JCT with FSR. Dry. Surficial depotsits: fine sandy soils.		
	628		↑	759166	5606958		Draw. Dry. Gradient: -15-20%. Grade: +7% bush.	IXD	Install cross-ditch
	627b		↑	759193	5606937		Grade: -7% town.		
	627a		↑	759211	5606882		Draw. Minor erosion on road sirface. Grade: +1% bush / -25% town.	IXD	Install cross-ditch.
	627		↑	759216	5606828		Minor ponding on road. Ditch dry. Grade: 0% town / 1% bush.		
	626		--	759231	5606755		Shallow draw in dip. Dry. Gradient: -15%. Grade: +3% / +3%.	NDP, Dip	
	625		↑	759255	5606671		Draw. Dry. Gradient: -20%. Surficial deposits: sandy; well drain. Grade: +5% bush, 0% town.		
	622		--	759212	5606344		Grade: ~0%. Surficial deposits: sandy.		
Spur 2									
	2200		↓	759321	5607613		Seepage flowing down trail. Br in cut slope.	Seep, #	
2200		2201					Moderate flow on road to Slide 3.		
	2200a		↓	759293	5607617		Large draw. Seepage in cut flows onto road to Wpt 2201. Slope: -60%.	Seep, NDP, IWB	Install water bar.
	2201		↓	759240	5607660		Headscarp of SLIDE 3. 3 m wide 3 m deep. Road surface flow into scarp. No road access beyond. Slope: -70% slope. Existing water bar 5 m past scarp.	!	Trim scarp. Construct berm on both sides of scarp. Post signs warning of hazard. See report for more detail.
Spur 3									
	1801		↓	759084	5607691		Road surface erosion. Dry. No ditch.	NDP, IWB	Install water bar.
	1802		↓	759024	5607697		Draw. Road access blocked by berm; becomes motorbike trail. Dry.	NDP	
Spur 4									
	600		↑	759409	5607746		Minor ditch flow. Debris Slide 1 on road. Grade: +8% bush.	!	Clean Slide 1 debris from road and ditch.
	601		↑	759422	5607696		Large NCD in track of Slide 1. Most flow is diverted 10m then over shoulder. Road surface flow from 602 flows off here. Grade: 10%.	!, NCD	
602		601					Water flows on road surface to Wpt 601.		
	602		↑	759416	5607656		Significant flow on road surface.		
	603		↑	759441	5607602		Seepage in draw. Slope: +50% / -65% fill. Grade: +15% bush / -12% town.	Seep, NDP	
604		603					Ditch flow.		

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Spur 4 continued…									
	604		↑	759443	5607547		NCD in draw. Slope: +40% / -75% No cross-ditch. Slope below is well drained, has some bedrock outcrops and talus. Grade: +15% bush.	NCD, #	
	605		↑	759443	5607496		Minor Seepage in draw. No ditch flow. Slope: -75%. About 40m lower are bedrock outcrops and talus. Grade: +8% bush.	Seep, NDP	
	606		↑	759465	5607414		Minor seepage zone about 30 m wide. Some ponding in ditch, and minor flow on road surface. Old cut slope failure 30m to south. Slope: 50-60%. Fill: 1-2m. Grade +2% bush.	Seep, NDP	
	607		↑	759468	5607326		Very minor seepage. No ponding. Draw downslope, bedrock outcrops upslope. Grade: +3% bush.	Seep, #, NDP	
	608		↑	759461	5607279		Shallow draw. Dry.		
	609		↑	759465	5607192		Old road fill failure, 8m wide. Dry. No ditch. Shallow draw. Grade: +8% bush.	NDP	
	610		↑	759435	5607204		Shallow bedrock. Road out-sloped. Dry. Slope: + 70%.	#	
	611		↑	759456	5607093		Draw. Dry. Slope: -70%. Grade: +2% bush.	NDP	
	612		↑	759466	5607054		Shallow draw. Dry. Grade: -3% bush.	NDP	
	613		↑	759440	5606978		Draw from above, Dry. Road grade +10% toward S.	NDP	
	614		↑	759460	5606898		Soils moist, but no water visible. Grade: 0% bush.		
	615		↑	759486	5606849		Shallow draw.Grade: +17% bush / 0% town.	NDP	
	616		↑	759593	5606667		Shallow draw. Dry. Slope: - 65%. Bedrock in cutslope. No ditch. Grade: +17% bush.	#, NDP	
	617		↑	759625	5606495		Frequent bedrock in cut slope. Frequent talus downslope. Dry. Slope: +90% / 80%. Grade: -10% town.	#	
	618		↑	759575	5606340		Talus and bedrock outcrop. Dry. Slope: -60% / +40%. Grade: -15% town.	#	
Spur 5									
	1610		↑	759728	5607404		**Existing water bar.** Dry. Bedrock in cut.	#, EWB	
	1609		↑	759730	5607309		**Existing cross-ditch.** Dry. Shallow ditch.	EXB	
	1608		↑	759734	5607241		**Existing water bar.** dry. No ditch.	EWB	
	1607		↑	759732	5607098		**Existing cross-ditch.** Drains minor flow from ditch. Slope: -55%. Grade -15% town.	EXD	
	1606		↑	759749	5607051		Minor seepage in shallow ditch.	Seep	
	1605		↑	759763	5607019		Bedrock in cut. Dry. Ns +40% -55%.	#	
	1604		↑	759800	5606899		**Existing water bar.** Dry. Slope: -60%. Surficial deposits: rubbly.	EWB	

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Other codes: CMP = corrugated metal pipe; CPP = corrugated plastic pipe; NCD = non-classified ditch age; POC = point of commencement; POT = point of termination. Slopes: + = above road, - = below road.

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From	At	To	Grade	Easting	Northing	Length	Description	Map Symbol	Upgrade Recommendations / Remarks
Spur 5 continued…									
	1603		↑	759796	5606806		**Existing water bar.** Dry.	EWB	
	1602		↑	759810	5606675		Dry.		
1601		1602					Talus below road. Slope: 80%.		
	1601		↑	759830	5606584		10 m wide bedrock outcrop.	#	
	1600		↑	759849	5606509		Dry. Slope: -65%. No ditch. Grade: -15%.		
Spur 7									
	1010			760272	5607539		**Seepage in swale.** Moderate flow onto road, seeps in before JCT. Broad swale below. No ditch.	NDP, Seep, IWB	Install water bar.
	1009		--	760381	5607610		**S6 in draw.** Gradient: -18%.	S6, NDP, Dip	
	1008		↑	760396	5607619		**Minor seepage** onto road. Flows to Wpt 1009.	Seep	
	1007		↑	760457	5607670	15m	**Minor seepage** onto road. Seeps into road 15 m down grade.	Seep	
	1006		--	760504	5607694		**S6 in gully.** Gradient: +25% / -30%. Grade: +3% town / +5% bush.	S6, NDP, Dip, IWB	Install water bar.
	1005		↑	760515	5607700		Draw.	NDP, IWB	Install water bar.
	1004		↑	760527	5607712		Swale.		
Spur 8									
	411		↑	760236	5607025		Shallow draw. Dry. Grade: -10% town / 12% bush.	NDP	
	410		--	760233	5606907		**Water from road surface flows off here.** Grade: +1% town / +5% bush.	NDP, Dip	
	409		↑	760236	5606897		**Seepage.** Slope: +28% / -25%. Grade: -5% town / 10% bush.	NDP, IWB	Install water bar.
	408		--	760235	5606845		**10 meter minor seepage zone. No ditch.** Cut: 1m. Fill: 1m fill. No ditch. Slope: +48% / -33%. Grade: +1% town / +10% bush.	Seep, Dip	
	407		↑	760229	5606802		No ditch, Dry. Slope: +60% / -25%. Grade: -6% town / 11% bush.	NDP	
	406		↑	760215	5606721		Bedrock in cutslope for 10m. No ditch, Dry. Slope: +30% / -40%. Grade: -8% town / 14% bush.	#	
	405		↑	760220	5606652		No ditch. Dry. Cut: 1.5m. Fill : 2m. Slope: 35% / -30% DH. Grade: -14% town / 12% bush.		
	404		↑	760236	5606507		Swale. Bedrock on road for 5m. No ditch, Dry. Slope: +55% / -10%. Grade: -5% town 17% bush.	#, NDP	
	403		--	760234	5606468		No ditch. Dry. Cut: 2.5 m. Fill: 2m fill. Slope: +25% / -45%. Grade: -17% home, 15% bush.	Dip	
	402		↑	760234	5606426		No ditch. Dry. Slope: +36% / -35%. Grade: -14% town / 9% bush.		

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Spur 8 continued…									
	401		↑	760207	5606279		Draw. No ditch. Fill 2m. Slope: +27% / -29%. Grade: -9% town/ 12% bush.	NDP	
	400		↑	760181	5606246		**Existing water bar.** Slope: +35% / -45%. Grade: -5% town / 10% bush.	EWB,	
Spur 9									
	111		↑	760433	5606753		Junction. No ditch.		
	110		--	760416	5606684		**Existing water bar** in swale. Dry. No ditch. Slope: -30%. Grade: +7% town.	EWB, Dip	
	109		↑	760403	5606629		**Existing water bar** in broad swale. Dry. Slope: -18% / +25%. No ditch. Grade: -8% town.	EWB, NDP	
	108		↑	760412	5606580		**5 m wide seepage zone.** Flows onto road for 10 m. No ditch. Slope: +13%. 3 m cliff below. Road on 8 m wide bench. Grade: -10%.	Seep, #	
	107		↑	760421	5606543		Bedrock in road surface for 25 m. Slope: -5% for 10 m, 3 m outcrop below / +15%. Road insloped. Grade: -11% town.	#	
	106		↑	760437	5606477		**Seepage.** Existing water bar. Entirely filled. No ditch.Water flows on road for 5 m, seeps in. Slope: -35% / +30%. Grade -15%.	EWB, Seep, M	Maintain water bar.
	105		↑	760456	5606461		**Existing water bar in draw.** Dry. No ditch. Slope: -25% / + 25%. Fill: 0.3m. Grade: -13% town.	EWB, NDP	
	104		--	760459	5606418		No ditch. Slope: -30%. Grade: -12% town.	Apex	
	103		--	760455	5606384		Draw. Dry. Gradient: -35% / +27%. Road outsloped. No ditch. Grade: +15% bush / +3% town.	NDP, Dip	
	102		↑	760453	5606364		**Existing water bar.** Dry. No ditch. Slope: +45% / -45%. Fill: 1.5 m .	EWB	
	101		--	760445	5606303		**Minor pooled water.** Broad draw. No ditch. Bedrock in cut. Road outslope. Slope: -50%. Grade: +10% bush, + 4% town.	#, NDP, Dip	
	100		↑	760438	5606281		**Existing water bar** in shallow draw. Dry. Slope: -35% / +15% for 10 m. No ditch. Grade +11% bush, - 6% town.	EWB, NDP	

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APPENDIX A
INTERPRETATION AND USE OF STUDY AND REPORT AND LIMITATIONS

1. STANDARD OF CARE.

This study and Report have been prepared in accordance with generally accepted engineering and geoscience practices. No other warranty, express or implied, is made. Geological and geotechnical studies and reports do not include environmental consulting unless specifically stated in the report.

2. COMPLETE REPORT.

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report which is of a summary nature and is not intended to stand alone without reference to the instructions given to us by the Client, communications between us and the Client, and to any other reports, writings, proposals or documents prepared by us for the Client relative to the specific site described herein, all of which constitute the Report.

IN ORDER TO UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS AND OPINIONS EXPRESSED HEREIN, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. WE CANNOT BE RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

3. BASIS OF THE REPORT.

The Report has been prepared for the specific site, development, design objectives and purpose that were described to us by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the document are only valid to the extent that there has been no material alteration to or variation from any of the said descriptions provided to us unless we are specifically requested by the Client to review and revise the Report in light of such alteration or variation.

4. USE OF THE REPORT.

The information and opinions expressed in the Report, or any document forming the Report, are for the sole benefit of the Client. NO OTHER PARTY MAY USE OR RELY UPON THE REPORT OR ANY PORTION THEREOF WITHOUT OUR WRITTEN CONSENT. WE WILL CONSENT TO ANY REASONABLE REQUEST BY THE CLIENT TO APPROVE THE USE OF THIS REPORT BY OTHER PARTIES AS "APPROVED USERS". The contents of the Report remain our copyright property and we authorise only the Client and Approved Users to make copies of the Report only in such quantities as are reasonably necessary for the use of the Report by those parties. The Client and Approved Users may not give, lend, sell or otherwise make the Report or any portion thereof, available to any party without our written permission. Any uses, which a third party makes of the Report, or any portion of the Report, are the sole responsibility of such third parties. Westrek accepts no responsibility for damages suffered by any third party resulting from unauthorised use of the Report.

5. INTERPRETATION OF THE REPORT.

(i) Nature and Exactness of Soil and Description: Classification and identification of soils, rocks, geological units, and engineering estimates have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature and even comprehensive sampling and testing programs, implemented with the appropriate equipment by experienced personnel, may fail to locate some conditions. All investigations utilising the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarising such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and all persons making use of such documents or records should be aware of, and accept, this risk. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. Where special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.

(ii) Reliance on Provided information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to us. We have relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, we cannot accept responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of misstatements, omissions, misrepresentations or fraudulent acts of any persons providing representations, information and instructions.

(iii) To avoid misunderstandings, Westrek should be retained to work with the other design professionals to explain relevant geotechnical findings and to review the adequacy of their plans and specifications relative to engineering issues. Further, Westrek should be retained to provide field reviews during the construction, consistent with generally accepted practices.

6. LIMITATIONS OF LIABILITY.

Westrek's liability will be limited as follows:

(a) In recognition of the relative risks and benefits of the Services to be provided to the Client by Westrek, the risks have been allocated such that the Client agrees, to the fullest extent permitted by law, to limit the liability of Westrek, its officers, directors, partners, employees, shareholders, owners, subconsultants and principals for any and all claims, losses, costs, damages of any nature whatsoever or claims expenses from any cause or causes, whether arising in contract or tort including negligence, including legal fees and costs and disbursements (the "Claim"), so that the total aggregate liability of Westrek, its officers, directors, partners, employees, shareholders, owners, subconsultants and principals:

i. if the Claim is satisfied by the re-performance of the Services proven to be in error, shall not exceed and shall be limited to the cost to Westrek in re-performing such Services; or

ii. if the Claim cannot be satisfied by the re-performance of the Services and:

1. if Westrek's professional liability insurance does not apply to the Claim, shall not exceed and shall be limited to Westrek's total fee for services rendered for this matter, whichever is the lesser amount. The Client will indemnify and hold harmless Westrek from third party Claims that exceed such amount; or

2. if Westrek's professional liability insurance applies to the Claim, shall be limited to the coverage amount available under Westrek's professional liability insurance at the time of the Claim. The Client will indemnify and hold harmless Westrek from third party Claims that exceed such coverage amount. Westrek shall maintain professional liability insurance in the amount of $2,000,000 per occurrence, $2,000,000 in the aggregate, for a period of two (2) years from the date of substantial performance of the Services or earlier termination of this Agreement. If the Client wishes to increase the amount of such insurance coverage or duration of such policy or obtain other special or increased insurance coverage, Westrek will cooperate with the Client to obtain such coverage at the Client's expense.

It is intended that this limitation will apply to any and all liability or cause of action however alleged or arising, including negligence, unless otherwise prohibited by law. Notwithstanding the foregoing, it is expressly agreed that there shall be no claim whatsoever against Westrek, its officers, directors, partners, employees, shareholders, owners, subconsultants and principals for loss of income, profit or other consequential damages howsoever arising, including negligence, liability being limited to direct damages.

(b) Westrek is not responsible for any errors, omissions, mistakes or inaccuracies contained in information provided by the Client, including but not limited to the location of underground or buried services, and with respect to such information, Westrek may rely on it without having to verify or test that information. Further, Westrek is not responsible for any errors or omissions committed by persons, consultants or specialists retained directly by the Client and with respect to any information, documents or opinions provided by such persons, consultants or specialists, Westrek may rely on such information, documents or opinions without having to verify or test the same.

(c) Notwithstanding the provisions of the Limitation Act, R.S.B.C. 2012 c. 13, amendments thereto, or new legislation enacted in its place, Westrek's liability for any and all claims, including a Claim as defined herein, of the Client or any third party shall absolutely cease to exist after a period of two (2) years following the date of:

i. Substantial performance of the Services,

ii. Suspension or abandonment of the Services provided under this agreement, or

iii. Termination of Westrek's Services under the agreement,

whichever shall occur first, and following such period, the Client shall have no claim, including a Claim as defined herein, whatsoever against Westrek.