May 17, 2019

Porcupine Wood Products Ltd.
Box 850
Salmo, BC
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Attn. Mike Kit

RE: TERRAIN STABILITY ASSESSMENT
DECEPTION CREEK, CP 409, ROAD CONSTRUCTION / RECONSTRUCTION
SPURS 1, 3, 4, 5 AND 6

INTRODUCTION

At the request of Mr. Mike Kit, RPF, of Porcupine Wood Products (PWP), Perdue Geotechnical Services Ltd. (PGS) conducted a geotechnical assessment for the proposed construction and reconstruction of the above-referenced roads within the Deception Creek operating area, Cutting Permit (CP) 409. The assessment was completed by Mr. Chris Perdue, P.Geo., Eng.L., of PGS on October 4 and 5, 2018.

The purpose of the assessment was to review the proposed road alignments and provide recommendations to minimize the potential for landslide initiation following road construction / reconstruction within or above potentially hazardous terrain.

SITE LOCATION

The proposed CP 409 development area is located along the southwestern side of the Lardeau River valley, approximately 12 km northwest of Meadow Creek, BC (see Figure 1). The study area is located in the Goat Range of the Selkirk Mountains within the Columbia Mountain System and is centered on UTM coordinates 494905E / 5575626N. The area is found on NTS map sheet 82K.035 in the Selkirk Forest District.

BACKGROUND INFORMATION

Terrain Stability Mapping

Detailed terrain stability mapping for the proposed development area was provided by PWP. The terrain hazard polygons are shown on Figure 2.

Bedrock Geology

Geological mapping of the study area, as illustrated by the Geological Survey of Canada (GSC) Open File 6184, Poplar Creek (R.I. Thompson and P. Dhesi, 2009), shows that the proposed development is underlain by meta-sedimentary and sedimentary bedrock of the Lardeau Group (phyllite and limestone, respectively). Field observations confirm the underlying bedrock types beneath the proposed development.

Biogeoclimatic Mapping

According to biogeoclimatic mapping completed for the area (Lardeau 82K map sheet), the proposed CP 409 development is situated within the Columbia-Shuswap Moist Warm Variant of the Interior Cedar Hemlock (ICHmw2). The area is considered to be within a moist climate region.

Resource Values

The following resources are considered potential elements at risk associated with the proposed development:

- According to the on-line database provided by the Ministry of Environment, Water Stewardship Division, and iMapBC websites, there are no licensed water users registered on either Deception Creek, or Mat Creek;
- Both Deception Creek and Mat Creek are directly connected to Meadow Creek, which is considered high value fish habitat.

RESULTS OF THE ASSESSMENT

A field assessment was completed with a foot traverse along each of the road alignments discussed herein. Unless otherwise stated, observations along the subject routes have been referenced to the existing hub stationing developed in the field by PWP. The following is a general description of the terrain along the proposed routes and their corresponding sections. The Geotechnical Recommendations Summary tables attached to this report include site-specific descriptions of the terrain conditions for each road section.

Spur 1

The proposed Spur 1 alignment diverges off the existing Deception Creek Road and ascends to the west for approximately 1,060 m to provide access within the proposed harvest area CP 409 Block 14. It is understood the proposed road will be built to a permanent standard.

According to previous terrain mapping, the terrain encompassing the initial, lower approximate half of the road length is unrated, or considered Stable (S) by default, while the final, upper remainder is rated Unstable (U) terrain, as shown on Figure 2. At the request of PWP, a geotechnical assessment was completed for the entire road length. A site plan of Spur 1 is shown in Figure 3.

The initial road section (up to Hub 16+15 m) extends across the remnant, coalescing alluvial fans of Deception Creek and Mat Creek. Slopes typically measured less than 20%. Soils observed along existing cut bank exposures, tree churns and shallow test pits consist of well-drained, granular deposits of silty sand and gravel. Soil thickness (depth to bedrock) is expected to be more than 3 m of the undisturbed ground surface.

The remainder of the road (up to Hub 57) extends across irregular and broken terrain with slopes generally measuring 20% to 60%. Limited, steeper slopes (up to 75%) were measured between Hubs 47 and 48. Soils consist of moderately well-drained deposits of silt-dominant till and colluviated till deposits affected by large, relic (inactive) landslide features. Soil depth is expected to exceed 3 m of the undisturbed ground surface.

Site conditions along the entire road length are considered predominantly moist. A small creek crosses the road at Hubs 16 and 29. A series of groundwater emergences were encountered within the areas affected by the relic landslide features and associated detached masses. The apex of the proposed switchback at Hub 42 is situated on gentle terrain within a zone of concentrated groundwater emergence.

No evidence of recent or imminent slope instability was identified along the proposed route or the immediate adjacent terrain during the field review.

Spur 3

The reviewed section of the proposed Spur 3 alignment diverges off an existing, un-named road and continues to the south for approximately 750 m to provide access within the proposed harvest areas, CP 409 Blocks 14 and 15. It is understood the proposed road will be built to a permanent standard.

According to previous terrain mapping, the entire road is encompassed by terrain rated as Unstable (U), as shown on Figure 2. At the request of PWP, a geotechnical assessment was completed for the entire proposed length. A site plan of Spur 3 is shown in Figure 3.

From Hub 02 to Hub 23, Spur 3 gradually descends adversely across irregular, gentle to moderately-sloping terrain. Hillside gradients generally range from 25% to 50% with limited, steeper slopes (up to 75%) encountered across the northern sidewall of the Deception Creek gully crossing. Soils along the initial road section consist of moderately well-drained deposits of silt-dominant till and colluviated till deposits affected by large, relic (inactive) landslide features. Soil depth is anticipated to be 2.5 m of the undisturbed ground surface.

Between Hubs 23 and 27+20 m, the proposed route crosses an incised creek gully with side wall slopes ranging from 60% to 75%. Soils consist of moderately well-drained accumulations of silty rubbly colluvium up to 2 m deep from the undisturbed ground surface.

The final road section (up to Hub 33), crosses slightly irregular and gullied, moderately-sloping terrain, across slopes measuring 30% to 50%. Soils consist of moderately well-drained deposits of silt till up to 2.5 m of the undisturbed ground surface.

Site conditions along the entire reviewed road length are considered predominantly moist. The road crosses Deception Creek at Hub 11 within an incised, bedrock-controlled gully. The north sidewall measures 70% to 75% with short slope lengths and exposed bedrock, while the southern sidewall encroaches of the detached mass of a relic (inactive) landslide feature. The road crosses a second, un-named and incised creek gully at Hub 25. Several lesser streams and groundwater emergences were encountered along the route.

No evidence of recent or imminent slope instability was identified along the proposed route or the immediate adjacent terrain during the field review.

Spur 4

The reviewed section of the proposed Spur 4 alignment diverges off an existing, un-named road and continues to the south for approximately 1,080 m to provide access within the proposed harvest area CP 409 Block 15. The initial approximate 290 m will utilize an existing alignment that was originally built in the 1960s and subsequently deactivated. The final 890 m will consist of newly built road. It is understood the proposed road will be upgraded and built to a permanent standard.

According to previous terrain mapping, the southern majority and a short, discontinuous section along the initial section are encompassed by terrain rated as Unstable (U), while the remaining length is unrated, or considered Stable (S) by default, as shown on Figure 2. At the request of PWP, a geotechnical assessment was completed for the entire proposed length. A site plan of Spur 4 is shown in Figure 3.

Previous road deactivation measures were completed up to Hub 11. Works included removing all existing cross-drain culverts and constructing surface drainage control measures (i.e. cross ditches). Overall, the reviewed length of the former access road is heavily vegetated with regenerative growth and appears stable in its present condition.

From Hub 01 to Hub 06, Spur 4 crosses the gentle slopes of a historic, colluvial or alluvial outwash plain with slopes measuring less than 20%. Soils consist of moderately well-drained deposits of sandy silt and gravel. The existing road grade is expected to contain a relatively high amount of coarse fragments. Between Hubs 06 and 11, the former alignment was built across gentle to moderate-sloping terrain. Hillside gradients measure 20% to 40% and soils consist of moderately well-drained deposits of silt till. Soil depth is expected to be in excess of 3 m of the undisturbed ground surface.

Site conditions along the initial road sections (up to Hub 11) are considered moist. The former alignment crosses Deception Creek at Hub 05, and appears to have previously utilized a log culvert. Several small streams and groundwater emergences were encountered along the lower, southern slopes within the confines of the Deception Creek gully.

From Hub 11 to Hub 33, the proposed alignment continues across variable terrain. Slopes typically measure 25% to 55%. Soils consist of moderately well-drained deposits of silt-dominant till and colluviated till deposits affected by large, relic (inactive) landslide features. Soil depth is anticipated to be 3 m of the undisturbed ground surface.

The proposed route continues across steep, gullied terrain between Hubs 33 and 37. Slopes range from 65% to 75% with soils consisting of silty rubbly colluvium. Soil depth is not expected to exceed 1.5 m of the undisturbed ground surface.

The final road section (up to Hub 41) crosses fairly uniform terrain, across slopes measuring 60%. Soils consist of well to moderately well-drained, shallow accumulations of silty rubbly colluvium amongst occasional exposures of meta-sedimentary bedrock (phyllite). Soil depth is expected to be less than 1 m of the undisturbed ground surface.

Site conditions along the final approximate 890 m transition from moist to dry towards the south. A series of small streams and groundwater emergences were encountered up to Hub 36. Site conditions are considerably drier along the final 140 m, as the road extends across a broad, bedrock-controlled topographic shoulder.

No evidence of recent or imminent slope instability was identified along the proposed route or the immediate adjacent terrain during the field review.

Spur 5

The proposed Spur 5 alignment diverges above the proposed Spur 4 route at Hub 18 and continues to the south for approximately 760 m to provide access within the proposed harvest area CP 409 Block 15. It is understood the proposed road will be built to a permanent standard.

According to previous terrain mapping, the terrain encompassing the initial approximate 100 m is unrated, or considered Stable (S) by default, while the southern remaining majority is rated Unstable (U) terrain, as shown on Figure 2. At the request of PWP, a geotechnical assessment was completed for the entire road length. A site plan of Spur 5 is shown in Figure 3.

The entire length of Spur 5 extends across irregular and broken terrain with slopes ranging from 25% to 60%. Soils consist of moderately well-drained deposits of silt-dominant till and colluviated till deposits affected by large, relic (inactive) landslide features. Soil depth is anticipated to be up to 2 m of the undisturbed ground surface.

Site conditions along Spur 5 are considered moist. Several small streams and groundwater emergences were encountered along its length.

No evidence of recent or imminent slope instability was identified along the proposed route or the immediate adjacent terrain during the field review.

Spur 6

The proposed Spur 6 alignment diverges below the proposed Spur 1 route at Hub 37 and continues to the north for approximately 60 m to provide access within the proposed harvest area CP 409 Block 14. It is understood the proposed road will be built to a permanent standard.

According to previous terrain mapping, the entire road is encompassed by terrain rated as Unstable (U), as shown on Figure 2. At the request of PWP, a geotechnical assessment was completed for the entire road length. A site plan of Spur 6 is shown in Figure 3.

The entire length of Spur 6 crosses irregular terrain across the detached mass of a relic (inactive) landslide feature. Slopes measure less than 30% with soils consisting of colluviated deposits of moderately well-drained, silt-dominant till. Soil depth is expected to be in excess of 3 m of the undisturbed ground surface.

Site conditions along the proposed route are considered moist.

No evidence of recent or imminent slope instability was identified along the proposed route or the immediate adjacent terrain during the field review.

Relic Slope Instability

A review of Light Detection and Ranging imagery (LiDAR, provided by PWP), in combination with ortho-imagery (Google Earth, 2004 and 2010) and field observations, has identified several large, relic landslide features throughout the proposed development area. A broader review reveals the southwestern side of the Lardeau River valley has been affected by a massive, detached bedrock mass extending from Cascade Creek to Deception Creek (approximately 6 km wide) and from the topographic height-of-land to the valley bottom (nearly 4 km long).

The cause of the instability is inferred to be the result of a loss of confining pressure during deglaciation of the Lardeau River valley, more than 10,000 years ago. Deep fractures likely developed within the weak, underlying meta-sedimentary bedrock (predominantly phyllite) in response to the immense weight of the overlying glacial ice that ultimately became the failure plane of the broad landslide feature. Groundwater is inferred to migrate within the deep fractures and emerge at sporadic locations, which may account for

several of the lesser landslide features within and adjacent to the proposed development area. No indication of recent movement or imminent slope instability was identified during the field review.

GEOTECHNICAL ASSESSMENT

The following discussion details the likelihood of a specific hazardous landslide initiating as a result of the proposed road construction / reconstruction. A hazardous landslide is considered the *landslide of significance*, which is the smallest landslide that could adversely affect one (or more) of the previously identified elements at risk. The likelihood of a landslide occurring is rated qualitatively as Very Low, Low, Moderate, High and Very High with respect to conventional (side cast) road construction techniques for permanent resource roads. The ratings are based primarily on the construction methods and historic performance of existing roads, the presence / absence of road-related slope instability, hillslope geometry, as well as professional judgment and experience of the author.

The ratings are identified in the attached Geotechnical Recommendations Summary (GRS) tables for each road section. A partial risk analysis will be completed only for road sections with a Moderate to Very High residual likelihood of landslide initiation, or where the proposed development is expected to adversely affect the stability of the adjacent (downslope) terrain. *Appendix A* defines the ratings used herein and details the methodology used to complete a partial risk analysis.

The assessment has determined that limited sections along the following roads extend across terrain rated as High hazard:

Spur 3 – Hub 23 to Hub 27+20 m
Spur 4 – Hub 33 to Hub 37

In general, the Moderate hazard rating is associated with side slopes typically ranging from 60% to 65%, while slopes in excess of 65% generally constitutes a High hazard. Alternative road construction recommendations are provided for these sections that are intended to reduce the residual hazard to Low or better.

The remaining length of Spur 3 and Spur 4 (both existing and proposed), as well as the entire lengths of Spurs 1, 5 and 6 are situated across terrain rated as Low, and may be built or reconstructed using conventional, side cast construction techniques. No construction limitations are recommended beyond standard road construction / reconstruction practices for permanent resource roads.

Road Reconstruction Recommendations (Spur 4 - Hub 01 to Hub 11)

Detailed road upgrade / reconstruction recommendations and prescribed culvert locations for the existing sections of Spur 4 are summarized in the attached GRS tables.

No significant limitations are recommended beyond standard road reconstruction practices for permanent resource roads. Overall, the existing road sections are of variable road widths and may require limited widening for operational use and, for the most part, typically require brushing, grading, ditch line improvement, in-filling surface drainage control measures (i.e. cross ditches) and installing cross drain culverts at prescribed locations. Clean, native soils and/or coarse rock should be used as fill material to increase the road width to a maximum running surface width of 5 m along linear road sections.

Road Construction Recommendations

Detailed road construction recommendations and prescribed culvert locations for the proposed roads are summarized in the attached GRS tables.

General Recommendations

Permanent roads should be built using clean, native soils. Three-quarter (¾) and Full Bench construction has been prescribed for limited sections of Spurs 3 and 4 as Moderate and High hazard terrain (respectively) where side hill gradients are considered too steep to support conventional, side cast fill slopes for longer-term or permanent use roads. It is likely that within sections prescribed for ¾ and Full Bench construction, short sections will exist where additional fill can be placed while maintaining a Low residual hazard rating.

Side cast road construction is recommended for the remaining lengths of Spurs 3 and 4, as well as the entire lengths of the other proposed roads discussed herein.

Overburden Material (OM) thickness, or depth to bedrock, is estimated in the GRS tables. The maximum recommended cut slope for OM (soil) is typically 100% (1H:1V). The recommended cut slope for competent (solid) bedrock is 400% (¼:1). Maximum cut slope angles of 80% are recommended for road sections built across fine-textured and/or wet site conditions where cut bank instability is expected to occur, as itemized in the attached GRS tables,

Fill slopes of 70% are recommended for road sections utilizing clean, silt-dominant mineral soil, while slightly oversteepened (80%) fill slopes are recommended wherever surficial materials are expected to consist of well-drained, rubbly colluvium and/or mixed rock fragments. Bedrock is only expected to be encountered during construction along the final length of Spur 4.

Spur 3 (Hub 42 Switchback)

The proposed Spur 3 switchback at Hub 42 is situated on a broad area of groundwater emergence zone within the detached mass of a relic (inactive) landslide feature. Slopes surrounding the switchback measure less than 25%. Considerably drier site conditions were observed to the south. As a result, the switchback is recommended to be relocated 20 m to the south.

Drainage Control Measures

Appropriately-sized cross drain culverts should be installed at all prominent surface watercourses to maintain the natural drainage patterns along the reviewed road sections, as itemized in the GRS tables. Additional culverts may be required where previously unidentified seasonal streams and/or groundwater emergence zones are encountered during construction.

Road construction practices and drainage control measures along access routes within and downslope of the proposed forest development (including seasonal surface drainage control measures during periods of non-operational use) will have the greatest influence on surface / sub-surface watercourses and slope stability.

The results of this assessment and the associated residual hazard assumes appropriate drainage control measures will be implemented along each road, including continuous ditch lines in between cross-drain culverts, or in-sloped road surfaces where minimal road widths are utilized.

Spur 4 (Hub 05) - Deception Creek Crossing

The proposed Spur 4 crossing of Deception Creek at Hub 05 appears to have formerly utilized a log culvert with limited vertical opening, as confirmed by the height of the road approaches. Cross-sectional measurements of the estimated Q_2 flow rate requires a minimum 1200 mm diameter culvert, which exceeds the depth of the existing crossing and adjacent road approaches. Alternatively, two (2) 800mm diameter culverts are recommended.

In addition, an estimated 200 m^3 of material is recommended to elevate the road grade across the broad colluvial outwash plain upstream of the existing alignment and provide sufficient burial depth of the recommended culverts.

Residual Hazard

Based on the nature of the terrain crossed by the proposed alignments discussed in this report and the anticipated soil conditions (i.e. genesis and drainage characteristics), the construction methods recommended above are expected to result in a Low (or better) residual hazard of landslide initiation both during and after construction. Road construction practices should be completed in accordance with Chapter 6 of the (former) Ministry of Forests and Range, *Engineering Manual* (Anonymous, 2006).

If soil conditions significantly differ from those identified in the GRS tables during construction, a subsequent field assessment should be completed by a geotechnical professional to provide appropriate construction parameters.

Provided all natural watercourses are appropriately managed and drainage control measures are maintained, the proposed road construction is not expected to have a significant adverse effect on hill slope hydrology or slope stability.

CLOSURE

This report has been prepared for the exclusive use of the Porcupine Wood Products Ltd. and their authorized representatives. The methods used herein are in accordance with generally accepted geological and geotechnical principles and practice. Site conditions are based on surface observations, shallow test pits and exposed soils. Deep, sub-surface exploration techniques were not used unless otherwise noted. Recipients of this report should be aware that sub-surface variability is inherent, as a function of natural geomorphic processes.

Any use of this report by a third party, or any reliance on or decisions to be made based on it are the responsibility of such third parties. Perdue Geotechnical Services Ltd. accepts no responsibility for damages incurred by any third party as a result of decisions made or actions based on this report. No other warranty is made, either expressed or implied.

Please contact the undersigned to resolve any questions or concerns regarding the foregoing information.

Regards,
PERDUE GEOTECHNICAL SERVICES LTD.

ORIGINAL SIGNED

Christopher G. Perdue, P.Geo., Eng.L.
Engineering Geologist

Attachments: Appendix A – Partial Risk Analysis
Geotechnical Recommendations Summary Tables (9 pages)
Figure 1 – Key Map (1:250,000 scale)
Figure 2 - CP 409, Development Overview Map (1:10,000 scale)
Figure 3 - CP 409, Spurs 1, 3, 4 and 5 Site Plan Map (1:5,000 scale)

APPENDIX A

Partial Risk Analysis

Partial Risk, P(HA), is defined as the product of the probability of a specific hazardous landslide occurring and the probability of that landslide reaching or adversely affecting the site occupied by a specific element. Partial risk is mathematically expressed as:

$$P(HA) = P(H) \times P(S:H) \times P(T:S)$$

P(H) is the probability (or likelihood) of occurrence of a specific hazardous landslide. P(S:H) is the spatial probability relating the potential of a landslide to reach or adversely affect the site occupied by a considered element. P(T:S) is the temporal probability of a mobile element to be at the affected site at the time the event occurs. Static elements, such as a bridge, road or a building for example, have a quantitative (numerical) value of 1 because it is certain that the element will be at the affected site when the event occurs. Under these circumstances and unless otherwise noted, the partial risk equation can be simplified and expressed as:

$$P(HA) = P(H) \times P(S:H)$$

The components of the partial risk analysis will be expressed qualitatively. Table 1 defines the likelihoods of a landslide occurring as a result of the proposed timber harvesting methods.

Table 1 - Landslide Occurrence

Likelihood of Occurrence, P(H)	Qualitative Definition
Very High	Landslide initiation is imminent or highly likely to occur shortly after timber harvesting or road construction has been completed. Evidence of naturally occurring instability identified within the proposed development area within the past 15 years. Evidence of development-related instability adjacent to the proposed development area with similar terrain characteristics and timber harvesting/road construction practices.
High	Landslide initiation as a result of the proposed timber harvesting or road construction is probable unless site conditions are significantly better than assumed. Subtle evidence of naturally occurring instability may be present.
Moderate	Landslide initiation is not likely to occur following the proposed timber harvesting or road construction but considered possible if one or more the assumed site conditions are significantly altered as a result of the proposed development.
Low	Landslide initiation following timber harvesting or road construction is considered unlikely, although is possible under exceptional circumstances (i.e. an extreme or anomalous hydrological event).
Very Low	Remote possibility of a landslide initiating as a result of the proposed timber harvesting or road construction.

Table 2 provides the qualitative definition of the potential spatial effect of a specific hazardous landslide to reach or otherwise affect a site occupied by an element.

Table 2 - Spatial Effect

Potential Effect, P(S:H)	Qualitative Definition
High	Landslide will reach or directly affect the considered element at risk (e.g. private or public infrastructure, high-value fish habitat or consumptive water source).
Moderate	Landslide will marginally affect the considered element. Possible termination within 200 m of the site. Secondary transport of sediment and/or small woody debris may affect the element.
Low	Landslide is unlikely to reach or affect the considered element. The terrain above the site is capable of intercepting or dissipating slide debris and the potential secondary affects.

Table 3 is an example of a linear partial risk matrix that illustrates the relationship between the potential landslide occurrence and its estimated spatial effect to an element.

Table 3 - Partial Risk Matrix

Partial Risk, P(HA)		Spatial Effect, P(S:H)		
		High	**Moderate**	**Low**
Landslide Occurrence, P(H)	**Very High**	Very High	Very High	High
	High	Very High	High	Moderate
	Moderate	High	Moderate	Low
	Low	Moderate	Low	Very Low
	Very Low	Low	Very Low	Very Low

For the purposes of this report, partial risk does not include the vulnerability of the element(s) at risk, and therefore, is not considered a completed estimate of risk. Partial risk is usually the preferred analysis method when insufficient information is known about the vulnerability of the element(s). The vulnerability of certain elements is best provided by professionals with a specific knowledge of the element(s) at risk.

Forest Resource Managers with a greater knowledge of the vulnerability of an element can determine the specific risk of an element by multiplying the assigned vulnerability rating with the partial risk value.

References

BC Ministry of Forests (2002). Forest Road Engineering Guidebook. Forest Practices Code of British Columbia. BC Ministry of Forests, Victoria, BC.

Wise, M.P., G.D. Moore and D.F. VanDine (2004). Landslide Risk Case Studies in Forest Development Planning and Operations. BC Ministry of Forests, Research Branch, Victoria, BC. Land Management Handbook No. 56.

Geotechnical Recommendations Summary Table

Section: Deception Creek (CP 409), Spur 1
Section Length: 1.060 km (total length)

Prepared for: Porcupine Wood Products Ltd.
Field Review Date: October 5, 2018

Stn from (m)	to Stn (m) (At)	Terrain Classification	Depth to Bedrock (m)	Side hill Slope (%)	Initial Hazard Rating [1] / Drainage Classification	Comments	Cut / Fill Slope (%)	Recommendations	Residual Hazard [2]
Hub 01	Hub 16 +15m	zsdCf	3.0	< 20	V. Low / w	Proposed alignment diverges off existing Deception Creek Road Slightly irregular, gentle terrain across Deception Creek and Mat Creek alluvial fans; permeable, coarse-grained soils; moist site conditions	80 / 70	Push-fill construction	V. Low
	Hub 06					Toe of relic colluvial deposition feature		Install 450mm culvert	
	Hub 12					Junction with proposed Spur 2			
	Hub 16					Small creek within shallow, broad drainage feature at base of incised gully; 5% channel gradient		Install 800mm culvert	
Hub 16 +15m	Hub 57	zxCb / zdMb	3.0	20 - 60	Low / mw	Road section crosses undisturbed, silt-dominant till deposits of and relic (inactive) landslide features consisting of colluviated till; irregular and broken terrain; moist site conditions	Cut 80 (OM) 400 (ROCK) Fill 70	Combined balanced bench and push-fill construction Max. 80% cut slope angles	Low
	Hub 29					Small creek within broad, shallow draw; 15% channel gradient; upslope of Hub 16		Install 800mm culvert	
	Hub 37					Junction with Spur 6 South flank of large, relic (inactive) landslide feature		Install 450mm culvert	
	Hub 42					Apex of switchback on gentle terrain; multiple groundwater emergences		Relocate switchback 20m south to avoid wet site conditions and excessive site disturbance	
	Hub 46					South flank of relic landslide feature; upslope of Hub 37; moist site conditions		Install 450mm culvert	

1 Initial hazard rating is based on site conditions capable of supporting conventional side cast (balanced bench) road construction practices.
2 Probability of specific hazardous landslide occurring as a result of the recommended construction measures. Refer to Appendix A for definitions.

Geotechnical Recommendations Summary Table

Section: Deception Creek (CP 409), Spur 1
Section Length: 1.060 km (total length)

Prepared for: Porcupine Wood Products Ltd.
Field Review Date: October 5, 2018

Stn from (m)	to Stn (m) (At)	Terrain Classification	Depth to Bedrock (m)	Side hill Slope (%)	Initial Hazard Rating [1] / Drainage Classification	Comments	Cut / Fill Slope (%)	Recommendations	Residual Hazard [2]
Hub 47	Hub 48			55 - 75		Short, steep section across flanking; relic landslide scarp; 15m to 20m above gentle slopes; dry site conditions No significant construction concerns			
	Hub 56 +15m					Moist site conditions within relic (inactive) landslide feature		Install 450mm culvert	
	Hub 57					End of traverse			

Geotechnical Recommendations Summary Table

Section: Deception Creek (CP 409), Spur 3
Section Length: 0.748 km (total reviewed length)

Prepared for: Porcupine Wood Products Ltd.
Field Review Date: October 5, 2018

Stn from (m)	to Stn (m) (At)	Terrain Classification	Depth to Bedrock (m)	Side hill Slope (%)	Initial Hazard Rating [1] / Drainage Classification	Comments	Cut / Fill Slope (%)	Recommendations	Residual Hazard [2]
Hub 02	Hub 23	zdMb / zxCb	2.5	25 - 50	Low / mw	Proposed alignment descends below existing, overgrown road; slightly irregular terrain; moist site conditions	Cut 100 (OM) 400 (ROCK) Fill 70	Balanced bench construction	Low
	Hub 3.1					Coalescent stream flow off old road, above		Install 600mm culvert	
	Hub 06					Moist site indicators		Install 450mm culvert	
	Hub 11					Deception Creek crossing 70% to 75% sidewall slopes across north sidewall (bedrock-controlled) Flashy, seasonal flow volumes Est Q_2 cross-section (2.5m x 0.25); 20% channel gradient; bedrock, boulder/cobble substrate		Install minimum 1600mm diameter culvert	
	Hub 12 +16m					Groundwater emergence		Install 450mm culvert	
	Hub 14					South flank of relic (inactive) slump feature		Install 450mm culvert	
Hub 23	Hub 27 +20m	zdCb - V	2.0	60 - 75	Mod. To High / mw	Deeply-incised creek gully crossing 10m deep; 60% to 75% sidewall slopes	Cut 100 (OM) 400 (ROCK) Fill 70	Combined ¾ and full bench construction Limited material may be placed within gully to elevate road grade; spoil excess material outside drainage feature	Low
	Hub 25					Creek crossing 25% channel gradient (flashy)		Install 800mm culvert	

1 Initial hazard rating is based on site conditions capable of supporting conventional side cast (balanced bench) road construction practices.
2 Probability of specific hazardous landslide occurring as a result of the recommended construction measures. Refer to Appendix A for definitions.

Geotechnical Recommendations Summary Table

Section: Deception Creek (CP 409), Spur 3
Section Length: 0.748 km (total reviewed length)

Prepared for: Porcupine Wood Products Ltd.
Field Review Date: October 5, 2018

Stn from (m)	to Stn (m) (At)	Terrain Classification	Depth to Bedrock (m)	Side hill Slope (%)	Initial Hazard Rating [1] / Drainage Classification	Comments	Cut / Fill Slope (%)	Recommendations	Residual Hazard [2]
Hub 27 +20m	Hub 33	zdMb - V	2.5	30 - 50	Low / mw	Slightly irregular, gullied terrain; silt-dominant till; moist site conditions	Cut 100 (OM) 400 (ROCK) Fill 70	Balanced bench construction	Low
	Hub 30					Incised (dry) gully 6m to 7m deep; 70% sidewall slopes		Install 450mm culvert	
	Hub 32					Shallow (dry) draw		Install 450mm culvert	
	Hub 33					End of traverse			

Geotechnical Recommendations Summary Table

Section: Deception Creek (CP 409), Spur 4
Section Length: 1.080 km (total length)

Prepared for: Porcupine Wood Products Ltd.
Field Review Date: October 4, 2018

Stn from (m)	to Stn (m) (At)	Terrain Classification	Depth to Bedrock (m)	Side hill Slope (%)	Initial Hazard Rating [1] / Drainage Classification	Comments	Cut / Fill Slope (%)	Recommendations	Residual Hazard [2]
Hub 01	Hub 06	szdCp	3.0	< 20	V. Low / mw	Existing road originally built in the late 1960s Heavily overgrown and brushy; sufficient operational width (min. 5m); previous road deactivation works completed (cross-drain removal, surface drainage control) Slightly irregular, gentle terrain; coarse-grained, silt-dominant alluvial outwash material; moist site conditions Road grade expected to contain high amount of coarse fragments		Reconstruct as required	V. Low
	Hub 05					Deception Creek crossing Previous log culvert removed; present channel poorly-confined across alluvial outwash plain; insufficient height of existing approaches to install large, single culvert Est. Q_2 cross-section (1.8m x 0.2m); 5% to 10% channel gradient		Elevate road grade along approaches to contain upstream floodplain area Install two (2) 800mm diameter culverts	
Hub 06	Hub 11	zdMb	3.0	20 - 40	Low / mw	Route continuous along existing, overgrown alignment; sufficient operational width; surface drainage control deactivation works (cross ditches) Deep, silt-dominant till soils; moist to wet site conditions		Reconstruct as required Establish continuous ditch line and install recommended culverts	Low
	Hub 08					Groundwater emergence; seasonal stream flow		Install 450mm culvert	
	Hub 09					Existing cross ditch; small stream		Install 450mm culvert	

1 Represents the likelihood of road-related instability anticipated along the existing road section in its present condition. Or else identifies initial hazard rating based on site conditions capable of supporting conventional side cast (balanced bench) road construction practices along proposed road section.
2 Probability of specific hazardous landslide occurring as a result of the recommended construction measures. Refer to Appendix A for definitions.

Geotechnical Recommendations Summary Table

Section: Deception Creek (CP 409), Spur 4
Section Length: 1.080 km (total length)

Prepared for: Porcupine Wood Products Ltd.
Field Review Date: October 4, 2018

Stn from (m)	to Stn (m) (At)	Terrain Classification	Depth to Bedrock (m)	Side hill Slope (%)	Initial Hazard Rating [1] / Drainage Classification	Comments	Cut / Fill Slope (%)	Recommendations	Residual Hazard [2]
	Hub 11					Wet site conditions		Install 450mm culvert	
Hub 11	Hub 33	zdMb / zxCb	3.0	25 - 55	Low / mw	Silt-dominant, colluviated till soils; moist site conditions	Cut 80 (OM) 400 (ROCK) Fill 70	Balanced bench construction Max 80% cut slope angle	Low
	Hub 15					Small stream		Install 450mm culvert	
	Hub 18					Junction with Spur 5; moist site conditions		Install 450mm culvert	
	Hub 22					Moist site conditions		Install 450mm culvert	
	Hub 23					Seasonal stream draw		Install 450mm culvert	
	Hub 25					Small stream emerges from toe of relic deposition feature upslope		Install 450mm culvert	
	Hub 28					Groundwater emergence		Install 450mm culvert	
	Hub 31					Shallow (dry) draw		Install 450mm culvert	
Hub 33	Hub 37	zxCbv - V	up to 1.5	65 - 75	High / mw	Steep, gullied terrain downslope of relic landslide feature; moist site conditions; bedrock expected to be encountered within 1.5m of ground surface	Cut 100 (OM) 400 (ROCK) Fill - -	Full bench construction Utilize limited volumes of coarse, angular rock as fill material within drainage features and spoil excess material along moderate-sloping terrain within preceding road section	Low
	Hub 34					Shallow, moist draw; groundwater expected to be encountered during construction		Install 450mm culvert	
	Hub 35					Shallow, moist draw; groundwater expected to be encountered during construction		Install 450mm culvert	

Geotechnical Recommendations Summary Table

Section: Deception Creek (CP 409), Spur 4
Section Length: 1.080 km (total length)

Prepared for: Porcupine Wood Products Ltd.
Field Review Date: October 4, 2018

Stn from (m)	to Stn (m) (At)	Terrain Classification	Depth to Bedrock (m)	Side hill Slope (%)	Initial Hazard Rating [1] / Drainage Classification	Comments	Cut / Fill Slope (%)	Recommendations	Residual Hazard [2]
	Hub 36					Shallow, moist draw; groundwater expected to be encountered during construction		Install 450mm culvert	
Hub 37	Hub 41	zxCv / Rk	up to 1.0	60%	Low / w, mw	More uniform terrain; shallow colluvial soils amongst exposed bedrock; dry site conditions Road grade expected to contain high amount of coarse rock	Cut 100 (OM) 400 (ROCK) Fill 80	Balanced bench construction	Low
	Hub 41					End of traverse			

Geotechnical Recommendations Summary Table

Section: Deception Creek (CP 409), Spur 5
Section Length: 0.763 km (total reviewed length)

Prepared for: Porcupine Wood Products Ltd.
Field Review Date: October 4, 2018

Stn from (m)	to Stn (m) (At)	Terrain Classification	Depth to Bedrock (m)	Side hill Slope (%)	Initial Hazard Rating [1] / Drainage Classification	Comments	Cut / Fill Slope (%)	Recommendations	Residual Hazard [2]
Hub 01	Hub 28	zxCb / zdMb	up to 2.0	25 - 60	Low / mw	Proposed alignment diverges from Spur 4 at Hub 18; irregular, broken terrain affected by large, relic (inactive) mass wasting; fine-grained colluviated till soils; moist site conditions	Cut 80 (OM) 400 (ROCK) Fill 70	Balanced bench construction Max. 80% cut slope angles	Low
	Hub 05					Upslope of Spur 4 Hub 22 recommended culvert; moist site conditions		Install 450mm culvert	
	Hub 06					Seasonal stream		Install 450mm culvert	
	Hub 08					Upslope of Spur 4 Hub 25 recommended culvert; moist site conditions		Install 450mm culvert	
	Hub 11 +15m					Upslope of Spur 4 Hub 28 recommended culvert; moist site conditions		Install 450mm culvert	
	Hub 15					Upslope of Spur 4 Hub 31 recommended culvert; moist site conditions		Install 450mm culvert	
	Hub 17					Downgrade edge of moist site; NP patch		Install 450mm culvert	
	Hub 19					Poorly confined, seasonal stream within NP patch		Install 450mm culvert	
	Hub 27					Sub-surface flow expected		Install 450mm culvert	
	Hub 28					End of traverse			

1 Initial hazard rating is based on site conditions capable of supporting conventional side cast (balanced bench) road construction practices.
2 Probability of specific hazardous landslide occurring as a result of the recommended construction measures. Refer to Appendix A for definitions.

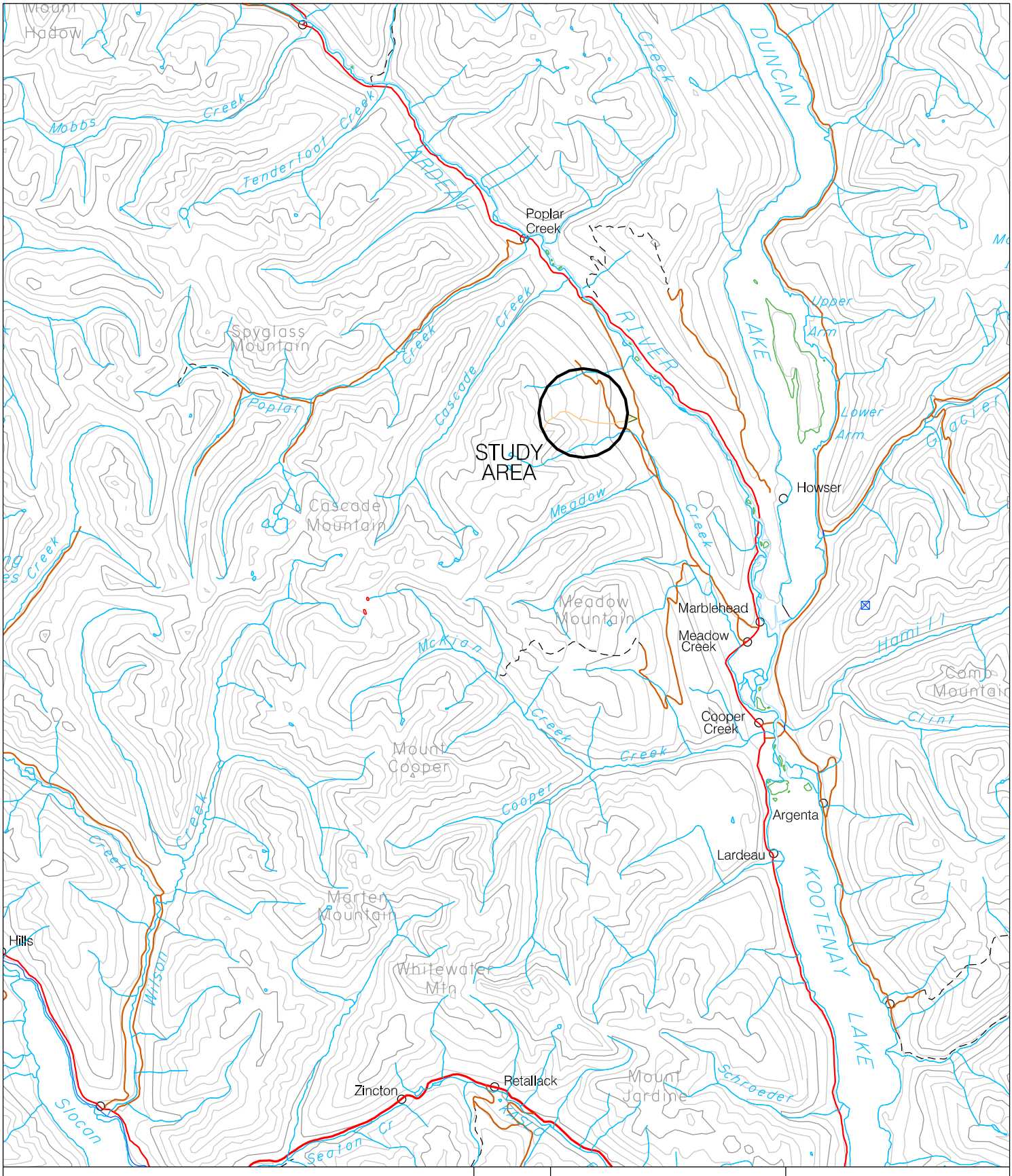
Geotechnical Recommendations Summary Table

Section: Deception Creek (CP 409), Spur 6
Section Length: 0.058 km (total length)

Prepared for: Porcupine Wood Products Ltd.
Field Review Date: October 5, 2018

Stn from (m)	to Stn (m) (At)	Terrain Classification	Depth to Bedrock (m)	Side hill Slope (%)	Initial Hazard Rating [1] / Drainage Classification	Comments	Cut / Fill Slope (%)	Recommendations	Residual Hazard [2]
Hub 01	Hub 03	zdCb	3.0	< 30	V. Low / mw	Short, proposed alignment diverges off Spur 1 at Hub 37; extends across relic (inactive) landslide deposition feature; irregular terrain; moist site conditions	80 / 70	Push-fill construction	V. Low
	Hub 03					End of traverse			

1 Initial hazard rating is based on site conditions capable of supporting conventional side cast (balanced bench) road construction practices.
2 Probability of specific hazardous landslide occurring as a result of the recommended construction measures. Refer to Appendix A for definitions.



PORCUPINE WOOD PRODUCTS LTD.

LOCATION MAP

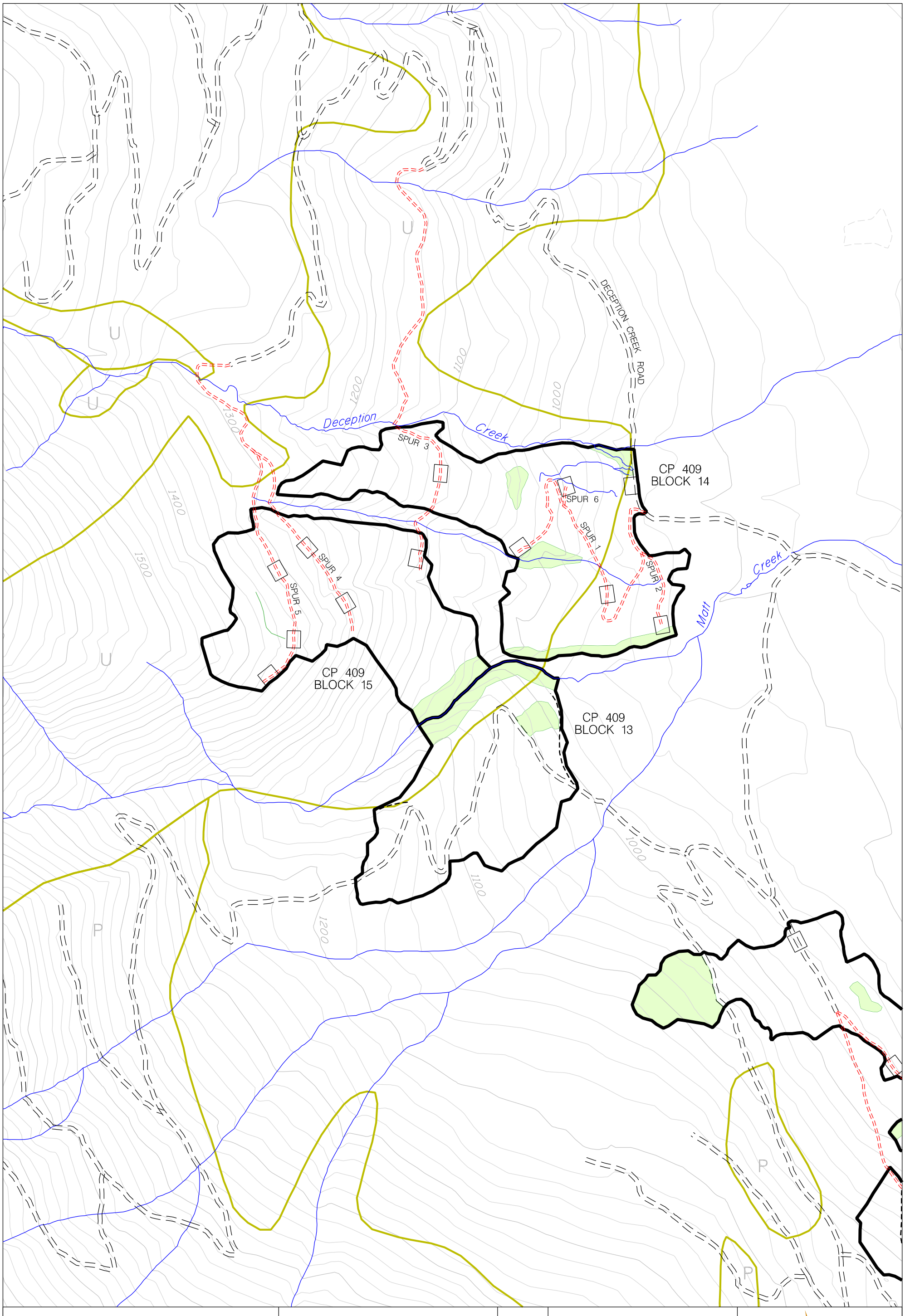
N

Scale: 1:250,000
Date: MAY 2019
Drawn by: CP

Adapted from: 82K Lardeau

Figure 1

PERDUE
GEOTECHNICAL SERVICES



PORCUPINE WOOD PRODUCTS LTD.	Mapsheet: 82K035 UTM: 495110E 5575170N Scale: 1:10,000 Figure: 2	N	OVERVIEW MAP

PERDUE
GEOTECHNICAL SERVICES

PORCUPINE WOOD PRODUCTS LTD.

CP 409
SPURS 1, 3, 4, 5, AND 6

LOCATION: DECEPTION CREEK	
MAPSHEET/OPENING NO: 82K.035	
UTM ZONE: 11 495110E 5575170N	NAD: 83

LEGEND

- CUTBLOCK BOUNDARY
- PAVED ROAD
- SECONDARY ROAD
- EXISTING ROAD
- PROPOSED PERMANENT ROAD
- PROPOSED TEMPORARY TRAIL
- EXISTING TRAIL
- CONTOURS
- PIPELINE
- TRANSMISSION LINE
- RAILROAD
- FALLING CORNER
- BLOWDOWN
- SLOPE
- LANDING
- EXISTING CULVERT
- PROPOSED CULVERT
- BRIDGE
- ROCK OUTCROP
- DRAW
- GULLY
- SLOPE BREAK
- RIDGE LINE
- WATER LICENCE INTAKE
- STREAM
- NCD
- LAKE
- SEEPAGE – EMERGENCE
- SWAMP
- RELIC LANDSLIDE SCARP
- LANDSLIDE
- HISTORIC LANDSLIDE
- SMALL SLOPE FAILURES
- AVALANCHE PATH
- WILDLIFE TREE RETENTION AREA
- EXISTING BLOCKS

SPUR 3	HUB 23 TO HUB 27+20m MODERATE TO HIGH HAZARD TERRAIN
SPUR 4	HUB 31 TO HUB 37 HIGH HAZARD TERRAIN

10m CONTOUR INTERVAL DERIVED FROM LIDAR DATA PROVIDED BY PWP.

0 Meters 250

Scale: 1:5,000

FL: A30171	MAP REF: 82K035
DISTRICT: SELKIRK	PROJECT: 18006-002
DATE: MAY 2019	
DRAWN: TRIPWIRE	
CHECKED: CP	
SITE PLAN	FIGURE: 3

PERDUE GEOTECHNICAL SERVICES