Terrain Stability Assessment

Additional area added to Cutblock C34M

McNab Creek

PREPARED FOR:

BCTS
BC TIMBER SALES
STRAIT OF GEORGIA BUSINESS AREA

PREPARED BY:

FORSITE
Engineering and Geoscience

COAST OPERATIONS
#213 -1720 14TH AVE.
CAMPBELL RIVER, BC
V9W 8B9

December 17, 2007

1.0 Introduction and Proposed Development[1]

Forsite Consultants Ltd. (Forsite) was retained by BC Timber Sales Strait of Georgia Business Area (BCTS) to carry out a terrain stability assessment (TSA) of the proposed addition to Cutblock C34M (formerly named MB049). This work was completed as part of the Multiphase Development Services Contract # SD08TCC016. The proposed development is located in the upper McNab Creek watershed approximately 32km northeast of Sechelt, BC.

The proposed development consists of Cutblock C34M and the proposed Branch 2716 Road. The total area of the cutblock proposed for harvesting is approximately 9 hectares. The cutblock is proposed for cable yarding. This assessment focused on the eastern end of the cutblock where a small (approximately 1 hectare) addition was made by Forsite timber development personnel to the original cutblock area.

The original cutblock and access road was assessed by Baumann Engineering in 2003 and is covered in the report dated February 26, 2003 for Cutblock MB049. This assessment only addresses the additional area added at the east end of the cutblock (see Figure 1) and the gully-like draw added adjacent to FC 4.

Elements at risk in the area of the proposed development include a high pressure natural gas pipeline (Terasen) and Box Canyon Creek. The pipeline is located within the right of way of the forest road that accesses Box Canyon Creek approximately 200m downslope of the cutblock. BCTS fish inventory information indicates that Box Canyon Creek is classified as fish bearing downstream of the proposed cutblock in the lowest reaches near the confluence with McNab Creek.

2.0 Rationale for the TSA

In completion of the layout for this *development*, Forsite timber development personnel have identified sections of the proposed cutblock addition located on slopes greater than 60% with potential indicators of instability.

The objectives of this TSA are to:

1. Characterize the existing landslide hazard (terrain and terrain stability conditions) in areas within, adjacent to or connected to the *development* area;
2. Evaluate the potential or existing effects of the *development* on the terrain stability potential;
3. Determine the landslide hazard and potential effects of the *development* on the identified elements at risk (i.e. the resources); and
4. Recommend site-specific actions to reduce and/or manage the landslide hazard and risk resulting from the *development*.

3.0 Limitations of the TSA

This TSA has been prepared in accordance with generally accepted geotechnical practises in the British Columbia forest industry and in general conformance with the "Guidelines for Terrain Stability Assessments in the Forest Sector"[2]. No other warranty, expressed or implied, is made. General observations are made on the

[1] Aspects of forest management, existing and proposed, related to *Planning* and *Operations.*
[2] Association of Professional Engineers and Geoscientists in British Columbia (APEGBC), 2003.

existing slope gradients, shape, morphology and the general stability. Information on the subsurface soil, groundwater and bedrock conditions are gathered from hand-dug test holes, bedrock outcrops, root balls of fallen trees and the cutslopes on the existing roads in the surrounding area. No subsurface information from deep test pits or drill holes was available.

The classification and identification of the type and condition of the geological units present are judgemental in nature. Variations (even over short distances) are inherent and are a function of natural processes. Forsite does not represent or warrant that the conditions listed in the report are exact and the user should recognise that variations may exist. **Sub-surface conditions other than those identified may be encountered, requiring a review of the recommendations contained in this report, with amendments made as needed.**

This report does not imply that a landslide will not occur following the proposed *development*. An estimate on the likelihood (or probability) of occurrence of a specific hazardous landslide (*i.e.* the P(H)[3]) is given in relation to the proposed activities. **The magnitude and runout of this landslide will be estimated only when the likelihood of occurrence exceeds very low.**

The partial risk (*i.e.* the P(HA)) to the adjacent resources from the specific hazardous landslide will be assessed using methods described in the "Landslide Hazard and Risk Case Studies in the Forest Sector" document[4]. **Partial risk is the product of the probability of occurrence of a specific hazardous landslide and the probability of that landslide reaching or otherwise affecting the site occupied by a specific element.** Partial risk does not consider the vulnerability of the element(s), and therefore is not a complete estimate of risk. In practice, partial risk is usually the preferred type of analysis when little is known about the vulnerability of the element(s) or where an estimate of vulnerability is not required. For the purpose of this assessment only the spatial probability[5] will be assessed and no analysis of the temporal probability[6] will be undertaken**. A risk analysis will only be completed where the likelihood of landslide occurrence exceeds low.**

Where recommendations are given to reduce the likelihood of landslide occurrence and/or mitigate the risk, the residual rating (where given) applies only if the recommendations from this report are followed.

The acceptance of these recommendations by *BCTS* indicates a willingness to manage the risks to the downslope and/or downstream resources (*i.e.* the elements at risk) associated with the occurrence of the specific hazardous landslide.

4.0 Background Data and Fieldwork

The following air photos were reviewed:

(1) 30BCC 03040 020 and 021
(2) BC4426 084 and 085

The following information was referenced in preparation for this assessment

1) Harvest plan maps with topographic information at a scale of 1:5000.

[3] Probability of occurrence of a specific hazardous landslide.
[4] Province of British Columbia, Ministry of Forests, 2004.
[5] Spatial probability relates to the potential of a landslide to reach or otherwise affect the site occupied by an element.
[6] Temporal probability relates to the potential of a mobile element, such as an occupant of a house or a moving vehicle, to be at the affected site at the time the event occurs.

2) TSA report prepared by Baumann Engineering for cutblock MB049 February 26, 2003
3) Geologic Survey of Canada Bedrock Geology Mapping located on BC Ministry of Energy and Mines MapPlace webpage, retrieved December 2007.

Fieldwork was completed on October 23, 2007 by Rod Williams, P.Geo, Eng L of Forsite accompanied by David Burke, RFT of Forsite. The weather at the time of the assessment was cool and clear. Rainfall in the preceding days was heavy and the streams within the development were close to annual high water levels.

5.0 General Site Description

Cutblock C34M is located in the McNab Creek watershed upslope of the tributary Box Canyon Creek within the Coast Mountains physiographic region. The topography is typical of a coastal glaciated valley; moderate to moderately steep gradient slopes in the lower valley lead to steep bedrock slopes and bluffs on the upper slopes. The present channel of Box Canyon Creek is incised into glaciofluvial and glacial till deposits resulting in discontinuous escarpment slopes along its length. Box Canyon Creek is within a hanging valley and becomes deeply incised where it joins the main valley of McNab Creek

Bedrock mapping indicates that the slopes in the area are underlain by Mid Cretaceous quartz dioritic intrusive rocks. These rocks tend to be massive and strong with widely spaced jointing. Areas of marine sedimentary and volcanic rock of the Lower Cretaceous Gambier group are mapped in the lower McNab Creek watershed. Road cuts in the area revealed tightly jointed sedimentary bedrock with steeply dipping bedding planes.

Surficial materials observed in the area consist of silty sand till deposits on the lower slopes within the cutblock transitioning to sandy rubble colluvial veneers on the upper slopes. Generally, an upper loose layer of weathered till was present overtop of a compact deposit.

Several recent landslides are visible on the air photos in the cutblock to the west of C34M. These slides primarily appear to be associated with the cutslope of the upper road constructed across steep gullied slopes with numerous avalanche tracks. The avalanche tracks are all visible on the 1967 air photos but on the more recent 2003 air photos several of the draws have recent debris flow scour and evidence of sediment deposition on the lower valley slopes. One event appears to have runout to the channel of Box Canyon creek. At least two of the debris flows likely resulted from the road cutslope failures.

The steep rock slopes upslope of and west of C34M are prone to snow avalanche activity and it is likely that the incised draws that transect the cutblock periodically transport snow avalanche and possibly debris flow events from the upper slopes to the moderate sloping valley bottom area.
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6.0 Proposed Harvesting - Discussion, Results and Recommendations

6.1 Addition along eastern edge of Cutblock C34M

Discussion

A small 1 hectare addition was added to the eastern portion of this cutblock (see Figure 1) This area extended the proposed cutblock over to the edge of the harvested cutblock to the east. This portion of the cutblock is proposed for cable based harvesting.

The slope gradients in this area range from 45% at the lower falling boundary to 80% at the upper boundary. The slope profile is concave. Two distinct draws containing streams 1 and 2 originate at the upper boundary and become progressively more confined down the slope to the proposed road location. Downslope of the road location the confinement of the draws decreases on the moderate slopes. The draws are not large enough to be visible on the air photos downslope of the cutblock.

Stream 1 initiates in a broad bowl from a collection of seepages that originate on moderate slopes downslope of a rock bluff. The stream is within a draw but is not gullied.

Stream 2 initiates from a wet bowl and then curves below a steep headwall slope within a bedrock controlled gully-like draw (see Figure 1). The stream channel is primarily bedrock and angular rubble. The bedrock surface is rough. The sidewalls of the draw are steep (to 80%) and up to 25m long. The headwall area near the upper falling boundary is primarily rock with very thin intermittent organic soils. The bedrock surface is rough, with minor irregularities suggesting a recent disturbance on the headwall area. The draw downslope contains no mature trees indicating disturbance.

The surficial materials on the ridges between streams 1, 2, and 2A consist of a blanket deposit of loose to dense at depth (i.e. below 1m) sandy gravel till. This material is assessed as well drained but the contact between the upper weathered loose horizon and the underlying dense material may restrict infiltration below this depth during intense precipitation or snowmelt.

The bedrock exposed in the channel of stream 2 consists of a dark grey sedimentary or metasedimentary rock with closely spaced joints and bedding planes dipping steeply and unfavorably (out of the slope). The rock is weathering to cobble size angular rubble.

Re-curved or pistol butted trees, particularly on Douglas fir were noted on the ridge between Streams 1 and 2. This condition is most likely the result of snow press and is not likely indicative of soil creep.

The only areas of seepage noted during the field review were within the broad bowl at the top of stream 1 and on the headwall like slopes at the top of stream 2.

Results

Results from this TSA conclude that **there is an estimated moderate[7] likelihood of post-harvest landslide occurrence on the steep slopes draped by the thin veneer of weathered soil present near the upper boundary and headwall area of the gully-like draw of stream 2.**
This rating is based on:

(i) the gradient of these slopes (i.e. generally steeper than 70%)
(ii) the areas of seepage, and
(iii) the thin unconsolidated surficial materials

If a post-harvest landslide were to originate from these slopes it would likely be in the form of a surficial, translational slide of less than 1m depth. The estimated initial magnitude would not likely exceed 100 m^3. The

[7] A **moderate** likelihood means that a landslide is not likely, but possible if there was a significant change to one or more of the assumed site conditions. Quantitatively the likelihood of a landslide is estimated as 1/200 to 1/500 annual probability and a long term (20 year) probability of 1/10 to 1/25.

landslide would likely develop into a debris flow in the gully-like draw; however, due to the limited amount of stored sediment and debris in this draw, entrainment of material would be low. The final magnitude of the event would not likely exceed 500m^3. The runout would likely terminate on the moderate slopes at or just downslope of the lower falling boundary. Runout to the location of the natural gas pipeline or Box Canyon Creek possible but unlikely (i.e. the P (S: H) is estimated as moderate).

Resources that could be impacted by a landslide of this magnitude include:

a) The replanted trees and/or the standing timber on the landslide path (<0.2 hectare). The partial risk to these resources is estimated as high;
b) The temporary loss of the surficial materials and growing sites on the landslide path (<0.2 hectare). The partial risk to this resource is estimated as high;
c) The fish habitat in Box Canyon Creek. The partial risk to this resource is estimated as moderate.
d) The natural gas pipeline. The partial risk to this resource is estimated as moderate.

If under extreme circumstances a landslide were to run out to the location of the natural gas pipeline downslope of this area of cutblock C34M, due to the open slopes at that location it would likely be beginning to deposit material and not downcutting.

The likelihood of a post-harvest landslide being triggered on the remaining moderate to moderately steep slopes in this area of the cutblock is estimated as low[8].

This rating is based on:

(i) the gradient of these slopes (i.e. less than 65%)

If a post-harvest landslide were to originate from these slopes, the estimated initial magnitude would not likely exceed 25 m^3 and the runout would likely terminate on the moderate slopes present at road location or the lower falling boundary.

Recommendations

No geotechnical recommendations are suggested for the proposed harvesting in this area of Cutblock C34M.

[8] A **low** likelihood means that the likelihood of a landslide is remote, although it is possible, given specific combinations of site conditions. Quantitatively the likelihood of a landslide is estimated as less than 1/1000 annual probability and a long term (20 year) probability of 1/50 to 1/100.

6.2 Former reserve area at the confluence of Streams 3 and 4

Discussion

The original cutblock layout contained several reserve areas within the harvest area. These reserve areas were removed as part of the current amendments to this cutblock due to windthrow concerns. The area around the confluence of streams 3 and 4 was included in one of the reserves (see Figure 1).

Stream 4 flows within an incised gully-like draw that extends from the steep bedrock slopes upslope of the cutblock down to the moderate gradient slopes in the valley bottom. The sidewalls are steep (up to 70% for distances up to 15m). The gradient down the invert of the draw is 60%. The scarp of an old failure is present on the east sidewall approximately 30m below the road location. No deposit was visible in the invert of the draw indicating that the material was transported downslope. The draw has few mature stems and relatively little understorey.

Stream 3 is incised above the road location but loses confinement at the road location. A small depositional area is present below the road location. The stream then becomes more incised downslope and flows over the sidewall of stream 4 at the lower falling boundary. The slopes adjacent to Stream 3 above the road consist of an avalanche chute with scrubby hemlock vegetation. This area has been excluded from the harvest area. The deposit at the road consists of colluvial rubble material that was likely transported to this location by snow avalanche events.

The surficial materials on the ridges between streams 3 and 4 consist of a blanket deposit of loose to dense, at depth (i.e. below 1m), sandy gravel till. This material is assessed as well drained. The channel of stream 4 is composed of rubble with a sandy gravel veneer on the sidewalls.

Results

Inclusion of this area into the harvest area of the cutblock removes the potential for windthrow that would have likely occurred if the reserve was left in place. Windthrow at the crest of the gully sidewalls would have been a significant concern with respect to the stability of the sidewalls.

The gully-like draw of stream 4 has a high likelihood of snow avalanche events and also likely experiences debris flow events possibly coupled with the snow avalanche activity. These events initiate upslope of the area recently added to the cutblock and assessed as part of this TSA. The draw is more densely vegetated closer to the pipeline location indicating that the snow avalanche and or debris flow events do not frequently runout very far below the location of the lower cutblock boundary.

Although the inclusion of this area into the harvest area removes the potential for windthrow on the gully sidewall slopes, the old slide scarp on the sidewall below the road and the unconsolidated surficial materials present on these slopes indicate that the surficial materials may be sensitive to scour during yarding. **Significant scour on the sidewalls of the draw during yarding operations would result in a moderate likelihood of sidewall failures in this area.**

This rating is based on:

(i) The gradient of the sidewall slopes;

(ii) The unconsolidated nature of the surficial materials present on these slopes.

If a landslide were to originate from these slopes, the estimated magnitude would not likely exceed 25 m^3 but the runout would reach the stream channel. Millard (1999)[9] suggest that the minimum debris flow criteria on coastal B.C. streams includes an initial landslide volume of 25 m^3 (from a gullied sidewall) and a debris volume delivered to the stream channel of at least 25 m^3. For a debris flow to be initiated in a gullied stream (along Howe Sound in coastal B.C.) VanDine (1996)[10] indicates that the channel gradients generally have to be greater than 47%.

Based on these criteria there is an estimated moderately high probability[11] that a debris flow would be triggered by a landslide on the draw sidewalls, if the debris were delivered to the stream channel during a high flow event.

In coastal B.C., Hungr et al (1984)[12] suggests that the runout from a debris flow would begin to deposit on gradients from 14% to 21% where the channel is confined. Based on this**, it is likely that if a debris flow were to be triggered, the runout would reach the location of the Terasen pipeline and potentially the channel of Box Canyon Creek (i.e. the P (S: H) is estimated as high).**

Resources that could be impacted by a landslide of this magnitude include:

a) The replanted trees and/or the standing timber on the landslide path (<1 hectare). The partial risk to these resources is estimated as high;
b) The temporary loss of the surficial materials and growing sites on the landslide path (<1 hectare). The partial risk to this resource is estimated as high;
c) The fish habitat in Box Canyon Creek. The partial risk to this resource is estimated as high;
d) The natural gas pipeline. The partial risk to this structure is estimated as high.

If a debris flow were to runout to the location of the natural gas pipeline downslope of this area of the cutblock there is the potential for impact to the pipeline dependent on the burial depth at the stream crossing. **Therefore in addition to the partial risk being high there is potential for a high specific risk to this structure dependent on the burial depth at the crossing.**

<u>Recommendations</u>

1) **Fall away yard away practices must be employed during harvesting in this area. Timber must be felled out of the gully-like draw of stream 4 and yarded away from the draw.**

2) **Any residual stems that can not be felled out of the draw should be left standing.**

[9] Millard, T. 1999. Debris flow initiation in coastal British Columbia gullies. Res. Br. B.C. Min. For., Vanc. For. Reg. Nanaimo, B.C. Tech. Rep. TR-002.
[10] VanDine, D. F. 1996. Debris flow control structures for forest engineering. Res. Br., B.C. Min. For., Victoria, B.C. Work. Pap. 22/1996.
[11] VanDine 1996 Moderately high probability of occurrence; is applied to those creeks that have significant physical characteristics that fall well within the threshold where debris flows are possible, although not in the range of category 4. To date these creeks have no recorded history of debris flows, or have experienced events of uncertain origin.
[12] Hungr, O., G.C. Morgan, and R. Kellerhals. 1984. Quantitative analysis of debris torrent hazards for design of remedial measures. Can. Geotech. J. 21:663-677.

Following implementation of these recommendations the likelihood of a landslide initiating from within this area of Cutblock C34M as a result of the proposed harvesting will be reduced to low. The resultant partial risk to downslope resources and the pipeline will be reduced to moderate.

7.0 Closure

Factual data and interpretation contained within this report were prepared specifically for BCTS Strait of Georgia Business Unit with whom Forsite has entered a contract. No representations of any kind are made to any third parties with whom Forsite has not entered a contract.

We trust that this report satisfies your present requirements. Should you have any questions or comments, please contact our office at your convenience.

Sincerely,

Forsite Consultants Ltd.

Prepared by:

Rod Williams, P.Geo, Eng. L
Project Geoscientist

Attached: Figure 1 Cutblock C34M Terrain Stability Assessment Map

BCTS

BC Timber Sales
Strait of Georgia

TSL :A79510-G053C34M
Figure 1.
Terrain Assessment Map

Mapsheet:	092G.053
Operating Area:	Powell River
TSA / TSB:	39 / B
Forest Region:	Coast Region
Forest District:	Sunshine Coast
Latitude:	49°35'16"
Longitude:	123°25'31"

Emergency UTM Coordinates : 469268E, 5492885N

Traverse Route RW October 23, 2007

Additional areas to the cutblock covered by this assessment. For the remaining areas of the cutblock and the prescription for the proposed access road see Baumann 2003

Block Information

- Block
- Wildlife Tree Patch
- Timbered Leave Area
- Falling Corner
- Road Station
- WBC (Replace)
- Machine Crossing
- Quarry
- Pit
- Landing
- CMP
- WBC
- Ford
- Existing CMP
- X Ditch

Riparian Information

- Reach Break
- NCD
- Fish Sensitive Zone
- S1; S2; S3; S4
- S5; S6;

Access Management

- Forest Service Road
- High-Way
- Road Permit
- Deactivated
- Maintained
- Unknown
- Proposed Permanent
- Proposed Temporary
- Existing Temporary

Physiographic Data

- Break
- Draw
- Gully
- Ridge
- Rock
- Windthrow
- Slide

1:5000

0 30 60 90 120 150

Meters

N

Declination: 18° 17'E

Date Printed: 12/17/2007
Completed by: J.HIEBERT

Map Coordinates: UTM Nad 83 Zone 10
Projection: BC Environment Albers

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Phone/Fax: (604) 892-2303
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BAUMANN ENGINEERING
Geological Engineers and Geoscientists

John Howe
JCH Forestry Ltd
#2-1160 Hunter Place
Squamish, B.C.
VON 3GO

Project: 03/11/14
February 26, 2003

Dear John,

re: Geotechnical Assessment of the proposed branch 2717, stations 241 – 877 m, McNab Creek, near Port Mellon, BC.

The proposed road was assessed on November 14, 2003. The purpose of the assessment was to:

- determine whether there are any areas where terrain conditions are so severe that it is unlikely that road construction would be successful.
- for road sections in unstable or potentially unstable terrain, estimate, on a metre-by-metre basis, the amount of benching that will be required to provide a stable road prism.
- for road sections in unstable or potentially unstable terrain, estimate, on a metre-by-metre basis, the amount of material in the road prism that will need to be endhauled.
- provide benching and endhauling prescriptions, if needed, for road sections in less difficult terrain.
- provide additional comments on terrain attributes, possible spoil sites, stream channels, gullies, and other terrain features.

Please see the appended supplemental information. The appendix contains a description of how to use this report, a glossary of terms, and descriptions of specific construction techniques. The general terms and ideas used in this report are described in detail to avoid the potential for misunderstanding.

The most important final product of this study is the table of detailed prescriptions that is attached; the comments below supplement this tabular information.

Comments:

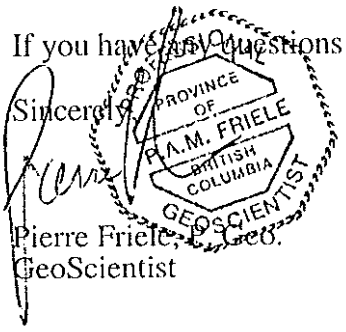
The roads are located in a mid slope position. The proposed road involves conventional construction techniques. Four small gullies will be crossed. Avoid filling the creek draws will spoil from the sidewalls, and use coarse clean rock to fill through the creek draws.

An Understanding:

The conclusions of this report are based on the currently available data and may need to be modified if additional information becomes available. It must be stressed that terrain analysis, hazard assessment and the evaluation of slope and hydrologic hazards is an inexact science and that any development in mountainous terrain is subject to some degree of geologic or hydrologic risk. This means that the absolute safety or stability of any proposed development cannot be guaranteed and that users of this report must accept a certain degree of risk if they carry out such development plans. If questions remain, additional specialist advice or a second opinion should be obtained.

If you have any questions please do not hesitate to call us.

Sincerely,



Pierre Friele, P. Geo.
GeoScientist

Notes (numbers refer to columns on the next pages):

1, 2, 3. Start and end station, and length, of a given section (in metres).

4. Slope: selected average natural slope over the given road section.

5. % Bench: refers to the estimated amount of benching required to provide a stable road prism.

6. % Endhaul: is an estimate of the amount of material from the road cut that must be endhauled. Note that 0% benching and 0% endhauling implies cut and fill construction.

7. Hazard: a qualitative assessment of hazard (S= stable; P= potentially unstable; U= unstable).

8. Certif. req'd: indicates whether the section requires post-construction sign-off by a P.Eng./P.Geo.

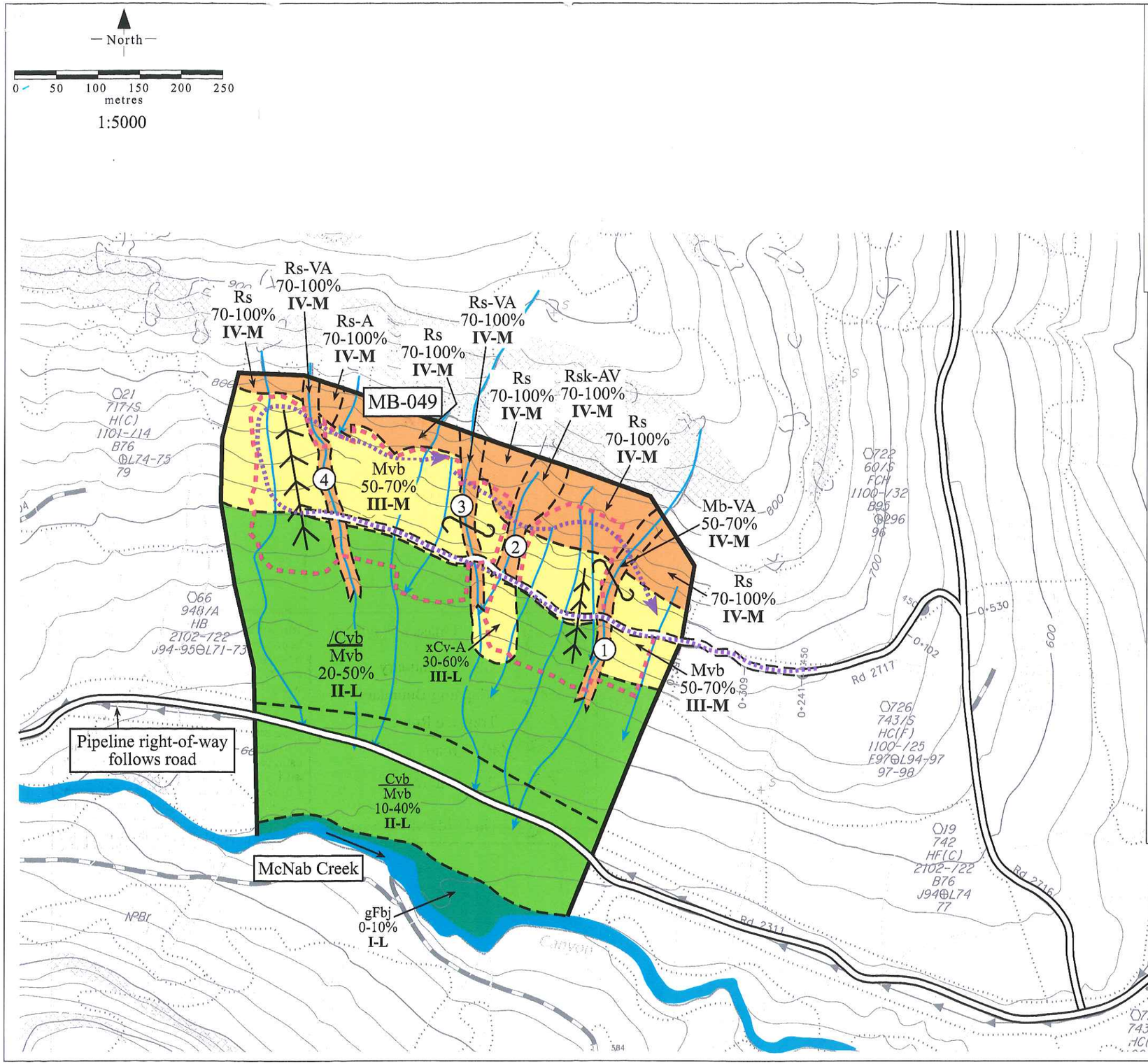
9. Template: refers to the recommended design template that should be used (see below).

Tem-plate	Sym-bol	Surficial material	Cutslope angle (%)	Fillslope angle (%)	Comment
1	Cv	Colluvial veneer	80	65	Assume that the colluvium will ravel and that bedrock will be encountered in the road prism (amount depends on natural slope angle).
2	Cb	Colluvial blanket	100	65	Assume that the road prism will be entirely built in surficial material and that some cutslope raveling will occur.
3	Mv	Till veneer	120	65	Assume that the till can be left oversteepened and that bedrock will be encountered in the road prism.
4	Mb	Till blanket	200	65	Assume that the till can be left oversteepened and that the road prism will be entirely located in surficial material. Very competent tills can be left with a 400% slope.
5	C/M	Mixed material	120	65	Either use two layers, or use a simplified layer with the cut and fillslope angles given.
6	R	Rock	400	65	Use the steepest cutslope possible. Badly fractured rock may only stand at 200% or less.

10. Comment: Terrain units: C=colluvium; R=rock; M=till; v=veneer; b=blanket (>1m thick); s=steep slope; k=moderately steep slope; a=moderate slope; j=gentle slope; t=terrace; h=hummocky;

Abbreviations used: $= silt; s= sand; g= gravel; d= mixed fragments; a= angular;
AC= active channel. Channel area occupied by yearly average high water flow. To estimate area occupied by Q100 flow, multiply A.C. by 3 and design water conveyance accordingly.

Start	End	Length	% Slope	% Bench	% Endhaul	Hazard	Certif. req'd.	Template	Comment
Rd 2717									
241									Start assessment
241	309			0	0	S	N	4	Grub all old landing debris and ensure no coarse woody debris is included in the road prism.
309	391		55-60	75	50	P	N	4	Ridged till blanket. Keep fill within reach and endhaul excess.
391	440		55	50	0	P	N	4	
440	480		65	100	90	P	N	4	
480	510		50	0	0	S	N	4	
490									Creek in small gully. Fill through with coarse clean rock.
510	531		65	100	90	P	N	4	
531	657		50-55	0	0	S	N	4	
593	642								Rubble veneer from snow avalanche path extends below road.
622	642								Creek in small gully. Fill through with coarse clean rock.
657	675		55-60	75	50	P	N	4	Small gully. Endhaul steep sidewalls, and fill through with coarse clean rock.
675	877		50	0	0	S	N	4	
877									End of road.



Hazard Classification

Class I: No significant stability problems exist.

Class II: There is a very low likelihood of landslides following timber harvesting or road construction.

Class III: Minor stability problems can develop. Harvesting should not significantly reduce terrain stability although there is a low likelihood of post harvest failures.

Class IV: Moderate to high likelihood of slope failures following conventional road construction. Moderate likelihood of failure in logged areas.

Class V: Natural failures present. High probability that slope failures will follow logging or conventional road building.

Impact Assessment

A measure of the relative impact that a slope failure would have on fish values, water quality, trees, or visual esthetics.

H: high impact. **M**: moderate impact. **L**: low impact.

Creek/Seepage area

Rock bluff

Polygon boundaries; gradational, approximate, definite.

Scarp crest; may coincide with polygon boundary

Small draw/gully

Ridge

Rapid mass movement

Block Boundary

Mapping Boundary

Traverse Route

Built road

Proposed road

(1) Gully identifier (see text)

Terrain Classification

Texture	**Surface Expression**
g=gravel	t=terraced topography
s=sand	v=veneer (<1m thick)
S=silt	b=blanket (>1m thick)
x=angular fragments	j=gentle slope
r=rubble	a=moderate slope
(angular<256 mm)	k=moderately steep slope
a=blocks	s=steep slope
(angular>256 mm)	h=hummocky
d=mixed fragments	f=debris or alluvial fan
(rounded and angular)	p=plain, including floodplain

Surficial Material	**Geologic Process**
M=till	V=gullying
C=colluvium	U=Inundation
F=fluvial	Rr=rockslide
A=anthropogenic	Rb=rockfall
F^G=glaciofluvial	Rd=debris flow
L^G=glaciolacustrine	Rs=debris slide
O=organic	R"=initiation zone
V=volcanic	A=snow avalanche
U=undifferentiated	L=seepage
R=rock	

A=active process
I=inactive process

qualifying descriptor
surficial material
texture
surface expression
slope range
geologic process
gF^G t - V^I
5-10%

Symbols
/ =preceding unit is more common // =preceding unit is much more common = =units equally abundant

Important Note: this information has been compiled on a Company-supplied base map assumed to be reasonably accurate. Terrain and hazard polygons were located using available air photographs, ground traverses, and the topographic information on the original base map. Since the delineation of these polygons involves some interpretation and estimation, the boundaries are approximate and some errors may be present. Cartographic errors may also be present since this map was originally drafted using 1:15,000 (approximate) air photographs. If questions remain, additional advice should be sought and/or critical boundaries marked out in the field.

Figure 3
McNab Creek
Block MB-049
JCH Forestry Ltd.

Terrain and Hazard Classification

Baumann Engineering
February 26, 2003