STEP SEVEN: Identify geologic process (presence)

Two classes of drainage are recognized:

- **Progressive deformation (creep):** Subdued, hummocky terrain that may have leaning or tilted trees and is undergoing active creep, but lacks decisive indicators of movement (e.g., tension fractures, headwall scarps, split trees) provides prime sites for future slump and earthflow movement.
- **Dissection by gullies (gully erosion):** Terrain dissected by deeply incised gullies and canyons are, as a general rule, areas prone to debris torrents or debris floods.

FINAL STEP: Determine potential landslide hazard and type from the assessment chart (page 77)

2.4.2 Bedrock

STEP ONE: Identify

Identify sites where there are vertical or steeply sloping outcrops of bedrock or where the activities of man (e.g., road construction) will result in a similar bedrock exposure.

STEP TWO: Determine general character and structure of the bedrock

Two general classes are recognized:

- **Massive:** rocks having a homogeneous texture over wide areas lacking layering (bedding), fractures, and foliation.
- **Non-massive:** rocks having a homogeneous texture and dissected by cracks such as joints and fractures; or rocks made up of layers (beds) that may be dissected by cracks.

STEP THREE: Determine dip of beds, fractures, and joints in the rock

Two categories are recognized:

- **Parallel to slope:** beds, joints, fractures, foliations dip parallel to or at a steep angle in the same direction as the hillslope gradient, providing surfaces of potential failure and open zones for transportation of subsurface water.
- **Perpendicular to slope:** beds, joints, fractures and foliations dip perpendicular to or away from the hillslope gradient, limiting groundwater passage and buttressing the hillslope with benches.

FINAL STEP: Determine potential landslide hazard and type from the assessment chart (page 77)

2.4.3 Analysis Limitations

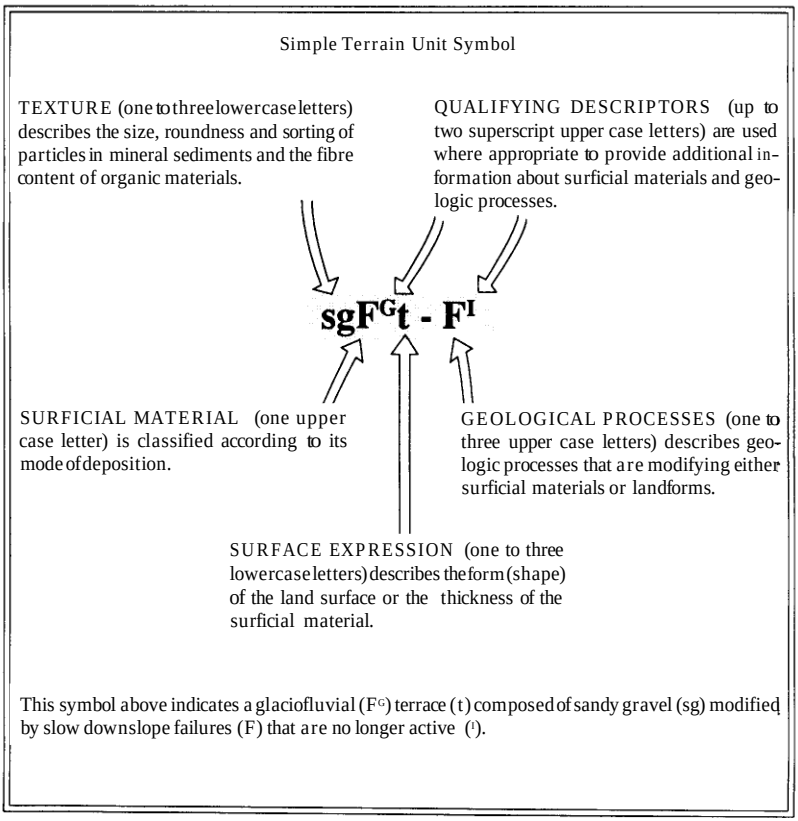
The hazard rating developed using this procedure provides a relative measure of the likelihood of a particular type of landslide occurring following forest harvesting operations. The high, moderate, and low ratings are based on the experience of practicing professionals, as published in the research literature pertaining to slope stability analysis in the Pacific Northwest. The ranges of various factors can vary from site to site and may require adjustment to local conditions. Thus, the hazard rating presented in this flow chart should be used only as a guide to identifying unstable terrain.

A five-class hazard rating system is used for slope stability assessment within coastal forest regions in British Columbia (Appendix 3).

As a general rule, the user should seek outside expertise of a specialist for further analysis of a site if the terrain has a moderately high to high rating, or if the user lacks the knowledge or experience in assessing the various factors influencing slope processes. Potential downslope impacts should also be considered at this time.

APPENDIX 1. Example of terrain unit symbol

Information is portrayed on a terrain map by a terrain unit symbol which is composed of a group of letters. These letters provide information about the character of the terrain and are arranged in a manner such that each letter position represents a particular characteristic of the terrain. Information provided by a terrain unit symbol includes texture and type of surficial material, surface expression, geologic processes, and qualifying descriptors.



Source: Terrain Classification System for British Columbia 1988

APPENDIX 2. Terrain classification system for British Columbia - codes and descriptions

TEXTURE

Symbol	Name	Size(mm)	Other Charateristics
a	blocks	>256	angular particles
b	boulders	>256	rounded & subrounded particles
k	cobbles	64-256	rounded & subrounded particles
p	pebbles	2-64	rounded & subrounded particles
s	sand	.062-2	
ƒ	silt	.002-.062	
c	clay	<.002	
d	mixed fragments	>2	mix of rounded and angular particles
g	gravel	>2	mix of boulders, cobbles and pebbles
x	angular fragments	>2	mix of rubble and blocks
r	rubble	2-256	angular particles
m	mud	<.062	mix of clay and silt
y	shells		shell or shell fragments
•	fibric	well-preserved fibre; (40%) identified after rubbing	
u	mesic	intermediate decomposition between fibric and mesic	
h	humic	decomposed organic material; (10%) identified after rubbing	

SURFICIAL MATERIALS

Symbol	Name	(Assumed Status of Formative Process)	Description
A	anthropogenic	(A)	Man-made or man-modified materials
C	colluvial	(A)	Products of mess wastage
D	weathered bedrock	(A)	In situ, decomposed bedrock
E	eolian	(I)	Materials deposited by wind action
F	fluvial	(I)	River deposits
Fᵉ	glaciofluvial	(I)	Ice contact fluvial materials
I	ice	(A)	Permanent snow, glaciers and icefields
L	lacustrine	(I)	Lake sediments; includes wave deposits
Lᵉ	glaciolacustrine	(I)	Ice contact lacustrine materials
M	morainal	(I)	Material deposited directly by glaciers
O	organic	(A)	Accumulation/decay of vegetative matter
R	bedrock	(-)	Outcrops/rock covered by less than 10cm
U	undifferentiated	(-)	Layered sequence; three materials or more
V	volcanic	(I)	Unconsolidated pyroclastic sediments
W	marine	(I)	Marine sediments; includes wave deposits
Wᵉ	glaciomarine	(I)	Ice contact marine sediments

QUALIFYING DESCRIPTORS

Symbol	Name	Description
G	glacial	Used to qualify surficial materials where there is evidence that glacier ice affected the mode of deposition of materials
A	active	Used to qualify surficial materials and geological processes with regard to their current state of activity
I	inactive	

Source: Terrain Classification System for British Columbia 1988

APPENDIX 2 (continued)

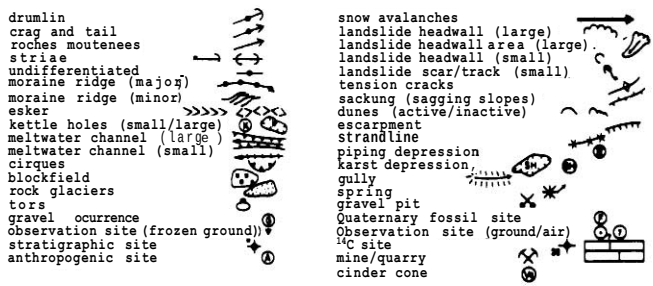
SURFACE EXPRESSION

Symbol	Name	Description
a	moderate slope	Unidirectional surface; >15° to ≤26°
b	blanket	A mantle of unconsolidated materials; >1m thick
c	cone	A cone or segment of a cone; >15
d	depression	A lower area enclosed by higher surrounding terrain
f	fan	A segment of a cone; up to 15°
h	hummocky	Hillocks and hollows irregular in plan; 15-35°
j	gentle slope	Unidirectional surface >3° and ≤15°
k	moderately steep	Unidirectional surface; >26° and ≤ 35°
m	rolling	Elongate hillocks 3 to 15° parallel forms in plan
p	plain	Unidirectional surface; up to 3°
r	ridged	Elongate hillocks; 15 to 35°; parallel forms in plan
s	steep	Steep slopes; >35°
t	terraced	Stop-like topography
u	undulating	Hillocks and hollows up to ≤15°, irregular in plan
v	veneer	Mantle of unconsolidated material; 10cm to 1m thick

GEOLOGICAL PROCESSES

Symbol	Name	(Assumed Process Status)	Description
A	avalanches	(A)	Terrain modified by snow avalanches
B	braiding	(A)	Diverging/converging channels; unvegetated bars
C	cryoturbation	(A)	Sediments modified by frost heaving and churning
D	deflation	(A)	Removal of sand and silt by wind action
E	channelled	(I)	Channel formation by meltwater
F	slow mass movement	(A)	Slow downslope movement of masses of cohesive or non-cohesive material and/or bedrock
H	kettled	(I)	Depressions due to the melting of buried glacier ice
I	irregular channel	(A)	A single, clearly defined main channel displaying irregular turns and bends
J	anastamosing channel	(A)	A channel zone where channels diverge and converge around many vegetated islands
K	karst	(A)	Processes associated with the solution of carbonates
M	meandering channel	(A)	Channel characterized by a regular pattern of bends with uniform amplitude end wave length
N	nivation	(A)	Erosion beneath and along the margin of snow patches
P	piping	(A)	Subterranean erosion by flowing water
R	rapid mass movement	(A)	Rapid downslope movement of dry, moist or saturated debris
S	solifluction	(A)	Slow downslope movement of saturated overburden across a frozen or otherwise impermeable substrate
U	inundation	(A)	Seasonally under water due to high watertable
V	gully erosion	(A)	Parallel/subparallel ravines due to running water
W	washing	(A)	Modification by wave action
X	permafrost	(A)	Processes controlled by the presence of permafrost
Z	periglacial processes	(A)	Solifluction, cryoturbation and nivation processes occurring within a single unit

ON-SITE SYMBOLS



APPENDIX 3. Terrain stability classification used within the Vancouver Forest Region, British Columbia

Introduction

Terrain stability maps are interpretive maps derived from terrain maps. The terrain maps follow conventions and definitions used in the Terrain Classification System for British Columbia (1988). The terrain stability maps are developed from data on surficial materials, landforms, geomorphic processes, slope angle, soil texture, moisture regime, landscape position, vegetation and bedrock types. Most of these data are present on the terrain maps; however, some may come from air photos, bedrock geology maps, vegetation or ecosystem maps and field notes.

Terrain stability rankings provide a relative assessment of mass wasting potential, but give no indication of expected frequency, magnitude or impact. Rankings are intended to identify potential problem areas; actual decisions on logging or road construction should be based on careful field evaluation by appropriate personnel.

The actual criteria that place a given terrain map unit in a specific stability class are usually based on the professional judgement and experience of the terrain mapper and the information contained in the terrain data bank and in the scientific literature. Major management implications expected for operations are included.

Terrain Stability Classes

Class I

- No significant stability problems exist.

Class II

- No significant problems exist.
- Normal road construction and logging practices will not significantly decrease terrain stability.
- Periodic maintenance involving ditch cleaning is expected due to sloughing along road cuts.

Class III

- Minor stability problems can develop.
- Harvesting should not significantly reduce terrain stability; there is a low likelihood of post-logging failure.
- Minor slumping is expected along road cuts on roads crossing areas with slopes greater than 30 degrees, especially for 1 or 2 years following construction.

Class IV

- Expected to contain areas with a moderate to high likelihood of slope failures following conventional road construction. Wet season construction will significantly increase the potential for slope failure.
- There is a moderate likelihood of slope failure in logged areas.
- A field inspection of these areas should be made by a qualified terrain specialist (P.Eng. or P.Geo.) prior to any development in order to assess in detail the stability of the affected area.

Class V

- There is a high likelihood that slope failures will follow logging or conventional road building.
- A field inspection of these areas should be made by a qualified terrain specialist (P.Eng. or P.Geo.) prior to any development in order to assess in detail the stability of the affected area.

Further Reading for Chapter 2

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