

Stuart-Takla Watersheds: Terrain and Sediment Sources

June M. Ryder



Province of British Columbia
Ministry of Forests Research Program

CONTENTS

Acknowledgements	iii
1 Introduction	1
2 Physiography	1
2.1 Bedrock Geology and Topography	1
2.2 Evolution of the Landscape	7
3 Methodology	13
3.1 Terrain Mapping	13
3.2 Sediment Source Maps	13
3.3 Reliability of Mapping	13
4 Surficial Materials	15
4.1 Till (M, M')	15
4.2 Glaciofluvial Materials (FG)	18
4.3 Glaciolacustrine Materials (LG)	19
4.4 Colluvium (C)	21
4.5 Fluvial Materials (F, FA)	22
4.6 Organic Materials (O)	23
4.7 Undifferentiated Materials (U)	24
4.8 Bedrock (R)	24
5 Geomorphological Processes	25
5.1 Rapid Mass Movement (-R, -Rd, -Rb)	25
5.2 Slow Mass Movement (-F, -Fg)	27
5.3 Snow Avalanches (-A)	27
5.4 Gully Erosion (-V)	28
5.5 Surface Seepage (-L)	28
5.6 Fluvial Processes (-I)	28
5.7 Past Glacial Processes (-E, -H)	28
5.8 Periglacial Processes (-S, -N, -Z)	28
6 Sediment Sources	29
6.1 Actual Sediment Sources: Recent Landslides	29
6.2 Potential Sediment Sources: Sensitive Terrain	31
7 Considerations and Recommendations for Management	31
7.1 Glaciolacustrine Sediments	31
7.2 Till	33
7.3 Glaciofluvial Materials	33
7.4 Planned Cutblocks and Road Alignments	33
References	34
Appendix 1: Standard Terrain Map Legend	35
Maps in pocket: Terrain Maps and Sediment Source Maps	

Figures

1	Locations of Stuart-Takla watersheds and field sites	2
2	Bedrock geology of the Middle River Range, from Armstrong (1949)	4
3	Geomorphological map of the Middle River Range	5
4	Late Quaternary history of the Middle River Range	8

Photographs

Photographers identified by initials: PF: Pierre Friele; ST: Sid Tsang; JMR: J.M. Ryder.

1	View southwestward up Forfar Creek (JMR)	3
2	Upper valley of Forfar Creek, looking westward to the peaks of the main drainage divide (ST)	3
3	View southward from slopes of Goat Mountain to alpine terrain at the heads of Tsitsutl and Forfar Creeks (PF)	4
4	Downstream view of the middle reach of Forfar Creek (ST)	6
5	View downstream near the head of the middle reach of Gluskie Creek (PF)	6
6	Middle reach of O'Ne-ell Creek (ST)	7
7	View southwestward toward the middle reach (canyon) of O'Ne-ell Creek (JMR)	11
8	View up Middle River from the mouth of O'Ne-ell Creek (JMR)	12
9	View down upper Tsitsutl Creek shows hillsides covered by stony till (forested) and meadows where till underlies a veneer of peat (ST)	16
10	Undercut bank of lower O'Ne-ell Creek reveals a cross-section through a glaciofluvial terrace: bouldery outwash gravels (bgFGt) overlie till (ST)	16
11	Soil pit at site S12 (upper Gluskie Creek) shows typical till with sandy silt matrix and about 50% clasts (ST)	17
12	Glaciofluvial gravels exposed in stream cut at Site S28, upper Forfar Creek (ST)	19
13	Glaciolacustrine silt exposed in cutbank of logging road on west side of Middle River (ST)	20
14	Granodiorite blocks, upper Forfar Creek, near Site 37	21
15	Colluvium exposed in soil pit at Site H2 (ST)	22
16	Kettle Lake in valley that interconnects upper Gluskie and Forfar valleys (JMR)	23
17	Smooth, glaciated bedrock on a ridgecrest in the foothills zone (Site 16) (ST)	24
18a	Silty till in moss-covered headscarp of a small debris slide and flow near upper Gluskie Creek, Site S13 (ST)	25
18b	View upslope along debris flow track at Site S13. (ST)	26
18c	Debris pile at lower end of debris flow track shown in Photo 18b. (ST)	26
19	Jackstraw (tilted) trees in deciduous patch, suggesting slope instability ("-F") at transition between upper and middle reaches of Forfar Creek (JMR)	27

20 Embayment in steep till slope on the north side of O'Ne-ell Creek near the old jade mine (JMR)	29
21 Lower reach of O'Ne-ell Creek (JMR)	30
22 Weathered coarse crystalline rock exposed by stream erosion (PF)	30

Moderate-sized scars and large scars are mostly sites of slope failure, but include a few sites where bank erosion has recently occurred. Rough estimates suggest that moderate-sized features are about 10–50 m across, and large scars are larger than about 40 m. Slope failure at these sites releases sufficient material to generate debris flows that travel long distances downslope.

6.2 Potential Sediment Sources: Sensitive Terrain

Sensitive terrain is defined as land that is susceptible to degradation by slope failures (mass movement) and/or erosion; degradation may be triggered by the effects of deforestation and road-building. The associated increase in sediment yield is likely to affect water quality and streambed characteristics in local streams.

Polygons that have been designated as potential sediment sources have significant erosion potential and/or are highly susceptible to slope failure. They have some or all of the following characteristics: fine-textured sediments, moderate to steep slopes, and wet soils. They are located adjacent to streams or tributaries, or in upslope positions from which sediment could easily reach the creeks. Three classes of sensitivity were assigned according to combinations of these characteristics:

Very high sensitivity was assigned to steep slopes and to wet slopes underlain by glaciolacustrine sediments (Section 4.3). Steep slopes, such as stream-side scarps, are sites where small slumps and slides could develop. The availability of water on wet slopes is such that if silty soils are exposed, erosion will be rapid.

High sensitivity was assigned to all other areas of glaciolacustrine sediments, to particularly vulnerable areas (steep, wet) underlain by till, glaciofluvial sediments, and colluvium, and to slopes where sensitivity is demonstrated by recent occurrence of debris flows. Glaciofluvial sediments, although typically gravelly, are included here because they may contain pockets of finer sediments; colluvium is included because colluvial veneers are commonly unstable on steep slopes.

Moderate sensitivity was assigned to other wet areas on till, to steep slopes on colluvium that drain directly to streams, and to stream-side scarps mapped as bedrock and colluvium. Bedrock scarps are not sensitive sites, but are included here because, at the scale and reliability of the mapping, some till and other drift that is sensitive may well be present in areas mapped as rock.

7 CONSIDERATIONS AND RECOMMENDATIONS FOR MANAGEMENT

7.1 Glaciolacustrine Sediments

Current logging plans require that roads be constructed across glaciolacustrine sediments. As already noted (Sections 4.3 and 6.2), this terrain is highly susceptible to erosion and slope failure. Release of silty sediments into creeks could cause serious deterioration in fish habitat and water quality in both the local creeks and Middle River. It is essential that appropriate measures to prevent erosion and slope failures be built into the initial plans for road construction and logging because degradation, once started, will be very difficult to control. Also, remedial measures would probably be much more costly than initial control measures.

In the Middle River area, problems of road maintenance were evident along the existing roads that have been constructed on glaciolacustrine sediments.

The following recommendations indicate the types of precautions that should be taken on glaciolacustrine terrain. They should be developed into standards for forestry in the Stuart-Takla watersheds by an appropriately qualified person who is familiar with both the problems of silty soils and the methods of road construction and silvicultural systems that are used in this region.

Recommendations:

1. More detailed mapping of surficial materials (soils) should be carried out in the vicinity of potential roads in order to determine an alignment that reduces road length on glaciolacustrine sediments.
2. Road cuts (length and height) should be minimized because cuts in wet silty soils are rarely stable.
To achieve these objectives, it may be necessary to have locally steep grades or adverse grades on roads.
3. Ditches that contain flowing water will be very prone to erosion and sediment transport. Effective measures to reduce erosion and to trap fine, suspended sediment will be needed. They should be installed at the time that the ditch is first excavated.
4. Ditches and culverts will need frequent inspection and maintenance, and constant vigilance.
5. Poorly consolidated glaciolacustrine sediments are likely to subside under heavy loads. The bearing strength of in-place silty soil should be measured and taken into account when designing roads. Silty material used as fill will likely subside due to compaction, and slopes on silty fill will creep or slump. This is happening along the existing road south of Middle River.
6. Logging activity, especially clearcutting, on glaciolacustrine sediments should be restricted to the level ground and very gentle slopes of the Middle River lowland (Section 4.3).
7. Before cutblocks are approved in the foothills zone, detailed inspection and mapping of soils, seepage zones, and small channels should be carried out by a terrain/soils/hydrology specialist. Then this map, and discussion with the specialist, should be used by foresters to plan silvicultural systems that will minimize potential degradation. Veneers of silty soil on moderately steep slopes and wet depressions and gullies will be highly susceptible to erosion.
8. Logging should minimize disturbance of shrubby vegetation, young conifers, and ground cover. A living root mat must be maintained to prevent surface erosion.
9. Yarding systems should not result in furrows that will channel surface runoff, thereby initiating erosion.
10. Exposure of bare soil should be minimized. Bare patches should be immediately reseeded, but it should be noted that although seeding with grass will reduce surface erosion, it will not prevent slumping and slow flow.

7.2 Till

Although basal till is generally strong and cohesive, its low permeability commonly results in poor drainage, particularly in depressions and on lower slopes. A perched water table may develop at the interface between soil and unweathered till, and this leads to sloughing of roadcuts where seepage emerges, and to shallow instability (debris slides) on moderate to steep slopes.

In the study area, silty and sandy tills, both basal and ablation, will be susceptible to erosion where disturbed, especially where soils are wet. Erosion could lead to significant input of fine sediment to creeks. Unlike the case of glaciolacustrine sediments, erosion on till may be self-arresting, because under conditions of low to moderate water velocities, fines are washed away while stones accumulate on the gully or ditch floor to form a protective armour. However, higher velocities resulting in transport of gravel can lead to removal of such armour, allowing rapid erosion of underlying material. Hence this process should not be relied upon to limit erosion.

In general, for sensitive areas on till, road length should be reduced as much as possible. In wet areas, road cuts should be minimized in order to avoid tapping shallow subsurface flow and thereby increasing runoff in ditches. Ditches and culverts should be inspected and maintained as frequently as necessary to reduce the risk of accelerated erosion and sediment yield. See also recommendations for the management of landslide-prone terrain in Chatwin et al. 1991.

7.3 Glaciofluvial Materials

Glaciofluvial sands and gravels are highly porous and permeable. Thus they form relatively dry and well-drained sites, although the material is non-cohesive and tends to ravel when exposed in steep streambanks and road cuts. Where glaciofluvial materials consist entirely of well-drained sandy gravels, they are relatively stable. Where lenses of finer materials (e.g., silt) are present, the resulting perched water tables may lead to instability, resulting in slides, gully erosion, and sloughing of road cuts. In general, glaciofluvial materials will probably provide good sites for roads and landings.

Gravelly glaciofluvial materials may be useful as aggregate for fill or road material. The terrain map can be used to identify potential sources: it can be rapidly converted into a map of potential aggregate sources by highlighting all terrain polygons that include the symbol "FG."

7.2 Planned Cut-blocks and Road Alignments

The group of cutblocks that extends northward from lower O'Ne-ell Creek encompasses much glaciolacustrine terrain rated as having very high and high sensitivity.

The proposed access road that extends from the lower O'Ne-ell blocks to the north side of O'Ne-ell zigzags across a wet and gullied hillside. This is mapped as a veneer of glaciofluvial sand over till, but it may include glaciolacustrine silts. It is rated as highly sensitive (H₃).

No other areas of very high or high sensitivity are overlapped by potential cutblocks in upper O'Ne-ell Creek.

Cutblocks in the vicinity of Gluskie Creek are, in general, located on terrain with low sensitivity. Some of the blocks lie adjacent to stream-side scarps of high or moderate sensitivity, and care should be taken to leave an undisturbed strip between the scarp and opening created by forestry. Road construction on scarps should be avoided, or carried out with special care.

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APPENDIX 1 STANDARD TERRAIN MAP LEGEND

1 Terrain Unit Symbols

Simple Terrain Units: e.g., gFt-A

texture ———— ↑↑↑ ———— process
surficial material ———— | ———— surface expression

Note: Two letters may be used to describe any characteristic other than surficial material, or letters may be omitted if information is lacking.

Composite Units: Two or three groups of letters are used to indicate that two or three kinds of terrain are present within a map unit.

e.g., Mm.Rr indicates that “Mm” and “Rr” are of roughly equal extent.

Mm/Rr indicates that “Mm” is more extensive than “Rr” (about 2/1 or 3/2).

$\frac{Mv}{Rr}$ indicates that Rr is partially buried by Mv.

Stratigraphic Units: Groups of letters are arranged one above the other where one or more kinds of surficial material overlie a different material or bedrock.

e.g., $\frac{Mv}{Rr}$ means that “Mv” overlies “Rr.”

APPENDIX 1 (Continued)

2 Materials

C	Colluvium	Products of gravitational slope movements; materials derived from local bedrock and major deposits derived from drift; includes talus and landslide deposits.
E	Eolian sediments	Sand and silt transported and deposited by wind; includes loess.
F	Fluvial sediments	Sands and gravels transported and deposited by streams and rivers; floodplains, terraces, and alluvial fans.
FA	“Active” fluvial sediments	Active deposition zone on modern floodplains and fans; active channel zone.
FG	Glaciofluvial sediments	Sands and gravels transported and deposited by meltwater streams; includes kames, eskers, and outwash plains.
LG	Glaciolacustrine sediments	Fine sand, silt, and clay deposited in ice-dammed lakes.
M	Till	Material deposited by glaciers without modification by flowing water; typically consists of a mixture of pebbles, cobbles, and boulders in a matrix of sand, silt, and clay; diamicton.
M'	Ablation till	Gravelly supra-glacial till.
O	Organic sediments	Material resulting from the accumulation of decaying vegetative matter; includes peat and organic soils.
R	Bedrock	Outcrops, and bedrock within a few centimetres of the surface.
U	Undifferentiated materials	Different surficial materials in such close proximity that they cannot be separated at the scale of the mapping.

APPENDIX 1 (Continued)

3 Texture Specific Clastic Terms

c	clay	<4 μ m
s	silt	4–62.5 μ m
s	sand	62.5 μ m–2 mm
p	pebbles	2–64 mm
k	cobbles	64–256 mm
b	boulders	>256 mm
a	blocks	angular boulders

Common Clastic Terms

d	mixed fragments
x	angular fragments
g	gravel
r	rubble
m	mud

APPENDIX 1 (Continued)

4 Surface Expression

a	moderate slope(s)	predominantly planar slopes; 15–26°
b	blanket	material >1–2 m thick with topography derived from underlying bedrock (which may not be mapped) or surficial material
c	cone	a fan-shaped surface that is a sector of a cone; slopes 15° and steeper
d	depression	enclosed depressions
f	fan	a fan-shaped surface that is a sector of a cone; slopes 3–15°
h	hummocky	steep-sided hillocks and hollows; many slopes 15° and steeper
j	gentle slope(s)	predominantly planar slopes; 4–15°
k	moderately steep slope	predominantly planar slopes; 26–35°
m	rolling topography	linear rises and depressions; <15°
p	plain	0–3°
r	ridges	linear rises and depressions with many slopes 15° and steeper
s	steep slope(s)	slopes steeper than 35°
t	terrace(s)	stepped topography and benchlands
u	undulating topography	hillocks and hollows; slopes predominantly <15°
v	veneer	material <1–2 m thick with topography derived from underlying bedrock (may not be mapped) or surficial material; may include outcrops of underlying material

APPENDIX 1 (Continued)

5 Geological Processes

A	Avalanches	slopes modified by frequent snow avalanches
B	Braiding channel	channel zone with many diverging and rejoining channels; channels laterally unstable
C	Cryoturbation	heaving and churning of soil and surficial materials due to frost action
D	Deflation	removal of sand and silt particles by wind action
E	Glacial meltwater channels	areas crossed by meltwater channels that are too small or too numerous to map individually
F	Failing	slope experiencing slow mass movement, such as sliding or slumping
H	Kettled	area includes numerous small depressions and/or lakes where buried blocks of ice melted
I	Irregularly sinuous channel	channel displays irregular turns and bends
J	Anastamosing channel	channels diverge and converge around semi-permanent islands
K	Karst processes	solution of carbonates (limestone, dolomite) resulting in development of collapse and subsidence features
M	Meandering channel	channel characterized by regular turns and bends
N	Nivation	surface modified by hollows developed around semi-permanent snowbanks
P	Piping	Subsurface erosion of silty sediments by flowing water resulting in the formation of underground conduits
R	Rapid mass movement	slope or parts of slope affected by processes such as debris flows, debris slides and avalanches, and rockfall
S	Solifluction	slope modified by slow downslope movement of seasonally unfrozen regolith
U	Inundated	
V	Gullying	slope affected by gully erosion
W	Washing	winnowing of fines by flowing water resulting in development of lag deposits
X	Permafrost processes	processes related to the presence of permafrost; permafrost aggradation and degradation
Z	Periglacial processes	Solifluction, nivation, and cryoturbation occurring together in a single terrain unit

APPENDIX 1 (Continued)






5 (Continued)**Mass movement sub-classes**

-F	slow mass movement
-Fc	soil creep
-Fg	rock creep
-Fk	tension cracks
-Fp	lateral spread in bedrock
-Fj	lateral spread in surficial materials
-Fe	earthflow
-Fm	slump in bedrock
-Fu	slump in surficial material
-Fx	slump-earthflow
-R	rapid mass movement
-Rf	debris fall
-Rb	rock fall
-Rs	debris slide
-Rr	rockslide
-Rd	debris flow
-Rt	debris torrent



APPENDIX 1 (Concluded)

6 On-Site Symbols and Boundary Lines




Ice-flow direction indicators

-  crag and tail
-  drumlins
-  striations
-  grooves
-  lineations





Scarps: escarpments, bluffs

-  in Quaternary materials
-  in bedrock

Terrain polygon boundary lines

-  definite boundary
-  indefinite, approximate, or gradational boundary
-  assumed or arbitrary boundary



Mass movement and erosion features

-  scar of recent small slide
-  scar of recent larger slide
-  scar of old landslide
-  recent debris flow

Cirques

Glacial meltwater channels

Eskers

-  flow direction known
-  flow direction unknown

Observation site S10