RESOURCES INVENTORY COMMITTEE APPROVED STANDARD

GUIDELINES AND STANDARDS TO TERRAIN MAPPING IN British Columbia

by
Resources Inventory Committee

Surficial Geology Task Group
Earth Sciences Task Force
British Columbia

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PREFACE AND ACKNOWLEDGMENTS

Purpose and Content of the Guidelines and Standards

This manual provides guidelines for terrain mapping (see Section 1.2) in the province of British Columbia. These guidelines and standards have been prepared under the auspices of the Surficial Geology Task Group (SGTG), a part of the Earth Science Task Force of the Resources Inventory Committee (RIC). RIC is a Canada - British Columbia Partnership Agreement on Forest Resource Development. Its' overall purpose is the improvement of provincial resource data bases in order to facilitate effective land management. Objectives of the SGTG are to identify terrain information (e.g. surficial geology, and geological hazards) that is needed by resource managers and to define standards for terrain mapping and data collection. Tasks also include the testing of standards, training of personnel, minimization of duplication of effort, promotion of cooperative data collection, improvement of availability of terrain information, encouragement of broad application of the data and maintenance of its long-term relevance.

Terrain (surficial geology) maps are relevant to forestry and to many other aspects of land management, land use planning and resource use, park development, wildlife management and mineral exploration. The use of information about surfcial materials, geomorphological processes and other aspects of terrain is expected to increase during the next decade as environmental concerns expand. Mapping for many specific purposes, such as slope stability, groundwater, seismic zonation, and biophysical habitat inventory, depends on basic terrain mapping and will benefit from the guidelines in this document.

The major objective of this manual is to define common standards and methods for the collection and presentation of terrain data. Terminology follows that of Cormier (1992; see also Appendices B and C). The manual also provides background information that can be used for training terrain mappers. Standards for terrain mapping and presentation of terrain data are provided in the form of a methodology for the preparation of terrain maps. Standards and requirements, for essential fundamental information and procedures, necessary to meet the guidelines, are clearly listed in bordered boxes as ***Minimum Requirements***. The standards defined in these guidelines shall be followed in all terrain mapping in the province of British Columbia (see summary list in Appendix A). The sequence of actions necessary for mapping, such as air photo interpretation and field checking are described, and matters such as map scale and survey intensity are discussed. The terrain classification system that is used for mapping has been previously published (Howes and Kenk, 1988) and is not repeated here. The 1988 manual provides definitions for the symbols that are used on terrain maps and instructions for their use. Thus the 1988 "terrain classification manual" and this publication -- a "guidelines and standards manual" -- are complementary and all terrain mappers must be familiar with both.

This manual also provides descriptions of how terrain mapping methodology can be modified for special purposes. For example, extra components can be added to the map symbols to accommodate additional parameters, such as depth to bedrock and age of materials. Other aspects of terrain analysis, such as the preparation of derivative maps, report writing, and digital data storage, are briefly covered. Although this manual and the terrain classification manual together describe a system of terrain mapping that has been widely used in British Columbia, neither the methodology nor the classification system is specific to this province and could well be used elsewhere, especially in similar glaciated landscapes.

Acknowledgments

Preparation of this manual was initiated by Dr. P. T. Bobrowsky. Specifications for terrain mapping were defined during a two-day meeting of the Surficial Geology Task Group Committee in February 1993. Committee members included P. Bobrowsky (chair), R. Buchanan, S. Chatwin, J. Clague, R. Fulton, D. Howes, R. Reger, N. Rutter, J. Ryder, E}. VanDine. (For affiliations and addresses, see Appendix H.) The results and minutes of this meeting were first compiled by J. Ryder and D. VanDine (under contract), and then underwent revision by the task group committee. Additional useful comments and suggestions were subsequently received by M. Bloodgood, B. Broster, D. Goldthorp, G. Horel, H. Luttmerding, P. Jordan, P. Matysek, J. Psutka and M. Roed who are not committee members.

1.0 INTRODUCTION

1.1 Historical Perspective

In British Columbia, the first geological descriptions of surficial materials were made in the late nineteenth and early twentieth centuries by geologists such as G. M. Dawson and R. Daly. These early explorers, who also made considerable contributions to our knowledge of natural history and anthropology, produced the first bedrock maps of British Columbia. They did no systematic mapping of surficial materials, although some of their bedrock maps show striations and other glacial features (Jackson and Clague, 1991). The Geological Survey of Canada initiated surficial geology mapping in British Columbia in about 1915, with mapping of the Victoria, Duncan and Saanich areas by C. Clapp. Systematic mapping of surficial materials did not begin until the late 1940s, however, when Quaternary geologists such as J. Fyles, J. E Armstrong, S. Leaming, H. Nasmith and E. Halstead began to work in southwestern B.C.

Federal soil surveys began before regular surficial geology work was established, with early maps and reports appearing in the 1920s and 1930s. At first, pedological mapping was not strongly oriented toward surficial materials, but by the 1960s, pedologists with the British Columbia Department of Agriculture (later Ministry of Environment) and Environment Canada were producing "soils and landforms" maps, on which surficial materials were specifically described.

The system of surficial geology mapping from which the present terrain mapping scheme evolved was introduced to British Columbia by R. J. Fulton of the Geological Survey of Canada in the early 1970s (Boydell, 1992). Mappers trained by Fulton were hired by the Resource Analysis Branch of the B.C. Ministry of Environment. In 1975 the mapping scheme was formalized by publication of the first terrain classification manual (E.L.U.C. Secretariat, 1975).

The 1970s and early 1980s were the heyday of terrain inventory mapping. Large areas of the province were mapped at scales ranging from 1:50,000 to 1:250,000. Work by the Geological Survey of Canada continued, but most mapping was done by Quaternary geologists and pedologists of the B.C. Ministry of Environment. Many projects were undertaken at the request of other provincial Ministries and the usefulness of terrain maps for various purposes was realized. Derivative maps (e.g., for "urban suitability", "suitability for forest roads") became routine products for some types of projects, and workshops about terrain map applications were conducted by Resource Analysis Branch geologists for other government staff.

Since the early 1980s, terrain maps have been used increasingly as the basis for many kinds of land use planning, although government-funded inventory mapping has gradually declined. Terrain maps are now used extensively by the forest industry both for general planning and as the basis for the slope stability mapping that is required before logging commences. Biophysical habitat mapping, which is used for park delimitation and planning purposes by the provincial parks department, is also based on terrain mapping. Environmental impact assessment, planning for new highways and other linear developments, regional planning, assessment of geological hazards, and fish-forestry interaction programs, all depend upon terrain maps. Terrain maps are also used as a tool for mineral exploration (e.g. Meldrum and Bobrowsky, 1994).

1.2 Terrain Mapping and Surficial Geology Mapping: Definitions and Comparison

A terrain map (Fig. 1) is a particular type of surficial (or Quaternary) map. It shows the distribution of surficial (Quaternary) deposits and related landforms on the earth's surface. However, it also provides information about present day geomorphological processes, and in this respect it differs from surficial geology maps. For example, areas affected by processes such as debris slides, shifting river channels, and wind erosion, are indicated in the terrain symbol (commonly, these processes are referred to as "geological" or "terrain" processes). in coast, surficial geology maps provide "chronostratigraphic" information, data which does not appear on terrain maps. With the exception of the legend and unit labels, all other aspects of the guideline apply equally to surficial geology mapping and maps.

Another characteristic that distinguishes terrain maps from other surficial geology maps is that a terrain map has a flexible or "open" legend. In other words, the legend does not specify the exact form of every symbol (a group of letters) that is used on the map. Instead, the letters that together comprise the symbol for a terrain polygon are selected by the mapper to denote the particular set of conditions in that polygon (Fig. 2). Specific letters are used to describe material type, texture, landform (surface expression) and processes, and a complex of two or three different kinds of materials and processes can be indicated (see Howes and Kenk, 1988). Thus, on any given map, many polygons have unique labels. By comparison, on a map with a "closed" legend, each polygon must be assigned to a predetermined category that is listed in the legend. The preference for terrain maps versus surficial geology maps has more to do with project needs and objectives than anything else.

The standard method of terrain mapping can be adapted readily for a variety of purposes. For example, "bioterrain mapping" is being used by the Wildlife Habitat Branch of the British Columbia Ministry of Environment, Lands and Parks to provide a basis for long term planning (Appendix F). This type of mapping takes into account characteristics of the landscape that are particularly important from the point of view of wildlife habitat, but not normally used as direct criteria for the delimitation of terrain polygons, such as aspect (proxy for temperature and humidity), soil drainage, and vegetation types. As a second example, terrain maps used as a basis for slope stability assessments by the British Columbia Ministry of Forests include symbols that represent soil drainage and slope gradients (see Section 10.2).

The methodology for terrain mapping is similar to that of other kinds of surficial geology mapping. Mapping is based on air photo interpretation, which in most cases is followed by ground checking.

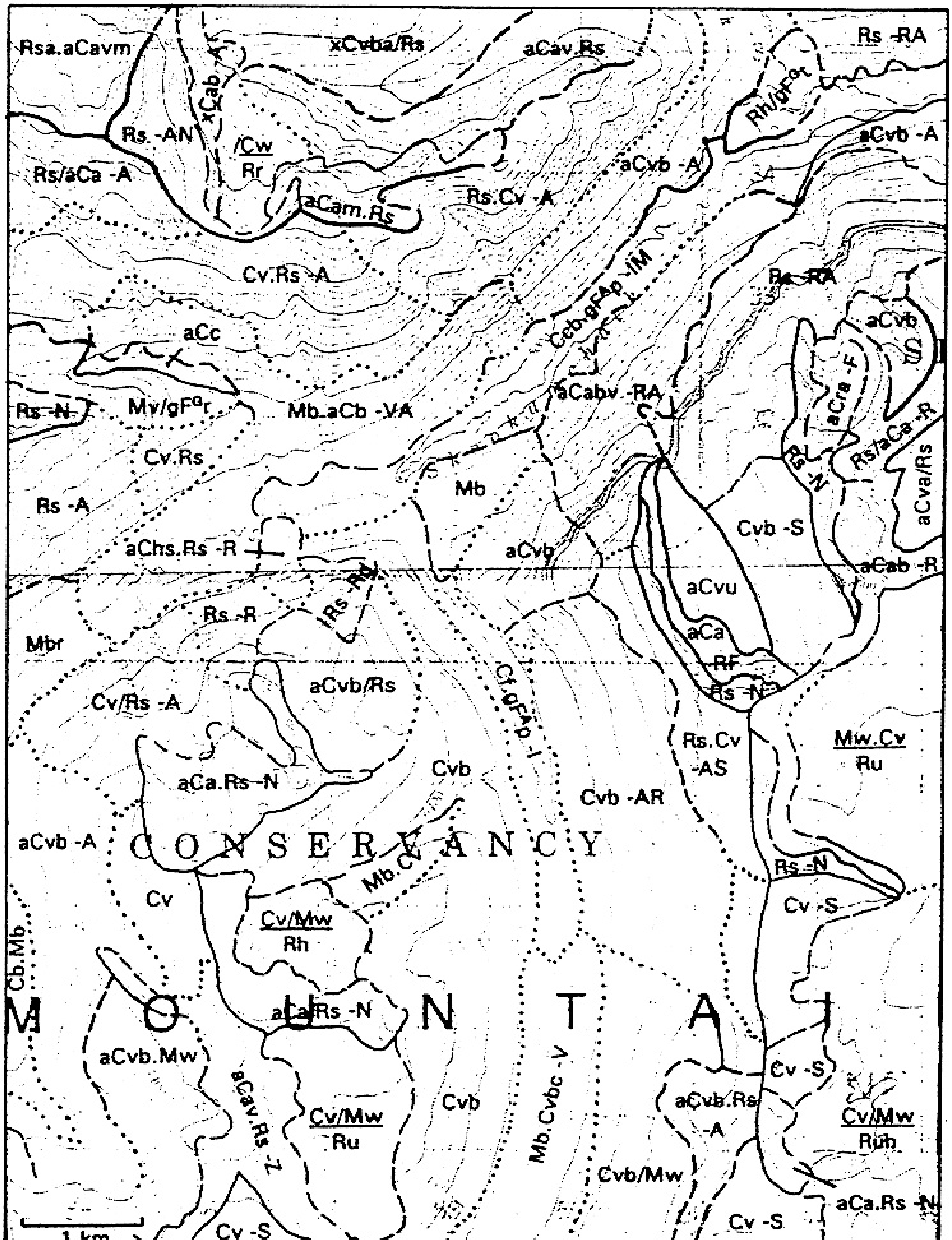


Figure 1. Example of a terrain map. Topographic base map is a 50% screened mylar, prepared photographically from NTS map 82F/16.

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 indicate that two or three kinds of terrain are present within a polygon.

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)

"/Mv" indicates that Rr is partially buried by
"Rr"
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., "Mv" means that "Mv" overlies "Rr".
Rr

(2) MATERIALS

C	Colluvium	FG	Glaciofluvial
F	Fluvial	M	Till
FA	Fluvial (active)	R	Bedrock

(3) TEXTURE

a	blocks	g	gravel

(4) SURFACE EXPRESSION

a	moderate slope(s)	p	plain
b	blanket	s	steep slope(s)
c	cone	t	terrace(s)
f	fan	u	undulating topography
h	hummocky	v	veneer
		w	mantle of variable thickness

(5) GEOLOGICAL PROCESSES

A	Avalanches	R	Rapid mass movement
F	Failing	S	Solifluction
I	Irregularly sinuous channel	V	Gullying
M	Meandering channel	Z	Periglacial processes
N	Nivation		

(6) TERRAIN UNIT BOUNDARY LINES

definite boundary
indefinite boundary
assumed or arbitrary boundary

Mv	a thin covering of till overlying bedrock (M = till, v = veneer) (contours of base map supply topographic information)
Mv Ru	a thin covering of till overlies gently undulating bedrock (R = bedrock, u = undulating) (topography is not adequately shown by base map contours)
rCc	talus cone (r = rubble, C = colluvium, k = moderately steep slope)
gF^{A}p-B	floodplain of river with braided channel (g = gravel, F^{A} = "active" fluvial, p = plain, -B = braided channel)
$sEv gFt	veneer of eolian silty sand on a river terrace ($ = silt, s = sand; E = eolian, v = veneer, g = gravel, F = fluvial, t = terrace)
Mv/Cv	most of the polygon is underlain by thin till; the remainder is underlain by thin colluvium
sEv/sgF^{A}f -B gFt	most of the polygon consists of river terraces (gFt) covered by a veneer in eolian sand (sEv); a smaller part of the polygon is occupied by active fluvial fans with braided streams (sgF^{A}f-B)
sFv/Ov -M sgF^{A}p	sandy gravels of active floodplain are veneered by fluvial sand and, in smaller areas, by organic sediments (peat) (O = organic sediments)
srCf gFt $LG	debris flow fans consisting of angular sandy gravel (r = rubble) rest on a river terrace that is underlain by glaciolacustrine silts

Figure 2. Examples of terrain symbols found on terrain maps in British Columbia.

2.0 SOURCES OF TERRAIN AND SURFICIAL GEOLOGY MAPS IN BRITISH COLUMBIA

2.1 Introduction

An index to "surficial geology" maps of British Columbia has recently been prepared by Bobrowsky et a/. (1992). This useful compilation, which lists about 2000 maps, provides the basis for the following summary of agencies carrying out mapping and the types of maps available. It also includes a series of page-size maps of British Columbia showing areas covered by maps of various scales and published by various agencies, keyed to the NTS grid. References on Quaternary geology are well summarized in a useful bibliography by Clague (1987).

The above index lists maps under a variety of names, most of which refer to the information content of the maps (Table 1). Both terrain maps and surficial geology maps (as defined in Section 1.2) are listed as "surficial geology" maps because their information content is similar. The list includes both base data maps, which show the distribution of surficial materials, landforms and other geomorphic feature, and derivative maps (sometimes called interpretive maps) prepared by selecting information from the base data maps. Only base data maps are considered in Section 2.2.; derivative maps are discussed in Section 10.0. Addresses of agencies from which information about maps can be obtained and from which maps can be purchased are listed in Appendix H.

2.2 Agencies

Most mapping of surficial materials (inventory mapping) has been carried out by the British Columbia Ministry of Environment, Lands and Parks (MELP; Table 2). MELP maps published after about 1975 are terrain maps; earlier maps are "soils and landforms" maps. Maps at a scale of 1:50,000 are available for most of the southern and central parts of the province; most of these are terrain maps, but some are soils and landforms maps. Terrain maps at smaller scales (1:100,000, 1:250,000) provide coverage in northwestern British Columbia, and maps at these scales elsewhere are mostly re-issues of maps originally produced at 1 :50,000. Larger scale maps, mostly at I :20,000 have been prepared for more densely populated areas such as the lower Fraser Valley, the Okanagan Valley, and parts of eastern Vancouver Island. Large scale mapping (1:20,000) has also been carried out for special projects, including assessment of terrain conditions for urban expansion near communities such as Invermere and Williams Lake.

MELP maps are reproduced as blackline prints that are run off from mylar masters when requested by users. Many maps are accompanied by reports which provide additional information about surficial materials, landforms, hazards such as avalanches and debris flows, and geological history.

Soil (pedological) maps (some are called "soils and landforms") issued by Agriculture Canada (AC) and MELP are based on terrain/surficial geology map units which are described in the soil map legend. Thus, information about surficial materials can be obtained from soil maps where terrain and surficial geology maps are not available. Map scales are most commonly 1:50,000 (MELP) and 1:100,000 (AC and MELP). Most soils maps are accompanied by reports which provide additional information about soils that is relevant to agriculture, forestry, and other forms of land use. Maps (mostly 1:100,000 scale) that accompany reports are off-set printed in several colours; other maps are available as blackline prints (Appendix H).

The more traditional geological agencies -- Geological Survey of Canada (GSC) and provincial Ministry of Energy, Mines and Petroleum Resources (MEMPR) -- have played a relatively minor, although significant, role in the mapping of surficial materials. GSC personnel map at scales ranging from 1 :50,000 to 1: 1 million and cover widely scattered parts of the province. Surficial geology maps produced by the GSC at 1:50,000 cover only a small part of British Columbia, (including the lower Fraser Valley and eastern Vancouver Island) and 1:100,000-scale maps, which are mostly terrain maps, also cover a limited area. Coverage at 1 :250,000 includes a few terrain maps and maps of glacial landforms. One to one million scale terrain maps have been compiled for the southern part of the province, and glacial landforms are mapped at this scale for northeastern B.C.

Most mapping by the MEMPR has been oriented toward mineral exploration, and most maps are at a scale of 1:50,000. Map types include aggregate resources, surficial geology maps of areas with mineral potential, terrain maps of access routes to mineralized areas, and maps for placer resources. Surficial geology map production by MEMPR staff has increased significantly since the establishment of an Environmental Geology Section in 1988. MEMPR maps are reproduced as blackline prints, and most are accompanied by short reports. Terrain/surficial geology mapping for similar purposes has been carried out by some mining companies.

A large number of terrain maps, at scales ranging from 1:5000 to 1:50,000 have been produced under the auspices of the Ministry of Forests (MOF) and major forest companies. These maps are used for planning of forestry activities and identification of landslide-prone areas (Section 10.2). The provincial Ministry of Transportation and Highways (MoTH) has prepared many terrain maps for use in planning road locations (e.g., 1:50,000) and alignments (e.g., 1:10,000), for locating sources of aggregate (e.g., 1:20,000), and to define zones of hazard due to processes such as debris flows and avalanches.

Maps of terrain, surficial geology, landforms and other components of the physical environment relevant to various departmental jurisdictions have also been prepared by other governmental and private agencies such as Environment Canada, various Regional Districts of British Columbia, and B. C. Hydro and Power Authority.

2.3 Current Mapping Programs

A report of the status of terrain mapping programs, data bases, user groups, and user requirements in British Columbia was prepared by A. N. Boydell for the Surficial Geology Task Group in April, 1992. The report was based partly on discussions of the Task Group and partly on the results of a questionnaire sent to users of terrain maps and related information. Information about current mapping programs summarized from Boydell's report, is presented in Table 3.

2.4 Terrain Mappers and Qualifications for Terrain Mapping

Terrain and surficial geology mapping for programs such as those listed in Table 3 have been carried out by geomorphologists, pedologists and Quaternary geologists. Some of these specialists are on the staff of those departments with a mandate to map surficial materials: MEMPR, GSC, MELP, MOF, MoTH, and AC. Many, however, are private consultants contracted by government agencies or private companies for specific projects.

Terrain mapping requires the application of experience and judgment, and the use of special skills such as air photo interpretation. Thus it is necessary to specify closely the qualifications required of a terrain mapper. Judgment is essential because many aspects of terrain mapping, such as polygon size and number of polygons delimited, are dictated by the characteristics of the landscape that is being mapped and cannot be specified by anyone but the mapper. Also, a thorough understanding of the geological and geomorphological history of the area, including processes, is essential.

Terrain mappers must be members in good standing of the Association of Professional Engineers and Geoscientists of British Columbia (P.Geo., P.Eng.) or equivalent, and have relevant experience in the fields of Quaternary geology, glacial geology, geomorphology and air photo interpretation. Training must include advanced courses (i.e., 3rd and 4th year university courses) in air photo interpretation (photogrammetry is not relevant), geomorphology and Quaternary geology. Terrain mappers working independently shall have prior experience in terrain mapping.

Minimum Requirements:

- Terrain mappers shall be a P.Geo. or P.Eng. in good standing, qualified and recognized as a specialist in terrain mapping.
- Terrain mappers shall have successfully completed advanced courses in geomorphology, Quaternary geology (or glacial geology) and air photo interpretation.
- Terrain mappers shall have demonstrable experience including supervised work in terrain mapping.

Table 1. Classification of Terrain/Surficial Geology Maps.
(After Bobrowsky *et al*., 1992)

MAP TYPE	MAP CONTENTS
Aggregate Resources	Sand and gravel deposits.
Biophysical	Terrain, recreation, wildlife, aquatic resources.
Forest Terrain	Basic surficial geology (terrain) maps with slope and topographic information, some with data for logging roads and slope stability.
Generalized Surficial Geology	Texture, genetic materials, depth of surface materials and geological processes.
Geological Hazards and Periglacial	As above with periglacial features.
Geological Hazards	Slope processes, periglacial processes, fluvial processes and other specific hazards.
Geological Processes	Geological processes and status, slopes and specific processes.
Periglacial	Periglacial features.
Physiographic Constraints	Limitations to development, such as depth to bedrock, drainage, impervious horizon, landscape position, organic content, stoniness, slope-topography, soil texture, depth to water table, environmental hazards.
Slope Processes	Slopes and processes acting on slopes (avalanching, gullying and failing).
Soils and Slopes	Typical soil maps with slope information.
Soils and Surficial Geology	Soil associations, surficial geology, topographic classes and soil drainage classes.
Surface Morphology	Similar to terrestrial maps but subaqueous and less specific.
Surficial Geology (Terrain or Landforms)	Texture, genetic materials, surface expression and geological processes.
Surficial Geology and Drainage	Surficial geology and soil drainage.
Surficial Geology and Physiographic Constraints	Combined surficial geology and physiographic constraints.
surficial Geology and Slopes	Surficial geology, slope, and topography.

Surficial Geology and Topography	Surficial geology and topography.
Surficial Geology, Drainage and Slopes	Surficial geology, soil drainage and slopes.
Surficial Materials	Surface materials.
Terrain Evaluation	Surficial sediments, soil survey data, surficial geology maps or soils and landform maps.
Terrain Features	Glacial, periglacial and mass-movement features as well as other landforms.

Table 2. Agencies involved in B.C. Terrain Mapping.

CATEGORY	AGENCY	MAP TYPES
Federal Government	Agriculture Canada	Soils and Surficial Geology
	Environment Canada	Physiographic Constraints Surficial Materials
	Geological Survey of Canada	Surficial Geology Surficial Materials Aggregate Resources Surface Morphology
Provincial Agencies	British Columbia Hydro and Power Authority	Geological Hazards Surficial Geology Generalized Surficial Geology Forest Terrain
Provincial Government	Ministry of Energy Mines and Petroleum Resources	Aggregate Resources Surficial Geology Generalized Surficial Geology Drift Exploration Potential Placer Geology Potential
	Ministry of Forests including Research Branch Forest Regions and Forest Districts	Surficial Geology Forest Terrain Surficial Geology Drainage and Slopes Surficial Geology and Drainage
	Ministry of Environment Lands and Parks	Surficial Geology Generalized Surficial Geology Soils and Surficial Geology Geological Hazards Surficial Materials Terrain Features Surficial Geology and Topography Surficial Geology and Drainage Geological Processes Aggregate Resources Soils and Slopes Physiographic Constraints Slope Processes Surficial Geology and Physiographic Constraints Surficial Geology and Slopes Surficial Geology Drainage and Slopes Biophysical Forest Terrain Periglacial
	Ministry of Transportation and Highways	Aggregate Resources Generalized Surficial Geology Geological Hazards Surficial Geology Surficial Materials Terrain Evaluation Physiographic Constraints
Regional Districts	Central Kootenay Regional District	Surficial Geology
	Prince Rupert Regional District	Surficial Geology

	Sunshine Coast Regional District	Geological Hazards
	Squamish Regional District	Geological Hazards
Municipalities	Town of Gibsons	Geological Hazards
Private Forest Co.	Atco Enterprises Ltd.	Forest Terrain
	Canadian Forest Products Ltd.	Surficial Geology
	Crestbrook Forest Industries Ltd.	Surficial Geology
	Coast Forest Management Coast Wood Products	Surficial Geology Drainage and Slopes Surficial Geology Drainage and Slopes
	Crows Nest Resources Ltd.	Surficial Geology
	Crown Forest Industries Ltd./ Crown Paper	Surficial Geology
	Fletcher Challenge Canada Ltd.	Surficial Geology Surficial Geology Drainage and Slopes
	International Forest Products Ltd.	Surficial Geology and Slopes
	Macmillan Bloedel Ltd.	Forest Terrain Surficial Geology Drainage and Slopes
	Northwood Pulp and Timber Company	Surficial Geology
	Skeena Cellulose Inc.	Forest Terrain Surficial Geology Drainage and Slopes
	Slocan Forest Products Ltd.	Forest Terrain
	Weyerhaeuser Canada Ltd.	Surficial Geology Drainage and Slopes Forest Terrain
	Westar Timber Ltd.	Forest Terrain
	Western Forest Products Ltd.	Surficial Geology
	Wedeene River Contracting	Surficial Geology Drainage and Slopes
Private Mining Companies	Cyprus Anvil Mining and Exploration Company	Surficial Geology
	Doman Industries Ltd.	Surficial Geology Drainage and Slopes
	Geddes Resources Ltd.	
	MineQuest Exploration Associates Ltd.	Generalized Surficial Geology
	Newhawk Gold	Surficial Geology
	Placer Dome Inc.	Surficial Geology
	Prime Geochemical Methods Ltd.	Generalized Surficial Geology
	Rio Algom Exploration Ltd.	Generalized Surficial Geology
Others	Coast Strategies Corp.	Surficial Geology Drainage and Slopes
	Gulf Canada Resources	Surficial Geology Aggregate Resources
	Industry (restricted)	Surficial Geology Surficial Geology (Photo)
	Ocean Falls Power Corporation	Surficial Geology Surficial Geology (Photo)

Table 3. Current Mapping Programs (Adapted from Boydell, 1992).

Ministry of Energy, Mines and Petroleum Resources, Environmental Geology Section Programs: Applied Quaternary Mapping, Drift Prospecting, Placer Deposit Delineation, Geological Hazards. Types of Mapping and Data Collection: terrain mapping, landform mapping, aggregate sources, slope stability/hazards mapping, stratiographic data. Principle Products: base data maps of types listed above; thematic maps for specific purposes, reports. Principle Clients: mining companies, foresters, field geologists, engineers, land use planners, soil scientists, exploration managers.
Ministry of Transportation and Highways, Geotechnical and Materials Engineering Branch Programs: Corridor Analyses, Aggregate Resource Evaluation. Types of Mapping and Data Collection: terrain mapping, landform mapping, aggregate sources mapping, slope stability/hazards mapping. Principle Products: highway preliminary design maps, terrain maps, corridor studies, geological hazard studies. Principle Clients: in Ministry; six regional offices.
Ministry of Environment, Lands and Parks, Environmental Emergency Services Branch Types of Mapping and Data Collection: shoreline mapping, physical attributes; information about wave energy, tides and currents. Principle Products: maps, video tapes and reports containing information about shoreline types, texture, wave exposure and oil residency. Principle Clients: oil industry, government agencies with interests in marine environment, local government planners and administrators.
Ministry of Environment, Lands and Parks, Wildlife Branch, Habitat Management Programs: Wildlife Biophysical Mapping Types of Mapping and Data Collection: biophysical terrain mapping (see Appendix F). Principle Products: l :5O,000 scale biophysical maps. Principle Clients: provincial and local government agencies.
Ministry of Environment, Lands and Parks, Recreational Fisheries Branch Programs: Aquatic inventory. Types of Mapping and Data Collection: data about surficial materials of river channels, channel morphology, gradient. Principle Products: maps of reaches of rivers at l :5O,000; less than 15% of province covered. Principle Clients: MELP and other government agencies, Fisheries and Oceans Canada.
Ministry of Environment, Lands and Parks, Water Management Branch, Groundwater Section Types of Mapping and Dam Collection: stratigraphic data from water well records, maps showing location of wells. Principle Products: records available in computerized database.
Ministry of Forests and Forest Companies Types of Mapping and Data Collection: terrain mapping, including soil drainage and slope steepness. Principle Products: terrain maps, maps of slope stability and potential erosion.

3.0 THE USE OF TERRAIN MAPS

3.1 Present Map Users

During the two decades since the inception of terrain mapping in British Columbia, terrain maps have come to be used for a wide variety of purposes within the general realms of resource management and land use planning (see "Principle Clients" in Table 3). Commonly, government regulations for licensing and permitting require that resource-based companies utilize terrain maps in their planning processes. Terrain maps are also used for environmental impact assessment, planning of roads and other linear developments, various types of community plans, and location of industrial facilities.

At the present time, the forest industry is one of the chief users of terrain maps. Terrain maps/information are used at three levels of reliability: (1) "Es" (= environmental sensitivity) terrain mapping is used at a reconnaissance level (little field checking) to identify unstable areas and potentially unstable areas that remain undisturbed; (2) Terrain maps prepared by rigorous field checking are the basis of the "five-class slope stability" maps (typically 1:20,000; Section 10.2) that the large forest companies are required to employ in the preparation and annual updating of their five-year plans; Ministry of Forests staff also use these maps for planning the activities of small forest companies; and (3) Detailed terrain mapping (1:5000) and/or on-site inspections by terrain specialists, and interpretations related to slope stability, road locations and proposed cut-block boundaries, are required where roads and cut blocks extend onto steep slopes. Where logging is planned in areas susceptible to landslides and/or erosion, and where increased sediment production would have an adverse effect on fish-bearing streams or community water supplies, terrain maps are used to identify existing and potential sediment sources for planning purposes.

In the mining industry, terrain maps are used for planning, environmental impact assessment and exploration. Information conveyed on terrain maps and derivative maps are used in the mine planning and development stages, mine expansion and mine decommissioning stages (e.g., Maynard and Walmsley, 1981). Reclamation planning and land rehabilitation activities undertaken by industry and consultants to industry rely heavily upon the information presented on terrain maps to evaluate baseline environmental conditions and establish decommissioning and reclamation objectives. Planning of facilities such as access roads requires information about substrate conditions, aggregate sources, and potential hazards such as snow avalanches. Recently, terrain maps have begun to be used in the planning of till geochemical surveys and in assessing the results of such surveys, because knowledge of the origin of the surficial materials sampled is essential (see Bobrowsky et al., 1995).

The Ministry of Transportation and Highways makes extensive use of terrain maps, both for general and detailed planning purposes. For example, 1:50,000 scale terrain maps have been used, along with other information for comparison of alternative potential routes for new highway design. Large scale terrain maps (e.g., 1: 10,000) provide information relevant to detailed planning of road alignment, subgrade conditions, and sources of aggregate. Terrain maps are always an integral part of geotechnical studies (e.g., Broster and Bruce, 1990).

Terrain maps provide information used by various government agencies (e.g., Ministry of Environment, Lands and Parks; Ministry of Transportation and Highways; regional districts; municipalities) for the identification of natural hazards and the delimitation of zones for hazard control. Preliminary assessment of hazards can be made by interpretation of terrain maps at scales such as 1:50,000 and 1:100,000: for example, areas affected by slope processes (landslides, debris flows, snow avalanches) and floods can be identified. Detailed hazard investigation can be done by using larger scale terrain maps (e.g., 1:1O,000) as a vehicle to portray relevant information. Micro-zonation for seismic hazards (seismic shaking, potential liquefaction) is based on maps of surficial materials (RIC, I 994b).

Government agencies at various levels also use terrain maps as the basis for preliminary or general planning of new residential areas, and urban and industrial facilities Relevant information includes hazards, substrate conditions that represent constraints to development (e g., poor drainage), and sources of aggregate. For example, terrain information is input to Official Community Plans, prepared by Regional Districts.

Terrain maps are used as the base for the biophysical mapping that is presently carried out by the British Columbia Ministry of Environment, Lands and Parks. Biophysical maps include information about soils, vegetation and wildlife habitat, keyed to map polygons that are defined largely on the basis of terrain conditions. (See description of bioterrain mapping, Appendix F.) Biophysical maps are being used for land use planning and resource management, for example as an aid to the identification of areas for protection, such as parks.

4.0 THE BASIC TERRAIN MAP

A terrain map shows numerous irregularly-shaped areas that are known as "terrain polygons". Ideally, polygons are delimited in such a way that terrain variability within each polygon is minimized. This means that the terrain within each polygon is relatively uniform with regard to the criteria upon which the terrain classification system is based: type and texture of surficial material, type of landform and/or material thickness, and present-day geomorphological processes (see Howes and Kenk, 1988). In practice, the variability of terrain is such that many polygons cannot be internally homogeneous; they include two or even three types of materials and landforms that are sufficiently intermixed that they cannot be separated at the scale of the mapping. In such cases, however, polygons are delimited so that the variability of terrain characteristics within a polygon is less than that between adjacent polygons.

4.1 Definition of a Terrain Polygon

The physical landscape is a mosaic of different kinds of materials and landforms (Mitchell, 1991). The simplest bit of the landscape, which can be referred to as a "basic element", is one kind of material formed by a single process and forming one kind of landform. An alluvial fan and a hillside covered with till of fairly uniform thickness are two examples of basic elements. A series of river terraces and a dune field are also basic elements. If map scale permits, a polygon should consist of a single element, ie., it should be internally homogeneous; this is a "simple terrain polygon". Alternatively, if single elements are too small to delimit, a polygon may include a repeated pattern of two or at most three basic elements; this is a "composite terrain polygon". Composite terrain polygons of bedrock and colluvium are common on steep mountain sides. Composite polygons of floodplain, river terraces and alluvial fans are common on valley floors. Wherever possible, composite terrain polygons should be delimited so that they include surficial elements of related genesis or surficial elements linked by common processes. For example, alluvial fans should be grouped with an adjacent floodplain, rather than with adjacent steep slopes; talus slopes and the rock bluffs from which the talus was derived are appropriately grouped together.

In other words, a polygon is a homogeneous part of the earth's surface. Internal variability within a polygon must be less than the difference between adjacent polygons. A single polygon can encompass a repetitive pattern of landforms and materials -- it can be homogeneous by virtue of its variability.

Basic elements vary considerably in area, for example a narrow floodplain may cut across an extensive till plain, and so adjacent terrain polygons may be of quite dissimilar size. The minimum size of a terrain polygon that is normally practical to delimit on a map is about 1 cm2. The average size of terrain polygons may vary from one landscape or physiographic region to another. Obviously, terrain polygons on a large scale map will encompass smaller true areas (i.e., less hectares) than polygons on a small scale map, as shown on Table 4.

4.2 Delimiting Terrain Polygons

Considerations outlined in Section 4.1 lead to definition of the following minimum requirements for mapping of terrain polygons.

Minimum Requirements:

- Polygons shall be delimited according to the degree of similarity or dissimilarity of terrain characteristics. Mappers shall not attempt to delimit polygons of uniform size.

- The minimum size of a polygon that can be shown on a terrain map is 1 cm2, regardless of map scale.

- Mappers shall determine minimum polygon size (the polygon size at the scale of the air photos that is equivalent to 1 cm2 on the terrain map) before beginning air photo interpretation.

4.3 Polygon Boundary Lines .

The type of line that is used provides valuable information about terrain characteristics and the reliability of polygon boundary locations.

Minimum Requirements:

Three types of polygon boundary lines shall be used:

- solid lines represent well defined, sharp boundaries that can be precisely delimited at the scale of mapping;

- dashed lines represent boundaries that are gradational over a short distance or that can be only approximately located, such as between the toe of a large alluvial fan and the floodplain that it overlies, or where precise boundary locations are masked by forest;

- dotted lines represent assumed boundaries, for example, around many composite units, and boundaries that are gradational over considerable distances.

4.4 Terrain Symbols: Letter Symbols

The letter symbols that are assigned to each terrain polygon represent four or more classes of information. Standard symbols represent:

- type (genesis) of surficial material;
- material texture;
- surface expression (landform and/or material thickness);
- geomorphological processes.

Mappers should refer to the terrain classification system manual (Howes and Kenk, 1988) for definitions of letter symbols and guidelines for their use. For some projects, soil moisture and slope gradient are also shown on a terrain map (see example in Fig. 1). This additional information is required, for example, on terrain maps that are used as a basis for biophysical mapping and on those that are used for interpretations of slope stability (see example in Section 10.2).

Minimum Requirements: **(from Howes and Kenk, 1988)**

Letter symbols representing material type (genesis) and surface expression shall be shown for every terrain polygon, e.g., "Mv".

- A texture symbol shall be added if material texture is known more precisely than indicated by the generalized description of that material in the map legend.

- Symbol(s) for processes shall be shown if the effects of geomorphological processes are apparent, eg., "Cv-A".

- Most composite units shall have no more than two components, ie., descriptors for two kinds of terrain, eg., "Mv/Cv".

- Three-component symbols, e.g., "gFtFf/FGt", shall be used rarely, and in no ease shall more than three components be used.

- If the symbol "U" (undifferentiated materials) is used, the specific materials that are present shall be indicated beside "U" in the map legend.

Description of a terrain polygon by means of a letter symbol requires not only adherence to the minimum requirements listed above, but also judgment by the mapper. In general, the number of letters used should be as small as is reasonable. Maps covered with long, complicated symbols have been justifiably criticized and then ignored by many potential users!

There are several ways of reducing the length of symbols, for examples:
- texture symbols can be omitted where material texture conforms to that described in the map legend;
- Iegend descriptions can indicate materials that commonly occur as minor inclusions (e.g., Colluvium commonly includes small areas of bedrock), and the minor materials omitted from the terrain unit symbol;
- symbols can be written in a condensed form (e.g., "Fpt" rather than "Fp.Ft") unless there is some good reason, such as textural differences, for the use of the longer version.

If the symbol "U" (undifferentiated materials) is used, it should be precisely defined. It should not be used to express the uncertainty of the mapper regarding type of material, but only where several types of material occur within a very small area, as specified by Howes and Kenk (1988). Extensive use of "U", or lack of a specific definition of "U" for a particular map area, hinders the preparation of derivative maps.

Where project objectives require mapping of data that are not normally shown on a terrain map, additional descriptors can be incorporated into the terrain symbol. For example, numerical superscripts have been used with "M" (till) to indicate tills of different lithological composition (e.g., Ryder, 1985); superscripts have been added to the process symbol "-Q" (land subject to flooding) to indicate flood frequencies (Miles and Harding, 1980; Fig. 3); the use of both superscripts and subscripts was suggested by Maynard (1989) to describe the pattern and gradients of gullies for detailed assessment of debris-torrent potential. It is best to use such add-ons for large scale mapping (>1:20,000) and for mapping for specific purposes such as hazard assessment.

4.5 On-Site Symbols

On-site symbols are added to terrain maps to indicate specific features that cannot be adequately delimited by the use of terrain polygons and letter symbols. Some of these represent features that are too small or too narrow to be represented by a polygon, such as kettles and terrace scarps; others represent features of relevance to glacial history, such as striations, strandlines, drumlins and cirques. Various mass movement features, such as landslides headscarps and debris flow tracks, also can be shown by on-site symbols.

Mappers should make sure that on-site symbols are clearly depicted on a terrain map, that linear symbols are distinguished from polygon boundary lines, and that on-site symbols do not cause the map to appear unduly cluttered. The appearance of a map can be improved by the use of a grey tone or colour for on-site symbols. In special cases, the problem of clutter may be resolved by the preparation of a separate "terrain features" map that shows only the on-site symbols (Figs. 4 and 5). The preparation of terrain features map is appropriate where on-site symbols provide important information about the location of potential hazards, such as debris flow tracks and avalanche tracks. Maps showing features, such as ice-flow directions, cirques and eskers are a useful tool for reconstruction of glacial history.

The symbols used in terrain mapping must be compatible with digital data storage; and the symbols should be suitable for hand and electronic drafting. The format for presentation adopted here follows the example established by the Bedrock Geology Task Group (RIC, 1995).

The features and symbols were compiled following a priority system. The first document used in the compilation, was Howes and Kenk (1988). Additional references used to flush out the original list included EMR Canada (n.d.), Geological Society of London (1972), Cooke and Doornkamp (1974), Blackadar et a/. (1979), International Association of Engineering Geology (1981a, 1981b), Australian Bureau of Mineral Resources (1989), Grant and Newell (1992) and RIC (1995). Some of the symbols in these references were modified for this compilation. Where no symbol existed, or was found for a specific feature, a symbol was created for this compilation.

The features and symbols have been organized into eight broad categories. These are, in alphabetical order:

- Anthropogenic Features;
- Geologic Features;
- Geomorphologic Features;
- Glacial Features;
- Hydrologic/Hydrogeologic Features;
- Landslide/Mass Movement Features;
- Observation/Sample/Test Site Features; and
- Periglacial Features.

The features and symbols within each broad category are also listed alphabetically. Table 5 is a summary of all features for which symbols have been compiled. The compilation of features and symbols is presented in Appendix I. A blank symbol template, with an explanation of each field is presented in Table 6. For the present document, the cartographic definitions and feature codes of the symbols have not been included. As for the bedrock symbol compilation, the terrain and surficial geology symbols were developed for 1:20,000 scale maps. Should this map scale change, the positional definition would change accordingly. The definitions of the features have been gleaned from a number of sources. Some of the definitions abstracted from the bedrock symbol library have been modified to include both rock and soil.

4.6 Map Scale and Terrain Survey Intensity Levels (TSIL)

Large scale maps (e.g., 1:20,000) are commonly assumed to be more reliable than small scale maps, and large scale mapping is generally considered to involve more ground checking than small scale mapping. Terms such as "reliability" are hard to define however (although see Section 12.0), and does "more ground checking" mean more time per unit area on the ground or on the map? In its simplest form, terrain mapping can be completed by air photo interpretation, with no ground checking. Specification of survey intensity levels is one approach to the definition of map reliability.

Survey intensity level expresses the relation between map scale and amount of field checking. Six survey intensity levels are used for terrain mapping ("terrain survey intensity levels" or TSIL) are defined in Table 7.

The commonly used definitions of survey intensity (% of polygons field checked) are indicated in column 3. However, the number of field checks per unit area (column 4) can be used as an alternative way of specifying the amount of field checking. For example, where the nature of the landscape results in delimitation of large polygons, it may be preferable to specify survey intensity in terms of checks per unit area rather than by % of polygons. Also, specification of the number of checks per unit area provides a simple way of calculating total number of field checks required. The two methods (columns 3 and 4) can be used concurrently by indicating that field work requires, for example, either xx% of the polygons checked or at least I check per xx ha, whichever results in the greater number of checks.

The definitions of survey intensity levels that are given here differ in two ways from those used by pedologists (*c.f.*, Mapping System Working Group, 1981). First, there is a lesser relation between map scale and survey intensity, and second, the terrain system requires less field checking. For example, in the pedological system, 1:20,000 scale mapping can only be done at SIL 2, whereas in the terrain system, it can be done at TSIL A or B or C. For pedological SlLs 1, 2 and 3, 100%, 90%, and 60-80% of polygons must be checked, whereas checking of 75--100%, 50-75%, and 25-50% of polygons is required for TSILs A, B and C.

For terrain mapping, it is appropriate to have a more flexible relation than in soils mapping between map scale and survey intensity because, under certain circumstances, satisfactory terrain mapping can be done largely or even wholly from air photo interpretation (see TSIL E). Some landforms and hence materials can be reliably recognized on air photos, for example alluvial fans, river terraces, and talus slopes. There is no point in requiring a mapper to field check terrain that has been correctly mapped under the stereoscope, unless project objectives call for additional information, for example, texture. Conversely, air photo interpretation may be hindered by vegetation cover, requiring more ground checking than for similar terrain under sparse vegetation. Thus an appropriate TSIL should be specified for a project according to terrain and vegetation characteristics and not based solely on map scale.

Minimum Requirements:

- All terrain maps shall clearly identify the Terrain Survey Intensity Level (TSIL) as estimated by the mapper.
- A percentage estimate of polygons field-cheeked shall be given on the map.
- An estimate of field cheeks per 100 ha shall be given on the map.

Table 4. Dimensions of terrain polygons at various scales*.

Map Scale	Minimum Polygon Size		Mean Size of Polygons		Range of Mean Sizes of Polygons	
	cm^2	ha	cm^2	ha	cm^2	ha
1:5000	1	0.25	no data		no data	
1:20,000	1	4	12	48	4-25	16-100
1:50,000	1	25	10	250	6-17	150-425
1:100,000	1	100	4	400	2.8-5.0	280-500
1:250,000	1	625	4.25	2650	3.0-5.4	1900-3400

*Source: From data compiled by A. Collett.

Example 1: Superscripts used to indicate estimates of flood frequency.

Terrain symbols, e.g.,

$sgF^{A}p - EQ^{3}$ $\qquad\qquad$ $\dfrac{sFv}{gFp}$ _ Q4

Legend*:

$-Q^{1}$	Frequent flooding: 1 to 3 yr. return interval
$-Q^{2}$	Occasional flooding: less than 50 yr. return interval
$-Q^{3}$	Rare flooding: 50 to 200 or more yr. return interval
$-Q^{4}$	Flooding unlikely under present hydrologic conditions
-E	Indicates river channel lies within the terrain polygon

* Estimates based on geomorphic and biological evidence of flooding.

Example 2: Superscripts used to differentiate subclasses of till.

Terrain symbols, *e.g.*, $M^{1}v$ $\quad$ $M^{2}b$ $\quad$ $M^{6}r$

Legend*:

M^{1}	grey to light grey, very calcareous, highly consolidated lodgement till derived from limestone
M^{2}	dark brown, calcareous, highly consolidated lodgement till derived from sandstone, mudstone, coal, shale, and limestone
M^{3}	black calcareous till, derived from sandstone, shale and coal, with moderate to high consolidation
M^{4}	dark brown to black, non-calcareous till, with moderate to high consolidation
M^{5}	loose, non-cohesive material that is a mixture of till and colluvium
M^{6}	late-Holocene moraines
M	undifferentiated till

Figure 3. Examples of the use of superscripts to differentiate subclasses of materials and processes. Example I is adapted from Miles and Harding (1980). A similar mapping scheme was used for terrain mapping of the floodplain of the Coquihalla River. Example 2 is from Ryder (1985). See Figure 9 for definitions of other terrain symbols.

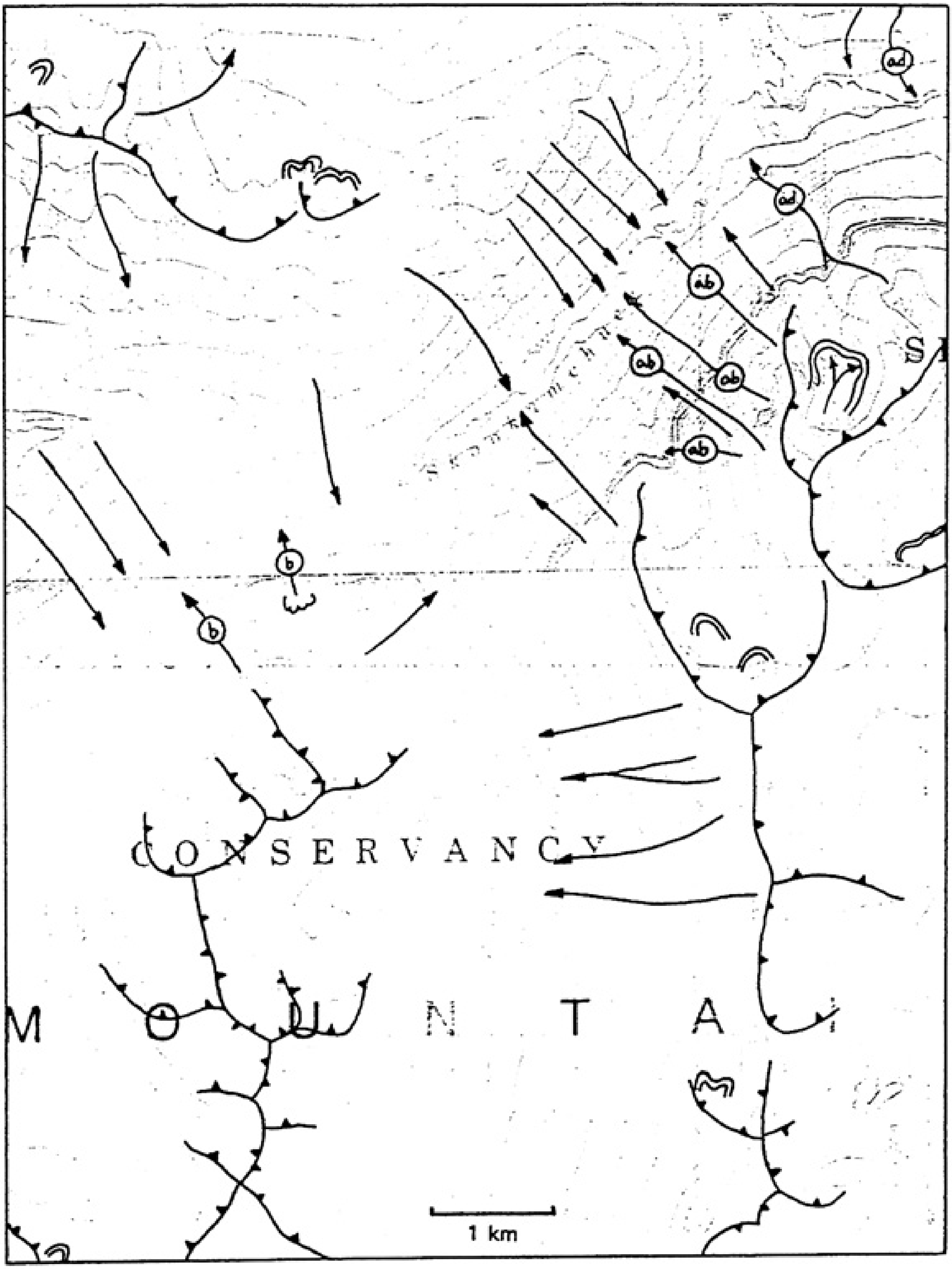


Figure 4. Map of on-site symbols, part of 82F/16. ~~Such maps have been~~ referenced as "terrain features" maps. They can be used for hazard assessment through detailed mapping of mass movement features, such as landslide headscarps, debris flow tracks and avalanche tracks.

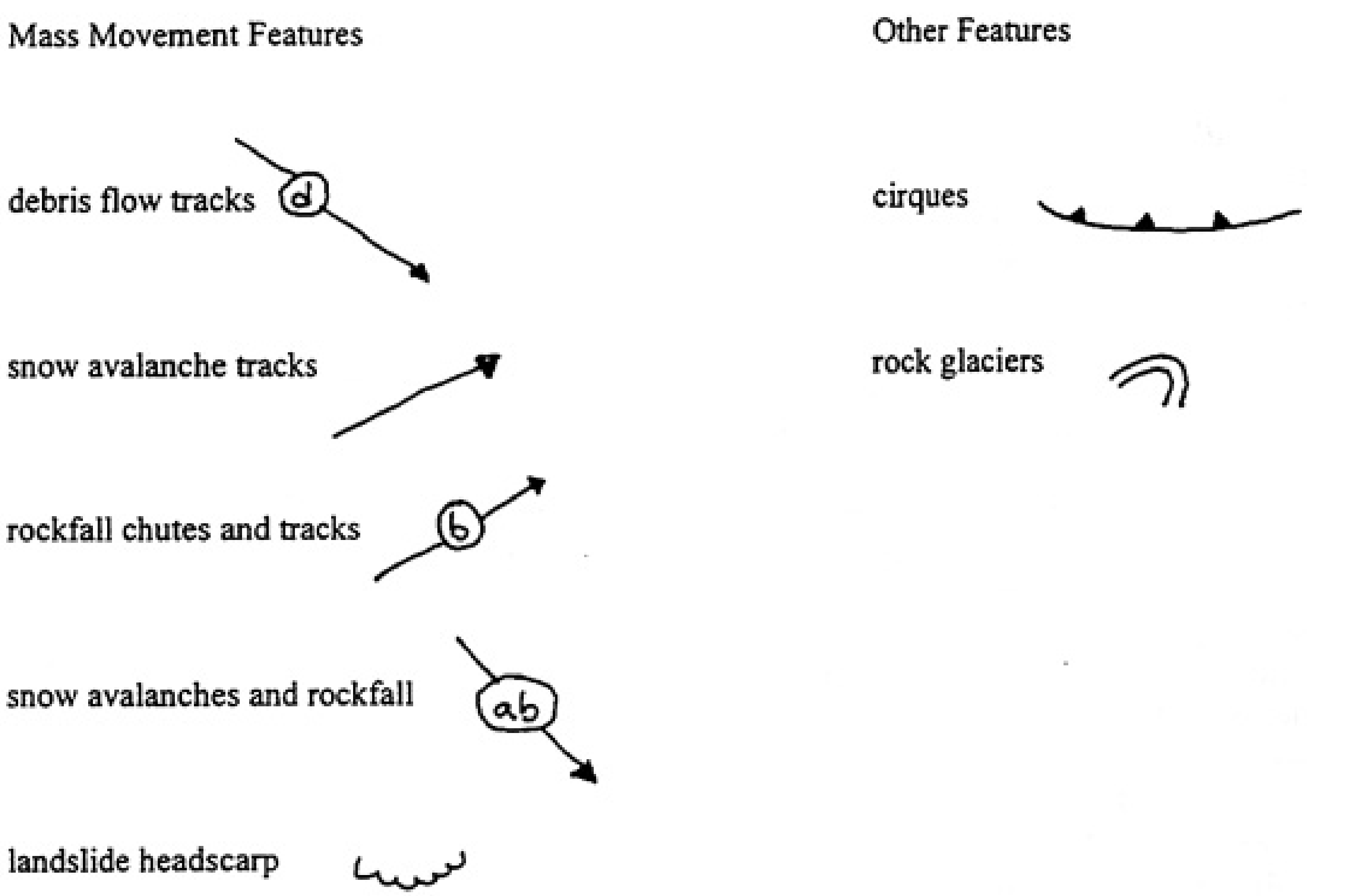


Figure 5. Legend to on-site symbols shown on Figure 4. See Appendix I for list of symbols.

Table 5. Summary of Features with Compiled Symbols.

Anthropogenic Features

Canal, drainage ditch
Dam, large
Dam, small
Dugout, lagoon, reservoir
Mine, adit or tunnel, closed
Mine, adit or tunnel, open
Mine, shaft, closed
Mine, shaft, open
Other feature (e.g. waste rock dump, tailings, landfill, etc.), use identified
Other feature (e.g. waste rock dump, tailings, landfill, etc.), use unidentified
Quarry or surface mine working, active, commodity known
Quarry or surface mine working, active, commodity unknown
Quarry or surface mine working, inactive (abandoned), commodity known
Quarry or surface mine working, inactive (abandoned), commodity unknown
Sand or gravel pit, active
Sand or gravel pit, inactive (abandoned)
Side hill cut
Side hill fill
Water well, artesian
Water well, common
Water well, mineral, mineral known
Water well, mineral, mineral unknown
Water well, thermal, temperature (degrees Celsius), known
Water well, thermal, temperature (degrees Celsius), unknown

Geologic Features

Area of overburden
Bedding, dip known
Bedding, dip unknown
Bedding, estimated dip
Bedding, horizontal dip
Bedding, vertical dip
Cross-section
Fault, normal, approximate
Fault, normal, assumed
Fault, normal, defined
Fault, normal, dip defined
Fault, normal, vertical
Fault, reverse (thrust), approximate
Fault, reverse (thrust), assumed
Fault, reverse (thrust), defined
Fault, reverse (thrust), dip defined
Fault, strike slip, approximate
Fault, strike slip, assumed
Fault, strike slip, defined
Fault, strike slip, dip defined
Fault, strike slip, vertical
Fault, unknown movement, approximate
Fault, unknown movement, assumed
Fault, unknown movement, defined
Fault, unknown movement, dip defined

Fault, unknown movement, vertical
Geological contact, approximate
Geological contact, defined
Geological contact, inferred
Limit of mapping
Limit of Quaternary cover
Rock outcrop, area
Rock outcrop, small, isolated

Geomorphologic Features

Buried valley
Cave
Coastal aggradation, active, non-rocky coast
Coastal aggradation, active, rocky coast
Coastal degradation, active, non-rocky coast
Coastal degradation, active, rocky coast
Delta, modern
Delta, raised
Dunes, area of sand dunes
Dunes, single, active
Dunes, single, inactive
Fan, alluvial
Fan, colluvial
Fan, talus cone
Limit of submergence
Linearnent (from airphotos)
Piping depression
Sandboils
Scarp, escarpment, bedrock, definite
Scarp, escarpment, bedrock, indefinite
Scarp, escarpment, overburden, definite
Scarp, escarpment, overburden, indefinite
Sink hole, karst depression, large
Sink hole, karst depression, small
Slope, concave
Slope, convex
Solifluction lobe
Strandline, abandoned shoreline, raised beach, definite
Strandline, abandoned shoreline, raised beach, indefinite
Volcano, active
Volcano, inactive
Volcano, crater, caldera
Volcano, ash cone
Volcano, cinder cone
Volcano, volcanic plug
Volcano lava field, aa (blocky)
Volcano lava field, pahoehoe (ropy)
Volcano lava field, pillow

Glacial Features

Arrete
Cirque
Crag and tail
Crevasse filling

Crescentic fracture
Crescentic gouge
Drumlin, drumlinoid ridge, till ridge parallel to the ice flow
Esker, direction of flow, known
Esker, direction of flow, unknown
Horn
Ice contact delta
Ice flow (on a glacier)
Ice thrust block ridge
Kame (conical gravel hill)
Kettle hole, large
Kettle hole, small
Linear feature, undifferentiated, direction, known
Linear feature, undifferentiated, direction, unknown
Lineation caused by floating ice
Lunate fracture
Meltwater channel, lateral, definite
Meltwater channel, lateral, indefinite
Meltwater channel, major, definite
Meltwater channel, major, indefinite
Meltwater channel, minor, definite
Meltwater channel, minor, indefinite
Meltwater channel, subglacial, definite
Meltwater channel, subglacial, indefinite
Moraine, major, DeGeer, large
Moraine, major, DeGeer, small
Moraine, major, end, definite
Moraine major, end, indefinite
Moraine, major, interlobate, definite
Moraine, major, interlobate, indefinite
Moraine, major, lateral, definite
Moraine, major, lateral, indefinite
Moraine, minor, rib moraines, washboard moraines, annual moraines, till ridges transverse to the ice flow, straight
Moraine, minor, rib moraines, washboard moraines, annual moraines, till ridges transverse to the ice flow, irregular
Roche moutonnee
Striae, groove, furrow, fluting, ice movement, known
Striae, groove, furrow, fluting, ice movement, unknown
Striae, groove, furrow, fluting, relative age

Hydrologic/Hydrogeologic Features

Groundwater, divide
Groundwater, general direction of flow, large scale, approximate
Groundwater, general direction of flow, large scale, assumed
Groundwater, general direction of flow, large scale, defined
Groundwater, general direction of flow, small scale, approximate
Groundwater, general direction of flow, small scale, assumed
Groundwater, general direction of flow, small scale, defined
Groundwater, piezometric surface
Groundwater, table, above sea level
Groundwater, table, below surface
Spring, artesian
Spring, common, no yield info

Spring, common, with yield
Spring, geyser
Spring, group/line of springs
Spring, intermittent
Spring, mineral, mineral known
Spring, mineral, mineral unknown
Spring, thermal, temperature (degrees Celsius) known
Spring, thermal, temperature unknown
Surface water disappearance of surface drainage
Surface water, divide
Surface water, falls, large, height in metres
Surface water, falls, large, height unknown
Surface water, falls, small, height in metres
Surface water, falls, small, height unknown
Surface water, flood level, event known
Surface water, flood level, event unknown
Surface water, flood level, maximum credible level
Surface water, lagoon
Surface water, lake
Surface water, lake bed, dry
Surface water, lake, slough, intermittently flooded,
Surface water, rapids, large
Surface water, rapids, small
Surface water, reappearance of surface drainage
Surface water, surface drainage, large channel (e.g. river), abandoned, dry
Surface water, surface drainage, large channel (e.g. river), active
Surface water, surface drainage, large channel (e.g. river), levee
Surface water, surface drainage, large channel (e.g. river), sand bar
Surface water, surface drainage, moderate (e.g. creek, stream), abandoned, dry
Surface water, surface drainage, moderate (e.g. creek, stream), intermittent
Surface water, surface drainage, moderate (e.g. creek, stream), perennial
Surface water, surface drainage, small (e.g. gully) intermittent
Surface water, surface drainage, small (e.g. gully) perennial
Surface water, swamp, marsh, bog, large
Surface water, swamp, marsh, bog, small
Surface water, tides, high water
Surface water, tides, low water
Surface water, tsunami level event known
Surface water, tsunami level event unknown
Surface water, tsunami level maximum credible level

Landslide/Mass Movement Features

Landslide generic
Landslide, large, fall, rock
Landslide, large, flow, debris
Landslide, large, flow, rock
Landslide, large, flow, soil, earth
Landslide, large, generic, debris
Landslide, large, generic, rock
Landslide, large, generic, soil, earth
Landslide, large, headwall, definite
Landslide, large, headwall, indefinite
Landslide, large rotational slide
Landslide, large, rotational slide, debris

Landslide, large, rotational slide, rock
Landslide, large, rotational slide, soil, earth
Landslide, large, topple, rock
Landslide, large, translational slide, debris
Landslide, large, translational slide, rock
Landslide, large, translational slide, soil, earth
Landslide, small, debris
Landslide, small, headwall scar
Landslide, small, headwall scar and runout
Landslide, small, rock
Landslide, small, soil, earth
Sackung (sagging slopes)
Snow avalanche, large
Snow avalanche, small
Soil erosion, badlands
Soil erosion, rill
Soil erosion, sheet
Tension crack

Observation/Sample/Test site Features

Age date, including radiocarbon, with data
Age date, including radiocarbon, without data
Archeological site
Boulder occurrence/concentration
Fossil location, marine
Fossil location, terrestrial
Geophysical test location, test known
Geophysical test location, test unknown
Gravel occurrence/concentration
Observation/sample/test site, air
Observation/sample/test site, ground
Photograph location, with direction
Photograph location, without direction
Peat occurrence/concentration
Sand occurrence/concentration
Stratigraphic section
Testhole, identification known
Testhole, identification unknown
Testpit, identification known
Testpit, identification unknown
Trench, identification known
Trench, identification unknown

Periglacial Features

Blockfield
Boulder field
Glacier
Ice wedge polygons
Palsen, palsa
Permafrost, frozen ground
Rock glacier
Tors

Table 6. Example Symbol Template with Explanation of Each Field.

Group: Broad category within the symbol compilation.	**Symbol Description:** Concise description of the symbol, in alphabetical order.
Cartographic Definition: Detailed cartographic definition of the symbol, including line widths, lengths, spacings, etc. will be added.	Example of the symbol.
Positional Definition: Description of what part of the symbol corresponds to the map location, or the precision and accuracy of the symbol, both positional and geological (assuming a 1:50,000 scale map).	
Definition: Geologic definition of the feature.	**Remarks:** Description of the pertinent parts of the symbol, unless obvious.
CAD Layer: Name of the CAD layer on which the symbol is located.	**Feature Code:** Digital definition of the symbol will be added.

Table 7. Terrain Survey Intensity Levels.

TERRAIN SURVEY INTENSITY LEVELS	SCALE	% OF POLYGONS FIELD CHECKED*	FIELD CHECKS ** PER 100 ha (1 km^2)	METHOD OF FIELD CHECKING	TYPICAL OBJECTIVES
A	> 1:20,000	75 - 100	> 1.5	foot traverses	slope stability in sensitive areas: residential land planning; hazard zonation
B	1:10,000 to 1:50,000	50 - 75	1.0 to 3	foot and vehicle traverses	slope stability assessment;
C	1:20,000 to 1:100,000	25 - 50	0.5 to > 1.0	foot, vehicle, some flying	inventory mapping; biophysical mapping
D	1:20,000 to 1:250,000	0 - 25	0 to 0.1	vehicle and flying	regional planning; preliminary mapping
E	any scale	0	none	no field work (air photo interp. only)	general reconnaissance

* See Section 7.5 for field checking methods.
**Data in column 4 are based on the following estimates of mean polygon size: 1:10,000 - 25 ha (estimated); 1:20,000 - 50 ha; 1:50,000 - 250 ha; 1:100,000 - 400 ha; 1:250,000 - 2500 ha. (see Table 4):

5.0 METHODOLOGY I: INITIATING THE PROJECT

5.1 Definition of Project Objectives

Project objectives should be clearly defined by the project proponent and made clear to the terrain specialist at the start of a project. It is also desirable to identify the end products of the terrain analysis at this stage (e.g., terrain map, specific derivative map(s), report), and the medium of presentation of the maps (e.g., mylar, overlay, air photo mosaic, etc.; see Section 9.0).

5.2 Selection of Map Scale and Survey Intensity Level

The purpose for which a terrain map is to be used determines the scale at which it should be presented. Thus the scale of the presentation (i.e., final) map(s) and survey intensity level should be defined at the same time as project objectives. For example, 1:5000 scale terrain and slope stability mapping is carried out for potential forestry cut blocks on steep slopes prior to road location and designation of yarding systems; mapping at 1:20,000 scale (I cm to 200 m) is appropriate for delimitation of avalanche hazards along a highway, whereas a 1:250,000 scale terrain map (I cm to 2.5 km) is appropriate for preliminary comparisons of terrain between potential provincial parks.

Survey intensity level should be selected according to the purpose of the mapping. Where the cost of any mistakes on the terrain map could be high, much ground checking is necessary. Where mapping is for reconnaissance purposes, and is later to be followed by detailed survey, then field checking can be reduced.

Other factors should also be considered. As noted above (Section 4.6), certain kinds of terrain are more easily mapped by air photo interpretation than others, and thus require less field checking. Dense tree cover hinders air photo interpretation, so more field checks per unit area are desirable in forested terrain than in treeless alpine and arid areas. For any given survey intensity level, an experienced mapper will generally produce a more reliable map than a mapper with less experience.

Specification of TSIL also has significant implications for the project costs. Although there is generally a direct relation between amount of field checking and the cost of field work, it should also be noted that for any TSIL specified, the checking of areas with ground access (roads) will be less expensive than checking of inaccessible areas. The latter require either helicopter transport or lengthy foot traverses, which take a long time, and so both these options add to project costs.

5.3 Selection of Air Photos

Once the scale of the finished map has been determined from project objectives, air photos should be selected according to the following considerations. In general, it is desirable to use air photos at a scale slightly larger than that of the finished map. This ensures that polygons of appropriate size can be delimited, and that transfer of terrain data from photos to map will minimize any errors in the placement of boundary lines. Suitable relations between map scale and air photo scale are indicated in Table 8. Air photos with a smaller scale than the finished map should not be used unless no photos of suitable scale are available. Interpretation of air photos at a scale significantly larger than that of the presentation map may assist in the recognition of some features, but it can result in delimitation of unnecessary details, more time is spent handling the many photos and matching polygons from one photo to the next, and the cost of the photos is greater.

When carrying out terrain mapping at very large scales, e.g., for maps at 1 :10,000 or 1:5000, the general rule for suitable air photo scale cannot be followed, for two reasons. First, air photos at a larger scale than the final map are often not available. If this is the case, it is necessary to use the smaller scale air photos, and to compensate for lack of visible terrain detail on the air photos by carrying out extra ground checking. Second, air photo interpretation of forested terrain on large scale air photos is difficult because the visual image is dominated by the trees. Features such as slope steepness, slope breaks, and landform morphology are commonly masked by the forest or not recognizable within the small area that is covered in a single stereoscopic view. In this case, it is useful to examine smaller scale photos of the map area.

Landforms that are obscured or incomplete on the large scale photos may be recognizable on the small scale photos, and information then transferred from one set of photos to the other.

Air photo scales are commonly referred to as "x chain", meaning that the scale is "x chains to one inch". A "chain" is an old imperial measure of distance -- the length of a cricket pitch, or 22 yards. Thus "20 chain air photos" have a scale of 20 x 22 yards to I inch, which works out to 1 :15,840 (at sea level) (Table 9).

Other characteristics of air photos that should be considered are noted below. To assess some of these, it is necessary to view the air photos, or at least, to request viewing and advice about specific characteristics from staff of an air photo library.

Scale: In densely forested landscapes, landforms with distinctive morphology, such as river terraces and drumlins, are most easily recognized on medium-scale air photos (about 1:25,000 to 1:50,000). On larger scale photos (e.g., 1 :15,000), details of the tree canopy obscure slope breaks and topographic features that are visible on smaller scale photos. When carrying out large scale mapping, it is commonly useful to refer to small scale air photos for clarification of indistinct features.

Snow cover Snow cover sufficient to seriously hinder air photo interpretation is a moderately common problem. If alpine areas are to be mapped, it is well worth reviewing selected flightlines for this potential problem before ordering specific air photos.

Date of air photos: For most projects, it is desirable to obtain the most recent photos available at the appropriate scale. The chief advantage of recent photos is that they show the current road network and other artificial features, and thus provide information about access. Old air photos may show roads and bridges that are no longer passable. Recent air photos also show the effects of recent geological processes such as landslides. Where recent development (e.g., urban or industrial development) has masked the natural features of the ground surface, however, it is easier to carry out air photo interpretation using older photos. When a project is concerned with active geomorphological processes, such as river channel migration or frequency of events such as debris flows, air photos of several different dates should be reviewed.

Technical quality of the photos: Sharpness of image and degree of contrast (range of grey tones) are usually adequate on recent air photos, but should be assessed if old air photos are to be used.

Black and white air photos vs. colour air photos: Colour photos allow recognition of features that are differentiated by their distinctive colour, such as some rocks and their weathering products, and some vegetation types. Characteristics such as soil moisture and age of substrate in disturbed areas, that are indicated by grey tones on black and white air photos, are commonly less readily distinguished on colour photos. On large scale colour photos of forested terrain, foliage patterns dominate the visual image; landforms may be more clearly defined. In general, both types of photos have advantages and disadvantages. Selection of colour or black and white photos should be based on project objectives, photo scale, and prior experience.

Black and white prints from colour negatives: Reducing costs by this means is generally a false economy because the prints have a narrower range of grey tones than prints from black and white negatives.

Shadows: When photos were not taken at the optimal time of year or time of day, shadows may be sufficiently extensive and dark that significant terrain features and details are obscured This problems most common where photography of rugged terrain was carried out in winter, for example, to record the effects of a specific flood or landslide.

Vertical exaggeration: Slope steepness is usually exaggerated in stereo view. If the overlap of stereo pairs is greater or less than about 60%, a misleadingly gentle or steep appearance of slopes can result. Vertical exaggeration also varies with camera focal length and photo scale.

Minimum Requirements:

- Air photo scale shall be the same or slightly larger than the scale of the finished map.
- Air photo scales used in the mapping shall be specified on the map.
- The actual flight lines and numbers shall be illustrated in the index map box.

5.4 Review of Previous Work Including Previous Mapping

A brief review of all previous mapping should be carried out at the time of project initiation in order to avoid unnecessary duplication of mapping (c./, Bobrowsky et al., 1992). At the start of a project, the mapper should obtain and review previous mapping (e.g., smaller scale mapping) of terrain, surficial geology and soils in or near to the study area. The objective of this review is to familiarize the mapper with the geomorphological characteristics (especially the glacial history) of the region, so that this knowledge can be used to assist air photo interpretation (see also Section 6.0). Information about bedrock geology should be reviewed because some bedrock reports include observations about Quaternary geology. Bedrock may also influence landforms, and characteristics of surficial materials such as texture. Government indexes (e.g., Geological Survey of Canada, B.C. Ministry of Energy, Mines and Petroleum Resources, federal and provincial Ministries of Environment, B.C. Ministry of Forests) and local government (e.g., regional district) sources should be checked. Drill hole records (e.g., water wells) may also provide useful information, but logs should be interpreted with caution.

Minimum Requirements:

- Project proponents shall review existing mapping information before defining objectives for any new mapping project.
- Prior to commencing air photo interpretation, the mapper shall thoroughly review previous work on terrain, surficial geology, bedrock geology and soils that has been carried out in both the study area and the broader region.

Table 8. Guide to the selection of air photo scale.

Scale of Presentation Map	Suitable Air Photo Scales (at sea level)	Scale on same photos at 1500 m or 5000 ft a.s.l.
1 :20,000	1: 1 S,OOO to 1 :20,000	1: 10,000 to 1: 15,000
1 :50,000	1 :35,000 to 1 :50,000	1 :30,000 to 1 :45,000
1: 125,000	1 :80,000 to 1: 125,000	1 :75,000 to 1: 120,000

Table 9. Common Air Photo Scales.

Description of Air Photo Scale	Scale at sea level
20 chain	1: 15,840 (4" to 1 mile)
40 chain	1:31,680 (2" to 1 mile)
80 chain	1:63,360 (1" to 1 mile)

6.0 METHODOLOGY II: AIR PHOTO INTERPRETATION

The objective of this procedure, which is commonly referred to as "pretyping", is to delimit terrain polygons by air photo interpretation. Photos are viewed stereoscopically, polygon boundaries are drawn, and each polygon is labeled using an appropriate combination of letters following Howes and Kenk (1988) (see also Section 4). On-site symbols should be added wherever appropriate. Pretyping must be completed before field work so that mappers can plan effective use of field time and design traverses that include representative terrain polygons and any ambiguous features.

Terrain polygons are marked on alternate photos along a flight line. The area that is mapped on each photo is limited by the conjugate principle points along the trend of the flight line, and by the midpoints between the principle points of photos in adjacent flightlines (Fig. 6). Thus mapping is carried out on the central part of each photograph, thereby avoiding marginal areas where distortion may be severe. Mappers should ensure that boundary lines and labels match between the edges of adjacent photos in the same flightline and between flightlines.

Mappers may wish, or be required, to define that part of each photo that is to be mapped by drawing a "box" around the central part of image. Boxes can be constructed either by drawing straight lines through conjugate principle points and principle points (noted above), or by using and/or drawing lines between obvious landmarks, such as roads, streams and peaks. In either case, polygon boundaries may need to extend slightly outside the box in order to join with those on the adjacent photo.

On-site symbols should be marked on the intervening photos to avoid confusion with terrain boundary lines. Mapping is usually done directly on the air photos, using a drafting pen and black ink or other fine-tipped pen. (Drawing ink can be easily erased using a damp Q-tip.) Mappers should ensure that letters and lines (including dotted boundary lines) are thick enough to be clearly legible to the technicians who later transfer terrain data to the base map.

The competence with which air photo interpretation is carried out is by far the most important factor that influences the reliability of the final terrain map (see Section 12.0 below). Thus it is essential that either the air photo interpreter have appropriate training and be experienced in the interpretation of terrain similar to that in the project area, or that she/he be closely supervised by a suitably experienced person.

The mapper must also be familiar (see Section 5.4 above) with the geological and geomorphological history of the study area, particularly the glacial history. As air photo interpretation proceeds, the mapper should work out the specific sequence of events that led to the deposition of surficial materials and development of landforms. In other words, she/lie should develop a model for evolution of the terrain, and use and modify this model continually during subsequent air photo interpretation and field work. For example, if ice downwasted at the end of Fraser Glaciation, a different suite of landforms and materials might be expected than if deglaciation occurred by frontal retreat. If the former existence of a glacial lake is established, knowledge of ice-dam location and lake surface elevation can be used to assist recognition of terrain underlain by lake sediments and hence the location of potentially unstable slopes.

During pretyping, exposures of surficial materials, sites for ground checks, routes for traverses, helicopter landing sites, etc. should be identified and marked on the same photos as the terrain polygons. These can be marked using a coloured wax pencil, (e.g., omnichrome); such marks are clearly visible yet can be very easily removed with an eraser or a damp Q-tip.

If project objectives include assessment of slope stability and/or other geological hazards, such as river bank erosion, air photos that predate (or postdate) those being used for ~e mapping should be examined in order to provide a historic perspective on geomorphological processes.

Minimum Requirements:

- Fully labeled terrain polygons and on-site symbols shall be marked on air photos prior to field checking.
- Terrain boundary lines and labels shall match between the edges of adjacent photos in the same flightline and between flightlines.
- Symbols defined by Howes and Kenk (1988) and these guidelines shall be used.

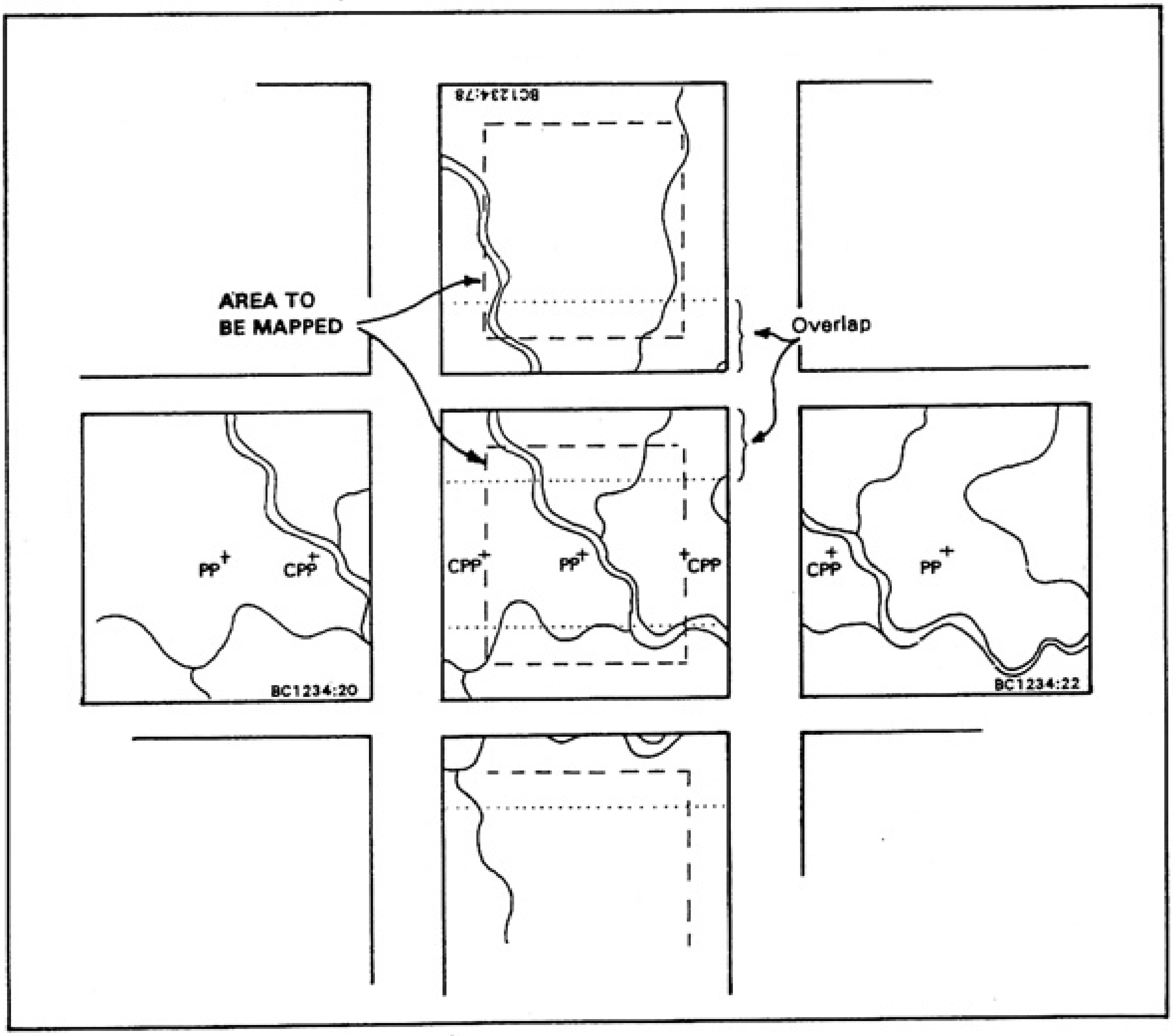


Figure 6. Definition of the area mapped on alternate photos.

7.0 METHODOLOGY III: FIELD WORK

7.1 Objective

Field work is carried out in order to confirm or correct the pretyped terrain data, and in particular, to check those characteristics of surficial materials, such as texture, that cannot be adequately interpreted from air photos. Additional data may be collected if required by project objectives.

7.2 Time Required for Field Work

The field time necessary for a project is based on the TSIL that was specified according to project objectives (Section 5.1), and hence the number of polygons that must be checked. The average length of time required per field-checked-polygon will depend upon the following conditions:

- Terrain characteristics; polygons of complex terrain, such as ice-disintegration moraine with kames and pockets of glacial lake sediments, may require extensive checking and the establishment of more than one "observation site" (see Section 7.4).
- The time required to travel from one observation site to the next; this will be greatest where travel is on foot through dense forest without trails and least when a vehicle or helicopter can be used.
- The amount and type of information to be collected at each site; descriptions of natural or artificial exposures where stratigraphic features are visible will require more time than soil pit observations.
- If the terrain mapper is part of a group collecting multi-disciplinary information, such as during biophysical mapping (e.g., terrain, vegetation and wildlife specialists working together), then time per site will be determined by the group member who is collecting the most information, and this is not usually the terrain specialist.

Depending on the above conditions, rates of progress range from about 4 to 10 polygons per day. Additional polygons may be checked briefly as the mapper travels from one observation site to the next, see for example Section 7.5. Potential delays due to bad weather should be included in time estimates.

7.3 Initial Procedures

An experienced mapper will begin field work in an area with which she/he is not familiar by carrying out rapid reconnaissance traverses and examining major exposures of Quaternary materials. Information so gathered provides input to the model of the area's geomorphological history that was constructed during preliminary air photo interpretation. If logistics permit, this preliminary work will be done before detailed checking of specific polygons commences. Otherwise, exposures should be examined when the mapper is in the vicinity.

7.4 Observation Sites

In order to collect information about the surficial materials in the polygons that are to be checked, the mapper should, where possible, designate "observation sites" where materials are well exposed, such as road cuts, river banks and landslide headscarps. If exposures are not present, sites will consist of pits or trenches excavated with shovels or mechanical equipment, or auger holes. Sites may also be designated where surface observations are sufficient to confirm (or modify) pretyping, such as on talus slopes and active floodplains. The use of site description forms is discussed in Section 7.6.

Minimum Requirement:

- Observation sites shall be numbered, marked on the air photo and shown on the completed terrain map.

7.5 Method of Field Checking

Routes to be followed in the field are normally determined by the mapper from air photo interpretation (Section 6.0). Polygons that require checking, exposures, and other places to visit are grouped into a series of day-long traverses. Either formally defined transects or sequences of random spot checks can be used. Travel in the map area may be on foot, by vehicle, by helicopter, or any combination. Mode of travel is usually related at least in part to the scale of the mapping (Table 7).

Field observations are not restricted to those at formally designated sites: many observations are made in places other than those where data forms are completed. Useful data can be gathered when traveling from one observation site to the next. In particular, the position of terrain unit boundaries should be checked against visible features at every boundary that is crossed in the field. Casual observations of ground surface conditions, roadcuts and stream banks should be made continuously. Features such as erratic boulders, angular versus rounded clasts, high water table, soil texture, materials exposed in the roots of fallen trees, and material excavated from animal burrows all provide useful information. Ice flow direction should be recorded if glacial striations or other flow direction indicators are found. Checking of remote sites with binoculars is a useful, time-saving technique: for example, distant hillsides can be searched for rock outcrops, and inaccessible sections can be more closely examined. (Sites that are not actually visited should not be designated as formal observation sites.) Information gathered during travel between formal sites can be recorded directly on air photos or in field notebooks, and eventually entered into a polygon data file (Appendix E). Routine observations that confirm polygon descriptions already on the air photos need not be noted.

During field work with a helicopter, many valuable observations can be made from the air. If the mapper compares pretyped data on air photos with land surface characteristics visible from slow, low-level flight, many terrain characteristics can be confirmed or corrected. Exposures of surficial materials that are not near landing sites (steep river banks and gullies, for example) can be briefly examined from a hovering aircraft and photographed. (An inexperienced mapper should be aware that the visual appearance of materials in sections partly obscured by surface wash can be misleading.)

7.6 Data Collected and Data Forms

Use of a data form with a fixed format for recording observation site information encourages collection of a standard data set, maintains consistency between different mappers, and facilitates data entry to computer storage and subsequent processing.

Minimum Requirement:

- For each project, data from all observation sites shall be recorded in a standard format on an appropriate form.

The objectives and terms of reference of many projects require the use of specific forms and coding systems. For other projects, mappers should design their own data form according to project objectives. Examples of sample data forms are provided in Figure 7. Existing coding systems can be used for recording field data appropriate to project objectives. Examples include the lithofacies code of Eyles et al. (1983) and the Unified Soil Classification System as described in all North American soil mechanics text books (Appendix D). Mitchell (1991) provides several other examples for generalized and specialized terrain mapping as does an excellent publication by the US Bureau of Reclamation (1989).

Use of forms for data recording does not preclude the collection of additional relevant data in field notebooks, e.g., sketches of exposures. Table 10 shows data that are routinely collected by most terrain mappers, as well as minimum requirements. It is normal to collect varying amounts of information from different sites, as determined by the nature of each site. Active geomorphic processes and hydrologic features are not apparent at many sites, and stratigraphic information is not normally obtained from a "soil pit".

7.7 Data Model

The mandate of the Resources Inventory Committee (RIC) is to develop inventory standards and guidelines for British Columbia. Besides the information presented elsewhere in this document, the Terrain Mapping Guidelines and Standards is also concerned with the digital capture of information (Appendix E) and the graphic representation and standardization of symbols (Appendix I). Appendix E provides an outline of a data model suitable for the digital storage, access, presentation and interpretation of terrain and surficial geology data.

The model presented here is similar to the model produced by the Archeology Task Group for the Data Model Rational Project of RIC (DMR Group Inc., 1993) and is presented in a format suitable to RIC (e.g. RIC, 1992). Development of the model presented here relies on products by the Archeology Branch, B.C. Ministry of Small Business, Tourism and Culture (~: DMR Group Inc., 1993) and the Surveys and Resources Mapping Branch, B.C. Ministry of Environment, Lands and Parks (MELP).

Data models/databases from other agencies were solicited and reviewed. These included:

- the Geological Database System used by the Geological Survey Branch, MEMPR (Brian Grant, PGeo, contact; BCGSB, 1994);
- the MINFILE Database housed with the Geological Survey Branch, MEMPR (Larry Jones, PGeo, contact; BCGSB, 1992);
- the Thematic Mapping Geographic Information System, CAPAMP, developed by Surveys and Resource Mapping Branch, MELP (Evert Kenk, contact; Kenk et al., 1987);
- the Aggregate Resource Management System and Aggregate Deposit Information System used by the BC Ministry of Transportation and Highways (Rob Buchanan, PGeo, contact);
- the Terrestrial Ecosystem Mapping Methodology, produced by the Ecosystems Working Group, Terrestrial Ecosystems Task Force, RIC (Ted Lea, contact; RIC, 1994a);
- the Surficial Geology Database being developed by the Geological Survey of Canada (Robert Fulton, contact); and
- the Quaternary Geology Field Forms used by the Geological Survey Branch, Newfoundland and Labrador Department of Natural Resources (David Liverman, contact).

The data model has been developed in a hierarchical form, and follows the format established by RIC (1992). An outline of the hierarchy is shown in Figure 8. An expanded summary of the hierarchy, along with the suggested computer acronyms, is presented in Table 11. The hierarchy follows a logical progression, and includes all possible data that might be included in the collection, interpretation and presentation of terrain and surficial geology data. The full data model, showing all fields/attributes and the data types is presented in Appendix E. This full data model also follows the format established by RIC (1992). To clarify and further expand the data model, comments, examples and references to lists of values have been included in the right hand column.

When collecting and recording information at a particular observation/sample site, it is common that more than one set of similar data are collected. For example when two distinct stratigraphic terrain units occur in the exposure, or when two or more photos are taken of the site. These types of situations are accounted for in the data model by using multiple entries or records, as indicated on the f 11 data model in Appendix E.

It is not intended that all information in the f 11 data model would or should be collected. A minimum amount of data, however, are required. The suggested minimum data is highlighted with an asterisk (*) in the left hand column of the full data model (Appendix E). The minimum requirements for data collection is summarized below in Table 12. It should be reiterated that the terrain data model is still in DRAFT form, but the minimum requirements for data collection are part of the standards.

7.8 Collection of Samples and Laboratory Analysis

Project objectives may require data from laboratory analyses. For example, particle size analyses are commonly performed on a limited number of samples in order to confirm hand texturing done in the field. Atterberg limits (plasticity), bulk density and natural moisture content may be determined for fine grained materials when terrain analysis is carried out in conjunction with geotechnical work. Petrological and geochemical soil analyses of surficial materials are included in reports related to drift prospecting. Appropriate procedures for sampling and sample storage should be determined before field work begins.

Confirmation of field determinations of the texture of fine materials, such as till matrix, is recommended for major projects with extensive field checking, when field checking is being done by relatively inexperienced persons, and when experienced mappers commence work in an unfamiliar area.

Minimum Requirements:

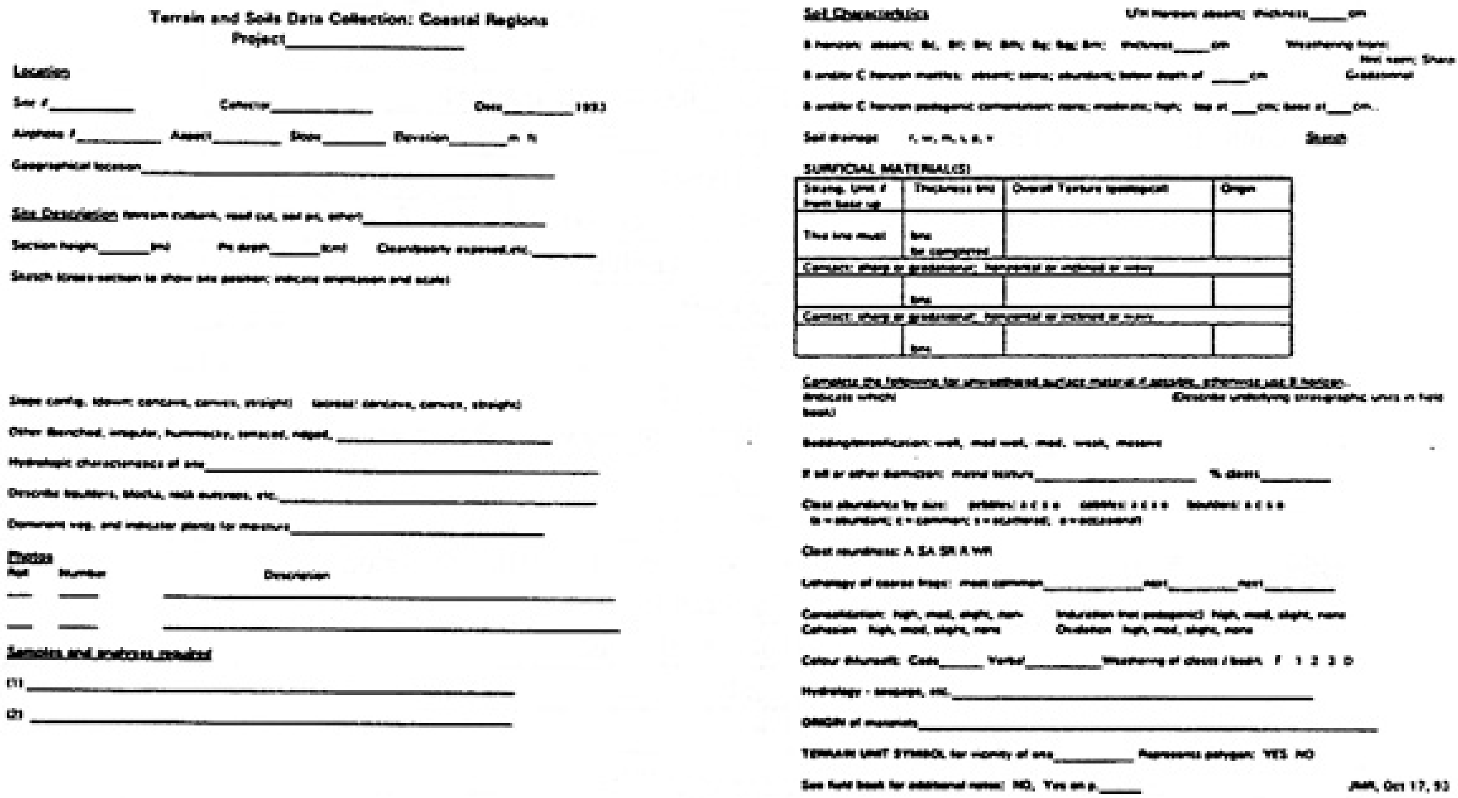
- All samples shall be clearly labeled, using a scheme designed at the beginning of the project.
- Sample identification number and required laboratory analyses shall be noted on site description forms.

7.9 Collection of Bedrock Data

If bedrock information is relevant to project objectives or a related project, then data about bedrock characteristics and the locations of rock outcrops can be plotted on air photos and maps, and hand specimens collected. This will be most useful in areas where no bedrock map exists, where bedrock mapping is being carried out concurrent with terrain mapping, and in drift-covered areas where bedrock outcrops are rare (cf. Bridgland, 1986).

7.10 Evening Activities

Terrain mapping on air photos should be corrected according to field observations as soon as possible after field work in order to take advantage of the mapper's recollection of the field sites. If possible, this should be done in the field during evenings. It is advantageous to select field accommodation that provides space for the use of a mirror stereoscope and adequate illumination. Field notes can also be entered into computer storage each evening if facilities are available.



Terrain and Soils Data Collection: Coastal Regions
Project____________

Location

Site #________ Collector__________ Date________1993

Airphoto #________ Aspect________ Slope________ Elevation________m ft

Geographical location______________________

Site Description (terrain cutbank, road cut, soil pit, other)______________

Section height______(m) Pit depth______(cm) Cleanly/poorly exposed,etc.________

Sketch (cross-section to show site position; indicate dimension and scale)

Slope config. (down: concave, convex, straight) (across: concave, convex, straight)

Other (benched, irregular, hummocky, terraced, ridged, ______________

Hydrologic characteristics of site______________

Describe boulders, blocks, rock outcrops, etc.______________

Dominant veg. and indicator plants for moisture______________

Photos
Roll Number Description

Samples and analyses required

(1) ______________

(2) ______________

Soil Characteristics

SURFICIAL MATERIAL(S)

Strat. Unit # from base up	Thickness (m)	Overall Texture (pedological)	Origin
This line must	(m) be completed		
Contact: sharp or gradational; horizontal or inclined or wavy			
	(m)		
Contact: sharp or gradational; horizontal or inclined or wavy			
	(m)		

Bedding/stratification: well, mod well, mod, weak, massive

Clast roundness: A SA SR R WR

Consolidation: high, mod, slight, non- Induration (not pedogenic) high, mod, slight, none
Cohesion high, mod, slight, none Oxidation high, mod, slight, none

Hydrology - seepage, etc.______________

ORIGIN of materials______________

TERRAIN UNIT SYMBOL for vicinity of site________ Represents polygon: YES NO

See field book for additional notes: NO, Yes on p._____ JMR, Oct 17, 93

Figure 7. Example of data form used for site descriptions.

Table 10. Checklist of Field Data.

Type of information	items	Minimum Requirement (x)
Project identification	project name and/or # date of observation name of observer	X X X
Location	UTM or lat/lon air photo number observation site number	X X X
Setting	Aspect slope (° or %) elevation (m) sketch map cross section	 X X
Terrain for vicinity of site	material texture (by hand) type of material (genesis) landform/surface expression geomorphic processes (if present) soil drainage local hydrologic features	X X X X
For each stratigraphic unit (if exposed)	material type thickness	X X
	nature of contacts lateral continuity texture structures consolidation clasts: lithology, %, shape; roundness	X X X X
Bedrock	Type structure	
Other geomorphic features	striae or other ice-flow direction indicators ice wedge casts paleosols etc.	X
Hydrologic Features	small channels springs seepage zones	
Soil (pedological) characteristics	horizon types and thickness soil drainage soil type	
Samples (if collected)	number number analyses required or reason for collection	X X
Photos	number	X

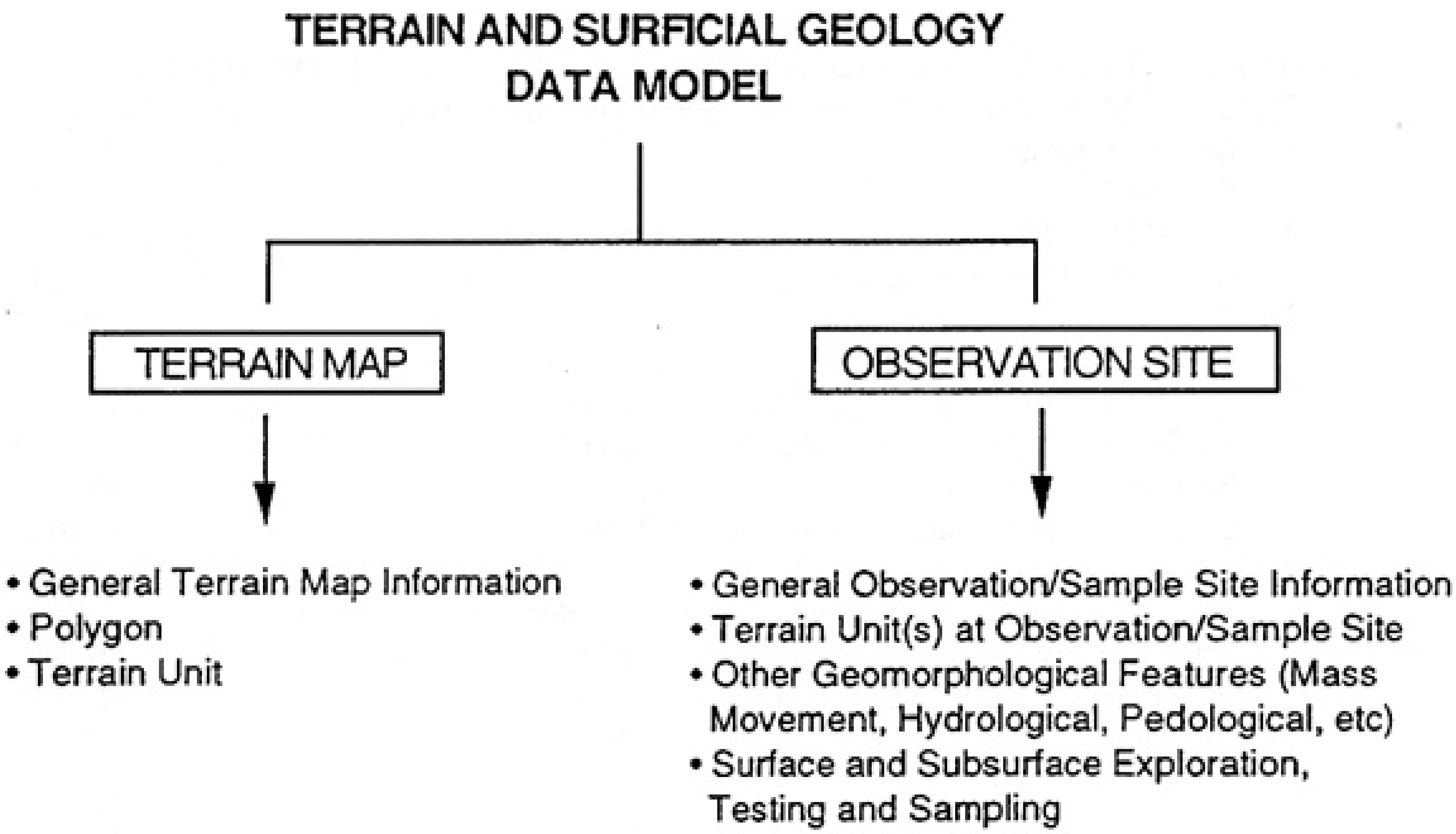


Figure 8. Hierarchy for terrain mapping information digital data model.

Table 11. Hierarchical Summary of Entity Groups, Names and Acronyms.

ENTITY GROUP: Terrain Map	[TERRMAP]
ENTITY NAME: General Terrain Map Information	[MAPINFO]
1. Project Identification	[PROJID]
2. Terrain Map/Report Identification	[TMRID]
3. Base Map identification	[BASEID]
4. General Mapping Information	[GENINFO]
5. General Physical Setting	[PHYSETI]
ENTITY NAME: Polygon	[MAPPOLY]
1. General Polygon Features	[POLYFEA]
ENTITY NAME: Terrain Unit	[MAPUNIT]
1. Single Terrain Unit	[SIUNITI]
2. Composite Terrain Units	[CTUNIT1]
3. Stratigraphic Terrain Unit	[STUNITI]
ENTITY GROUP: Observation/Sample Site	[TERRSITE]
ENTITY NAME: General Observation/Sample Site Information	[SITEINFO]
1. General Information	[GENINFO]
2. Specific Location	[SPECLOC]
3. Visual Data (Photographs/Sketches/Sketch Maps/Cross-Sections)	[VISUALS]
4. Reference to Pre-existing Data	[PREEXIST]
5. Physical Setting	[PHYSET2]
ENTITY NAME: Terrain Unit(s) at Observation/Sample Site	[SITEUNIT]
1. Single Terrain Unit at Observation/Sample Site	[SIUNIT2]
2. Bedrock	[BEDROCK]
3. Colour/Odour of a Single Terrain Unit or Bedrock	[COLOUR]
4. Pebbles of a Single Terrain Unit	[PEBBLES]
5. Striae/Other Ice Flow Indicators of a Single Terrain Unit or Bedrock	[FLOWIND]
6. Structures/Discontinuities of a Single Terrain Unit or Bedrock	[STRUCT]
7. Palaeosols of a Single Terrain Unit	[PALOSOLS]
8. Engineering Character of a Single Terrain Unit	[ENGCHAR]
9. Composite Terrain Units	[CTUNIT2]
10. Statigraphic Terrain Units	[STUNIT2]
ENTITY NAME: Other Geomorphological Features (Mass Movement, Hydrological, Pedological, Other)	[SITEGEOM]
1. Mass Movement Features	[MASSMOVE]
2. Hydrological Features	[HYDROL]
3. Pedological Soil Characteristics	[PEDOLOG]
4. Other Geomorphological Features	[GEOMOTH]
ENTITY NAME: Surface and Subsurface Exploration, Testing and Sampling	[SITEETS]
1. Surface exploration	[SURFEXP]
2. Surface testing	[SURFTEST]
3. Surface sampling	[SURFSAMP]
4. Subsurface exploration	[SUBEXP]
5. Subsurface testing	[SUBTEST]
6. Subsurface sampling	[SUBSAMP]

Table 12. Minimum terrain data and data type.

FIELD/ATTRIBUTE	DATA TYPE	COMMENTS/EXAMPLES/ REFERENCE TO VALUE LISTS
ENTITY GROUP: Terrain Map [TERRMAP]		
ENTITY NAME: General Terrain Map Info [MAPINFO]		
NAME OF SENIOR MAPPER	Text (String)	
AGENCY/ORGANIZATION	Text (String)	of mappers
PROJECT NAME	Text (String)	
MONTH/YEAR OF PUBLICATION	Text (String)	
MAP TITLE	Text (String)	
MAP LEGEND	Text (String)	
MAP MARGINAL NOTES	Text (String)	if no report
NTS MAP NUMBERS	Text (String)	NTS or BCGS/TRIM not both
BCGS/TRIM MAP NUMBER	Text (String)	
MAP SCALE	Numeric (Real)	
MAP NORTH ARROW	Graphic	
MAP BAR SCALE	Graphic	
INDEX MAP	Graphic if no report	
MONTH/YEAR OF MAPPING	Text (Date)	
TERRAIN SURVEY INTENSITY	Text (String)	this document, Table 7
ENTITY NAME: Polygon[MAPPOLY]		
POLYGON LOCATION	Graphic	
BOUNDARY LINE TYPE	Graphic	e.g, solid. dashed. dotted
ENTITY NAME: Terrain Unit [MAPUNIT]		
DOMINANT TEXTURE	Text (String)	from Howes and Kenk. 1988
TYPE OF MATERIAL (GENESIS)	Text (String)	from Howes and Kenk. 1988
LANDFORM/SURFACE EXPRESS	Text (String)	from Howes and Kenk. I 988
GEOLOGICAL PROCESSES	Text (String)	from Howes and Kenk. 1988
plus Surficial Geology Symbols, as required		
ENTITY GROUP: Observation/Sample Site [TERRSITE]		
ENTITY NAME: General Observation/Sample Site Information [SITEINFO]		
NAME OF OBSERVER/SAMPLER	Text (String)	
DATE OF OBSERVATION/SAMPLE	Text (Date)	
OBSERVATION/SAMPLE SITE NO.	Numeric	
LATITUDE (D/M/S)	Numeric	seconds or tenths of minutes
LONGITUDE (D/M/S)	Numeric	seconds or tenths of minutes
UTM GRID ZONE	Numeric	lat/long or UTM. not both
UTM EASTING	Numeric	
UTM NORTHING	Numeric	
PHOTO ROLL NUMBER	Numeric	if photo taken
PHOTO EXPOSURE NUMBER	Numeric	if photo taken
ELEVATION (m)	Numeric	
MEASURED/ESTIMATED	Text (String)	
SLOPE GRADIENT	Numeric	
DEGREE/PERCENT	Text (String)	
ENTITY NAME: Terrain Unit(s) at Observation/Sample Site [SITEUNIT]		
DOMINANT TEXTURE	Text (String)	from Howes and Kenk. 1988
TYPE OF MATERIAL (GENESIS)	Text (String)	from Howes and Kenk. 1988
LANDFORM/SURFACE EXPRESS	Text (String)	from Howes and Kenk. 1988
GEOLOGICAL PROCESS	Text (String)	from Howes and Kenk. 1988
SOIL MOISTURE	Text (String)	

8.0 METHODOLOGY IV: COMPILING THE TERRAIN MAP

8.1 Finalizing Terrain Information on Air Photos

Following field work, terrain mapping is corrected on the air photos, and a final consistency check is made of all mapped photos. All adjacent photo edges should be checked for continuity of boundary lines and matching of fewer symbols. Alterations on air photos should be made clearly and cleanly, and unnecessary symbols and lines deleted.

8.2 Transfer of Terrain Data to Base Map or Other Medium

Terrain polygon boundary lines can be transferred to topographic base maps or to other media by using a stereoplotter (such as a kail plotter) or freehand. The latter method is recommended only if topographic detail and other features sufficient to ensure accurate positioning of boundaries on the map are visible on both air photos and base map.

Minimum Requirements:

- When transferring terrain polygon boundary lines from air photos to base map, the use of a stereoplotter shall be considered for TSILs A and B.

- If line transfer is not done by the mapper, the mapper shall review carefully the preliminary draft of the terrain map.

8.3 Preparation of the Map Legend

Although a standard terrain legend, with definitions as given in Howes and Kenk (1988), can be applied to any terrain map, more information about a specific map area can be supplied if the legend is tailored to terrain conditions in that area. The chief difference between the standard legend (Fig. 9) and a tailored legend (Fig. 10) is that material and process descriptions in the latter are written so as to apply specifically to the study area. The length of these descriptions will depend on whether or not the map is accompanied by a report. In a tailored legend, unused symbols and their definitions are omitted.

If any modifications to the terrain classification scheme were made in order to meet project objectives, for example, if different types of till were mapped as M1, M2, M3, etc., (e.g., Fig. 3) these symbols must be defined in the legend.

8.4 Additional Information

Information from well records, borings or similar sources should be used by a mapper if high quality data are available (Section 5.4). Sites from which data are obtained or where field samples were collected should be marked on the map and numbered, using a scheme that is distinct from that of the field observation sites.

(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 use 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".

(2) MATERIALS

A	Anthropogenic materials	Artificial materials, and materials modified by human actions such that their original physical appearance and properties have been drastically altered.
C	Colluvium	Products of gravitational slope movements; materials derived from local bedrock and major deposits derived from drift; includes talus and landslide deposits.
D	Weathered bedrock	Bedrock modified in situ by mechanical and chemical weathering.
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.
F^A	"Active" fluvial sediments	Active deposition zone on modern floodplains and fans; active channel zone.
F^G	Glaciofluvial sediments	Sands and gravels transported and deposited by meltwater streams; includes kames, eskers and outwash plains.
I	Ice	Permanent snow and ice; glaciers.
L	Lacustrine sediments	Fine sand, silt and clay deposited in lakes.
L^G	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.
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.
V	Volcanic materials	Unconsolidated pyroclastic sediments.
W	Marine sediments	Sediments deposited by settling and gravity flows in brackish or marine waters, and beach sands and gravels.
W^G	Glaciomarine sediments	Sediments laid down in marine waters in close proximity to glacier ice.

(3) TEXTURE

Specific Clastic Terms

c	clay	< 4µm
s	silt	62.5 - 4µm
s	sand	2 mm - 62.5µm
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
y	shells

(4) SURFACE EXPRESSION

a	moderate slope(s)	predominantly planar slopes: 15-26°
b	blanket	material > 1m thick with topography derived from underlying bedrock or surficial material
c	cone	fan-shaped surface that is a sector of a cone: > 15°
d	depression	enclosed depressions
f	fan	fan-shaped surface that is a sector of a cone: 3 - 15°
h	hummocky	steep-sided hillocks and hollows: many slopes > 15°
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 with many slopes > 15°
s	steep slope(s)	slopes > 35°
t	terrace(s)	stepped topography and benchlands
u	undulating topography	hillocks and hollows; slopes predominantly < 15°
v	veneer	material < 1-2m thick with topography derived from underlying bedrock or surficial material

(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 due to frost action
D	Deflation	removal of sand and silt particles by wind action
E	Glacial meltwater channels	areas crossed by meltwater channels
F	Fading	slope experiencing slow mass movement
H	Kettled	area includes numerous small kettles
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 underground conduits
R	Rapid mass movement	processes such as debris flows, debris slides and avalanches, and rockfall
S	Solifluction	slow downslope movement of seasonally unfrozen regolith
U	Inundated	areas seasonally covered by standing water
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
Z	Periglacial processes	Solifluction, nivation and cryoturbation together

Figure 9. Standard terrain map legend. (Only letter symbols are shown here. Normally, those on-site symbols used on a map would also be shown in the legend.)

TAILORED 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 use 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".

(2) MATERIALS

C	Colluvium	Materials accumulated as a result of gravitational slope movements; includes blocky talus derived from granodiorite, rubbly talus from volcanic rocks, deposits of two major rock avalanches, and numerous debris-flow fans.
F	Fluvial sediments	Materials transported and deposited by streams; includes large dissected, bouldery fans at the mouths of tributaries and low river terraces of limited extent.
F^A	"Active" fluvial sediments	Active channel zone of modern floodplain; includes gravels capped by overbank sand and small areas of organic veneer along trunk stream, and large alluvial fans with laterally unstable channels.
F^G	Glaciofluvial sediments	Materials deposited by glacial meltwater streams; includes kame terraces of sandy gravel along the trunk valley, and proglacial outwash of modern glaciers.
L^G	Glaciolacustrine sediments	Materials deposited in ice-dammed lakes; includes small pockets of silt in tributary valleys; very susceptible to gully erosion and instability.
M	Till	Material deposited by glaciers; includes widespread dense lodgement till with silty sand matrix and numerous boulders, scattered patches of loose, gravelly ablation till, and small pockets of glaciolacustrine silt.
R	Bedrock	Outcrops, and bedrock covered by thin drift and colluvium; includes granodiorite, volcanic rocks, and minor schist.

(3) TEXTURE

z	silt	62.5 - 4μm
s	sand	2 mm - 62.5μm
b	boulders	> 256 mm
a	blocks	angular boulders
x	angular fragments	
g	gravel	
r	rubble	

(4) SURFACE EXPRESSION

a	moderate slope(s)	predominantly planar slopes: 15-26°
b	blanket	material > 1m thick with topography derived from underlying bedrock or surficial material
c	cone	fan-shaped surface that is a sector of a cone; > 15°
f	fan	fan-shaped surface that is a sector of a cone; 3 - 15°
h	hummocky	steep-sided hillocks and hollows; many slopes > 15°
j	gentle slope(s)	predominantly planar slopes: 4-15°
k	moderately steep slope	predominantly planar slopes: 26-35°
p	plain	0-3°
s	steep slope(s)	slopes > 35°
t	terrace(s)	stepped topography and benchlands
u	undulating topography	hillocks and hollows; slopes predominantly < 15°
v	veneer	material < 1-2m thick with topography derived from underlying bedrock or surficial material

(5) GEOLOGICAL PROCESSES

A	Avalanches	Slopes affected by frequent snow avalanches.
B	Braiding channel	Channel zone with many diverging and rejoining channels; channels laterally unstable
F	Failing	Slope experiencing slow mass movement; restricted to areas of glaciolacustrine sediments.
I	Irregularly sinuous channel	Channel displays irregular turns and bends
R	Rapid mass movement	Slopes affected by processes such as debris flows, debris slides and avalanches, and rockfall
Rd	Debris flows	Common debris flows, typically originating from gullies in bedrock cliffs and from small slides in till.
Rb	Rock fall	Common rockfalls, typically originating from steep slopes underlain by volcanic rocks
V	Gullying	Slopes affected by gully erosion
Z	Periglacial processes	Solifluction, nivation and cryoturbation together

Figure 10. Example of tailored legend. Unused symbols are omitted, and descriptions of surficial materials and geological processes are specific to the map area.

9.0 THE COMPLETED TERRAIN MAP

9.1 Base Maps

For presentation purposes, terrain map data are usually superimposed onto a topographic base map (NTS maps and TRIM maps). The contours on these maps provide information about the large topographic features (mountains, valleys) that are not shown by terrain symbols, relief and slope grade. Terrain information is normally drafted onto 50°/O screened mylar (i.e., a reproducible medium) copies of topographic maps (e.g., Fig. 1). Blackline prints from the mylar map show base map information (contours, cultural features) in grey and terrain information in black.

Topographic maps that are used as base maps should not be enlarged to the presentation scale unless no larger scale map base is available. In practice, 1:50,000 maps have commonly been enlarged to 1:20,000 scale because, until the advent of 1:20,000 scale TRIM mapping in 1990, large scale topographic maps were available only for a few parts of British Columbia. The contour patterns on enlarged topographic maps do not show the small topographic features that are clearly visible on larger scale air photos. Consequently, features shown on the terrain map, such as slope steepness, may be at odds with the contours.

Air photo mosaics and orthophotos can also be used as base maps for terrain mapping. Many people who are not familiar with topographic maps can relate more easily to a photographic base, and so this is a useful option for certain projects. If project objectives specify that an air photo mosaic (or other non-topographic medium) is to be used as a base, then the mapper should show slope steepness on the terrain map, either by using additional descriptors for slope or by using surface expression symbols that specify slope (e.g., "Mv over Ra" rather than Mv alone) in all polygons.

For some projects, terrain maps are prepared on transparent overlays to topographic maps, orthophotos, or other types of map. A terrain overlay is commonly one of a series of thematic overlays that show various types of information that are to be integrated for planning or management purposes. If project objectives require that maps are scanned and digitized, then an overlay showing polygon boundaries only should be made of the map before terrain symbols are added.

9.2 Terrain Information

Minimum Requirements:

Terrain maps shall show:

- polygon boundaries, by solid, dashed and dotted lines, as appropriate; terrain letter symbols; on-site symbols,
- observation sites, with clearly labeled identification numbers,
- sites of any radiocarbon ages obtained during the project.

9.3 Legend

It is recommended that a tailored legend (Fig. 10) be prepared for each mapping project. The legend may be specific to one or several map sheets. The smallest letters in the legend should be clearly legible, and on-site symbols should be represented in the legend at approximately the same size as they appear on the map. The legend should appear adjacent to the terrain map, not on the back of the map sheet.

Minimum requirements:

- Every map shall have a legend attached.
- Every symbol used on the terrain map, including on-site symbols, shall be defined in the legend.

9.4 Marginal Information

Information that should be shown in the border of a terrain map is listed in Table 13. If terrain information has been added to an NTS or TRIM map, then some of this information, such as scale, will be present automatically. If terrain mapping is presented on an orthophoto or an overlay, then all information listed as a minimum requirement should be added.

In general, the terrain map and marginal information together should cover an area of no more than one square metre. Large maps should be split into two or more sheets, each with a legend. An example of map layout, with marginal information, is provided in Figure 11.

9.5 Scale

Terrain maps should be used at the scale at which they were originally presented. They should not be enlarged because this magnifies any errors that are present. Also, since larger-scale maps are commonly thought to be more reliable than smaller scale maps, enlargement can give a misleading impression of accuracy.

Minimum Requirement:

- Large scale terrain maps cannot be produced by enlarging smaller scale maps (e.g. I :5O,OOO cannot be used to produce a 1:20,000 map or figure).

Table 13. Marginal Information for Terrain Maps.

Category	Description or Comments	Minimum Requirement (x)
Map title	should include NTS #	x
Name of mapper		x
Source/agency		x
Year of Publication		x
Year of field work		x
Terrain survey intensity level		x
Scale	bar scale representative fraction	x x
terrain legend	standard legend tailored legend	x
Reference to accompanying report	(if report exists)	x
Marginal notes or abstract	(if no associated report, should include objectives of mapping project)	x
References to associated data files or stored data	(if additional data was collected)	x
Cross section(s)	(may be in accompanying report)	
Radiocarbon ages	keyed to map sites (if dates obtained)	x
References to previous work	surficial geology or terrain bedrock	
Acknowledgments		
index map(s)	field stations and routes of traverses distribution of bore holes areas covered by different mappers areas mapped at different intensities (or include in accompanying report)	x x x
air photo identification	series (flight line) year day/month	x x
base map identification	agency year north arrow lat. and long. legend to base map symbols	x x x x x

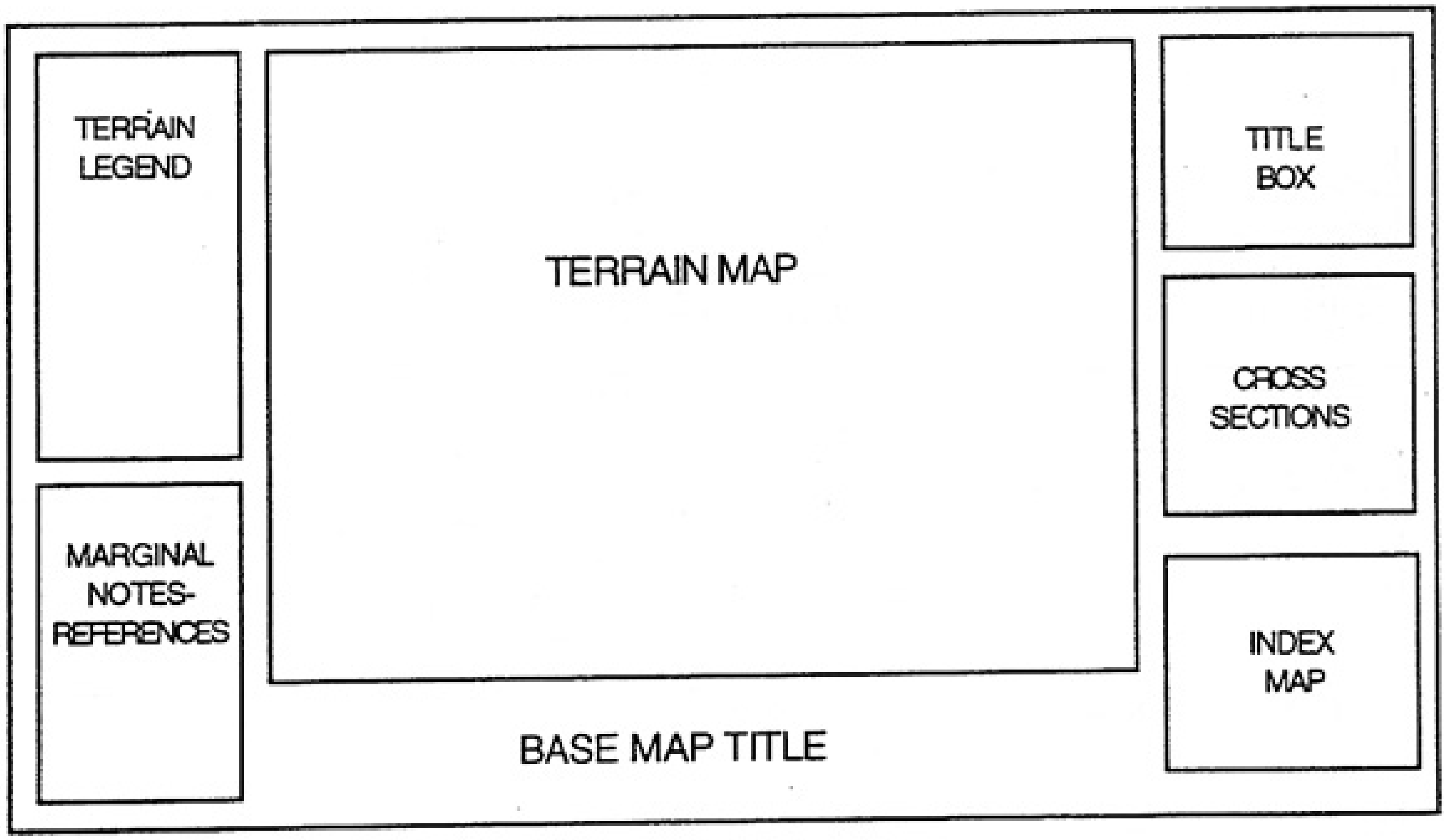


Figure 11. Example of layout: terrain map and marginal information.

10.0 DERIVATIVE MAPS

10.1 Introduction

The use of terrain maps for practical purposes by persons who are not Geoscientists usually requires the preparation of interpretive or derivative maps. A derivative map presents terrain data in a form in which it can be easily understood and utilized by planners, resource managers and others (Ryder and MacLean, 1980). Usually, each derivative map will have a specific theme, such as geological hazards or aggregate resources. Some derivative maps are based on terrain information plus data from another type of thematic map, such as vegetation, or hydrologic features, or bedrock geology.

10.2 Examples

Derivative maps are made by selecting a subset of data from the base data (terrain) map. This subset may be one part of the terrain symbol, for example, hazard maps have been prepared by selecting the geological process symbol. Thus a terrain polygon mapped as "Cv/Mv-A" for example, would translate into an area of snow avalanche ("-A") hazard, as illustrated in Figure 12. More commonly, however, preparation of a derivative map is done by applying criteria that are based on more than one terrain component. For example, the hazard interpretation system indicated in Figure 13 is based on all components of the terrain symbol. The method of interpretation illustrated in Figure 12 is appropriate for small scale (e.g., 1:250,000) reconnaissance maps, whereas the method illustrated in Figure 13 is appropriate for larger scale maps.

In both methods of hazard interpretation described above, the resulting map gives a generous impression of the extent of hazardous terrain. A symbol such as "Cv/Rs-Rd" for example, would be used by a mapper to indicate that debris flows ("-Rd") occur within the terrain polygon. The debris flows would probably be restricted to specific "tracks" however, and large parts of the polygon would be unaffected. Thus the derivative map indicates the presence of a hazard, and more detailed mapping -- of specific debris flow tracks -- would be required to delimit specific hazard zones. It is also worth noting that derivative maps of hazards do not provide information about the frequency or magnitude of the hazardous processes: determination of these parameters is a step that would normally follow terrain mapping and preparation of the hazards map.

Derivative maps showing slope stability and erosion potential are commonly prepared from terrain maps for use in the planning of forestry activities. Usually, terrain mapping at moderately large scales (1:20,000 or larger) is carried out specifically for the preparation of stability maps. Soil drainage conditions and slope steepness are also mapped and used for the interpretation of slope stability. A combined terrain and slope stability map is illustrated in Figure 14, and the criteria that were applied to derive those stability classes are shown in the legend to that figure. Guidelines for the preparation of slope stability maps for forestry purposes are available from the Ministry of Forests, (e.g., Schwab, 1993; Mapping and Assessing Terrain Stability Guidebook, 1995). Derivative maps showing sediment sources are being used increasingly for management of forestry and other land uses on steep slopes. Sediment sources that are commonly mapped include sites where sediment is presently being released, such as recent debris slides, and undercut stream banks. Potential sediment sources, ie., steep slopes where road construction or clear cutting could result in initiation of slope failures, are also shown on sediment source maps. Thus preparation of the derivative map involves transfer of on-site symbols from the base map (e.g., symbols for debris slide scars and tracks, undercut stream banks, etc.) as well as identification of potentially unstable areas (i.e., terrain polygons) by application of criteria based on all parts of the terrain letter symbol.

Terrain maps are commonly translated into maps of aggregate resources by selecting areas underlain by gravely and sandy materials. Thus fluvial and glaciofluvial polygons are selected, and colluvium may also be indicated as a potential source of fill. To some extent, the quality of the aggregate source can be estimated from the geomorphological nature of the deposit. For example, ice-contact materials (e.g., gFGh) are likely to have more adverse characteristics, such as a high degree of variability, lenses of silt, or boulder beds, than outwash gravels (e.g., gF*t).

Derivative maps showing "terrain constraints" to development of various facilities, such as waste disposal sites, roads, and residential subdivisions are prepared from terrain maps. Constraints are conditions that hinder construction or development but that can be overcome by appropriate engineering techniques. They include steep slopes, poor drainage, high water table, rocky ground, compressible soils, and the presence of permafrost. Such a map would be used for preliminary planning purposes, such as the identification of several alternative sites for a subdivision within a wider area. Maps of terrain constraints are prepared at various scales, as appropriate. For example, a scale of 1:50,000 is appropriate for a map showing terrain constraints to logging roads, where information is to be used for preliminary planning of road access in an undeveloped area. Terrain constraints to urban development are normally portrayed at large scales, such as 1: 10,000.

In recent years, derivative terrain maps have been used increasingly as an aid to both the planning and the interpretation of geochemical drift exploration surveys. These surveys are used to identify anomalously high concentrations of economic minerals in till, and then the source of the sediment is sought by examining underlying bedrock or by following glacier (or stream) flow paths upstream. These techniques are effective only where sediment (surficial material) was derived from underlying bedrock or where its source upstrearn can be identified. Where surficial materials are thick, and where the surface materials rest upon older sediments of a different kind, till sampling is less likely to yield information about underlying bedrock. Thus information about types of surficial materials and their thickness, glacier flow directions, and meltwater flow directions can be used for planning the location and lay-out of the geochemical survey grids (see Proudfoot et al., 1995). This information can be read directly from terrain maps, or, for use by people unfamiliar with the terrain legend, it can be shown on a derivative map (Fig. 15).

10.3 Preparation and Presentation

Derivative maps are derived from a terrain (or other) data map by the application of predetermined criteria that are based on the definitions of the classes that are to be portrayed on the derivative map, e.g., legend to Figure 12. As noted above, these criteria may refer to only one part of each terrain symbol, such as texture, or they may refer to two or more parts, or they may refer to parts of the terrain symbol plus additional mapped parameters, such as slope steepness. Criteria may also be based on data derived from more than one type of map. Where a digital (or other) data base contains additional information that is keyed to the polygons on the terrain map, then this too can be incorporated into the derivative criteria.

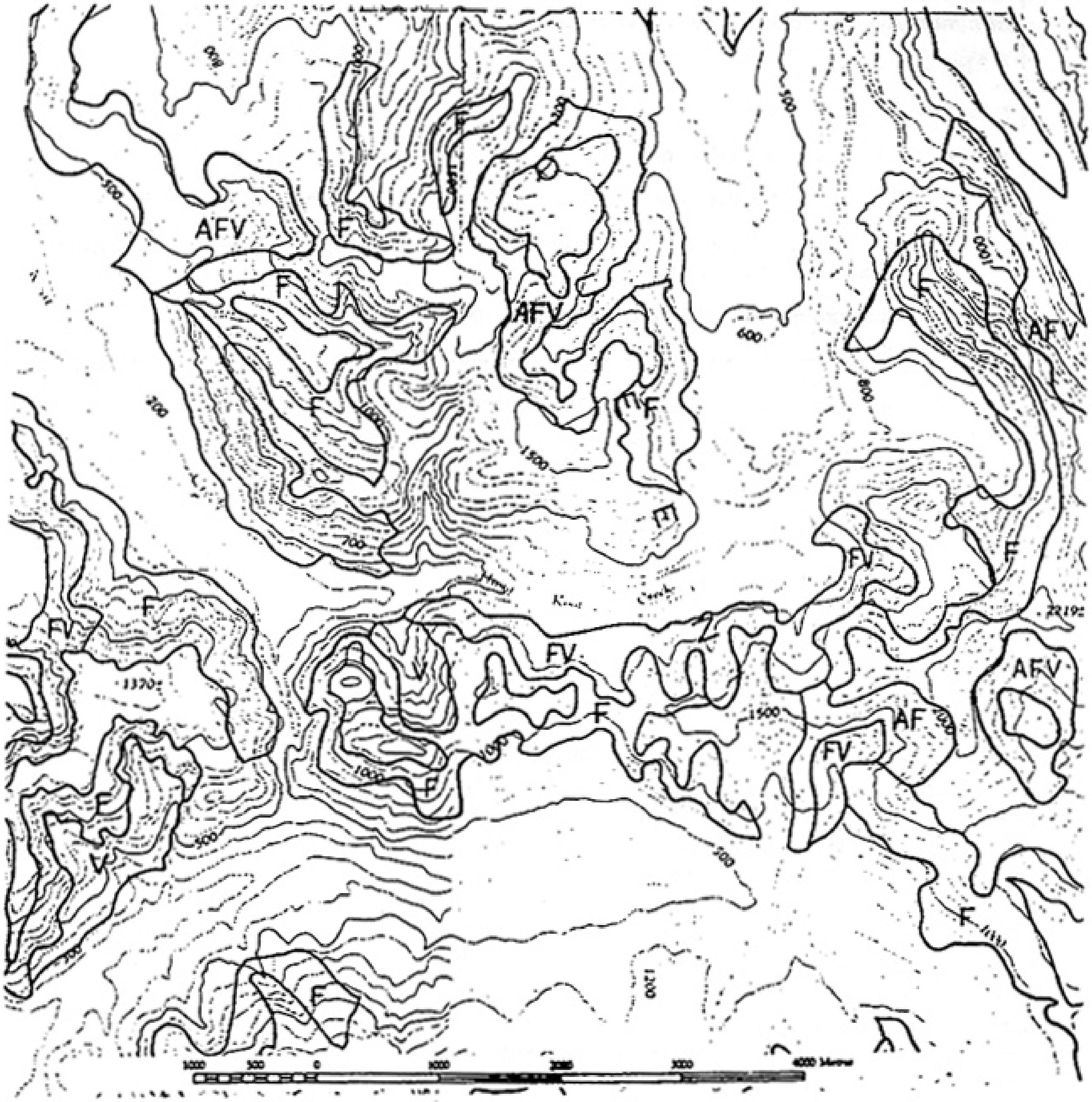
Interpretations can be done "by hand" by the terrain specialist, or by a GIS program. The advantage of the former method is that a person who is familiar with the mapped area can assess the significance of features observed in the field or on the air photos, but not shown on the terrain map, with regard to the interpretations. For example, slope profiles (irregular vs. smooth) and exposure to wind (and hence tree blow-down potential) may influence interpretations for slope stability in some polygons. However, this information can be entered into a GIS program to carry out various analyses, e.g., highlight all potentially unstable slopes, etc.

Terrain mapping and interpretations can be portrayed on a single map. In the simplest case, a terrain map can be colour coded according to the derivative criteria. Alternatively, interpretative symbols can be added to the terrain map (e.g., Fig. 14). This method of presentation has the advantage of allowing the map user to easily review the basic terrain data; it has the disadvantage of appearing cluttered; especially if terrain polygons appear small at the map scale.

If simple symbols are required, such as when maps will be used for public presentation, then a separate derivative map can be prepared. In this case, a copy of the line work (polygon boundary lines), to be used later for the derivative map, should be made when the terrain map is being drafted. The derivative map can be prepared on the same base map as the terrain map, or it can be presented as an overlay to the terrain map, or it can be presented on an orthophoto.

Minimum Requirements for Derivative Maps:

- Map legend.
- Map scale.
- Marginal information shall provide:
  - identification of the base data map(s) from which the derivative map was derived;
  - a statement of the criteria that were used for interpretation, or the reference to a generally available statement of the criteria;
  - the name and organization of the map compiler.



	LEGEND
A	Avalanching: slopes affected by frequent snow avalanches
F	Failing: slopes modified by rockslides, debris avalanches and debris slides
V	Gullying: slopes modified by erosion of gullies

Figure 12. Example of a hazard map derived from a terrain map by selecting symbols for active geological processes. (From Alley and Thomson, 1978).

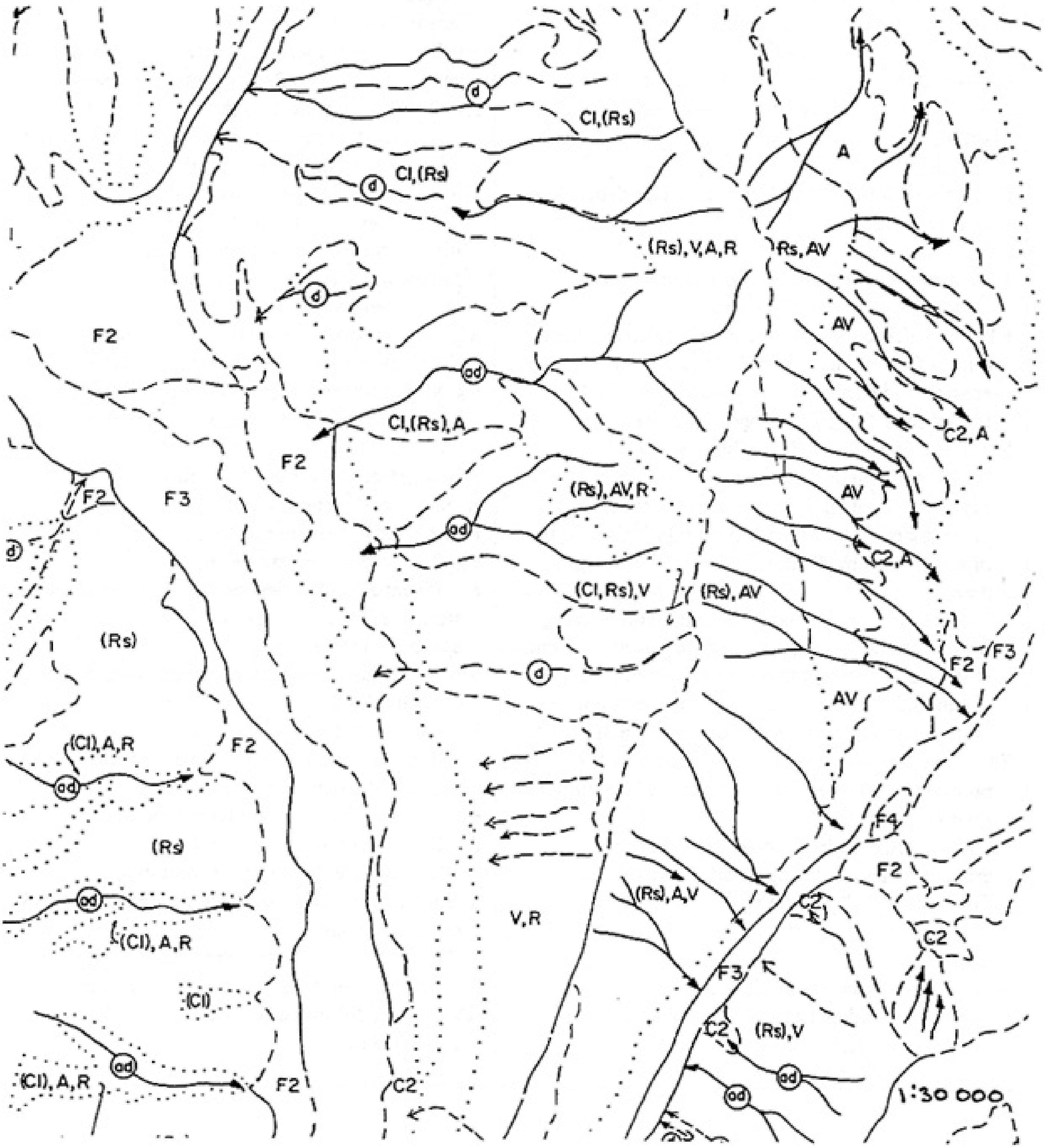


Figure 13. Example of hazard map derived from terrain map. From Ryder (1985). See accompanying legend on facing page.

C Areas underlain by colluvium

C1 Areas that may be affected by rockfall and debris flows: talus slopes, talus cones, and other steep slopes underlain by thick colluvium. (xCa, rCa, rCc etc. on terrain map)

C2 Areas that may be affected by debris flows and/or flash floods emerging from gullies and small, steep drainage basins: colluvial fans. (Cf on terrain map)

C3 Sites of former landslides: landslide debris (*e.g.*, xCh on terrain map)

F Areas underlain by fluvial sediments and affected by fluvial processes

F1 areas affected by abrupt shifts of stream channels during floods; bank erosion, local inundation, erosion and deposition may also occur: "active" fluvial fans. (F^Af, F^Af-B on terrain map)

F2 Areas previously affected by processes described for F1, but where no evidence of recent events is apparent; a potential hazard may exist close to present stream channels and on relatively low parts of a fan: "inactive" alluvial fans. (Ff on terrain map)

F3 Areas affected primarily by inundation during floods, but rapid bank erosion may occur on bends, erosion and deposition on the floodplain, and channels may occasionally shift to new courses: "active" floodplains. (F^Ap-I on terrain map)

F4 Areas that may possibly be affected by the processes described for F3: "inactive" floodplains. Fp on terrain map)

F5 Areas affected by inundation and rapid bank erosion on bends during floods: "active" floodplains. (F^Ap-M on terrain map)

Arrows:

--------------	snow avalanche tracks
-----ad------	avalanches and debris flows
------b------	rockfall

Steep slopes (> 30° or 70%) that may be affected by rapid mass movement; source areas for landslides and flows that may affect areas further downslope

Rs Rocky slopes where rockfalls and rockslides may be initiated. (Rs, Rr on terrain map)

Ls Slopes underlain by glaciolacustrine silt and clay; may be subject to slumps, slides and debris flows (Ls, Lt on terrain map)

F^Gs Slopes underlain by glaciofluvial gravels and sands; may be subject to minor downslope movement by raveling, or to deeper-seated slope failure if underlain by silt, clay or till. (F^Gs, F^Gt etc. on terrain map)

Ms Slopes underlain by till; may be subject to debris flows and slumps. (Ms on terrain map)

Cs Slopes underlain by colluvium; may be subject to debris flows and slumps. (Cs on terrain map)

Areas affected by mass movement

A Snow avalanches (-A on terrain map)

F Slow mass movement (-F on terrain map)

Fg Rock creep (-Fg on terrain map)

Fk Potential rockslides indicated by presence of tension cracks in bedrock (-Fk and on-site symbol on terrain map)

Fm Slow mass movement (slumping and sliding) of bedrock (-Fm on terrain map)

Fc Rapid soil creep. (-Fc on terrain map)

R rapid mass movement (-R on terrain map)

Rb Rockfall (-Rb on terrain map)

Rd Debris flows (-Rd on terrain map)

Rr Rockslide (-Rr on terrain map)

Rt Debris torrents (-Rt on terrain map)

S Solifluction; slow soil flow in alpine areas (-S on terrain map)

V Gully erosion (-V on terrain map)

AV Gullies followed by snow avalanches

RV Gullies followed by debris flows, flash floods and rockfall.

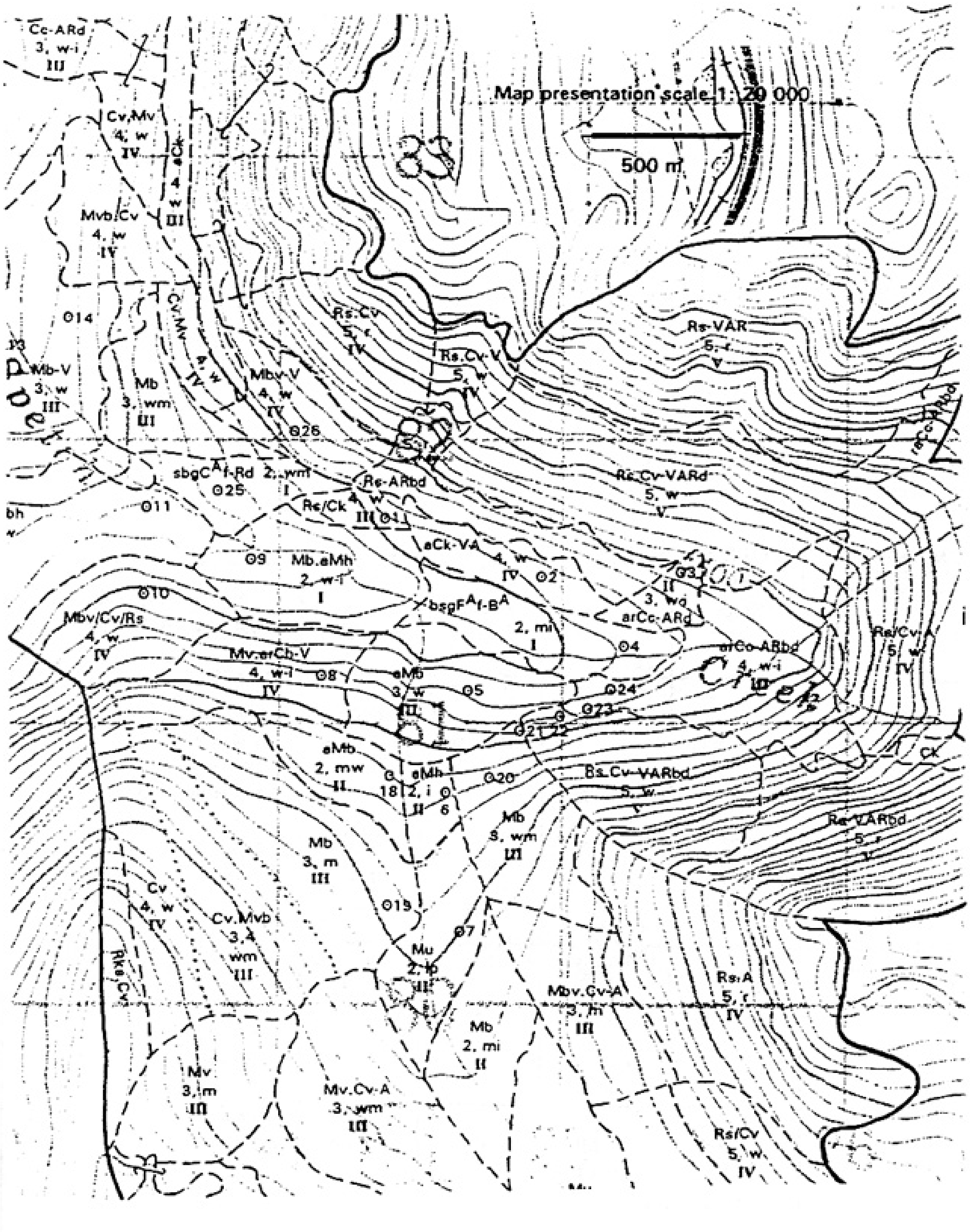


Figure 14. Example of terrain and slope stability map and legend (facing page). Note that soil drainage and slope steepness are components of the terrain symbol. Slope stability interpretation (Classes I-V) are based on the criteria shown here, but may be modified by the mapper where appropriate. (From Ryder and Friele, 1993.) Terrain symbols follow standard legend (Figure 9, and Howes and Kenk, 1988).

SLOPE CLASSES

Class	%	degrees
1	0-5	0-3
2	6-27	4-15
3	28-49	16-26
4	50-70	27-35
5	>70	>35

SOIL DRAINAGE CLASSES

<table>
<tr><td>r</td><td>rapidly drained</td><td>i</td><td>imperfectly drained</td></tr>
<tr><td>w</td><td>well drained</td><td>p</td><td>poorly drained</td></tr>
<tr><td>m</td><td>moderately well drained</td><td>v</td><td>very poorly drained</td></tr>
<tr><td colspan="4">Where two drainage classes are shown: if the symbols are separated by a comma, e.g., "w,i", then no intermediate classes are present; if the symbols are separated by a dash, e.g., "w-i", then all intermediate classes are present.</td></tr>
</table>

CRITERIA FOR SLOPE STABILITY INTERPRETATIONS

<table>
<tr><th>Potential Slope Stability and Surface Erosion Classes</th><th>Dominant Slope Class*</th><th>Material and Landforms</th><th>Dominant Texture</th><th>Active Processes</th><th>Soil Drainage</th><th>Slope Morphology</th></tr>
<tr><td>I</td><td>1 and 2
....
1&2 mixed</td><td>F^Gt, F^Gu; Cf; Ff
....
Mv, Mb; Cv; R</td><td>g; sr, g

$s, s; sr</td><td>none
none</td><td rowspan="5">poorly drained and wet soils are relatively susceptible;

units with slopes within 3 or 4° of an upper class boundary may be assigned to the next highest class</td><td rowspan="5">slopes with irregular or benched topography controlled by bedrock are relatively stable; units with slopes close to a lower class boundary may be assigned to the next lowest class</td></tr>
<tr><td>II</td><td>2
....
2 and 3</td><td>Mv, Mb
....
Cf; F^G; R</td><td>s$

sr; g</td><td>none
none</td></tr>
<tr><td>III</td><td>3
....
4</td><td>Mv, Mb; Cv
....
Ca, Ck, R, F^G</td><td>$s; sr

sr, x; g</td><td>none
none</td></tr>
<tr><td>IV</td><td>4 and 5
....
4 and 5</td><td>Mv, Mb, Cv, Cb
....
Rk, Rs</td><td>all</td><td>-V, -Rb"</td></tr>
<tr><td>V</td><td>any gradient</td><td>M, C, R</td><td>all</td><td>-F, -Rd", -Rs" **</td></tr>
</table>

Figure 14 continued.

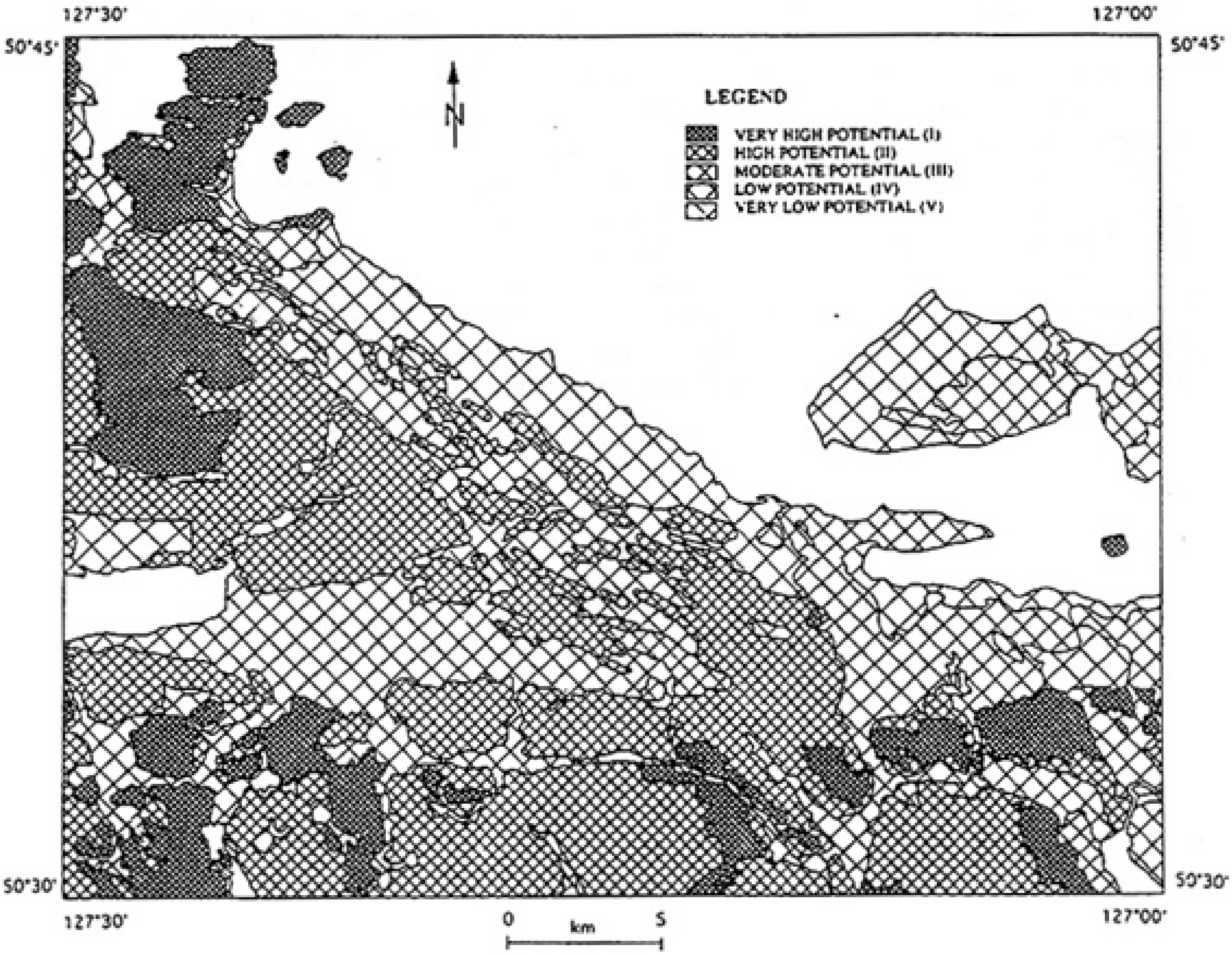


Figure 15. Drift Exploration Potential Map (modified from EMPR, Open File 1994-11). This derivative map uses terrain data and geologic principles to prioritize areas for potential to interpret drift data (see Meldrum and Bobrowsky, 1994; Proudfoot *et al.*, 1995).

11.0 TERRAIN REPORTS

Whenever possible, a terrain map should be accompanied by a written report that provides information about terrain characteristics or related features that are not shown on the terrain map.

11.1 Contents of the Report

The most important contents of a terrain report are outlined in Table 14. Many reports will contain additional material oriented toward the specific objectives. For example, reports on mapping carried out for slope stability assessment should include discussions of factors influencing slope stability and descriptions of the criteria that were used to define stability classes. Reports for drift prospecting should emphasize geological history, especially former flow directions of ice and meltwater, and stratigraphy of drift.

The distribution of landforms, surficial materials, and stratigraphic relations as observed in sections, is usefully presented in the form of cross sections. Accurate cross sections can be drawn for specific transects, or schematic cross sections can be constructed to show typical features and their relations. Observations can be distinguished from interpretations by the use of solid vs. dashed or dotted lines. Schematic cross sections with terrain symbols can be used to illustrate complex terrain.

Any new radiocarbon dates that appear in a report should be accompanied by the following information: laboratory number; type of material dated; stratigraphic context (preferably a stratigraphic section drawing); discussion of chronological significance. Dates derived from published sources should be clearly identified as such, and the sources should be referenced.

Table 14. Essentials of a terrain report.

- statement of project objectives
- review of previous work
- brief description of the physiography of the area, including topography, bedrock geology and geomorphological (including glacial) history; diagrams, such as schematic cross sections and maps of ice-flow direction, to illustrate geological/geomorphologica/glacial history;
- descriptions of each surficial material, stressing those aspects that are not shown on the map, such as thickness, stratigraphy, consolidation, clast lithologies, and complexity (e.g., variability of texture of till);
- description of terrain mapping methods, including field work;
- discussion of the reliability of the basic terrain data, including description of access problems, difficulties in field sampling, and including a map showing ground and helicopter traverse routes and sites of ground checks;
- description of methods used for preparation of interpretive maps, including explanation of rationale for criteria used and any assumptions made;
- discussion of results and recommendations tailored to project objectives;
- photographs with captions;
- acknowledgments;
- references;
- field data forms (appended)

12.0 CONSIDERATIONS REGARDING THE RELIABILITY OF TERRAIN MAPS

The "reliability" of a terrain map refers to the extent to which it correctly shows the real characteristics of the terrain. Reliability can be considered in terms of the three types of information shown on the map: polygon boundary lines, letter symbols, and on-site symbols.

The reliability of polygon boundary lines can be assessed with regard to:

Accuracy: How well do boundary lines either delimit (or separate) the basic elements (Section 4.1) of the landscape (simple terrain polygons) or group them into composite terrain units? In other words, the spatial pattern of the boundary lines can be assessed. This will include characteristics such as the size and number of polygons.

Precision: This is represented by how far the boundary lines deviate from the true boundaries of the basic elements. The mapper indicates her/his impression of the precision of a boundary by the use of solid, dashed or dotted lines.

Both of these aspects of reliability are determined primarily by air photo interpretation: those parts of a polygon boundary lines that are actually checked in the field constitute only a very small proportion of their total length. Accuracy will depend partly upon the nature of the terrain that is being mapped -- how dissimilar are adjacent basic units and, therefore, how apparent are their boundaries. It will also depend upon the skill and experience of the air photo interpreter, especially where there are only subtle differences between adjacent basic units. Precision will depend upon the clarity of the boundaries, air photo scale, the points already mentioned above, and whether or not boundaries are partly obscured by forest.

The degree of correctness of terrain letter symbols depends upon how well the mapper is able to determine the type of material, its texture, and associated landforms within each polygon. This correctness will depend upon the skill and experience of the air photo interpreter, upon the effectiveness and amount of field checking carried out, and upon the variability of the materials, and so on, within each polygon.

The use and placement of on-site symbols also depends on mapper experience and air photo interpretation, because, except for mapping at TSIL A, few locations of on-site symbols are visited in the field.

Those aspects of a mapping project that influence the reliability of a terrain map can then be listed:

- The correctness of the initial air photo interpretation (pretyping) depends upon:
  - the skill and experience of the air photo interpreter; - air photo scale;
  - quality of the air photos (sharpness, grey tones, etc.);
  - the characteristics of the terrain;
  - vegetation characteristics.

- The effect of field checking on map reliability depends upon:
  - the length of time spent in the field;
  - the effectiveness of field work;
  - the presence of exposures of surficial materials;
  - the ease of travel in the field area, including the accessibility of critical sites.

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APPENDIX A

MINIMUM REQUIREMENTS SUMMARY

The following list of Minimum Requirements is derived from the full text from the Guidelines and Standards for Terrain Mapping in British Columbia (this volume).

- Terrain mappers shall be a P.Geo. or P.Eng. in good standing, qualified and recognized as a specialist in terrain mapping.
- Terrain mappers shall have successfully completed advanced courses in geomorphology, Quaternary geology (or glacial geology) and air photo interpretation.
- Terrain mappers shall have demonstrable experience including supervised work in terrain mapping.
- Polygons shall be delimited according to the degree of similarity or dissimilarity of terrain characteristics.
- Mappers shall not attempt to delimit polygons of uniform size.
- The minimum size of a polygon that can be shown on a terrain map is 1 cm2, regardless of map scale.
- Mappers shall determine minimum polygon size (the polygon size at the scale of the air photos that is equivalent to 1 cm2 on the terrain map) before beginning air photo interpretation.

Three types of polygon boundary lines shall be used:

- solid lines represent well defined, sharp boundaries that can be precisely delimited at the scale of mapping;
- dashed lines represent boundaries that are gradational over a short distance or that can be only approximately located, such as between the toe of a large alluvial fan and the floodplain that it overlies, or where precise boundary locations are masked by forest;
- dotted lines represent assumed boundaries, for example, around many composite units, and boundaries that are gradational over considerable distances.
- Letter symbols representing material type (genesis) and surface expression shall be shown for every terrain polygon, e.g., "Mv".
- A texture symbol shall be added if material texture is known more precisely than indicated by the generalized description of that material in the map legend.
- Symbol(s) for processes shall be shown if the effects of geomorphological processes are apparent, e.g., "Cv-A".
- Most composite units shall have no more than two components, i.e., descriptors for two kinds of terrain, e.g., "Mv/Cv".
- Three-component symbols, e.g., "gFtFf/FGt", shall be used rarely, and in no case shall more than three components be used.
- If the symbol "U" (undifferentiated materials) is used, the specific materials that are present shall be indicated beside "U" in the map legend.
- All terrain maps shall clearly identify the Terrain Survey Intensity Level (TSIL) as estimated by the mapper.
- A percentage estimate of polygons field-checked shall be given on the map.
- An estimate of field checks per 100 ha shall be given on the map.
- Air photo scale shall be the same or slightly larger than the scale of the finished map.
- Air photo scales used in the mapping shall be specified on the map.
- The actual flight lines and numbers shall be illustrated in the index map box.
- Project proponents shall review existing mapping information before defining objectives for any new mapping project.

- Prior to commencing air photo interpretation, the mapper shall thoroughly review previous work on terrain, surficial geology, bedrock geology and soils that has been carried out in both the study area and the broader region.
- Fully labeled terrain polygons and on-site symbols shall be marked on air photos prior to field checking.
- Terrain boundary lines and labels shall match between the edges of adjacent photos in the same flightline and between flightlines.
- Symbols defined by Howes and Kenk (1988) and these guidelines shall be used.
- Observation sites shall be numbered, marked on the air photo and shown on the completed terrain map.
- For each project, data from all observation sites shall be recorded in a standard format on an appropriate form.
- All samples shall be clearly labeled, using a scheme designed at the beginning of the project.
- Sample identification number and required laboratory analyses shall be noted on site description forms.
- When transferring terrain polygon boundary lines from air photos to base map, the use of a stereoplotter
- shall be considered for TSILs A and B.
- If line transfer is not done by the mapper, the mapper shall review carefully the preliminary draft of the terrain map.

Terrain maps shall show:

- polygon boundaries, by solid, dashed and dotted lines, as appropriate; terrain letter symbols; on-site symbols,
- observation sites, with clearly labeled identification numbers,
- sites of any radiocarbon ages obtained during the project.
- Every map shall have a legend attached.
- Every symbol used on the terrain map, including on-site symbols, shall be defined in the legend.
- Large scale terrain maps cannot be produced by enlarging smaller scale maps (e.g. 1:50,000 cannot be used to produce a 1:20,000 map or figure).

APPENDIX B

GLOSSARY OF SURFICIAL GEOLOGY TERMS

Introduction

The following glossary contains terms used in the text of this report, terms commonly used by Quaternary geomorphologists and geologists, and terms used in the British Columbia Terrain Classification System (Howes and Kenk, 1988). Glossary sources are listed in Part I of the Annotated Bibliography.

*Terms peculiar to the BCTCS and non-standard definitions used in the BCTCS are marked by asterisks.

Italics are used to indicate words that are defined elsewhere in this glossary.

Glossary

ABLATION: The processes whereby mass is removed from a glacier; includes melting, evaporation, and calving of icebergs.

ABLATION MORAINE: A moraine resulting, from ablation; typically hummocks of ablation till formed by melting of stagnant ice.

ABLATION TILL: Material accumulated on top of a melting glacier; coarser textured and less consolidated that basal till; common where glacier recession is dominated by downwasting of stagnant ice.

ACTIVE (STATUS)*: A qualifying descriptor (superscript) used to indicate that a material is undergoing deposition at the present time*.

AERIAL PHOTOGRAPH: See air photo.

AGGREGATE: Granular material of mineral composition such as sand, gravel, crushed rock, slag, or similar inert material, used with a cementing medium to form mortar, concrete, and asphalt, or alone as in railroad ballast, etc.. Aggregate is described as gravel or coarse aggregate if it is retained on a 4.76 mm square (no. 4) sieve screen and as sand or fine aggregate if it passes this mesh size.

AIR PHOTO: A photograph of the earth's surface taken from the air. It is usually a vertical view, and one of a series of photos taken from an aircraft flying a systematic pattern at a given altitude in order to obtain continuous photo coverage for mapping purposes.

AIR PHOTO INTERPRETATION: The identification of specific earth-surface features and conditions by recognition of the patterns displayed on air photographs.

AIR PHOTO MOSAIC: A photographic reproduction of a series of air photos assembled in such a manner that features such as roads and streams match from one photo to the next and there is no overlap or repetition. CONTROLLED MOSAICS are made by locating some points precisely, as on a map, and using prints that have to some extent been corrected for tilt and topographic distortion, whereas UNCONTROLLED MOSAICS, which are less expensive, are made by matching edges from one photo to the next as well as possible; images are distorted and cannot be used for reliable measurements.

ALLUVIAL: See pavial.

ALLUVIAL FAN: A fan-shaped deposit of fluvial sand and gravel, usually located at the mouth of a tributary valley; a type of floodplain.

ALLUVIUM: Material deposited by a stream; gavial materials.

ALLUVIAL PLAIN: (i) See flood plain. (ii) A plain underlain by fluvial deposits, including alluvial (fluvial) fans, and lacustrine deposits (stream transported materials that have accumulated in lakes).

ALLUVIAL TERRACE: See river terrace.

ALPINE: (i) Refers to areas above treeline (adjective). (ii) Pertaining to high mountains.

ANASTOMOSING CHANNEL: Applied to stream channels that diverge and converge around many islands. ("Islands" support mature vegetation and their surfaces are relatively high above mean maximum discharge levels.)

ANGULAR FRAGMENTS: Broken rock with sharp edges.

ANTHROPOGENIC MATERIALS*: Earth materials modified by human activities to the extent that their initial physical properties (e.g., structure, cohesion, consolidation) have been drastically altered. Includes spoil heaps and fill*.

ANTHROPOGENIC SITE*: Cultural sites; archaeological sites; historic sites.

ASPECT: The direction toward which a slope is facing; recorded as a compass direction..

AVALANCHE: A large mass of snow and/or ice, sometimes accompanied by rocks and vegetative debris, moving rapidly down slope.

AVALANCHE CONES: Cones of debris deposited by snow avalanches; similar to talus cones but with concave longitudinal profiles and gentler slopes.

AVALANCHE TRACKS: Paths followed by snow avalanches; readily identified below treeline by their characteristic vegetation of deciduous shrubs and young conifers, and bright green colour.

BASAL TILL: Material that accumulates underneath a glacier from basal ice; includes lodgement till and basal meltout till.

BASE MAP: The map (usually a topographic map) to which terrain mapping is added, either by drafting directly onto the base map, or by drafting onto a transparent overlay which laid over the base map.

BASIC ELEMENT*: The simplest unit of a landscape, consisting of a single type of material formed by a single process and forming a single landform*. (See 4.1.)

BEACH: The gently sloping shore of a body of water that is washed by waves and usually composed of loose sandy or gravelly material.

BED: (i) The ground on which any body of water lies, limited laterally by a bank or shore. (ii) A single layer of sediment or rock, separated from layers above and below by more or less well defined boundary planes.

BEDDING: Collective term signifying the existence of beds or laminae. WELL BEDDED indicates beds are immediately apparent, clearly defined and can be easily traced across ~e deposit; POORLY

BEDDED means beds are only discernible after careful scrutiny, or bedding planes are discontinuous;

MODERATELY BEDDED is intermediate between the other two.

BEDROCK: Solid rock, usually older than Quaternary (except rock formed by cooling of lava); either exposed at the land surface or underlying surficial deposits or regolith of varying thickness.
BIOPHYSICAL HABITAT MAPPING: A mapping system that integrates those elements of the natural environment that are relevant to wildlife, including terrain, soils, and vegetation.

BIOTERRAIN MAPPING: Terrain mapping with criteria slightly modified to emphasize or include those elements of the landscape that are relevant to wildlife habitat, such as soil moisture conditions, aspect, and vegetation characteristics.

BLANKET*: A mantle of surficial material, thicker than about I metre, that reflects the topography of the bedrock or older surficial material upon which it rests although minor details of that topography may be masked*.

BLOCKS: Angular rock fragments with intermediate diameter greater than 256 mm.

BLOCKFIELD: A level or gently sloping area covered with blocks derived from underlying bedrock or drift by weathering and/or frost heave, and having undergone no significant downslope movement; characteristic of periglacial regions.

BLOWOUT: A general term for a small saucer-, cup-, or trough-shaped hollow or depression formed by wind erosion on a pre-existing dune or other sand deposit.

BLUFF: A steep, precipitous slope of great lateral extent compared to its height.

BOREHOLE: A hole drilled into the earth, commonly to great depth, as a prospective well for water or oil, of for exploratory purposes.

BOULDER: (i) A rock fragment larger than 256 mm intermediate diameter (Wentworth scale). (ii) Somewhat rounded rock fragment larger than 256 mm intermediate diameter*.

BRAIDING CHANNEL: Refers to streams where the active channel zone is occupied by many diverging and converging channels separated by bars. ("Bars" are largely unvegetated, temporary deposits of sand and gravel.)

BULK DENSITY: The weight of material per unit volume (including pore spaces); commonly applied to bulk samples of soil and clastic sediments such as till; usually expressed as kg m3 i.

BURIED VALLEY: A valley which has been filled by unconsolidated deposits, such as glacial drift.

CARBONATE ROCK: A rock composed of carbonate minerals; most commonly limestone or dolomite; a sedimentary rock composed of more than 50°/O by weight of carbonate minerals.

CHANNELED BY MELTWATER*: Erosion and channel formation by glacial meltwater*.

CINDER CONE: A steep-sided conical hill formed by the accumulation of cinders and otherpyroclastic deposits around a volcanic vent; normally of basaltic or andesitic composition.

CIRQUE: A rounded recess in a mountain formed by glacial erosion, with steep head and side walls, and a relatively gently-sloping floor that is commonly a basin with a small lake and terminated downvalley by a convex break of slope. Cirques range in diameter from a few hundred meters to several kilometers. They occur at the head of, or cut into the flanks of, glacial troughs.

CLAST: An individual particle of a detrital sediment or a sedimentary rock, initially produced by the disintegration of a larger mass of bedrock; classified according to size as pebbles, boulders etc.

CLASTIC SEDIMENTS: Sediments consisting of detrital particles derived by mechanical breakdown of rocks.

CLAY: (i) A rock or mineral fragment of any composition having a diameter less than 1/256 mm (4 micrometres) (Wentworth scale). (ii) A finely crystalline hydrous silicate of aluminum, iron, manganese, magnesium, and other metals belonging to the phyllosilicate group, such as kaolinite, montmorillonite, bentonite, and vermiculite; known as CLAY MINERALS.

COBBLES: (i) A rock fragment between 64 and 256 mm intermediate diameter (Wentworth scale). (ii) Rounded and subrounded rock fragments between 62 and 256 mm intermediate diameter*.

COHESION: The capacity of particles to stick or adhere together.

COLLUVIAL FAN*: A fan-shaped mass of sediments deposited by colluvial processes, most commonly debris flows*.

COLLUVIAL PROCESSES: See slope processes and mass movement.

COLLUVIUM: (i) Materials that have reached their present positions as a result of direct, gravity-induced mass movements; no agent of transportation such as water or ice is involved, although the moving material may have contained water or ice. includes talus, landslide debris, and debris flow deposits*. (ii) As above definition, but also including deposits resulting from slope wash.

COMPACTION: (i)The degree of packing of the individual particles of detrital sediments. (ii) The densification of soil or sediment by compression.

COMPOSITE TERRAIN POLYGON (UNIT): A polygon (unit) that includes two or three types of basic elements, usually occurring repetitiously; e.g., "Mv/Cv").

CONE: (i) A mountain, hill or other landform shaped like a cone, having relatively steep slopes and a pointed top. (ii) A sector of a cone with a straight or concave long profile and slopes generally steeper than 15° (26%); includes talus cones and avalanche cones .

CONJUGATE PRINCIPLE POINTS: The positions, on the air photo being considered, of the principle points of adjacent photos in the same flight line.

CONSOLIDATION: (i) The gradual reduction in volume of a soil mass resulting from an increase in compressive stress; involves removal of pore water and a decrease in void ratio. (engineering definition) (ii) Used to describe the density of surficial materials, especially those that contain silt and clay; HIGHLY CONSOLIDATED means of high density and low void ratio.

CONTACTS (STRATIGRAPHIC): The surfaces that separate a stratigraphic unit from overlying and underlying units; may be sharp or gradational, horizontal or inclined, planar or wavy.

CORDILLERAN ICE SHEET: The complex of icefields, mountain icecaps and piedmont glaciers that covered much of the Canadian Cordillera, including all of British Columbia, during Fraser Glaciation.

CORRUGATED MORAINE: Terrain crossed by a series of subparallel, small, regularly spaced morainal ridges that are oriented transverse to the ice movement; collectively they resemble a washboard.

CRAG AND TAIL: A streamlined hill consisting of a knob of resistant bedrock (the crag) and a elongate tail of drift, usually till, pointing in the direction of glacier flow.

CREEP: The imperceptibility slow, more or less continuous downhill movement of soil or rock on slopes. The movement is essentially flow of a highly viscous medium under shear stresses sufficient to produce deformation but too small to produce shear failure as in a landslide.

CREVASSE: A fissure formed in the brittle upper part of a glacier or ice sheet due to glacier flow.

CROSSBEDDING: The arrangement of sets of inclined beds or laminations between the main horizontal plains of stratification of a deposit; present in fluvial sands and gravels and eolian sands.

CRYOTURBATION: Heaving, churning, and sorting of soil and surficial materials due to repeated freezing and thawing; results in the development of convoluted and flame-like structures in the soil, and patterned ground such as stone stripes and sorted polygons.

DEBRIS AVALANCHE: Rapid downslope movement on steep slopes of saturated soil and/or surficial material, commonly including vegetative debris; a very rapid to extremely rapid debris flow.

DEBRIS FALL: Descent of a mass of soil and/or surficial material by falling, bouncing and rolling.

DEBRIS FLOW: Rapid flow of a slurry of saturated debris, including some or all of soil, surficial material, weathered rook, mud, boulders, and vegetative debris. A general designation for all types of rapid downslope flow, including mudflows, rapid earthflows, and debris torrents.

DEBRIS FLOW TRACKS: The paths followed by debris flows; marked by features such as levees, gullies, lack of vegetation or immature vegetation, and debris flow deposits.

DEBRIS SLIDE: Downslope sliding of a mass of soil or surficial material; initial displacement is along one or several surfaces of rupture (shear planes); debris may continue to slide downslope over the ground surface, or movement may be transformed into a debrisflow.

DEBRIS TORRENT: A variety of debrisflow that includes little fines (silt and clay) and that follows a pre existing stream channel.

DEFLATION: The erosion of non-cohesive particulate material, chiefly sand and silt by wind.

DEPOSIT: An accumulation of earth material resulting from naturally-occurring physical, chemical, or organic processes.

DELTA: An accumulation of stream-transported sediments deposited where a stream enters a body of water. The landform is flat or very gently sloping, triangular or fan-shaped in plan, and consists of fluvial (alluvial) gravel, sand, silt and/or clay.

DEPRESSION: A circular or irregular enclosed hollow separated from the surrounding area by a distinct slope break*.

DERIVATIVE MAPS*: Maps derived from information contained on a terrain map or in a terrain data base, but displaying information relevant only to some specific theme or application; examples include slope stability maps, urban capability maps and maps of granular resources

DIAMICTON: A textural term applied to non-sorted sediments consisting of sand and larger particles in a matrix of silt and/or clay; particle size distribution is bimodal, with modes. in the silt/clay and sand/gravel fractions.

DISTORTION (ON AIR PHOTOS): Distortion is caused by several effects, of which the two most relevant to air photo interpretation are listed here. Radial distortion occurs because the camera is not vertically above every point on the photograph: features near the edges appear to lean outward. Topographic distortion results from differences in scale related to topography: scale is larger where topography is high and camera-to-ground distance is least, and vice versa.

DOWNWASTING OF ICE: Lowering of the surface of a glacier or ice sheet due to ablation. Downwasting of the Cordilleran Ice Sheet at the end of Fraser Glaciation lead to ice stagnation over large parts of the intermontane zone of the Cordillera.

DRIFT: (i) All sediments deposited by glacier ice or by glacial meltwater. (ii) Includes till, glaciofluvial and glaciolacustrine materials*.

DRIFT PROSPECTING: Mineral exploration by sediment sampling and geochemical analysis of sediments such as till, in conjunction with reconstruction of former ice-flow directions.

DRUMLIN: A streamlined hill or ridge of till or other drift, with a long axis that parallels the direction of flow of a former glacier; generally the upstream end is widest and highest, and the drumlin tapers in the downflow direction.

DUNE: (i) A low ridge, hummock, or mound of loose sandy material transported and deposited by wind. (ii) Low mounds or ridges on the bed of a stream consisting of mobile bed material (sand or gravel).

DUNE FIELD: An extensive area occupied by wind-formed dunes.

EARTH: Any or a mixture of soil, surficial materials, and weathered rock.

EARTHFLOW: A slowly (imperceptibly) moving mass of earth, commonly containing a high proportion of silt and clay.

E. L. U. C.: Environment and Land Use Committee of the Government of British Columbia.

END MORAINE: A ridge-like accumulation of till, or less commonly other drift, formed at the terminus of a valley glacier or at the margin of an ice sheet; includes terminal moraines and recessional moraines.

ENGINEERING SOIL: Engineer's "soil" is equivalent to surficial materials or Quaternary deposits; see soil.

EOLIAN MATERIALS: Sediments transported and deposited by wind.

EPHEMERAL: Applies to streams and lakes that may contain water for only a day or a few days at a time.

EROSION: The loosening and removal of materials by wind, moving water, and glacier ice.

ERRATIC: Boulders or smaller clasts of rock types that are dissimilar to underlying bedrock and transported to their present location by glacier ice.

ESCARPMENT: A steep slope that is usually of great lateral extent compared to its height, such as the risers of river terraces and steep faces associated with stratified rocks.

ESKER: A sinuous ridge of sand and gravel resulting from deposition by meltwater in a tunnel beneath or within a glacier or ice sheet. The ridges generally trend at right angles to a glacier margin, and the sand and gravel may be covered by till or glaciolacustrine sediments.

EUSTATIC: Pertaining to worldwide changes of sea level that affect all the oceans. GLACIO-EUSTACY refers to changes in sea level brought about by the interchange of water between oceans and ice sheets.

FABRIC: The attitude of clasts within a sediment or sedimentary rock; recorded as the trend and plunge of clast long-axes.

FACIES: A stratigraphic unit of rock or sediment distinguished by its composition or other characteristics.

FAN: (i) An accumulation of detrital material in the shape of a low-angle cone, usually at the point where a stream emerges from a canyon onto a plain. (ii) A sector of a cone with gradient not steeper than 15°. (See alluvial fan, colluvial fan.)*

FELSENMEER: See blockfield.

FIBRIC: A textural descriptor applied to organic materials. The least decomposed organic material: it consists largely (> 40%) of fibres that are readily identifiable as to botanical origin; they retain their character upon rubbing*.

FIELD CHECK: Refers to the observations and written description of conditions at a particular site in a terrain polygon. Use to assess correctness of air photo interpretation and to collect information that cannot be obtained by air photo interpretation.

FIORD: A glacial trough with a floor below sea level, appearing as a long, narrow arm of the sea flanked by steep mountainsides and hanging valleys; commonly characterized by great depth.

FLIGHT LINE: (i) the succession of overlapping air photos (about 250) on one roll of film and identified by specific index numbers and letters, e.g., BC5211 (British Columbia government photos), A12345 (federal government photos). (ii) the succession of overlapping air photos taken along a single straight segment of the flight path of the aircraft.

FLOODPLAIN: Level or very gently sloping surface bordering a river that has been formed by river erosion and deposition; it is usually subject to flooding and is underlain by fluvial sediments; similar to alluvial plain (i).

FLOW TILL: Formed when saturated supraglacial debris (ablation till) on melting ice moves downslope as a debris flow and came to rest on an adjacent lower, stable surface; common in stagnant-ice deposits and typically interlayered with glaciofluvial and glaciolacustrine sediments.

FLUTINGS: (i) Smooth, straight furrows, parallel to ice-flow direction and formed in bedrock by glacial abrasion. (ii) Smooth, straight, shallow furrows, parallel to ice-flow direction, in till or other drift.

FLUVIAL: Pertaining to streams and rivers; similar to alluvial.

FLUVIAL TERRACES: See river terraces.

FOCAL LENGTH of a camera: The distance from the focal plane to the centre of the lens when focused at infinity.

FRASER GLACIATION: Name given to the most recent Pleistocene glaciation in British Columbia and adjacent Washington State (Armstrong et al., 1965), equivalent to Late Wisconsinan Glaciation.

FRONTAL RECESSION of ice sheet or glacier: Retreat of a glacier terminus by melting back upvalley, against the direction of ice flow; the common mode of retreat of valley glaciers.

GENTLE SLOPE$: A planar surface sloping at 3 to 15°*.

GEOCHEMICAL ANALYSIS: Laboratory analysis to determine chemical and/or mineralogical composition of earth materials.

GEOLOGICAL PROCESSES: (i) GEOMORPHOLOGICAL PROCESSES*. (ii) Including those dynamic actions or events that take place below the earth's surface, and result in effects such as earthquakes and volcanism, as well as geomorphological processes.

GEOLOGICAL STRUCTURE: The three dimensional arrangement of geological contacts and discontinuities, such as bedding, stratification, joints, faults, dykes, plutons, folds.

GEOMORPHOLOGY: The study of the origin of landforms, the processes whereby they are formed, and the materials of which they consist.

GEOMORPHOLOGICAL HISTORY: The evolution of landforms and landscapes, surface materials, and changes with time in geomorphological processes.

GEOMORPHOLOGICAL PROCESSES: Dynamic actions or events that occur at the earth's surface due to application of natural forces resulting from gravity, temperature changes, freezing and thawing, chemical reactions, seismic shaking, and the agencies of wind and moving water, ice and snow. Where and when a force exceeds the strength of the earth material, the material is changed by deformation, translocation, or chemical reactions.

GLACIAL ABRASION: The scouring action of particles embedded in glacier ice.

GLACIAL GROOVE: A pronounced, generally straight furrow or depression, larger and deeper than a striation, and produced by glacial abrasion of bedrock, or erosion or compression of drift.

GLACIAL HISTORY: The time-sequence of glaciations, glacial advances and recessions.

GLACIAL LAKE: (i) A lake that derives much or all of its water from the melting of glacier ice, ie., fed by meltwater. (ii) A lake that is dammed by a glacier or resting on glacial ice.

GLACIAL LINEATION: A collective term for linear features that indicate former ice-flow directions.

GLACIAL TROUGH: A valley with a U-shaped cross profile due to erosion by a valley glacier.

GLACIER: A body of ice formed by the compaction and recrystallization of snow, that has definite lateral limits, and with motion in a definite direction.

GLACIER OUTBURST FLOOD: A catastrophic flood that result from the collapse of an ice-dam and rapid drainage of a glacial lake.

GLACIOFLUVIAL: (i) Pertaining to the channelized flow of glacier meltwater (meltwater streams), and deposits and landforms formed by meltwater streams.

GLACIOFLUVIAL MATERIALS*: Sediments that exhibit clear evidence of having been deposited by glacial meltwater streams either directly in front of, or in contact with, glacier ice; most commonly sands and gravels*.

GLACIOLACUSTRINE: Pertaining to glacial lakes.

GLACIOLACUSTRINE MATERIALS*: Sediments deposited in or along the margins of glacial lakes; primarily fine sand, silt and clay settled from suspension or from subaqueous gravity flows (turbidity currents), and including coarser sediments (e.g., ice-rafted boulders) released by the melting of floating ice; also includes littoral sediments (e.g., beach gravels); accumulated as a result of wave action.

GLACIOMARINE: Pertaining to processes, sediments and landforms associated with glacier termini in marine waters, such as receding glaciers in fiords and ice shelves.

GLACIOMARINE MATERIALS*: Sediments of glacial origin laid down from suspension in a marine environment in close proximity to glacier ice, and deposits of submarine gravity flows; includes particles released due to the melting of floating ice and ice shelves; primarily fine sand, silt and clay, and stony muds; marine shells or shell casts may be present.

GLACIOMARINE DRIFT: Sediments deposited in a glaciomarine environment; includes well-sorted clays, silts sands and gravels, stony muds, and diamictons.

GRADING: An engineering term pertaining to the degree of sorting by size of particles in a clastic sediment or sedimentary rock; sandy and gravelly materials with a wide range of particle sizes are termed WELL GRADED; material with a small range of sizes is POORLY GRADED. (Note that these terms are the reverse of the geological expressions "well sorted" and "poorly sorted".

GRAVEL: (i) An accumulation of rounded pebbles. (ii) An accumulation of rounded particles that includes at least two of the size classes represented by pebbles, cobbles and boulders; may include interstitial sand*.

GREY TONES: The various shades of grey that appear on an air photo; any density or shade between and including absolute white and absolute black that is registered by the land surface on a non-coloured air photo or photographic negative.

GRAVITY FLOWS (SUBAQUEOUS): Downslope flow of a dense mixture of water and sediment; commonly generated by subaqueous slumping of deltas.

GROUND CHECKING: Field work carried out to assess the correctness of air photo interpretation or other sources of information; see also field check.

GROUND MORAINE: A plain or very gently undulating area underlain by till.

GROUND TRUTHING: See ground checking.

GRUS: The fragmental products of in situ granular disintegration of coarse crystalline rocks, especially granitic rocks.

GULLY: A small valley or ravine, longer than wide, and typically from a few metres to a few tens of metres across.

GULLY EROSION*: Formation of gullies in surficial materials and/or bedrock by a variety of processes including erosion by running water; erosion as a result of weathering and the impact of falling rocks, debris slides, debris flows and other types of mass movement; and erosion by snow avalanches.

HANGING VALLEY: A tributary valley whose floor is higher than that of the trunk valley in the vicinity of their junction; most commonly applied to glacial troughs..

HOLOCENE EPOCH: The most recent interval of geological time; from approximately 10,000 years ago to present; similar to postglacial time.

HUMIC*: A textural descriptor applied to organic materials; refers to material at an advanced stage of decomposition; it has the lowest amount of fibre, the highest bulk density, and the lowest saturated water-holding capacity of the organic materials; fibres that remain after rubbing constitute less that 10% of the volume of the material.

HUMMOCKS*: Steep-sided hillocks and hollows, non-linear and chaotically-arranged, and with rounded or irregular cross-profiles; slopes are between 15 and 35° (26-70%) on surficial materials and between 15 and 90° (more than 26%) on bedrock*.

HUMMOCKY MORAINE: A moraine consisting of an apparently random assemblage of knobs, kettles, hummocks, ridges, and depressions; see ablation moraine.

HYDROLOGY: The scientific study of the distribution and characteristics of water at and close to the earth's surface.

HYDROLOGIC FEATURES (LOCAL)*: Refers to water-related features visible at the land surface, such as stream channels, see page zones, springs, and soil moisture, including soil moisture characteristics as deduced from vegetation characteristics.

HYPSITHERMAL: Early to mid-Holocene warm interval; also referred to as "xerothermic interval" and "climatic optimum"; in British Columbia, warm interval commenced at or shortly after deglaciation; dates reported for end of warm interval are not consistent, and vary from about 6000 to about 2500 years ago.

ICE-DISINTEGRATION MORAINE: A moraine resulting from the accumulation of ablation till and other drift on top of stagnant ice; similar to hummocky moraine and ablation moraine.

ICE-CONTACT: Pertains to sediments deposited against, on top of, or in tunnels underneath a glacier or Ice sheet.

ICE-RAFTED STONES: Stones dropped into glaciolacustrine and glaciomarine sediments from melting icebergs.

ICE SHEET: A continental-scale, more or less continuous cover of land ice that spreads outward in all directions and is not confined by underlying topography.

ICE SHELF: A floating tabular mass of ice at the margin of, an attached to, an lee sheet.

ICE-WEDGE CASTS: Infilled cavities formerly occupied by ice wedges; cavities are vertical and taper downward; width at the top is typically between a few centimetres and a metre, and the vertical dimension of most cavities is greater than their width; used as indicators of former periglacial conditions.

INACTIVE (STATUS)*: A qualifying descriptor (superscript) used to indicate that a material is not undergoing deposition at the present time*. See Howes and Kenk (1988) for further information*.

INTERMEDIATE AXIS: See shape of clasts.

INTERSTITIAL: Pertaining to the INTERSTICES (pore spaces) of a particulate sediment.

INUNDATION*: Applied to areas seasonally or occasionally covered by water.

INVENTORY MAPPING: Mapping carried out systematically over large areas in order to record the characteristics of some component of the environment, such as terrain. Mapping is oriented toward compilation of a data base for future use, rather that some specific objective.

IRREGULAR CHANNEL: Refers to streams with an irregularly sinuous channel; channel displays irregular turns and bends without repetition of similar features.

ISOSTACY: The condition of equilibrium of the lithosphere above the asthenosphere; gradual depression or elevation of the earth's surface due to the addition or removal of ice sheets is termed GLACIOISOSTACY.

JoKULHLAUP: An Icelandic term in general usage for glacier outburst flood.

KAME: Irregular or conical hillocks composed chiefly of sand and gravel; formed by deposition of meltwater-transported sediments in contact with (against, within, or upon) stagnant glacier ice; a type of glaciofluvial deposit.

KAME DELTA: A delta of sand and gravel constructed in contact with (against or on top of) glacier ice; commonly a conspicuous terrace-like landform bounded by a steep ice-contact face or by hummocky collapsed ground; a type of glaciofluvial deposit.

KAME TERRACE: A terrace of drift, chiefly sand and gravel, deposited by meltwater in a depression between a melting glacier and the adjacent valley side, and left as a terrace when the glacier melted; the terrace is commonly irregular or fragmentary, and shows topographic and stratigraphic evidence of collapse; a type of glaciofluvial deposit.

KAME-AND-KETTLE TOPOGRAPHY: Hummocky topography with enclosed depressions, commonly resulting from ice stagnation, and underlain by ablation till and ice-contact glaciofluvial materials.

KARST: Pertains to landforms and processes associated with dissolution of soluble rocks such as limestone, marble, dolomite, or gypsum; characterized-by underground drainage, caves, and sinkholes.

KARST DEPRESSION: A depression resulting from solution of bedrock and/or collapse of the land surface into underground cavities.

KARST PROCESSES: Processes associated with the solution of carbonate bedrock and other soluble rock; includes surface and underground weathering, and collapse and subsidence*.

KETTLE: A closed depression or hollow in glacial drift which has resulted from the melting of a buried or partly buried mass of glacier ice; common in glaciofluvial deposits.

KETTLED: Surficial materials with kettles.

KETTLED OUTWASH: Outwash plain with kettles.

LACUSTR1NE: Pertaining to a lakes.

LACUSTRINE MATERIALS*: Sediments that have settled from suspension or underwater gravity flows in lakes; also includes littoral sediments (e.g., beach gravels) accumulated as a result of wave action.

LAG DEPOSIT: Residual deposit of coarse material from which the fine fraction has been removed by wind or water; lag gravel.

LAMINAE, LAMINATlONS: A sedimentary sequence within which most individual beds are thinner than about 1 cm.

LANDFORM: Any physical, recognizable form or feature of the earth's surface, having a characteristic shape, and produced by natural processes.

LANDSCAPE: A particular part of the earth's surface, such as can be seen from a vantage point or examined on an air photo, and the various landforms and other physical features which together make up the field of view.

LANDSLIDE: A general term for the downslope movement of large masses of earth material and the resulting landforms.

LANDSLIDE HEADSCARP: The relatively steep slope, commonly arcuate in plan, that forms the upper part of a landslide scar.

LANDSLIDE HEADWALL: See landslide headscarp.

LANDSLIDE SCAR: The part of a slope exposed or visibly modified by detachment and downslope movement of a landslide; Usually lies upslope from the displaced landslide material; commonly a steep, concave slope.

LAPILLI: Volcanic ejecta; typically small broken fragments or cinders of 2 to 64 mm diameter.

LARGE SCALE MAP: Maps on which earth surface features appear relatively large; e.g., 1 :10,000.

LATE-NEOGLACIAL (INTERVAL): See Little Ice Age.

LATERAL MORAINE: A ridge built along the side of a valley glacier.

LATERAL SPREAD: A type of gravitational (mass movement) process in which movement in dominantly lateral extension accompanied by shear or tensile fractures.

LEVEE (NATURAL): A naturally formed, elongate ridge or embankment of fluvial sediments built up alongside a stream channel.

LIMESTONE PAVEMENT: A more or less horizontal exposure of limestone, usually coinciding with a bedding plane and consisting of irregular blocks separated by deep clefts formed by the widening of joints by solution.

LITHIFY: To turn into rock; e.g., cementation of sediments and solidification of magma.

LITHOFACIES: A unit of sediments or sedimentary rock that contains a record of a particular environment of deposition.

LITHOFACIES CODE: A system for the description of lithofacies; c.f:, Eyles et al., (1983).

LITHOLOGY: The characteristics of a rock; commonly used to refer to rock type.

LI1lLE ICE AGE: The interval of relatively cool/moist climate that occurred during the 1 5th to 1 9th centuries and during which most mountain glaciers attained their greatest size since the last Pleistocene glaciation; see also Neoglaciation.

LI1TORAL: Pertaining to the shore of a water body.

LODGEMENT TILL: Material that accumulates at the base of a moving glacier; typically highly consolidated.

LOESS: A homogeneous, nonstratified, not indurated, yellowish to buff-coloured wind borne deposit consisting predominantly of silt-sized particles with subordinate amounts of fine sand and clay, porous and permeable, commonly with incipient vertical joints.

MARGINAL NOTES: Text placed in the margin of a map or diagram.

MARGINAL INFORMATION: Information such as scale, map legend, notes, magnetic declination, etc. that appears in the margin of a large map.

MARINE MATERIALS*: Sediments deposited in the ocean by settling from suspension and by submarine gravity flows, and sediments accumulated in the littoral zone due to wave action .

MARL: Soft calcium carbonate, usually mixed with varying amounts of clay and other impurities; may include fossils.

MASS MOVEMENT: A general term for downslope gravitational movement of earth materials by processes such as rockfall and debris slides.

MASS WASTING: (i) A general term for a variety of processes, including weathering and erosion, that together effect reduction of slopes and lowering of the land surface. (ii) See mass movement.

MASSIVE: Rocks or sediments without stratification, bedding, flow-banding, or foliation.

MATERIAL: See surficial material.

MATRIX: The groundmass of smaller grains in which larger particles are supported.

MEANDERING CHANNEL: Refers to a stream channel characterized by meanders.

MEANDERS: Regular and repeated of bends of similar amplitude and wave length along a stream channel.

MEDIAL MORAINE: A morainal ridge in the middle of a glacier, parallel to the direction of glacier flow, and formed by the union of lateral moraines of two coalescing glaciers.

MELTOUT TILL: Material that accumulates directly by meltout from stationary or stagnant glacier ice; may accumulate on top of the ice (SUPRAGLACIAL MELTOUT TILL) or underneath the ice (BASAL MELTOUT TILL).

MELTWATER CHANNEL: A channel or a valley formed or followed by a glacial meltwater stream; according to their position, they are divided into ice-marginal (lateral) channels, subglacial channels, and so on.

MESIC: A textural descriptor applied to organic materials. Material is at a stage of decomposition that is intermediate between fibric and humic*.

MIXED FRAGMENTS*: A mixture of rounded and angular particles greater than 2 mm in size*.

MICRORELIEF: Small or relatively small topographic features; generally less than 1 meter in amplitude.

MIDDEN: A heap or stratum of cultural ref se (broken tools, shells, ashes, etc.) normally found on the site of an historic or prehistoric settlement.

MODERATE SLOPE*: A planar surface sloping at 16 to 26° (28-50%)$.

MODERATELY STEEP SLOPE*: A planar surface sloping at between 27 and 35° (51-70%).

MORAINE: (i) A landform that consists of till or, less commonly, of other drift; it exhibits a variety of shapes, ranging from plains to mounds and ridges, that are initial constructional forms independent of underlying bedrock or older materials. (ii) See till*.

MORAINE RIDGES$: Refers to major moraines, such as end moraines, lateral moraines, and recessional moraines, and small moraines, such as washboard moraine.

MORPHOLOGY: The three-dimensional shape or geometry of a landform or other feature.

MUD: (i) Soft, wet, sticky or slippery mixture of water and predominantly fine-textured sediments. (ii) A textural term used to refer to silt, clay, or a mixture of silt and clay.

MUDFLOW: A debris flow consisting predominantly of mud.

MYLAR: A semi-transparent medium onto which maps are photographed and/or drafted; can be used to reproduce black- or blue-line copies of maps and diagrams; also used for overlays on air photos;

NATURAL MOISTURE CONTENT: The moisture content of soil or surficial material at the time a sample was collected.

NEOGLACIAL INTERVAL, NEOGLACIATION: The episode of relatively cool/moist climate during the later part of the Holocene Epoch during which glaciers were more extensive than during the earlier part of the Holocene (see Hypsithermal. In British Columbia, three Neoglacial advances have been recognized, approximately 6000-5000, 3400-2200 yr BP and since about 1000 yrs ago; the most recent of these intervals is the Little Ice Age.

NEOGLACIAL MORAINE: Moraines formed during the Neoglacial interval; includes the fresh Little Ice Age (late-Neoglacial) moraines that adjoin many modern glaciers.

NIVATION: Enlargement of hollows occupied by snowbanks due to erosion of bedrock and/or surficial materials by a variety of processes, including freeze-thaw, chemical action of meltwater, solifluction, and snow creep; snow-patch erosion.
OBSERVATION SITES: Sites at which field checks are carried out.

ON-SITE SYMBOLS*: Symbols used on terrain maps to represent features that cannot be adequately shown as terrain polygons. Some of these represent linear features, such as eskers and strandlines, others represent landforms of significance for glacial history, such as glacial lineations and lateral moraines.

ORGANIC MATERIALS: Sediments formed by the accumulation of decaying vegetative matter, such as peat.

ORTHOPHOTOS: Images based on air photos but which are true to scale and free of distortion; orthophotos resemble air photos but, in fact, are maps.

OUTWASH: Glaciofluvial sediments deposited by glacial meltwater downstream from a glacier.

OUTWASH PLAIN: A flat or very gently sloping surface underlain by glaciofluvial sediments.

OVERBURDEN: (i) Barren material overlying an economic mineral deposit that must be removed before mining. (ii) The upper part of a soil or sedimentary deposit that causes the consolidation of the material below. (iii) Soil and surficial material that overlies bedrock.

OVERLAY MAPS: Maps presented on a transparent medium so that they can be placed over and viewed in conjunction with information on other maps at the same scale.

PALEOSOL: A soil buried by younger surficial materials.

PARTICLE SIZE ANALYSIS: Determination of the grain size composition of a sediment by laboratory analysis.

PATTERNED GROUND: Land surface with distinctive arrangement of stones or microtopography due to the effects of ground freezing and seasonal frost; characteristic of periglacial environments; includes stone stripes, sorted circles and tundra polygons.

PEAT: Black or brown, partly decomposed, fibrous vegetative matter that has accumulated in a waterlogged environment such as a bog.

PEBBLE: (i) A rock fragment between 2 and 64 mm intermediate diameter (Wentworth scale). (ii) A rounded rock fragment between 2 and 64 mm diameter*.

PEDOLOGIST: A scientist who studies the soil.

PEDOLOGY: The science of the soil.

PERIGLACIAL: Pertaining to cold climates, such as in arctic and alpine areas.

PERIGLACIAL PROCESSES*: Solifluction, cryoturbation and nivation occurring within the same terrain polygon* .

PERMAFROST: Material in which temperature has remained below 0°C continuously for at least 2 years, regardless of type of material or water content; a thermal condition.

PERMAFROST PROCESSES*: Processes controlled by the presence of permafrost and permafrost aggradation or degradation in moist surficial materials.

PERMEABLE: A material through which water can pass.

PHYSIOGRAPHY: Pertains to the factors that influence the development of landforms or a landscape, such as relief and topography, bedrock geology and structure and geomorphological history.

PHYSIOGRAPHIC REGION: An area of similar relief and topography, bedrock geology and structure, geomorphological history and landforms.

PIPING: Subsurface erosion of particulate materials by flowing water, resulting in the formation of underground caves and conduits and the development of collapse depressions at the land surface.

PIPING DEPRESSION*: A small enclosed depression formed by collapse of the land surface associated with piping.

PITTED OUTWASH (PLAIN): A outwash plain with kettles.

PLAIN: (i) A level or very gently sloping planar surface with gradient up to 3° (5%); local relief is less than 1 m*. (ii) An extensive region of comparatively smooth and level or gently undulating land, having few or no prominent surface irregularities, and usually at a low elevation with reference to surrounding areas.

PLEISTOCENE: An epoch of the Quaternary Period, after the Pliocene of the Tertiary and before the Holocene; characterized by repeated glacial and non-glacial intervals, also, the corresponding worldwide series of rocks.

POLYGON BOUNDARY LINES: The lines that delineate polygons on a terrain map or other map; solid, dashed and dotted lines are used to represent definite, indefinite and assumed boundaries.

PORE SPACES: The spaces between the particles of detrital sediments that are not occupied by mineral matter.

POROSITY: The amount of pore space present, expressed as a percentage of the total volume of the - material.

POSTGLACIAL: Pertaining to the time interval since the disappearance of glaciers or an ice sheet from a particular area; similar to Holocene Epoch.

PRETYPING*: The process of preliminary terrain mapping on air photos prior to field work*.

PRESENTATION MAP: The completed map in its final form.

PRESENTATION SCALE*: The scale of the presentation map.

PRINCIPLE POINT: The point where a perpendicular projected through the centre of the camera lens intersects the photo image.

PYROCLASTIC SEDIMENTS (MATERIALS): A general term applied to detrital volcanic materials that have been explosively or aerially ejected from a volcanic vent, such as ash and cinders.

QUATERNARY PERIOD: The most recent geological time period; subdivided into the Pleistocene and Holocene (Recent) Epochs; currently defined as beginning about 1.6 million years ago.

QUATERNARY DEPOSITS (MATERIALS): Sediments deposited during the Quaternary Period; similar to surficial materials.

RAISED DELTA: A delta now standing above the level of the water body into which is was deposited; commonly resembles a terraces, with the terrace top marking the former water level.

RAPID MASS MOVEMENT: Rapid downslope movement of earth material by falling, rolling, sliding or flowing; includes rockfall, debris flows, and rapid landslides*.

RECESSIONAL MORAINE: An end moraine built during a temporary but significant halt or minor re-advance of the ice front during a period of overall glacial recession.

REGOLITH: The mantle of loose material that overlies bedrock; includes weathered rock, soil and surficial materials

RIDGES*: Elongate hillocks with slopes dominantly between 15 and 35° (26-70%) on unconsolidated materials and steeper on bedrock; local relief is greater than 1 m*.

RIVER TERRACE: A more or less flat surface bounded downslope by a scarp and resulting from fluvial erosion and deposition. Same as fluvial terraces and alluvial terraces.

ROCHE MOUTONNEE: A knob of rock with a whale-back form, the long axis of which is oriented parallel to former ice flow, and having a smooth, glacially-abraded stoss (up-flow) slope and a much steeper and rougher, glacially-plucked lee slope.

ROCK AVALANCHE: Rapid downslope movement of a large mass of rock fragments derived from bedrock; the rock fragments in motion, although not saturated, take on the character of a (dry) flow and are highly mobile; typically the result of very large rock falls and rock slides.

ROCK CREEP: Slow downslope movement of rock fragments; commonly associated with the presence of interstitial ice and/or solifluction.

ROCK FALL: The relatively free falling or precipitous movement of a newly detached fragment of bedrock of any size from a cliff or other very steep slope; it is the fastest form of mass movement.

ROCK GLACIER: A tongue shaped or lobate, ridged accumulation of angular fragments containing interstitial ice which moves slowly downslope; morphologically similar to a glacier.

ROCK SLIDE: Rapid or slow downslope movement of a large mass of rock by sliding along one or more well defined surfaces of rupture.

ROLLING (SURFACE EXPRESSION)*: Elongate hillocks with slopes dominantly between 3 and 15° (5 and 26%) with local relief greater than I m.

ROUNDNESS OF CLASTS: Pertains to the sharpness or degree of rounding of the edges of clasts; commonly described by the terms: ROUNDED, SUBROUNDED, SUBANGULAR, and ANGULAR.

RUBBLE: (i) Angular rock fragments. (ii) Angular particles between 2 and 256 mm; may include interstitial sand*.

SACKUNG: On mountainsides, trenches and uphill-facing scarps trending parallel to contours and developed as a result of gravitational movement.

SAND: A detrital particle having a diameter in the range of 1/16 to 2 mm.

SAPROLITE: A soft, earthy, clay-mineral-rich product of chemical weathering of igneous and metamorphic rocks.

SCARP: See escarpment.

SCREENED MYLAR: Linework on a screened mylar map appear grey. If terrain information is then drafted onto a screened base map, subsequent prints will show base map information in grey and terrain information in black, thereby avoiding confusion between base map and terrain information.

SEEPAGE ZONE: An area where soil is saturated due to emerging ground water.

SEISMIC: Pertaining to earthquakes.

SEISMIC ZONATION: (i) Broad subdivision of a province or country into regions of similar susceptibility to earthquakes. (ii) Subdivision of an area according to types of surface materials and their properties with regard to seismic shaking, location of faults, etc., commonly termed MICRO-ZONATION.

SHAPE OF CLASTS: The shape of clasts as defined by the relative lengths of their a (long), b (intermediate) and c (short) axes; terms such as spherical (a=b=c) and discoid (a=b>c) refer to clast shape.

SILT: A detrital particle having a diameter in the range of 11256 to 1/16 mm (0.004 to 0.0625 mm).

SIMPLE TERRAIN UNIT/POLYGON: A terrain polygon consisting of a single type of basic element; a single type of terrain; e.g., "Mv".

SINKHOLES: A funnel shaped depression in the land surface that communicates with a subterranean passage developed by solution; common in limestone and karst regions: also applied to similar features caused by piping.

SLOPE BREAK: The point on a slope where gradient changes rather abruptly.

SLOPE FAILURE: Rupture and collapse, or flow, of surficial materials, soil, or bedrock due to shear stress exceeding the shear strength of the material.

SLOPE PROCESSES: Mass movement processes, such as debris slides, and surface wash whereby fine sediments are transported downslope by overland flow.

SLOPE STABILITY: Pertains to the susceptibility of slope to landslides and the likelihood of slope failure.

SLOPE WASH: Fine sediments, on or at the foot of hillsides, that have been moved down slope by overland flow.

SLOW MASS MOVEMENT*: Slow, usually imperceptible, downslope movement of masses of surficial material or bedrock by creeping, flowing or sliding; slow slope failure*.

SLUMP: A landslide characterized by a shearing and rotary movement of a cohesive mass of rock or earth along a concave, Upwardly curved slip surface; ROTATIONAL SLUMP.

SLUMP-EARTHFLOW: A complex landslide displaying characteristics of a slump in its headward zone, and characteristics of an earthflow in its downslope zone.

SLUMP STRUCTURE: Warped or faulted bedding or stratification within a deposit, resulting from downslope movement due to gravity since deposition.

SMALL SCALE MAPS: Maps on which earth surface features appear relatively small; e.g., 1:250,000.

SNOW AVALANCHE: See avalanche.

SOIL: The natural medium for growth of land plants; the result of the combined effects of physical, chemical and biological processes.

SOIL (ENGINEERING): See surficial materials, Quaternary materials..

SOIL CREEP: Slow (imperceptible) downslope movement of soil.

SOIL DRAINAGE*: Refers to the rapidity and extent of water removal from the soil in relation to additions, especially by surface runoff and by percolation downwards through the soil.

SOIL HORIZON: A zone in the soil that is generally parallel to the land surface and distinguished from zones above and below by characteristic physical properties, such as colour, structure and texture, and soil chemistry.

SOIL MOISTURE: The water content of the soil in its natural state.

SOIL PIT: A pit excavated for the purpose of examining the soil; most commonly dug by hand using shovels, and usually less than I m deep.

SOIL SURVEYS: (i) Mapping the distribution of soil types; requires air photo interpretation and field work by pedologists. (ii) Assessing the engineering properties of surficial materials, such as bearing strength and plasticity, at a site or in an area where construction is proposed. (iii) Collecting soil or surficial material samples for geochemical analysis for the purposes of mineral exploration; a component of drift prospecting.

SOIL TYPE: (i) In a general sense, pertains to classes of soil defined according to soil horizons present and horizon thickness. (ii) A subclass of the Canadian soil classification system that is no longer in use.

SOLIFLUCTION: Slow downslope movement of moist or saturated, seasonally frozen surficial material and soil.

SOLUTION: The process of dissolving.

SORTING: A geological term pertaining to the variability of particle sizes in a clastic sediment or sedimentary rock; materials with a wide range of particle sizes are termed POORLY SORTED; material with a small range of sizes is WELL SORTED. (Note that these terms are the reverse of the engineering expressions "well graded" and "poorly graded".

STAGNANT ICE: Part of a glacier or ice sheet within which ice is no longer flowing; stationary ice; usually melting by downwasting.

STEEP SLOPE*: A planar surface steeper than about 35° (70%)*.

STEREOPAIR: Two adjacent photos from a flight line; can be viewed simultaneously under a stereoscope to obtain a three-dimensional image.

STEREOPLOTTER: An instrument used for transferring mapped data from air photos to maps.

STEREOSCOPE: An instrument used for obtaining a three-dimensional view of overlapping pairs of air photos.

STEREOSCOPIC FIELD OF VIEW: The overlapping parts of a stereopair that can be seen in three dimensions under a stereoscope.

STRANDLINE: An abandoned shoreline.

STRATIFICATION: Horizontal or inclined structure in a sedimentary unit that results from its mode of deposition; includes beds, laminae, abrupt and gradual textural changes, and orientation and concentrations of particles.

STRATIGRAPHIC UNIT: A bed or series of beds with characteristics that differ from those of overlying and underlying materials; a subdivision of a larger sequence of sediments or sedimentary rock..

STRIAE, STRIATIONS: Fine cut lines (scratches) on the surface of bedrock or clasts formed by glacial abrasion; oriented parallel to former ice-flow direction; more than one ice-flow directions may be represented by criss-crossing striae..

STRUCTURE: See geological structure.

SUBGLACIAL: Pertaining to the area underneath a glacier or the base of a glacier.

SUBGLACIAL TILL: Material that accumulates directly from melting ice at the base of a glacier; includes basal till and lodgement till.

SUPRAGLACIAL: Pertaining to the upper surface of a glacier

SURFACE EXPRESSION*: Refers to small topographic features and landforms that are not usually shown adequately on a topographic map, and to the relation of a surficial material to the underlying surface; terminology, such as "terrace", "cone", is defined in a non-genetic sense.

SURFICIAL DEPOSITS (MATERIALS): Relatively young, non lithified sediments, usually of Quaternary age; usually classified as to their genesis, hence fluvial sediments, colluvium, glaciolacustrine sediments, etc.

SURFICIAL GEOLOGY: Geology of surficial deposits.

SURFICIAL GEOLOGY MAP: A map that shows the types and distribution of surficial materials in a chronostratigraphic framework.

SURVEY INTENSITY (LEVEL): Expresses the relation between map scale and the amount off field checking carried out during preparation of a terrain map.

TALUS: Angular rock fragments accumulated at the foot of a steep rock slope and being the product of successive rock falls; a type of colluvium.

TALUS SLOPE: A slope of about 35°, the natural angle of rest of non-cohesive rock fragments, and underlain by talus; usually located at the foot of a rock slope that is steeper than 35°.

TENSION CRACKS: Open fissures in bedrock or surficial materials resulting from tensile stress; typically located at or near the crest of a steep slope, and indicative of potential slope failure.

TEPHRA: A collective term for all pyroclastic sediments; all detrital volcanic materials..

TERMINAL MORAINE: The end moraine that marks the furthest point reached by an advancing glacier.

TERRACE: Any relatively level or gently inclined surface, generally less broad than a plain, and bounded along one side by a steeper descending slope or scarp and along the other by a steeper ascending slope or scarp.

TERRACED*: Either one or several step-like forms, each consisting of a scarp face and a horizontal or gently inclined tread upslope*.

TERRAIN: (i) A comprehensive term to describe a tract of landscape being studied with respect to its natural features. (ii) Pertains to maps showing surficial materials, material texture, surface expression, present day geomorphological (geological) processes, and related features*.

TERRAIN ANALYSIS: The process of terrain mapping and interpretation or assessment of terrain conditions for a specific purpose such as construction of logging roads or Urban expansion .

TERRAIN CLASSIFICATION SYSTEM*: A classification of surficial materials, their texture, surface expression, present day geomorphological (geological) processes, and other features, used for mapping.

TERRAIN DATA BASE: Terrain map information and related additional information stored in digital form; may also apply to information on maps and in notebooks.

TERRAIN LEGEND: The legend of a terrain map; usually the symbols for surficial materials, their texture, surface expression, present day geomorphological (geological) processes, and other features are defined individually.

TERRAIN FEATURES*: landforms and related phenomena, such as striations, gravel pits, and fossil sites, shown on a terrain map by on-site symbols.

TERRAIN MAP*: A map showing surficial materials, their texture, surface expression, present day geomorphological (geological) processes, and other features.

TERRAIN POLYGON*: The area enclosed by a boundary line on a terrain map; the basic mapping unit*.

TERRAIN PROCESSES*: Same as geomorphological processes.

TERRAIN STABILITY*: Same as slope stability.

TERRAIN UNIT*: See terrain polygon.

TERRANE: Area of the lithosphere distinguished by a certain assemblage of rock types.

TEXTURE OF SEDIMENTS: Pertains to the grain sizes, shape, and arrangement of particles in a sedimentary unit.

TILL: Material deposited by glaciers and ice sheets without modification by any other agent of transportation. See also basal till, lodgement till, ablation till, flow till, supraglacial till, meltout till.

TILL PLAIN: A level or gently undulating surface underlain by till.

TOR: A small castellated hill of bedrock with open joint planes rising abruptly from a relatively smooth hilltop or slope; comm only surrounded by fallen blocks.

TRANSECT: A section across a region selected to show spatial relations of landforms, vegetation, and/or other features.

TRAVERSE: A survey line; applied to various kinds of surveys, including topographic, geological, soil, and biological surveys.

TRIM MAPS: Terrain Resource Information Management maps: a new series of topographic maps of British Columbia produced by the provincial government; scales: 1:20,000; 1:250,000; 1:2 million.

UNCONFORMITY: A substantial break or gap in the geologic record where a rock unit is overlain by another that is not next in stratigraphic succession, such as an interruption in the continuity of a depositional sequence of sedimentary rocks or a break between eroded igneous rocks and younger sedimentary rocks.

UNCONSOLIDATED MATERIALS: See surficial materials.

UNDIFFERENTIATED MATERIALS*: A layered sequence of more than three types of surficial material outcropping on a scarp slope*.

UNDULATING*: Gently sloping hillocks and hollows with multidirectional slopes generally up to 15° (26%); local relief is greater than 1 m*.

UNIFIED SOIL CLASSIFICATION SYSTEM: Soil classification used by engineers: based on particle size of coarse materials and consistency of fines (silt/clay mixtures).

UTM: Universal Transverse Mercator grid; present on most topographic maps and used for quantitative description of locations.

VALLEY FILL: Surficial materials that fill or partly fill a valley.

VALLEY GLACIER: Glacier confined by valley sides; usually much longer than broad.

VARVES: Sedimentary beds or laminae where annual layers are distinguishable; most commonly present in glaciolacustrine and lacustrine sediments.

VENEER*: A thin mantle of surficial material that does not mask the topographic irregularities of the surface upon which it rests, ranges in thickness from 10 cm to about 1 m*.

VOLCANIC ASH: Pyroclastic material less than 2 mm in size.

VOLCANIC MATERIALS *: Unconsolidated pyroclastic sediments* .

WASHING*: Removal, of fines from a surficial material due to the action of waves or running water; winnowing; results in the formation of lag deposits*.

WATER TABLE: The upper surface of the zone of groundwater saturation in permeable rocks or surficial materials.

WASHBOARD MORAINE: See corrugated moraine.

WEATHERING: The decomposition and disintegration of bedrock in situ due to chemical and physical processes.

WEATHERED BEDROCK*: Bedrock that has decomposed or disintegrated in place due to mechanical and/or chemical weathering*.

WENTWORTH PARTICLE SIZE SCALE: A logarithmic scale for size classification of sediment particles; defines terms such as silt, pebbles, and boulders.

YARDING SYSTEMS: Methods for moving timber from the sites where the trees are felled to sites where they are loaded onto logging trucks; includes high lead, skyline, skidding, and so on.

APPENDIX C

ANNOTATED BIBLIOGRAPHY OF GLOSSARIES

The following references contain glossaries relevant to surficial geology.

Bates, R.L. and J.A. Jackson (editors), 1980. Glossary of Geology, Second Edition, American Geological Institute, Falls Church, Virginia, 751 p.

The most comprehensive dictionary of geological terms covering most terms in use by surficial geologists. This publication is a standard reference for all geologists.

Bird, J.B., 1980. The Natural Landscapes of Canada. John Wiley and Sons, Toronto, Canada, 260 p.

The text provides very brief definitions for over 150 terms. Basic geology, geomorphology and terms emphasizing conditions unique to northern environments comprise this glossary. A number of specialized terms unique to surficial geology are included, but unfortunately the definitions are too brief.

Birkeland, P.W. and E.E. Larson, 1989. Putnam's Geology. Oxford University Press, Toronto, 646 p.

Definitions for approximately 600 general geology terms are included in this text. The text and glossary are aimed at an individuals with an undergraduate level understanding of geology; hence surficial geology terms are very generalized.

Catto, N.R., 1988. Geology 482 Field and Laboratory Manual. Quaternary Research Group, University of Alberta, Edmonton, 215 p.

This text provides detailed definitions for over 300 terms of direct interest to Quaternary geology, surficial mapping and sedimentology. Explanations are lengthy, accurate and useful to those individuals with a significant background in geology. Highly recommended source of information which may be difficult to obtain.

Cormier, C., 1992. Canadian Quaternary Vocabulary. Terminology Bulletin 209. Canada Communication Group, Ottawa, 154 p.

This book is a bilingual terminological publication meant to accompany the Quaternary Geology of Canada and Greenland text. Although the publication covers a number of terms and concepts that deal specifically with North American Quaternary geology, about half are not defined but simply presented in , both languages.

Gartner, J.F., Mollard, J.D. and M.A. Roed, 1981. Ontario Engineering Geology Terrain Study Users' Manual. Ontario Geological Survey, Ministry of Natural Resources, Toronto, 5 I p.

The text provides short, accurate and informative definitions for over 100 terms unique to Quaternary geology and surficial mapping. The explanations are written in simple English suitable for individuals with limited geological training. It is a highly recommended source of information to those interested in mapping terminology.

Howes, D.E. and E. Kenk, 1988. Terrain Classification System For British Columbia. MOE Manual 10. Ministry of Environment, Recreational Fisheries Branch, and Ministry of Crown Lands, Surveys and Resource Mapping Branch, Victoria, 90 p.

This publication provides short definitions for 76 terms of importance to surficial geology mapping. Most of the definitions are abbreviated from "The Glossary of Geology" and are incorporated into the glossary provided above.

Keser, N., 1979. Interpretation of Landforms from Aerial Photographs. Research Branch, Ministry of Forests. Victoria, B.C., 271 p.

The text provides 10 separate glossaries following thematic chapters devoted to air photo interpretation. Numerous terms and lengthy definitions comprise the publication. The compilation is useful for consultation in surficial geology, but the separation into thematic glossaries makes the text cumbersome for the user.

Kupsch, W.O. and N.W. Rutter, 1982. Mineral Terrain Terminology. Technical Memorandum No. 131, National Research Council of Canada, Ottawa, 153 p.

This publication provides over 1500 definitions devoted to surficial geology and mapping. It is intended for non-geologists interested in terrain and landform studies who require easy access to technical literature. Accompanying illustrations clarify many of the terms. The text is highly recommended for all users of surficial geology information.

Mollard, J.D., Landforms and Surface Materials of Canada. Sixth Edition. Commercial Printers Ltd., Regina, 410 p.

Over 2500 terms in the glossary relevant to several disciplines including geology, biology, forestry and pedology. All definitions are lengthy and useful to those with a minor understanding of geology. Some of the explanations are no longer accurate to specialized fields of study.

Mollard, J.D. and J.R. Janes, 1984. Airphoto Interpretation and the Canadian Landscape. Energy Mines and Resources Canada, Ottawa, 413 p.

Approximately 600 definitions of terms of direct relevance to air photo interpretation and landform analysis. Man)' of the entries are of use to surficial geology. The compilation is an updated and shortened version of the earlier version by Mollard.

Sharp, R.P., 1991. Living ice, Understanding Glaciers and Glaciation. Cambridge University Press, New York, 225 p.

The glossary consists of about 400 entries which cover both general geology and terms primarily applicable to glaciology. Many of the terms included are also of direct relevance to surficial geology. The brevity of the definitions makes this compilation of primary use to individuals with limited knowledge in geology.

ADDITIONAL REFERENCES

ASTM Committee E-8 on Nomenclature and Definitions. 1976. Compilation of ASTM Standard Definitions, Third Edition; American Society for Testing and Materials, Easton, MD., 731 p.

Fairbridge, R.W. (Ed.) 1968. The Encyclopedia of Geomorphology. Encyclopedia of Earth Sciences Series, Volume III. Reinhold Book Corporation, New York, 1295 p.

Geological Hazards Recognition Manual. 1996. Geotechnical Materials and Engineering Branch, Ministry of Transportation and Highways. Province of British Columbia

Luttmerding, H.A, Demarchi, D.A., Lea, E.C., Meidinger, D.V. and Vold, T. (Editors). 1990. Describing Ecosystems in the Field, Second Edition; MDE Manual 11. Ministry of Environment and Ministry of Forests, Victoria, B.C. 213 p.

Paine, D.P. 1981. Aerial Photography and image interpretation for Resource Management; John Wiley and Sons, New York. 571 p.

Transportation Research Board. 1978. Landslides, Analysis and Control, R.L. Schuster and R.J. Krizek, Editors; Special Report 176, National Academy of Sciences, Washington, D.C. 234 p.

Washburn, A.L. 1973. Periglacial Processes and Environments; Edward Arnold Ltd., London. 320 p.

Whittow, J.B. 1984. Dictionary of Physical Geography; Penguin Books Ltd., Middlesex, England. 591 p.

APPENDIX D

OTHER SOURCES OF INFORMATION

1) Quaternary Time Scales

Oxygen isotope stages:

Emiliani, C. and Shackleton, N. J., 1974. The Brunhes Epoch: isotopic paleotemperatures and geochronology; *Science*, 183, P. 51 1-514.

Shackleton, N. J. and Opdyke, N. D.1973. Oxygen isotope and paleomagnetic stratigraphy of equatorial Pacific core V28-238: oxygen isotope temperatures and ice volumes on a 105 year and 106 year scale; *Quaternary Research*, 3, p. 39-55.

Shackleton, N. J. and Opdyke, N. D.1976. Oxygen-isotope and paleomagnetic stratigraphy of Pacific core V28-239: Late Pliocene to latest Pleistocene; *In*: investigation of Late Quaternary Paleooceanography and Paleoclimatology, R. M. Cline and J. D. Hays, Editors; *Geological Society of America*, Memoir 145, p. 449-464.

Framework for Canadian Quaternary Stratigraphy:

Fulton, R. J. 1989. Foreword; In: Quaternary Geology of Canada and Greenland, R. J. Fulton, Editor; *Geological Survey of Canada*, Geology of Canada no.1. (Table 2)

2) Wentworth Scale for Particle Size Classification

The Wentworth particle size classification, or grade scale, was proposed by C. K. Wentworth (1922) after the older Udden grade scale. It supplies quantitative definitions for terms such as "boulder" and "sand grain" that describe individual particles, and for terms that refer to aggregates of particles, such as "boulder gravel" and "sand". It remains the grade scale that is most commonly used by geologists and geomorphologists, although somewhat different particle size classifications are used by soil scientists and engineers. The "Phi scale" is a commonly-used modification of the Wentworth system that allows the use of simple whole numbers for class boundaries by applying the logarithmic transform: phi = -log2d, where d is the particle diameter.

The British Columbia terrain classification system (Howes and Kenk, 1988; Section 12) uses Wentworth size classes for the definition of all boundaries for textural classes except the silt-clay boundary, which is set at 0.002 mm, following the Canadian soil classification system. Under the Wentworth system, the silt-clay boundary is 0.004 mm (1/256 mm). Information about "hand texturing", the determination of the sand-silt-clay content of fine sediments by hand tests, is included in Howes and Kenk (1988). The Wentworth scale is described in most physical geology and sedimentology text books and reference books, e.g., Carver (1987).

Carver, R. E. 1978. Wentworth Scale, in: The Encyclopedia of Sedimentology, R. W. Fairbridge and Bourgeois, J., Editors, *Dowden, Hutchinson and Ross, Inc.* Stroudsburg, Pa., p.872-873.

Wentworth, C. K., 1922. A scale of grade and class terms for clastic sediments; *Journal of Geology*, 30: 377-392.

3) Unified Soil Classification

This system of soil (i.e., clastic sediment) classification was developed by A. Casagrande (1948) and utilized by the U.S. Army Corps of Engineers (1953) and the U.S. Bureau of Reclamation (1974). Today it is commonly used by engineers in many countries, including Canada. Coarse textured soils (gravels, sand) are classified according to their particle sizes and particle size distribution. Finer soils are classified as "silt" or "clay" according to their plasticity-compressibility characteristics as determined by consistency tests. Preliminary estimates of soil characteristics for many engineering purposes can be made from tables keyed to the unified soil classes (Van Horn, 1968, reproduced in Costa and Baker, 1981, p. 237-238.). A guide to the field classification of soils (after U.S. Army Corps of Engineers, 1953) is also presented in Costa and Baker (1981, p. 210-211); laboratory procedures for classification are given in ASTM (1980).

ASTM (American Society for Testing of Materials), 1980. 1980 Annual Book of ASTM Standards, Part 19; ANSI/ASTM D 2487 - 69.

Casagrande, A. 1948. Classification and Identification of Soils; *American Society of Civil Engineers*, Transactions, 113, p. 901 -991.

Costa, J. E. and Baker, V. R. 1981. Surficial Geology, Building with the Earth; *John Wiley and Sons*, New York, Toronto, 498 p.

U.S. Army Corps of Engineers, 1953. The Unified Soil Classification System; *U.S. Army Technical Memorandum*, No.3-357.

U.S. Bureau of Reclamation, 1974. Earth Manual; *U.S. Government Printing Office*, Washington, D.C., 810 p.

Van Horn, R. 1968. Physical Property and Construction Use Data Sheet for Surficial Deposits*; Association of Engineering Geologists Bulletin*, 5, p. 18-22.

4) Lithofacies Code

This coding system (Eyles et al., 1983) permits the rapid field description of clastic sediments ranging from well sorted sands and gravels to diamictons. The code is based largely on non-genetic terms that describe texture and structure. It is particularly useful for the rapid or detailed logging of sections or core.

Eyles, N., Eyles, C. H. and Miall, A. D. 1983. Lithofacies types and vertical profile models; an alternative approach to the description and environmental interpretation of glacial diamict and diamictite sequences; *Sedimentology*, 30, p. 393-410.

5) Stratigraphic Code for North America

The code consists of recommendations for the classification and naming of stratigraphic Units. "The prime purpose is (i) to formulate a usefully comprehensive, yet explicit statement of principles and practices for classifying and naming stratigraphic units, and (ii) to secure the greatest possible uniformity in applying these principles and practices."

International Subcommission on Stratigraphic Classification, 1976. International Stratigraphic Guide, Hedberg, H.D., Editor; *John Wiley and Sons*, New York, 200 p.

North American Commission on Stratigraphic Nomenclature, 1983. North American Stratigraphic Code; *American Association of Petroleum Geologists Bulletin*, 67, p. 841 -875.

6) Index of Terrain and Surficial Geology Maps for British Columbia

This publication lists about 2000 surficial geology/terrain maps for B.C. Lists are arranged by NTS map areas, by agencies producing the maps, and by types of maps. A series of maps of the province, showing areas that have been mapped by various agencies at various scales, is also included. This publication is currently under revision and will be updated from time to time. The map index will be available on disk for the second edition.

Bobrowsky, P. T., Giles, T. and Jackaman, W., 1992. Surficial Geology Map Index of British Columbia*; B. C. Ministry of Energy, Mines and Petroleum Resources*, Open File 1992- 13.

7) Bibliography of Quaternary Geoscience Information for British Columbia

This bibliography lists published papers, monographs, maps, theses, and readily available manuscript reports concerned with various aspects of the Quaternary Period in B.C. Lists are arranged alphabetically by author, and by subject headings, such as engineering and environmental geology, geochemistry, geochronology, glaciology, hydrology, regional physiography, seismology, soils, and maps.

Clague, J. J., 1987. Bibliography of Quaternary Geoscience Information for British Columbia; *Geological Survey of Canada*, Open File 1448.

8) References to Standard Analytical Procedures

The Encyclopedia of Sedimentology (Fairbridge and Bourgeois, 1978) contains usefuI descriptions of methods for particle size analysis and other analyses of clastic sediments. See under headings such as "Grain Size Studies", "Granulometric Analysis", Roundness and Sphericity", and "Sedimentological Methods". Additional geochemical analytical procedures appear in Lett (1995).

Fairbridge, R. W. and Bourgeois, J. (Editors) 1978. The Encyclopedia of Sedimentology; *Dowden, Hutchinson and Ross, Inc.*, Stroudsburg.

Lett, 1995. Analytical Methods for Drift Samples; In: Drift Exploration in the Canadian Cordillera, Bobrowsky, P.T., Sibbick, S.J., Newell, J. and Matysek, P.F., Editors, *B.C. Ministry of Energy, Mines and Petroleum Resources*, Paper 1995-2, p. 215-228.

9) Miscellaneous

Fulton, R.J. (Compiler). 1995. Surficial Materials of Canada, Geological Survey of Canada, Map 1 880A, scale 1:S,000,000.

Maurice, L. 1988. Status of Quaternary geology mapping in Canada with bibliography, Geological Survey of Canada, Map 1 704A, scale 1 :7,500,00.

Tarnocai, C., Kettles, I.M. and Ballard, M. 1995. Peatlands of Canada, Geological Survey of Canada, Open File 3152, scale 1:6,000,000.

Permafrost of Canada, 1995. National Atlas of Canada, 5~ Edition, Geological Survey of Canada, scale 1 :7,500,000.

APPENDIX E

DIGITAL DATABASE

The following data model relates to Figure 8 and Tables 11 and 12 in the Guidelines and Standards for Terrain Mapping in British Columbia (this volume). Minimum terrain data requirements are highlighted with an asterisk in the left column.

TASK FORCE: Earth Sciences, Surficial Geology Task Group

PARENT ENTITY: Surficial Geology

ENTITY GROUP: Terrain Map [TERRMAP]

ENTITY GROUP DEFINITION: A Terrain Map shows the distribution of surficial (Quaternary) deposits on the Earth's surface. It also provides information on the characteristics of the surficial materials, landforms and geological and geomorphological processes. Physical properties and conditions of the land surface can be inferred from these data.

ENTITY NAME: General Terrain Map Information [MAPINFO]

ENTITY DEFINITION: General Terrain Map Information identifies the project, the terrain map and report, and the base map. It provides general information on the mapping and the physical setting.

	FIELD/ATTRIBUTE	DATA TYPE	COMMENTS/EXAMPLES/ REFERENCES TO VALUE LISTS
1. Project identification [PROJID]			
*	NAME OF SENIOR MAPPER	Text (String)	
	NAME OF ASSISTANT(S)	Text (String)	
*	AGENCY ORGANIZATION	Text (String)	of mappers
*	PROJECT NAME	Text (String)	
	PROJECT NUMBER	Text (String)	often an alphanumeric mix
	PRIME PURPOSE OF MAPPING	Text (String)	e.g. forestry, urban planning
	CLIENT/AGENCY	Text (String)	
*	MONTH/YEAR OF PUBLICATION	Text (Date)	
	MONTH/YEAR OF REVISION(S)	Text (Date)	
	COMMENTS	Text (String)	
2. Terrain Map/Report Identification [TMRID]			
*	MAP TITLE	Text (String)	
*	MAP LEGEND	Text (String)	
*	MAP MARGINAL NOTES	Text (String)	* if no report
	ABSTRACT	Text (String)	
	REPORT	Text (String)	
	REFERENCES	Text (String)	
	ACKNOWLEDGMENTS	Text (String)	
	ARCHIVAL LOCATION	Text (String)	of original
	COMMENTS	Text (String)	
3. Base Map Identification [BASEID]			
*	NTS MAP NUMBER(S)	Text (String)	NTS or BCGS/TRIM, not both
*	BCGS/TRIM MAP NUMBER	Text (String)	
	OTHER BASE MAP	Text (String)	other than NTS or BCGS/TRIM
	MAP NAME	Text (String)	
*	MAP SCALE	Numeric (Real)	
	MAP DATUM	Text (String)	e.g. NAD 27, NAD 83
	CONTOUR INTERVAL	Numeric (Integer)	

	METRES/FEET	Text (String)	
	RANGE OF LATITUDE (D/M/S)	Numeric (Integer)	
	RANGE OF LONGITUDE (D/M/S)	Numeric (Integer)	
*	MAP NORTH ARROW	Graphic	
*	MAP BAR SCALE	Graphic	
	BASE MAP SYMBOLS	Graphic	
*	INDEX MAP	Graphic	* if no report
	DIGITAL MAP BASE	Text (String)	e.g. ARCINFO, Terrasoft
	ARCHIVAL LOCATION	Text (String)	of Digital Map Base
	COMMENTS	Text (String)	

4. General Mapping Information [GENINFO]

*	MONTH/YEAR OF MAPPING	Text (Date)	
	RG OF MAPPING (LATS) (D/M/S)	Numeric (Integer)	if different than base map
	RG OF MAPPING (LONGS) (D/M/S)	Numeric (Integer)	if different than base map
	RG OF MAPPING (UTM ZONE)	Numeric (Integer)	lat/long or UTM, not both
	RG OF MAPPING (UTM EAST)	Numeric (Integer)	
	RG OF MAPPING (UTM NORTH)	Numeric (Integer)	
	AIRPHOTO (FT LINES & NOS.)	Text (String)	
	YEAR OF AIRPHOTOS	Text (Date)	
	APPROX AIRPHOTO SCALE	Numeric (Real)	
*	TERRAIN SURVEY INTENSITY LEVEL	Text (String)	this document Table 7
	POLYGONS FIELD CHECKED %	Numeric (Integer)	
	FIELD CHECKS/100 HA	Numeric (Integer)	
	COMMENTS	Text (String)	

5. General Physical Setting [PHYSET1]

	PHYSIOGRAPHICAL REGION	Text (String)	Holland, 1976; MOE, 1990
	BIOGEOCLIMATIC ZONE	Text (String)	MOF, 1988; MOE, 1990
	COMMENTS	Text (String)	

CURRENT SOURCES: Ministry of Energy, Mines and Petroleum Resources, Ministry of Environment, Ministry of Forests, Ministry of Transportation and Highways, Forest Companies, and Regional Districts

CUSTODIAN AGENCY: Ministry of Energy, Mines and Petroleum Resources

COMMENTS: Other Entities associated with General Terrain Map information [MAPINFO] in the Terrain Map Entity Group [TERRMAP] include Polygon [MAPPOLY] and Terrain Unit [MAPUNIT]. Surficial Geology Symbols are also related. The Terrain Map Entity Group [TERRMAP] is also associated with the Observation/Sample Site Entity Group [TERRSITE].

ENTITY NAME: Polygon [MAPPOLY]

ENTITY DEFINITION: A **Polygon** is a relatively homogeneous area on a terrain map whose boundaries are delineated by a single, composite or stratigraphic terrain unit.

	FIELD/ATTRIBUTE	DATA TYPE	COMMENTS/EXAMPLES/ REFERENCES TO VALUE LISTS
1. General Polygon Features [POLYFEA]			
*	POLYGON LOCATION	Graphic	

*	BOUNDARY LINE TYPE	Graphic	e.g. solid, dashed, dotted
	POLYGON NUMBER	Numeric (Integer)	
	COMMENTS	Text (String)	

CURRENT SOURCES: Ministry of Energy, Mines and Petroleum Resources, Ministry of Environment, Ministry of Forests, Ministry of Transportation and Highways, Forest Companies, and Regional Districts

CUSTODIAN AGENCY: Ministry of Energy, Mines and Petroleum Resources

COMMENTS: Other Entities associated with Polygon [MAPPOLY] in the Terrain Map Entity Group [TERRMAP] include General Terrain Map Information [MAPINFO] and Terrain Unit [MAPUNIT]. Surficial Geology Symbols are also related. The Terrain Map Entity Group [TERRMAP] is also associated with the Observation/Sample Site Entity Group [TERRSITE].

ENTITY NAME: Terrain Unit [MAPUNIT]

ENTITY DEFINITION: A **Terrain Unit** is a basic surficial element consisting of one kind of material formed by a single geological process and forming one kind of landform. If single terrain units are too small to delineate as a polygon, two or at the most three terrain units, collectively referred to as a composite terrain unit, may be grouped together. If stratigraphy is mappable, a terrain unit may include up to two stratigraphic units.

	FIELD/ATTRIBUTE	DATA TYPE	COMMENTS/EXAMPLES/ REFERENCES TO VALUE LISTS
1. Single Terrain Unit [SIUNIT1]			
	TERTIARY TEXTURE	Text (String)	Howes and Kenk, 1988
	SECONDARY TEXTURE	Text (String)	Howes and Kenk, 1988
*	DOMINANT TEXTURE	Text (String)	Howes and Kenk, 1988
*	TYPE OF MATERIAL (GENESIS)	Text (String)	Howes and Kenk, 1988
	QUALIFYING DESCRIPTOR	Text (String)	Howes and Kenk, 1988
*	LANDFORM/SURFACE EXPRESS	Text (String)	Howes and Kenk, 1988
*	GEOLOGICAL PROCESS	Text (String)	Howes and Kenk, 1988
2. Composite Terrain Units [CTUNIT1]			
	DOMINANT TERRAIN UNIT	Text (String)	refer to Single Terrain Unit
	PROPORTION (=,/,//)	Graphic	
	SECONDARY TERRAIN UNIT	Text (String)	refer to Single Terrain Unit
	PROPORTION (=,/,//)	Graphic	
	TERTIARY TERRAIN UNIT	Text (String)	refer to Single Terrain Unit
3 Stratigraphic Terrain Unit [STUNIT1]			
	TERRAIN UNIT AT SURFACE	Text (String)	refer to Single Terrain Unit or Composite Terrain Unit above
	UNDERLYING UNIT	Text (String)	refer to Single Terrain Unit or Composite Terrain Unit above

CURRENT SOURCES: Ministry of Energy, Mines and Petroleum Resources, Ministry of Environment, Ministry of Forests, Ministry of Transportation and Highways, Forest Companies, and Regional Districts.

CUSTODIAN AGENCY: Ministry of Energy, Mines and Petroleum Resources

COMMENTS: Other Entities associated with Terrain Unit [MAPUNIT] in the Terrain Map Entity Group [TERRMAP] include General Terrain Map Information [MAPINFO] and Polygon [MAPPOLY]. Surficial Geology Symbols are also related. The Terrain Map Entity Group [TERRMAP] is also associated with the Observation/Sample Site Entity Group [TERRSITE].

ENTITY NAME: General Observation/Sample Site Information [SITEINFO]

ENTITY DEFINITION: **General Observation/Sample Site Information** identifies the observer/sampler, the date and the specific location of the observation/sample collection, plus references to photographs, sketches, sketch maps, cross-sections and pre-existing data associated with the site. In addition, general information on physical setting is recorded.

	FIELD/ATTRIBUTE	DATA TYPE	COMMENTS/EXAMPLES/ REFERENCES TO VALUE LISTS
1. General Information [GENINFO]			
*	NAME OF OBSERVER/SAMPLER	Text (String)	
*	DATE OF OBSERVATION/SAMPLE	Text (Date)	
	TRAVERSE NUMBER	Numeric (Integer)	
	METHOD OF TRAVERSE	Text (String)	
	COMMENTS	Text (String)	
2. Specific Location [SPECLOC]			
*	OBSERVATION/SAMPLE SITE NO	Numeric (Integer)	
	GEOGRAPHIC LANDMARK	Text (String)	e.g. proximity to a creek, hill top
	NTS MAP NUMBER	Text (String)	NTS or BCGS/TRIM, not both
	BCGS/TRIM MAP NUMBER	Text (String)	
*	LATITUDE (D/M/S)	Numeric (Integer)	seconds or tenths of minutes
*	LONGITUDE (D/M/S)	Numeric (Integer)	seconds or tenths of minutes
*	UTM GRID ZONE	Text (String)	lat/long or UTM, not both
*	UTM EASTING	Numeric (Integer)	
*	UTM NORTHING	Numeric (Integer)	
	UTM LOCATION TO NEAREST	Numeric (Integer)	e.g. 10 m, 100m, 1000m
	OTHER LOCATION DATA	Text (String)	e.g. Reg. Municipality, TFL
	LEGAL DESCRIPTION	Text (String)	
	AIRPHOTO (FT LINE & NO)	Text (String)	
	APPROX AIRPHOTO SCALE	Numeric (Real)	
	COMMENTS	Text (String)	
3. Visual Data (Photographs/Sketches/Sketch Maps/Cross-Section) [VISUALS] (use multiple entries as required)			
*	PHOTO ROLL NUMBER	Numeric (Integer)	* if photo taken
*	PHOTO EXPOSURE NUMBER	Numeric (Integer)	* if photo taken
	SKETCH NUMBER	Numeric (Integer)	
	SKETCH MAP NUMBER	Numeric (Integer)	
	CROSS SECTION NUMBER	Numeric (Integer)	
	CAPTION/SHORT DESCRIPTION	Text (String)	
	PHOTOGRAPHER/SKETCHER	Text (String)	
	DATE	Text (Date)	if different than observation date
	ARCHIVAL LOCATION	Text (String)	
	COMMENTS	Text (String)	

4. Reference to Pre-existing Data [PREEXIST] (use multiple entries as required)

	REFERENCE	Text (String)	Reference to other reports, studies in vicinity of Observation/Sample site
	ARCHIVAL LOCATION	Text (String)	
	COMMENTS	Text (String)	e.g. Geotechnical, Water well, Bedrock, Agricultural, Wildlife

5 Physical Setting [PHYSET2]

	BRIEF DESCRIPTION	Text (String)	
*	ELEVATION (m)	Numeric (Integer)	
*	MEASURED/ESTIMATED	Text (String)	
	ASPECT READING (AZIMUTH)	Numeric (Integer)	
	ASPECT READING (QUADRANT)	Text (String)	
*	SLOPE GRADIENT	Numeric (Integer)	
*	DEGREE/PERCENT	Graphic	
	SLOPE CLASS	Text (String)	e.g. RIC, 1996
	SLOPE POSITION	Text (String)	e.g. MOE, 1990, pg 29-31
	SLOPE CONFIG/DOWN	Text (String)	e.g. RIC, 1996
	SLOPE CONFIG/ACROSS	Text (String)	e.g. RIC, 1996
	SURFACE SOIL DRAINAGE	Text (String)	e.g. RIC, 1996
	LAND USE LEVEL	Numeric (Integer)	Anderson et al., 1976
	LAND USE LEVEL	Numeric (Integer)	Anderson et al., 1976
	DOMINANT TREE SPECIE(S)	Text (String)	MOE, 1990, Table 5.3
	OTHER VEGETATION	Text (String)	
	COMMENTS	Text (String)	

CURRENT SOURCES: Ministry of Energy, Mines and Petroleum Resources, Ministry of Environment, Ministry of Forests, Ministry of Transportation and Highways, Forest Companies, and Regional Districts.

CUSTODIAN AGENCY: Ministry of Energy, Mines and Petroleum Resources

COMMENTS: Other Entities associated with General Observation/Sample Site Information [SITEINFO] in the Observation/Sample Site Entity Group [TERRSITE] include Terrain Unit(s) at Observation/Sample Site [SITEUNIT], Other Geomorphologic Features (Mass Movement, Hydrological, Pedological, Other [SITEGEOM] and Surface and Subsurface Exploration, Sampling and Testing [SITEEST]. The Observation/Sample Site Entity Group [TERRSITE] is also associated with the Terrain Map Entity Group [TERRMAP] and its related Entities.

ENTITY NAME: Terrain Unit(s) at Observation/Sample Site [SITEUNIT]

ENTITY DEFINITION: **Terrain Unit(s) at an Observation/Sample Site** describe a wide variety of the terrain, geological and engineering character of a single terrain unit, a composite terrain unit, and/or a stratigraphic terrain unit at a specific observation/sample site.

	FIELD/ATTRIBUTE	DATA TYPE	COMMENTS/EXAMPLES/ REFERENCES TO VALUE LISTS
1. Single Terrain Unit at Observation/Sample Site [SIUNIT2] (use multiple entries as required)			
	TERTIARY TEXTURE	Text (String)	Howes and Kenk, 1988
	SECONDARY TEXTURE	Text (String)	Howes and Kenk, 1988

*	DOMINANT TEXTURE	Text (String)	Howes and Kenk, 1988
*	TYPE OF MATERIAL (GENESIS)	Text (String)	Howes and Kenk, 1988
	QUALIFYING DESCRIPTOR	Text (String)	Howes and Kenk, 1988
*	LANDFORM/SURFACE EXPRESS	Text (String)	Howes and Kenk, 1988
*	GEOLOGICAL PROCESS	Text (String)	Howes and Kenk, 1988

2. Bedrock [BEDROCK] (Use multiple entries as required)

	TYPE	Text (String)	BCGSB, 1992, App III
	AGE	Text (String)	Grant and Newell 1992, pg 132
	AGE	Numeric (Integer)	BCGSB, 1992, App IV
	FORMATION	Text (String)	
	MINERALIZATION	Text (String)	
	FOSSIL(S)	Text (String)	
	QUALITATIVE ROCK STRENGTH	Text (String)	CFEM, 1992, Table 3.4
	STATE OF WEATHERING	Text (String)	e.g. IAEG, 1981, Table 10
	COMMENTS	Text (String)	

3. Colour/Odour of a Single Terrain Unit or Bedrock [COLOUR] (use multiple entries as required)

	COLOUR HUE	Text (String)	Munsell Color Charts
	COLOUR VALUE	Text (String)	Munsell Color Charts
	COLOUR CHROMA	Text (String)	Munsell Color Charts
	COLOUR NAME	Text (String)	Munsell Color Charts
	OXIDATION	Text (String)	
	ODOUR	Text (String)	

4. Pebbles of a Single Terrain Unit [PEBBLES] (use multiple entries as required)

	PEBBLE LITHOLOGY	Text (String)	BCGSB, 1992, App III
	PERCENT	Numeric (Integer)	of pebble lithology
	SHAPE/ROUNDNESS	Text (String)	Howes and Kenk, 1988, Fig 2
	PERCENT	Numeric (Integer)	of shape/roundness
	FABRIC DIRECTION	Numeric (Integer)	
	QUADRANT (AZIMUTH)	Text (String)	
	WEATHERING GRADE	Text (String)	e.g. IAEG, 1981, Table 10
	COMMENTS	Text (String)	

5. Striae/Other Ice Flow Indicators of a Single Terrain Unit or Bedrock [FLOWIND] (use multiple entries as required)

	FEATURE	Text (String)	
	DIRECTION (AZIMUTH)	Numeric (Integer)	
	COMMENTS	Text (String)	

6. Structures/Discontinuities of a Single Terrain Unit or Bedrock [STRUCT] (use multiple entries as required)

	STRUCTURE/DISCONTINUITY	Text (String)	e. g. bedding, fissility
	STRIKE (AZIMUTH)/DIP/QVAD	Text (String)	
	DIP DIRECTION(AZIMUTH)/DIP	Text (String)	
	TREND (AZIMUTH)/PLUNGE	Text (String)	
	SPACING (m)	Numeric (Integer)	CFEM, 1992, Table 3.5
	PERSISTENCE (m)	Numeric (Integer)	
	ROUGHNESS	Text (String)	CFEM, 1992, pg 32
	APERTURE (mm)	Numeric (Integer)	CFEM, 1992, pg 32
	INFILLING	Text (String)	CFEM, 1992, pg 33
	SEEPAGE/WATER FLOW	Text (String)	CFEM, 1992, pg 32
	COMMENTS	Text (String)	

7. Palaeosols of a Single Terrain Unit [PALOSOLS] (use multiple entries as required)

	DEPTH BELOW SURFACE (mm)	Numeric (Integer)	

	DESCRIPTION	Text (String)	
	THICKNESS (mm)	Numeric (Integer)	
	COMMENTS	Text (String)	

8. Engineering Character of a Single Terrain Unit [ENGCHAR] use multiple entries as required

	QUALITATIVE INSITU STRENGTH	Text (String)	CFEM, 1992, Table 3.3
	INSITU DENSITY (COARSE)	Text (String)	CFEM, 1992, Table 3.1
	INSITU CONSISTENCY (FINE)	Text (String)	CFEM, 1992, Table 3.2
*	SOIL MOISTURE	Text (String)	
	PLASTICITY	Text (String)	
	UNIFIED SOIL CLASSIFICATION	Text (String)	e.g. Costa and Baker, 1981 Table 8-3
	COMMENTS	Text (String)	

9. Composite Terrain Units [CTUNIT2]

	DOMINANT TERRAIN UNIT	Text (String)	refer to Single Terrain Unit
	PROPORTION (=, /, //)	Graphic	
	SECONDARY TERRAIN UNIT	Text (String)	refer to Single Terrain Unit
	PROPORTION (=, /, //)	Graphic	
	TERTIARY TERRAIN UNIT	Text (String)	refer to Single Terrain Unit
	COMMENTS	Text (String)	

10. Statigraphic Terrain Units [STUNIT2]

	TERRAIN UNIT AT SURFACE	Text (String)	refer to Single Terrain Unit
	THICKNESS (mm)	Numeric (Integer)	
	LATERAL CONTINUITY (m)	Numeric (Integer)	
	NATURE OF CONTACT	Text (String)	e.g. well defined, planar
	SHAPE OF CONTACT	Text (String)	e.g. layer, lens, wedge
	UNDERLYING UNIT	Text (String)	refer to Single Terrain Unit
	THICKNESS (mm)	Numeric (Integer)	
	LATERAL CONTINUITY (m)	Numeric (Integer)	
	COMMENTS	Text (String)	

CURRENT SOURCES: Ministry of Energy, Mines and Petroleum Resources, Ministry of Environment, Ministry of Forests, Ministry of Transportation and Highways, Forest Companies, and Regional Districts.

CUSTODIAN AGENCY: Ministry of Energy, Mines and Petroleum Resources

COMMENTS: Other Entities associated with the Terrain Unit(s) at Observation/Sample Site [SITEUNIT] in the Observation/Sample Site Entity Group [TERRSITE] include General Observation/Sample Site Information [SITEINFO], Other Geomorphologic Features (Mass Movement, Hydrological, Pedological, Other) [SITEGEOM] and Surface and Subsurface Exploration, Sampling and Testing [SlTEEST]. The Observation/Sample Site Entity Group [TERRSITE] is also associated with the Terrain Map Entity Group [TERRMAP] and its related Entities.

ENTITY NAME: Other Geomorphic Features (Mass Movement, Hydrological, Pedological, Other) [SITEGEOM]

ENTITY DEFINITION: Other Geomorphic Features describes mass movements (landslides), hydrological features (surface water and drainages), and pedological (agricultural) soil characteristics, among others.

	FIELD/ATTRIBUTE	DATA TYPE	COMMENTS/EXAMPLES/ REFERENCES TO VALUE LISTS
1. Mass Movement Features [MASSMOVE] (use multiple entries as required)			
	CROWN ELEVATION (m asl)	Text (String)	Cruden and Varnes, in press
	TOE ELEVATION (m asl)	Text (String)	Cruden and Varnes, in press
	LENGTH DISPLACED MASS (m)	Text (String)	Cruden and Varnes, in press
	WIDTH DISPLACED MASS (m)	Text (String)	Cruden and Varnes, in press
	DEPTH DISPLACED MASS (m)	Text (String)	Cruden and Varnes, in press
	APPROX VOLUME (m3)	Text (String)	Cruden and Varnes, in press
	DATE OF OCCURRENCE	Text (Date)	Cruden and Varnes, in press
	STATE OF ACTIVITY	Text (String)	Cruden and Varnes, in press
	DISTRIBUTION OF ACTIVITY	Text (String)	Cruden and Varnes, in press
	STYLE OF ACTIVITY	Text (String)	Cruden and Varnes, in press
	RATE OF MOVEMENT	Text (String)	Cruden and Varnes, in press
	DIRECTION OF MOVEMENT (AZ)	Numeric (Integer)	
	WATER CONTENT	Text (String)	Cruden and Varnes, in press
	MATERIAL INVOLVED	Text (String)	Cruden and Varnes, in press
	TYPE OF MOVEMENT	Text (String)	Cruden and Varnes, in press
	POSSIBLE CAUSES	Text (String)	Cruden and Varnes, in press
	DAMAGE	Text (String)	Cruden and Varnes, in press
	COMMENTS	Text (String)	
2. Hydrological Features [HYDROL] (use multiple entries if required)			
	SURFACE DRAINAGE	Text (String)	e.g. river, creek, gully
	PERMANENT/EPHEMERAL	Text (String)	
	MAX CHANNEL WIDTH (m)	Numeric (Integer)	
	SIDE SLOPE GRADIENT	Numeric (Integer)	
	DEGREE/PERCENT	Graphic	
	INCISE DEPTH (m)	Numeric (Integer)	
	CHANNEL GRADIENT	Numeric (Integer)	
	DEGREE/PERCENT	Graphic	
	DRAINAGE PATTERN	Text (String)	MOF, 1995
	CHANNEL GRADIENT CLASS	Text (String)	MOF, 1995
	EVIDENCE OF MASS MOVEMENT	Text (String)	MOF, 1995
	AVAIL SIDE SLOPE SEDIMENT	Text (String)	MOF, 1995
	AVAIL MATERIAL IN CHANNEL	Text (String)	MOF, 1995
	SPRINGS	Text (String)	
	SEEPAGE ZONES	Text (String)	
	COMMENTS	Text (String)	
3. Pedological Soil Characteristics [PEDOLOG] (use multiple entries as required)			
	SOIL ORDER/LANDSCAPE	Text (String)	if known, e.g. MOE, 1986
	SOIL NAME	Text (String)	if known
	REFERENCE	Text (String)	
	HORIZON	Text (String)	MOE, 1990, pg 71
	DEPTH FROM SURFACE (mm)	Numeric (Integer)	
	THICKNESS (mm)	Numeric (Integer)	
	BOUNDARY	Text (String)	MOE, 1990, pg 72
	SOIL TEXTURE	Text (String)	MOE, 1990, pg 73
	SOIL MOISTURE	Text (String)	MOE, 1990, pg 79
	COMMENTS	Text (String)	

4. Other Geomorphological Features [GEOMOTH] (use multiple entries as required)

	FEATURE	Text (String)	
	DESCRIPTION	Text (String)	
	COMMENTS	Text (String)	

CURRENT SOURCES: Ministry of Energy, Mines and Petroleum Resources, Ministry of Environment, Ministry of Forests, Ministry of Transportation and Highways, Forest Companies, and Regional Districts

CUSTODIAN AGENCY: Ministry of Energy, Mines and Petroleum Resources

COMMENTS: Other Entities associated with Other Geomorphological Features (Mass Movement, Hydrological, Pedological, Other) [SITEGEOM] in the Observation/Sample Site Entity Group [TERRSITE] include General Observation/Sample Site Information [SITEINFO], Terrain Unit(s) at Observation/Sample Site [SITEUNIT], and Surface and Subsurface Exploration, Sampling and Testing [SITEEST]. The Observation/Sample Site Entity Group [TERRSITE] is also associated with the Terrain Map Entity Group [TERRMAP] and its related Entities.

ENTITY NAME: Surface and Subsurface Exploration, Testing and Sampling [SITEETS]

ENTITY DEFINITION: **Surface and subsurface exploration, testing and sampling** can be carried out for a wide variety of purposes and using a wide variety of methods. The activities may be done in association with the present mapping, or may have been done totally independent.

	FIELD/ATTRIBUTE	DATA TYPE	COMMENTS/EXAMPLES/ REFERENCES TO VALUE LISTS
1 Surface exploration [SURFEXP] (use multiple entries as required)			
	EXPLORATION BY WHOM	Text (String)	
	DATE	Text (Date)	if different than observation date
	PURPOSE	Text (String)	
	METHOD	Text (String)	
	RESULTS	Text (String)	
	ARCHIVAL LOCATION	Text (String)	of results
	COMMENTS	Text (String)	
2. Surface testing [SURFTEST] (use multiple entries as required)			
	TESTING BY WHOM	Text (String)	
	DATE	Text (Date)	if different than observation date
	PURPOSE	Text (String)	
	METHOD	Text (String)	e.g. seismic, EM, gravity
	RESULTS	Text (String)	
	ARCHIVAL LOCATION	Text (String)	of results
	COMMENTS	Text (String)	
3. Surface sampling [SURFSAMP] (use multiple entries as required)			
	SAMPLING BY WHOM	Text (String)	
	DATE	Text (Date)	if different than observation date
	PURPOSE	Text (String)	
	METHOD	Text (String)	
	SAMPLE NUMBER	Text (String)	
	RATIONALE FOR COLLECTION	Text (String)	e.g. texture, dating, geochem.
	SAMPLE DESCRIPTION	Text (String)	
	ANALYSIS	Text (String)	
	RESULTS OF ANALYSIS	Text (String)	

	ARCHIVAL LOCATION	Text (String)	of samples
	COMMENTS	Text (String)	

4. Subsurface exploration [SUBEXP] (use multiple samples as required)

	EXCAVATION BY WHOM	Text (String)	
	DATE	Text (Date)	if different than observation date
	PURPOSE	Text (String)	
	METHOD	Text (String)	e.g. backhoe, rotary drill
	EXCAVATION/HOLE NUMBER	Numeric (Integer)	
	LOG OF EXCAVATION/HOLE	Text (String)	
	EQUIPMENT LEFT IN GROUND	Text (String)	e.g. Standpipe, Thermistor
	ARCHIVAL LOCATION	Text (String)	of logs
	COMMENT	Text (String)	

5. Subsurface testing [SUBTEST] (use multiple entries as required)

	TESTING BY WHOM	Text (String)	
	DATE	Text (Date)	if different than observation date
	PURPOSE	Text (String)	
	METHOD	Text (String)	e.g. down hole seismic, SPT, CPT, etc.
	RESULTS	Text (String)	
	ARCHIVAL LOCATION	Text (String)	of results
	COMMENTS	Text (String)	

6. Subsurface sampling [SUBSAMP] (use multiple entries as required)

	SAMPLING BY WHOM	Text (String)	
	DATE	Text (Date)	if different than observation date
	PURPOSE	Text (String)	
	METHOD	Text (String)	e.g. Vibracore, Shelby, Split spoon
	SURFACE ELEVATION (m)	Numeric (Integer)	
	MEASURED/ESTIMATED	Text (String)	
	SAMPLE ELEVATION (m)	Numeric (Integer)	
	MEASURED/ESTIMATED	Text (String)	
	SAMPLE NUMBER	Text (String)	
	RATIONALE FOR COLLECTION	Text (String)	e.g. texture, dating, geochem.
	SAMPLE DESCRIPTION	Text (String)	
	ANALYSIS	Text (String)	
	RESULTS OF ANALYSIS	Text (String)	
	ARCHIVAL LOCATION	Text (String)	of samples
	COMMENTS	Text (String)	

CURRENT SOURCES: Ministry of Energy, Mines and Petroleum Resources, Ministry of Environment, Ministry of Forests, Ministry of Transportation and Highways, Forest Companies, and Regional Districts.

CUSTODIAN AGENCY: Ministry of Energy, Mines and Petroleum Resources

COMMENTS: Other Entities associated with Surface and Subsurface Exploration, Testing and Sampling [SITEETS] in the Observation/Sample Site Entity Group [TERRSITE] include General Observation/ Sample Site Information [SITEINFO], Terrain Unit(s) at (Observation/Sample Site [SITEUNIT], and Other Geomorphologic Features (Mass Movement, Hydrological, Pedological, Other) [SITEGEOM]. The Observation/Sample Site Entity Group [TERRSITE] is also associated with the Terrain Map Entity Group [TERRMAP] and its related Entities.

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APPENDIX F

BIOTERRAIN MAPPING

The Wildlife Branch of the British Columbia Ministry of Environment produces many forms of ecologically-based maps, such as habitat maps, wildlife capability and suitability maps, fire and habitat management maps, and others. In most cases, a terrain or soil map forms the basis of these biophysical maps. The maps also take account of any ecologically significant features that influence the habitat of a species.

In order to subdivide the landscape into ecologically-significant entities, the following characteristics are considered in addition to the usual terrain soil parameters: ecoregion, biogeoclimatic zone, and ecosystem. Some specific ecological features that are considered in the definition of bioterrain polygons, but not included for normal terrain mapping, include: aspect; distinct vegetation boundaries, foreshore characteristics, riparian zones, wetland characteristics, bedrock mineralogy,

Site forms for bioterrain mapping include the following characteristics in addition to those recorded for normal terrain mapping: aspect, soil (pedological) classification (subgroup); soil phase, site position (macro, meso), site surface shape, microtopography, site diagram, exposure type, ecological moisture regime, slope position (shedding, normal, receiving, holding), soil drainage, perviousness, free water, depth to water table, effective rooting depth, root restricting layer, frozen layer, carbonate, salinity, humus form class, description of decaying wood. Soil description forms are also completed for each site.

The methodology for bioterrain mapping is evolving rapidly, as mappers endeavour to develop criteria for recording significant habitats. Schemes for detailed mapping of cliffs and talus, and avalanche fans and chutes have recently been developed. Mapping parameters and criteria for soil biodiversity, glacial refugia, bedrock weathering and shallow soils, and hydrologic features such as ephemeral streams, bogs and ponds are being investigated.

see Standards for Terrestrial Ecosystems Mapping of British Columbia, Resources Inventory Committee.

(From unpublished notes by R. Maxwell, Wildlife Branch, BC Ministry of Environment, Lands and Parks, 780 Blanshard Street, Victoria, BC.)

APPENDIX G

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APPENDIX H

SOURCES 0F MAPS

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Maps and Publications
Natural Resources Canada
100 West Pender Street
Vancouver, British Columbia V6B 1R8
Phone-604-666-0271
Fax-604-666-1124

MEMPR MAPS

Crown Publications
521 Fort Street
Victoria, British Columbia V8W IK8
Phone-604-386-4636
Fax-604-386-0221

MOE/MOEP MAPS

Maps B.C.
1802 Douglas Street
Victoria, British Columbia
Phone-604-387- 1441
Fax-604-387-3022

MOTH MAPS

Ministry of Transportation and Highways
Geotechnical and Materials Engineering Branch
4A-940 Blanshard Street
Victoria, British Columbia V8W 3E6
Phone-604-387-1881
Fax-604-356-0624

BC HYDRO MAPS

BC Hydro
Hydroelectric Engineering Division
Administrative Services (Records)
6911 Southpoint Drive
Burnaby, British Columbia V3N 4X8
Phone-604-528-2455
Fax-604-528-2444

MOF MAPS (DISTRICTS AND REGIONAL OFFICES)

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Ministry of Forests
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Ministry of Forests
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V9W 6Y7
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Ministry of Forests
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Ministry of Forests
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Ministry of Forests
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