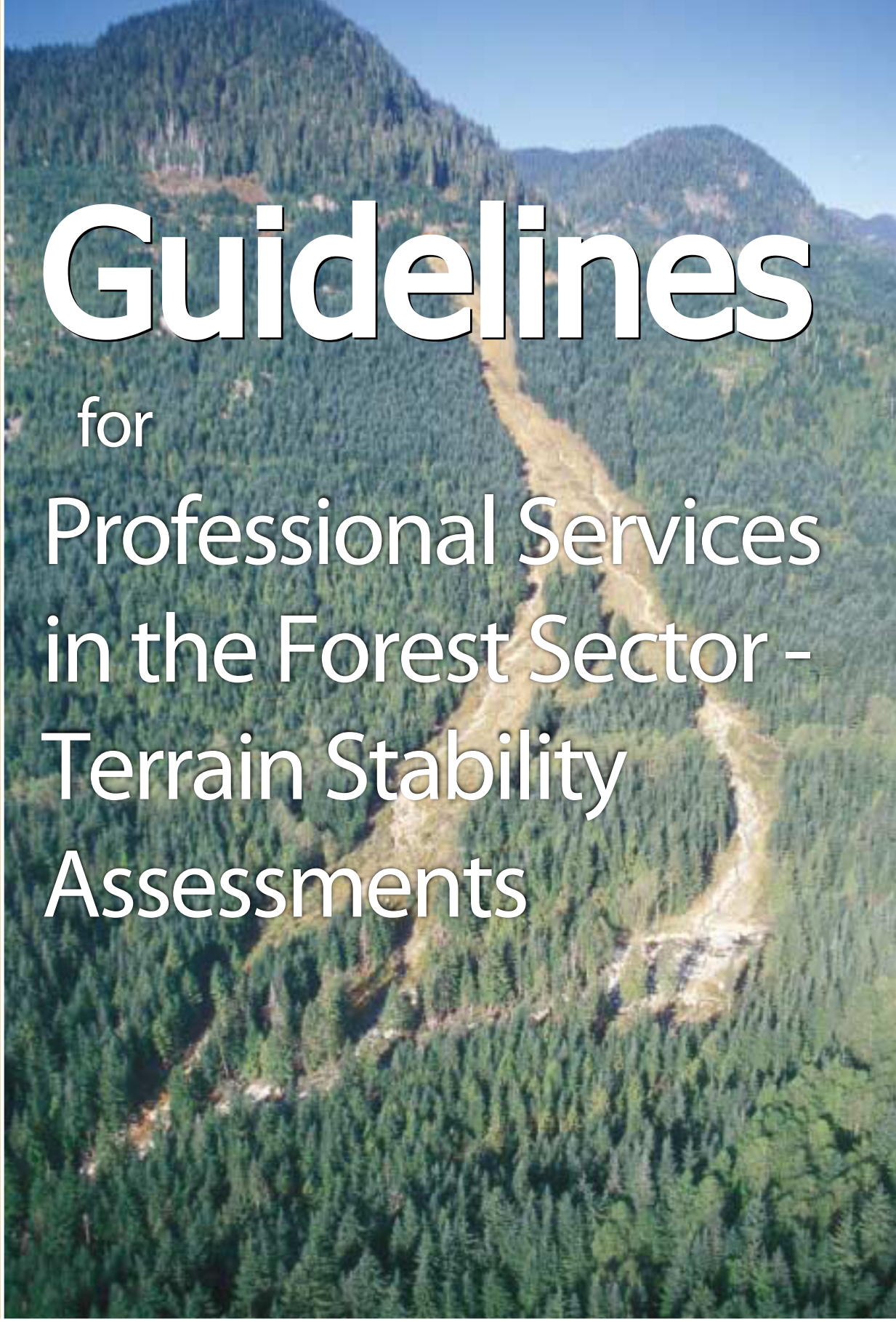

Guidelines

for

Professional Services in the Forest Sector - Terrain Stability Assessments

Association of Professional Engineers and Geoscientists of British Columbia

Association of BC Forest Professionals

August 2010

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Cover: 1995 slope failure in the Indian River watershed about 20 km southeast of Squamish, BC. Photo: Frank Baumann PEng

FOREWORD

A goal of the Joint Practices Board (JPB) of the Association of British Columbia Forest Professionals (*ABCFP)*[1] and the Association of Professional Engineers and Geoscientists of British Columbia (*APEGBC)* is to establish a standard of care for managing terrain stability in the forest sector.

Accordingly, *APEGBC* and *ABCFP* have issued *Guidelines for Management of Terrain Stability in the Forest Sector* (A*BCFP/APEGBC* 2008). That document is directed primarily to *forest professionals* for developing a *terrain stability management model* that includes guidance for when and where to conduct *terrain stability assessments*, and outlines roles and responsibilities for *members* involved in terrain stability management. In addition, *Guidelines for Professional Services in the Forest Sector – Forest Roads*[2] describes roles and responsibilities for *members* involved in forest road activities, including *terrain specialists* and the use of *terrain stability assessments* in that application.

These *Guidelines for Professional Services in the Forest Sector – Terrain Stability Assessments* are directed to *members* of both *ABCFP* and *APEGBC* who carry out *terrain stability assessments.* They supercede the *APEGBC Guidelines for Terrain Stability Assessments in the Forest Sector* (*APEGBC* 2003).

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1 Terms in italics are defined in Section 1
2 *Guidelines for Professional Services in the Forest Sector – Forest Roads* are currently in preparation by the Joint Practice Board.

1 DEFINITIONS

The following definitions are specific to these guidelines. All references in the text to these terms are italicized.

ABCFP
Association of British Columbia Forest Professionals.

APEGBC
Association of Professional Engineers and Geoscientists of British Columbia.

Client
A party who engages a *terrain specialist* to conduct a *terrain stability assessment.* In this document, *client* also refers to the employer where a *member* is directly employed by a *licensee* or other organization that carries out *planning* or *operations*. For forest roads, the *client* may be a coordinating *member* (see *Guidelines for Professional Services in the Forest Sector – Forest Roads*).

Consequence
The effect on human well-being, property, the environment, or other things of value; or a combination of these (adapted from CSA1997). Conceptually, *consequence* is the change, loss or damage to the elements caused by the *landslide* (Wise et all 2004).

Field Review
Such reviews of the works at the cutblock or forest road site considered necessary, in the *member*'s opinion, to ascertain whether or not the significant aspects of the works are in general compliance with recommendations in the *terrain stability assessment*; or to verify that ground conditions are as anticipated in the *terrain stability assessment*; or reviews by the *forest professional* to verify whether or not *operations* have been carried out as planned, directed or advised.

Forest Professional
A registered *member* of *ABCFP*.

Government
Regulatory authorities having jurisdiction over *planning* and/or *operations* on Provincial Crown land or private land. Such authorities include federal, provincial and local *governments*.

Hazard
A source of potential harm, or a situation with a potential for causing harm, in terms of human injury; damage to property, the environment, and other things of value; or some combination of these (CSA 1997). With respect to *landslide risk* management, the *landslide* is the source of potential harm – it is the *hazard* (Wise et al 2004). A *hazard* includes the geomorphic attributes and effects of a *landslide*, such as volume of material involved and spatial extent, as well as the effect of the *landslide* on other geomorphic processes such as fluvial processes.

Hazard analysis
A qualitative or quantitative estimate of the likelihood or probability of a *landslide* occurring.

Landslide
A movement of a mass of rock, debris, or earth down a slope (Cruden 1991).

Licensee

An individual, company or Provincial Crown agency that has the legal right to harvest timber; or to construct, maintain or deactivate forest roads. For the purpose of these guidelines, *licensee* includes land owners in the case of forest *planning* or *operations* on private property.

Member
A registered professional forester, registered forest technologist or special permit holder registered and in good standing with *ABCFP*; or a *professional engineer*, *professional geoscientist*, or holder of non-resident or limited license registered and in good standing with *APEGBC*.

Operations
Physical site work for forest development including construction, maintenance, deactivation and reactivation of forest roads and trails; timber harvesting; and silviculture activities.

Planning
Activities involved in preparing plans to carry out *operations*. These include selection and evaluation of route corridors; preparation of *road plans*[3]; design of crossing structures or other special designs; identifying harvest areas; layout of cutblock boundaries; and selection of harvesting and silviculture systems.

Professional Engineer
Member of *APEGBC.*

Professional Geoscientist
Member of *APEGBC.*

Risk
The chance of injury or loss as defined as a measure of the probability and the *consequence* of an adverse effect to health, property, the environment, or other things of value (adapted from CSA 1997, Wise et al 2004).

Road Plan
A document providing road standards, design specifications, and other information required to provide direction to carry out road construction. Similarly, maintenance plans and deactivation plans are documents providing direction to carry out those activities. See *Guidelines for Professional Services in the Forest Sector – Forest Roads*.

Specialist
An individual that has specialized training and experience in a particular occupation, practice or branch of learning. Such individuals include, but are not limited to, *members* with specialized expertise (e.g., windthrow or geotechnical, structural or rock slope engineering); professional biologists, professional agrologists, archaelogists, hydrologists or others specializing in the management or valuation of forest resources. See also *terrain specialist*, below.

Terrain Specialist
A *member* with appropriate levels of education, training and experience (skill sets) as defined in these guidelines to conduct a *terrain stability assessment*.

Terrain Stability Assessment (TSA)
An assessment of *landslide hazard,* a *landslide hazard analysis* or a *landslide risk* analysis for terrain on or adjacent to which *operations* may be carried out. A *TSA* may include options or recommendations to manage *hazard* or *risk*.

3 See *Guidelines for Professional Services in the Forest Sector – Forest Roads*

Terrain Stability Management Model (or Model)
A system, process or procedure to manage terrain stability related to forest development. It can consist of a document, a map, a diagram; or some combination of these, and should provide guidance with respect to:

- when and where a *TSA* should be carried out;
- managing terrain stability;
- acceptable *hazard* or *risk* criteria for specified elements at *risk*;
- selecting forest development strategies that are consistent with identified *hazards* or *risks*; and
- establishing a consistent and logical decision-making process to analyze and document decisions concerning the management of terrain stability.

Refer to *Guidelines for Management of Terrain Stability in the Forest Sector* (*ABCFP/APEGBC* 2008).

Tolerable Risk
A *risk* that stakeholders are willing to live with so as to secure certain net benefits, knowing that the *risk* is being properly controlled, kept under review, and further reduced as and when possible. In some situations, *risk* may be tolerated because the stakeholders cannot afford to reduce *risk* even though they recognize that it is not properly controlled (adapted from AGS 2000). *Tolerable risks* exceed established or acceptable thresholds of *risk* (Wise et al 2004).

2 INTRODUCTION

A *TSA* is carried out by a *terrain specialist* to:

- assess the potential for *operations* to affect or to be affected by *landslide hazards*, and
- depending on the requirements of the *forest professional*, evaluate *risk* and/or provide options or recommendations to manage *hazards* or *risk* related to *operations.*

Forest professionals use *TSAs* as part of *planning* in order to meet objectives for safety, performance and *risk* management of roads and harvest areas.

The goal of carrying out a *TSA* is ultimately to protect the safety, health and welfare of the public, to protect the environment, and to provide for health and safety within the workplace.

2.1 PURPOSE AND SCOPE OF GUIDELINES

These guidelines establish a standard of care for carrying out *TSA* related to *planning* and *operations* in British Columbia.

These guidelines can also assist a *terrain specialist* and his/her *client* to establish the scope of work in an agreement to conduct a *TSA*.

In addition, these guidelines describe the skill sets required by a *member* to be competent to carry out a *TSA*.

Consistent with *ABCFP/APEGBC* Joint Practice Board's (JPB's) terms of reference, these guidelines apply solely to *members* of *ABCFP* and *APEGBC* and to *TSAs* associated with forest development in British Columbia.

2.2 BASIC CONCEPTS

Delivery of professional services relating to *operations* involves professional forestry, professional engineering and professional geoscience.

These guidelines are based on the following concepts:

- adherence to the *Engineers and Geoscientists Act*, R.S.B.C. 1996 c. 116 as amended;
- adherence to the *Foresters Act*, R.S.B.C. 2003 c. 19;
- fulfilling the professional obligations to protect the interests of the public, worker safety and the environment; and
- relying on the training, experience and professionalism of *members*;
- recognizing and building on the team concept involving both *ABCFP* and *APEGBC members*.

Government has granted *ABCFP* and *APEGBC* legislative authority to regulate *members* working in the forest sector. This authority includes determining which professional activities *members* of the respective association can carry out, and developing practice standards. These guidelines have been prepared by the Joint Practice Board comprising *members* of *ABCFP* and *APEGBC*. The Joint Practice Board was mandated by the Councils of *ABCFP* and *APEGBC,* in a Memorandum of Understanding originally signed in 1994 and updated in 2006, to make recommendations to their respective Councils on matters related to the practice overlap among the professions.

APEGBC and *ABCFP* recognize that *TSAs* are an area of practice overlap as set out in the language of the respective acts.

Under the *Foresters Act* section 4(2)(e), it is the duty of the association "…to establish, monitor and enforce codes of conduct and standards of practice for its members".

The *Foresters Act* includes, within the definition of the practice of professional forestry:

> "*…assessing the impact of professional forestry activities to*
>
> *(iii) advise or direct corrective action as required to conserve, protect, manage, rehabilitate or enhance the forests, forest lands, forest resources or forest ecosystems;*
>
> *"…auditing, examining and verifying the results of activities involving the practice of professional forestry, and the attainment of goals and objectives identified in or under professional documents*".

ABCFP's Bylaw 11.3.10 requires its *members* "*to have proper regard in all work for the safety of others*"; and Bylaw 12.7 requires that "*members maintain safe work practices and consider the safety of workers and others in the practice of professional forestry*". *ABCFP's* Bylaw 13 requires a quality assurance program for professional forestry.

The *Engineers and Geoscientists Act* includes, within the definition of the practice of *professional geoscience*:

> "*…reporting, advising, acquiring, processing, evaluating, interpreting, surveying, sampling or examining related to any activity that:*
>
> *(a) is directed towards …the investigation of surface or sub-surface geological conditions, and*
>
> *(b) requires the professional application of the principles of geology, geophysics or geochemistry"*

- within the definition of the practice of professional engineering:

  "...reporting on, designing, or directing the construction of any works that require for their design, or the supervision of their construction, or the supervision of their maintenance, such experience and technical knowledge as are required by or under this Act..."

Under the *Engineers and Geoscientists Act*, the association has the object…"*to establish, maintain and enforce standards for the qualifications and practice of its members and licensees*".

APEGBC's Bylaw 14(b)(4) requires its *members* and *license holders* to establish quality management processes for their practices which shall include "…*field reviews by members or licensees of their projects during construction*". *APEGBC's* Code of Ethics requires professional *members* and *license holders* to "*hold paramount the safety, health and welfare of the public, the protection of the environment and promote health and safety within the workplace*".

Government regulates forest management in B.C. on crown and private land separately. The *Foresters Act* does not distinguish the practice of forestry by land ownership. *Planning* and *operations* must be consistent with all applicable legislation in the area where these activities are carried out.

In the event of any inconsistencies or contradictions between these guidelines and legislation, the latter shall prevail.

2.3 PROFESSIONAL CONDUCT

Members must exercise professional judgment when providing professional services, and as such, the application of these guidelines can vary depending on the circumstances. Notwithstanding the purpose and scope of these guidelines, the decision of *Members* not to follow one or more aspects of these guidelines does not necessarily mean that they have failed to meet the appropriate standard of practice in the performance of professional services. Such judgments and decisions depend upon an evaluation of all facts and circumstances in a particular project.

ABCFP and *APEGBC* support the principle that *members* should receive fair compensation for professional services; adequate to ensure that the professional services can be carried out appropriately. Inadequate compensation is not a justification for services that do not meet the standards set out in these guidelines. *Members* may wish to discuss these guidelines with their *clients* or employer when receiving instructions for an assignment and reaching agreements regarding compensation.

When *professional engineers* or *professional geoscientists* are retained to carry out *TSAs*, they must provide to their *client* the following notification in accordance with the *Engineers and Geoscientist Act* and Bylaw 17(a) related to liability insurance:

> *"Before entering into an agreement to provide professional engineering or professional geoscience services to the public, a member, licensee or certificate holder must notify the client, in writing, whether or not professional liability insurance is held and whether that insurance is applicable to the services in questions. The note shall include a provision for an acknowledgement of the advice to be signed by the client."*

Members must only practice in areas where they are appropriately trained and experienced. *Professional engineers* and *professional geoscientists* "*shall undertake and accept responsibility for professional assignments only when qualified by training or experience*."[4] *Forest professionals* have a responsibility "*to practice only in those fields where training and ability make the member professionally competent.*"[5]

In all cases, *members* must sign professional documents that they are responsible for in accordance with the bylaws and guidelines of each association.

2.4 ACKNOWLEDGMENTS

These guidelines have been prepared by two Task Forces of the *ABCFP/APEGBC* JPB. They expand and update the *Guidelines for Terrain Stability Assessments in the Forest Sector* (*APEGBC* 2003).

ABCFP and *APEGBC* acknowledge the efforts of the JPB Task Force members, the *APEGBC* Division of Engineers and Geoscientists in the Resource Sector, and *ABCFP* Professional Practice Committee in preparing this document, and of those who provided review comments including *members* of both Associations and staff of WorkSafeBC.

Funding for the development of an earlier version of these guidelines was provided by the Ministry of Forests and Range and represented a crucial stage in the completion of these joint *APEGBC* and *ABCFP* Guidelines.

[4] APEGBC Bylaw 14(a)(2)
[5] ABCFP Bylaw 11.3.7

3 OBJECTIVES AND PURPOSE OF A TERRAIN STABILITY ASSESSMENT

Legislation such as the *Forest and Range Practices Act* relies on the regulated professions to provide guidance for professional practice to *members*. The *Guidelines for Professional Services in the Forest Sector - Terrain Stability Assessments* is one such guidance document. Objectives for a *TSA* will vary depending on the purpose of the assessment, the complexity of terrain, the nature of the *hazards*, the elements at *risk*, and a *client's* specific requirements. Objectives could include one or more of the following:

- To evaluate effects of *operations* on terrain stability;
- To characterize the terrain and existing *hazards* in areas within or connected to the *operations* area;
- To determine the *hazards* or *risks* of *operations* on identified elements at *risk*, including worker and public safety;
- To compare the *hazards* or *risks* with established or implied tolerable *hazard* or *risk* criteria, including those set by *government* or those set in a *licensee's Model*;
- To provide site-specific recommendations and options to manage the *hazards* and/or *risks* either to the *operations* from adjacent *landslide hazards*, or resulting from the *operations*, including addressing worker safety.

In this context, "connected to" means areas adjacent to, upslope or downslope of the *operations* that could affect or be affected by the *operations*.

*TSA*s are commonly conducted for the following reasons:

- To assess the potential for *landslides* to occur as a result of timber harvesting. Typically this would be a *TSA* for a cutblock to assess the *hazard* or *risk* of post-harvest *landslides*.
- To identify potential *hazards* upslope of proposed harvest areas, road alignments, or other forest development.

  TSA for upslope *hazards* assess the *hazard* or *risk* of *landslides* originating upslope that could affect the safety of workers and the integrity of forest *operations*, such as roads or plantations. These could be natural events, or events arising from upslope development.

- To assess terrain conditions along proposed route corridors.

  *TSA*s for route corridors evaluate *landslide hazards* that could affect a road, and the potential terrain response to road construction. This type of assessment may be done where a route corridor is identified in a preliminary phase to select a road location or to compare alternative routes. A route corridor is not always established before doing road layout. Refer to *Guidelines for Professional Practice in the Forest Sector - Forest Roads*.

- To make recommendations or provide options for *risk* management for forest road construction, maintenance, deactivation or reactivation.

This type of assessment provides specific recommendations or options for road design or for construction, remediation, deactivation or reactivation measures. It includes consideration of safety during and after construction for workers and road users including the ability of the road to safely support industrial vehicles. It does not include geotechnical design recommendations for specialized construction, retaining structures, reinforced fills, rock slope stabilization or other *specialist* engineering services, although these may also be provided in conjunction with a *TSA* if the *TSA* is

done by a *professional engineer* qualified to provide these services. *TSA*s do not normally include written instructions for safe entry into or next to an excavation, such as a road cutslope; these would typically be provided as needed in a separate document to meet requirements of worker safety legislation. However they may be included in a *TSA* if the author is qualified to provide them.

A *TSA* may have any or all of the above purposes, depending on the forest *operation* that is the subject of the *TSA*, and the needs of the *forest professional* that is responsible for the *operation*.

4 ROLES AND RESPONSIBILITIES

The general roles and responsibilities for *members* and others involved in terrain stability management are established in *Guidelines for Management of Terrain Stability in the Forest Sector* (A*BCFP/APEGBC* 2008). In addition, *Guidelines for Professional Practice in the Forest Sector - Forest Roads* (*ABCFP/APEGBC* currently in preparation) describes roles and responsibilities for *members* involved in forest road activities, including *terrain specialists* and the use of *TSAs* in that application.

Incorporating the *TSA* into *planning*, including evaluating *risk* to specific values is most often done by a *forest professional* (refer to Section 3.3 of *Guidelines for Management of Terrain Stability in the Forest Sector*). A *TSA* typically estimates the *landslide hazard*, including the likelihood of occurrence and the geomorphic effect (probable *landslide* size and runout distance). *Forest professionals* use this information to estimate the *risk* to specific elements.

However, to assist with this, the *client* may include in the scope of a *TSA*, *hazard analysis*, partial *risk* analysis or in some cases more detailed *risk* analysis for one or more values. Refer to *Land Management Handbook 56* (Wise et al 2004). The *client* may also ask for a *TSA* to include recommendations or options to manage *hazard* or *risk* related to the *operations*.

Section 5.1 below describes the responsibility of *terrain specialist*s who carry out *TSAs.*

5 GUIDELINES FOR PROFESSIONAL PRACTICE

This section outlines the responsibilities and tasks that a *terrain specialist* should consider when carrying out a *TSA*. This outline can assist in explaining the scope of a *TSA* to *clients* or employers; however, the scope, objectives and specific concerns of a *TSA* can vary widely, and professional judgment is required to select an appropriate level of effort.

Landslide characteristics and terrain stability concerns vary widely by geographic or physiographic region throughout the province. For example, mountainous, high-precipitation areas historically feature the occurrence of shallow, rapid *landslides* (debris slides, debris avalanches, and debris flows), whereas deep-seated slumps in fine-textured surficial deposits or weak bedrock can often be the common failure type in many areas of the interior plateau and north-eastern B.C. In much of the dry southern interior plateau, sediment delivery to streams derived from road surface erosion and small-scale mass wasting along roads and skid trails is often a greater concern than *operations* related *landslides*. In many mountainous areas, snow avalanches following harvesting are a concern.

As well, different forest management objectives and different harvesting methods are used in different regions and under different circumstances. Consequently, different skill sets may be required to address regional variations. A *terrain specialist* is expected to know the specific *landslide* concerns associated with forest development for the region in which he/she works, and to keep abreast of new and pertinent information and research related to forest management and *landslides* in the region.

Although the primary focus of most *TSAs* is *landslides*, other terrain-related issues such as snow avalanching or significant surface erosion may be included in the scope of a *TSA.* These other issues could be identified by a *forest professional* responsible for *planning*, or by a *terrain specialist* during the course of the *TSA*. If the *terrain specialist* is not qualified in these areas, the other issues should be addressed in a separate report, or a recommendation should be made to retain a *specialist*. A team approach is one method to address multiple terrain-related issues.

In carrying out the *TSA*, the *terrain specialist* should keep in mind his/her professional obligations to protect the safety, health and welfare of the public, to protect the environment, and to provide for health and safety within the workplace; and to practice only in areas where he/she is appropriately trained and experienced.

5.1 RESPONSIBILITIES OF THE TERRAIN SPECIALIST

Steps prior to conducting a *TSA* typically include the following.

a) Clarify with the *client*:

i. The scope of the *TSA.* Specifically,

- Whether the assessment includes some level of *risk* analysis of specified elements at *risk*, or an evaluation of *hazard* and the stability implications of various options to help manage the *hazard* or *risk*. If the scope includes a *risk* analysis, the *terrain specialist* should obtain detailed information on elements at *risk* and *tolerable risk* criteria from the *client*.

  Where downslope elements at *risk* could involve public safety, infrastructure, or private property, a high level of due diligence is particularly important. Depending on the *risk* management approach being employed by the *forest professional* responsible for *planning*, a more rigorous and detailed *TSA* may be required, or a *specialist* assessment.

- Whether the *TSA* should address the entire *operations* area, most of the area, or only a specified portion of the area. Depending on terrain conditions and the *client*'s specific needs, a *TSA* can range from reconnaissance (consisting of a review of background information with little or no fieldwork) to detailed (including considerable fieldwork).

ii. Whether a *model* is in place, and if so, obtain the sections of the *model* that are relevant to the conduct of the *TSA*, including:

- Definitions of *hazard, consequence* and *risk* ratings, if available; and
- Specific regional content required to be addressed as set out in the *model*.

iii. The roles and responsibilities and communication protocol within the *client's* organization that are relevant to the *TSA*.

b) Confirm that the *terrain specialist* has the appropriate skill set to complete the scope of work and, if not, recommend what additional expertise is needed.

c) Notify the *client* whether or not professional liability insurance is held and whether that insurance is applicable to *TSA* services.

d) Establish terms for any additional services that may be required beyond the scope of a typical *TSA* (Section 6).

e) Inform the *client* of any particular limitations or special circumstances that may affect the *TSA* results (for example, site access, snow cover, reliability of background information).

f) Make reasonable attempts to obtain all pertinent information (written or otherwise) related to the *TSA.*

The *terrain specialist's* responsibilities during the *TSA* typically include the following.

a) Conduct sufficient fieldwork to reasonably evaluate the terrain conditions and *hazards* or *risks* as set out in the scope of the *TSA.* Fieldwork can include areas outside of the *operations* that could affect or be affected by *operations* (Section 5.3).

b) If the area of the *TSA* is limited to a specific portion of the proposed *operations,* inform the *client* as to the implications the limits could have on the *TSA*.

c) Identify and analyze *hazards* or *risks* along existing and proposed road alignments, within existing and proposed cutblocks, and in adjacent areas that could be affected by the *operations*, or could affect the *operations.*

d) If within the scope of the *TSA*, compare the results of the *hazard* or *risk* analysis associated with the *operations* with established or implied *tolerable hazard* or *risk* criteria.

e) If within the scope of the *TSA*, provide recommendations or options to manage the *hazards* and *risks.*

f) Notify the *client* when specialty services are required (Section 6) and whether a *specialist* should be retained.

g) Document the results of the *TSA* in a written report with supporting rationale and a statement of limitations (Section 5.5).

The *terrain specialist* is responsible for communicating to the *client* the possible *consequences* of not following the report recommendations or carrying out *field reviews*. If this failure or refusal could compromise the *terrain specialist'*s professional obligations, the *terrain specialist* should:

- advise the *client* in writing of the potential *consequences* of his/her inactions;
- consider whether he/she should continue as the *terrain specialist* for the *TSA;* and
- consider whether the situation warrants notifying the appropriate *government*, *ABCFP*, *APEGBC* or other relevant agencies or regulatory bodies.

5.2 PRELIMINARY WORK

Prior to fieldwork, the *terrain specialist* should review pertinent information regarding the *operations* and *operations* area. Relevant background information will depend on the nature of the *TSA* and available information. Typically, this could include:

- plans or maps showing the *operations* area and future *operations* opportunities in the vicinity;
- air photos at various scales and dates;
- large and small scale topography;
- bedrock and surficial geology;
- terrain classification and terrain stability mapping;
- silviculture and logging plans;
- design drawings such as profiles and cross-sections of roads and trails, or drawings of completed works;
- road, trail, cutblock and deflection line traverse information;
- stream or gully traverse notes;
- hydrological or watershed assessments;
- forest cover;
- other resource information such as stream classification and fish habitat;
- terrain attribute studies or other information regarding existing or potential *landslides*;
- previous geotechnical, geological or *TSA* reports in the general *operations* area;
- overview reports that address terrain stability and/or constraints related to terrain stability.

The *terrain specialist* should collect and evaluate relevant information available from past *operations* in nearby areas of similar terrain as part of the supporting rationale for the *TSA* (Section 5.4).

Where possible, the *terrain specialist* should acquire this information to assist in *planning* fieldwork, to provide background on the terrain conditions, to understand future *operations* in the area and to begin developing the supporting rationale (Section 5.4). The *terrain specialist* should consider the reliability and accuracy of the background information and the potential effects that unreliable or inaccurate information could have on the *TSA.* If pertinent information is not provided until after the fieldwork, the *terrain specialist* may have to complete further fieldwork.

A *terrain specialist* may rely on the work of other professionals, such as fish stream classifications or geometric road designs, but should be aware of the limitations of that work.

5.3 FIELDWORK

Terrain specialists must exercise professional judgment in selecting a level of fieldwork (i.e. intensity, amount and timing) that is appropriate for the scope of the *TSA.*

The level of fieldwork is dependent on terrain conditions, adjacent elements at *risk*, and non-terrain factors such as weather conditions, accessibility, and local knowledge and experience of the *terrain specialist*. More extensive fieldwork may be warranted where:

- there is limited background information;
- *landslides* (natural or *operations* related) have occurred in areas within or connected to the assessment area; or
- there is a high density of existing overgrown roads and trails.

Fieldwork typically needs to consider all critical areas as determined from the background information, within and connected to the proposed *operations*. Examples are:

1. Within the assessment area:
   (a) moderately steep to steep slopes and unstable or potentially unstable terrain as identified from background information*;*
   (b) road or trail sections on moderately steep to steep slopes, or on unstable or potentially unstable terrain;
   (c) gully systems and other areas of concentrated surface or near surface water flow;
   (d) existing or proposed road drainage structures including culverts, cross-ditches and water bars, ditches, swales and drainage divides in the road surface; and
   (e) areas upslope of high value elements at *risk* as identified by the *client*

2. Connected to the assessment area:
   (a) gullies bordering the *operations*, particularly where prone to windthrow; and
   (b) unstable, potentially unstable, and moderately steep to steeply sloping terrain downslope of the *operations* that could be affected by hydrological changes caused by the *operations*
   (c) *landslide* transport and deposition zones in the vicinity of high value elements at *risk*
   (d) drainage from existing roads, trails or cutblocks upslope of the *operations* that could affect slope stability
   (e) areas of natural *landslides* or other terrain-related processes.

If past *landslides* have occurred on terrain within or connected to the assessment area, fieldwork should include these slopes to determine, where possible, the contributing factors of the *landslides*.

The scope of the *TSA* may determine the fieldwork required. For example, a *terrain specialist* may be retained to assess a specific feature such as an escarpment or a gully; or to assess and make recommendations for an entire road, regardless of the *hazard* on individual segments.

5.4 SUPPORTING RATIONALE

The *terrain specialist* must provide a rationale to support his/her conclusions and recommendations or options. Such rationale typically uses the geomorphic history of terrain in or in the vicinity of the study area to predict what may happen in future, either from natural events or as a consequence of *operations*. Past terrain performance can be determined from *landslide* inventories; terrain attribute or similar studies of *landslide* occurrence; imagery such as airphotos or satellite images; observations made near the *operations* area; the knowledge of the *terrain specialist* gained from experience in similar terrain; or a combination of these.

For example, the presence or absence of *landslides* in nearby similar terrain can provide an indication of the likelihood of *landslide* occurrence (*hazard analysis*) resulting from the proposed *operations*. In this instance, a supporting rationale is developed by evaluating the terrain conditions at the proposed *operations* in comparison to the terrain conditions at the previous *operations*. Investigating the factors

contributing to past *landslide* activity in nearby areas can help with predicting the likelihood of future *landslides*.

The *terrain specialist*'s rationale should provide a logical link between the prediction of *landslide* occurrence, and the recommendations or options provided to manage *hazards* or *risks*.

Limit equilibrium or similar slope stability analyses may be useful in developing a supporting rationale in some circumstances, but typically require more detailed information than is obtained in a *TSA*. Slope stability analyses normally requires subsurface investigation, and testing and evaluation of groundwater conditions and the geotechnical properties of subsurface materials. The accuracy of the analysis depends on the accuracy of the data and is limited by the variability that typically exists at the spatial scale of *operations*. If particular circumstances justify slope stability analysis, such work should be considered a specialty service outside the scope of a typical *TSA* (Section 6).

5.5 REPORTS

TSA report format and content may vary to suit the needs of the *client*, the target readers and the scope of the *TSA*. Typically the primary user of the *TSA* is a *forest professional* responsible for *planning*. The *terrain specialist* should review the format and contents of the report with his/her *client* to check that the report will provide sufficient and appropriate information, and will meet the professional standards of both the *terrain specialist* and the *client*.

A *TSA* report typically includes the following:

- objectives;
- scope and limitations of work;
- available background information, what information was used and its relevance;
- methodology, including the extent of fieldwork;
- observations;
- method of analysis;
- supporting rationale (Section 5.4);
- established or implied acceptable *hazard* or *risk* criteria, as applicable to the scope of the *TSA*;
- relevant and reliable maps and figures;
- conclusions;
- recommendations and options to manage *hazards* or *risks*, if this is part of the scope of work;
- recommendations for when and where *field reviews* should be done;
- definitions of qualitative *hazard* or *risk* ratings used; and
- other information as specified in the scope of work.

It is usually desirable to describe and rate *hazard* or *risk* by specific areas (for example, homogenous terrain units, road segments) within an *operations* area, rather than providing a single *hazard* rating for the entire area.

The report should be clearly written with sufficient detail to allow the *client* to implement the recommendations and evaluate options. There should be sufficient detail to allow other *terrain specialists* to understand the supporting rationale, conclusions, recommendations and options. The report should contain enough information to enable the *client* to understand the *hazards* or *risks*, and to be able to evaluate whether they are acceptable.

If the *operations* are within a jurisdiction that has local or provincial *government landslide hazard* or *risk* acceptability criteria, the report should compare the *hazards* or *risks* to those criteria.

A peer review of the *TSA* report is encouraged as part of the quality assurance/quality control program (Section 7.4).

5.6 Limitations of the Terrain Stability Assessment and Terrain Stability Assessment Report

The *TSA* report should specify the limitations of the *TSA* and report. Examples of items typically addressed under limitations include:

- the standard of care followed while carrying out the *TSA*;
- interpretation of subsurface conditions from surface observations;
- terrain and weather conditions that could affect the observations;
- the *TSA* report is based on professional judgement and does not represent a guarantee; and
- restriction of the use of the report to the *client* for its intended purpose.

As an example, subsurface conditions are inferred from observations of surface characteristics.

The *client* must fully understand and appreciate the limitations, and understand when unexpected subsurface conditions warrant further assessment by the *terrain specialist.*

As another example, *TSA* do not typically include bridge foundation investigations and assessments, nor do they typically consider the effects of earthquakes. Such work is considered specialty services (Section 6).

5.7 Field Reviews

APEGBC's Quality Management Bylaw 14(b)(4) requires *field reviews* of projects under construction as a component of a *professional engineer's, professional geoscientist's* or *license holder's* quality assurance and due diligence. Under the *Forester's Act* the practice of professional forestry includes "assessing the impact of professional forestry activities to verify that those activities have been carried out as planned, directed or advised".

The purpose of *field reviews* is to:

- verify conformance to the *member's* plan or design; and/or
- confirm that actual ground conditions encountered during road construction are as anticipated in the *TSA*; and if different, to reassess whether the *terrain specialist's* recommendations that were incorporated into the *road plan* or design are suitable or should be revised.

The need for *field reviews* is based on the professional judgment of the *terrain specialist*. The extent to which *field reviews* for conformance or to reassess ground conditions are recommended by the *terrain specialist* depends on:

(a) the severity of the *landslide hazards*;
(b) value of elements at *risk* with particular attention paid to worker safety;
(c) complexity or sensitivity of the terrain;
(d) complexity of the recommendation(s); and
(e) potential effect that variations in the subsurface conditions could have on the analysis and recommendations.

Field reviews are particularly important where the *operation* presents a significant *hazard* to adjacent elements at *risk*; where non-typical forest *operations* are recommended; and where variations in the subsurface conditions could significantly affect slope stability within or connected to the *operations*.

Field reviews are required for all designs resulting from specialty services (Section 6).

Where a *field review* has been recommended by the *terrain specialist*, the *terrain specialist* should inform the *client* that in order to meet the intent of the above requirements defined in professional legislation and for the *terrain specialist* to be accountable for the completed work, then the *client* needs to provide adequate opportunity for *field reviews.* The *terrain specialist* should clarify the expectation around *field reviews* with the *client*, and make sure that the *client* understands that the *terrain specialist* may be unable to take responsibility for the outcome if there is insufficient *field review*.

While not exhaustive the following examples are provided in the context of *TSAs:*

- for a cutblock, a *terrain specialist* has recommended that a falling boundary be positioned at a certain location to avoid unstable terrain, and based on his/her assessment of *risk*, has recommended a *field review* of the final cutblock boundary to verify that falling boundary markings are physically located as intended. This could be done during the course of the initial fieldwork; that is, the falling boundary is positioned during the assessment. *Field review* of the block boundary can also be delegated, for example, where a *forest professional* verifies the block boundary location and reports this back to the *terrain specialist*.
- for a road, where a *TSA* has recommended a particular construction method for a specified section (e.g. end haul) based on expected ground conditions, and that recommendation has been incorporated into a *road plan*, a *field review* would be done to verify that ground conditions were as anticipated by the *terrain specialist* and construction was done as intended.

The *terrain specialist* may delegate *field reviews* to another individual that acts under his/her direct supervision (Section 7.2).

The results of *field reviews* should be communicated to the *client* in a timely and effective manner.

Field reviews do not replace the need for appropriate supervision on the part of the *client*. Nor do they relieve road or harvesting personnel of their responsibilities to supervise the work, conduct the work in accordance with good practice and provide safe working conditions.

*Terrain specialist*s should encourage their *client*s to inform them of the results of the *operations* on terrain, for example, actual ground conditions encountered, or occurrence of *landslides* subsequent to the *operation*.

5.8 SUPPLANTING THE TERRAIN SPECIALIST

If another *terrain specialist* is retained to advise on terrain stability issues or to conduct *field reviews*, that *member* should carry out *TSAs* and *field reviews* as required to accept full responsibility for the terrain stability aspects of the *operations*.

6 SPECIALTY SERVICES

Different types of *TSAs* require different skill sets (Section 8). As well, an individual *terrain specialist* may have a special area of expertise. *Terrain specialists* must adhere to their Code of Ethics and provide specialty services only when qualified by education, training or experience.

Common specialty services that are not part of a typical *TSA* include:

- full rather than partial *risk* analysis;
- retaining wall investigation and design;
- design of reinforced or mechanically stabilized slopes;
- investigation and design of bridge foundations and/or abutments;
- design of road base or sub grade stabilization works;
- snow avalanche *hazard* assessments and design of mitigation measures;
- *landslide* investigations and design of mitigation measures;
- investigation and design of debris flow control structures;
- subsurface drainage design;
- investigation and design of slope stabilization works;
- safe entry instructions, where required by worker safety legislation;
- *landslide* rehabilitation and stream channel restoration;
- soil erosion assessment and design of mitigation measures;
- seismic slope *hazard* assessments;
- detailed *hazard analysis* to better estimate probability or occurrence, potential magnitude and run-out.

In these cases a detailed and thorough knowledge of these subject areas is required, beyond the normal level of knowledge expected for *TSAs*.

For example, where downslope *consequences* are not forest development and are high, such as public safety, infrastructure, or private property, a high level of due diligence is required. *Risk* management approaches may include consideration of specific silviculture systems or road strategies to reduce *risk*; and include more rigorous assessments for identification of *hazard* and *risk*. Depending on the *risk* management approach being employed, a higher level of investigation and expertise would be expected than is typical for a *TSA*. This could involve *specialist* services to undertake:

a) a more detailed *risk* analysis rather than partial *risk* analysis (*refer to Land Management Handbook 56*);
b) a more rigorous site investigation such as field mapping of historic IIandslide events; or
c) determination of the probability of occurrence of events with varying magnitudes and runout distances.

Landslide investigations are another example of a specialty service and may be conducted to determine the factors that contributed to the *event*, the mechanism of failure and the effects; and to provide recommendations and options for managing residual or future *hazards* and *risks*. The scope of work required for a *landslide* investigation depends on the magnitude of the *landslide*, the damage caused by the *landslide* and the elements at *risk*. *Landslide* investigations where the value of the elements at *risk* are relatively low may simply involve a review of background information and field reconnaissance. Where the value of the elements at *risk* are greater, more thorough investigations are usually required and can include drilling, sampling, instrumentation, laboratory testing and detailed slope stability analyses.

Specialty services are beyond the scope of a typical *TSA*. If a *specialist* service is warranted, the *terrain specialist* should inform the *client* whether or not he/she is qualified to carry out the required specialty service and, if so, should agree upon a suitable scope of work.

7 QUALITY ASSURANCE AND QUALITY CONTROL

A *terrain specialist* should carry out quality assurance and quality control (QA/QC) for *TSAs* that he/she is responsible for. The level of QA/QC depends on:

- the complexity of the terrain;
- the *hazards* and *risks;*
- the training and experience of the *terrain specialist* in relation to the terrain, and the *hazards* or *risks;* and
- whether field observations for the *TSA* or *field review* are made directly by the *terrain specialist* or under his/her direct supervision.

7.1 APEGBC AND ABCFP QUALITY MANAGEMENT BYLAWS

For *APEGBC members* a QA/QC program must, as a minimum, satisfy the requirements of *APEGBC* Quality Management Bylaws 14(b)(1), (2), (3) and (4) with regards to:

- retention of complete project files for a minimum of 10 years;
- in-house checks of designs as standard procedure;
- independent reviews of the designs of structural protective works that require the engagement of a *professional engineer* having the appropriate training and experience; and
- *field reviews* at the project site considered necessary, in the *member's* opinion, to ascertain whether or not the significant aspects of the work are considered in general compliance with the *member*'s recommendations. [6]

Under Quality Assurance Bylaw 13 *ABCFP* has a continuing competency program with the following elements[7]:

- self assessment, required to be done annually by the *member*;
- peer review, at the judgment of the *member*; and
- practice review, undertaken by *ABCFP* on *members* selected randomly.

7.2 DIRECT SUPERVISION AND FIELD REVIEWS

Another *member* or non-member can be delegated to carry out *field reviews* under the direct supervision of the *terrain specialist* responsible for the *TSA*.

Direct supervision means taking responsibility for the control and conduct of the work of a subordinate.

With regards to *field reviews* this could typically take the form of specific instructions on what to observe, check, confirm, test, record and report back to the *terrain specialist* who is responsible for the *TSA*. The *terrain specialist* should exercise judgment when relying on delegated field observations by conducting a sufficient level of review to be satisfied with the quality and accuracy of those field observations.

7.3 SUPPORTING RATIONALE

A key component of a *member's* QA/QC program is having a documented rationale to support his/her conclusions and recommendations. The *terrain specialist* must be able to provide supporting

[6] APEGBC membership approved new Quality Management Bylaws which are awaiting government approval. As a result this section will be updated in December 2010.

[7] "A continuing competency program for members of the ABCFP". Approved by ABCFP council July 2003.

rationale for his/her recommendations backed by the appropriate level of analysis carried out. Section 5.4 discusses supporting rationale in the context of *TSAs*.

7.4 INTERNAL AND EXTERNAL PEER REVIEW

Where the *terrain specialist* considers it appropriate the QA/QC program should include an internal and/or external peer review of the *TSA*. This should occur before the *TSA* recommendations are incorporated into *planning*. An internal peer review is carried out by another *member*, usually employed by the same organization. An external peer review is carried out by a *member* who is independent and may be a *specialist*.

The level of peer review undertaken should be based on the professional judgment of the *terrain specialist*. Considerations should include the stability and complexity of the terrain; type of elements at *risk;* availability, quality and reliability of background information and field data; and the *terrain specialist's* training and experience. If the peer review includes reviewing the analyses and professional judgment of the *terrain specialist*, then the reviewing *member* should also be a *terrain specialist*.

The external peer review process should be more formal than an internal review and it should be appropriately documented. An external reviewer should submit a signed, sealed and dated letter or report, to be either included with the report or put on file, which includes the following:

- limitations and qualifications with regards to the review, and
- results of the review.

For both internal and external peer reviews, the name of the reviewing *member* should be identified in his/her report.

8 SKILL SETS FOR TERRAIN STABILITY ASSESSMENTS

The *terrain specialist* must adhere to his/her respective Code of Ethics and have appropriate education, training and experience (collectively referred to as 'skill sets') consistent with the services provided. *Members* that conduct *TSAs* without sufficient skill sets may be subject to disciplinary action.

Professional competence in a subject area is gained from:

- formal study such as university courses; or equivalent knowledge gained from short courses, workshops and self study;
- work experience, usually with mentoring by a senior professional with relevant expertise; and
- continuing professional development – keeping abreast of emerging literature, research and studies.

Table 1 and Sections 8.1 – 8.4 summarize the common skill sets required to carry out all *TSAs*, as well as specific knowledge required to carry out different types of *TSAs*:

- for cutblocks and upslope *hazards*;
- for proposed route corridors; and
- for road construction, maintenance, deactivation or reactivation.

Where the *terrain specialist* does not have the full skill set for a particular type of *TSA*, the required skills can be met through a team approach.

Where downslope elements at *risk* include public health and safety, infrastructure or private property, skill sets beyond those required for typical *TSAs* are expected. Such skill sets could involve specialty services (Section 6).

8.1 SKILL SETS COMMON TO ALL TERRAIN STABILITY ASSESSMENTS

A basic requirement for all *terrain specialists* is an undergraduate science or applied science degree to provide a background in scientific method and analysis. Key to all *TSAs* is a professional level of understanding of geomorphology, geology, terrain identification, and terrain response to development. An understanding of the parameters that can affect *landslide* initiation, transport and deposition is essential. Mere familiarity with these topics is inadequate.

TSAs typically require thorough field observations of terrain features and visible exposures of surficial materials and bedrock, augmented with airphoto interpretation of the terrain surrounding the proposed forest development. Subsurface investigation or materials testing is not normally part of a *TSA*. For this reason, the *terrain specialist*'s terrain identification and field observation skills are highly important.

A *terrain specialist* should be familiar with local resource materials and regulatory requirements relevant to terrain stability and natural *hazards* in the forest sector. For example: Ministry of Forests' Technical Reports and Land Management Handbooks; Occupational Health and Safety regulations pertaining to *landslides*.

A *terrain specialist* is expected to understand the specific *landslide* concerns associated with *operations* for the region(s) in which he/she works, and to keep abreast of new and pertinent information and research.

Climate scientists have highlighted the increasing frequency of extreme climatic events as a result of climate change. *Terrain specialist*s should be aware of emerging literature on this subject as it relates to prediction of *landslide* occurrence for *operations* and where deemed appropriate consider such effects in assessing the stability of terrain.

See Table 1, column heading '*TSA* Type All'.

8.2 Type 1 – Skill Sets Specific to Terrain Stability Assessments for Cutblocks and Upslope Hazards

In addition to the common skill sets, a *terrain specialist* should be familiar with regional terrain conditions in the area, with the type of *landslides* that occur naturally or as a result of *operations* in the region, and with the factors associated with *operation* related *landslide*s. He/she should also be familiar with harvest and silviculture systems and methods most commonly used in the region.

This type of assessment requires the ability to identify terrain types, particularly natural and development-related *hazards*; to interpret the spatial and temporal extent of the *hazard*; and an understanding of the potential terrain response to harvesting.

See Table 1, column heading '*TSA* Type 1'.

8.3 Type 2 – Skill Sets Specific to Terrain Stability Assessments for Proposed Route Corridors

In addition to the common skill sets, a *terrain specialist* who carries out *TSAs* for proposed route corridors needs to understand typical access requirements for various silviculture systems, and should be able to identify landform characteristics important for road performance, and terrain response to road construction.

This type of assessment also requires the ability to identify terrain types, particularly natural and development-related *hazards* and to be able to interpret the spatial and temporal extent of the *hazard*.

See Table 1, column heading '*TSA* Type 2'.

8.4 Type 3 – Skill Sets Specific to Terrain Stability Assessments for Road Construction, Maintenance, Deactivation or Reactivation

In addition to the common skill sets, a *terrain specialist* who carries out *TSAs* for road construction, maintenance, deactivation or reactivation should understand forest road design; historic forest road stability issues and the factors that caused them; forest road construction methods; and limitations and relative costs of commonly used equipment. This type of *TSA* requires a higher level of knowledge of soil mechanics, slope stability, and of surficial materials and rock characteristics that affect the performance, stability and safety of the road. He/she should also be familiar with applicable regulatory requirements as well as standard operating procedures normally used in the *licensee's* operation for road construction, maintenance, deactivation and reactivation.

See Table 1, column heading '*TSA* Type 3'.

Table 1 -- Skills Sets for TSAs

TSA Type				Skill Sets
All	**1**	**2**	**3**	
x	x	x	x	**1. Basic requirement: Bachelor of Science or Applied Science, or equivalent**
				2. Subject areas and equivalent level of knowledge
				2.1 Introductory university-level courses or technology program equivalents*
x	x	x	x	Terrain analysis/airphoto interpretation
x	x	x	x	Terrain stability assessments/geotechnics/risk analysis
x	x	x	x	Field geology/field surveying/field techniques
x	x	x	x	Soil science/soil physics
		x	x	Structural geology/rock mechanics
		x	x	Soil mechanics/slope stability analysis
				2.2 Introductory <u>and</u> Advanced university-level courses*
x	x	x	x	Geomorphology/landforms/surficial geology/Quaternary geology
x	x	x	x	Hydrogeology/groundwater geology
x	x	x	x	Hydrology/surface water/fluvial geomorphology***
x	x	x	x	Natural hazards/landslides/remedial measures
				2.3 General familiarity and understanding of subject matter
x	x	x	x	BC Terrain Classification System/terrain stability mapping classification for forestry
x	x	x	x	Biogeoclimatic Ecosystem Classification system (BEC)
x	x	x	x	Forest access planning/forest harvesting systems/silvicultural systems
x	x	x	x	GIS/CADD/cartography/digital information sources
				2.4 Familiarity and understanding of subject matter, specific to region
x	x	x	x	Vegetative indicators of soil/water relationships
x	x	x	x	Soil characteristics and stability behaviour
x	x	x	x	Relationships among terrain, hydrology and meteorology.
x	x	x	x	Types and causes of landslides associated with forest development
x	x	x	x	Common road construction, harvesting and silvicultural systems
	x			Windthrow occurrence and influence on stability.
		x	x	Access requirements for silvicultural systems
		x	x	Landform characteristics and terrain response to road construction and performance
			x	Forest road design principles/water management/crossing structures.
			x	Methods of forest road construction/equipment types/licensee's SOP's
			x	Factors affecting workability/stability/performance of road fills and cutslopes.
			x	Relevant regulatory requirements for forest road assessment, design or construction.
				3. Field Experience
x	x	x	x	Typically a member with suitable experience would have three to five years experience relevant to terrain stability, with a strong field component, under the supervision of a senior professional. At least one year related to field identification of terrain in the forest sector (or a similar resource sector) under the supervision of a senior terrain stability or forest professional.
x	x	x	x	Field experience in the region to gain an understanding of regional terrain characteristics, forest development approaches and harvest systems used.
		x	x	Field experience with forest professionals who do forest road layout and prepare forest road designs
			x	Time spent on road construction or deactivation with grade foremen and operators both during and following construction.

TSA Type: **All**: Common to all TSAs **1**: TSAs for cutblocks and upslope terrain hazards **2**: TSAs for proposed road locations **3**: TSAs for road construction, maintenance, deactivation or reactivation

**Introductory*: Understanding of subject, typically gained in university-level introductory or technology program courses.

***Advanced*: Thorough knowledge of subject, typically gained in advanced university courses.

***Fluvial Geomorphology required when a *Terrain Stability Assessment* evaluates effects to stream channels.

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