Quality Assurance Guidelines: Terrain Stability Mapping (TSM)

Draft

Prepared by
Ministry of Environment, Environmental Stewardship Division, Ecosystem Information Section
For the Resource Inventory Committee

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Version 1.0

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1. Introduction

1.1. Purpose

This draft document is intended to provide the basis for a Resource Information Standards Committee (RISC)-approved Terrain Stability Mapping (TSM) Quality Assurance (QA) Guideline. Its purpose is to provide a consistent QA process for all TSM data destined for the BC Government Corporate Data Warehouse including Forest Investment Account (FIA) funded projects. A general approach to QA on ecological data collection projects is described in the document *Introduction to Quality Assurance Procedures*; however, the document does not include QA for TSM projects. The outlined QA procedure is appropriate for third-party QA, internal Quality Control/Quality Assurance and professional sign-off.

1.2. Scope

This TSM QA guideline outlines the procedures for completing a QA review of a TSM project.

This document does *not* provide detailed QA review procedures for digital data capture and submission of TSM. It must be used in conjunction with other QA guideline documents and RISC standards, as shown in the following table:

Guidelines or Standards Document	**Required for:**
Guidelines and Standards for Terrain Mapping in British Columbia (1996)	Reviews of the methodology to complete terrain mapping in British Columbia for use in any resource sector.
Introduction to Quality Assurance Procedures (2003)	Background and general guidelines for QA
Manual for Describing Terrestrial Ecosystems in the Field (1998)	Reviews of field data
Mapping and Assessing Terrain Stability Guidebook (1999)	Reviews of TSM projects and includes guidelines on the required level of field checking.
Terrain Classification System for British Columbia. Revised Edition (1997)	Reviews of terrain projects that use the provincial classification system for surficial materials, surficial material texture, surface expression, bedrock and geomorphological processes.
Standard and Procedures for Integration of Terrestrial Ecosystem Mapping (TEM) and Vegetation Resources Inventory (VRI) in British Columbia Version 1.0 (2002)	Reviews of TEM projects completed in conjunction with VRI (VRI QA review to be completed according to RISC standards)
Standard for Digital Terrain Data Capture in British Columbia. Terrain Technical Standard & Database Manual. Version 1 (1998)	Reviews of the digital requirements for terrain mapping projects completed in the province, including TSM projects.
Standard for Digital Terrain Data Capture in British Columbia Errata 2006-1.1 (2007)	Reviews of the terrain digital data standards. This manual includes updates to the RIC 1998 document.
Standard for Terrestrial Ecosystem Mapping in British Columbia, Version 1 (1999)	Reviews of TEM projects
Standards for Terrestrial Ecosystems Mapping - Digital Capture in BC (2000)	Reviews of spatial and non-spatial TEM databases
Terrestrial Ecosystem Information Digital Data Submission Standard – Draft for Field Testing (database and GIS data Standards) Version 1.0 RISC (2010)	Reviews of the terrain digital data standards.

2. Quality Assurance Procedures for TSM

This section provides specific guidelines for TSM QA procedures. These guidelines are in addition to the general QA guidelines outlined in the *Introduction to Quality Assurance Procedures*.

A TSM QA review can follow all seven QA review stages outlined in section 2.1 or it can be tailored to a TSM project by selecting a subset of the stages. When selecting a subset of the stages, consider the risks of not following all seven stages with the project objectives, experience and expertise of the mapper, and the overall quality of the inventory and data. QA review stages 1, 5, 6 and 7 are the minimum required for a third-party QA in this guideline. The outcome of any QA review stage may trigger further review at that stage or point to the necessity of an omitted QA review stage. These procedures and the QA forms can be used as part of internal QA/QC professional sign-off.

2.1. QA Procedures – Review Stages

The following review stages outline the QA procedures common to all TSM projects. Where other RISC standard attributes are included as a component of TSM, the applicable QA guidelines should be followed (See section 1.2 Scope).

1. Project Planning

The purpose of QA review stage 1 is to ensure that:

- Inventory methods reflect the project objectives.
- The appropriate background information has been gathered.
- The terrain professional has the appropriate qualifications, training and supervision.
- The project design conforms to the contract requirements, specified RISC standards and procedures, and other best management practices.

QA review stage 1 is a minimum requirement for a third-party QA in this guideline as subsequent review stages cannot be completed without the information listed above.

If QA review stage 1 is carried out in conjunction with project start-up, it typically involves a meeting between the QA contractor and the mapping contractor, as well as the client, the contract monitor and anyone else involved in the project. The main objectives of a start-up meeting are to:

- Familiarize the QA contractor with all aspects of the project.
- Familiarize the mapping contractor, the client, and the contract monitor with the QA process.
- Review the project design for conformance with RISC standards.
- Highlight mandatory requirements and expectations.
- Clarify the roles and responsibilities of each individual during each stage of the QA process and TSM project. See example roles and responsibilities at http://www.env.gov.bc.ca/terrain/terrain_files/roles.html

Deliverable: QA Form T1.

2. Pretyping

The purpose of QA review stage 2 is to ensure that the mapping meets all RISC standards for both TSM and terrain mapping. In particular, polygon delineation and labelling will be reviewed. QA review of the pretyping ensures that the interpretation and application of the inventory standards is done correctly, that there is adequate training and supervision of junior mappers to ensure consistent and quality

interpretations, that the methods reflect all relevant standards, guidelines, and best management practices, and that the methods will support final deliverables to meet contract requirements. This review stage can address mandatory requirements but can also provide an opportunity for mentoring and exchange of expertise—both the QA reviewer and mapper can benefit from this QA stage. The QA form for this stage is a useful tool for internal QA/QC and training of junior mappers. Ideally, the QA review of pretyping is conducted during the early stages of the terrain polygon delineation. Conducting this QA review after the pretyping is completed is possible but can be costly if critical mapping issues are identified.

The risk of skipping this stage is that the mapping interpretations from the imagery may not support adequate field sampling where features are not being recognized.

Use the general questions on the QA form and also provide polygon-specific examples with annotated notes to give the mapper a clear idea of any areas that need modification, field verification, etc. These annotated notes should also be documented and included in the QA report. Any subtypes designated by the mapper should be approved by the provincial terrain specialist.

Deliverable: QA Form T2.

3. Field Sampling

The purpose of QA review stage 3 is to ensure that the field crew is collecting data consistently, meeting the RISC standard, collecting data that will support the objectives of the project, and fulfilling other contract requirements. QA review stage 3 has components:

- pre-field (field work planning),
- field (field techniques, recording of data, correlation between crews, etc.), and
- post field (data consistency and completeness) components.

The post-field component is the minimum requirement for QA review stage 3 and ensures that all required data have been collected to standard and that the number and location of field sites meet the project objectives. Conducting QA review stage 3 with all three components after the field work is completed is possible but can be costly if critical issues are identified, especially, if the mapper did not address field techniques.

The risk of skipping this stage is that field work (the most costly portion of most projects) may not be conducted in a consistent manner to adequately support the final mapping and interpretations. If errors are detected in later stages or in a post-field review, revisiting field sampling can be cost prohibitive.

Design field sampling QA to account for risks associated with multiple field personnel of varying experience/expertise, multiple crews, a variety of field site types, and the variety of data being collected. Wherever multiple field crews are collecting data, assess each crew in the field.

Detailed review procedures are outlined in the QA forms. Record all recommendations, whether made in the field or in the office, and submit as part of the final QA report.

Deliverable: QA Form T3.

4. Final Terrain Stability Mapping

The purpose of QA review stage 4 is to ensure that the final terrain stability mapping meets RISC standards, has incorporated the field findings, has consistently applied interpretation criteria, and has been digitally captured, correctly. This review stage involves the review of the polygon delineation and labeling for the post-field TSM on the air photos/images and draft digital and/or hardcopy maps (if stand-

alone terrain maps and terrain interpretive maps are required in the contract). Consider how slope stability criteria are incorporated into the terrain delineation and terrain polygon labels.

The risk of skipping this stage is that final digital deliverables will have to be reproduced to correct any errors found. Time and cost for GIS processing and production of final hardcopy maps will be increased if errors are found in later QA review stages. If review stage 2 was also skipped this would be the final opportunity to scrutinize image interpretations (see risks listed in section 2. Pretyping).

Communicate with the contract monitor, and if needed, the appropriate government specialist, to ensure that the terrain linework adequately supports all deliverables and project objectives. Also ensure that comments and feedback from preceding stages of QA, that affect the final terrain stability mapping, have been adequately addressed. Complete the general questions in the QA form and document all polygon specific comments and/or general comments to submit as part of the final QA report.

Deliverable: QA Form T4.

5. Spatial and Non-Spatial Database

The purpose of QA review stage 5 is to ensure that the Geographic Information System (GIS) spatial data meet RISC standards required for loading into the provincial Corporate Data Warehouse. Also, this stage ensures that non-spatial data (e.g., user-defined fields, report, field notes, quality assurance/quality control reports, and sign-off letters or project completion certificates) meet digital standards requirements. Both terrain inventory and GIS expertise is required to complete this stage.

QA review stage 5 is a minimum requirement for third-party QA in this guideline and for any dataset destined for the provincial Corporate Data Warehouse. The risk of skipping this stage for government-funded datasets is that the deliverables may not meet RISC digital deliverable standards and will be sent back to the proponent at a later date for correction at their own cost. The risk of skipping this stage for any datasets is that they may not be published or will be published with flagged errors. Also the use of any tools and value-added products dependent on standardized terrain data will not be possible or may produce erroneous results.

The nature of terrain digital data for TSM makes it very difficult for automated data capture tools to detect every possible error. These tools are unable to detect errors that fall within acceptable ranges or are subjective by both definition and application. Design QA procedures to address common errors, anomalies, and illogical attribute combinations that are beyond the capability of these tools. For critical data elements subject to zero-error tolerance, electronic data checking is imperative. In order to increase efficiencies, the QA contractor should inform the provincial terrain specialists of any common errors or misconceptions not captured by these tools. Future upgrades can incorporate such recommendations. Contact soilterrain@victoria1.gov.bc.ca for current digital data QA tools and templates and to identify any gaps or errors in these tools.

Deliverable: QA Form T5.

6. Final Mapping Deliverables

The purpose of QA review stage 6 is to ensure that all final deliverables are provided in the standard formats required for loading into the provincial database. Final deliverables typically include the final TSM project report in .pdf format, field notes and field data cards in .pdf format and/or Microsoft Excel .xls format, complete set of typed air photos/images (if air photo interpretation was completed), final

digital files containing project information, terrain polygons with full attributes, terrain on-site features, sample sites, and user-defined fields (as applicable).

QA review stage 6 is a minimum requirement for third-party QA in this guideline and for any dataset destined for the provincial Corporate Data Warehouse. The risk of skipping this stage for government-funded datasets is that the deliverables may not meet RISC digital deliverable standards and will be sent back to the proponent at a later date for correction at their own cost. The risk of skipping this stage for any datasets is that they will not be published or will be published with flagged errors. Also the use of any tools and value-added products dependent on standardized terrain data will not be possible or may produce erroneous results.

Thoroughly review the final TSM project report, including legends, to ensure that it is correct and complete. Ensure that all project deliverables have been delivered as outlined in the original TSM contract. Also ensure that comments and feedback from preceding stages of QA, that affect the final terrain stability mapping, have been adequately addressed. There is a zero-error tolerance for critical data elements submitted to the province. For more details regarding mandatory government deliverables please refer to the *Standard for Digital Terrain Data Capture in British Columbia Errata 2006-1.1 (2007)* or contact soilterrain@victoria1.gov.bc.ca.

Complete the general questions in the QA form and document all polygon specific comments and/or general comments to submit as part of the final QA report. Upon project completion, review and sign-off all final deliverables accordingly, if acceptable.

Deliverable: QA Form T6

7. QA Summary and Sign-off

The purpose of QA review stage 7 is to keep track of the status of the other QA review stages relative to the final sign-off each stage, in particular, where multiple submissions are deemed necessary at a given review stage.

Upon delivery and acceptance of all final deliverables, complete and submit the QA summary and sign-off form (Form T7) as part of the final QA report. The number of submissions required before acceptance of each individual QA review stage should be indicated along with the date of the final sign-off.

Deliverable: QA Form T7

2.2. QA Deliverables

Submit the final QA deliverables as described in *Introduction to Quality Assurance Procedures,* section 1.3 How to Use These Guidelines.

The final TSM QA report includes:

- All completed QA sign-off forms (Form #T1-T7) – either signed-off by a third-party QA contractor or by the mapping contractor;
- All additional review and sign-off forms from other QA Guidelines – either signed-off by a third-party QA contractor or by the mapping contractor;
- Any additional review documentation and communications.

It is the responsibility of the client to deliver all final TSM QA data to the province. Contact soilterrain@victoria1.gov.bc.ca for data delivery instructions.

3. QA Forms

QA forms, complete with project information fields, checklists, review questions and sign-off, are provided in this section. Use the forms to document QA correspondence for each review stage. Fill out separate forms for multiple submissions of a particular stage (e.g., if it takes three submissions to pass review stage 2 then three T2 forms will be filled out). Include these forms as part of a formal QA report or to document QA/QC procedures. These forms and procedures conform to the Association of Professional Engineers and Geoscientists of BC's Quality Management Bylaws 14(b) (1) and (2) which outline document retention and in-house checks of design and procedures. The QA forms also provide evidence of direct supervision as outlined in the Engineers and Geoscientists Act Section 1 (1). Formal submission is in .pdf format. It is recommended that mappers use these QA forms to perform internal QA/QC reviews prior to submission of any project materials.

The first section, at the top of each form, includes the form number and title followed by several fields for general project information including submission number, date of the review, project name, and the name(s) of the mapper(s).

The second section is a materials checklist to be submitted by the mapper to the QA reviewer for each QA review stage. Some of the listed materials are repeated on different QA forms because TSM QA is currently optional; therefore, each QA review stage is optional.

The third section is a list of QA review questions intended to guide the review process. Supplement these yes/no review questions with comments and recommendations, including the following information:

- An explanation of errors and omissions with specific examples from the mapping project (where appropriate);
- An indication of the extent of an error, expressed either qualitatively (e.g., several, few, minor, major, etc.) or quantitatively (e.g., three out of the 60 polygons reviewed);
- Recommendations on how to correct the error; or
- Highlight exceptional work

Additional comments/recommendations can be accommodated by adding more space under each question or by appending them as a separate section in the report. A separate section is advised for detailed air photo/image interpretation, polygon-specific comments for forms T2, T4 and T6, and for field work, site-specific comments for form T3. Where no polygon numbers are available, it is recommended that each comment be numbered and indicated on the air photo/image or mapsheet. Please refer to the form and question number if reporting comments/recommendations in a separate section (e.g., form T2 question 5). Add extra questions to the end of the list where needed. It is critical that the QA comments clearly indicate all corrections that are required for successful completion of the mapping process. As with the second section, some of the questions in section three are repeated on different QA forms because each QA review stage is optional.

The fourth and final section is for sign-off. This section can be used to document internal QA/QC or for third-party review by a QA contractor. The QA contractor indicates whether or not the particular submission meets RISC standards and the requirements in the mapping contract. A QA review stage is only considered to be signed-off once the QA contractor has checked the 'yes' box under 'Acceptable?' and signed their name. If a subset of the seven QA review stages were selected for a third-party QA, it is to the advantage of the QA contractor and client to have the mapping contractor sign-off the remaining subset of review stage's particular project deliverable. In addition to the QA forms provided for each of the review stages there is also a TSM QA summary sign-off form (Form #T7). This form includes a field

to indicate the total number of submissions that were required before the completion and sign-off of each review stage. The summary sign-off form should be kept up to date and used as a method of tracking project status. Note that these forms must be submitted electronically as part of the final QA report (please see section 1.3.2 of the *Introduction to Quality Assurance* for further QA reporting details).

The following forms are included for these guidelines:

Form T1: Project Planning QA
Form T2: Pretyping QA
Form T3: Field Sampling QA
Form T4: Final Terrain Stability Mapping QA
Form T5: Spatial and Non-Spatial Database QA
Form T6: Final Mapping Deliverables QA
Form T7: QA Summary and Sign-off

Form T1: Project Planning QA

Submission # _____ **Date of Submission** _____

Project Name _____

Mapper(s) _____

_____

_____

Materials checklist:

- ❑ Contract/Terms of Reference/Request for Proposals outlining the project objectives.
- ❑ Project proposal/plan indicating the methodology, roles and responsibilities of each person outlined in the contract, and work schedule.
- ❑ Large-scale topographic maps (e.g., 1:20,000 TRIM) of project area, with project area boundaries clearly marked.
- ❑ List of background information for the project area including existing terrain, soils, and geology maps and/or reports.
- ❑ List of project information including the total number of air photos/images, maps, area (ha), mapping team, contact information, etc.

Comments/Recommendations: _____

_____

Project Planning QA Review Questions:

1. Are project objectives clearly defined and appropriate? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____
2. Are all relevant RISC standards listed in the contract? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____
3. Is the proposed methodology appropriate for the stated objectives? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____
4. Will the mapping be completed and/or supervised by a qualified registered professional (QRP) (e.g., P.Geo. or P.Eng in good standing, qualified and recognized as a specialist in terrain mapping (i.e., training and experience as outlined in the Terrain Mapping and Interpretations Skill Sets for qualified registered professionals by the APFBC/APEGBC Joint Practice Board)? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____
5. Is the air photo/image scale and resolution appropriate for the stated objectives? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____

6. Are project and study area boundaries appropriate and are they outlined at an appropriate scale? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____

7. Have boundaries from previously mapped adjacent areas been taken into account? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____

8. Prior to commencing pretyping, did the mapping contractor thoroughly review previous work on terrain, surficial geology, bedrock geology and soils that had been carried out in both the study area and the broader region? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____

9. Is the Terrain Survey Intensity Level (TSIL) appropriate for the stated objectives (take into account mapper experience, terrain-complexity and access)? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____

10. Has a BAPID (Business Area Project IDdentification) number been requested or assigned to the project from the province? If yes, please record below. ❑Yes ❑No ❑N/A
    Comments/Recommendations: _____

11. Other: ❑Yes ❑No ❑N/A
    Comments/Recommendations: _____

QA Sign-off:

Name (Please Print)	**Signature**	**Acceptable?**	**Review Date**
		❑Yes ❑No	

QC Sign-off:

Name (Please Print)	**Signature**	**Date Signed**

Form T2: Pretyping QA

Submission # _____ **Date of Submission** _____

Project Name _____

Mapper(s) _____

_____

_____

Materials checklist:

- ❑ Contract/Terms of Reference/Request for Proposals outlining the project objectives.
- ❑ Project proposal/plan indicating the methodology, roles and responsibilities of each person outlined in the contract, and work schedule.
- ❑ Large-scale topographic maps (e.g., 1:20,000 TRIM) of project area, with project area boundaries clearly marked.
- ❑ Flight line/image index map with project boundaries and flight lines/images clearly marked.
- ❑ An agreed upon, representative sample of air photos/images with preliminary terrain mapping (pretyping) completed—this sample should represent the diversity of terrain types in the project area and the situation where there are multiple mappers.
- ❑ Preliminary criteria for interpretations (e.g., slope stability, erosion potential, landslide induced stream sedimentation, potential sediment delivery from surface erosion sources).
- ❑ List of background information that has been reviewed for the project area including any existing terrain, soils, and geology maps and/or reports.
- ❑ List of project information including the total number of air photos/images, map sheet(s), area (ha), mapping team, contact information, etc.
- ❑ A list indicating the areas or air photos/images mapped by each of the mappers (if more than one mapper).

Comments/Recommendations: _____

_____

Polygon-Specific Comments:
Document all polygon-specific comments and/or recommendations in a separate .pdf or Microsoft Word .doc file and include as part of the final QA report. It is recommended that mapping corrections be numbered and/or indicated on the air photos/images. Comments associated with each number can then be kept in a separate file.

Terrain Stability Mapping Pretyping QA Review Questions:

Note: Symbols for slope steepness, soil drainage and slope stability are optional at this stage, although it is a good idea to show tentative slope stability interpretations (U-P-S and I-V) as a guide to planning field work. (Soil drainage is hard to assess before field work.)

1. Will the mapping be completed and/or supervised by a qualified registered professional (QRP) (e.g., P.Geo. or P.Eng in good standing, qualified and recognized as a specialist in terrain mapping (i.e., training and experience as outlined in the Terrain Mapping and Interpretations Skill Sets for qualified registered professionals by the APFBC/APEGBC Joint Practice Board)? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____

2. Is the mapping consistent and appropriate in meeting the project objectives (TSM and any other interpretations) with respect to polygon size and the level of detail? Have small but important features been pulled out in a consistent manner (e.g., cliffs, landslides)? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____

3. Does polygon delineation and terrain polygon labels adequately represent the terrain attributes in the landscape precisely and accurately? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____

4. Does the mapping (air photo/image interpretation, terrain polygon labels and linework) adequately support the project objectives (e.g., terrain stability mapping and any other interpretations)? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____

5. Have labeled terrain polygons and on-site symbols been pretyped to a level appropriate for field checking? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____

6. Where solid, dashed and dotted lines are used are they consistently applied? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____

7. Are all terrain mapping codes (terrain polygon labels) and on-site symbols used consistent with provincial mapping standards set out in *Terrain Classification System for British Columbia (1997)*? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____

8. Have stability criteria been clearly defined and consistently applied (throughout the study area between mappers and across map sheets and flight lines)? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____

9. Are any other terrain interpretation (e.g., slope steepness, soil drainage, slope stability, erosion potential, landslide-induced stream sedimentation, surface erosion sedimentation) criteria defined and where pretyped are they consistent throughout the project area (between mappers and across map sheets and flightlines)? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____

10. Are all interpretation codes used consistent with provincial mapping standards set out in *Standard for Digital Terrain Data Capture in BC (1998) and Errata 2006-1.1 (2007)*? For example, lower case letters for soil drainage; numerals for slope steepness; and roman numerals for slope stability. ❑Yes ❑No ❑N/A
    Comments/Recommendations: _____
11. Have areas of uncertainty been marked for field verification? ❑Yes ❑No ❑N/A
    Comments/Recommendations: _____
12. Record the percent of the study area that was reviewed.
    Comments/Recommendations: _____
13. Other: ❑Yes ❑No ❑N/A
    Comments/Recommendations: _____

QA Sign-off:

Name (Please Print)	**Signature**	**Acceptable?**	**Review Date**
		❑Yes ❑No	

QC Sign-off:

Name (Please Print)	**Signature**	**Date Signed**

Form T3: Field Sampling QA

Submission # _____ **Date of Submission** _____

Project Name _____

Field Crew(s) _____

_____

_____

Fieldwork Dates _____

Method of Review _____

Materials checklist:

- ❑ Field work details including the total number of ground and visual field observation sites, total number of mapped polygons, field work dates, and field crews.
- ❑ Complete, edited field data forms with field observation site locations marked on the air photos/images and/or maps.
- ❑ Map showing field traverses (foot, vehicle, helicopter) to show coverage of the study area.
- ❑ Digital photos at field observation sites (optional).
- ❑ Results of sample analyses (if available).
- ❑ Preliminary criteria table.
- ❑ Copy of pretyping.
- ❑ List of pretyping notes or questions from Form T2.

Comments/Recommendations: _____

_____

Plot-Specific Comments:
Document all plot-specific comments and/or recommendations in a separate .pdf or Microsoft Word .doc file and include as part of the final QA report.

Sampling Plan QA Review Questions:

1. Will the fieldwork be completed and/or supervised by a qualified registered professional (QRP) (e.g., P.Geo. or P.Eng in good standing, qualified and recognized as a specialist in terrain mapping (i.e., training and experience as outlined in the Terrain Mapping and Interpretations Skill Sets for qualified registered professionals by the APFBC/APEGBC Joint Practice Board)? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____

   _____
2. Is there adequate rationale for the number and distribution of sampling site types (i.e., where and why ground or visual inspections will be completed)? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____

3. Is the proposed timing of the sampling plan logical? ❑Yes ❑No ❑N/A
   Comments/Recommendations:

4. Have all of the access issues been accounted for? Are there contingency plans in place? ❑Yes ❑No ❑N/A
   Comments/Recommendations:

5. Does the preliminary criteria for interpretations account for all of the typical terrain types and terrain stability attributes found in the project area? ❑Yes ❑No ❑N/A
   Comments/Recommendations:

6. Are the terrain and terrain stability relationships outlined in the preliminary criteria for interpretations logical? ❑Yes ❑No ❑N/A
   Comments/Recommendations:

7. Other: ❑Yes ❑No ❑N/A
   Comments/Recommendations:

Field Work QA Review Questions:

Field Visit Questions

1. Record the number of field observation sites visited.

   Comments/Recommendations:

2. Have the definitions outlined in the *Terrain Classification System for British Columbia (1997)* been correctly and consistently interpreted (i.e.,surficial material textural terms, surficial material terms, surface expression terms, geomorphological processes terms, etc.)? ❑Yes ❑No ❑N/A
   Comments/Recommendations:

3. For multiple field crews: Is there consistency in site description and classification between field crews? For example, surficial material type, surficial material description, terrain stability class rating, soil drainage, etc. ❑Yes ❑No ❑N/A
   Comments/Recommendations:

4. Does the field crew know where they are on the air photo/image (i.e., in which polygon and where in the polygon)? ❑Yes ❑No ❑N/A
   Comments/Recommendations:

5. For multiple field crews: Are important mapping questions and observations in the field adequately communicated between field crews? ❑Yes ❑No ❑N/A
   Comments/Recommendations:

6. Have any areas of uncertainty marked for field verification been field checked? ❑Yes ❑No ❑N/A
   Comments/Recommendations:

7. Have any questions raised during pretyping been investigated in the field? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____

8. Were adequate mapping notes being kept to facilitate correction of terrain linework and polygon labels? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____

9. Does the terrain mapper have a consistent, clear view of the glacial history of the project area relative to the selection of their field observation site locations? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____

10. Was the selection of field observation site location(s) within a given terrain polygon suitably chosen? ❑Yes ❑No ❑N/A
    Comments/Recommendations: _____

11. Was the preliminary criteria for interpretations refined while in the field? ❑Yes ❑No ❑N/A
    Comments/Recommendations: _____

12. Are the criteria for interpretations applied consistently throughout the project area (i.e., are the terrain polygon labels and interpretations logical and consistent?)? ❑Yes ❑No ❑N/A
    Comments/Recommendations: _____

13. Was relevant data collected for all additional interpretations (e.g., field verification of erosion potential classes, polygon slope classes, soil drainage classes, etc.)? ❑Yes ❑No ❑N/A
    Comments/Recommendations: _____

14. Other: ❑Yes ❑No ❑N/A
    Comments/Recommendations: _____

Field Work QA Review Questions:
General Mapping Questions

1. Record the number of field observation sites reviewed.

   Comments/Recommendations: _____

2. Have the standards set out in *Mapping and Assessing Terrain Stability Guidebook (1999)* been followed? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____

3. Has the data from all field observation sites been recorded in a standard format on an appropriate form? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____

4. Have the minimum data collection requirements for the project been met? ❑Yes ❑No ❑N/A
   Refer to Table 10 of the *Guidelines and Standards to Terrain Mapping in British Columbia (1999)*.
   Comments/Recommendations: _____

5. Were the minimum project requirements for TSIL met? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____

6. Were the field observation sites representative of the complexity of the terrain? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____

7. Other: ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____

QA Sign-off:

Name (Please Print)	**Signature**	**Acceptable?**	**Review Date**
		❑Yes ❑No	

QC Sign-off:

Name (Please Print)	**Signature**	**Date Signed**

Form T4: Final Terrain Stability Mapping QA

Submission # _____ **Date of Submission** _____

Project Name _____

Mapper(s) _____

_____

_____

Materials checklist:

- ❑ Contract/Terms of Reference/Request for Proposals outlining the project objectives.
- ❑ Project proposal/plan indicating the methodology, roles and responsibilities of each person outlined in the contract, and work schedule.
- ❑ Large-scale topographic maps (e.g., 1:20,000 TRIM) of project area, with project area boundaries clearly marked.
- ❑ Flight line/image index map with project boundaries and flight lines/images clearly marked.
- ❑ An agreed upon, representative sample of air photos/images with finalized terrain mapping and interpretations—this sample should represent the diversity of terrain types in the project area.
- ❑ Finalized criteria for interpretations (e.g., slope stability, erosion potential, landslide induced stream sedimentation, potential sediment delivery from surface erosion sources).
- ❑ List of background information that has been reviewed for the project area including any existing terrain, soils, and geology maps and/or reports.
- ❑ Map legend(s) with definitions for all mapping codes and on-site symbols.
- ❑ List of project information including type of mapping (e.g., RTSM or DTSM), TSIL, the total number of air photos/images, map sheet(s), area (ha), mapping team, contact information, etc.
- ❑ A list indicating the areas or air photos/images mapped by each of the mappers (if more than one mapper).
- ❑ Estimate of percentage of polygons field checked (or number of field checks per 100 ha).
- ❑ Field data for submitted area.
- ❑ Additional mapping information/notes (subtypes, mapping conventions, peculiarities, etc.)
- ❑ Non-spatial database (if available).

Comments/Recommendations: _____

_____

Polygon Specific Comments:
Document all polygon-specific comments and/or recommendations in a separate .pdf or Microsoft Word .doc file and include as part of the final QA report. It is recommended that mapping corrections be numbered and/or indicated on the air photos/images. Comments associated with each number can then be kept in a separate file.

Final Terrain Stability Mapping QA Review Questions:

1. Will the mapping be completed and/or supervised by a qualified registered professional (QRP) (e.g., P.Geo. or P.Eng in good standing, qualified and recognized as a specialist in terrain mapping (i.e., training and experience as outlined in the Terrain Mapping and Interpretations Skill Sets for qualified registered professionals by the APFBC/APEGBC Joint Practice Board)? ❑Yes ❑No ❑N/A
   Comments/Recommendations:

2. Does the terrain stability mapping conform to all relevant RISC standards? ❑Yes ❑No ❑N/A
   Comments/Recommendations:

3. Where solid, dashed and dotted lines are used are they consistently applied? ❑Yes ❑No ❑N/A
   Comments/Recommendations:

4. Does the mapping (air photo/image interpretation, terrain polygon labels and linework) adequately support the project objectives (e.g., terrain stability mapping and any other interpretations)? ❑Yes ❑No ❑N/A
   Comments/Recommendations:

5. Is the mapping consistent and appropriate in meeting the project objectives (TSM and any other interpretations) with respect to polygon size and the level of detail (e.g., have small but important features such as landslides been pulled out in a consistent manner)? ❑Yes ❑No ❑N/A
   Comments/Recommendations:

6. Does polygon delineation and terrain polygon labels adequately represent the terrain attributes in the landscape precisely and accurately? ❑Yes ❑No ❑N/A
   Comments/Recommendations:

7. Are all terrain mapping codes (terrain polygon labels) and on-site symbols consistent with provincial mapping standards set out in *Terrain Classification System for British Columbia (1997*) and applied consistently throughout the study area (between mappers and across map sheets and flightlines)? ❑Yes ❑No ❑N/A
   Comments/Recommendations:

8. Have stability criteria been clearly defined and consistently applied (throughout the study area between mappers and across map sheets and flight lines)? ❑Yes ❑No ❑N/A
   Comments/Recommendations:

9. Are any other terrain interpretation (e.g., slope steepness, soil drainage, slope stability, erosion potential, landslide-induced stream sedimentation, surface erosion sedimentation) criteria defined and mapped consistently throughout the project area (between mappers and across map sheets and flightlines)? ❑Yes ❑No ❑N/A
   Comments/Recommendations:

10. Are all interpretation codes used consistent with provincial mapping standards set out in *Standard for Digital Terrain Data Capture in BC (RIC, 1998) and Errata 2006-1.1 (2007)*? For example, lower case letters for soil drainage; numerals for slope steepness; and roman numerals for slope stability. ❑Yes ❑No ❑N/A
    Comments/Recommendations: _____

11. Have areas of uncertainty marked for field verification been field checked? ❑Yes ❑No ❑N/A
    Comments/Recommendations: _____

12. Have all field observation sites been identified spatially with a unique identifier? ❑Yes ❑No ❑N/A
    Comments/Recommendations: _____

13. Were the field observation sites representative of the complexity of the terrain with specific focus on critical areas (e.g., potentially unstable and unstable slope)? ❑Yes ❑No ❑N/A
    Comments/Recommendations: _____

14. Were the field observations incorporated into the mapping (in the vicinity of the site and in similar polygons throughout the study area)? ❑Yes ❑No ❑N/A
    Comments/Recommendations: _____

15. Were comments and recommendations from previous stages of review addressed? ❑Yes ❑No ❑N/A
    Comments/Recommendations: _____

16. Record the percent of the study area that was reviewed. ❑Yes ❑No ❑N/A
    Comments/Recommendations: _____

17. Other: ❑Yes ❑No ❑N/A
    Comments/Recommendations: _____

QA Sign-off:

Name (Please Print)	**Signature**	**Acceptable?**	**Review Date**
		❑Yes ❑No	

QC Sign-off:

Name (Please Print)	**Signature**	**Date Signed**

Form T5: Spatial and Non-Spatial Database QA

Submission # _____ **Date of Submission** _____

Project Name _____

Mapper(s) _____

_____

_____

Materials checklist:

- ❑ Spatial files in .E00 format (.FGDB format is acceptable) which includes the following:
  - ❑ – Project boundary with project information file (TBAPIDJ.E00)
  - ❑ – Terrain polygons with full attributes file (TBAPIDR.E00)
  - ❑ – Terrain on-site features file (TBAPIDF.E00)
  - ❑ – Area-based on-site features file (TBAPIDA.E00)
  - ❑ – Sample sites file (TBAPIDS.E00)
- ❑ Non-spatial files which may include the following:
  - ❑ – User-defined fields file
  - ❑ – Report with figures, maps, and photos
  - ❑ – Field notes
  - ❑ – Quality assurance, quality control, and/or accuracy assessment reports
  - ❑ – Sign-off letters or project completion certificates
- ❑ Validation and error reports

Comments/Recommendations: _____

_____

Spatial Database QA Review Questions:

1. Do the submitted spatial files conform to the digital standards outlined in the contract? See *Standard for Digital Terrain Data Capture in BC (1998)* and *Standard for Digital Terrain Data Capture in British Columbia Errata 2006-1.1 (2007*) and/or the *Terrestrial Ecosystem Information Digital Data Submission Standard – Draft for Field Testing (database and GIS data Standards) Version 1.0 RISC March 2010.* ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____

   _____

2. Have the appropriate spatial features been submitted in the format and to the naming conventions specified in the provincial standards (e.g., T*BAPID*J.E00, T*BAPID*R.E00, T*BAPID*F.E00, T*BAPID*A.E00, T*BAPID*S.E00 or TEIS_Master_Long_Tbl, TEIS_Master_Short_Tbl, TEIS_Project_Boundaries, TEIS_Project_Details, TEIS_Terrestrial_Point_Symbols, TEIS_Terrestrial_Line_Symbols, TEIS_Terrestrial_Area_Sym_Poly, TEIS_Terrestrial_Area_Sym_Arc, TEIS_Terrestrial_Polygon_Arcs, TEIS_Point_Sample_Sites, TEIS_Linear_Sample_Sites)? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____

3. Do the database structures match the provincial digital standards (field length and type)? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____

4. Have minimum attribute requirements been met for all features (e.g., SurfM_1 is present for all long table polygons)? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____

5. Do attribute relationships conform to the provincial mapping standards (e.g., subtypes match the GEOP_X)? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____

6. Are the terrain attribute combinations and relationships logical (e.g., Ub, third component present without a first or second)? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____

7. Do all spatial features include the project BAPID? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____

8. Do all spatial features have a unique ID that is unique (e.g., TER_TAG or PROJPOLYID)? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____

9. Does linework transfer meet the government standard for accuracy and precision? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____

10. Are valid attribute values used (review validation reports or use error validation tools)? ❑Yes ❑No ❑N/A
    Comments/Recommendations: _____

11. Are all points, lines (arcs), and polygons assigned a valid feature code (FCODE) (e.g., FF84550000 for the project boundary, FF84555210 for terrain polygons? ❑Yes ❑No ❑N/A
    Comments/Recommendations: _____

12. Were the correct feature codes for SRC_FCODE used where appropriate? ❑Yes ❑No ❑N/A
    Comments/Recommendations: _____

13. Is the TES_TAG for the sample site spatial coverage complete and correct? ❑Yes ❑No ❑N/A
    Comments/Recommendations: _____

14. Other: ❑Yes ❑No ❑N/A
    Comments/Recommendations: _____

Non-Spatial Database QA Review Questions:

1. Were user-defined fields (if applicable) used appropriately? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____

2. Does the user-defined database follow the format in Table 2.4.1.1 in the *Standard for Digital Terrain Data Capture in British Columbia Errata 2006-1.1 (2007)*? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____

3. Are reports, figures, legends and any other required documents submitted in .pdf format? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____

4. Are field notes submitted in .pdf format in the case of scanned field notes, or as database files (e.g., MS Excel .xls, gdb table format)? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____

5. If field data is in a database is there a unique tag and does it match 1:1 to the field spatial data? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____

6. Are Quality Assurance, Quality Control and Accuracy Assessment Reports, (if applicable) submitted in .pdf format? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____

7. Was a sign-off letter or project completion certificate submitted from the responsible terrain professional and the GIS supervisor or project manager from the vendor providing digital data capture services for the project? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____

8. Other: ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____

QA Contractor Sign-off:

Name (Please Print)	**Signature**	**Acceptable?**	**Review Date**
		❑Yes ❑No	

QA GIS Specialist Sign-off:

Name (Please Print)	**Signature**	**Acceptable?**	**Review Date**
		❑Yes ❑No	

QC Sign-off:

Name (Please Print)	**Signature**		**Date Signed**

Form T6: Final Mapping Deliverables QA

Submission # _____ **Date of Submission** _____

Project Name _____

Mapper(s) _____

_____

_____

Materials checklist:

- ❑ Contract/Terms of Reference/Request for Proposals outlining the project objectives
- ❑ A copy of all QA forms from any preceding stages of QA
- ❑ Final TSM project report
- ❑ Final map legend
- ❑ Hard copy maps (if applicable)
- ❑ Field notes and field data cards
- ❑ All final-typed air photos (if applicable)
- ❑ Final spatial data files
- ❑ Error reports (if applicable)
- ❑ Any final non-spatial data files

Comments/Recommendations: _____

_____

Final Deliverables QA Review Questions:

DATA

1. Has the correct BAPID number been used in naming all of the project files? See naming conventions in Table 2.2.1 in *Standard for Digital Terrain Data Capture in British Columbia Errata 2006-1.1 (2007)*. ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____

   _____
2. Has the sign-off letter or project completion certificate been completed by the QRP terrain professional (see form T1 question 4) and the GIS supervisor or GIS project manager, indicating that the project has been completed to the required terrain mapping and digital data standards? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____

   _____
3. Have the project deliverables (e.g., data and report) been submitted as specified in the contract and the provincial standards (e.g., posted to FTP site with e-mail notification to soilterrain@victoria1.gov.bc.ca)? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____

   _____

4. Have all project deliverables been delivered as outlined in the original TSM contract? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____

REPORT

1. Has a final terrain stability mapping project report been submitted? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____
2. If a terrain report has been produced, is the content correct and complete? Refer to Table 14 in section 11.1 of the *Guidelines and Standards to Terrain Mapping in British Columbia (1996)* for the list of essentials of a terrain report? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____
3. Have the project objectives been clearly stated? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____
4. Have all of the data sources and background information been identified including any existing mapping that was used? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____
5. Has the physiography of the area been described, including topography, bedrock geology, and geomorphological/glacial history? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____
6. Has each surficial material been described, including a description of the most common material textures, surface expressions, geomorphological processes, and soil drainages? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____
7. Has the terrain mapping method been described, including the use of different terrain attributes (i.e., surficial materials, material textures, slope steepness, soil drainage)? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____
8. Has the method for field sampling been described, including the numbers of field observation sites that were completed? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____
9. Have the aspects of map reliability been discussed, including discussions regarding the limitations of air photo interpretation (i.e., poor resolution and air photo scale), limitations due to the survey intensity level, and difficulties encountered during field sampling (i.e., access issues)? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____
10. If interpretative maps have been created, have the methods of production (including any assumptions made), the results, and the recommendations been outlined? ❑Yes ❑No ❑N/A
    Comments/Recommendations: _____

HARDCOPY MAP AND MAP LEGEND

1. Has a final terrain map legend been submitted? ❑Yes ❑No ❑N/A
   Comments/Recommendations:

2. Is the content of the map legend(s) correct and complete and follow the conventions in *Mapping and Assessing Terrain Stability Guidebook (1999)* and conform to all relevant RISC standards and requirements outlined in the contract?? ❑Yes ❑No ❑N/A
   Comments/Recommendations:

3. If applicable, do the terrain map and/or terrain interpretive maps conform to provincial mapping standards *(Guidelines and Standards to Terrain Mapping in British Columbia (1996)*, *Standard for Digital Terrain Data Capture in British Columbia? Terrain Technical Standard & Database Manual. June, 1998 Version 1*, and *Standard for Digital Terrain Data Capture in British Columbia Errata 2006-1.1 (2007))*? ❑Yes ❑No ❑N/A
   Comments/Recommendations:

4. Were the minimum project requirements for TSIL met? Does the TSIL correspond with the actual amount of work completed? ❑Yes ❑No ❑N/A
   Comments/Recommendations:

OTHER DATA

1. If applicable, have all of the field notes and field data cards been submitted? ❑Yes ❑No ❑N/A
   Comments/Recommendations:

2. If applicable, have all of the final-typed air photos or soft-copy digital files been submitted? ❑Yes ❑No ❑N/A
   Comments/Recommendations:

3. Does the spatial data conform to provincial standards set out in *Standard for Digital Terrain Data Capture in British Columbia Errata 2006-1.1 (2007)* and/or the *Terrestrial Ecosystem Information Digital Data Submission Standard – Draft for Field Testing (database and GIS data Standards) Version 1.0 RISC March 2010*? ❑Yes ❑No ❑N/A
   Comments/Recommendations:

4. Does the polygon attribute table for the terrain polygons have any anomalies or errors that are not adequately documented in the comment field(s) or the error report? ❑Yes ❑No ❑N/A
   Comments/Recommendations:

5. If applicable, does the non-spatial data conform to provincial standards set out in *Standard for Digital Terrain Data Capture in British Columbia Errata 2006-1.1 (2007)*? ❑Yes ❑No ❑N/A
   Comments/Recommendations:

6. Are the terrain codes listed in the terrain project report and map legend consistent with one another and with those found in the polygon attribute table for the terrain polygons? A unique sort of the polygon attribute table for the terrain polygons ensures that all terrain codes mapped have been described. ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____
7. Have all comments and feedback from preceding stages of QA been adequately addressed? ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____
8. Other: ❑Yes ❑No ❑N/A
   Comments/Recommendations: _____

QA Sign-off:

Name (Please Print)	**Signature**	**Acceptable?**	**Review Date**
		❑Yes ❑No	

QC Sign-off:

Name (Please Print)	**Signature**	**Date Signed**

Form T7: QA Summary and Sign-off

This section is intended to track project status relative to the final sign-off of each stage of QA review. Provide a date and signature on this form once a particular QA review stage has been deemed complete and acceptable. Any additional comments not covered in the forms above should be included at this time. Also, please record the total number of submissions reviewed for each of QA review stages in the space provided. Submit this form in electronic format as part of the final QA report (see QA deliverables section).

Project Planning QA:

The project planning stage has been completed to an acceptable standard.

Print Name QA Contractor	Signature	Date
Additional Comments/Recommendations:		

- ❑ This represents the final sign-off, and represents submission number ___of___ submissions received for the project planning QA review stage.

Pretyping QA:

The TSM pretyping has been completed to an acceptable standard.

Print Name QA Contractor	Signature	Date
Additional Comments/Recommendations:		

- ❑ This represents the final sign-off, and represents submission number ___of___ submissions received for the pretyping QA review stage.

Field Sampling QA:

The fieldwork has been completed to an acceptable standard.

Print Name QA Contractor	Signature	Date
Additional Comments/Recommendations:		

- ❑ This represents the final sign-off, and represents submission number ___of___ submissions received for the field sampling QA review stage.

Final Terrain Stability Mapping QA:

The final terrain stability mapping has been completed to an acceptable standard.

Print Name QA Contractor	Signature	Date
Additional Comments/Recommendations:		

- ❑ This represents the final sign-off, and represents submission number ___of___ submissions received for the final terrain stability mapping QA review stage.

Spatial and Non-Spatial Database QA:

The spatial and non-spatial databases have been completed to an acceptable standard.

Print Name QA Contractor	Signature	Date
Additional Comments/Recommendations:		

- ❑ This represents the final sign-off, and represents submission number ___of___ submissions received for the Spatial and Non-Spatial Database QA review stage.

Final Mapping Deliverables QA:

All of the final deliverables meet RISC standards.

Print Name QA Contractor	Signature	Date
Additional Comments/Recommendations:		

- ❑ This represents the final sign-off, and represents submission number ___of___ submissions received for the final deliverables QA review stage.

4. References

Guidelines and Standards to Terrain Mapping in BC. 1996. Resources Inventory Committee, Victoria, B.C.

Introduction to Quality Assurance Procedures – Ecosystem Inventory and Mapping, Wildlife Inventory, Wildlife Habitat Rating. 2003. Ministry of Sustainable Resources Management, Victoria, BC.

Manual for Describing Terrestrial Ecosystems in the Field. 1998. Land Management Handbook 25, Ministry of Environment, Lands and Parks, and Ministry of Forests, Victoria, BC.

Mapping and Assessing Terrain Stability Guidebook. 1999. Second Edition. Forest Practices Code. BC Ministry of Forests and BC Ministry of Environment.

Quality Assurance Guidelines for Terrestrial Ecosystem Mapping (TEM) – Draft. 2003. Ministry of Sustainable Resources Management, Victoria, BC.

Standard for Digital Terrain Data Capture in British Columbia, Version 1. 1998. Terrain Data Working Committee, Surficial Geology Task Group Earth Science Task Force, Victoria, BC.

Standard for Digital Terrain Data Capture in British Columbia – Terrain Technical Standard and Database Manual. Errata 2006-1.1. 2007. Ministry of Environment, Ecosystem Information Section, Ecosystem Branch.

Standard and Procedures for Integration of Terrestrial Ecosystem Mapping and Vegetation Resource Inventory in BC. 2002. Resources Inventory Committee, Victoria, BC.

Standard for Terrestrial Ecosystem Mapping in British Columbia. 1998. Resources Inventory Committee, Victoria, BC.

Standards for Terrestrial Ecosystems Mapping - Digital Capture in BC. Version 3. 2000. Ecological Data Committee, Ecosystem Working Group, Terrestrial Ecosystem Task Force, Resources Inventory Committee, Victoria, BC.

Terrain Classification System for British Columbia. Revised Edition, 1997. Manual 10. Howes, D.E. and E. Kenk., B.C. Ministry of Environment, Lands, and Parks. Victoria, B.C.

Terrain Mapping and Interpretation: Skill Set for QRPs. 2002. ABCPF/APEGBC Joint Practices Board.

Terrestrial Ecosystem Information Digital Data Submission Standard – Draft for Field Testing (database and GIS data Standards) Version 1.0, 2010, Ministry of Environment. Victoria, B.C. – Pending Publication.