FREP

FOREST AND RANGE EVALUATION PROGRAM

Scientifically Valid Evaluations of Forest Practices under the *Forest and Range Practices Act*

# *Protocol for*
# Soil Resource Stewardship Monitoring: Cutblock Level

For the most current version of this document, please consult the FREP web site Indicators-Soils-Protocol-2009.pdf

For other FREP information, please go to http://www.for.gov.bc.ca/hfp/frep/

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Ministry of Environment

Resource Stewardship Monitoring

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Prepared by:
MFR staff on the Soils Value Team (Cutblock Level)

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## Foreword

The soil conservation provisions in British Columbia's *Forest and Range Practices Act* are intended to protect the productive and hydrologic capacity of the soil. The Act and regulations are based on best available information and recognize that it may take many years to fully understand the effects of soil disturbance on forest productivity or hydrologic function. Except for obvious losses of productive sites through access development, the Act, regulations, and this process for resource stewardship monitoring and effectiveness evaluation consider site conditions, observable on the ground at the time of completing operations (including soil disturbance) as a proxy for longer-term effects.

Other indicators outlined here, including those related to slope stability, hydrologic function, biological function, and organic matter retention are also considered essential for evaluating the extent to which forest management is consistent with desired results, as expressed by government objectives for soil values (i.e., to maintain soil productivity and hydrologic function).

The method and indicators presented here are suitable for use 1–2 years after harvesting operations are completed. Some indicators of forest productivity, such as site index, have not been included in this protocol because they are more useful after longer time periods.

Research efforts (validation monitoring) are under way to evaluate the linkage between soil disturbance at the time of operations, long-term forest productivity, and hydrologic function.

## Acknowledgements

Thanks to the many District staff who provided helpful input in creating and revising this document whether during the pilot workshops or cutblock-level soil resource stewardship monitoring over the last few years. We are also grateful for David Yole and Larry McCulloch who commented on the mapping and field work.  Rick Trowbridge and Harry Quesnel provided contributions to earlier drafts of this document. Special thanks to Cindy Chevalier for her editorial and research assistance.

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## Purpose of this Protocol

This protocol provides background and information about data collection for Cutblock-level Soil Resource Stewardship Monitoring activities under the British Columbia Ministry of Forests and Range Forest and Range Evaluation Program (FREP).

This document also serves as a guidance document for practicing forest professionals in that it informs them what the FRPA Soils Value team of internal government experts (Research Soil Scientists from Regions and Research Branch, and Technical Advisor at Forest Practices Branch) feel are essential components and behavior for successful stewardship of the soil resource.

## Goal of Soil Resource Monitoring

The goal of Cutblock-level Soil Resource Stewardship Monitoring is to determine whether *Forest and Range Practices Act* (*FRPA*) standards and practices governed by regulation are achieving the desired result of protecting soils. In other words, monitoring soil conservation allows to see whether the underlying assumptions for *FRPA* are met with current forest practices. Specifically:

- Do access structures have the least possible impact on productive soil loss and hydrologic function of the soil (e.g., natural drainage patterns are maintained)?
- Are forest practices resulting in levels of site disturbance detrimental to soil productivity and hydrologic function (e.g., soil disturbance unduly concentrated in specific areas)?
- Are sensitive soils properly identified so appropriate harvest strategies match site conditions in order to protect these sensitive soils?

## Objectives of the Monitoring Process

Cutblock-level Soil Resource Stewardship Monitoring is undertaken to achieve the following objectives:

1. Quantify and describe:
    - the extent of the area within cutblocks that is lost to permanent access structures;
    - the detrimental effects of soil disturbance on natural drainage patterns, potential for landslides, and erosion;
    - the amount of soil disturbance within cutblocks and roadside work areas;
    - the amount of green tree, dead wood, and organic matter retention that has occurred in the various standards units.
2. Compare these data with accepted operational standards (e.g., acceptable thresholds for BC in Bulmer et al. 2008 ) and determine whether the results are consistent with the objective set by government for soils (i.e., to maintain soil productivity and hydrologic function).
3. Monitor the data collected over time to enable tracking trends in provincial soil resource management practices and to identify issues requiring further information, technical support, guidance, detailed monitoring or research to ensure sustainable soil resource management.

Resource stewardship monitoring is not directed towards compliance or enforcement, although incidents of possible or apparent non-compliance will become evident during the data collection process. These will be identified for consideration by staff in the Compliance and Enforcement Program.

## Indicators

The monitoring assessment is organized into five key indicators, each focusing on an aspect related to soil resource stewardship. A brief scientific rational for each indicator is presented in Bulmer *et al.* (2008). These five indicators and some rationale for their inclusion are listed below.

1. **Lost productivity due to access construction**

   Permanent access structures, such as main roads, permanent spur roads, landings, and borrow pits, represent a fundamental change in the ground surface, reducing the productive land base and also affecting hydrologic function over large areas. Roads are often one of the main factors in issues related to slope instability, erosion, and sedimentation both on and off the cutblock. Because of these concerns, it is desirable to minimize the amount of permanent access constructed and to rehabilitate temporary access areas back to productive forest land.

2. **Landslides, erosion, and drainage diversion**

   These represent losses, or potential losses, in the productive land base and (or) hydrologic function, and may affect other *FRPA* resource values both on and off the cutblock.

   Landslide and other erosion can result in a wide range of soil disturbance and may be related to road construction and/or maintenance practices or disruption of natural drainage patterns. Drainage diversion onto potentially unstable slope below is often a trigger for soil failure (e.g., gentle over steep landslide, Jordan 2001).

   Depending on site type and its sensitivity to disturbance, equipment traffic can also impede or divert natural surface and subsurface drainage by blocking and re-channeling water flows. Compaction and puddling from wheel ruts and log or other woody debris jams can cause water ponding near or within depressional areas and therefore, affect growing sites, water quality, quantity and timing downstream in small drainage areas.

3. **Dispersed soil disturbance in the net area to be reforested**

   Improper identification or stratification of soil sensitivity to disturbance can result in inappropriate practices and greater risks to soil productivity, hydrologic function and other forest resources. If the resulting disturbance represents widespread compaction or displacement of topsoil, it can affect both forest productivity and hydrologic function as well as other FRPA resource values both on and off the cutblock.

Soil disturbance within the Net Area to be Reforested (NAR) is a concern for both longterm soil productivity and hydrologic function. This is particularly true in relation to both concentrated areas of potentially inordinate disturbance[1] and large or heavily disturbed roadside work areas.

4. **Green tree retention**

   Some soil organisms (e.g., beneficial mycorrhizae) require live trees retained on site. This is an important aspect of soil stewardship that should be tracked over time. This indicator will be assessed by stand-level biodiversity monitoring.

5. **Dead wood**

   Organic matter, including forest floor and dead wood, is an essential driver of ecosystem processes, acting as an important reservoir of on-site nutrient pools, longer-term productivity and on-site hydrologic function (e.g., water relations for trees). Under cutblock-level soil monitoring, we focus on measuring fine organic matter whereas stand-level biodiversity monitoring will provide data on coarse dead wood.

## Principles of Site Selection

For resource stewardship monitoring, sample cutblocks are randomly selected from a master list (broken down by region and forest district) generated in FREP Information Management System (IMS) (http://apps.for.gov.bc.ca/frep). District staff must then select the first 5 cutblocks that meet site selection criteria from the master list in sequential order. Sites that do not fit the criteria are not in the target population and must be deemed rejected in IMS. In the opposite case, the site is accepted in IMS and staff can start gathering information for evaluation.

For cutblock-level soil monitoring, site selection criteria are areas with ground-based harvesting without snow or frozen soils in the last two years. However, other factors that make a site at higher risk of degrading soil disturbance may be considered by Districts during the selection process. The following are higher risk factors that may warrant a greater sampling effort:

- sites with high or very high sensitivity to soil-degrading processes (increased hazard)
- sites that were salvage-harvested
- sites with partial cutting
- complex sites with ridged or hummocky terrain, or catenas with mixes of distinctly different soil types
- small cutblocks
- steep slopes
- drier or wetter ecosystems

1. These are defined herein as areas larger than 0.2 ha with 30% or higher disturbance, or smaller areas if a high risk to other *FRPA* resource values exists.

- specific prescribed practices meeting higher disturbance guidelines (e.g., stump removal or other aggressive site preparation)
- roadside work areas where these are considered to represent a large proportion of the cutblock

For cases in which not enough cutblocks meet one or more of these criteria, the selection scope may be broadened (e.g., cutblocks logged in the last 3 years instead of 2 years); however, the additional categories such as older cutblocks will need to be considered as factors when analyzing the data. Please discuss these cases with Soil Value team members before proceeding outside of the agreed-upon criteria for selection or stratification.

For general information on the site selection process, refer to the Resource Stewardship Monitoring Framework at: http://www.for.gov.bc.ca/hfp/frep/site_files/rsm/RSM Resource_Stewardship_Monitoring_Framework.pdf

## Getting Started: Background Data Needs and Documentation (Office)

A review of existing information for each selected cutblock is essential to planning and executing the field portion of resource stewardship monitoring, and also for interpreting the results of field surveys. Establish a file for each cutblock to be sampled. Use the checklist below to ensure that copies of the following records and any other applicable information are placed in the file.

| Office Checklist for Cutblock-level Soil Resource Stewardship Monitoring | Copy placed in file? | Reviewed |
|---|---|---|
| 1. Operational plan, including maps, Site Plan* | ☐ | ☐ |
| 2. Post-harvest or interim inspections (if available) | ☐ | ☐ |
| 3. Cutblock cruise summary | ☐ | ☐ |
| 4. Preliminary site plan data collection cards | ☐ | ☐ |
| 5. Digital air photos provided by FREP and other types of imagery (check Base Map Online Store through GeoBC Gateway at http://www.geobc.gov.bc.ca) | ☐ | ☐ |
| 6. Summary output from RESULTS or IMS | ☐ | ☐ |
| 7. Other items** | ☐ | ☐ |

* While licensees are not legally compelled to provide a Site Plan, if the licensee is willing to provide you with one it will be a very useful source of information.

** (e.g., Compliance and Enforcement file notes, field monitoring reports, or actions; certification audits; Forest Practices Board audits).

## Effectiveness Monitoring of Soil Resources Using Air Photos

Describing and mapping indicators of soil resources is done using recent geo-referenced air photos of selected cutblocks loaded in OziExplorer, a GPS mapping software (© D&L Software Pty Ltd. Brisbane, Australia). Air photo review, in conjunction with operational plans and maps, is used to:

- fill in the checklist (FS 1246) by making measurements - in some cases estimates for less visible ground features - and assessments of the five indicator areas;
- identify and estimate areas of other features (including areas of potentially inordinate disturbance and sensitive areas such as gullies, riparian and terrain depression) that need to be visited in the field to evaluate the level of soil disturbance;
- determine and mark with waypoints (a point of reference for GPS) walk throughs and survey transects that cross the main disturbance pattern in representative areas of the Standards Units (SU); and
- develop an overall travel plan and produce a GPS survey map for field deployment on mobile devices (e.g., HP Ipaq or Tablet PC's).

The walk through survey is designed to: (i) stop at pre-identified areas of interest, and (ii) address soil related issues that could not be seen on the air photo. It includes inspection of areas of potentially inordinate disturbance, access structures, fine organic matter and other features of interest, as well as areas that appear to represent average conditions on the cutblock. To evaluate soil disturbance, survey transects are conducted at air photo determined representative areas during the walk through. Detailed methods for transect layout are presented in Appendix 3.

An example of the air photo review method is presented in Appendix 3. Use of the OziExplorer software to conduct this step is described in the OziExplorer training manual located at: http://www.for.gov.bc.ca/hfp/frep/site_files/indicators/Ozi-Training-Manual.pdf

## Field Gear Checklist

Use the following checklist to ensure that all field gear is available.

| Item | Description | In field gear? |
|---|---|---|
| 1 | 100 m tape or equivalent | ☐ |
| 2 | 2 m tape or equivalent | ☐ |
| 3 | Shovel for compaction evaluation and soil pits | ☐ |
| 4 | GPS unit mobile device (PDA, netbook or tablet PC) | ☐ |
| 5 | Clinometer | ☐ |
| 6 | Compass | ☐ |
| 7 | Cutblock-level Soil Resource Stewardship Monitoring cards (FS 1246)[a] | ☐ |
| 8 | Soil Disturbance Survey Reconnaissance Survey Field Cards (FS 879)[b] or appropriate field paper for transect data | ☐ |
| 9 | Silviculture Prescription (Site Plan) Plot Card for checking soil disturbance hazards (FS 39A, both halves[c] or FS 711B-1) | ☐ |
| 10 | *Soil Conservation Surveys Guidebook*[d] | ☐ |
| 11 | *Silviculture Prescription Data Collection Field Handbook*, Land Management Handbook (LMH) No. 47[e] | ☐ |
| 12 | *Protocol for Soil Resource Stewardship Monitoring: Cutblock Level*[f] | ☐ |
| 13 | Camera, preferably digital with high-resolution capability | ☐ |
| 14 | Site plan map, air photo, access notes, and other information on the site | ☐ |
| 15 | Calculator | ☐ |
| 16 | Personal field gear, food, water, any safety gear needed | ☐ |
| 17 | Hip chain for width and length measures (optional) | ☐ |
| 18 | Auger to check deeper soil layers in hazard rating checks (optional) | ☐ |

a Waterproof versions of forms and guidebooks are often available from the Regional Soil Scientist and the web. Cutblock-level Soil Resource Stewardship Monitoring cards can be downloaded from the FREP website: http://www.for.gov.bc.ca/hfp/frep/indicators/table.htm

b Soil Disturbance Survey Reconnaissance Survey Field Cards can be downloaded at: http://www.for.gov.bc.ca/isb/forms/lib/FS879.PDF

c Silviculture Prescription Plot Cards can be downloaded at: http://www.for.gov.bc.ca/isb/forms/lib/FS39A.PDF

d The Soil Conservation Surveys Guidebook (BC Ministry of Forests 2001) can be downloaded at: http://www.for.gov.bc.ca/tasb/legsregs/fpc/FPCGUIDE/SOILSURV/soilconsurv.pdf

e The Silviculture Prescription Data Collection Field Handbook (Land Management Handbook No. 47 by Curran et al. 2000) can be downloaded at: http://www.for.gov.bc.ca/hfd/pubs/Docs/Lmh/Lmh47.htm

f The Protocol for Soil Resource Stewardship Monitoring: Cutblock Level can be downloaded from the FREP website at: http://www.for.gov.bc.ca/hfp/frep/indicators/table.htm

## Field Data Collection

The purpose of the field data collection phase is to verify the GPS survey map and complete the soils checklist at cutblock-level (FS 1246) in real-time tracking (i.e. using a GPS receiver in combination with a mobile device to display the map and collect data):

- field check area calculations of access structures, landslides, drainage diversion, eroded areas, roadside work areas and inordinate soil disturbance areas obtained from the air photo overview,
- provide responses to stewardship questions with rationale for affirmative answers,
- visit and evaluate each feature identified from the air photo,
- evaluate sites where drainage or erosion may be of concern,
- survey each transect as planned from the air photo overview to evaluate dispersed (including roadside work areas) and areas of potentially inordinate disturbance,
- evaluate the effectiveness of rehabilitation treatments,
- using principles in LMH 47, confirm the soil disturbance hazard ratings and the existence of appropriate SU's and their boundaries, and
- better evaluate factors, which may have affected the results observed.

Use the following checklist to ensure that all relevant aspects of the field survey will be completed.

| Item | Description | Survey required? | Survey completed? |
|---|---|---|---|
| a) | length and width for roads and landings | ☐ | ☐ |
| b) | size, location and rehab status of rehabilitated structures | ☐ | ☐ |
| c) | structures built through materials unsuitable for rehabilitation | ☐ | ☐ |
| d) | landslides (area) | ☐ | ☐ |
| e) | active erosion | ☐ | ☐ |
| f) | areas with altered drainage | ☐ | ☐ |
| g) | areas of potentially inordinate disturbance | ☐ | ☐ |
| h) | area and soil disturbance within roadside work areas | ☐ | ☐ |
| i) | transects for dispersed soil disturbance | All SUs* | ☐ |
| j) | areas of other features of interest (e.g., gullies, riparian or depressional areas) | ☐ | ☐ |
| k) | Soil disturbance hazards and Standards Units | All SUs | ☐ |
| l) | Assess fine organic matter using FS 1246 Table 2 (modified from Schedule 7 [am BC Reg. 148/96, sec. 8] Fire Hazard assessment, section 31) | ☐ | ☐ |

* Other items may require survey in some situations.

# Filling in the Forms

This section provides detailed information for filling out the soil checklist FS 1246.

| Section | Instructions/Descriptions |
|---|---|

**Opening Information**

**Section 1 Side 1**

BRITISH COLUMBIA Forest and Range Evaluation Program

Soil Resource Stewardship Monitoring Checklist: Cutblock-Level
Section 1 – Side 1

LIC _____ CP _____ BLK _____ Date __________ Evaluator __________

**Soil opening identification**

Opening # __________ Opening ID __________
License # __________ CP# __________ Cutblock __________
Evaluator __________ Evaluation Date Y Y Y Y / M M / D D
Licensee __________
District __________ Harvest Completion Date Y Y Y Y / M M / D D
Net Area to be Reforested (NAR) (ha) __________ Disturbance Gross Area (ha) __________
No UTM Signal Available ☐
Zone __________ Easting __________ Northing __________
Location Description __________

**1. Estimating lost soil productivity due to access construction**
*(Note: Identify each feature being measured or surveyed with a unique number.)*

**1.1 Delineate and measure cutblock area in un-rehabilitated roads, landings, and borrow pits.**

| Structure Type | Structure # | Area (ha) | Description | % of Cutblock |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

**1.2 Delineate and measure cutblock area in rehabilitated access and effectiveness of rehabilitation treatments.** *(Use method described in table 1.)*

| Structure Type | Structure # | Area (ha) | Description | ER | % of Cutblock |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

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**Opening Identification**

*Opening/License/CP/Cut block number* – generated from IMS

*Evaluator* – your name

*Licensee* – generated from IMS

*Evaluation date* – date of evaluation

*District* – Forest District

*Harvest completion date* – generated from IMS

*Location description* – additional info

*NAR* – generated from IMS

*Gross area* – generated from IMS

*No UTM signal available* – check off box if applicable

*Zone, Easting, Northing* – UTM coodinates from GPS, air photo or other source

**1. Estimating lost productivity due to access construction**

**1.1 Roads, landings, and borrow pits**

*Structure type* – indicate whether structure is a road, excavated bladed trail, landing, pit or quarry

*Structure #* – provide an unique number for each structure. Mark location on GPS survey map

*Area* – length X width; enter in ha

*Description* – describe the structure

*% of cutblock* – 100 x structure size / Gross area. Generated field in IMS

**1.2 Rehabilitated access**

*Structure type* – indicate whether structure is a road, excavated bladed trail, landing, pit or quarry

*Structure #* – provide a unique number for each structure. Mark location on GPS survey map

*Area* – enter in ha

*Description* – describe the structure

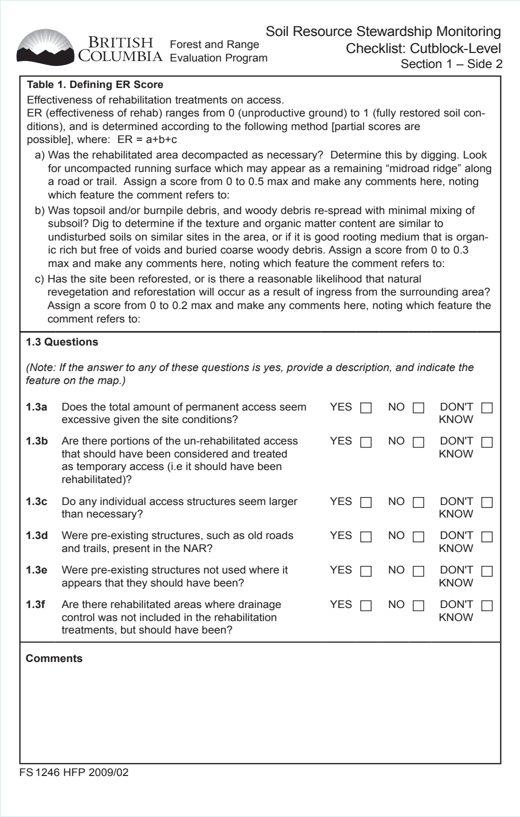
*ER* – determine ER based on calculation from Table 1 - Defining ER Score on Section 1 - Side 2 (enter a value between 0 and 1)

*% of cutblock* – 100 x Rehabilitation area * (1-ER) / Gross area. Generated field in IMS

| Section | Instructions/Descriptions |
|---|---|

**Section 1 Questions**

**Section 1 Side 2**



BRITISH COLUMBIA Forest and Range Evaluation Program

Soil Resource Stewardship Monitoring
Checklist: Cutblock-Level
Section 1 – Side 2

**Table 1. Defining ER Score**

Effectiveness of rehabilitation treatments on access.
ER (effectiveness of rehab) ranges from 0 (unproductive ground) to 1 (fully restored soil conditions), and is determined according to the following method [partial scores are possible], where: ER = a+b+c

a) Was the rehabilitated area decompacted as necessary? Determine this by digging. Look for uncompacted running surface which may appear as a remaining "midroad ridge" along a road or trail. Assign a score from 0 to 0.5 max and make any comments here, noting which feature the comment refers to:

b) Was topsoil and/or burnpile debris, and woody debris re-spread with minimal mixing of subsoil? Dig to determine if the texture and organic matter content are similar to undisturbed soils on similar sites in the area, or if it is good rooting medium that is organic rich but free of voids and buried coarse woody debris. Assign a score from 0 to 0.3 max and make any comments here, noting which feature the comment refers to:

c) Has the site been reforested, or is there a reasonable likelihood that natural revegetation and reforestation will occur as a result of ingress from the surrounding area? Assign a score from 0 to 0.2 max and make any comments here, noting which feature the comment refers to:

**1.3 Questions**

*(Note: If the answer to any of these questions is yes, provide a description, and indicate the feature on the map.)*

| | | | | |
|---|---|---|---|---|
| **1.3a** | Does the total amount of permanent access seem excessive given the site conditions? | YES ☐ | NO ☐ | DON'T KNOW ☐ |
| **1.3b** | Are there portions of the un-rehabilitated access that should have been considered and treated as temporary access (i.e it should have been rehabilitated)? | YES ☐ | NO ☐ | DON'T KNOW ☐ |
| **1.3c** | Do any individual access structures seem larger than necessary? | YES ☐ | NO ☐ | DON'T KNOW ☐ |
| **1.3d** | Were pre-existing structures, such as old roads and trails, present in the NAR? | YES ☐ | NO ☐ | DON'T KNOW ☐ |
| **1.3e** | Were pre-existing structures not used where it appears that they should have been? | YES ☐ | NO ☐ | DON'T KNOW ☐ |
| **1.3f** | Are there rehabilitated areas where drainage control was not included in the rehabilitation treatments, but should have been? | YES ☐ | NO ☐ | DON'T KNOW ☐ |

**Comments**

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## 1.3 Additional information for answering the stewardship questions

**1.3a** *Does the total amount of permanent access seem excessive given the site conditions?*

Permanent roads and other structures represent a permanent deletion of land from productive growing sites. Roads are necessary to gain access to the forest for timber harvest, fire suppression, recreation, or other needs. Excessive road construction reduces the amount of land available for growing trees and thereby reduces overall forest productivity. Roads also require maintenance, and poorly maintained roads pose a risk of erosion, slope failure and sedimentation of water sources used by people and fish. To determine whether the amount of permanent access is excessive, consider the following:

- Are road widths greater than what would normally be needed considering the amount of traffic expected on the road?
- Logging operations can often be conducted efficiently with less access. In fact some jurisdictions in Western Canada and the Pacific Northwest specify limits for permanent access that are lower than 7 percent.
- Permanent access may exceed 7 percent and still not be considered excessive. For example, a mainline road often cuts through a small block, and switch backs are a necessary part of road construction on steep slopes.

**1.3b** *Are there portions of the un-rehabilitated access that should have been considered and treated as temporary access (i.e., it should have been rehabilitated)?*

Sometimes a temporary road or landing can be used to reduce skidding distances and thereby improve the efficiency of logging operations. Despite this, if an access structure (a) is not expected to provide access for timber harvesting and other activities that are not wholly contained in the cutblock, and (b) does not contain materials unsuitable for the establishment of a commercial crop of trees (or productive forage if the area is managed as open rangeland), it should be considered temporary and rehabilitated.

Such temporary roads are only needed once, and may not be useful in the future because harvesting technology is likely to change over the long time frames of a forest rotation. For this reason, roads that will not be used until the next rotation are best considered temporary. Although costs of rehabilitation vary, compaction caused by road construction can be alleviated by rehabilitation techniques, and productive forests can establish on rehabilitated areas on many soil and site types throughout BC. Although costs of rehabilitation vary, failing to rehabilitate temporary roads reduces the amount of growing site and thereby reduces forest productivity. When deciding whether rehabilitation should have been carried out, consider:

- Is the road or landing likely to be used for timber hauling before the trees planted on the cutblock are ready for harvest?
- Is partial cutting occurring or likely to occur in the area, so that ongoing access is required?
- Are there important reasons to keep the road open for forest management activities such as spacing, thinning, or for other reasons such as Non-Timber Forest Product harvesting, recreation, fire suppression, etc.?
- Are there reasons to believe that rehabilitation efforts will not succeed, including the presence of unsuitable material for rehabilitation, such as ballast, fine textured soils, calcareous subsoils, or where roads were constructed through blasted rock?

**1.3c** *Do any individual access structures seem larger than necessary?*

Roads and landings need to be large enough for equipment to operate safely, and in some special cases, additional space may be needed for log sorting or other activities. Sometimes operational efficiencies can be gained by having a larger working surface than would otherwise be necessary. Despite this, excessively large access structures reduce the amount of land available for growing trees and reduce forest productivity. More importantly, larger structures require deeper cuts which intercept a lot more drainage on sloping land, or impede natural soil water movement on gentler ground. Large structures that are built to facilitate extra-ordinary log sorting or other activities may not need to be so large in future logging operations where piece size and species mix are likely to be different than today. Where such structures exist, the best approach would be to carry out rehabilitation on portions of the structure, thereby reducing their size. When deciding whether structures are larger than necessary, consider:

- Special cases of extra-ordinary sorting operations may have necessitated a large landing for the current harvest, but this should not be used to justify leaving it unrehabilitated for the next harvest.
- Wide roads are not needed where visibility is good and little traffic is expected in the future.

**1.3d** *Were pre-existing access structures, such as old roads and trails, present in the NAR?*

In many parts of BC, previous logging, mineral exploration or other activities have left soils in a disturbed state. Where pre-existing access structures are present (e.g., roads, trails), current operations should be carefully planned so that cumulative effects are minimized. Ideally, the pre-existing access structures would simply be re-used for the current operations. Pre-existing access structures can often meet at least some of the needs of the new operations with some adjustments. For good soil conservation practice to occur, recognizing the presence of such structures is essential. Consider:

- Is there a history of previous cutting or mineral exploration, or ranching in the area?
- Are previously constructed roads, trails, borrow pits or other features present on the harvested area?
- Previously constructed structures may be obscured because of revegetation that has occurred.

**1.3e** *Were pre-existing structures not used where it appears that they should have been?*

If logging or other forest management operations are not planned in consideration of pre-existing access structures, cumulative effects could impinge on future soil, productivity and hydrologic function. The soil conservation provisions (i.e., disturbance limits) in FPC and *FRPA* were developed under the assumption that the growing site areas of the block had not been subjected to previous disturbance such as that associated with pre-existing trails. Research has shown that the greatest amount of compaction occurs to soil during the first few passes of heavy equipment. Where significant amounts of pre-existing disturbance are present, and subsequent harvesting operations do not attempt to re-use these structures, large portions of the growing site area can be subjected to alteration of soil properties due to compaction. For determining whether pre-existing structures should have been used, consider:

- Are there examples of new roads and/or trails that run parallel to old structures on similar slope positions?
- Does it appear as if minor adjustments to road or landing locations could have facilitated skidding down existing trails?
- Would it have been possible to carry out simple rehabilitation techniques on the area to alleviate the cumulative effects of previous trail disturbance?
- Do cumulative effects of pre-existing disturbance and the effects of current operations appear to have resulted in inordinate disturbance?

**1.3f** *Are there rehabilitated areas where drainage control was not included in the rehabilitation treatments, but should have been?*

The most important aspect of rehabilitation is water control, because (a) disrupted drainage patterns are a cause of sedimentation and slope instability, and (b) productivity of the new forest is highly dependant on the moisture regime. For these reasons, it is essential that rehabilitation work incorporate structures and techniques to restore natural drainage patterns. Consider the following:

- For rehabilitated skid roads on steep slopes, check to ensure that the subsurface was decompacted in an outsloping profile, so that water will not be trapped against the old cutbank and be channeled down the previous inner ditch under the replaced soil (re-contoured fill).
- Ensure that gentle swales and dips have been incorporated into long unbroken slopes of rehabilitated roads to prevent moving water from channeling over long distances.
- It is best practice to incorporate cross drainage into rehabilitated trails and roads even though the subsurface flow patterns are thought to have been restored through restoration treatments.

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**Section 2 & 3**

**Section 2 & 3 Side 1**

BRITISH COLUMBIA Forest and Range Evaluation Program

Soil Resource Stewardship Monitoring
Checklist: Cutblock-Level
Section 2 & 3 – Side 1

LIC _____ CP _____ BLK _____ Date __________ Evaluator ______________

**2. Estimating in-block area affected or potentially affected by landslides, drainage diversion or significant erosion from roads, landings or trails**
*(Note: In this table, identify each feature being measured or surveyed with a unique number.)*

**2.1 Delineate and measure cutblock areas in new failures outside the roads, landings or trail prism.** *(Include dry ravel.)*

| Failure # | Description | Affected Area (ha) |
|---|---|---|
| | | |
| | | |
| | | |
| | | |

**2.2 Delineate and measure cutblock areas that could be affected by road, landing or trail construction or maintenance practices.** *(e.g., Roadcuts through material and/or slope conditions, known to have stability problems in the local area, often including clay textured materials on wet slope locations.)*

| Failure # | Description | Area Potentially Affected (ha) |
|---|---|---|
| | | |
| | | |
| | | |
| | | |

**2.3 Delineate and measure areas of water diversion, or potential water diversion, onto slopes, channels or structures that normally would not receive that much water.**
*(e.g., Evidence of overland flow. Describe potential concerns regarding stability and/or erosion that may be expected to occur.)*

| Failure # | Description | Area (ha) |
|---|---|---|
| | | |
| | | |
| | | |
| | | |

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## 2. Estimating landslides, drainage diversion and erosion within in-block area

### 2.1 Landslides

*Failure #* – provide a unique number for each failure. Mark the location on the GPS survey map

*Description* – describe the feature

*Affected area* – enter in ha

### 2.2 Construction and maintenance practices

*Failure #* – provide a unique number for each area. Mark the location on the GPS survey map

*Description* – describe the structure and nature of the concern

*Area potentially affected* – enter in ha

### 2.3 Water diversion

*Failure #* – provide a unique number for each area. Mark the location on the GPS survey map

*Description* – describe the structure and nature of the concern

*Area* – affected or potentially affected downslope area; enter in ha

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|---|---|

## Section 2 & 3

### Section 2 & 3 Side 2

BRITISH COLUMBIA Forest and Range Evaluation Program

Soil Resource Stewardship Monitoring
Checklist: Cutblock-Level
Section 2 & 3 – Side 2

**2.4 Delineate and measure eroded areas, or those at significant risk of erosion in the cutblock.** *(Such areas are typically devoid of vegetation. Do not count deposits.)*

| Eroded Area # | Description | Affected Area (ha) |
|---|---|---|
| | | |
| | | |
| | | |

**2.5 Questions**
*(Note: If the answer to any of these questions is yes, provide a description, and indicate the feature on the map.)*

**2.5a** Have harvesting practices or access construction led to or significantly increased the potential for mass movement or soil erosion? YES ☐ NO ☐ DON'T KNOW ☐

If YES, explain: ____________________

**2.5b** Are there any potential or existing off-site effects related to mass movement, erosion or sedimentation evident during your field or office review? YES ☐ NO ☐ DON'T KNOW ☐

If YES, explain: ____________________

**3. Estimating percent of the NAR area affected by disturbance to natural drainage patterns as a result of forestry operations**
*(Note: In this table, identify each feature being measured or surveyed with a unique number.)*

**3.1 Delineate and measure cutblock areas experiencing, or at risk of experiencing, altered drainage or standing water as a result of construction of roads, landings, trails, or inordinate soil disturbance.** *(e.g., Areas with evidence of saturated soils, drowned vegetation or regeneration problems due to raised water table, interception of ephemeral streams or seeps by ditchlines; or areas expected to experience these problems due to evident drainage problems.)*

| Feature # | Description | Affected Area (ha) |
|---|---|---|
| | | |
| | | |
| | | |

**3.2 Questions**
*(Note: If the answer to any of these questions is yes, provide a description, and indicate the feature on the map.)*

**3.2a** Are there areas where measures should have been taken to restore natural drainage patterns, but they were not carried out? *(e.g., Waterbarring and cross ditching as appropriate on various structures, ditching to control water across the back of landings.)* YES ☐ NO ☐ DON'T KNOW ☐

If YES, explain: ____________________

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## 2.4 Erosion

*Eroded area #* – provide a unique number for each area. Mark the location on the GPS survey map

*Description* – describe the structure and nature of the concern

*Affected area* – affected or potentially affected area; enter in ha

## 2.5 Additional information for answering the stewardship questions

**2.5a** *Have harvesting practices or access construction or maintenance led to, or significantly increased the potential for mass movement or erosion?*

If landslides or erosion are evident on the cutblock, it is important to determine the extent to which harvesting practices or access construction or maintenance contributed to their occurrence, as compared to features that may have been formed by natural processes. Consider:

- Are permanent roads and landings above existing or potential failures stable but water was channeled onto areas that could have or did cause a failure/erosion event?
- Are permanent roads and landings not maintained in stable drainage or cut and fill slope condition, such that it could or did cause a failure/erosion event?
- Was inadequate water-barring, cross-ditching, culvert spacing and sizing evident along permanent roads in the vicinity of existing or potential failures/erosion?
- Should slope stability issues have been recognized in the planning process, or were construction/maintenance practices not carried out in a manner consistent with the recognition of stability problems?
- Should measures (e.g., seeding) have been implemented to stabilize areas of exposed mineral soil to prevent erosion?

**2.5b** *Are there any potential or existing off-site effects related to mass movement, erosion or sedimentation evident during your field or office review?*

Major liabilities and costs can be experienced when harvesting creates off-site impacts on water or slope movement. A major cause of land-sliding is altered drainage from forest roads and trails. Consider:

- Are permanent roads and landings stable and in a condition where water will not be channeled into areas that would become unstable if saturated?
- Is appropriate culvert spacing and sizing evident along permanent roads?
- Have deactivated roads been left in a stable condition and with adequate drainage control?

- Are there sensitive or high risk areas or water bodies adjacent to or downslope of the cutblock that suggest special care should have been taken in harvesting? If so, does it appear that appropriate care was taken in the harvesting operations?
- Is erosion evident on running surfaces or in ditches of roads or trails

If required, consult relevant guidance documents, local engineering or regional specialists to assist in answering these questions.

### 3. Estimating disturbance within NAR to drainage patterns from timber harvesting (problems outside the road/ landing prism)

#### 3.1 Areas experiencing, or at risk of experiencing disturbance to natural drainage patterns

*Failure #* – provide a unique number for each feature. Mark the location on the GPS survey map

*Description* – describe the feature

*Affected area* – enter in ha

#### 3.2 Additional information for answering the stewardship questions

**3.2a** *Are there areas where measures should have been taken to restore natural drainage patterns, but they were not carried out? (e.g., water barring on skid trails on steep slopes, removal of corduroy trails across seepage areas)*

NAR affected by drainage diversion or accumulation of water can reduce productivity. Research has shown that the success of reforestation efforts on rehabilitated areas is highly correlated with the site moisture regime, and changes in moisture regime also affect the success of silviculture treatments in areas of the cutblock that have not experienced this soil disturbance (e.g., crossing of natural drainages or rutting trails). Consider:

- Is there evidence that water is collecting in areas that were previously mesic or drier, and does the changed water regime appear to be capable of affecting forest productivity?
- Is there evidence that dispersed soil disturbance such as rutting is leading to the channeling of water draining or accumulating water in the area?

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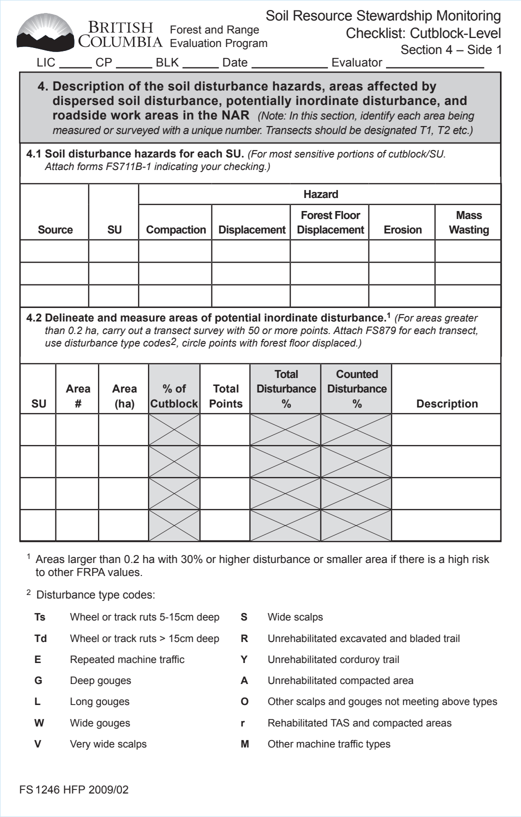
**Section 4**

**Section 4 Side 1**



BRITISH COLUMBIA Forest and Range Evaluation Program

Soil Resource Stewardship Monitoring Checklist: Cutblock-Level
Section 4 – Side 1

LIC _____ CP _____ BLK _____ Date __________ Evaluator ______________

**4. Description of the soil disturbance hazards, areas affected by dispersed soil disturbance, potentially inordinate disturbance, and roadside work areas in the NAR** *(Note: In this section, identify each area being measured or surveyed with a unique number. Transects should be designated T1, T2 etc.)*

**4.1 Soil disturbance hazards for each SU.** *(For most sensitive portions of cutblock/SU. Attach forms FS711B-1 indicating your checking.)*

| | | Hazard | | | | |
|---|---|---|---|---|---|---|
| Source | SU | Compaction | Displacement | Forest Floor Displacement | Erosion | Mass Wasting |
| | | | | | | |
| | | | | | | |
| | | | | | | |

**4.2 Delineate and measure areas of potential inordinate disturbance.**[1] *(For areas greater than 0.2 ha, carry out a transect survey with 50 or more points. Attach FS879 for each transect, use disturbance type codes*[2]*, circle points with forest floor displaced.)*

| SU | Area # | Area (ha) | % of Cutblock | Total Points | Total Disturbance % | Counted Disturbance % | Description |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

[1] Areas larger than 0.2 ha with 30% or higher disturbance or smaller area if there is a high risk to other FRPA values.

[2] Disturbance type codes:

| | | | |
|---|---|---|---|
| Ts | Wheel or track ruts 5-15cm deep | S | Wide scalps |
| Td | Wheel or track ruts > 15cm deep | R | Unrehabilitated excavated and bladed trail |
| E | Repeated machine traffic | Y | Unrehabilitated corduroy trail |
| G | Deep gouges | A | Unrehabilitated compacted area |
| L | Long gouges | O | Other scalps and gouges not meeting above types |
| W | Wide gouges | r | Rehabilitated TAS and compacted areas |
| V | Very wide scalps | M | Other machine traffic types |

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**4. Soil disturbance hazards, dispersed disturbance, inordinate disturbance, and roadside work areas**

**4.1 Soil disturbance hazards**

Determine the soil disturbance hazards for the predominant (most sensitive) soil condition in each standards unit using form FS 39A or FS 711B. Follow the protocols in LMH 47. Indicate source of assessment, i.e. from site plan or assessed by you. Provide both assessment sources if you can to enable direct comparison.

**4.2 Areas of potentially inordinate disturbance**

Lay out a transect following the methods described in Appendix 3 on the GPS survey map. Carry out a transect survey of at least 50 points for each area of potentially inordinate disturbance greater than 0.2 ha using form FS 879. Disturbance type codes are defined in FS 1246 section 4 – side 1 (note: circle disturbance types to determine forest floor displacement). The Soil Conservation Surveys Guidebook (BC Ministry of Forests 2001, http://www.for.gov.bc.ca/tasb/legsregs/fpc/FPCGUIDE/SOILSURV/soilconsurv.pdf) provides detailed information on methods for carrying out a soil disturbance survey. Record the transect results in IMS Disturbance Summary tab, section 4.6. On the field card, the summary table in section 4.6 is shaded out and provided for information only.

*SU* – provide a letter for each Standard Unit

*Area #* – provide a unique number for each area. Mark the location on the GPS survey map

*Area* – enter in ha

*% of cutblock* – 100 x disturbance area / NAR. Generated field in IMS

*Total points* – number of survey points in the transect

*Total disturbance %* – generated field in IMS from data entered in section 4.6

*Counted disturbance %* – generated field in IMS from data entered in section 4.6. See Appendix 2 for types of soil disturbance to count based on self assessed soil hazard ratings

*Description* – describe the area and nature of disturbance (e.g., rutted wet area, large scalped area on hillslope, etc.)

2 Predominant is the condition that has the strongest influence, and exerts control over operations; hence, this is the most sensitive soil condition.

| Section | Instructions/Descriptions |
|---|---|

## Section 4

## Section 4 Side 2

BRITISH COLUMBIA Forest and Range Evaluation Program

Soil Resource Stewardship Monitoring
Checklist: Cutblock-Level
Section 4 – Side 2

**4.3 Transects for dispersed disturbance in remainder of each SU.** *(Attach FS879 for each transect, use disturbance type codes, circle points with forest floor displaced.)*

| SU | Total Points | Total disturbance % | Counted disturbance % | Description |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

**4.4 Delineate and measure disturbance associated with roadside work areas.** *(The edges of roadside work areas are typically found where the heavy disturbance or woody debris drops off substantially. Attach FS879 for each transect, use disturbance type codes, circle points with forest floor displaced.)*

| SU | Total RWA Area (ha) | % of Cutblock | Total Points | Total disturbance % | Counted disturbance % | Description |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

**4.5 Delineate and measure areas of soil rehabilitation within the NAR, and determine the effectiveness of rehabilitation treatments (ER).** *(Use the method described in Table 1.)*

| SU | Area # | Rehabilitation Area (ha) | ER | % of Non-Rehabilitation | Description |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

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*Counted disturbance %* – generated field in IMS from data entered in section 4.6. See Appendix 2 for types of soil disturbance to count based on self assessed soil hazard ratings.

*Description* – describe the transect in relation to the standards unit, (e.g., is the transect representative of the entire SU, or of the most sensitive portion – it desirable that it is representative)

### 4.3 Dispersed soil disturbance

Following principles and procedures in Appendix 3, locate one or more transects in a representative portion of each standards unit on the GPS survey map. Carry out a transect survey of at least 100 points per SU using form FS 879. Disturbance type codes are defined in FS 1246 section 4 – side 1 (note: circle disturbance types to determine forest floor displacement). Record total points per SU in section 4.2, and the transect results in the IMS Disturbance Summary tab, section 4.6.

*SU* – provide a unique letter for each SU. Mark the location on the GPS survey map

*Total points* – number of survey points in transect

*Total disturbance %* – generated field in IMS from data entered in section 4.6

### 4.4 Roadside work areas

Following principles and procedures in Appendix 3, locate one or more transects in a representative portion of RWA on the GPS survey map. Carry out a transect survey of at least 50 points per SU using form FS 879. Disturbance type codes are defined in FS 1246 section 4 – side 1 (note: circle disturbance types to determine forest floor displacement). Record total points per SU in section 4.2, and the transect results in the IMS Disturbance Summary tab, section 4.6.

*SU* – provide a unique letter for each SU. Mark location on the GPS survey map and carry out a transect survey of at least 50 points total in representative RWA.

*Total RWA Area* – enter in ha (not only the area for RWA surveyed)

*% of cutblock* – 100 x RWA / NAR. Generated field in IMS

*Total points* – number of survey points in transect

*Total disturbance %* – generated field in IMS from data entered in section 4.6

*Counted disturbance %* – generated field in IMS from data entered in section 4.6. See Appendix 2 for types of soil disturbance to count based on self assessed soil hazard ratings.

*Description* – describe the nature of disturbance in the RWA

### 4.5 Rehabilitated areas

Provide information for areas of soil disturbance that have been rehabilitated to restore productivity. [3]

*SU* – Provide a letter for each Standard Unit

*Area #* – provide a unique number for each area. Mark location on the GPS survey map

*Rehabilitation Area* – enter in ha

*ER* – see section 1.2 for the method

*% of non-rehabilitation* – 100 * Rehabilitated area * (1-ER) / NAR. Generated field in IMS

*Description* – describe the nature of the disturbance and rehabilitation

3 Standards of professional practice for soil stewardship, established during the Forest Practices Code of BC, include the rehabilitation of corduroy trails, compacted areas (100 m2 and > 5 m wide) and any disturbance that was used to temporarily exceed disturbance standards by the permitted amount of up to 5% during operations.

| Section | Instructions/Descriptions |
|---|---|
| **Section 4** | **4.6 Transect summaries** |
| **Section 4 Side 3** | Back at the office, sort counted and non-counted soil disturbance types based on self assessed soil hazard ratings according to Appendix 2, and record the results of FS 879 for all transects in IMS (FREP243 screen – disturbance summary tab). Disturbance totals calculation will be automatically performed in IMS. |

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Soil Resource Stewardship Monitoring
Checklist: Cutblock-Level
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LIC ______ CP ______ BLK ______ Date ______ Evaluator ______

**4.6 Summary of dispersed disturbance categories in the NAR**

| | | Countable Disturbance Type Codes | | | | | | | | | | | | Non-Countable Disturbance Type Codes | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SU | Disturbance Type | Ts | Td | E | G | L | W | V | S | R | Y | A | Total | O | r | M | Grand Total |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
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## Section 4 Questions

## Section 4 Side 4

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Soil Resource Stewardship Monitoring
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**4.7 Questions**

*(Note: If the answer to any of these questions is yes, provide a description, and indicate the feature on the map.)*

| | | | | |
|---|---|---|---|---|
| **4.7a** | Do any of the sensitivity ratings appear to have been incorrectly determined in the planning stage? | YES ☐ | NO ☐ | DON'T KNOW ☐ |
| **4.7b** | Do any of the SU's appear to have been mapped incorrectly, or are there complexes that have not been recognized? | YES ☐ | NO ☐ | DON'T KNOW ☐ |
| **4.7c** | Were any of the roadside work areas wider than necessary for the harvesting system used? | YES ☐ | NO ☐ | DON'T KNOW ☐ |
| **4.7d** | Does there appear to be more soil disturbance within the roadside work areas than necessary? If so, discuss the relative trade-offs between the size and severity of disturbance within roadside work areas versus the use of conventional landings. | YES ☐ | NO ☐ | DON'T KNOW ☐ |
| **4.7e** | Considering a range of factors, including safety and efficiency, does the amount of area occupied by skid trails and temporary access structures and/or the disturbance associated with these structures appear excessive? | YES ☐ | NO ☐ | DON'T KNOW ☐ |
| **4.7f** | Were there features smaller than 0.2 ha, or other areas where soil disturbance was not recognized in the survey, but appeared to be a concern. | YES ☐ | NO ☐ | DON'T KNOW ☐ |
| **4.7g** | Are there disturbance types present that should have been rehabilitated but the rehabilitation treatments were not carried out? | YES ☐ | NO ☐ | DON'T KNOW ☐ |

**Comments**

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## 4.7 Additional information for answering the stewardship questions

**4.7a** *Do any of the soil disturbance hazard ratings appear to have been incorrectly determined in the planning stage?*

A key feature of *FRPA*'s soil conservation provisions is that management activities are guided by knowledge of site conditions. Techniques for evaluating the site conditions are provided in LMH 47. Because soil response to disturbance is highly dependant on properties such as site moisture, soil texture, and depth of soil development, these features need to be accurately assessed in order to develop and implement good forest management strategies. Unfortunately, inaccurate description of the soil disturbance hazards is not uncommon, and can have serious consequences for soil conservation. Consider:

- If soil texture is incorrectly determined, it is likely that the soil disturbance hazards will also be incorrect.
- Some standards units may have differing conditions in different portions of the unit. The correct soil disturbance hazards are determined on the most sensitive portions of the SU.
- Where standards units are characterized by intermixed complexes with different soil disturbance hazards, special provisions may be needed in the operations to protect soils.
- Soil compaction ratings are determined on the most sensitive soil horizon (≥5 cm thick) within the top 30 cm of the surface.

**4.7b** *Do any of the SU's appear to have been mapped incorrectly, or are there complexes that have not been recognized?*

Determining the standards units prior to harvest is made somewhat difficult because the standing trees can obscure differences in site conditions. Once the harvesting is completed, the lack of trees, as well as the ability to observe machine impacts makes a retrospective look at the initial SU mapping a worthwhile exercise. During the walkthrough survey, refer to LMH 47 and consider the following to determine whether or not serious errors occurred in the mapping of standards units:

- The presence of complexes within sites with significantly different soil disturbance hazards is a common cause of excessive soil disturbance. Good management practices may have the skidders travelling along the high ground rather than repeatedly traversing a low lying area.
- Poor management practice may see the low lying area repeatedly traversed so that disturbance of it is almost complete, rather than creating one "crossing" and restoring water flows if necessary at the end of operations.
- If complexes were not recognized, try to envision what the initial site assessment personnel were able to see, and try to describe what you think went wrong and how it could be prevented in future.

**4.7c** *Were any of the roadside work areas wider than necessary for the harvesting system used? If so, discuss the relative trade-offs between the size and severity of disturbance within roadside work areas versus the use of conventional landings.*

In many areas, changing technology has made the roadside logging system more efficient than systems using dedicated landings. Roadside logging is also thought to have some soil conservation advantages because the roadside work areas often have lower overall hydrologic and soil disturbance compared to landings, and prevent the loss of productive land from the growing site. However, where roadside work areas are too wide or cover too large an area of the cutblock the perceived benefits may be lost. This is especially true where rehabilitation techniques are available that could restore productivity to temporary landings. When evaluating the effect of roadside work areas on forest productivity, consider:

- Roadside work areas where there are high levels of soil disturbance over large areas may negate their perceived benefits for soil conservation. Two tree lengths may be an acceptable width in many situations for a roadside work area, but they can often be smaller, or they may be discontinuous (i.e., not running the entire length of the road). Do they occupy a very large portion of the block e.g., greater than 12% of the gross area (which is equivalent to an average 3% of gross block area represented by PAS)?
- Is the roadside work area a large proportion of the cutblock?
- Does it appear likely that a logging system based on the use of conventional landings, with or without rehabilitation would have created similar or lower amounts of soil disturbance (including temporary access and dispersed disturbance) over the entire cutblock?
- Has the roadside work area approach required the creation of a lot of temporary road within the cutblock?

**4.7d** *Does there appear to be more soil disturbance within the roadside work areas than necessary?*

A large part of the disturbance in roadside work areas can be related to piling debris. Another factor affecting disturbance is the repeated traffic associated with skidders concentrating their activity in the area. In addition, selecting more sensitive areas for location of roadside work areas, or planning (or choosing to continue) to work in the area when soils are wetter and more sensitive can create much more disturbance than working under drier soils or conditions. To determine if disturbance is excessive, consider:

- Was piling of debris within the roadside work area a major cause of soil disturbance?
- Was there excessive soil disturbance within any of them i.e. higher that 25% disturbance limit?
- Was the road running surface used for piling, processing, and/or burning the debris?
- Was the road, and therefore the roadside work area, located in a portion of the cutblock where soils were relatively sensitive to soil disturbance (e.g., wet areas or fine textured soils), exacerbating the effects of machine traffic?

**4.7e** *Considering a range of factors, including safety and efficiency, does the amount of area occupied by skid trails and temporary access structures and/or the disturbance associated with these structures appear excessive?*

Close spacing of temporary roads and skid trails can increase operational efficiencies up to a point, but excessive trail densities may also result from poor logging design, changing weather conditions, or other factors. With good planning and operations, soil rehabilitation can be a valuable tool for improving efficiency in the case of a temporary road, and it can also be used to repair mistakes or disturbance caused by unforeseen circumstances, changing weather, etc. However, rehabilitation should not be used as a substitute for preventing soil disturbance, because (a) there are costs associated with it, and (b) the results of rehabilitation, though promising are still uncertain and are not successful under all site conditions (e.g., wet sites and/or fine-textured soils can be problematic). To determine if there is excessive soil disturbance associated with trails, and temporary structures, consider:

- Does close trail spacing appear to have resulted in higher or lower levels of overall disturbance on the cutblock?
- Does it appear that rehabilitated areas are likely to have had productivity fully restored?

**4.7f** *Were there features smaller than 0.2 ha, or other areas where soil disturbance was not recognized in the survey that appeared to be a concern?*

Please describe any features that were not picked up in the survey, but may have an impact on future forest productivity. Consider:

- The presence of significant amounts of ruts that do not meet the 5 cm depth or 2 m length criteria.
- Extensively trafficked areas but disturbance does not meet the requirements for compaction or size associated with scalps and gouges.

**4.7g** *Are there disturbance types present that should have been rehabilitated but the rehabilitation treatments were not carried out?*

Describe features where rehabilitation treatments were not carried out but should have been, or they were carried out incompletely. Consider:

- Are there unrehabilitated spur roads or landings that dead-end in the middle of the cutblock, with no obvious connection to future standing timber supplies?
- Are there trails that meet the requirements of excavated and bladed trails (i.e., cut height and length requirements), and should have been rehabilitated, but weren't?
- Are there rehabilitated areas where the rehabilitation treatments appear to have been poorly implemented? For example (1) a simple light scratching of disturbed and compacted areas may have been considered a treatment without full decompaction, (2) available topsoil or organic material may not have been respread, (3) full restoration of drainage patterns may not have been carried out on a cut and fill skid trail, and (4) slash or other cover not provided to facilitate soil protection and revegetation
- Compacted areas larger than 100 $m^2$ or large and greater than 5 m wide.
- Are there corduroy trails[4], or crossings of wet areas that have not been removed?

4 These are defined here as logs and woody debris placed side-by-side to form a surface >2 m long capable of supporting machine traffic.

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**Section 5 & 6**

**Section 5 & 6 Side 1**

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**5. Fine Organic Matter**

| | Value (1, 3, 5, or 7) | | Value (1, 3, 5, or 7) |
|---|---|---|---|
| Fuel depth | | Fuel size | |
| Horizontal fuel arrangement | | Vertical fuel arrangement | |

**5.1 Questions**

*(Note: If the answer to any of these questions is yes, provide a description, and indicate the feature on the map.)*

**5.1a** Does it appear that measures to conserve fine organic matter should have been carried out on the site, but such measures were either neglected or ineffective? YES ☐ NO ☐ DON'T KNOW ☐

**Table 2. Fine Organic Matter Assessment**

| Fuel Loading Factors | Site Characteristics and Point Rating | | | |
|---|---|---|---|---|
| Fuel depth | < 20<br>1 | 20-40 cm<br>3 | 40-60 cm<br>5 | > 60 cm<br>7 |
| Fuel size (% of all fuels that are < 7.1 cm) | < 15%<br>1 | 15-30%<br>3 | 31-45%<br>5 | > 45%<br>7 |
| Horizontal fuel arrangement (% of area, fine fuels < 7.1 cm) | Fuel coverage < 20%<br>1 | Fuel coverage 20-50%<br>3 | Fuel coverage 51-80%<br>5 | Fuel coverage > 80%<br>7 |
| Vertical fuel arrangement (fine fuels < 7.1 cm) | Mixed with soil<br>1 | On ground<br>3 | Partially elevated<br>5 | Mostly elevated<br>7 |

The post-harvesting assessment form should be filled out in field while walking through the block. Care should be taken to include all of the fuel types and/or treatment units so that the estimate is representative of the complete block.

Comments

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### 5. Fine Organic matter

Enter point rating values for fuel loading factors by completing an assessment (see Table 2). Choose a representative area of the complete cutblock and complete measurement during a walk through.

*Fuel depth* – enter corresponding value 1, 3, 5 or 7

*Fuel size (% of all fuels that are <7.1 cm)* – enter value 1, 3, 5 or 7

*Horizontal fuel arrangement (% of area)* – enter value 1, 3, 5 or 7

*Vertical fuel arrangement (fine fuels <7.1 cm)* – enter value 1, 3, 5 or 7

### 5.1 Additional information for answering the stewardship questions

**5.1a** *Does it appear that measures to conserve fine organic matter should have been carried out on the site, but such measures were either neglected or ineffective?*

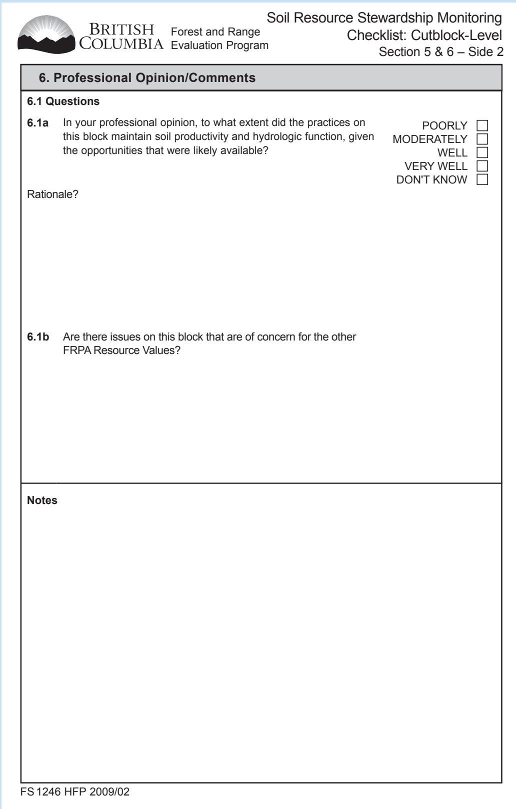
Research in BC and elsewhere has demonstrated concern that considerable nutrient export can occur from cutblocks when whole tree harvesting is employed on nutrient poor soils. Such soils include gravely sandy glaciofluvial deposits, shallow developed soils in calcareous (high pH soils derived from limestone) or fluvial deposits, dry sites, or where frequent forest fires have reduced levels of organic matter. If the site is typical of these conditions, consider the following:

- Did most tops end up burned in debris piles?
- Were forwarding or processing at the stump not used in this block?

| Section | Instructions/Descriptions |
|---|---|

**Section 5 & 6**

**Section 5 & 6 Side 2**



BRITISH COLUMBIA Forest and Range Evaluation Program

Soil Resource Stewardship Monitoring
Checklist: Cutblock-Level
Section 5 & 6 – Side 2

**6. Professional Opinion/Comments**

**6.1 Questions**

**6.1a** In your professional opinion, to what extent did the practices on this block maintain soil productivity and hydrologic function, given the opportunities that were likely available?

POORLY ☐
MODERATELY ☐
WELL ☐
VERY WELL ☐
DON'T KNOW ☐

Rationale?

**6.1b** Are there issues on this block that are of concern for the other FRPA Resource Values?

**Notes**

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## 6. Professional opinion/comments

### 6.1 Questions

**6.1a** *In your professional opinion, to what extend did the practices on this block maintain soil productivity and hydrologic function, given the opportunities that were likely available?*

Tick one of: poorly, moderately, well, very well or don't know. This is a subjective ranking of the cutblock, which will be used as a check against the objective data collected. A question you should ask yourself is – "did they do as well as they could have considering the forest they began with?" Note general comments as well as anything unusual about the cutblock in the comments section. Provide a rationale for your professional opinion. To assist you further, check whether estimates for each SU for the various indicators fit into the thresholds as discussed in the next section.

Additional information is available in Appendix 2 to help you in considering the following points:

- amount of permanent access – is the amount of access the minimum practical given the site conditions.
- presence of landslides, altered drainage or erosion – the presence of these features is detrimental.
- disruption of natural drainage patterns – harvesting operations should be conducted with minimal disturbance to natural drainage patterns.
- soil disturbance in the NAR, including areas of potentially inordinate disturbance and roadside work areas.
- green tree retention observed throughout the walk through– should be adequate to provide refugia for beneficial soil organisms.
- amount of dead wood from your estimate of fine organic matter and observed throughout the walk through – presence of long (>12 m) logs in decay class 1, 2 and 3 in the harvested area is good.

**6.1b** *Are there issues of concern for other FRPA Resource values?*

This is a place to indicate issues of concern for FRPA Resource Values other than soils.

## Additional information for completing the Professional Opinion Section 6.1: Preliminary determination of soil conservation achievements

This section provides additional information for determining whether or not harvesting practices conserved soil productivity and hydrologic function. Bulmer et al. (2008) proposed threshold values that can be used to guide such decisions, along with consideration of the responses to stewardship questions related to each of the indicators.

Exceeding the threshold for any indicator suggests that harvesting practices as they were carried out may not be fully consistent with soil conservation objectives. The stewardship questions can be used to confirm such suggestions. As a general rule, confirmation that soil conservation objectives have not been met is indicated when (a) the value for the indicator exceeds the threshold and (b) a positive response is returned for one of the stewardship questions related to the indicator.

If the response to the stewardship question does not confirm the indicator score, or a positive response is returned for a question without the indicator value exceeding the threshold, then the evaluator needs to use their professional judgment and provide rationale when completing the professional opinion section (6.1) of soils RSM card.

For cutblocks where thresholds were not exceeded, and no stewardship questions received a positive response, it is likely that harvesting practices achieved soil conservation objectives.

Where it appears that soil conservation objectives, as they are understood at this time, have not been met, blocks should be noted and may be scheduled for future monitoring to determine longer term effects on soil productivity and other FRPA values.

**Thresholds of soil disturbance to help determine whether timber harvesting practices conserved soil productivity and hydrologic function (adapted from Bulmer et al. 2008)**

| Indicator | Thresholds and scores: Acceptable | Thresholds and scores: Soil conservation objectives may not have been met |
|---|---|---|
| 1. Percent of the cutblock area occupied by unproductive soil as a result of access construction | | |
| a. Simple topography and slope less than 30% | 5% | >5% |
| b. Complex topography or slopes greater than 30% | 7% | >7% |
| 2. In-block area affected or potentially affected by landslides, drainage diversion, or significant erosion occurring from roads, landings or trails | 0 $m^2$ | ≥200 $m^2$ |
| 3. Occurrences of inordinate soil disturbance | 0 | ≥1 |
| a. % of cutblock area affected by concentrated and dispersed soil disturbance in the NAR | | |
| i. Sensitive soils | ≤5% | >5% |
| ii. Non-sensitive soils | ≤10% | >10% |
| b. % of NAR affected by forest floor displacement | <20% | ≥20% |
| c. Extent of RWA's disturbed | <25% | ≥25% |

## Help

For additional information on completing these field forms, please contact your regional soil scientist or Stéphane Dubé, BC Ministry of Forests, Prince George 250-565-6100.

## References

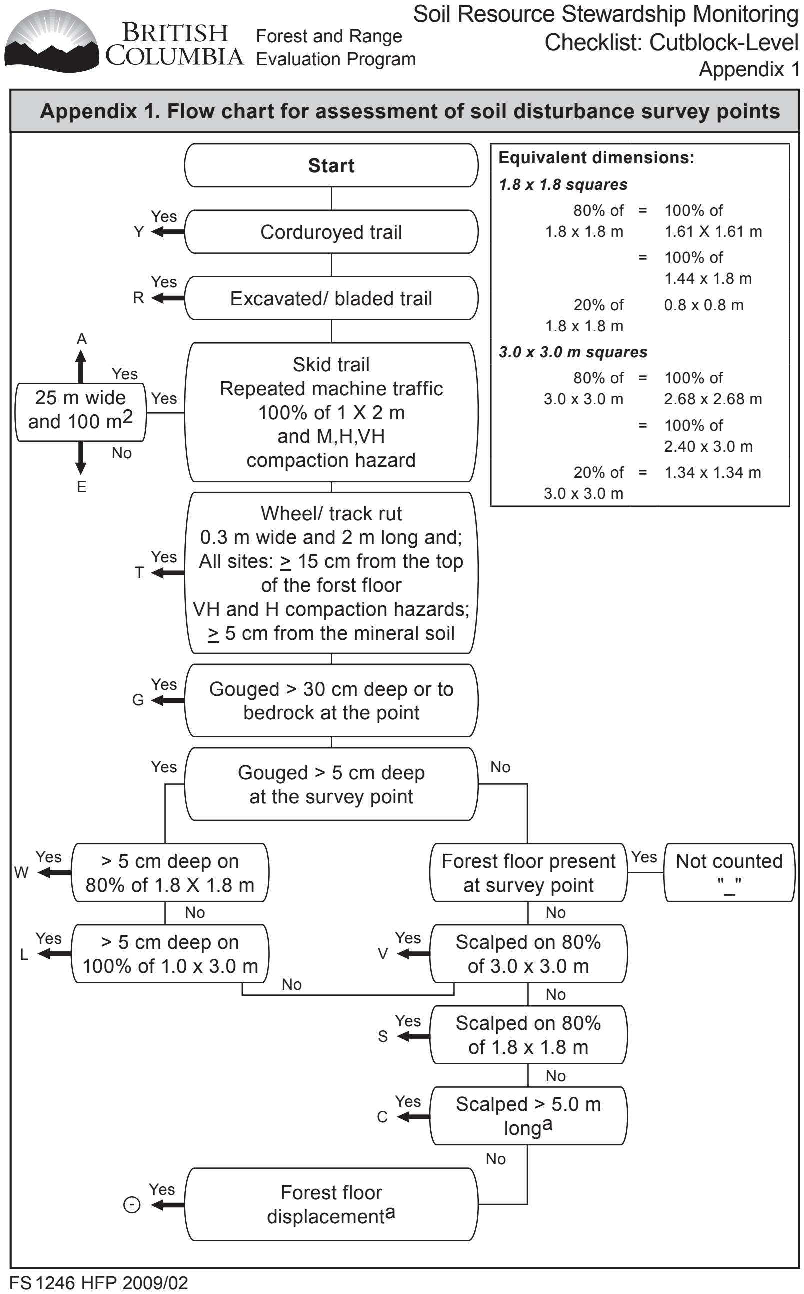
B.C. Ministry of Forests. 2001. Soil conservation surveys guidebook. 2nd ed. For. Prac. Br., B.C. Min. For., Victoria, B.C. Forest Practices Code of British Columbia Guidebook. http://www.for.gov.bc.ca/tasb/legsregs/fpc/FPCGUIDE/SOILSURV/soilconsurv.pdf

Bulmer C., Berch S., Curran M., Chapman B., Kranabetter M., Dubé S., Hope G., Courtin P. and R. Kabzems. 2008. Monitoring the effects of forest practices on soil productivity and hydrologic function. BC Journal of Ecosystems and Management 9(2):48-59.

Curran, M.P., I. Davis, and B. Mitchell. 2000. Silviculture prescription data collection field handbook: interpretive guide for data collection, site stratification, and sensitivity evaluation for silviculture prescriptions. B.C. Min. For., Res. Br., Victoria, B.C. Land Manag. Handb. No. 47. http://www.for.gov.bc.ca/hfd/pubs/Docs/Lmh/Lmh47.htm

Jordan P. 2001. Regional incidence of landslides. Watershed Assessment in the Southern Interior of BC: Workshop Proceedings, March 9-10, 2000. P. Toews and S. Chatwin, Eds.,Res. Br., BC Min. For., Victoria, BC Work. Pap. 57.

# Appendix 1. Flowchart for Assessment of Soils Disturbance Sampling Points



# Appendix 2. Counted Soil Disturbance Categories and Recommended Limits According to Hazard Ratings

BRITISH COLUMBIA Forest and Range Evaluation Program

Soil Resource Stewardship Monitoring Checklist: Cutblock-Level
Appendix 2

**Appendix 2. Counted soil disturbance categories and recommended limits according to hazard ratings**

| Soil disturbance hazard[a] | Soil sensitivity rating | Categories counted in allowable soil disturbance | Allowable soil disturbance (% NAR) | |
|---|---|---|---|---|
| | | | Coast and Interior | |
| Assessment of soil hazards not required | | Always + S + E + T5 + A | 5 | |
| Likelihood of landslides | M, H | Always + S | 5 | |
| Soil erosion | VH | Always + S | 5 | |
| Soil displacement | VH | Always + S | 5 | |
| Soil compaction | VH | Always + S + E + T5 + A | 5 | |
| | | | Coast | Interior |
| Soil erosion | H | Always | 5 | 10 |
| Soil erosion | M, L | Always | 5 | 10 |
| Soil displacement | H, M, L | Always | 5 | 10 |
| Soil compaction | H | Always | 5 | 10 |
| Soil compaction | M | Always | 5 | 10 |
| Soil compaction | L | Always | 5 | 10 |
| Likelihood of landslides | L | Always | 5 | 10 |

[a] Assessing the hazards for soil compaction, soil displacement, and soil erosion need not be done if the harvesting method is cable or aerial.

[b] Under the "Categories counted" column, the term "Always" includes soil disturbance that is always counted, namely excavated or bladed trails, corduroyed trails, 15-cm-deep ruts, deep gouges, long gouges, wide gouges, very wide scalps. The meaning of the other symbols are: "S": wide scalps; "T5": 5-cm-deep ruts; "E": repeated machine traffic; and "A": compacted areas.

Combine the categories measured for different hazard ratings if that will result in more categories being counted or a lower allowable disturbance limit. For example, on a site with a Very High compaction hazard and a High surface erosion hazard, the categories counted are "Always + S + E + A + T5," the soil disturbance limit would be 5%.

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# Appendix 3. Example Air Photo Overview - Creating a GPS survey map

Figures 1 and 2 illustrate the process of creating a GPS survey map from an air photo for resource stewardship monitoring. Once you have opened the cutblock image in OziExplorer, you can import shape files of the cutblock boundary and standard units shown as green and black lines, respectively on Figure 1 and 2 (refer to the OziExplorer Training and Manual for uploading shape files). In this example, the 10.8 ha block consists of a single standards unit, and is entered by a single road. Three wildlife tree patches occupy a total of 0.8 ha (measured). The NAR area indicated on the Site Plan was 9.8 ha. Soil compaction and displacement hazards were indicated as high and the surface erosion hazard moderate. No slope stability indicators were noted but sandy soil materials were identified as an unfavorable subsoil material occurring at 24–55 cm depth on the Site Plan. A root removal treatment was planned, so the limit for soil disturbance in the NAR was set at 20%.

In Figure 1, three areas of potential inordinate soil disturbance (polygon A, B, C in red) were identified, and measurements of their size were made (each area measured 0.2 ha). A possibly rehabilitated area was apparent (Polygon D in dark red), and a landing (Polygon E in yellow) was shown on the operational plan map, but was not readily identified from the photo. It may have been rehabilitated, so size and status will be determined in the field with a GPS. Road area (dark blue line F) was measured at 0.38 ha. A representative RWA polygon was marked (sky blue) for evaluating dispersed soil disturbance.

In Figure 2, the planned walk through is shown in white and in-block dispersed disturbance survey transects in purple (marked with waypoints, numbered yellow flag), starting at the Point-of-Commencement (PoC). The objective is to visit all features of interest and confirm their condition as well as look at areas representing typical conditions on the block. Features that were not apparent on the air photo can be identified in the field with a unique letter, and information on their extent and characteristics would be included in the field cards.

In-block dispersed soil disturbance transects are pre-located using the photo and each transect will be surveyed in the field using FS 879 field cards. Disturbance type codes are defined in FS 1246 Section 4 – Side 1. These transects are shown in purple on Figure 2. The in-block disturbance transects are labeled with “T1, T2, T3”, etc. and are designed to meet the following criteria:

1. go at right angles to the major disturbance
2. be representative of the entire area being surveyed, including block edges.

The target is 100 points per SU. Achieve this by determining approximate total length of transects from the photo and divide by 100 to get sample point spacing to the nearest metre. The actual number of points may be more or less, but simply complete the survey to the block edge.

The method for assessing fine organic matter is one spot observation representative of the whole block during the walk through.

Areas of potentially inordinate disturbance are delineated on the photo as red polygons (A, B, and C in the example here) and new ones are also checked for during the walk through (white lines). Upon initial overview, a decision is made as to whether the disturbance appears inordinate, and if so, a series of parallel transects are laid out to assess the level of soil disturbance as per the Soil Conservation Surveys Guidebook (BC Ministry of Forests, 2001). These are parallel transects with closer sample point spacing, using the same criteria (above) for in-block disturbance transects (purple lines, Fig. 2). The target is 50 points for each potentially inordinate disturbance area. If many potentially inordinate disturbance areas are present and assumed to have similar levels of disturbance, only one or two of those areas need to be surveyed with transects (50 points each). However, each inordinate disturbance area needs to be marked on the GPS survey map.

As illustrated in Figure 2, roadside work areas are surveyed with transects (purple lines) that are established with an orientation about 45 degrees to the road (target is 50 points per SU).

In the example in Figure 2, the walk through begins at the (PoC), and proceeds along the edge of the wildlife tree patch to transect (T1), which is established in the southeast portion of the block to evaluate dispersed soil disturbance. A second transect (T2) is established through the middle of the block to evaluate dispersed soil disturbance, with an initial evaluation of the potentially inordinate disturbance (area C) made at the one end that is crossed. A third transect (T3) is established in the northwest portion after looking at an area of potentially inordinate disturbance (area A). Returning, the extent of potentially inordinate disturbance at area B is evaluated, along with a possibly rehabilitated area above the landing (dark red, D), and further transects are put in area C. Then, the state of disturbance and rehabilitation of the landing itself is evaluated (yellow, E). Dimensions for the road and roadside work area can be confirmed on the way back to the start point (PoC). Measurement of disturbance associated with the roadside work area (polygon E in sky blue) is done last.

Throughout the entire exercise, evaluations are made of the soil disturbance hazard ratings for the Standards Units (cutblock) and the appropriateness of the Standard Unit boundaries (or lack thereof). Green tree retention and dead wood are observed throughout the walk through in preparation for completing the professional opinion section. Soil texture (compaction hazard) should be checked regularly based on local experience with soil variation. Distance measurements, area calculations and line placements are done in OziExplorer (refer to OziExplorer Training and Help manual); however, it is important to field check widths and lengths to validate the air photo measurements.

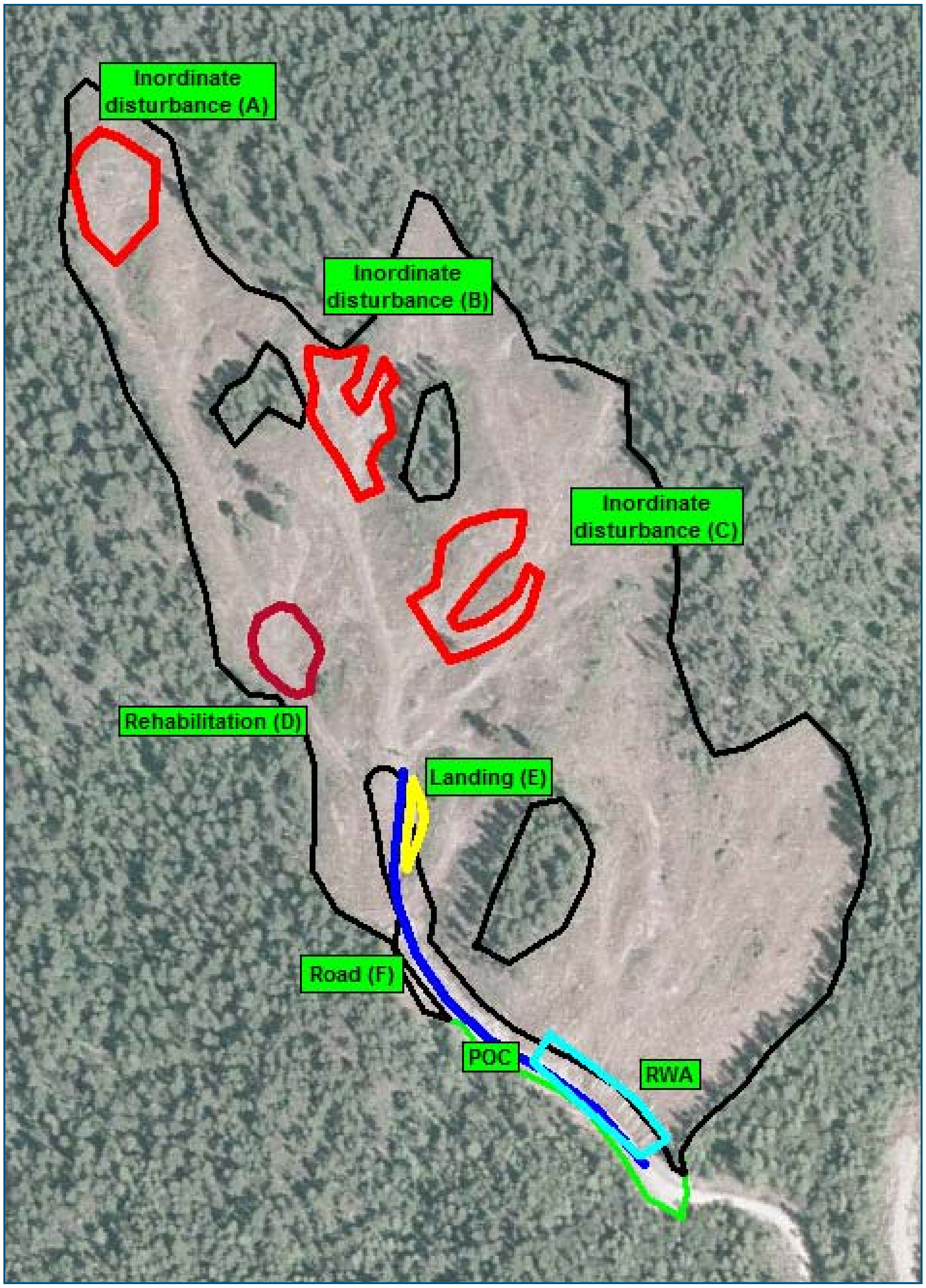


*Figure 1. GPS survey map of cutblock CP364-3, on TFL 23, showing features of interest for soil resource stewardship monitoring.*

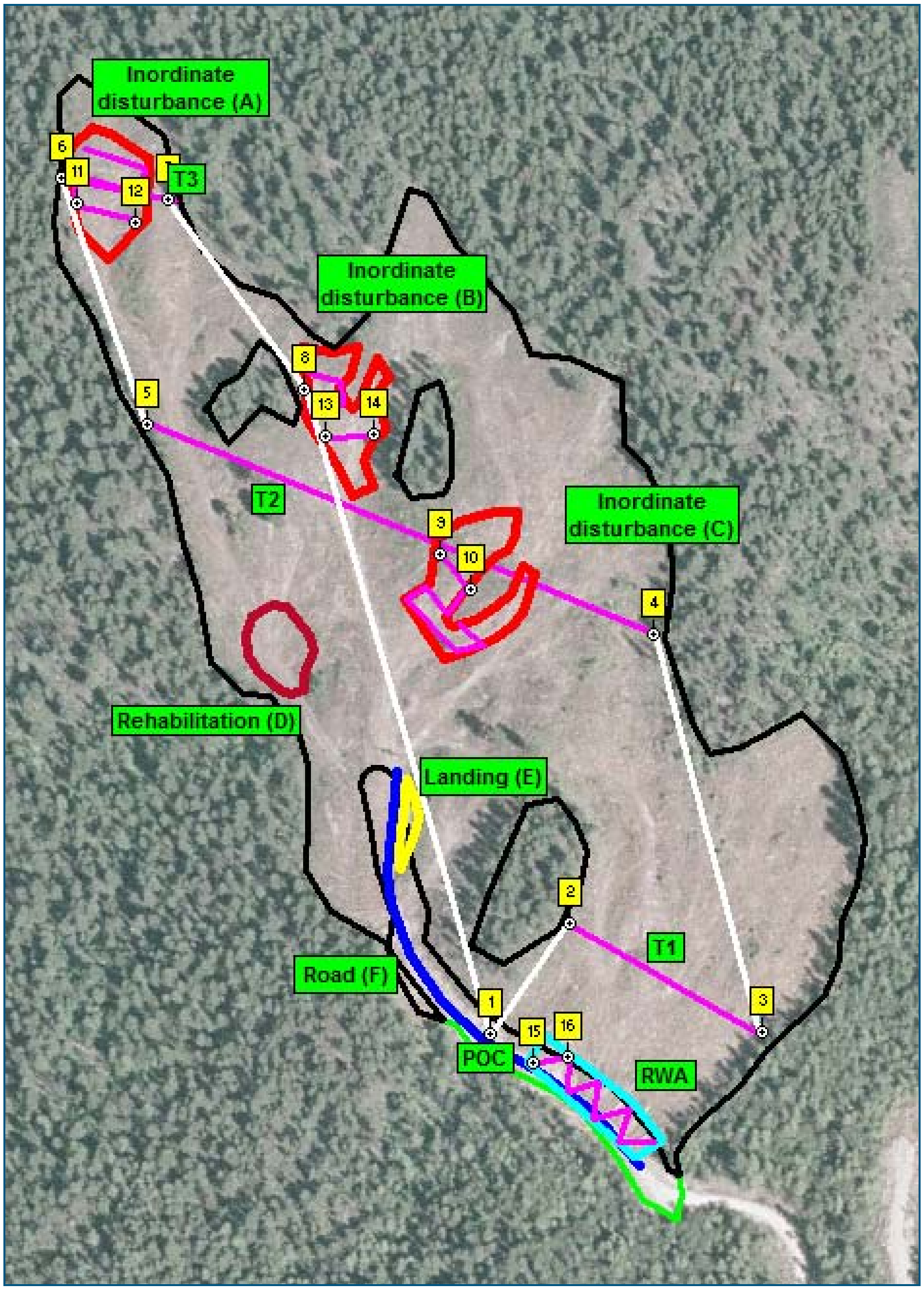


*Figure 2. GPS survey map of cutblock CP364-3, on TFL 23. The white lines show the planned walk through. Purple lines indicate locations of dispersed soil disturbance transects (T1, T2 and T3)*