Forest Practices Board

Soil Conservation Planning and Practices in the Quesnel and Vanderhoof Forest Districts

Special Investigation

FPB/SIR/29

August 2010

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Executive Summary

Soil is one of 11 subjects specifically identified in the *Forest and Range Practices Act (*FRPA), for which government may set objectives. In past Board audits, soil disturbance has arisen as an area for improvement for several licensees, including one significant non-compliance finding.

Over the past several years, factors including changing weather patterns, mountain pine beetle infestations and harvesting productivity, have led to pressures on good soil conservation practices. These factors appear to be creating a situation where the risk of potential adverse impacts to soil productivity and hydrologic function may be elevated.

As a result of these concerns, the Board initiated this special investigation to assess soil conservation practices for harvesting in the Quesnel and Vanderhoof Forest Districts. The investigation reviewed the activities of four major forest licensees—Canfor and West Fraser in both districts, Tolko in the Quesnel district, L&M Lumber in the Vanderhoof district—and two British Columbia Timber Sales operations and associated timber sales licensees, between July 1, 2006, and July 31, 2008. The investigation reviewed soil conservation activities and obligations associated with timber harvesting and associated site-level planning. In total, soil conservation practices in 111 cutblocks, covering 10,871 hectares, were examined.

To assess whether legislation and forest practices are adequately providing for good stewardship of the soil resource in the net area to reforest, the investigation considered four items: the level of compliance with soil disturbance legislation, the magnitude of soil disturbance, how forest planning supports soil conservation practices, and how forest management systems provide for soil conservation practices.

The investigation found that, for the most part, the licensees had a good understanding of the legislation, and their planning, management systems and practices adequately addressed soil conservation. Overall, the licensees effectively developed and implemented operational plans that ensured impacts from their harvest activities were limited.

Current legislation provides a framework that serves as a reasonable basis for management of the soil resource, balancing operational flexibility with soil conservation practices. However, practices can lead to the creation of localized areas where soil disturbance is higher and may not provide for optimal soil conservation.

While the investigation found a high degree of compliance with soil disturbance limits, 146 of the 10,781 hectares examined consisted of dispersed patches, ranging from 1 to 20 hectares in size, where soil disturbance was higher. These areas were compliant because disturbance is measured over the entire standards unit (SU), but are an example of practices that could be improved upon.

Commentary

Based on past work, the Board decided to carry out a special investigation to assess soil conservation practices under the Forest and Range Practices Act (FRPA). The objective of the investigation was twofold: first, to assess compliance; and second, to identify opportunities for continuous improvement.

This special investigation looked at the level of soil disturbance caused by timber harvesting operations in a sample area of the Quesnel and Vanderhoof Forest Districts. Soil disturbance is important because it is an indicator of potential damage to soil and water. While it is often not feasible to avoid soil disturbance completely while harvesting, the amount of disturbance allowed is limited through regulation.

The operations the Board looked at carried out salvage harvesting of mountain pine beetle (MPB) killed timber, which creates a unique set of circumstances, as, the provincial government has identified a need to harvest MPB-killed timber quickly, before it loses its commercial value. This level of urgency, combined with changes in soil moisture (due to the die-off of the trees), changing weather patterns, and at times, marginal economic conditions, all combine to make forestry operations on these sites challenging.

The Board was pleased to find that despite the challenges, all the licensees were assessed with a very high level of compliance (99.7 percent) with soil disturbance limits.

Investigators did note, however, that there were some situations where soil protection could have been improved. Methodology for measuring soil disturbance is based on stratifying sites into standards units (SUs) and assessing the percentage of disturbance within each. It follows that a larger unit could have a significant area of disturbance within it and still fall within allowed limits. This occurred on some of the areas examined.

The Ministry of Forests and Range (MFR) recently produced a guidance document called Best Management Practices for Soil Conservation in Mountain Pine Beetle Salvage Operations. Given that the intended result of the legislation is to minimize disturbance, the Board strongly encourages adoption of these best practices by all operators.

Introduction

Soil is an essential component of the function and productive capacity of forest ecosystems and its health is one of the criteria used by the Canadian Council of Forest Ministers (CCFM) to evaluate sustainable forest management in Canada.

Background

Over the past decade, annual weather patterns have had significant effects on BC's forests. Recent warming trends have affected forest resources, the forest industry, resource dependent businesses and communities; MPB infestations have increased production pressure and contributed toward fluctuations in the water table in some areas, increasing soil moisture; irregular weather patterns have constrained operating windows; an unpredictable economy has resulted in market instability, affecting log flows; and, operational flexibility has been limited by low developed timber and log yard inventories and a disproportionate balance of summer and winter ground. The combined effects are creating situations where soils are sometimes more sensitive to degradation, which can compromise long-term soil productive capacity and hydrologic function if soils are unduly disturbed.

In recent Board audits, evidence of potential impacts on soil was observed when auditors detected localized areas with higher soil disturbance. These disturbance levels have mostly been compliant with legislation, but they may indicate that practices need improvement, and that operations may be adversely affecting soil productivity and hydrologic function.

Legislative Framework

Under the *Forest and Range Practices Act* (FRPA), the BC government has specifically identified soil as one of 11 subjects for which government can set objectives under FRPA's associated regulations. The objective for soils is:

> "without unduly reducing the supply of timber from British Columbia's forests, to preserve the productivity and hydrologic function of soils.".

Since FRPA was enacted, the *Forest Practices Code of British Columbia Act* (the Code) is no longer in effect for the majority of forestry operations, but is still applicable for operations conducted under an approved forest development plan (FDP) during the transitional period to FRPA. However, the soil disturbance limits under FRPA and the Code are the same[1].

[1] *Protocol for* Soil Resource Stewardship Monitoring: Cutblock-level Version 5.0 May 2009 MOFR FREP

The Ministry of Forests and Range Forest Resource Evaluation Program (FREP)[2] website states that the objectives of soil conservation under FRPA, relating to soil disturbance in the net area to reforest (NAR), are:

- To limit the extent of soil disturbance caused by harvesting and silviculture activities that negatively affect the physical, chemical, and biological properties of the soil.
- To conduct forest practices in a manner that addresses the inherent sensitivity of a site to soil-degrading processes in order to minimize detrimental soil disturbance, landslides, soil erosion, and sediment delivery to streams.

The *Forest Practices and Planning Regulation* (FPPR), section 35, classifies disturbance in the NAR into two types;

- dispersed disturbance in the NAR and
- disturbance in roadside work areas (RWA).

The RWA is contained within the NAR but because soil disturbance limits are different in the RWA portion of the NAR, this investigation assessed and reported on each separately.

Under FRPA, "**soil disturbance**" means disturbance to the soil in the net area to be reforested in a cutblock because of (a) temporary access structures, (b) gouges, ruts and scalps, or (c) compacted areas, but does not include the effect on the soil of rehabilitating an area in accordance with section 35.

Unless removing infected stumps or wind throw, FPPR specifies dispersed soil disturbance limits of five percent of the NAR for areas with predominantly sensitive soils[3], 10 percent of the NAR for areas with predominantly non-sensitive soils, depending on soil hazards and 25 percent disturbance in RWA's. Disturbance levels are calculated on an SU[4] basis and may be exceeded by no more than 5 percent for the construction of temporary access structures provided that they are rehabilitated.

For compacted areas larger than one hectare, the district manager, may require the licence holder to rehabilitate the area of compacted soil even though the soil disturbance limits are not exceeded. FRPA further addresses soil conservation under section 46 and in the FPPR, section 3, where it specifies that, with exceptions, persons must not carry out activities that result in damage to the environment, including soil disturbance, that fundamentally and adversely alter an ecosystem. If environmental damage has occurred, FRPA specifies the actions required to be taken to address the damage.

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[2] The Forest and Range Evaluation Program, also known as FREP, is a long term commitment by government to determine if forest and range policies and practices in British Columbia are achieving government's objectives for FRPA resource values and to implement continuous improvement of forest management. The MFR runs the program with assistance from other agencies.

[3] Sensitive soils means soils that, because of their slope gradient, texture class, moisture regime, or organic matter content have the following risk of displacement, surface erosion or compaction: (a) for the Interior, a very high hazard; (b) for the Coast, a high or very high hazard.

[4] For soils FPPR in part defines a Standards Unit (SU) as one or more parts of a cutblock for which part or parts there is only one soil disturbance limit. Under the *Forest Planning and Practices Regulation* (FPPR), Section 35 (3), soil disturbance limits are set for each standards unit contained within a cutblock.

Scope and Approach

Objectives

The primary objective of this investigation was to assess whether legislation and forest practices are adequately providing for good stewardship of the soil resource.

To address this objective the Board evaluated how:

- the legislation provides for stewardship of the soil resource, including;
    - the degree to which soil disturbance legislation has been complied with and
    - the magnitude of soil disturbance levels.
- industry planning and management systems provide for stewardship of the soil resource, including;
    - forest planning adequately supports soil conservation practices and
    - forest management systems are successful in managing detrimental impacts to soil productivity and hydrologic function.

Scope

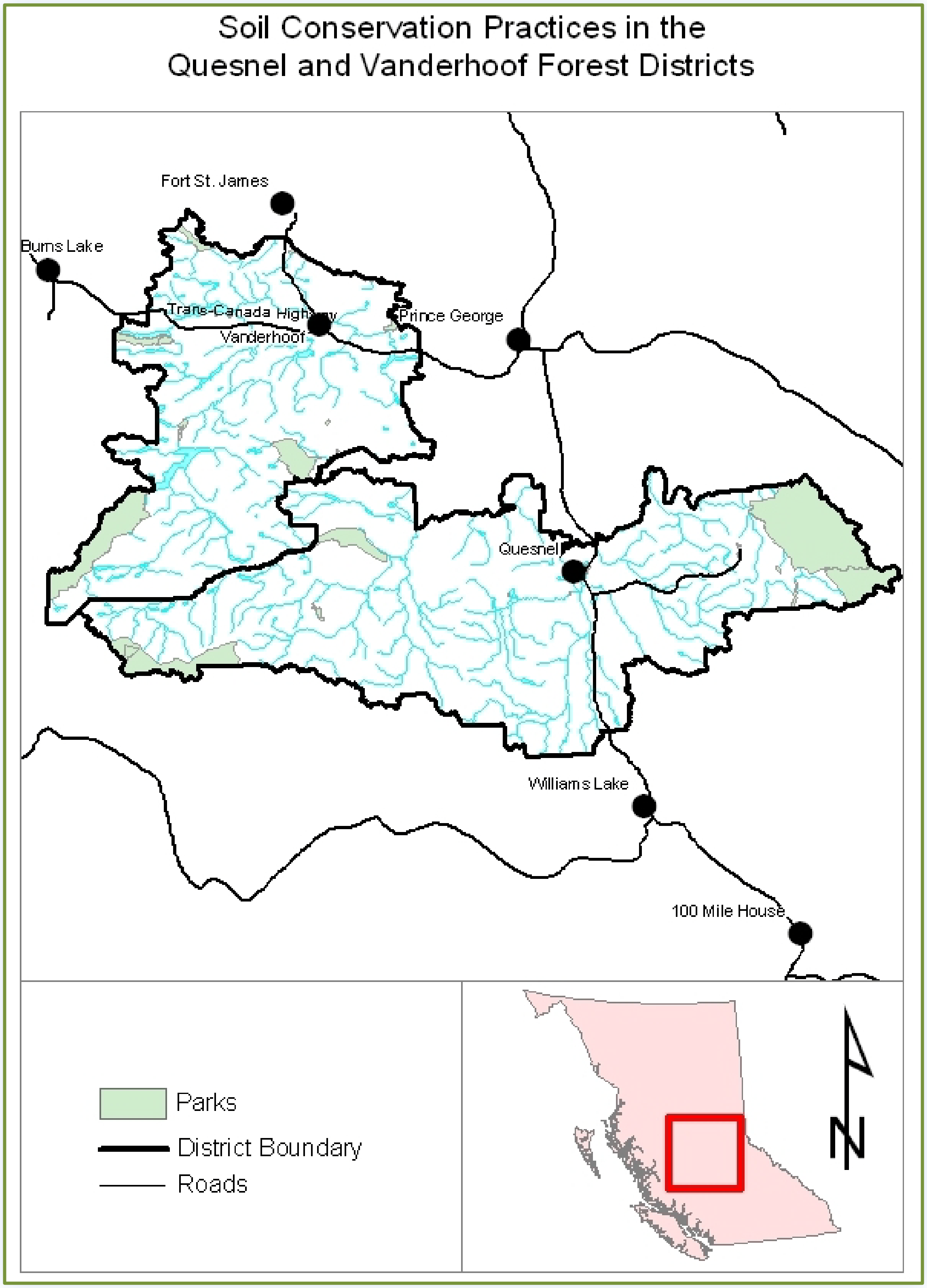
The investigation assessed forest planning and practices related to forest soil conservation conducted from July 1, 2006, to July 31, 2008. Investigators reviewed site plans, field practices and management systems to assess compliance with soil-related FRPA requirements and effectiveness of practices for optimizing soil conservation. Examples of planning and practices examined during the investigation were:

- soil hazard assessments and site plans;
- harvest practices on sensitive soils;
- rehabilitation of temporary access structures;
- management of terrain stability; and
- soil conservation practices in roadside work areas and in the remainder of the NAR.

Methodology

Selection of Investigation Area

In 2008, the Board selected the Quesnel and Vanderhoof Forest Districts as locations for this soil special investigation (see map on page 6). The two districts are characterized by epidemic mountain pine beetle infestations, irregular precipitation patterns, accelerated harvest levels, elevated water tables (in some areas) and seasonal access limitations, which in combination present challenges to soil conservation practices (see Appendix D for more detail on the audit area). The Board has previously conducted audits in these districts, and found that soil conservation practices that could be improved, which prompted the choice of for this investigation.


Soil Conservation Practices in the
Quesnel and Vanderhoof Forest Districts
Fort St. James
Burns Lake
Trans-Canada Highway
Vanderhoof
Prince George
Quesnel
Williams Lake
100 Mile House
Parks
District Boundary
Roads
N

Licensee and Cutblock Selection

The cutblock population was established by reviewing harvesting records to determine harvest activities in the investigation area over the two-year investigation period. To provide a broad range of operating conditions and harvest systems, harvest activities for major licensees were prioritized over small tenure holders as potential cutblocks for field review. The Board selected four major licensee operations as well as a British Columbia Timber Sales (BCTS) operation in each district. Table 2 summarizes the cutblock sample by licensee.

A set of risk ranking criteria (Appendix B) was developed in order to prioritize cutblocks for field sampling. Sampling priority was given to cutblocks with higher risk ratings, with consideration given for geographic distribution. Table 1 summarizes harvesting activities that occurred during the investigation period and their sampling intensity.

Table 1 – Summary of cutblocks and areas investigated by forest district (harvest activities July 1, 2006 to July 31, 2008).

Forest District	Cutblocks Harvested	Cutblocks Assessed	Area Harvested (hectares)	Area Assessed (hectares)
Quesnel	876	70	44,851	5,355
Vanderhoof	296	41	16,788	5,426
Total	**1,172**	**111**	**61,639**	**10,781**

Table 2 – Summary of cutblocks and areas investigated by Licensee.

Forest District	Licensee	Cutblocks Assessed	Area Assessed (hectares)
Quesnel	Canfor	3	590
	West Fraser	13	1,003
	Tolko	13	1,138
	BCTS Licensees	41	2,624
Total		**70**	**5,355**
Vanderhoof	Canfor	11	1,790
	West Fraser	13	2,086
	L&M Lumber	9	836
	BCTS Licensees	8	714
Total		**41**	**5,426**
Project Total		**111**	**10,781**

The majority of the blocks investigated contained non-sensitive soils, but 2,727 hectares contained sensitive soils, characterized by fine textured soils (silts and clays) and a very high compaction hazard rating. Sensitive soils usually require specific management practices, such as; restricting harvest operations to a period when soils are either dry or frozen, using specialized equipment for timber harvesting, or using rehabilitative measures to achieve acceptable soil disturbance levels. Figure 1 illustrates some typical locations where sensitive soils can occur.

Figure 1: An example of sensitive areas associated with riparian features.

Investigation Team

Personnel qualified to assess and interpret soil disturbance types were assigned to the investigation team. Field assessments and reporting were conducted by:

- Rick Trowbridge, RPBio, soil scientist
- Glen Pilling, RPF, certified soil disturbance surveyor
- Daryl Spencer, RPF, certified soil disturbance surveyor

Compliance Assessment of Soil Conservation Practices

Consistent with the *Soil Conservation and Soil Conservation Surveys Guidebook*, the investigation examined cutblocks for typical soil disturbance including rutting, scalping, compaction, gouging and bladed structures (see Appendixes A and D, Figures D1 – D4).

Information contained in site plans served as the basis for assessing legislative compliance. Maximum soil disturbance limits were specified in site plans by SU. For each SU, the prescription stated the assessed hazards for soil compaction, soil displacement, and soil erosion, and indicated the likelihood of landslides (if detailed terrain stability mapping was done). The assessed hazards were used to determine:

- the maximum amount of soil disturbance allowed within a SU; and
- which types of soil disturbance to count in each SU (see Appendix A).

The measurement process was adapted to increase reliance on professional judgment, with detailed quantification of soil disturbance in circumstances of non-compliant, or ineffective, practices only rather than detailed measurement on all sites.

Field procedures included an aerial overview to assess overall disturbance levels and accuracy of site plans. To provide a benchmark for aerial observations, a representative cutblock containing areas with elevated soil disturbance was aerial photographed and field surveyed, quantifying disturbance levels. During aerial overviews, disturbed areas were mapped and photographed from the air. Ground reconnaissance was conducted in areas with higher soil disturbance levels to estimate dispersed soil disturbance and disturbance in RWAs, and to confirm soil textures and hazard classifications. Estimates of soil disturbance obtained during ground reconnaissance were compared with limits specified in site plans to assess compliance.

Assessing the Magnitude of Soil Disturbance and Its Potential Impact on Soil Productivity and Hydrologic Function

During aerial inspections, areas in the NAR containing elevated soil disturbance or landslides were mapped and photographed. Data from mapped areas was tabulated and summarized to calculate an estimate of the magnitude of soil disturbance within the investigation area.

Forest Planning

Information contained in site plans, including soil textures, soil hazard classifications and the delineation of standards units, were compared with that found in the field in order to assess the accuracy of the site plans. Those areas that were inconsistent with site plans were ground sampled to verify site information. The findings were summarized to provide an overall impression of the degree of accuracy of the soil information contained in site plans.
To confirm that terrain stability was adequately addressed, site plan content was compared with terrain stability mapping, legislative requirements and field observations.

Management Systems

Before and during fieldwork, Board investigators conducted interviews with representatives from four licensees, BCTS, as well as regional staff from MFR in Prince George. Interviews covered the following topics:

- Soil planning, management systems and practices
- Implementation and monitoring of harvesting and silviculture activities
- Practices limiting soil erosion events

The effectiveness of management systems was tested by comparing soil conservation practices and outcomes prescribed in site plans with those found in the field.

Findings

The Board assessed a total of 10,781 hectares in 111 cutblocks; 5,426 hectares in 41 cutblocks in the Vanderhoof Forest District and 5,355 hectares in 70 cutblocks in the Quesnel Forest District.

The findings were consistent between districts, licensees and BCTS operations. They all demonstrated a high level of compliance with legislation, but sometimes created localized areas with elevated levels of soil disturbance.

Compliance

Dispersed Soil Disturbance

Forest legislation requires that the average dispersed soil disturbance in an SU fall within the disturbance targets specified in the site plan. The investigation found that of 10,781 hectares field reviewed, all but 35 hectares, comprised of three SUs, met the SU targets and were therefore in compliance with forest legislation (See Appendix D, Figure D9). At the time of the investigation, 33.7 of the 35 hectares in non-compliance were under review by the MFR and a rehabilitation plan had been developed to help restore soil productivity.

Soil Disturbance in RWAs

The licensees examined used RWAs for processing, sorting and loading timber. The investigation examined over 400 kilometres of RWAs for soil disturbance, including over 190 kilometres in Vanderhoof Forest District and 210 kilometres in Quesnel Forest District. Average soil disturbance was found to be within the limit of 25 percent in all areas examined and was compliant with legislation.

Terrain Stability

All cutblocks sampled were assessed for terrain stability. Licensees conducted terrain stability field assessments (TSFA) in eight cutblocks, all of which were in the Quesnel Forest District. There were no potentially unstable areas observed during field inspections that were not included in site plans. TSFA recommendations were followed by licensees and no landslides were observed during the investigation. Terrain stability practices were compliant with legislation.

The high levels of compliance found demonstrate that the operators understand the legislated standards and are successfully able to achieve disturbance limits specified in the FPPR.

Magnitude of Soil Disturbance

Dispersed Soil Disturbance

Legislation specifies that soil disturbance limits be assessed on an SU basis. Disturbance levels are calculated by averaging disturbed areas within an SU.

In some cases, when operating conditions are wet or when there are smaller areas of sensitive soils contained within a SU, areas with higher soil disturbance can be created during harvest activities when operators do not recognize and adapt to site and soil conditions. However, in such cases average disturbance for the SU often falls within legal limits and is compliant with legislation. For large SUs, when averaging soil disturbance, sizeable areas can be created where soil productivity may be reduced, which may not promote optimal soil conservation practices (Figure 2). This outcome has been accepted by licensees because, in most cases, it is compliant with FRPA and they feel it generally balances soil conservation practices with timber harvest production.

Of the 10,781 hectares examined, the area that had portions exceeding disturbance limits was 146 hectares, consisting of patches ranging from 1 to 20 hectares in size. Disturbance levels could have been avoided by harvesting when soils were less sensitive or by modifying harvesting methods or equipment. Although a relatively small portion of the sample, cumulatively, this finding may indicate that a significant area may be adversely affected by similar harvesting practices and represent an opportunity for improvement.

Pockets of higher disturbance in compliant SUs can be quite large compared to what is considered non-compliant in smaller SUs because limits are set on a percentage basis.

The investigation found that for larger SUs, depending on harvest practices, how SUs are delineated and how sensitive areas are combined in SUs, FRPA permits practices where sizeable areas with higher soil disturbance levels can be created if harvesting supervisors and equipment operators are not careful.

The investigation also found that in 46 blocks (27 of 71 in Quesnel and 19 of 41 Vanderhoof) investigated contained minor levels of dispersed soil disturbance, consisting of small areas (less than one hectare) where disturbance was avoidable (Figures 3 and 4). These were typically small, unmarked wetlands or ridges where rutting, scalping and compaction were observed and, due to their dispersion, were difficult to quantify. Disturbance in these areas could have been avoided by adapting technique and timing of harvesting operations and by improving mapping and field marking of sensitive areas. While compliant with legislation, this is a practice that could be improved.

Figure 2: An example of a cutblock where average soil disturbance is within the limit in the site plan but contains a portion where soil disturbance exceeds the limit.

An area of approximately three hectares where the soil disturbance limit (5 percent) has been exceeded (estimated at 15 percent) due to compaction, rutting and scalping. However, the remainder of the SU (58 hectares.) had disturbance levels of 3 percent. Therefore average soil disturbance was 3.6 percent, less than the limit and compliant with legislation.

Figure 3: An example of a preferred practice where a small sensitive area was marked in the field and was undisturbed by heavy machinery.

Figure 4: An example of a non-preferred practice where a small sensitive area was not marked in the field and was disturbed by heavy machinery.

When dispersed soil disturbance exceeded allowable limits, licensees sometimes used rehabilitation treatments to restore soil productivity. The investigation found that portions of six cutblocks had been rehabilitated to assist soil recovery (See Appendix D, Figure D12). Temporary access structures (TAS) were rehabilitated where necessary.

Disturbance in Roadside Work Areas

The investigation found that soil conservation practices on RWAs were within disturbance limits with few instances of higher soil disturbance observed. Four cutblocks (2 of 70 in Quesnel and 2 of 41 in Vanderhoof) contained portions of RWAs, totaling 5.2 of the 400 kilometres sampled, where the disturbance levels exceeded 25 percent (Figure 5). While compliant with legislation, disturbance was avoidable and could be an opportunity for improvement by altering harvest timing and technique. (See Appendix D, Figures D5 and D6 for additional examples).

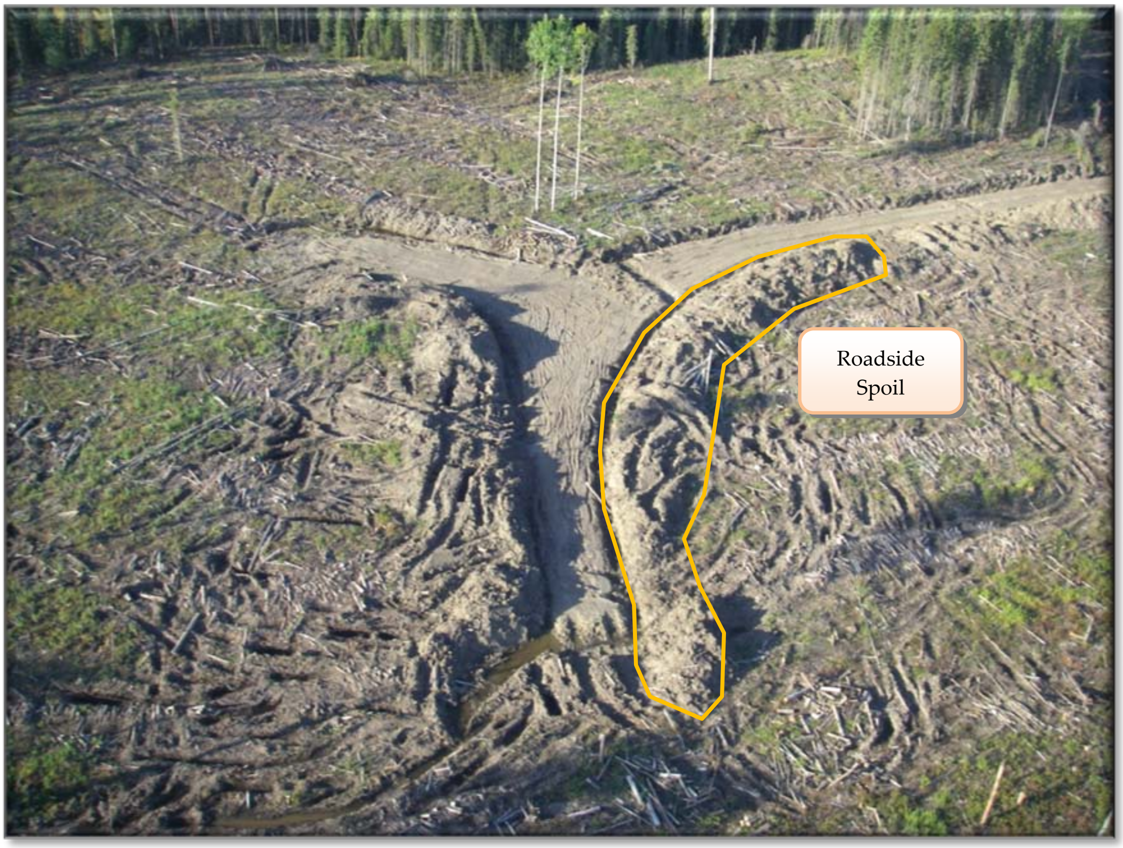


Figure 5: An example of non-preferred soil conservation practices in a RWA. Soil disturbance levels are elevated due to rutting, gouging and compaction. The spoil from road construction serves as a poor growing medium and reduces the productive area of the cutblock.

Terrain Stability

There were no areas observed during the field review where the risk of landslides was high, due in part to the generally benign terrain found in the forest districts reviewed. No landslides were observed during the investigation.

Planning for Soil Conservation

It is important that soil properties are correctly identified to ensure soil conservation practices reflect recognized soil hazards. Reliance is placed on practitioners to provide accurate information and recommendations upon to base practices, and to prescribe soil management practices that are appropriate for the site. The investigation reviewed licensees' systems and found that forest certification schemes, and environmental management systems, have been considered in the planning process, including the use of required procedures to provide assurance that soil hazards are accurately identified and interpreted in planning documents.

The investigation found that, where practical, site plans were prepared to recognize a potential range of soil conditions, and that recommendations were made to protect the most sensitive areas. Despite this, situations occurred where sensitive areas were not identified in plans because they were either impractical to delineate or were not observed during development activities. In these cases it was expected that practitioners carry out appropriate activities to limit soil disturbance.

The investigation compared SU stratification and soil hazard classifications contained in site plans with those observed in the field. Eleven of 111 (5 out of 70 in Quesnel and 6 out of 41 in Vanderhoof) of the cutblocks sampled contained SUs where soil hazards in the field were inconsistent with those in site plans. Inconsistencies included soil texture identification and soil hazard classification. Of these, eight SUs were classified as more sensitive than actual, with the remainder less sensitive, demonstrating that licensees tended to take a conservative approach.

Where site conditions differed from the plan, in all but one instance, equipment operators were able to recognized field conditions and adapt their practices to limit soil disturbance.

Soil Conservation – Systems and Practices

The Board interviewed industry representatives to understand their perspectives on soil conservation legislation, and to assess their practices and systems intended to address soil conservation. The interviews focused on the management systems used to address soil conservation and practices designed to minimize soil disturbance.

Management systems

Wide-ranging management systems were used by licensees to assure consideration for resource interests, including planning, implementation, monitoring, and evaluation procedures for soil conservation and terrain stability. All licensees investigated were environmentally certified and have adopted an environmental management system (EMS), which among other items incorporated soil conservation practices.

Particular to soil conservation, management systems amalgamated the following key operational phases:

- Collection of field information to determine soil and terrain hazards and delineate SUs
- Incorporation of field information into operational plans

- Implementation and monitoring of harvesting activities
- Implementation and monitoring of rehabilitation or silviculture activities

Systems linked operational phases to ensure continuity of soil management practices, and contained evaluation mechanisms to address system and operational strengths and weaknesses. Management systems effectively addressed soil conservation.

Implementation and monitoring of harvesting activities

Although, for the most part, implementation and monitoring procedures were effective in limiting excessive soil disturbance, the instances of localized disturbance, as cited in previous sections, still occurred. When questioned, the rationale for these occurrences included:

- Production pressures
- Lack of practitioner/operator training and experience
- Adverse operating conditions and no suitable alternative areas to operate due to limited standing and developed timber inventories
- Acceptability through compliance with legislation
- Soil hazards not accurately portrayed in plans
- Soil hazards not clearly identified in the field

The instances of higher soil disturbance observed during the investigation indicate that the implementation and monitoring of harvest activities is not wholly effective and is an area that can be improved.

Soil Management on Roadside Work Areas

Rather than use traditional landings, RWAs were the primary method used by licensees to process, sort and load logs. Given the evolution of harvest techniques, the cost of landing construction and the reductions from the NAR that landings present, licensees considered using RWAs more cost effective, and a better soil conservation practice.

Roads were generally developed immediately before harvest due to a low or seasonally unbalanced standing timber inventory (STI) and to reduce development costs. When roads are not pre-developed they can be infirm. When roads are infirm, the infirm roadbed needs to be excavated and piled and the ditches trenched to drain and dry the road’s running surface for hauling. The spoil material from this practice is placed alongside the road, increasing the size of the permanent access structures (Figure 5 and Appendix D, Figure D11). Unless the roads are reclaimed, rather than the road prism being higher than the surrounding area, it will be lower leaving a poorly constructed road for future harvesting passes. Optimally, if roads were pre-developed they would be firm for hauling and minimize reductions to the NAR.

A larger and more diverse standing timber inventory may improve operational flexibility and allow pre-development of roads, minimizing reductions in the NAR.

Conclusions

The primary objective of this investigation was, in consideration of the soil conservation challenges associated with shifting forest health and environmental conditions, to assess whether legislation and forest practices are adequately conserving the productivity and hydrologic function of soils. Overall, the investigation found that licensees have a good understanding of the legislation, which serves as a reasonable meter to guide soil management practices. Operations examined by the Board were conducted so that planning, management systems and practices limited adverse effects on soil productivity and hydrologic function caused by harvesting.

Effectiveness of Legislation

The investigation found that licensees were able to operate within the confines of current legislative framework. The investigation found full compliance with terrain stability requirements. As well, there was full compliance with allowable soil disturbance standards in roadside work areas and a 99.7 percent compliance rate within the rest of the net area to be reforested.

However, the investigation found that larger SUs sometimes contained sizeable areas with higher soil disturbance, but still complied with the legislation because disturbance was averaged over a large SU. These disturbed areas were sometimes larger than the areas of disturbance that were in non-compliance. Further, the investigation found numerous small dispersed areas, generally associated with ridges or wet areas, where repeated machine traffic created excess soil disturbance. FRPA permits practices where sizeable areas with high disturbance levels can be created and is not wholly effective in minimizing soil disturbance.

Effectiveness of Planning, Management Systems and Practices

The investigation reviewed licensees' planning and management systems to assess their effectiveness in managing soil conservation. A review of their systems found that forest certification schemes, and environmental management systems have been considered in the planning process, showing that auditees were aware of, and were implementing, objectives and strategies addressing soil conservation practices and legislative requirements. Systems included soil conservation measures which serve to guide field practitioners and operators through sound soil management practices.

Notwithstanding a comprehensive management framework, the investigation found instances of higher soil disturbance still occurred due to: production pressures, timber inventory constraints, disturbance falls within legal limits, errors contained in site plans, hazards not marked in the field or practitioner and operator inexperience, indicating that planning, systems and practices are not wholly effective in minimizing soil disturbance.

Recently the Forest Practices Branch of the MFR released *Timber Harvesting Practices Extension Note #1: Best Management Practices for Soil Conservation in Mountain Pine Beetle Salvage Operations* (November 2009) (Appendix C), which addresses soil conservation practices in areas infested by mountain pine beetle. This extension note serves as a guide to minimizing soil disturbance.

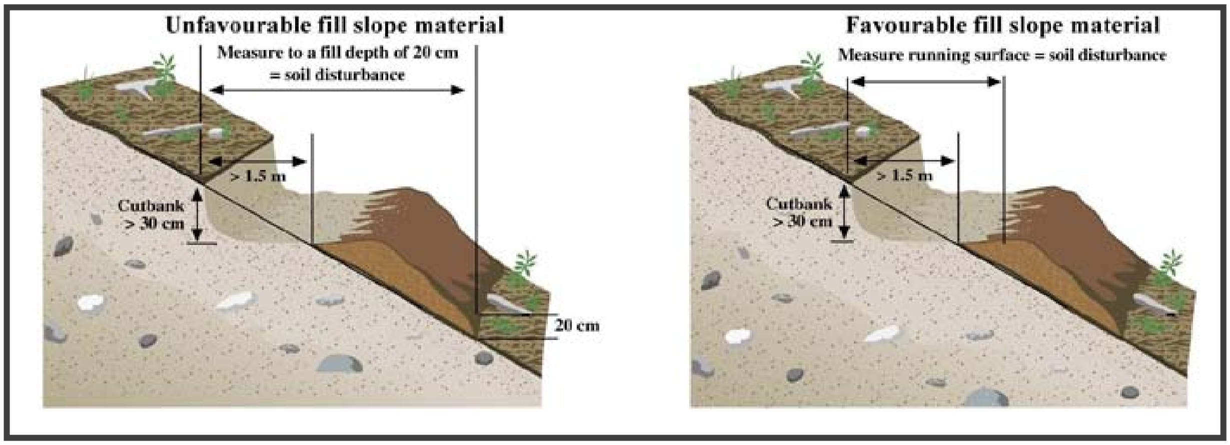
Appendix A: Background on Soil Disturbance

Impacts from Harvest Activities that Affect Soil Productivity and Hydrological Function

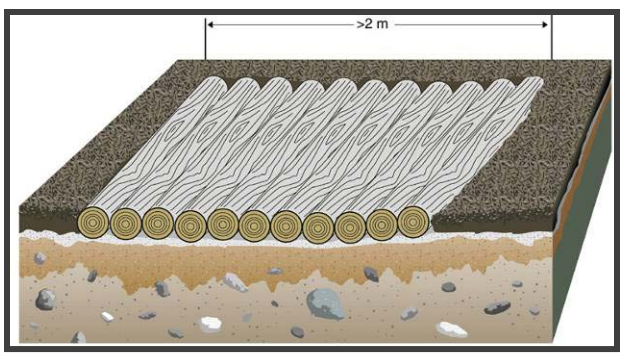
The following are a series of diagrams that depict various scenarios that may be present in a cutblock as the result of harvesting activity. These forms of soil disturbance are used in assessing compliance and effectiveness with the soils conservation criteria developed for the 2004 pilot soils audit and modified to incorporate more recent changes.

Excavated or Bladed Trail

The classification of soil disturbance on excavated and bladed trails depends on whether fill slopes are considered a favourable or unfavourable medium for growing trees.



Corduroyed Trails

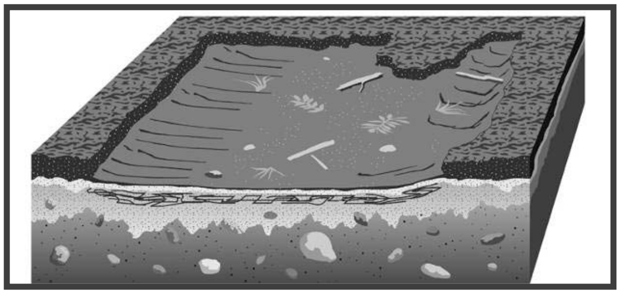


If satisfactorily rehabilitated, a corduroyed trail does not count as soil disturbance.

This is an example of a trail that has not been satisfactorily rehabilitated, as woody material covers soil and reduces plantable spots for seedlings.

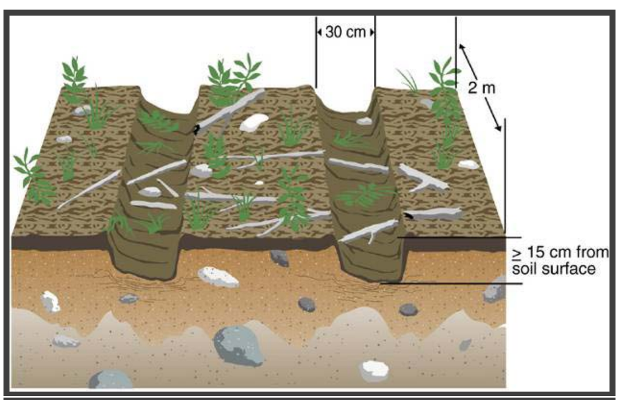
Compaction

Compacted areas are areas on which there is evidence of compaction and on 100 percent of a portion that is both greater than 100 metres squared in area, and greater than five metres wide.

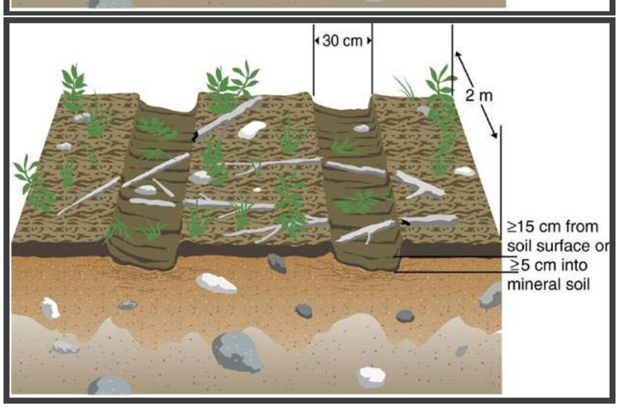


Dispersed Trail (wheel or track ruts)

Wheel or track ruts are impressions or ruts in the soil caused by heavy equipment traffic. They are at least 30 centimetres wide and twometres long. Two different depth criteria (five centimetres and 15 centimetres) apply, depending on the compaction hazard of the standards unit being assessed.

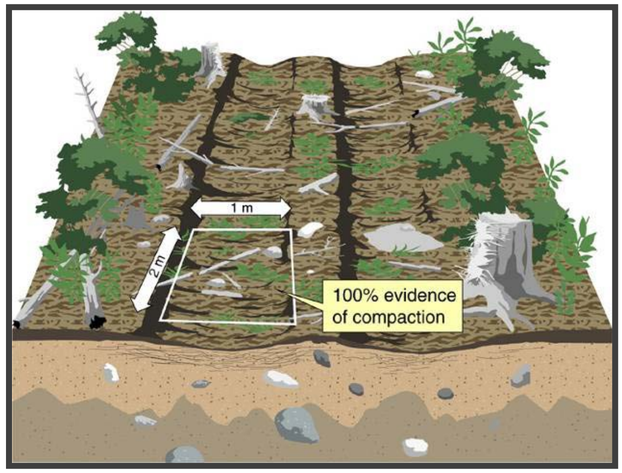


Wheel or track ruts 15 cm deep.



Wheel or track ruts 5 cm deep applies to high or very high compaction hazards.

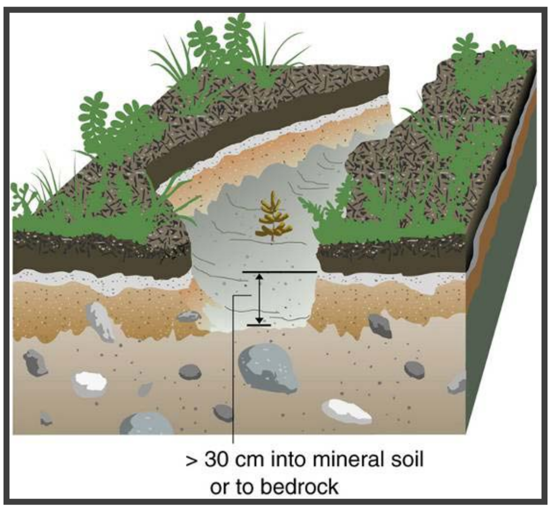
Dispersed Trail (repeated machine traffic)



The category *repeated machine traffic* describes disturbance resulting from repeated heavy machine traffic. Such disturbance is typically found on repeatedly used skid trails, which are obvious linear features. It may also occur on heavy traffic areas associated with roadside work areas and around piles constructed by windrowing or piling slash.

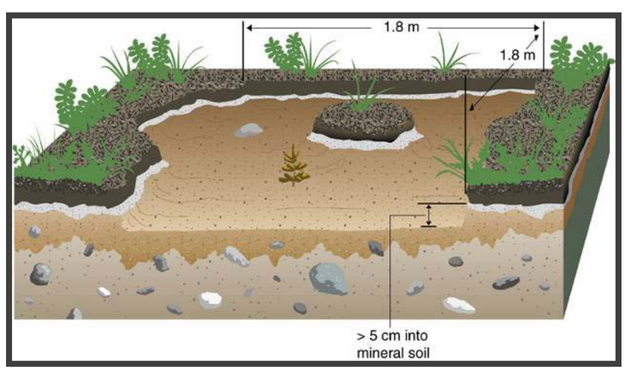
Deep Gouges

Deep gouges are excavations into mineral soil that are deeper than 30 centimetres into mineral soil or to bedrock.

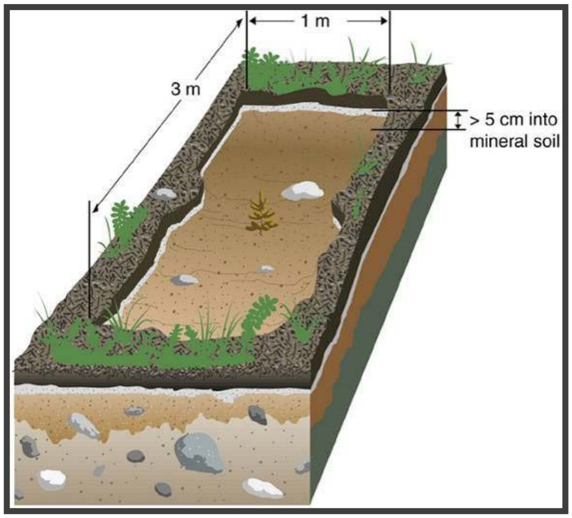


Wide Gouge

Wide gouges are excavations into mineral soil that are a) deeper than five centimetres or to bedrock and b) on at least 80 percent of an area 1.8 x 1.8 metres.



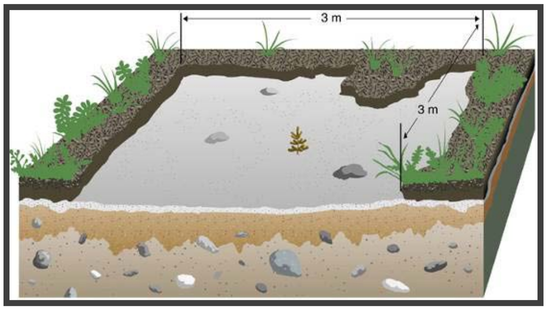
Long Gouge



Long gouges are excavations into mineral soil that are a) deeper than five centimetres or to bedrock and b) on 100percent of an area 1 x 3 metres.

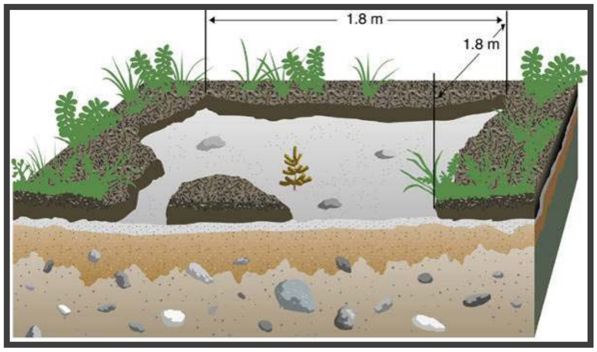
Very Wide Scalp

Very wide scalps are areas where the forest floor has been removed from over 80percent of an area 3 x 3 metres.



Wide Scalp

Wide scalps are areas where the forest floor has been removed from over 80 percent of an area 1.8 x 1.8 metres with very high soil displacement, compaction or erosion hazards; or medium or high likelihood of landslides.



Related soil conservation terms are defined in FRPA, transitional provisions, and the following FPC Guidebooks (limits and principles remain the same between the *FPC Act* and FRPA):

- Soil Disturbance Hazard Ratings for Compaction, Displacement, and Surface Soil Erosion (PDF);
- Soil Disturbance Limits (PDF);
- Soil Rehabilitation
- Soil Disturbance Measurement (PDF);
- Pre-harvest data collection and site stratification (along with forest floor displacement and mass wasting hazard keys that are recommended for harvest and site preparation planning) (PDF).

Appendix B: Cutblock Risk Ranking Criteria

Parameter	Risk Criteria
Known issues	Areas that had been subject to prior or ongoing investigations pertaining to soil disturbance.
Soil texture, soil and terrain hazards	Higher risk was associated in areas with fine textured, variable or sensitive soils (very high sensitivity to soil degrading processes) or where terrain hazards were high.
Timing of harvest	Higher risk was associated with areas that were harvested during late spring or wet summer and fall months.
Topography and local soil moisture	Higher risk was associated with blocks containing steeper terrain or wetter ecosystems.
Landscape susceptibility to wet soils	Higher risk was associated with broad climatic regions which are prone to wet climatic patterns.
Harvest and silviculture system	Higher risk was associated with ground based harvest systems and partial cut silviculture systems.
Cutblock size	Higher risk is associated with smaller cutblocks where there are fewer options to relocate operations to areas containing less sensitive soils during unfavourable conditions and where soil disturbance is averaged over a smaller standards unit.
Roadside Work Areas (RWA)	Higher risk is associated with cutblocks where RWAs are considered to represent a large proportion of the cutblock
Contractor knowledge and performance	Higher risk was associated with less experienced contractors and those with past performance issues.
Geographic coverage	Sampling was geographically dispersed to adequately capture ecological variation and operating conditions over the landscape.

Appendix C: Timber Harvesting Practices Extension Note #1

Best Management Practices for Soil Conservation in Mountain Pine Beetle Salvage Operations November 2009

Background and Issue

The mountain pine beetle (MPB) epidemic is changing British Columbia forests and watersheds at the landscape scale. Watersheds with pine-leading stands experience dramatic changes in their water balance when the pine dies (Winkler et al. 2008). Because they have little or no foliage or fine branches, stands of dead trees intercept less snow and therefore accumulate more snow on the ground than live stands (Boon 2007). Dead and dying trees also transpire less than live trees as physiological processes (other than those associated with decomposing organisms) have slowed or ceased. With less interception and evapotranspiration (evaporation and transpiration), more precipitation reaches the forest soil and less water is removed from it. The soils under stands of dead trees are, therefore, generally wetter than soils under stands of live trees through much of the snow-free season.

This is similar to the situation in recent cutblocks during normal forest operations, where soils are generally wetter than in uncut forests (Spittlehouse 2007). In both cutblocks and MPB-killed stands, wetter soil conditions persist until the growing vegetation begins to make significant contributions to evapotranspiration. However, in stark contrast to normal forest operations, because the wetter soil conditions pre-date timber harvesting they can therefore dramatically affect operability.

Wet soils are more susceptible than dry soils to soil disturbance, especially soil compaction, rutting, and puddling. Some forest licensees have reported that during months when ground-based forestry operations could normally proceed with few constraints, dry, firm soil (typical of summer ground) has been replaced by wetter, less firm soil (usually restricted to winter operations). This makes the operation of ground equipment more difficult or impossible until sufficient snowfall or freeze-up renders the ground firm enough to be operable.

Rex and Dubé (2008) are studying the hydrologic effects of MPB infestation on soil water conditions and developing a risk-based assessment model for predicting which areas are most likely to be too wet for normal summer operations. They have determined that the most effective indicators for predicting the risk of wet ground at the watershed level are overstory lodgepole pine percent composition and mortality, amount of understory, density of drainage and topography, and sensitivity of soils (Rex and Dubé 2008).

Percent composition of lodgepole pine (and of other tree species that are not susceptible to the beetle and therefore not killed) determines how much living overstory remains. The amount of living overstory directly affects the amount of interception and evapotranspiration and the subsequent soil water content. Similarly, the amount of live understory, including advanced regeneration and other vegetation, contributes to the total amount of living vegetation and therefore the amount of evapotranspiration and the resulting soil water content.

Density of the drainage and topography refers to the number of surface channels and the watershed slope gradient and length. These factors directly relate to how quickly surface and subsurface water is removed from a site and from the soil. Toe-receiving areas, for instance, are often wet, so salvage operations and site preparation activities on them should be avoided during the spring, summer, and fall months.

Sensitivity of soils refers to soil properties that affect internal soil drainage, such as soil texture and structure. Increasing sand and gravel content means that soils generally drain more quickly. However, soil disturbance can occur on soil of all textures if conditions are unsuitable for ground-based harvesting.

In general, the sites at greatest risk of being wetter than expected and therefore of the soil being detrimentally disturbed if harvested at any time except under snowpack are lodgepole pine dominated with little understory, in gently sloping or flat receiving (toe-slope) positions and on fine- to medium-textured soils.

Season of operation and precipitation are also critical factors. Frozen ground or sufficiently deep snowpacks (Curran 1999) protect the soil from harvesting disturbance. Because such conditions are rarely seen in most of the province, the operating window for conventional logging is therefore reduced. Snowmelt and rain events make the soil wetter and more at risk of harvesting disturbance.

Guidance: Best Management Practices

Planning operations is essential to logging success. It will determine how the harvesting system can be matched site sensitivity by recognizing inherent soil constraints to salvage logging. Guidance on selecting strategies to minimize soil disturbance during MPB salvage essentially fall into one of the four groupings outlined by Lewis et al. (1991): scheduling and season of harvest; choice of equipment; on-the-ground strategies; and rehabilitation options.

Scheduling and season of harvest

- A best management practice for forest management is to plan operations, including time of harvest, based on the sensitivities of all soils in the harvest unit regardless of the size of the standard unit against which excessive soil disturbance is measured. Even in areas of apparent uniform sensitivity, small wet drainages and draws should be recognized and avoided so that natural surface drainage patterns are not impeded. Consider soil moisture conditions at the time of harvest because there are continuous changes in soil water conditions within MPB areas as trees die, road networks increase, and areas of salvage logging increase. Consider harvesting low sensitivity soils in wetter periods and the most sensitive soils only once the soil dries or in winter under sufficient snowpack.

- Focus harvesting on winter months but do not extend past spring shut-down (snowmelt and beyond) when soils are saturated and easily disturbed. Soils in the interior are generally unfrozen under a snowpack (warm wet snow, if deep enough, is the most effective in protecting the soil), and during periods of low snowpack, wet, unfrozen soils will be highly susceptible to soil disturbance.
- Avoid spring and wet summer or fall harvesting, especially on toe-slope positions and in wetter (subhygric to hygric) sites or portions of a harvesting unit. This includes sites where soils have restricting layers that can impede drainage. When salvage logging must be hurried under these conditions, pre-harvest activities such as forest drainage could be carried out to reduce soil moisture. Forest drainage is not a panacea and the potentially negative long-term impacts of altering natural drainage of a site must be weighed against the possible short-term benefits of improved operability. In drier areas of the province, including the southern interior, wet soils may not be a concern under normal summer and fall precipitation, except on the most sensitive sites.
- Early identification of green-attack stands, especially those without advanced regeneration, reduces the risk of on-site moisture problems because harvesting can be carried out before the stand dies.
- When harvesting red- and grey-attack trees, take the time to let the soils dry properly before beginning ground-based harvesting because soils take longer to drain excess moisture under ponding conditions.

Choice of equipment

- If harvesting under unfavourable soil moisture conditions is unavoidable, consider using innovative or non-conventional harvesting strategies (e.g., hoe chucking, designated trails, or low ground pressure equipment).

On-the-ground strategies

- When harvesting during the snow-free season, weather-related shut-down may needed more quickly than normal because due to higher soil moisture contents.
- Retain areas with live trees as a first priority to maximize the potential to remove water from the soil through evapotranspiration.
- Retain advanced regeneration and understory vegetation during salvage operations whenever practicable to maximize the potential to remove water from the soil through evapotranspiration.
- During the growing season, do not cut trees too far in advance of skidding and bucking. This ensures that any live trees continue to transpire and reduce soil moisture levels until immediately before skidding, which is the riskiest ground-based operation.
- Construct, inspect, and maintain roads to ensure natural surface and shallow subsurface drainage remain intact both during and after salvage (Winkler et al. 2008).
- Upgrade drainage networks on permanent roads before salvage logging as necessary to accommodate expected increases in peak flows (Winkler et al. 2008).

Rehabilitation options

Plan for rehabilitation of main trails and roadside work areas if high soil moisture content during harvesting is expected. Causing soil disturbance that must be rehabilitated is a less desired approach than delaying harvesting until the soil dries. When a disturbed area requires rehabilitation, soil moisture conditions at the time of rehabilitation will be an important consideration for ensuring success. Soils that respond well to treatment in dry conditions may be further damaged when treated when too wet.

References

- Berch, S., Dube, S. And Hope, G. 2009 Best Management Practices for Soil Conservation in Mountain Pine Beetle Salvage Operations
- Boon, S. 2007. Snow accumulation and ablation in a beetle-killed pine stand in Northern Interior British Columbia. B.C. J. Ecosystems Manag. 8:1–13.
- Curran, M.P. 1999. Harvest systems and strategies to reduce soil and regeneration impacts (and costs). In: Impact of machine traffic on soil and regeneration: Proc. FERIC's Machine Traffic/Soil Interaction Workshop, Edmonton, Alta., Feb. 1999. B. McMorland and S. Corradini (compilers). FERIC Spec. Rep. SR-133, pp. 75–111.
- Eng, M. 2004. Forest stewardship in the context of large-scale salvage operations: an interpretation paper. B.C. Min. For., Res. Br., Victoria, B.C. Tech. Rep. 019. http://www.for.gov.bc.ca/hfd/pubs/Docs/Tr/Tr019.pdf
- Forest Analysis Branch. 2004. Expedited timber supply review for the Lakes, Prince George and Quesnel timber supply areas. B.C. Min. For., Victoria, B.C. Public Discussion Paper. http://www.llbc.leg.bc.ca/public/PubDocs/bcdocs/369847/tsa_PDP_TSAs.pdf
- Lewis, T. and the Timber Harvesting Subcommittee. 1991. Developing timber harvesting prescriptions to minimize site degradation. B.C. Min. For., Res. Br., Victoria, B.C. Land Management. Rep. 62.
- Rex, J. and S. Dubé. 2008. Hydrologic effects of mountain pine beetle infestations and salvage harvesting operations. Mountain Pine Beetle Work. Pap., MPBI Project #8.26.
- Spittlehouse, D. 2007. Influence of the mountain pine beetle on the site water balance. In: Mountain pine beetle and watershed hydrology workshop: Preliminary results for research from BC, Alberta and Colorado (Workshop Handbook and Presentation Summaries). Kelowna, B.C., Jul. 10, 2007. Redding, T.E. and Winkler, R.D. (editors). pp. 25-26. http://www.forrex.org/program/water/mpb_hydrology.asp
- Winkler, R.D., J.F. Rex, P. Teti, D.A. Maloney, and T. Redding. 2008. Mountain pine beetle, forest practices, and watershed management. B.C. Min. For. Range, Res. Br., Victoria, B.C. Exten. Note 88. http://www.for.gov.bc.ca/hfd/pubs/Docs/En/En88.htm

Appendix D: Additional Background and Illustrations

Background

The Audit Area

Briefly, the Quesnel and Vanderhoof districts are characterized by variations in soil properties, particularly drainage and soil texture caused by minor variations in terrain relief. These assemblages of variable soil types are called catenas. They pose a particular concern for soil conservation as the poorly drained phases of the catenas are often associated with pockets with high levels of soil disturbance, created during timber harvesting. Therefore these potentially sensitive areas may require special consideration for soil management practices. In Quesnel, there are steeper slopes in eastern regions and along the Fraser River which may contain potentially unstable terrain. Many areas can be logged both in summer and winter, primarily using ground based harvest systems, with cable systems sometimes used in steeper areas.

The investigation focused on the net area to reforest, including the roadside work area:

Net Area to Reforest

This investigation focuses on dispersed soil disturbance and soil erosion events occurring in the net area to reforest (NAR). The NAR is that part of the cutblock that is required to be reforested. Areas excluded from the NAR may include permanent roads, wetlands, rocky outcrops, and wildlife tree patches. Without rehabilitation, some disturbed sites may have reduced soil productivity and hydrologic function and may not provide optimum growing conditions for new trees. Some examples of disturbance in the NAR are shown in the following figures.

D1: RUTTING – operating during wet periods has resulted in the creation wheel track ruts on forwarding trails.

D2: SCALPING – forest floor removal from repeated machine traffic and dragging logs has exposed mineral soil.

D3: COMPACTION – multiple skidding passes has removed the forest floor and compacted soils.

D4: ROADSIDE WORK AREA – operating when soils were wet has resulted in rutting and compaction.

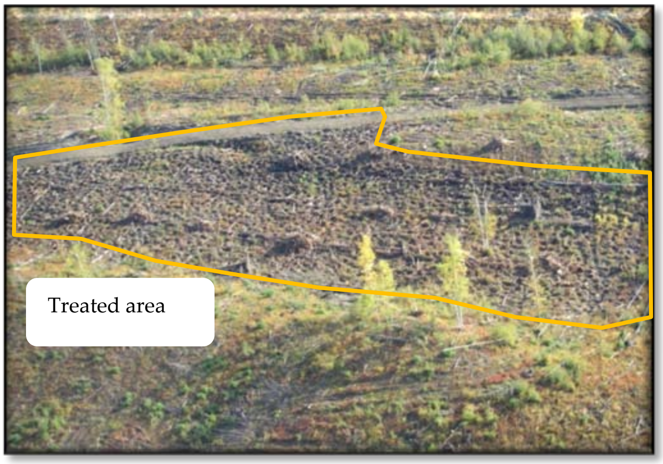
Roadside Work Area

The NAR includes a special area called a roadside work area (RWA) and although it is part of the NAR and must be reforested, the legislation allows a higher degree of disturbance for the RWA. The RWA is the area beside the road used for decking, processing, loading and debris disposal.

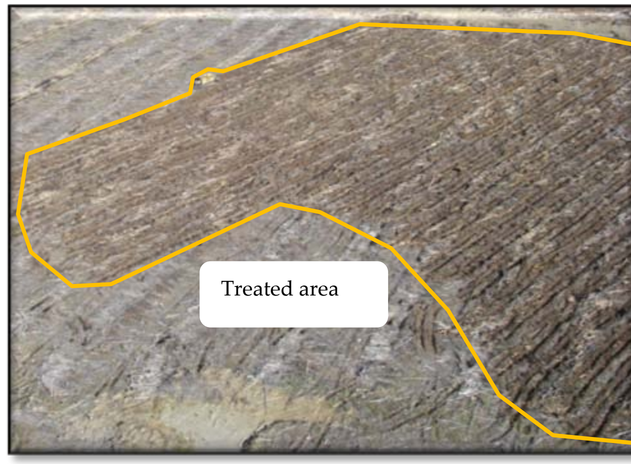
D5: An example of preferred soil conservation practices in a RWA. Soil disturbance levels are low, with few ruts, scalps or compacted areas. Small dispersed slash piles have been created to facilitate disposal.

D6: An example of non-preferred soil conservation practices in a RWA. Soil disturbance levels are elevated due to rutting, gouging and compaction. Side cast from road construction serves as a poor growing medium and reduces the productive area of the cutblock.

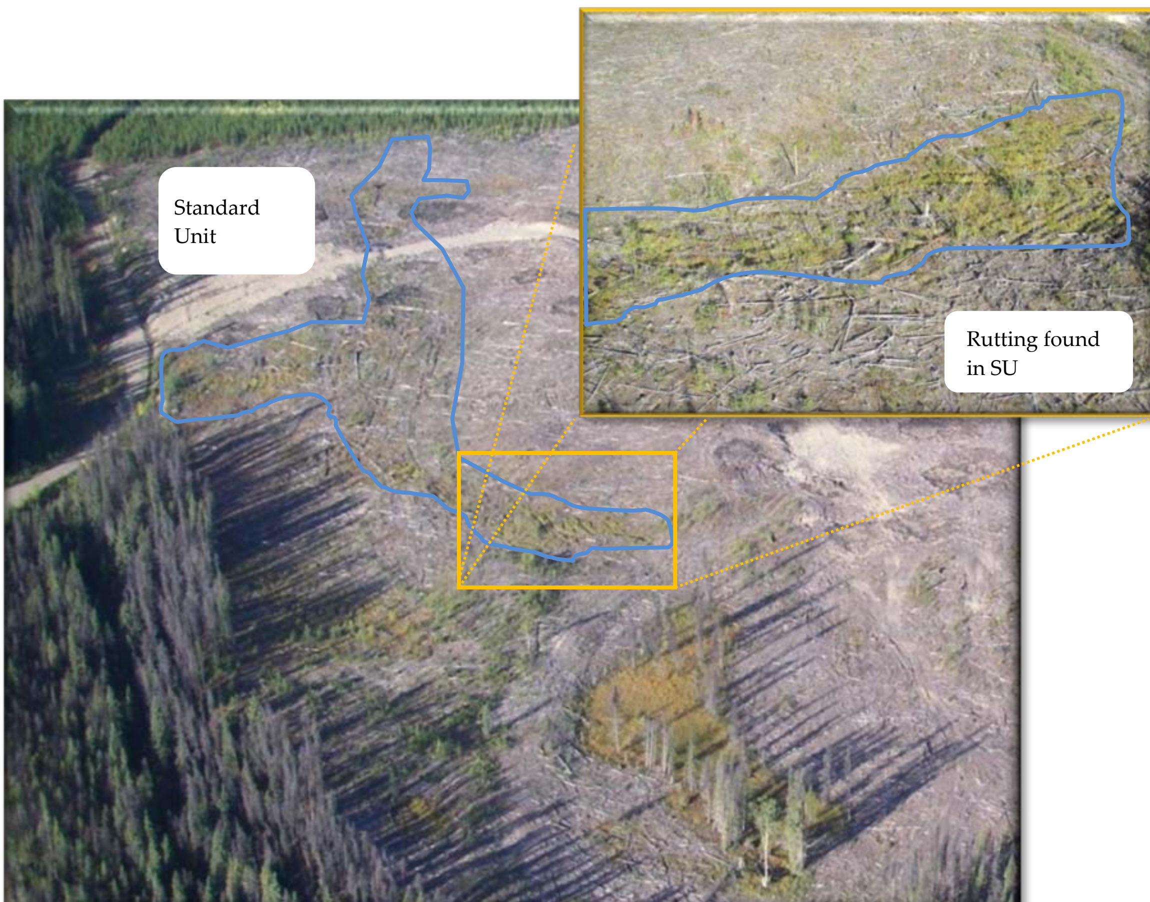
Sometimes soil productivity may be restored by site preparation treatments, including disc trenching or mounding. When combined with re-vegetation, both may speed soil recovery.



D7: MOUNDING – usually conducted in wet areas, elevates soils to improve drainage and aeration, reduces frost heaving, improving seedling survival and growth.



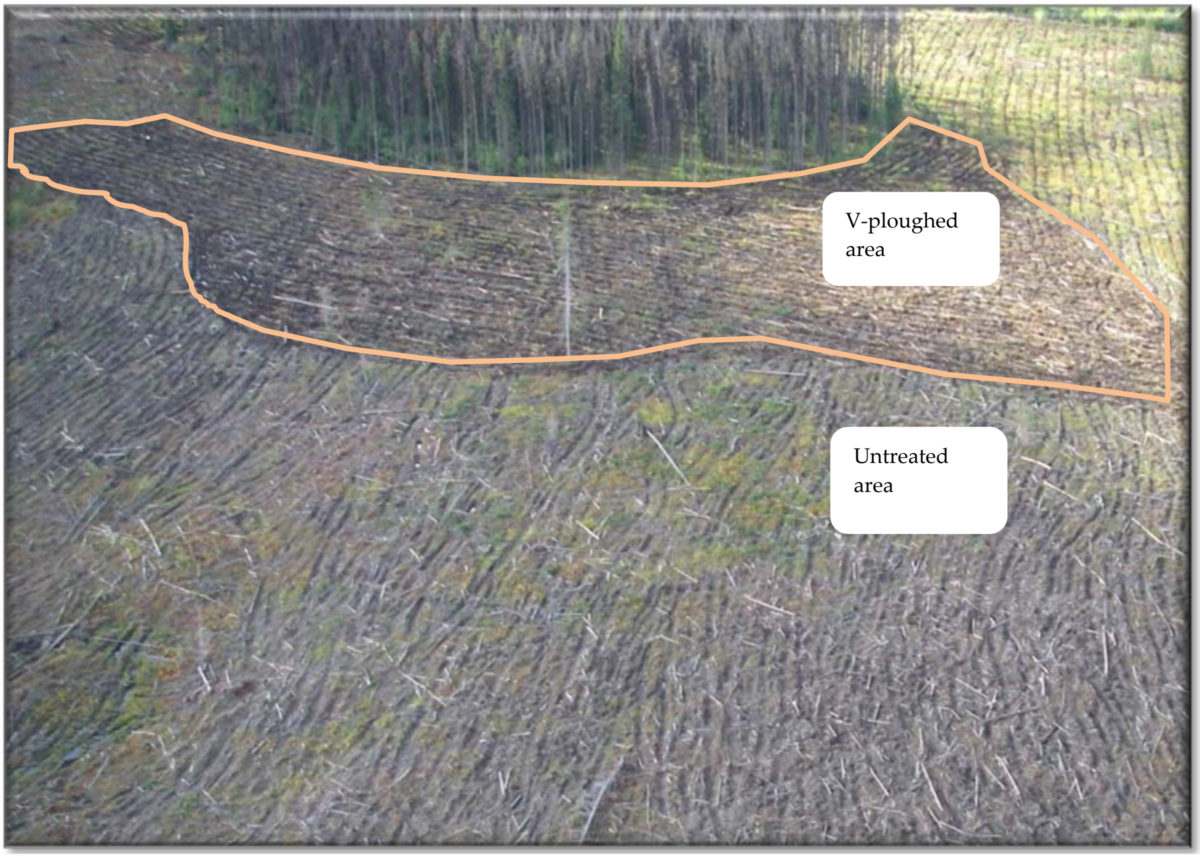
D8: DISC TRENCHING – may be used in conjunction with spreading woody debris to improve seedling establishment and short term growth. It de-compacts and mixes organic matter into the soil to improve short term soil productivity.



D9: An example of an SU containing sensitive soils where disturbance levels (20%) have exceeded the limits set in the Site Plan (5%) and is non-compliant with S35 (3) (a) of the FPPR.

D10: An area where soil hazards contained in the site plan were M-H (10% disturbance limit) but field observations found they were VH (5% limit). Soil disturbance limits were exceeded in this area (>10%) when operations were conducted on wet soils. In this case, equipment operators failed to recognize on-site soil sensitivity and adapt their practices to minimize soil disturbance.

D11: Roadside dirt piles are sometimes created when roads are not pre-developed. Side cast soil increase the area occupied by PAS and reduce the productive area that can be planted with new trees.



D12: An example where v-ploughing was used to help de-compact soil and mix organic matter to restore soil productivity in a cutblock where soil disturbance was excessively high (estimated to exceed 40%).

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