Manual of Procedures for the Management of Soils Associated With Timber Harvesting in Native Forests

Sustainable Forest Management Series

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Environment and Conservation
Our environment, our future

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Cover photograph: Thinning of karri forest in Big Brook block
(Taken by Geoff Stoneman)

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TABLE OF CONTENTS

Tables, Figures and Appendices

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1. Background and context

1.1. Purpose

The Forest Management Plan 2004-2013 introduces a range of new requirements for the management of soil disturbance associated with timber harvesting in native forests. The intent of these requirements is to reduce the occurrence of soil damage by taking a more proactive approach to management of soils than under previous arrangements.

The purpose of this document is to outline the procedures to be used by officers of the Department of Environment and Conservation (DEC) and the Forest Products Commission (FPC) in the management of soil disturbance associated with timber harvesting in native forests.

1.2. Scope

This document applies within the geographic area of the Swan, South West and Warren Regions of the Department, other than marine waters. The document covers the management of activities associated with timber harvesting in indigenous State forest and timber reserves and freehold land held in the name of the CALM Act Chief Executive Officer (CEO) that contains indigenous vegetation, but does not apply to land planted with exotic species.

1.3. Legislative requirements

All areas of indigenous State forest and timber reserves within the Swan, South West and Warren Regions, other than those identified in Appendix 2 of the Forest Management Plan 2004-2013, are reserved for the purposes of conservation, recreation, timber production on a sustained yield basis, water catchment protection and other purposes being a purpose prescribed by the regulations. To date no additional purposes for State forest and timber reserves have been prescribed in regulations. A summary of some of the legislation relevant to timber harvesting in native forest is listed below.

1.3.1. Wildlife Conservation Act 1950

The *Wildlife Conservation Act 1950* is an Act to provide for the conservation and protection of wildlife in Western Australia. Harvesting operations which occur outside of the conditions presented in this Manual are potentially in breach of Section 23B of the *Wildlife Conservation Act 1950* (the "WC Act"), by taking flora without lawful authority.

1.3.2. Conservation and Land Management Act 1984

Harvest operations need to consider Section 103(1) of the *Conservation and Land Management Act 1984* (the "CALM Act"). Operations outside of conditions specified in this Manual may potentially be in breach by, without lawful authority felling, cutting, injuring destroying or removing forest produce on / from State forest being land to which Part IX of the CALM Act applies.

1.3.3. Conservation and Land Management Regulations

Regulation 35 of the *Conservation and Land Management Regulations 2002* concerns constructing or marking out any road, track, firebreak, or landing strip for building or machinery on DEC-managed land without lawful authority.

1.3.4. Forest Management Regulations

Regulation 19 of the *Forest Management Regulations 1993* concerns felling trees outside a coupe.

1.3.5. Soil and Land Conservation Act 1945

The *Soil and Land Conservation Act 1945* provides measures for the conservation of soil and land resources principally through mitigation of the effects of erosion, salinity and flooding. A Soil Conservation Notice may be placed on private property, where it is the Commissioner's belief that land degradation has occurred, or may foreseeably occur, due to the failure of any person to take adequate precautions to prevent or control soil erosion, salinity or flooding (S. 31).

A Soil Conservation Notice may be placed on land in order to:

- prevent further degradation on that property or elsewhere;
- aid regeneration of vegetation; and
- require the landholder to undertake any activities that may be required to address land degradation concerns.

1.3.6. Environmental Protection Act 1986

Under amendments of 8 July 2004 to the *Environmental Protection Act 1986*, all clearing of native vegetation requires a clearing permit, unless subject to an exemption. Exemptions are of two classes:

- requirements or approvals under another law (Schedule 6); and
- clearing for routine land management activities that have a low impact (regulations).

In deciding whether to issue a clearing permit, the CEO must consider ten clearing principles outlined in the Act, one of which is directly concerned with soil resources (Principle "g" in Schedule 5).

The harvesting of flora is included in the definition of 'clearing' under the *Environmental Protection Act 1986* and a permit to clear is required. However, under the *Forest Products Act 2000*, clearing of vegetation maintained, or established and maintained, under Section 10(1)(g) of that Act, or under a production contract or road contract is exempt from the *EP Act* clearing permit requirements. DEC and FPC activities are exempt from requiring a clearing permit where the management is in accordance with the *CALM Act*. This exemption applies to all management of land in accordance with a management plan, or where no plan exists, as necessary operations (nature reserves) or compatible operations (national parks, conservation parks). Exemptions also exist for other areas of legislation, such as the *Bush Fires Act 1954*, that may relate to the department's operations in relation to firebreaks, etc.

1.3.7. Metropolitan Water Supply Sewerage and Drainage Act 1909

By-laws made under s146 of this Act enable the Department of Water to control potentially polluting activities, to regulate land use, inspect premises and to take steps to clean up pollution. Such by-laws apply in proclaimed Public Drinking Water Source Areas (PDWSA). A PDWSA may be a declared catchment area (*Country Areas Water Supply Act*), water reserve (*Country Areas Water Supply Act*) or underground water pollution control area (*Metropolitan Water Supply Sewerage and Drainage Act*).

The use of chemicals (e.g. petroleum hydrocarbon, fertilisers and pesticides) in any PDWSA (Perth metro and country regions) requires prior written approval from the Department of Water. The Department may oppose or place conditions on specific chemical use where they are considered likely to cause a significant risk to water resources.

1.3.8. *Country Areas Water Supply Act 1947*

A Licence to Clear is required from the Department of Water if proposed clearing of native vegetation is located in a catchment controlled under Part IIA of the *Country Areas Water Supply*

Act 1947. Controlled catchments proclaimed under the First Schedule this Act are the Wellington Dam Catchment Area, Harris River Dam Catchment Area, Mundaring Weir Catchment Area, Denmark River Catchment Area, Kent River Water Reserve, and Warren River Water Reserve.

However, following an amendment to the *Country Areas Water Supply Regulations 1981*, if a clearing permit under the *Environmental Protection Act 1986* has been issued, it is now not necessary to also obtain a licence as well under the *Country Areas Water Supply Act*, except if compensation for the refusal of a licence has been paid to a previous applicant.

1.3.9. Rights in Water and Irrigation Act 1914

Water allocation plans *(Rights in Water and Irrigation Act 1914)* and source protection plans (defining land planning and use strategies to implement the provisions of the MWS, S & D Act 1909 and CAWS Act 1947) are prepared by the Department of Water or its delegate. These plans include objectives and policies that the Department takes into account when planning at strategic and operational levels.

1.3.10. Aerial Spraying Control Act 1966

The *Aerial Spraying Control Act 1966* regulates the aerial spraying of agricultural chemicals. Weed control and fertilising activities need to be compliant with the requirements of this Act.

1.3.11. Health Act 1911

The *Health Act 1911* is an enabling Act to provide for the establishment of the Pesticides Advisory Committee and the creation of regulations considered necessary for the protection of health in relation to pesticides. The objectives of the regulations are to regulate the use of agricultural chemicals in relation to human health issues rather than environmental effects. Regulations deal with the storage, transport and use of pesticides. Department of Water policy on *Pesticide Use in Public Drinking Water Source Areas (2000)* is also relevant.

1.3.12. Waterways Conservation Act 1976

The *Waterways Conservation Act 1976* provides for the conservation and management of certain waters and of the associated land and environment. There are 5 conservation management areas to be aware of when planning or conducting works: Peel/Harvey estuaries; Leschenault estuary and associated rivers; Albany harbour and associated rivers; Avon River; and Wilson Inlet and associated rivers.

1.4. Custodianship and management of this document

The custodian of this document is the Manager of the Forest Policy and Practices Branch of the Sustainable Forest Management Division of the Department of Environment and Conservation. This document will operate from the approval date, and replace earlier versions of this Manual.

Summary

- The felling of trees (native vegetation) is exempt from requiring a clearing permit under the Environmental Protection Act provided it is done in accordance with the Forest Management Plan.

- In addition to the Forest Management Plan, there is a range of legislation in place to regulate the management of indigenous State forest and timber reserves. The legislation includes consideration of soil and land conservation, environmental protection, public health and water supply.

- This document was produced to guide officers from DEC and FPC in the management of soil disturbance associated with timber harvesting in native forests. Adherence to the procedures outlined in this document will assist forest managers in being compliant with the relevant legislation.

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2. Trafficability Index $_{(SDI)}$ and permissible management activities

2.1. Introduction

Appendix 6 of the Forest Management Plan 2004–2013, as reviewed, sets out the key requirements for the protection of soil in native forest harvesting. The Forest Management Plan and Appendix 6 of the Forest Management Plan, as reviewed, can be found at:

http://calmweb/drb/sfm/fmb/doc_plans.htm

As from June 2007 (when Appendix 6 of the Forest Management Plan, as reviewed, was approved), the requirements in this Appendix are to be used as operational practice until the completion of the proposed *Soil and Water Conservation Guidelines*. An important part of the requirements is that Trafficability Index $_{SDI}$ (TI_{SDI}) (an indirect estimate of soil moisture) is to be used to determine the risk levels for soil damage. Trafficability Index $_{SDI}$ Is calculated daily and published (by approximately noon), on the DEC intranet page:

http://calmweb.calm.wa.gov.au/drb/sfm/fmb/sti_estimates.htm

The values published by this system are to be used by all DEC and FPC officers implementing or monitoring soil management activities. A summary of the risk periods in relation to Trafficability Index $_{SDI}$ is shown in Table 1 below. Further information can be found on the DEC intranet.

Table 1: Soil management risk periods in relation to Trafficability Index (TI_{SDI}) and other factors.

TI_{SDI} value	Pre-trans & transitional (1 Mar-31 Aug)	Post-transitional (1 Mar-31 Aug)		Spring / Summer (1 Sep-28 Feb)	
	All soils	UGS soils	Non-UGS soils	UGS soils	Non-UGS soils
TI=0	MH	H-	H	H-	H
0<TI≤50	MH	MH	H-	MH	H-
50<TI≤250	M	MH	H-	MH	H-
250<TI≤500	M	M	M	M	M
500<TI≤750	L	L	L	M	M
TI>750	L	L	L	L	L

UGS = Upland gravels and sands (excluding the Blackwood Plateau)[1]
L = Low risk period
M = Medium risk period
MH = Medium to high risk period
H = High risk period
H– = High risk period if it is raining or free water is present, or Medium to high risk period if it is not raining and no free water is present

[1] Soil types (upland gravels and sands, other soils) are as described by Rab et al. 2005. The custodian of the map of soil types to be used for this purpose is the Forest Management Branch of the Department of Environment and Conservation. Blackwood Plateau is as described by Mattiske and Havel 1998.

2.2. Permissible activities in relation to level of risk

Appendix 6 of the Forest Management Plan 2004 – 2013 defines the permissible management activities for timber harvesting in native forest at four levels of risk. The requirements for the various risk periods are described below:

2.2.1. All risk periods

Management requirements under all risk periods are:

- Requirements of legislation, policies, DEC and FPC guidelines, manuals and other regulatory documents are to be met;
- The soil disturbance limits of Table 6 in Appendix 6 of the Forest Management Plan 2004 – 2013 apply;
- A coupe diary is to be maintained by the Forest Products Commission and is to record information on actions taken by FPC to commence or manage harvesting activities. Issues to consider recording in the coupe diary include a record of each day that each feller's block was operated in, machinery that was used, date of completion of each phase of the harvesting for each feller's block, any decisions to cease harvesting and the reasons for cessation particularly those related to soils, decisions made regarding issues of compliance (date and time of stoppages), records of discussions and agreement between FPC and DEC staff, record of action taken in response to breaches or non-compliance, health and safety issues associated with the coupe, instructions issued to FPC contractors, coupe data such as rainfall records, and date and time and type of monitoring undertaken;
- Off-road and off-landing use of heavy vehicles is to cease when free water is present; and
- Harvest planning should encompass the requirements for all risk periods during which it is anticipated that a particular feller's block could be active.

See Appendix 1 for definitions of free water. For the purposes of ceasing the use of heavy vehicles where a particular extraction track in a feller's block has puddles of free water present then measures should be taken to drain the puddles. This does not by itself exclude the use of another extraction track in another part of the feller's block.

Additional management requirements within the risk periods are:

2.2.2. Low risk period

- Low risk is when soils are relatively dry. The TI_{SDI} is greater than 500 in autumn or winter or greater than 750 in spring or summer.

The off-road and off-landing use of heavy vehicles is permissible subject to the following conditions:

- Planning and implementation of management techniques that will enable the area to be harvested without exceeding the soil disturbance limits;
  - ❑ The layout of extraction tracks is planned prior to extraction, including demarcation and the preparation of a sketch map;
  - ❑ The use of old extraction tracks is maximised; and
  - ❑ Duplicate, parallel and criss-crossing extraction tracks are not constructed unless under exceptional circumstances;
- The Forest Products Commission is to monitor soil disturbance in each feller's block, as outlined in Attachment 2 of Appendix 6 of the Forest Management Plan 2004 – 2013, which is shown as Table 6 in Section 5.1 of this Manual, and as specified in Section 5 of this Manual*;*

- Surveillance in each feller's block is to be undertaken by the Forest Products Commission, as specified in Section 5.2 of this Manual. Copies of the records of surveillance are to be available for inspection by DEC;
- If surveillance indicates that a soil disturbance threshold may be exceeded if the operation continues then a long transect survey of visible soil disturbance and / or a survey of rutting and erosion in the feller's block is to be undertaken by the Forest Products Commission, as specified in Sections 5.3 and 5.4 of this Manual, and a copy of the results of that survey is to be provided to the Department as specified in Section 5.6 of this Manual;
- The Forest Products Commission is to undertake a long transect survey of visible soil disturbance, as specified in Section 5.4 of this Manual, and provide a copy of the results of those surveys to the Department as specified in Section 5.6 of this Manual;
- If surveillance, the long transect survey of visible soil disturbance or the survey of rutting and erosion indicates that a soil disturbance threshold is likely to be exceeded if the operation continues then the operation in the feller's block is to cease and the Department is to be notified as specified in Section 5.6 of this Manual;
- If an operation ceases due to the likelihood of exceeding soil disturbance limits then it cannot recommence until the Forest Products Commission has satisfied the Department that the operation will not exceed the soil disturbance limits;
- If a significant rainfall event (TI_{SDI} reduced by 400) occurs then conditions as specified in Tables 2 and 3 below are to be applied; and
- The Department will monitor soil disturbance and provision of information from the Forest Products Commission, as specified in Section 5 of this Manual.

The management requirements following significant rainfall in the low risk period are described in Table 2.

Table 2: Management requirements following significant rainfall in the low risk period.

TI_{SDI} after being reduced by 400	Risk Category after being reduced by 400	Management requirements
<500 in the wetting up phase of the year or <750 in the drying out phase of the year	Medium, Medium-High or High	Apply appropriate risk criteria until the TI_{SDI} rises above the threshold for the Low risk period, or for a minimum of 3 days, whichever is the greater. See Section 5 for monitoring requirements.
>500 in the wetting up phase of the year or >750 in the drying out phase of the year	Low	Stop extraction whilst free water is present. See Section 5 for monitoring requirements.

Rainfall patterns may be quite variable in space during the summer and autumn period and a rain gauge at the site of harvesting may assist in determining if a significant rainfall event occurred at the feller's block as opposed to at a weather station used for calculating TI_{SDI}. The following rule set is to be used to determine if a significant rainfall event has occurred at the feller's block and the requirements for management.

Table 3: Rules for determining significant rainfall events at the feller's block and the requirements for management.

Did the rainfall event occur at the coupe?	Basis of determination	Action
Yes	Can use weather station if appropriate or be based on rain gauge in the feller's block or field inspection of the feller's block.	Apply the requirements for significant rainfall events outlined in Table 2.
Unsure	FPC / DEC staff to undertake field inspection, if no rain gauge is set up in the coupe.	Apply the requirements for significant rainfall events outlined in Table 2, unless the feller's block has been inspected by a DEC SFM officer who recommends continuation of the operation.
No	Confirm via on-site rain gauge.	Do not apply the requirements for significant rainfall events outlined in Table 2. Continue to operate as is required for the low risk period. FPC to document the quantity of rain, record the decision in the coupe diary, and inform DEC of the decision. FPC to use daily rain gauge readings and calculate TI_{SDI} and thus risk period and permissible activities during the remainder of time the feller's block remains open. Records are to be provided to DEC Regional Leader for SFM on a weekly basis.

Where forecast predictions indicate a high likelihood of a significant rainfall event i.e. in advance of cyclonic or strong frontal developments, erosion control barriers should be installed in active coupes to reduce the impact of erosion.

2.2.3. Medium risk period

- Medium risk is when soils may be moist enough that soil damage could occur, depending on the specific soil, management and vehicle factors. The TI_{SDI} is:
  - Less than or equal to 500 and greater than 50 in the wetting up phase of the year (autumn or winter – pre-transitional (see below)); or
  - Less than or equal to 500 and greater than 250 in the wet season after the transitional stage of the Medium - high risk period (see below) has been passed through; or
  - Greater than 250 and less than or equal to 750 in the drying out phase of the year (spring or summer);

The off-road and off-landing use of heavy vehicles is permissible subject to the following conditions:

- Planning and implementation of management techniques that will enable the area to be harvested without exceeding the soil disturbance limits:
  - The layout of extraction tracks is planned prior to extraction, including demarcation and the preparation of a sketch map;

- ❑ The use of old extraction tracks is maximised; and
- ❑ Duplicate, parallel and criss-crossing extraction tracks are not constructed unless under exceptional circumstances;

- The Forest Products Commission is to monitor soil disturbance in each feller's block, as outlined in Attachment 2 of Appendix 6 of the Forest Management Plan 2004 – 2013, which is shown as Table 6 in Section 5.1 of this Manual, and as specified in Section 5 of this Manual*;*
- Surveillance in each feller's block is to be undertaken by the Forest Products Commission, as specified in Section 5.2 of this Manual. Copies of the records of surveillance are to be available for inspection by DEC;
- If surveillance indicates that a soil disturbance threshold may be exceeded if the operation continues then a long transect survey of visible soil disturbance and / or a survey of rutting and erosion in the feller's block is to be undertaken by the Forest Products Commission, as specified in Sections 5.3 and 5.4 of this Manual, and a copy of the results of that survey is to be provided to the Department as specified in Section 5.6 of this Manual;
- The Forest Products Commission is to undertake a long transect survey of visible soil disturbance, as specified in Section 5.4 of this Manual, and provide a copy of the results of those surveys to the Department as specified in Section 5.6 of this Manual;
- If surveillance, the long transect survey of visible soil disturbance or the survey of rutting and erosion indicates that a soil disturbance threshold is likely to be exceeded if the operation continues then the operation in the feller's block is to cease and the Department is to be notified as specified in Section 5.6 of this Manual;
- If an operation ceases due to the likelihood of exceeding soil disturbance limits, with the exception of precautionary cessation because of impending wet weather or other circumstances, then it cannot recommence until the TI_{SDI} is greater than 750; and
- The Department will monitor soil disturbance and provision of information from the Forest Products Commission, as specified in Section 5 of this Manual.

2.2.4. Medium to high risk period

Medium to high risk is when soils are moist or wet and soil damage is likely in parts of most working areas unless intensive management action is taken to avoid such damage and attention to soil type, topography and position in the landscape is given. This period has two stages; Medium to high risk period - Transitional stage and Medium to high risk period - Post transitional stage.

The off-road and off-landing use of heavy vehicles is permissible on the basis described below:

Medium to high risk period - Transitional stage

The transitional stage commences from the first day that the TI_{SDI} has fallen to 50 or below in the wetting up phase of the year (autumn or winter). In the circumstance where the transitional stage has been initiated, but due to subsequent drying conditions the TI_{SDI} rises above 50 before it has fallen to 0, the transitional stage will be cancelled. A new transitional stage will commence from the first day that TI_{SDI} falls to 50 or below following rain. The transitional stage will apply up to the time when either:

- An additional 50 mm of rain has occurred at the relevant harvest location;
- Rutting, caused by a failure of soil strength, has been initiated at the level described as significant in this Manual;
- Other soil disturbance that threatens the allowable limits has occurred; or

- The harvesting operation ceased because of concerns about soil disturbance, with the exception of precautionary cessation because of impending wet weather or other circumstances

During the transitional period the off-road or off-landing use of heavy vehicles is permissible subject to the following conditions, which have the objective of minimising soil damage, monitoring soil disturbance and improving the definition of this transitional period:

- Planning and implementation of management techniques that will enable the area to be harvested without exceeding the soil disturbance limits:
  - ❑ The layout of extraction tracks has been planned prior to extraction, including demarcation and the preparation of a sketch map;
  - ❑ The use of old extraction tracks has been maximised; and
  - ❑ Duplicate, parallel and criss-crossing extraction tracks are not constructed unless under exceptional circumstances;
- The Forest Products Commission is to monitor soil disturbance in each feller's block, as outlined in Attachment 2 of Appendix 6 of the Forest Management Plan 2004 – 2013, which is shown as Table 6 in Section 5.1 of this Manual, and as specified in Section 5 of this Manual*;*
- Surveillance in each feller's block is to be undertaken by the Forest Products Commission, as specified in Section 5.2 of this Manual. Copies of the records of surveillance are to be available for inspection by DEC;
- If surveillance indicates that a soil disturbance threshold may be exceeded if the operation continues then a long transect survey of visible soil disturbance and / or a survey of rutting and erosion in the feller's block is to be undertaken by the Forest Products Commission, as specified in Sections 5.3 and 5.4 of this Manual, and a copy of the results of that survey is to be provided to the Department as specified in Section 5.6 of this Manual;
- The Forest Products Commission is to undertake a long transect survey of visible soil disturbance and a survey of rutting and erosion, as specified in Sections 5.3 and 5.4 of this Manual, and provide a copy of the results of those surveys to the Department as specified in Section 5.6 of this Manual;
- If surveillance, the long transect survey of visible soil disturbance or the survey of rutting and erosion indicates that a soil disturbance threshold is likely to be exceeded if the operation continues then the operation in the feller's block is to cease and the Department is to be notified as specified in Section 5.6 of this Manual;
- If an operation ceases due to the likelihood of exceeding soil disturbance limits, with the exception of precautionary cessation because of impending wet weather or other circumstances, then it cannot recommence until the TI_{SDI} is greater than 750;
- The Department will monitor soil disturbance and provision of information from the Forest Products Commission, as specified in Section 5 of this Manual; and
- Rainfall information can be based on either:
  - ❑ Bureau of Meteorology or DEC rainfall data at an appropriate weather station, which may be extrapolated to the desired location using the TI_{SDI} system; or
  - ❑ A rain gauge appropriately located near to the area where heavy vehicle activity is planned and rainfall measured by the Forest Products Commission, preferably on a daily basis, but on a maximum interval of 3 days. FPC to document the quantity of rain, record the decision in the coupe diary, and inform DEC of the decision. FPC to use rain gauge readings and calculate TI_{SDI} and thus risk period and permissible activities during the remainder of time the feller's block remains open. Records are to be provided to DEC Regional Leader for SFM on a weekly basis.

Medium to high risk period - Post transitional stage

The Medium to high risk period (post transitional stage) occurs in autumn and winter after limits for the Medium to high risk period (transitional stage) have been exceeded, and in spring and summer, and is dependent on soil type.

- For upland gravels and sand, excluding the Blackwood Plateau*, the Medium to high risk period (post transitional stage) is when the TI_{SDI} is:
  - 0 and it is not raining and free water is not present; or
  - Greater than 0 and less than or equal to 250;
- For all other soil types, including all of the Blackwood Plateau*, the Medium to high risk period (post transitional stage) is when the TI_{SDI} is:
  - Greater than 0 and less than or equal to 250, and it is not raining and free water is not present;

* The mapped soil types described by Rab et al. (2005) and Blackwood Plateau as described by Mattiske and Havel (1998) will be used as the primary determinant of soil type and associated risk period for the Medium to high (post transitional stage) and High risk periods. Where FPC presents information, to DEC's satisfaction, that demonstrates that an alternative interpretation of soil type is appropriate, then this alternative may be used.

The off-road and off-landing use of heavy vehicles is permissible subject to the following conditions:

- Written approval is obtained in each stage of a two-stage approvals process:
  - Firstly, written approval is obtained from DEC's Director, Sustainable Forest Management Division or a delegated officer as described in Section 3.2 of this Manual. Approval will be considered subject to the provision of a strategic level plan, that covers all candidate areas proposed to be accessed during this period in a particular calendar year, and demonstrates that candidate areas are the most suitable harvest areas on the annual harvest plan. This plan will be required to demonstrate the suitability of candidate areas in terms of:
    - Landforms, soils, topography, site, rainfall zone, dieback management and access that make the harvest area suitable for operations in soil moisture conditions expected during the Medium to high risk period;
  - Secondly, written approval is obtained from DEC's Director, Sustainable Forest Management Division or a delegated officer as described in Section 3.3 of this Manual. Approval will be considered subject to the provision of a feller's block level plan, that demonstrates the suitability of the feller's block in terms of the management techniques to be employed that will enable the area to be harvested without threatening the soil disturbance limits. This should include:
    - Planned layout of extraction tracks, including the preparation of a map and identification of any special treatments to protect soil, for example cording, matting, brushing or avoidance of susceptible areas. For karri thinning operations where this information cannot be provided together with other information for the feller's block level plan, then the location of landings or forwarder landings should be mapped and this provided prior to disturbance operations commencing. A map of the extraction tracks, including any special treatments to protect soil, used to feed each landing or forwarder landing should be provided at the completion of load out of each landing or forwarder landing;
    - The use of old extraction tracks is maximised;
    - Provisions to prevent soil mixing on landings; and

    - Any issues that because of the unavailability of information could not be addressed for the feller's block in the strategic level plan;

- Whilst for upland gravels and sand, excluding the Blackwood Plateau, the Medium to high risk period (post transitional stage) includes $TI_{SDI} = 0$, machine harvesting is not allowed when the TI_{SDI} is 0, except for first thinning of young (less than 35-year-old) regrowth karri forest. First thinning of young (less than 35-year-old) regrowth karri forest is allowable on the basis that it has a dense layer of litter and trash to serve as natural matting (i.e. is unburnt or has an understorey age >7 years old), is harvested using a harvester/forwarder operation that does not involve snigging, and that it is managed so that soil disturbance thresholds are not threatened;
- The Forest Products Commission is to monitor soil disturbance in each feller's block, as outlined in Attachment 2 of Appendix 6 of the Forest Management Plan 2004 – 2013, which is shown as Table 6 in Section 5.1 of this Manual, and as specified in Section 5 of this Manual*;*
- Surveillance in each feller's block is to be undertaken by the Forest Products Commission, as specified in Section 5.2 of this Manual. Copies of the records of surveillance are to be available for inspection by DEC;
- If surveillance indicates that a soil disturbance threshold may be exceeded if the operation continues then a long transect survey of visible soil disturbance and / or a survey of rutting and erosion in the feller's block is to be undertaken by the Forest Products Commission, as specified in Sections 5.3 and 5.4 of this Manual, and a copy of the results of that survey is to be provided to the Department as specified in Section 5.6 of this Manual;
- The Forest Products Commission is to undertake a long transect survey of visible soil disturbance and a survey of rutting and erosion, as specified in Sections 5.3 and 5.4 of this Manual, and provide a copy of the results of those surveys to the Department as specified in Section 5.6 of this Manual;
- If surveillance, the long transect survey of visible soil disturbance or the survey of rutting and erosion indicates that a soil disturbance threshold is likely to be exceeded if the operation continues then the operation in the feller's block is to cease and the Department is to be notified as specified in Section 5.6 of this Manual;
- If an operation ceases due to the likelihood of exceeding soil disturbance limits, with the exception of precautionary cessation because of impending wet weather or other circumstances, then it cannot recommence until the TI_{SDI} is greater than 750;
- The Forest Products Commission is to undertake surveys of rutting and erosion for feller's blocks not certified as complete, as specified in Section 5.3 of this Manual, and provide a copy of the results of those surveys to the Department as specified in Section 5.6 of this Manual;
- The Department will monitor soil disturbance and provision of information from the Forest Products Commission, as specified in Section 5 of this Manual*;*
- The Forest Products Commission is to ensure that extraction tracks are demarcated in the field prior to extraction commencing;
- Duplicate, parallel and criss-crossing extraction tracks are not constructed unless under exceptional circumstances as specified in Section 4.9 of this Manual; and
- The Forest Products Commission is to verify, through daily surveillance, that the provisions of the management plan are being complied with. Copies of the records of surveillance are to be available for inspection by DEC.

2.2.5. High risk period

High risk is when soils are wet and soil damage is likely in parts of most feller's blocks for operations that involve off-road use of heavy vehicles. The High risk period occurs after the Medium to high risk period (transitional stage) has ceased, and is dependent on soil type:

- For upland gravels and sand, excluding the Blackwood Plateau*, the High risk period is when the TI_{SDI} is:
  - 0 and it is raining or free water is present;
- For all other soil types, including all of the Blackwood Plateau*, the High risk period is when the TI_{SDI} is:
  - 0; or
  - Less than or equal to 250, and it is raining or free water is present.

* The mapped soil types described by Rab et al. (2005) and Blackwood Plateau as described by Mattiske and Havel (1998) will be used as the primary determinant of soil type and associated risk period for the Medium to high (post transitional stage) and High risk periods. Where FPC presents information, to DEC's satisfaction, that demonstrates that an alternative interpretation of soil type is appropriate, then this alternative may be used.

See Appendix 1 for definitions of rain and free water.

The Forest Products Commission is to undertake surveys of rutting and erosion for feller's blocks not certified as complete, as specified in Section 5.3 of this Manual, and provide a copy of the results of those surveys to the Department as specified in Section 5.6 of this Manual.

Use of heavy vehicles, off-road or off-landing, is not allowed, except for first thinning of young (less than 35-year-old) regrowth karri forest (see below).

First thinning of young regrowth karri forest

The first thinning of young (less than 35-year-old) regrowth karri forest is permissible subject to the following conditions:

- On the basis that it has a dense layer of litter and trash to serve as natural matting (i.e. is unburnt or has an understorey age >7 years old), is harvested using a harvester/forwarder operation that does not involve snigging, and that it is managed so that soil disturbance thresholds are not threatened;
- Written approval is obtained in each stage of a two-stage approvals process:
  - Firstly, written approval is obtained from DEC's Director, Sustainable Forest Management Division or a delegated officer. Approval will be considered subject to the provision of a strategic level plan, that covers all candidate areas proposed to be accessed during this period in a particular calendar year, and demonstrates that candidate areas are the most suitable harvest areas on the annual harvest plan. This plan will be required to demonstrate the suitability of candidate areas in terms of:
    - Landforms, soils, topography, site, rainfall zone, dieback management and access that make the harvest area suitable for operations in soil moisture conditions expected during the high risk period;
  - Secondly, written approval is obtained from DEC's Director, Sustainable Forest Management Division or a delegated officer. Approval will be considered subject to the provision of a feller's block level plan, that demonstrates the suitability of the feller's block in terms of the management techniques to be employed that will enable the area to be harvested without threatening the soil disturbance limits. This should include:

- Planned layout of extraction tracks, including the preparation of a map and identification of any special treatments to protect soil, for example cording, matting, brushing or avoidance of susceptible areas. Where this information cannot be provided together with other information for the feller's block level plan, then the location of landings or forwarder landings should be mapped and this provided prior to disturbance operations commencing. A map of the extraction tracks, including any special treatments to protect soil, used to feed each landing or forwarder landing should be provided at the completion of load out of each landing or forwarder landing;
- The use of old extraction tracks is maximised;
- Provisions to prevent soil mixing on landings; and
- Any issues that because of the unavailability of information could not be addressed for the feller's block in the strategic level plan;

- Extraction is to cease while it is raining.
- The Forest Products Commission is to monitor soil disturbance in each feller's block, as outlined in Attachment 2 of Appendix 6 of the Forest Management Plan 2004 – 2013, which is shown as Table 6 in Section 5.1 of this Manual, and as specified in Section 5 of this Manual*;*
- Surveillance in each feller's block is to be undertaken by the Forest Products Commission, as specified in Section 5.2 of this Manual. Copies of the records of surveillance are to be available for inspection by DEC;
- If surveillance indicates that a soil disturbance threshold may be exceeded if the operation continues then a long transect survey of visible soil disturbance and / or a survey of rutting and erosion in the feller's block is to be undertaken by the Forest Products Commission, as specified in Section 5.4 of this Manual, and a copy of the results of that survey is to be provided to the Department as specified in Section 5.6 of this Manual;
- The Forest Products Commission is to undertake a long transect survey of visible soil disturbance and a survey of rutting and erosion, as specified in Sections 5.3 and 5.4 of this Manual, and provide a copy of the results of those surveys to the Department as specified in Section 5.6 of this Manual;
- If surveillance, the long transect survey of visible soil disturbance or the survey of rutting and erosion indicates that a soil disturbance threshold is likely to be exceeded if the operation continues then the operation in the feller's block is to cease and the Department is to be notified as specified in Section 5.6 of this Manual;
- If an operation ceases due to the likelihood of exceeding soil disturbance limits, with the exception of precautionary cessation because of impending wet weather or other circumstances, then it cannot recommence until the TI SDI is greater than 750;
- The Forest Products Commission is to verify, through daily surveillance, that the provisions of the management plan are being complied with. Copies of the records of surveillance are to be available for inspection by DEC; and
- The Department will monitor soil disturbance and provision of information from the Forest Products Commission, as specified in Section 5 of this Manual*;*

Loading and haulage of stockpiled logs on landings

The loading and haulage of stockpiled logs on landings is permissible, subject to:

- Written approval is obtained in each stage of a two-stage approvals process:
  - Firstly, written approval is obtained from DEC's Director, Sustainable Forest Management Division or a delegated officer as described in Section 3.2 of this Manual. Approval will be considered subject to the provision of a strategic level plan, that

covers all candidate areas proposed to be accessed during this period in a particular calendar year, and demonstrates that candidate areas are the most suitable harvest areas on the annual harvest plan. This plan will be required to demonstrate the suitability of candidate areas in terms of:

- Landforms, soils, topography, site, rainfall zone, dieback management and access that make the harvest area suitable for operations in soil moisture conditions expected during the high risk period;

- Secondly, written approval is obtained from DEC's Director, Sustainable Forest Management Division or a delegated officer as described in Section 3.3 of this Manual. Approval will be considered based on the provision of a plan that demonstrates that the landing and access route will be appropriately managed. This should include:
  - How soil mixing on the landing will be avoided, for example the use of static boom loaders; and
  - How dieback management is to be achieved, for example the use of hard-surfaced all-weather roads.

- The Forest Products Commission is to verify, through daily surveillance, that the provisions of the plan are being complied with. Copies of the records of surveillance are to be available for inspection by DEC.

2.2.6. Overnight estimation of Trafficability Index

To facilitate forward planning of harvesting activities, an FPC officer may elect to predict the TI_{SDI} and corresponding risk period for the following day, prior to the DEC website update. The calculation and source of data used are to be provided to the DEC Regional Leader SFM by 0900 on the day for which the predicted TI_{SDI} is calculated.

2.3. Timber harvesting in native forest that is a precursor to land clearing

Where timber harvesting in native forest occurs as part of land clearing for bauxite mining, coal mining, extraction of basic raw materials, establishment of a permanent road, or any other form of clearing, then the restrictions on activity by heavy vehicles in the high and medium-high risk periods specified above will not necessarily apply. Activity by heavy vehicles during these risk periods will be addressed in the approvals for access to DEC-managed lands provided by the DEC Regional Manager. The DEC Regional Manager will assess such proposals based on a regard for the intent of the soil conservation measures and the objectives and authority of the subsequent clearing operation.

The rationale for not applying the same restrictions on these activities as applies to operations not involving clearing is that the need to conserve the soil for biodiversity and productive capacity objectives is not as great where the site is to be permanently cleared, or where subsequent to timber harvesting, the soil is to disturbed to a greater extent than during the timber harvesting operation.

Summary

- Trafficability Index $_{SDI}$ (TI_{SDI}) is an indirect estimate of soil moisture.
- Lower values of TI_{SDI} indicate higher soil moisture and greater risk of soil damage.
- Permissible management activities for timber harvesting in native forest vary according to four levels of risk. The risk thresholds are determined by TI_{SDI} and change with the wetting or drying phases of the year.
- Values of TI_{SDI} are calculated and published daily and can be found on the DEC intranet page http://calmweb.calm.wa.gov.au/drb/sfm/fmb/sti_estimates.htm. The values at this site are to be used by all DEC and FPC officers implementing management and monitoring requirements in relation to TI_{SDI}.
- Some management requirements apply over all risk periods such as the requirement for harvest planning, coupe diary entries, observation of soil disturbance limits and the requirements of legislation, policy and guidelines.
- During the Medium to high (post transitional) risk period increased planning, monitoring and approvals are required. Operators are also required to mark the extraction network and identify any special treatments to protect soil.
- During the High risk period, the use of heavy vehicles, off-road or off-landing, is not allowed except for first thinning of young (less than 35-year-old) regrowth karri forest which is subject to written approval. The loading and haulage of stockpiled logs on landings is permissible, subject to written approval.

Commenced: 1 September 2004
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Custodian: Manager, Forest Policy and Practices Branch
Approved by: Director, Sustainable Forest Management Division

3. Plans for access for timber harvesting in the Medium to high (post transitional stage) risk period and High risk period

3.1. Introduction

A two-stage process for the FPC to seek access to harvest cells during the Medium to high (post transitional stage) and High risk period is a requirement.

It is expected that the level and quality of the information provided by the FPC will be similar to that required to obtain approval in 2005, however the information to support the second stage approval will be submitted to, and dealt with by DEC Regional staff. The following section is intended to highlight and guide issues regarding procedures, information management, and professional courtesy, between DEC and FPC.

3.2. Stage 1 – Strategic level plan

The first stage is a strategic level plan and analysis of the suite of coupes available to the FPC within the current harvest year, to identify those most likely to be able to sustain harvest operations during the Medium to high (post transitional stage) risk period or High risk period.

3.2.1. Areas

Consideration can only be given to coupes, cells or feller's blocks that are on the Annual Harvest Plan for that particular year.

3.2.2. Process and timing

The first stage comprises a formal submission by FPC of candidate moist soil coupes, as a consolidated proposal for all Regions, to DEC's Director, Sustainable Forest Management Division. The submission must incorporate all the required maps and supporting information and be submitted by the 15th April each year. The DEC Director, Sustainable Forest Management Division will provide a written response listing the approved coupes and any specific conditions to the FPC by 15th May each year.

As a precursor to the formal submission, it is recommended that the FPC prepare a draft list of candidate coupes that are on the Regional Indicative Harvest Plan and provide a copy to DEC's Director, Sustainable Forest Management Division before the 15th of February each year. The draft list of candidate coupes will act as a "heads up" planning tool to facilitate the scheduling of any mapping, planning and field inspection required by the agencies in preparation for planning and approving moist soil coupes. The Director, Sustainable Forest Management Division will only provide comments on the Regional Indicative Harvest Plan if necessary.

3.2.3. Issues to address

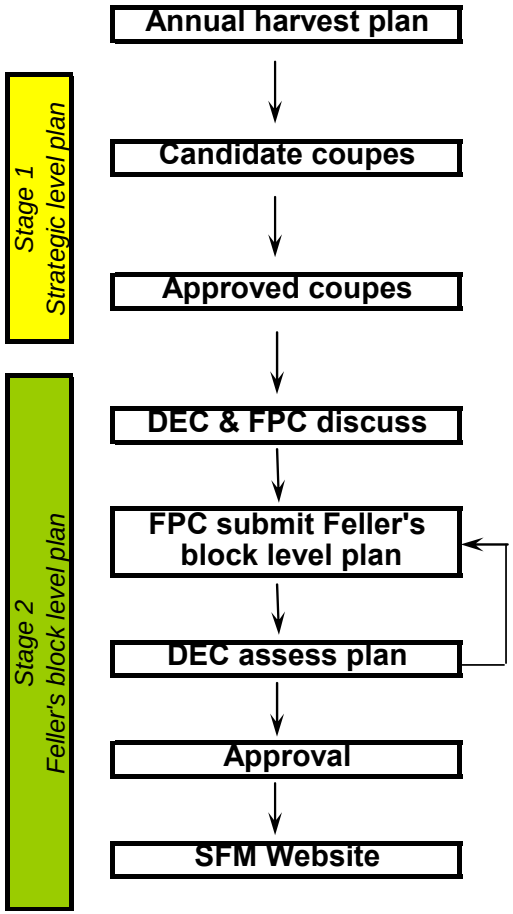
The strategic level plan will be required to demonstrate the suitability of candidate areas in terms of landforms, soils, topography, site, rainfall zone, dieback management and access that make the harvest area suitable for operations in soil moisture conditions expected during the Medium to high (post transitional stage) risk period or High risk period. Aspects suggested for inclusion in order to facilitate approval include per cent dieback impact categories, per cent slope, per cent landform groups, rainfall, priority and further comments such as the likely order of scheduling. An example showing data and comments to support a strategic level submission are shown in Figures 1 and 2 below.

Region	Coupe	Coupe Geography							Dieback Information					Harvest Status			Soil Approvals Status	
		Rainfall zone	Slope %			Percent Landform Groups			Vegetation	Mapped	HMP Available	Percent Impact Categories			Commenced		Not commenced	Previous approval date	Priority for second stage
			<6	6 to 10	>10	Upland gravel/sand	Shallow to clay	Karri loams				High	Moderate	Low	Active	Percent completed	Date scheduled		
Swan	Ashendon 02 07	1000-1200	84	16		80	17		Refer to	Yes	No		86	11	No		Jun-07		Med.
	Bannister 03 07	600-800	98	2		69	31		Vegetation	No	No			100	No		Oct-07		Low
	Cobiac 01 06	1000-1200	93	7		50	50		Maps on	Yes	Yes	48	49	1	Yes	50			Low
	Wearne 05 05	600-800	99	1		21	79		Web	Yes	Yes			100	No	10	Sep-07		Low
	Wilson 01 07	1200-1400	73	20	7	65	35			Yes	Yes	13	70	16	No		Aug-07		High
South West	Beaton 05 07	1100-1200	83	17		67	33			No	No		67	33	No		May-07		High
	Beaton 06 03	1100-1200	68	29	3		100			Yes	Yes			100	Yes	70			Med
	Beaton 06 05	1100-1200	81	19		21	76			Yes	Yes		21	76	Yes	10			High
	Catterick 05 02	800-900	100			70	30			Yes	Yes			100	No	90	May-07		Low
	Chalk 07 07	800-1000	78	22		81	19			Yes	Yes	5	56	39	Yes	50			Low
	Denham 03 05	1100-1200	90	10		77	23			Yes	Yes		99		Yes	50		11/08/2006	
	Ellis Creek 06 07	1000-1100	42	32	26	25	75			Yes	No		70	10	No		Apr-07		Low
	Hadfield 04 05	1200-1300	80	20		74	26			Yes	Yes		99		No	1	May-07		High
	Hoffman 04 02	1100-1200	87	13		74	26			Yes	Yes		99		No	40	Jun-07		High
	Jolly 03 07	700-800	100			24	76			Yes	No			100	No		May-07		Low
	Maryvale 02 06	900-1000	95	5		46	54			Yes	Yes	55	46		No		Jun-07		High
	Maryvale 02 07	900-1000	100			51	47			Yes	Yes	46	52		No		Jun-07		High
	McAlinden 02 07	800-900	100			72	28			Yes	Yes			100	No		May-07		High
	Mullalyup 04 07	900-1000	65	34	1	61	39			Yes	Yes		100		Yes	5			High
	Palmer 03 07	800-1000	92	7	1	92	8			Yes	No	1	71	25	No		Jun-07		High
	Yabberup 03 07	900-1000	87	12	1	48	52			Yes	No		93	7	No		Sep-07		Med
Warren	Big Brook 03 07	1100-1300	29	51	20		25	75		No	No			100			Jun-07		Med
Mature	Channybearup 08 3E	1000-1200	99	1			100			Yes	Yes			99		40	May-07		Low
	Channybearup 02 S4	1100-1200	100				100			Yes	Yes			98			May-07		Med
	Crowea 09 05	1400-1500	40	44	16		37	63		Yes	Yes			100			May-07		Low
	Diamond 2 13 07	1000-1200	23	40	37		27	74		Yes	Yes			100			Jun-07		High
	Diamond 2 14 06	1000-1200	45	34	21		71	29		Yes	Yes			96		5	Jun-07		High
	Diamond 2 14 07	1000-1200	45	34	21		30	69		Yes	Yes			100			Jul-07		High
	Diamond 2 04 03	900-1000	58	42			98	2		Yes	No			100			Sep-07		Med
	Dingup 06 07	900-1000	48	38	14		94	6		No	No			99			Sep-07		Med
	Dombakup 11 03	1400-1500	95	5			100			Yes	Yes			99			May-07		Med
	Dombakup 12 03	1400-1500	90	10			100			Yes	Yes			100			May-07		Med
	Lindsay 27 07	1200-1300	28	39	33	4	31	65		No	No		4	96			Oct-07		Med
	Nairn 03 06	1100-1200	98	2		50	42	8		Yes	Yes		50	50			May-07		Med

Figure 1: An example of data submitted to support a formal strategic level submission

Region	*Coupe*	*Comments*
Swan	Ashendon 02 07	High suitability due to robust soils. Relatively low volume
	Bannister 03 07	Low volume Eastern coupe. SDI likely to stay relatively high all season. Not a priority to progress to stage 2.
	Cobiac 01 06	Harvesting well progressed, the need to progress to stage 2 is weather dependant. Access restricted due to COE requirements in part.
	Wearne 05 05	Coupe part cut, Eastern coupe low volume. Didn't fall into M-H in 2006.
	Wilson 01 07	High suitability and reasonable volumes this coupe is key in FPC plans for winter. Road network is in infested forest.
South West	Beaton 05 07	Critcal given situation with Ellis Ck (old growth), hope to complete with two contractors prior to approval need.
	Beaton 06 03	Mainly Karri to cut. Should complete prior to approval requirement.
	Beaton 06 05	Pure Karri associated with Gravelly loams. Haulage restricted to no soil movement. Will suspend at some point for return in Spring.
	Catterick 05 02	Silvic op to reduce unwanted small culls. Likely to complete prior to M-H risk
	Chalk 07 07	Likely to complete prior to M-H risk
	Denham 03 05	Due to high suitability and reasonable volumes this coupe is key in FPC plans for winter. Road network is in infested forest.
	Ellis Creek 06 07	Review of OG to be completed
	Hadfield 04 05	High suitability reas volumes. Access via infested road network.
	Hoffman 04 02	High suitability proven in adjacent operation. Mostly infested forest.
	Jolly 03 07	Aim to complete prior to M-H, return in Spring
	Maryvale 02 06	High suitability due to laterite upslope, critical as a coupe for large area for one main contractor. Infested access.
	Maryvale 02 07	High suitability due to laterite upslope, critical as a coupe for large area for one main contractor. Infested access. Adjacent to BMV0206
	McAlinden 02 07	High suitability with moderate volumes. Will split between two contractors.
	Mullalyup 04 07	Limited areas suitable, should complete majority prior to M-H risk.
	Palmer 03 07	High suitability with moderate volumes.
	Yabberup 03 07	Will depend on FPC ability to construct roads prior to wet.
Warren	Big Brook 03 07	One fallers block available adjacent to all weather road with deep loams
Mature	Channybearup 08 3E	Expect to complete prior to M-H risk
	Channybearup 02 S4	Signs of gravelly loams, Prelog/thin only.
	Crowea 09 05	Prelog only in M-H risk
	Diamond 2 13 07	High suitability due to well drained loams. All weather access on unprotectable rd.
	Diamond 2 14 06	Adjoins Diamond 2 13 07
	Diamond 2 14 07	Adjoins Diamond 2 13 07
	Diamond 2 04 03	Start-up area once C.O.E. access practical. Good all weather roads.
	Dingup 06 07	Prelog only as a start-up early in Spring. Good all weather access
	Dombakup 11 03	Some evidence of suitable ground on site inspection. All infested. Aim to complete prior to M-H risk.
	Dombakup 12 03	Adjoins Dombakup 11 03
	Lindsay 27 07	Prelog operation in early Spring.
	Nairn 03 06	Signs of gravelly loams, Prelog/thin only.

Figure 2: An example of comments submitted to support a formal strategic level submission



Stage 1 - Strategic level plan

To be eligible, coupes must be on the current annual harvest plan.

FPC Identify the coupes most likely to sustain harvest operations during moist soil conditions.

DEC's Director of Forests may provide feedback to refine draft list of candidate coupes.

FPC provides formal proposal as a consolidated request for all Regions.

The proposal to DEC's Director of Forests includes maps and supporting information to demonstrate suitability of candidate areas in terms of landforms, soils, topography, site, rainfall zone, dieback management and access.

Director of Forests provides written response listing approved coupes & any specific conditions.

NOTE: Approval at stage 1 does not entitle access for M-h & H risk periods.

Stage 2 - Feller's block level plan

FPC to check that feller's blocks for 2nd stage proposal have a current FPC 109 signed by the Regional Manager & a current hygiene management plan.

Local DEC & FPC officers discuss issues in advance of submission of the feller's block level plan.

Plan to include layout of extraction tracks, map identifying type and extent of any special treatments to protect soil, evidence that the use of old extraction tracks is maximised, details of provisions to prevent soil mixing on landings & any issues that could not be addressed because of the unavailability of information during stage 1.

DEC to assess and respond in writing within 3 working days (copy by email is acceptable), and will either:

- Identify actions that must be completed before approval can be reconsidered;
- Identify additional information that must be provided before approval can be reconsidered;
- Identify issues which must be resolved before approval can be reconsidered; or
- Approve the operation and clearly identify any conditions of this approval.

Disputes will be urgently referred to the Director of Forests for resolution.

Once approved, the DEC approval, FPC proposal and attachments to the FPC proposal will be made available on DEC's SFM website.

Figure 3: Summary of two stage approvals process for access during the Medium to high (post transitional stage) and High risk periods.

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Custodian: Manager, Forest Policy and Practices Branch
Approved by: Director, Sustainable Forest Management Division

3.3. Stage 2 – Feller's block level plan

3.3.1. Introduction

The Director, Sustainable Forest Management Division has delegated the authority to approve cell level harvesting in the Medium to high (post transitional stage) risk period and High risk period to the Regional Manager in the Swan, South West and Warren Regions. This is to ensure that the decisions are able to be based on the site-specific requirements of each individual area, and to make the administrative process as efficient as possible.

The objective for SFM staff is to ensure that the FPC harvesting proposal is assessed and processed in an appropriate and timely fashion. To ensure that this second stage of the approvals process does not unreasonably affect the ability of FPC to gain approval to access State forest and timber reserves for timber harvesting, the following guidance is provided.

Consideration of coupes may commence once the approval by the Director, Sustainable Forest Management Division has been provided through approval of the strategic level plan. Ideally the information for the feller's block level plans should be presented as part of a consolidated package of areas for which access is sought, however this is not a specific requirement. Approval at stage 1, does not entitle the FPC to expect access to all feller's blocks within the coupe during the Medium to high (post transitional stage) risk period and High risk period. DEC will not be responsible for delays in access to harvest cells as a result of insufficient lead time to allow adequate consideration of the proposals. It is FPC's responsibility to ensure that the second stage applications are submitted to DEC in a timely way.

3.3.2. Areas

Consideration can only be given to coupes, cells or feller's blocks that:

- Are on the Annual Harvest Plan for that particular year;
- Have been approved in the first stage (strategic level plan) of the approvals process for access in the Medium to high (post transitional stage) risk period or High risk period;
- Have a current FPC 109 signed by the Regional Manager; and
- Have a current hygiene management plan.

3.3.3. Process

DEC should liaise with FPC planners to prioritise planning work. DEC and FPC staff should meet to discuss and resolve harvest issues in advance of submission of the feller's block level plan.

3.3.4. Issues to address

The following issues need to be addressed in the FPC proposal for each feller's block level plan:

- Planned layout of extraction tracks, including the preparation of a map and identification of the type and extent of any special treatments to protect soil, for example cording, matting, brushing or avoidance of susceptible areas. For karri thinning operations where this information cannot be provided together with

other information for the feller's block level plan, then the location of landings or forwarder landings should be mapped and this provided prior to disturbance operations commencing. A map of the extraction tracks, including any special treatments to protect soil, used to feed each landing or forwarder landing should be provided at the completion of load out of each landing or forwarder landing;

- Evidence that the use of old extraction tracks is maximised;
- Details of the type of the provisions to prevent soil mixing on landings; and
- The final plan should outline the agreed resolutions to any issues that, because of the unavailability of information, could not be addressed for the feller's block in the strategic level plan.

A proforma table of contents for feller's block level plan submissions for stage 2 approvals is shown in Figure 4 below

1) Document Checklist — Attach (Y/N)

First stage approval granted	_____ *Date*	*N*
Approved Pre-Harvest Checklist	_____ *Date*	*N*
Approved Hygiene Mgt. Plan	_____ *No.*	*N*
Current Hygiene Mgt. Map	_____ *Expiry Date*	*N*
*Landform base map**		*Y*

*showing feller's block boundaries / landings / extraction tracks / access roads and tracks / proposed silvicultural prescription. See notes on mapping standard in section 3.3.5.

2) Feller's Block Name(s)
3) DEC Region and District
4) Proposed Operation
   - *a. Harvest Area*
   - *b. Silvicultural prescription (recommended options below)*
   - *c. Harvest method (recommended options below)*
   - *d. Timing*
5) Forest Type
6) Rainfall Zone
7) Landform and Soils
8) Dieback Management
9) Treatments
   - *a. Cording*
   - *b. Brushing*
   - *c. Matting (bark / chips)*

FPC staff must provide a detailed map and / or GPS coordinates of all locations where the use of cording, or woodchip matting is intended to be used on landings or extraction tracks.

11) Actions to maximise use of old extraction tracks
12) Appendices
   - *a. Table of cells*
13) FPC officer (sign)
14) Date prepared

(4b) Silvicultural Method Options
First thinning (stand age may be important for karri)
Second or later thinning
Pre-logging
Shelterwood
Selective
Gap creation
Clearfell
Clearfell with seed trees
Clearing

(4c) Harvest Method options
Manual falling, extraction using skidder / Forwarder
Manual falling, extraction using loader
Manual falling, extraction using forwarder
Machine harvesting, extraction using bulldozer / skidder
Machine harvesting, extraction using loader
Machine harvesting, extraction using forwarder
Manual falling, cable logging
Machine harvesting, cable logging

Figure 4: Proforma table of contents for feller's block level plan submissions for stage 2 approvals

3.3.5. Mapping Standard

The following standards are to be implemented for maps supporting feller's block level plan submissions for stage 2 approvals. Guidelines assume the software used is ArcGIS. Data should be presented at an appropriate scale with the coupe centred on the map if possible. Recommended specifications are shown below. Standard scales are 1:25 000 for larger areas or 1:12 500.

Colours for presentation of maps are defined in RGB. RGB is components of the primary colours red, green and blue (graded 0 to 255) that define a colour.
RGB is defined in ArcGIS by "change colours – more colours – set RGB"

Line weight or thickness is defined in pixel width.

Text is described in font. Text size is variable but should be appropriate for the printout scale and positioned in such a way as to be legible and not obscure other data.

Feller's Block colour (RGB)	135	0	0
Feller's Block weight	0.6		
Feller's Block line style	continuous		
Snig track colour (RGB)	242	2	170
Snig track weight	0.3		
Snig track line style	dashed		
Feller's block number font	Times New Roman		
Feller's block number colour	135	0	0
Proposed access road (RGB)	0	115	255
Proposed access road weight	0.6		
Proposed access road line style	dashed		

Areas not for harvesting, i.e. informal reserves, TEAS and uneconomic areas should be cross hatched. Hatching should be at a spacing of 50m (on the ground) and black with a weight of approximately 0.2.

A one character text should be placed next to snig track to indicate either cording, matting or brushing (C or M or B). The text should be the same size as the feller's block number only in black.

- Feller's block boundaries should be consistent in their definition. For example stream buffers should always be excluded from feller's blocks;
- Feller's block number should be placed so as not to obscure map information and be legible. Too heavy a font makes them unreadable; and
- Where a feller's block has more than one silvicultural objective, then this should be shown. A colour copy of the tree marker's map may be sufficient unless the boundaries can be clearly shown of the Landform base maps.

The DEC Regional Manager will not approve proposals where the quality of maps is inadequate i.e. the maps should provide all the information so that DEC officers can undertake their role of approving and monitoring the operation.

3.3.6. Verification of soil type.

Verification will be required where there is a discrepancy between the soil type shown on the Feller's Block Level Plan and the field observations made by the officer preparing the plan. The verification should be undertaken by a suitably experienced FPC officer and concentrate on areas where maximum heavy vehicle traffic is expected. As a guide to intensity of survey, a surface assessment should be made every 50 m, targeted to incorporate factors such as landscape and vegetation change. The surface assessment should incorporate assessment of factors such as gravel content, vegetation indicators and surface soil observations. Every third point should also include a deeper sample (obtained by shovel or auger) to describe the soil texture and determine the depth to clay or impeding layer.

DEC approving officer is to certify that they agree that the methodology used is adequate.

Note: For Karri thinning operations, verification of soil type is only required where cording or matting is not planned to be used.

An example of field data collected to verify soil type for a Feller's Block Level Plan is shown in Figure 5 below.

Harvest Cell Extraction Track Assessment Form

District Frankland **Block/cou** Mindanup 6 **Page** 2 **of** 5

Cell no. 1 **Officer** B.Ellis

Date 7/09/2006

Point Id	MGAE	MGAN	Qualitative Visual Gravel Assessment		Gravel Content	Soil Indicators	Soil texture	Comments
			<60%	>60%				
722	456 025	173 660	*		10%	A.Urophylla	Clay/Loam	750mm to Clay
						Pattersonia		
						Bossiae		
						K,M,J		
732	456 075	173 650	*		40%	A.Pentadinia	Loam	>60% Gravel@600mm
						P.Drouwnianus		
						A.Urophylla		
733	456 120	173 630	*		30%	Lassiopetalum	Loam	700mm to Clay
						L.Verticicatus		
						A.Pentadinia		
						A.Urophylla		
719	456 740	173 790	*		20%	A.Urophylla	Loam	600mm to Clay
						L.Verticicatus		
						K,M,J		
720	456 065	173 760	*		0%	T.Floribundum	Loam	600mm to Clay
						A.Urophylla		
						K,M,J		
718	456 135	173 735	*		0%	A.Urophylla	Loam	650mm to Clay
						T.Floribundum		
						K,M		
712	456 270	173 090	*					
					50%	A.Urophylla	Clay/Loam	500mm to Clay
						P.Drouwnianus		Tree Root Assessed
						K,M,J		
713	456 230	174 060	*		0%	T.Floribundum	Loam	600mm to Clay
						P.Drouwnianus		
						K,M,J		
714	456 180	174 040	*		50%	A.Urophylla	Sandy/Loam	>60% Gravel@700mm
						P.Drouwnianus		
						K,M		
734	456 130	174 015	*			A.Urophylla	Loam	>60% Gravel@900mm
						K,M		
711	456 096	173 9996	*		0%	A.Urophylla	Sandy/Loam	>60% Gravel@900mm
						K,M		
715	456 120	173 951	*		0%	A.Urophylla	Sandy/Loam	1000mm+
						P.Drouwnianus		
						K,M		
716	456 124	173 909	*			A.Urophylla	Sandy	1000mm+
						P.Drouwnianus		
						K,M		
735	456 133	173 876	*			T.Floribundum	Loam	950mm+
						A.Urophylla		
						K,M		

Indicators
1 sheet laterite
2 laterite floaters
3 Black gravel
4 **plant species**
Free Draining Soil
Xanthorea. gracilis
Banksia grandis
Allocasuarina fraseriana
Persoonia longifolia
Bossiaea linophylla
Bossiaea ornata
Patersonia rudis
Macrozamia riedlei
Isopogon spaerocephalus
Herbertia cuneiformis

Indicators
5 **plant species**
Poorly drained soils
Kingia australis
Eucalyptus megacarpa
Leucopogon australis
Dasypogon hookeri
Dasypogon bromelifolius
(Agonis) Taxandria parviceps
Melaleuca species

Soil Texture
clay
clay loam
sandy clay loam
loam
sandy loam
clayey sand
loamy sand
sand

Comments (examples)
Slope change
water gaining site
Large Laterite outcropping
Graveyard dieback site
Old track/snig track

Figure 5: Example of field data used to verify soil type for a Feller's Block Level Plan.

3.3.7. DEC approvals

DEC staff should check the conditions of the approved FPC 109 – Pre-harvest Checklist and the conditions on feller's blocks approved in the first stage (strategic level plan) of the approvals process for access in the Medium to high (post transitional stage) risk period or High risk period, to ensure that the proposed operation is compatible with all aspects and conditions of the higher level approvals for access.

The letter of approval from the Regional Manager to FPC is to reiterate the key aspects of the FPC proposal.

The letter of approval is to include the following minimum conditions:

- The FPC will comply with agreed monitoring requirements as outlined in *Manual of Procedures for the Management of Soils Associated With Timber Harvesting in Native Forests*;
- The FPC will comply with all other requirements of the Medium to high (post transitional stage) risk period or High risk period, as set out in Appendix 6, as revised following the review, and all the requirements as outlined in *Manual of Procedures for the Management of Soils Associated With Timber Harvesting in Native Forests*;
- Surveillance is to be based on daily visits and direct observations by the FPC coupe OIC; and
- The FPC coupe OIC is to notify the DEC Regional Leader for SFM:
  - Immediately prior to commencement of operations in the feller's block;
  - Each Monday morning when the feller's block is planned to be active for that week; and
  - On the day of completion of extraction of the feller's block.

Additionally, for feller's blocks not involving the first thinning of young karri regrowth forest, the letter of approval is to include:

- No machine harvesting when TI=0.

For feller's blocks involving the first thinning of young karri regrowth forest, the letter of approval is to include:

- Where layout of extraction tracks, including the preparation of a map and identification of the type and extent of any special treatments to protect soil, cannot be provided together with other information for the feller's block level plan, then the location of landings or forwarder landings should be mapped and this provided prior to disturbance operations commencing; and
- A map of the extraction tracks, including any special treatments to protect soil, used to feed each landing or forwarder landing should be provided at the completion of load out of each landing or forwarder landing.

DEC staff must email a copy of the letter of approval, together with the FPC proposal and all attachments to the FPC proposal, on the day that it is approved, to Tony Smith at Forest Policy and Practices Branch, Bunbury (Tony.Smith@dec.wa.gov.au), so that the information can be made available on the SFM website.

DEC staff responsible for assessing feller's block level plans for access in the Medium to high (post transitional stage) risk period or High risk period should ensure that they record the actions associated with the assessment and approval of the plans. It is recommended that DEC staff record the date submission received, the date of meeting, any interim advice provided to FPC and the date of response from DEC.

3.3.8. Timing of DEC approvals

DEC staff should seek to respond to the FPC within 3 working days of receipt of the submission of the feller's block level plan. This response will be in writing (copy by email is acceptable), and will either:

- Identify actions that must be completed before approval can be reconsidered;
- Identify additional information that must be provided before approval can be reconsidered;
- Identify issues which must be resolved before approval can be reconsidered; or
- Approve the operation and clearly identify any conditions of this approval.

Where issues are still to be resolved for a small number of feller's blocks within a coupe, conditional approval may be given for those feller's blocks that meet the required conditions.

3.3.9. Disputes

Where intractable issues are delaying the approval of the proposal of the feller's block level plan for access in the Medium to high (post transitional stage) risk period or High risk period then the feller's block level plan should be urgently referred to DEC's Director, Sustainable Forest Management Division for consideration.

3.3.10. Monitoring of compliance with these procedures

Monitoring of compliance with the procedures outlined above will be undertaken opportunistically by FPPB officers when visiting Regions, or will be reviewed as a result of complaints about the delays in approval of particular feller's blocks.

Summary

- Areas to be harvested during the Medium to high risk period (post transitional stage) and the High risk period are to be identified early in the harvesting year, and additional information for these areas is to be provided and approved for agreed feller's blocks as part of a two-stage approval process.
- The first stage is called the strategic level and the second stage is called the feller's block level.
- The strategic level plan is required to demonstrate the suitability of candidate coupes in terms of landforms, soils, topography, site, rainfall zone, dieback management and access that make the harvest area suitable for operations in moist soil conditions. The plan should indicate why the chosen coupes are the most suitable out of all the coupes on the Annual Harvest Plan.
- The aim of the feller's block level plan is to demonstrate how consideration of the physical features of the area combined with operational tactics make the harvest area suitable for operations in moist soil conditions. The fellers block level plan is required to provide detail on the feller's blocks to be harvested including planned layout of extraction tracks, the preparation of a map and identification of roads, landings and the type and extent of any special treatments to protect soil, for example cording, matting, brushing or avoidance of susceptible areas.

Commenced: 1 September 2004
Effective from: 17 November 2010
Custodian: Manager, Forest Policy and Practices Branch
Approved by: Director, Sustainable Forest Management Division

4. Soil disturbance

4.1. Introduction

The physical, chemical and biological health of soil contributes to forest productivity and the stability of forest ecosystems. Soils are sometimes referred to as non-renewable resources. This is because the time taken to repair damaged soil is longer than most conventional planning or operational timeframes. In this regard, preventing damage through active planning and management is better than trying to seek a cost effective cure after damage has occurred. Soil damage in forest harvesting operations is usually caused by the operation of heavy vehicles and consists of three primary disturbances. These are:

- Soil compaction;
- Soil mixing; and
- Soil removal, scalping or deposition.

These disturbances combine to produce a variety of visible or obvious types of disturbance. Examples are:

- *In situ* compaction;
- Removal of litter;
- Scalping of soil e.g. gouges from dragging logs during extraction;
- Mixing of soil layers;
- Mounding or other deposition of soil;
- Puddling – mixing with water; and
- Rutting – compaction and mixing with a loss of structure.

In addition to the obvious or visible forms of soil disturbance, sub-soil compaction is often present, particularly where multiple machinery passes are made over the same track. The level of compaction caused during forest operations is related to the type of vehicle, the number of vehicle passes, soil type and soil moisture status at the time of operation.

Assessment of soil disturbance requires consideration of two components:

- The proportion of the total area that is disturbed; and
- The intensity of the disturbance on this area.

4.2. Identifying soil layers

The definitions of topsoil and subsoil used here are generalisations that are intended to assist in protecting the soil from disturbance that leads to soil damage. The depths given here apply to undisturbed soil.

The soil layers consist of litter, topsoil, subsoil and the soil parent material. The litter layer includes the decayed and partially decayed organic matter (humus) sitting above the mineral earth. The topsoil is the uppermost layer of soil beneath the litter that is darkened by the organic matter which has been incorporated into the soil and contains the majority of fine roots. The thickness of the topsoil layer typically varies from only a few centimetres in some soils down to 40 cm in others, and often varies across the

feller's block. The subsoil is the layer of soil below the topsoil, which is lacking in organic matter. It is typically a lighter colour than the topsoil and may also have a higher clay content, or be a clay layer. The soil parent material is the unconsolidated material from which the topsoil and subsoil have developed by pedogenic processes. Concreted laterite is generally not the parent material of the overlying soil.

For the purpose of this Manual, which is intended to facilitate the minimisation of unnecessary soil disturbance in those parts of the landscape available for timber harvesting, generalised assumptions about topsoil depth are used to guide the assessment.

The following points should be considered in distinguishing topsoil from subsoil:

1. Generally topsoil depth should not be less than 7 cm, as the range from 7 to 20 cm is the range of topsoil depth generally found in those parts of the landscape available for timber harvesting;
2. Topsoil depth can generally be assumed to be about 15 cm;
3. Where a clear colour or texture change at a depth less than 20 cm can be observed to identify the topsoil, this depth should be used;
4. Where a clearly identifiable clay layer exists at less than 20 cm depth, this should be used as the lower extent of the topsoil;
5. Topsoil depth will not exceed 20 cm;
6. Careful and thorough examination of the soil profile is required if a topsoil depth less than 10 cm is used when assessing soil disturbance. In this case, clearly identify the topsoil /subsoil boundary by digging a pit at least 30 cm deep and at least 20 cm wide using a spade.

The following should be considered in identifying parent material:

1. In Western Australia, the predominant soils of the jarrah and karri forest are very deep. The parent material is often many metres below the soil surface (e.g. 5 – 10+ m);
2. Only in limited areas of rock outcropping is the true parent material likely to be affected by harvesting;
3. For the purposes of this Manual, subsoil at a depth of 50 cm or greater will be considered as parent material.

4.3. Categories of soil disturbance

The assessment of soil disturbance relies on classification of soil disturbance at a sample point into one of several categories:

- Undisturbed - characterised by an intact litter layer;
- Lightly disturbed - characterised by the litter layer being disturbed or a light disturbance to the topsoil;
- Moderately disturbed - characterised by the topsoil mixed with subsoil or the topsoil partially removed;
- Severely disturbed - characterised by the topsoil completely removed and subsoil exposed or the topsoil mixed with subsoil, or the subsoil disturbed, or subsoil mixed with parent material or soil at greater than 50 cm depth, or the subsoil partially removed; or

- Very severely disturbed - disturbance that involves parent material or soil layers that are greater than 50 cm below the soil surface (excluding caprock), or meets any of the definitions of very severe soil disturbance in Appendix 3.

See Appendix 5 for further details of soil disturbance categories. Photographic examples of the categories of soil disturbance are shown at Appendix 6.

4.3.1. Procedure for categorising visible soil disturbance

Assess the category of soil disturbance at each point in the transect survey in the following manner:

1. Determine if disturbance is the result of previous disturbance, non-timber harvest activities or the current harvesting operation;
2. Determine the dominant soil layer involved in the disturbance:
   a) Litter layer;
   b) Topsoil;
   c) Subsoil;
   d) Parent material or soil deeper than 50cm in the soil profile; or
   e) If the sample point is on a extraction track or a non-soil occurrence;
3. For sample points not on an extraction track, determine the level of mixing / removal (e.g. litter layer intact, litter layer broken/partially removed, litter completely removed and topsoil exposed, etc. – see Appendix 5 and 6), and assign the appropriate booking code (see Appendix 4 and 11)
4. Where the sample point is on an extraction track, record the default category of soil disturbance (or other value, if significantly different to default category) as per Appendix 11 and 12, and assign the appropriate booking code.

4.4. Assessment of landings and log storage areas

4.4.1. Landings

When assessing landings, as part of surveillance of soil disturbance it is necessary to measure the extent of the landing and use this as part of the overall assessment of soil disturbance for the coupe or feller's block. The width of the landing is considered to be the distance measured from the roadside to the back of the landing. The length of the landing is considered to be distance between the edges of the landing, measured parallel to the road or track. Landings are considered to include log stockpiles, log residues and soil stockpiles created as part of activities associated with the landing.

4.4.2. Log storage areas

In some cases logs will be stockpiled adjacent to the landing, using static loaders or forwarders, which results in very little machine traffic to compact or disturb the soil, and limited disturbance from log movement. Where these log storage areas exist, and there is no visible evidence of repeated machine movement under the logs, then the assessor may decide such areas are log storage areas and are not a part of the landing.

Where forwarders are used, particularly with thinning, the operation may not utilise a recognisable landing, but will be based on an adapted road network with widened “pull-off” areas to allow trucks and trailers to be parked and loaded. Logs may be forwarded short distances along the road to these “pull-offs”, and the roadside will be used for log storage. These log storage areas are generally not severely disturbed, because the logs are boom loaded by a forwarder parked on the road surface and the assessor may also recognise these as log storage areas and not a part of the landing.

Where log storage areas are encountered as a part of a long transect survey of visible soil disturbance, soil disturbance under the log storage area is to be assumed to be moderate (D2) unless another disturbance category is clearly applicable. The runway used by the forwarders will be treated as a primary extraction track, and assigned the appropriate default code.

4.4.3. Landing management

A necessary component of any harvesting operation will be a landing with some level of disturbance. The objective should be to limit the extent of this disturbance to that necessary for the requirements of the particular operation, to minimise the amount of unnecessary disturbance, and to limit the intensity of the soil disturbance to the lowest achievable level.

The extent of the landing will be affected by the following factors:

- Room for access / egress from landing;
- Area for treatment of logs;
- Area for product storage;
- Area for topsoil storage;
- Area for disposal of off-cuts / debris;
- Sufficient room to sort / load logs;
- Landing management by operators; and
- The safety of workers.

The eventual outcome as a result of these requirements will generally vary with:

- Harvesting system;
- Machine configuration;
- Size of machines;
- Loading / carting system;
- Truck configuration;
- Variety of products;
- Dimensions of products;
- Hygiene requirements; and
- Topography.

The assessor is required to comment on whether the dimensions of the landing are consistent with the landing being the minimum size for the effective implementation of these requirements.

Planning the location of extraction tracks, and the point at which the machines enter the landing with products, can affect the required dimensions of the landing. For example where products are long then entering the landing in the corners, enabling as much of the length as possible to contribute to the extraction requirement (this length will also be required for loading), can serve to minimise the overall width of the landing.

For operations where logs are extracted using a dozer or skidder, then the landing is likely to need to have sufficient width to cater for the length of a harvesting unit (machine + the maximum product length), as a minimum. For forwarding operations the length of the harvesting unit will be different (machine + maximum safe overhang from the log bunker). The length of the landing will be affected by the maximum width of the product to be carted (i.e. for pole operations the width should allow for the longest pole to be loaded). This length will be increased by the amount of stockpiled logs, and the number of product stockpiles that are required. Irrespective of the number of products good management of the landing with respect to both merchantable logs, and residues may ensure that the minimum area required is disturbed.

The use of forwarders, excavators or static loaders as part of the harvesting system will reduce the width of landing. These machines do not require as much distance to pick up, and load the products, as does a front-end loader. In addition their configuration can reduce the intensity of disturbance because they can pick up and place logs rather than skid, push or drop logs.

During the establishment and use of landings it is important to plan for the management of water. This will involve attention to the movement of water in relation to the landing itself, the extraction tracks that feed the landing and the access road. This can include:

- Selection of the landing site (water gaining or water shedding), and issues relating to hygiene management;
- Construction of drains to encourage water to drain off the landing, and reduce the potential for significant ponding on the landing;
- Installation of interceptor banks or drains on the landing, or at the head of each extraction track to ensure that water is dispersed into vegetation or debris, and does not drain off the landing down extraction tracks;
- Orientation of drains so that water is directed outside the curve of any extraction track to reduce the likelihood of the effluent water being re-collected on the extraction track;
- Location of pipes and table drains on roads to safely disperse water away from landings, and to reduce erosion associated with the roads; and
- Implementation of maintenance and remedial action to control water movement and erosion as soon as it becomes apparent that it is required.

Landings should be inspected for potential ponding or erosion issues in winter to determine if the drainage and erosion control has been effective. Urgent remedial action to correct ineffective drainage and/or repair erosion must be completed immediately, and non-urgent remedial action completed as soon as hygiene or soil conditions permit.

Rutting and soil mixing needs to be considered as part of the assessment of management of landings. Treatments such as cording need to be used when moist soil conditions are likely so that heavily trafficked landings do not become rutted or

have soil mixing occurring. These treatments must be installed prior to onset of damage, and not as a remedial action after damage has occurred.

Where the assessor is required to comment on the effective implementation of these requirements, then appropriateness should be judged on the accumulation of judgements about each of the major factors, and the particular aspects of each site.

Where cording, matting or brushing is used as a treatment to minimise soil disturbance on landings or extraction tracks, the following key points are to be observed:

- Material is to be used as a preventative measure and applied before soil disturbance occurs;
- Woodchips or bark matting are not to be applied to bare soil either for use on the landing, the extraction tracks, or for stockpiling for subsequent use;
- The material must be satisfactorily removed or prepared for silvicultural burning by either:
    1. Recovery and removal for re-use;
    2. Recovery and removal for disposal at an approved site;
    3. Heaping and burning on site; or
    4. Heaping and preparation for burning in accordance with burn security requirements.

Prior to commencement of the ripping phase of rehabilitation, all bark, cording, matting or brushing must be burnt or removed from the landing or extraction track to the required standard.

4.5. Assessment of rutting

The assessment of rutting is a critical component of the soil damage assessment and monitoring tasks. It is accepted that some compaction is an inevitable by-product of harvesting and extraction by heavy vehicles, and that it is the formation of ruts that is the readily visible indication of this disturbance occurring.

There are two forms of ruts created during harvesting and extraction operations:

- Ruts resulting from compaction

  These ruts are formed by the compression of the soil under the weight of the vehicle or log. The formation of a rut may be combined with disturbance or removal of the surface layer of the soil. These ruts can be formed in dry soils.

- Ruts resulting from failure of soil strength

  These ruts are formed by a combination of mechanical disturbance of the soil by vehicles and logs, and the increasing moisture content of the soil, resulting in a loss of structure, and mixing of the soil profiles. Puddling of the soil is often a precursor to this form of rutting.

Ruts are relatively easy to identify and measure. It is likely that the formation of ruts on extraction tracks will occur sooner than similar failure of the soil structure in the

remainder of the harvest area, thereby acting as an early warning of the general soil condition.

Because compaction and soil mixing can have long-term consequences, it is very important that the area affected is minimised. Therefore, wherever possible, existing extraction tracks should be re-used. Where an old extraction track that has pre-existing rutting is used in the current harvesting, the assessment is to focus on the additional disturbance that occurs. Prior to harvest, the extraction plan should identify any old extraction tracks that are to be re-used and measure the length of any significant pre-existing rutting. Assessments carried out during the harvesting will judge compliance in terms of any additional rutting resulting for the current harvest operation.

Once a rut has been formed, the application of remedial treatments such as cording / matting will not fix the damage, and must not be installed. Blading over ruts can only be used as part of the rehabilitation of the site, once the final disturbance survey has been conducted.

4.6. Assessment of erosion

Erosion is defined as the detachment and transportation of soil, and its deposition at another site, by wind, water or gravitational effects. For the purposes of monitoring and assessing erosion, it is important to be able to recognise the main types of water erosion (Table 4).

Table 4: Main types of water erosion.

Term	Definition / Description
Sheet erosion	The removal of a fairly uniform layer of soil from the land surface by raindrop, splash and/or runoff. No perceptible channels are formed. This term may also be applied with respect to wind erosion
Rill erosion	The removal of soil by runoff from the land surface whereby numerous small channels, generally up to 30 centimetres deep, are formed. Typically this type of erosion occurs on recently disturbed soils.
Gully erosion	A complex of processes whereby the removal of soil is characterised by large incised channels in the landscape. Such channels are generally more than 30 centimetres in depth.
Headward erosion	Gully enlargement in an upstream direction due to incision by concentrated runoff and the formation of a waterfall and splash pool. The action of water at the waterfall and splash pool will lead to undercutting and slumping of the gully head. This type of erosion is commonly associated with roadside table drains and culverts. It is an indicator of potential rapid escalation of damage, and should be addressed promptly.
Tunnel erosion	The removal of subsurface soil by water while the surface soil remains relatively intact. Such a tunnel usually outlets in the side of a gully, batter or earth wall, or at the ground surface lower down a slope. The tunnel normally collapses in due course and a gully is formed. The process can occur in soils in their natural field situation or in constructed earthworks.

Term	Definition / Description
Deposition	A process where soil or organic material is left in a new position by a natural transporting agent such as wind or water. Deposition is an indicator that erosion has occurred elsewhere. Depending on its location and scale, deposition may require an investigation to determine the source. Based on the investigation remedial action may be required to control the erosion at the source, and/or to manage the location and extent of the deposition
Turbid runoff	Turbid water occurs when fine soil particles are suspended in the water resulting in discolouration.

The Forest Management Plan specifies that any erosion other than “minor erosion” will be classed as “Very severe visible soil disturbance”, for the purpose of determining soil disturbance limits in association with timber harvesting. Table 5 describes the various types of soil erosion and prescribes the allowable limits.

The assessment of erosion is integrated into all aspects of monitoring of soil disturbance.

Table 5: Types of soil erosion and allowable limits

Type	Classification	Situation	Threshold	Action / consequence
Sheet erosion	Minor	All	<5mm	No action required if no perceptible channels are formed.
Rill erosion	Minor	In coupe	<20mm deep; and <10m in length; or <50m^2 in extent*.	No action.
		Extraction track	<50mm deep; and <10m in length; or <50m^2 extent*; and Contained within control structures.	At the upper limit if no structures in place these must be installed immediately.
	Minor–action required.	In coupe	<20mm deep; and <10m in length; or 50-100m^2 in extent*.	The range is the allowable circumstances where operations may continue (within that range) provided preventative action is taken. Install primary erosion control immediately. Monitor effectiveness daily. If erosion is stabilised in the presence of continued harvesting / extraction then the operation may continue; If erosion continues individual occurrence will be classed as "Very severe visible soil disturbance".
		Extraction track	<50mm deep; and 10-15m in length; or 50 - 100m^2 extent*; and Not contained within control structures.	The range is the allowable circumstances where operations may continue (within that range) provided preventative action is taken. Install primary erosion control immediately. Monitor effectiveness daily. If erosion is stabilised in the presence of continued harvesting / extraction then the operation may continue; If erosion continues or increases, cease harvesting / extraction.
	Major	In coupe	>20mm deep; and >10m in length; or >100m^2 in extent*.	Individual occurrence will be classed as "Very severe visible soil disturbance"
		Extraction track	>50mm deep; and >15m in length; or >100m^2 extent*; or Erosion has breached the erosion control barriers.	Individual occurrences will result in the cessation of harvesting / extraction.
		Roads, boundary tracks and table drains.	>100 deep	Rills associated with the roads, culverts and table drains must be maintained or repaired to prevent the problem from becoming worse. Severe cases that are not controlled may result in a need to stop either the harvesting or haulage operations.
Gully erosion	Major	In coupe / extraction tracks	>300mm deep	All gully erosion is consider major erosion and will be classed as "Very severe visible soil disturbance".
		Roads, boundary tracks and table drains.	>300mm deep	Erosion associated with the roads, culverts and table drains must be maintained or repaired to prevent the problem from becoming worse. Severe cases that are not controlled may result in a need to stop either the harvesting or haulage operations.
Deposition	Minor	All		Where deposition is the result of minor erosion.
	Major	All	A single deposition >30m^2 in extent or any deposition from major erosion	Deposition from any form of major erosion in the coupe or surrounding areas will be classed as "Very severe visible soil disturbance".
Turbid runoff	Minor	In coupe		Where turbid runoff is contained within the coupe, or within the filter strips.
	Major	In coupe		Where turbid runoff is not contained within the coupe, or within the filter strips, and reaches the watercourse

* Area criteria should not be applied if the depth and length criteria have been exceeded.

Commenced: 1 September 2004
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Custodian: Manager, Forest Policy and Practices Branch
Approved by: Director, Sustainable Forest Management Division

4.7. Assessment of drainage

The assessment of drainage associated with extraction tracks, landings, access roads and perimeter tracks that are contiguous with the feller's block is required to identify where erosion and deposition is occurring. This will allow for early installation of erosion control barriers or maintenance of the existing drainage infrastructure before failure occurs.

Aspects of drainage to check for are:

- Erosion / deposition on extraction tracks and landings;
- Erosion in the table drain or batter;
- Erosion at pipe outfalls;
- Build up of vegetation or debris in the table drain or pipes that is affecting water flow;
- Adequate design / dimensions of surface water control structures;
- Siltation of pipe sumps;
- Channelling of water across or along the road or track; and
- Deposition of eroded soil on the road or track surface or into adjoining vegetation.

4.8. Gouges from dragging logs during extraction

Gouges from dragging logs during extraction, where they occur, are generally found running down the centre of extraction tracks. They may vary in depth according to the combination of soil type, log size and the method of harvest. Gouges from dragging logs during extraction may extend for long distances and act as a channel along which water is collected and concentrated, leading to the potential for major water erosion.

Gouges are not assessed as ruts. Soil disturbance associated with gouges will be assessed:

- By the long transect survey of visible soil disturbance and categorised as lightly to very severely disturbed, depending on the level of soil disturbance at the sample point, or default code applied; and
- The occurrence of erosion within the gouge.

Gouges require rehabilitation by levelling of the extraction track and installation of erosion control barriers in the following circumstances:

- Before a significant rainfall event;
- Prior to harvesting vehicles leaving the feller's block for a period of two weeks or more; and
- At any time that erosion within the gouge is observed to be approaching the allowable limit.

Where gouges are present, erosion control barriers may need to be installed at much closer spacing than otherwise required for the combination of soil type and slope as specified in Appendix 7. This is to ensure that the barriers effectively disperse water

away from the extraction track and ensure that erosion is limited to between erosion control barriers.

4.9. Tracks and the importance of minimising trafficked areas

Tracks created during timber harvesting are the site of the most intensive traffic and usually the greatest soil disturbance, particularly soil compaction and in some cases rutting. Both the harvesting and the extraction phase may create tracks.

Research into changes in soil bulk density resulting from vehicle movement shows that significant soil compaction occurs on the primary and secondary extraction tracks. The extent of this compaction is not always visible from the surface. Based on these results, default disturbance categories relating to the order or hierarchy of the extraction track have been determined. These are to be used in addition to the assessment of visible soil disturbance and are shown in Appendix 12.

Typically a large proportion of the total compaction occurs in the first few passes of a vehicle over the soil surface. Subsequent vehicle passes add progressively less compaction. Key objectives are therefore to:

1. Concentrate machine movement onto as few tracks as possible; and
2. Minimise machine traffic off the tracks.

These actions reduce the area of the harvest cell that is disturbed.

To achieve this:

- Plan the track layout prior to harvest;
- Both the pattern of harvesting tracks (where machine harvesting is used) and the extraction track layout should be considered so that the overall area of tracks is minimised;
- Use old extraction tracks from the previous harvest where practical;
- Do not duplicate tracks;
- Do not have parallel tracks or multiple extraction tracks heading to the same area;
- Do not have separate harvest tracks and extraction tracks leading to the same area;
- Do not have a extraction track going around both sides of a tree;
- Do not “criss cross” extraction tracks;
- Minimise the width of extraction tracks. The extraction track should be no wider than the wheel tracks of the vehicle; and
- Avoid the use of machine harvesting where possible, particularly under moist soil conditions or in stands with an unsuitable structure.
- Minimise the width of harvest tracks (where machine harvesting is used). This is achieved by using a harvest machine of the minimum size necessary and with the careful operation of the machine.

In short, plan the layout and manage the development of the harvest and extraction track pattern.

Appendix 6 of the Forest Management Plan 2004 - 2013 (revised) requires that "Duplicate, parallel and criss-crossing extraction tracks are not constructed unless under exceptional circumstances". For the purpose of addressing this clause the "exceptional circumstances" will be:

- In urgent circumstances for the purposes of gaining access to harvesting personnel for medical treatment or rescue, without consultation to DEC; or
- To avoid unforeseen hazards, and soil conditions that are atypical of the remainder of the feller's block. This is only to occur following consultation and approval by DEC (these instances should be recorded in the coupe diary) e.g. where a small localised bog hole is avoided in a generally dry area or where the shape of infected and clean areas requires more than the normal amount of tracks to maintain hygiene.

Summary

- Soil disturbance in forest harvesting operations is usually caused by the operation of heavy vehicles. Harvest operators are required to minimise soil disturbance through active planning, monitoring and management.
- The main forms of soil disturbance are soil compaction, mixing and removal, scalping, mounding, erosion and deposition.
- Assessment of soil disturbance is carried out by visual observation and requires consideration of proportion of the total area that is disturbed, and the intensity of the disturbance.
- For the management of harvesting operations, four levels for intensity of soil disturbance are defined. The intensity of disturbance is determined by the soil layers that are impacted. Each disturbance category has an allowable threshold.
- One of the most effective ways to minimise soil disturbance is to concentrate vehicle movement onto as few tracks as possible; and minimise vehicle traffic off these tracks.

Commenced: 1 September 2004
Effective from: 17 November 2010
Custodian: Manager, Forest Policy and Practices Branch
Approved by: Director, Sustainable Forest Management Division

5. Monitoring of soil disturbance

The Forest Management Plan 2004-2013 requires the FPC and DEC to monitor soil damage. The purpose of this section is to describe how the required monitoring is to be undertaken. Monitoring is to be undertaken by an appropriately trained officer or by an appropriately trained contractor that has been delegated this responsibility.

5.1. Timing

The FPC are required to monitor soil disturbance as indicated in Tables 6 and 8. DEC are required to monitor soil disturbance as indicated in Table 7.

5.2. Surveillance of soil disturbance

Appendix 9 (DEC SFM 005) is to be used for recording information collected during surveillance during all parts of the year.

5.2.1. General

1. Record location details and prepare a sketch map of the feller's block, showing the landing and extraction tracks using DEC SFM 004 (Appendix 8);
2. Record the date and current TI_{SDI} for the compartment;
3. Determine and record the risk level (low, medium, medium-high [transitional], medium-high [post transitional stage], or high);

5.2.2. Landing management

4. Measure and record the size of the landings (see Section 4.4), the feller's block and the percent of the feller's block occupied by the landing:
    a) Measure average landing length and width and use these to calculate the area of the landing. In the case of rear barrier split-phase landings include both sides of the barrier in the size of the landing;
    b) Determine the area of the feller's block;
    c) Calculate the percent of feller's block occupied by the landing and compare this with the allowable limits (Appendix 2);
5. Check that the landing is effectively drained (see Section 4.7);
6. Check for erosion and deposition associated with the landing or roads and specify remedial action where required (see Section 4.6);
7. Check that rutting or soil mixing is not occurring (see Section 4.5) and that landing treatments such as cording are in good condition. Where remedial action to repair or add to the cording, matting, brushing, woodchips etc on landings is required, this must be done in consultation with DEC;
8. Verify that landing management is appropriate (see Section 4.4) and record outcome;

Table 6: Soil disturbance monitoring required to be undertaken by FPC for each feller's block (except where stated otherwise).

Type of Monitoring	Risk period						
	Low	Medium	Medium - high		High		
			Transitional	Post transitional stage	Karri thinning	Where loading out is approved	Coupes not certified as complete, including karri thinning
Surveillance (including verification of plan to access in Medium-high or High risk periods)	Weekly[1]. Daily for the first two (2) days following a significant rainfall event[2]	Weekly[1]	Daily	Daily[3]	Daily[3]	Daily[3]	
Survey of rutting and erosion	If triggered by surveillance	If triggered by surveillance	Weekly[1] or if triggered by surveillance	Weekly[1] or if triggered by surveillance. Fortnightly in coupes not certified as completed[4]	Weekly[1] or if triggered by surveillance.		Fortnightly in coupes not certified as completed[4]
Long transect survey of visible soil disturbance	Monthly per coupe or if triggered by surveillance	Monthly per coupe or if triggered by surveillance	Weekly[1,5,6,7] or if triggered by surveillance	Weekly[1,5,6,7] or if triggered by surveillance	Weekly[1,6,7] or if triggered by surveillance		

[1] Weekly is considered to be five active days of use of heavy vehicles in the feller's block. If a week comprises a combination of risk periods, the monitoring requirements of the higher risk period will apply.

[2] A significant rainfall event is when the TI_{SDI} falls by 400.

[3] This surveillance is to be based on daily visits and direct observations by the FPC coupe OIC.

[4] Certification of completion is based on the FPC104.

[5] In harvest operations where removed log volumes are low and numerous feller's blocks may be completed in a week, a long transect survey will be completed on at least one completed feller's block per coupe per week. The results of the survey will then form the basis of any decision to continue, modify or cease harvest operations at the coupe level.

[6] For karri thinning, if weekly transect surveys of soil disturbance show levels of disturbance are less than half of the allowable thresholds then surveys at two-weekly intervals may be appropriate i.e. ten active days of use of heavy vehicles in the feller's block.

[7] For Karri thinning, where fortnightly transect surveys (from 6 above) consistently show levels of disturbance are less than half of the allowable threshold, survey intensity may be reduced from the feller's block to the coupe level as follows:

- one survey every 20 working days per coupe when fuels are > 10 years old;
- one survey every 10 working days per coupe when fuels are < 10 years old; and
- one survey every 10 working days per coupe for the first 2 months of a new machine operators employment.

Table 7: Soil disturbance monitoring to be undertaken by DEC.

Type of Monitoring	Risk period				
	Low	**Medium**	**M-h (Transitional)**	**M-h (Post transitional stage)**	**High**
Surveillance (including verification of plan to access in Medium-high or High risk periods)	One feller's block for each contractor per District per month	One feller's block for each contractor per District per month	One feller's block for each contractor per District per fortnight	Weekly for each feller's block	Weekly for each feller's block
Survey of rutting and erosion	If triggered by surveillance	If triggered by surveillance	If triggered by surveillance	One feller's block for each contractor per District per week	One feller's block for each contractor per District per week
Long transect survey of visible soil disturbance	One completed[1] feller's block per District per month	One completed[1] feller's block per District per month	One completed[1] feller's block per District per week	One completed[1] feller's block per District per week	One completed[1] feller's block per District per week
FPC reporting requirements[2]	Weekly[2]	Weekly[2]	Weekly[2]	Weekly[2]	Weekly[2]

[1] The feller's block needs to have been operated during the specified risk period. Certification of completion is based on the FPC104.
[2] Refer to Section 5.6 (Table 10) of this Manual.

Table 8: Monitoring requirements following significant rainfall events in the low risk period

Risk category after being reduced by at least 400	Monitoring requirements
Low	Monitoring as is required for the Medium risk period for at least 3 days. Discontinue after 3 days if no issues are apparent. Transect survey of visible soil disturbance is required if other monitoring indicates that it is necessary (i.e. threshold is likely to be exceeded), otherwise a transect survey is not required.
Medium	Monitor as is required for the Medium risk period until the Low risk period is entered, or for a minimum of 3 days, whichever is the greater
Medium-High	Monitor as is required for the Medium-High risk period
High	Monitor as is required for the High risk period

5.2.3. Extraction tracks

9. Verify that rutting and erosion is not starting to occur on the extraction tracks, including erosion within gouges caused by dragging logs during extraction;

10. If rutting is starting to occur then undertake a survey of rutting and erosion (see Section 5.3);

11. Check for gouges caused by dragging logs during extraction that require remedial action to prevent erosion;

12. Check the condition of any corded sections of extraction tracks and note the need for any remedial treatments. Where remedial action to repair or add to the cording, matting, brushing, woodchips etc on extraction tracks is required, this must be done in consultation with DEC;

5.2.4. In-coupe

13. Check for the occurrence of moderate, severe or very severe soil disturbance associated with use of heavy vehicles;

14. Check for rutting that is not associated with rutting on the major extraction tracks and if any occurrences are observed than initiate an assessment as per the procedure in Section 5.3, ensuring that the assessment includes all extraction tracks up to and including this order;

15. Check for occurrence of major erosion or deposition and if any occurs then cease all harvesting operations in feller's block and notify the Regional Leader for Sustainable Forest Management in the Department. Checking should concentrate on areas where slope is > 10^0, areas of vulnerable sandy soils or areas that are likely to be affected by runoff;

16. Check for turbid water exiting the feller's block and determine whether it is a minor or major occurrence. If a major turbid water flow occurs then cease all harvesting operations in feller's block and notify the Regional Leader for Sustainable Forest Management in the Department;

17. Record the need for additional erosion control work and the GPS coordinates of the location of the required work;

5.2.5. Roads and perimeter tracks

18. Check that drainage of roads and perimeter tracks contiguous with the feller's block is adequate and effective. This includes checking table drains for occurrences of erosion, road verges for deposition, and pipes and drains for blockages;

19. If major erosion or deposition is identified then cease all harvesting operations in the feller's block and notify the Regional Leader for Sustainable Forest Management in the Department;

20. If required, record the need for road maintenance / remedial work, and the location of the required work;

5.2.6. Verification of operation against approved plan

21. Check that site conditions and operations are in accordance with the appropriate approvals and plans. During the Medium to high and High risk periods, DEC SFM 010 (Appendix 16) and DEC SFM 011 (Appendix 17) forms provide the required information to check for verification. These forms are to be used by DEC officers (as described in Steps 22 to 24 below) and are recommended for use by FPC as a checklist when conducting daily surveillance.

Note: For FPC, the coupe OIC is to monitor and record information for the surveillance. During the Low risk, Medium risk and Medium to high (transitional) risk periods, this may be based on information provided by the FPC harvesting contractor. During the Medium to high (Post transitional stage) and High risk periods the surveillance is to be based on daily visits and direct observations by the FPC coupe OIC.

When daily surveillance is required, the surveillance of rutting and erosion is not expected to be comprehensive of the complete harvest cell. The surveillance for this aspect should focus on the most heavily used areas, steeper slopes, most recently trafficked areas (since last surveillance) and more prone soil types where rutting and erosion are more likely to develop.

22. DEC is to monitor that the provisions of the approved plan to access feller's blocks in the Medium to high (not transitional) and High risk periods are being complied with, by checking to verify on a weekly basis:

    A. That any special treatments to protect soil (for example cording, matting, brushing or avoidance of susceptible areas) that are required by the approved plan are in place;

    B. That the method of harvest (for example hand falling and snigging) is as required by the approved plan;

    C. That the heavy vehicles being used for harvesting are as required by the approved plan;

    D. That the management of landings is as required by the approved plan:

    E. That the use of old extraction tracks is maximised;

    F. That the silvicultural methods are as required by the approved plan;

    G. That dieback management is as required by the approved plan;

    H. That the access routes are as required by the approved plan;

    I. That the condition of landings is as required by the approved plan;

    J. That any special treatments to protect soil required by the approved plan remains in an appropriate condition;

    K. The acceptability of the extraction track pattern complies with the provisions of the management plan. Compliance is to be categorised as:

        1. Compliant;

        2. Variation that <u>does not threaten</u> disturbance limits or cause duplication, parallel or criss-crossing tracks unless under exceptional circumstances; or

        3. Variation that <u>does threaten</u> disturbance limits or cause duplication, parallel or criss-crossing tracks unless under exceptional circumstances. Operations are to cease and not to recommence until TI_{SDI} is greater than 750;

    Copies of the records of monitoring (DEC SFM 010) are to be provided to Forest Policy and Practices Branch on a monthly basis.

23. DEC is to monitor that the provisions of the approved plan to access landings in the High risk period are being complied with, to verify on a weekly basis:

A. That the management of landings is as required by the approved plan;

B. That the condition of landings is as required by the approved plan;

C. That the heavy vehicles / machinery used on the landing are as required by the approved plan;

D. That dieback management is as required by the approved plan; and

E. That access routes are as required by the approved plan.

Copies of the records of monitoring (DEC SFM 011) are to be provided to Forest Policy and Practices Branch on a monthly basis.

24. Where monitoring by DEC officers indicates that the required action has not been carried out according to the approved plan or conditions or that an operation is not compliant with requirements, then the DEC Regional Leader for SFM will formally write to FPC notifying that remedial action is required or that the operation in the feller's block may need to cease. This advice should specify a deadline for a response from FPC. Record the date and time that FPC was notified and sign.

5.3. Survey of rutting and erosion

1. At the intervals defined in Table 6, or where Steps 10 or 14 in Section 5.3 indicate that rutting is starting to occur, then FPC is to walk extraction tracks and record occurrences of rutting. DEC officers are required to conduct a survey of rutting and erosion as indicated in Table 7 and using DEC SFM 006 (Appendix 10) to record the results. The procedure for the survey of rutting and erosion is as follows:

   a) Prepare a sketch map of the feller's block, showing the landing and extraction tracks using DEC SFM 004 (Appendix 8). Use the map of the extraction track layout of the feller's block to plan the most efficient method to assess all extraction tracks for the occurrence of rutting. Start with the most heavily trafficked extraction tracks;

   b) When a rut is located, use a GPS to identify its location and assign it a *Rut Number*;

   c) Use a tape or pace to estimate length of the rut;

   d) Depth of rut is estimated from the original level of the topsoil;

   e) Record soil type and for each rut determine whether it is a significant rut.

   f) The criteria for significant ruts is dependent on soil type (i) for gravel and sand soils significant ruts are those with a maximum depth greater than or equal to 150 mm which occur over a length greater than or equal to 5m, and (ii) for other soils significant ruts are those with a maximum depth greater than or equal to 300 mm which occur over a length greater than or equal to 5m;

   g) Record length of significant ruts for each day and summarise total length of significant ruts for each day;

   h) Appendix 10 can be used on multiple days to assist in tracking the growth of ruts towards the allowable limit;

   i) Determine whether the length of significant ruts exceeds the allowable limit;

2. If rutting exceeds or is likely to exceed the allowable limits if the operation continues (see Appendix 2), then cease all harvesting operations in feller's block

and notify the Regional Leader for Sustainable Forest Management in the Department;

3. Check for and record occurrences of significant erosion, including within gouges caused by dragging logs during extraction. The procedure for the erosion assessment is as follows:

   a) When erosion requiring remedial action (minor or major) is located, use a GPS to identify its location and assign it an *Erosion Number*;

   b) Use a tape measure depth and a tape or pace to estimate length and area of the erosion;

      - Depth of erosion is estimated from the original level of the topsoil or in the case of erosion within a gouge caused by dragging logs during extraction, it will be the additional depth from the bottom of the gouge;
      - Length of the erosion commences from the point at which the depth of the rill or headward erosion exceeds the allowable limit, and ends at the downstream end of the erosion channel or deposition arising from the channel;
      - Area of the erosion is to include the area of the erosion channel, the area of rill erosion that contributes to the channel and deposition arising from the channel;

   c) Record the measurements for each day;

   d) Appendix 10 can be used on multiple days to assist in tracking the growth of erosion until remedial work has been completed, or until the size of the erosion event exceeds the allowable limit. At this time harvesting in the coupe must cease;

4. Check that the use of old extraction tracks is maximised, and record;

5. Identify the remedial action required;

6. Record the date that remedial action is completed.

7. Check the installation, standard of construction, and the effectiveness of erosion control barriers for all instances of erosion that have been identified as requiring action in the feller's block;

5.4. Long transect survey of visible soil disturbance

The purpose of a long transect survey of visible soil disturbance is:

- To determine the amount of soil disturbance in different categories and whether harvesting or extraction with heavy vehicles should cease because of excessive disturbance; and
- To provide information on the amount of soil disturbance in various categories that occurs in a range of circumstances. This information will assist in the continuous improvement of forest management practices associated with soil disturbance.

Additionally, DEC will undertake these surveys to audit FPC environmental performance on completed feller's blocks against requirements of the Forest Management Plan.

DEC officers are required to use forms shown in Appendices 8, 11, 12, 13, 14 and 15 to assist undertaking and recording results of the long transect survey. These forms are also recommended for FPC use. Alternatively, FPC officers may elect to use a FPC 511 form to record results of a long transect survey.

5.4.1. Timing

The Forest Products Commission is required to undertake a long transect survey of visible soil disturbance according to the requirements of Tables 6 and 8. DEC will undertake a long transect survey of visible soil disturbance according to the requirements of Table 7.

In harvest operations where removed log volumes are low and numerous feller's blocks may be completed in a week, a long transect survey will be completed on a least one completed feller's block per coupe per week. The results of the survey will then form the basis of any decision to continue, modify or cease harvest operations at the coupe level.

5.4.2. Planning

The procedure for planning the long transect survey of a feller's block is as follows:

1. Map the boundary of the feller's block using GPS;
2. Prepare a sketch map of the feller's block, showing the landing and extraction tracks using DEC SFM 008 (Appendix 8);
3. Determine the spacing, number and location of transect lines using the sketch map of the feller's block and the pattern of extraction tracks;
    - Determine transect spacing, using the following procedure;
        - Approximate transect spacing (m) = survey area (ha) x 4..Equation 1
        - Note: the minimum transect spacing to use is 25 m. This means that for harvest areas less than 6 hectares an error limit of 2 per cent may not be achieved. On these small harvest areas an error limit greater than 2 per cent is acceptable. An error limit of 2 per cent requires the number of points assessed to be 2500.
    - Determine the number of transects by dividing the distance from the front of the feller's block to the back of the feller's block by the transect spacing as determined in Equation 1;
        - Number of transects = Distance (m) / Transect spacing (m)……Equation 2
    - Plan the layout so that transects are at right angles to the general direction of the extraction tracks, and note the required compass bearing;
    - Plan the layout so that transects are parallel to each other;
    - Position the first transect so that it is approximately half the transect spacing from the front of the feller's block (eg. If the transect spacing is 30 m, then the first transect is located 15 m from the front of the block);
    - Ensure transects are evenly spaced from the front to the back of the feller's block; and
4. Mark the proposed assessment transects on the sketch map.

5. The transect survey should be planned to cover the whole feller's block incorporating at least 2500 points.
6. Plan to conduct the first survey using every second transect line (must be at least 1250 points).
7. Plan to conduct the second survey (if required according to Tables 6 and 7) or continue the first survey if limits are being approached using the alternate suite of transect lines.

5.4.3. Transect assessment

The procedure for assessing soil disturbance along transects in the field is described below:

1. Sufficient full transects are to be completed to provide at least 1250 sample points, as described below.
2. Locate the start point of the first transect line to be assessed, and flag the starting point and number the transect line on the flagging;
3. Assess soil disturbance categories at 1 m intervals along each transect. Determine if the disturbance is a result of previous disturbance, non-timber harvesting activities or the current harvesting operation;
4. Determine the dominant soil disturbance category (see Section 4.3) within a 10 cm radius circle at each assessment point;

   Note: Where there is more than one type of soil disturbance and one of them occupies a significantly larger proportion of the assessment point, then the dominant soil disturbance categories is that occupying the significantly larger proportion.

   Note: Where there is more than one type of soil disturbance, each occupying a similar proportion of an assessment point, the dominant soil disturbance category is that with the highest level of soil disturbance eg. where the assessment point is on a secondary extraction track that is brushed (booking code - ET2, level of disturbance - D2), and where soil mixing is observed (booking code – D3, level of disturbance – D3) then the soil mixing is the dominant soil disturbance category.
5. Record the booking code for the type of soil disturbance at each point using DEC SFM 007 and DEC SFM 009 (Appendices 13 and 15);

   Note: Information for each transect line is to be recorded separately.
6. In addition to assessing the individual points, look for occurrences of rutting and erosion that are visible from the transect lines. Where rutting or erosion is observed initiate a survey of rutting and erosion using the procedure described in Section 5.3 above. If significant rutting or erosion is observed then halt the transect survey and undertake the survey of rutting and erosion;
7. If the rutting or erosion does not exceed the allowable limits (see Appendix 2), then continue the transect survey of visible soil disturbance;
8. At the end of each transect line flag the end point and number the transect line on the flagging;
9. Based on the transect spacing, locate the starting point for the next transect (using every second line) and continue assessing using steps 2 through 8 until at

least 1250 sample points have been assessed and the end of a transect line has been reached;

10. Determine the percentage of each soil disturbance category, record the results on the summary sheet on DEC SFM 009 (Appendix 15) and compare results with allowable limits in Appendix 2:

    - If the results from the calculations indicate the allowable limits are exceeded or likely to be exceeded if the operation continues, then FPC is to decide to (i) close the operation, or (ii) go to step 11;
    - If the results from the calculations indicate the allowable limits are not exceeded and not likely to be exceeded if the operation continues, then the operation can continue without the need to go to step 11;

11. Continue assessment for a total of 2500 points (i.e. including the first 1250 points), repeat calculations and compare the results to the allowable limits in Appendix 2:

    - If the results from the calculations indicate the allowable limits are exceeded or likely to be exceeded if the operation continues, then FPC is to close the operation;
    - If the results from the calculations indicate the allowable limits are not exceeded and not likely to be exceeded if the operation continues, then the operation can continue.

Notes specific to DEC Officers

Long transect surveys by DEC will be used to monitor soil disturbance only on completed feller's blocks. These transect survey's must provide a representative coverage of the whole feller's block. The minimum requirement is a 1250 point survey, and the completion of a 2500 point survey is required if the soil disturbance is not well below the allowable limits. In order to achieve this it is required that:

1. The transect survey should be planned to cover the whole feller's block incorporating at least 2500 points;
2. Conduct an initial survey using every second transect line (must be at least 1250 points);
3. If the assessed disturbance is well below the allowable limit, no further survey is required. Well below is defined as follows:

   <u>For Jarrah</u>
   D2 + D3 less than or equal to 7.0;
   D3 less than or equal to 1.8.

   <u>For Karri clearfall</u>
   D2 + D3 less than or equal to 14.0;
   D3 less than or equal to 1.8.

   <u>For Karri thinning</u>
   D2 + D3 less than or equal to 7.0;
   D3 less than or equal to 0.8.

4. If the level of disturbance is not well below the allowable limits, continue to survey the remaining transects and complete the survey of the entire feller's block (>2500 points);

5. On completion of the survey DEC SFM 008 (Appendix 14) may be used to record the disturbance categories for each transect line and in doing so collate the information for use in DEC SFM 009 (Appendix 15) and to calculate the percentage disturbance;
6. Where the assessed disturbance is below 8 per cent for moderate disturbance, and below 2 per cent for severe disturbance, no further action is required, unless another aspect of disturbance or management is considered to be an issue;
7. Where the assessed disturbance is between 8-10 per cent for moderate disturbance, and between 2-3 per cent for severe disturbance, then a formal letter to FPC should be issued. In special circumstances where the activities in the coupe are considered best practice, then the Regional Manager will report to FPPB with justification / explanation of reasons for not issuing a formal letter to FPC. A FPPB officer will inspect and advise the Regional Manager whether or not to issue a formal letter to FPC;
8. Where the assessed disturbance is >10 per cent for moderate disturbance, and >3 per cent for severe disturbance, then a formal letter to FPC must be issued.

   Copies of the records of monitoring forms are to be provided to Forest Policy and Practices Branch on a monthly basis.

5.4.4. Equipment

A list of equipment needed for the transect survey of visible soil disturbance is provided at Appendix 18.

5.5. Closure of operations

Where the results from surveillance show the allowable limits are exceeded, or where a survey of rutting and erosion or a long transect survey of visible soil disturbance indicate the allowable limits are exceeded or likely to be exceeded if the operation continues, then FPC is to close the operation, notify DEC's Regional Leader for SFM, and record the details in the Coupe Diary.

5.6. Communication and reporting

Effective management of soil disturbance relies on regular communication between FPC and DEC regarding circumstances where timber harvesting operations are likely to exceed allowable soil disturbance limits due to reasons including small size of harvest cell, dieback hygiene requirements or slope. Communication is also required in relation to the status of operations and results of monitoring and surveys. The required reporting and communication is outlined in Tables 9 and 10 below.

Table 9: Communication and reporting required to be undertaken by FPC in relation to management of soil disturbance.

Stage of operation	Issue	Action by FPC and when
Commencement	Where timber harvesting operations are likely to exceed allowable soil disturbance limits due to reasons including small size of harvest cell, dieback hygiene requirements or slope.	Notify DEC Regional Leader for SFM for each feller's block involved including: 1. advice that limits are likely to be exceeded and the reason for this; 2. an estimate of the manageable limits for the operation; 3. any specific tactics that will be adopted to reduce the level of damage; 4. feller's block level map to assist monitoring; 5. the proposed timing of harvest operations; and 6. the appropriate contact person for the coupe.
	Commencement of operations in the feller's block or loading out from landing stockpiles.	Notify DEC Regional Leader for SFM for each feller's block / landing on each Monday morning prior to commencement of operations in the feller's block or loading out from landing stockpiles i.e. the notification to cover the period from the Tuesday to the subsequent Monday.
Ongoing operation	Notification on ongoing operations.	Notify DEC Regional Leader for SFM of all feller's blocks / landings intended for continued operation on each Monday morning.
Surveillance	Surveillance of feller's blocks.	Provide copies to, or access by, DEC to surveillance records if requested.
Survey of rutting / erosion	Survey of rutting / erosion.	Provide copies to DEC Regional Leader for SFM each Monday morning (in Low / Medium risk periods, only if available).
Transect survey	Transect survey results.	Provide copies to DEC Regional Leader for SFM on 1st Monday of month in Low / Medium risk periods. Provide copies to DEC Regional Leader for SFM each Monday morning in Medium – high and High risk periods.
Cessation	Cessation related to soil management.	Notify DEC Regional Leader for SFM on the day of cessation.
Completion	Completion of extraction in the feller's block or loading out from landing stockpiles.	Notify DEC Regional Leader for SFM each Monday morning for the day of completion of extraction of the feller's block, or completion of landing. Also provide a copy of FPC104's.

Table 10: Communication required to be undertaken by DEC in relation to management of soil disturbance.

Stage of operation	Issue	When	Action by DEC
Commencement	Notification of commencement.	Ongoing	Formally write to FPC for all instances where DEC has not been advised.
Ongoing operation	Notification of continuing operations	Monday pm	Remind FPC if notification has not been provided.
	Follow-up regarding failure to notify of continuing operations	Tuesday am	Formally write to FPC re failure to notify of continuing operations.
Surveillance	Monitor surveillance by FPC of feller's blocks	Occasional	Remind FPC of surveillance requirements.
	Follow-up regarding failure by FPC to undertake surveillance.	Occasional	Formally write to FPC regarding failure to undertake required surveillance.
Survey of rutting / erosion	Monitor survey of rutting / erosion by FPC.	Monday pm	Remind FPC of requirement for surveys and notification to DEC.
	Follow-up regarding failure to notify or undertake surveys.	Tuesday am	Formally write to FPC for each feller's block regarding failure to undertake required surveys and/or notification to DEC.
Transect survey	Monitor transect surveys by FPC	Monday pm	Remind FPC of requirement for surveys and notification to DEC.
	Follow-up regarding failure to notify or undertake surveys.	Tuesday am	Formally write to FPC for each feller's block regarding failure to undertake required surveys and/or notification to DEC.
Cessation	Notification of cessation related to soil management.	Ongoing	Formally write to FPC for all instances where DEC has not been advised.
Completion	Notification of completion.	Monday pm	Remind FPC if notification has not been provided.
		Tuesday am	Formally write to FPC regarding failure to notify of completion.

Summary

- FPC are required to monitor soil disturbance in order to manage compliance of harvest operations by keeping within allowable soil disturbance thresholds.

- DEC are required to monitor soil disturbance on completed fellers blocks, and check FPC monitoring and reporting in order to monitoring FPC environmental performance.

- Three types of monitoring are used (i) surveillance, (ii) surveys of rutting and erosion and (iii) long transect surveys of visible soil disturbance. These techniques are primarily designed to assist forest managers in recognising and responding to soil disturbance before allowable thresholds are approached.

- For a harvesting operation to be compliant, monitoring must be undertaken at defined intervals according to soil moisture conditions and the type of operation.

- To effectively implement soil management and monitoring, regular communication and reporting is required between FPC and DEC officers.

Commenced: 1 September 2004
Effective from: 17 November 2010
Custodian: Manager, Forest Policy and Practices Branch
Approved by: Director, Sustainable Forest Management Division

6. Data management

6.1. Corporate data relevant to this Manual

The implementation of this Manual results in the collection of the following data or information sets:

- Estimates of Trafficability Index TI_{SDI};
- Records of monitoring of soil disturbance by officers of the Forest Products Commission; and
- Records of monitoring of soil disturbance by officers of the Department of Conservation and Land Management.

6.2. Custodianship of data

The Manager of Forest Management Branch is the custodian of the data sets related to Trafficability Index system and associated records. The Manager of Forest Policy and Practices Branch is the custodian of datasets related to the monitoring of soil disturbance by officers of the Department of Environment and Conservation.

The Forest Products Commission is the custodian of the records of monitoring of soil disturbance collected by officers of the Forest Products Commission.

6.3. Responsibilities for data collection

Monitoring of soil disturbance by officers of the Forest Products Commission is the responsibility of the FPC Authorised Officer. The data collected by these officers is to be copied to DEC's Regional Leader for SFM as identified in Table 9 in section 5.6. The information will be used to facilitate the review of implementation of the provisions of the Forest Management Plan.

Monitoring of soil disturbance by officers of DEC is the responsibility of Sustainable Forest Management officers located in the Swan, South West and Warren Regions. The data collected by these officers and that provided by FPC is to be collated by the Regional Leader for SFM and copied to Tony Smith at Forest Policy and Practices Branch to facilitate review and continuous improvement in forest management practices.

Appendix 1: Glossary

Term	Definition / Description
Block	A named administrative subdivision of the forest, varying in size from about 3,000 to 8,000 hectares.
Cell	See "**feller's block**"
Clay	A soil texture class consisting primarily of fine grained minerals less than 0.002 mm in diameter, which is generally plastic at appropriate water contents and will harden when dried.
Coupe	An area of forest that is planned for timber harvesting as a single unit. It may contain more than one silvicultural objective, such as a number of discrete gaps or clearfell areas or a combination of both.
Corded	See **corduroy**
Corduroy	The process of cross-laying the ground of tracks with small logs and branch material to provide flotation for heavy vehicles and to protect the soil from being damaged by the repeated passage of vehicles.
Disturbance	Any range of conditions affecting the condition of a natural area. Disturbance may be natural (e.g. fire) or human induced (e.g. timber harvesting).
Drizzle[1]	Fairly uniform precipitation composed exclusively of fine drops of water (diameter less than 0.5mm) very close to one another. The drops appear almost to float, thus making visible even slight movement of the air. Drizzle is associated with the following cloud types; Stratocumulus, and Stratus.
Erosion	The wearing away of the land surface by rain, running water, wind, ice, gravity, or other natural or anthropogenic agents.
Extraction track	A track along which logs are pulled or carried from the felling point at the stump to a landing or point of loading.
Feeder extraction track	A second or higher order extraction track that leads onto a primary extraction track.
Feller's block	The area of harvest supplying timber to an individual landing. The term "cell" may also be used to describe this management unit of harvesting
Forwarder	A self-propelled machine, usually self-loading, that is used to extract logs by carrying them completely off the ground, usually in a bunker behind the cabin.
Forwarder landing	A cleared area, generally along the edge of a road or track, where logs are stored prior to transport. These will generally be based on an adapted road network with widened "pull-off" areas to allow trucks and trailers to be parked and loaded. There may be significant areas of moderate soil disturbance but only small areas of severe soil damage.
Forwarder track	A track along which a forwarder carries logs, completely off the ground, from the felling point to a landing or point of loading.
Free water	Free water is defined as any puddles or overland flow anywhere in the feller's block, but in particular on the extraction track.
Gouge	A furrow or depression in the soil caused by the action of dragging logs during extraction. Where they occur, they are generally found running down the centre of the extraction track.
Gully erosion	The removal of soil by water running in narrow channels, which may be eroded to depths exceeding 30 cm.
Landing	A cleared area in the forest to which logs are yarded or skidded for loading on to trucks for transport. The landing is considered to be the area where there is repeated machine movement and / or severe soil disturbance resulting from the movement or stockpiling of logs.

Term	Definition / Description
Litter layer	The surface layer of the forest floor that is not in an advanced stage of decomposition, usually consisting of freshly fallen leaves, needles, twigs, stems, bark and fruit.
Log storage area	A cleared area adjacent to a landing that is not subjected to repeated machine movement, or severe soil disturbance from log movement or stockpiling. Generally associated with operations of forwarders or static loaders.
Matting	Material such as bark or wood chips that is used to cover an extraction track or landing, whether by itself or in addition to cording, to reduce soil disturbance, improve trafficability or reduce unevenness of cording to improve operator comfort.
Monitoring	Regular assessment of a management program and of the resources being managed, checking that desired outcomes are achieved, and adjusting the plan where necessary.
Mounding	Heaping of the soil. This is caused by the movement and deposition of soil onto the ground, or by the upward movement of the soil due to pressure applied to the adjacent ground.
Parent material	The unconsolidated or less chemically weathered mineral material from which the soil horizons are developed by pedogenic processes. For the purpose of this Manual, parent material is also considered as soil material at a depth greater than 50cm below ground level.
Pedogenic process	A pedogenic process is any chemical or physical process that contributes to the formation of soil through the break down or combination of minerals and mineral material.
Primary extraction track	The main extraction track that leads into a landing.
Puddling	Mixing of the soil under wet conditions that results in the breakdown of soil structure.
Rain[1]	Precipitation of liquid water particles, either in the form of drops of more than 0.5mm in diameter, or of widely scattered smaller drops. May be distinguished from drizzle by the fact that drops are scattered. Rain is associated with the following cloud types; Altostratus, Nimbostratus, Stratocumulus, Cumulus and Cumulonimbus. Rain does not include drizzle or intermittent light showers. Persistent light showers, intermittent medium or heavy showers or more intense forms of precipitation are considered rain.
Rill erosion	The removal of soil by numerous small channels, generally less than 5 cm in depth, but may be as deep as 30cm.
Rut	A rut is a depression in the soil surface initially caused by the passage of machine tyres or tracks over the soil surface. Rut development may also involve the processes of soil removal, mixing and puddling.
Scalping	Removal of a layer of soil. Typically caused by scraping of the soil surface.
Sheet erosion	The movement of a thin, fairly homogeneous layer of soil material by surface runoff.
Soil compaction	The process by which soil particles are rearranged, resulting in a decrease in void space and causing closer contact with one another, thereby increasing bulk density. Soil compaction can result from applied loads, vibration or pressure from harvesting or site preparation equipment. Compaction can cause decreased tree growth, increased water runoff and erosion.
Soil damage	An undesirable level of soil disturbance.

Term	Definition / Description
Soil disturbance	Any range of events affecting the condition of the soil in an area. Soil disturbance may be natural (e.g. fire) or human induced (e.g. timber harvesting) and may be beneficial (e.g. facilitating establishment of seedlings) or detrimental (e.g. causing compaction).
Soil disturbance categories	**Undisturbed** – characterised by an intact litter layer. **Lightly disturbed** – characterised by the litter layer being disturbed or a light disturbance to the topsoil. **Moderately disturbed** – characterised by the topsoil mixed with subsoil or the topsoil partially removed. **Severely disturbed** –by the topsoil completely removed and subsoil exposed or the topsoil mixed with subsoil, or the subsoil disturbed, or subsoil mixed with parent material or soil at greater than 50cm depth, or the subsoil partially removed. **Very severely disturbed** – Disturbance that involves parent material or soil layers that are greater than 50cm below the soil surface (excluding caprock), or meets any of the definitions of very severe soil disturbance in Appendix 3.
Trafficability Index (TI_{SDI})	A predictor of the deficiency of soil moisture in a hypothetical soil profile having 200 mm capacity. The predictor uses rainfall input, run-off, evaporation and transpiration by plants. The measure is zero when soils are at field capacity and 2000 when completely dry.
Soil mixing	When soil horizons such as the topsoil and subsoil are mixed.
Subsoil	The layer of soil below the topsoil, which is lacking in organic matter. It is typically a lighter colour than the topsoil and may also have a higher clay content, or be a clay layer.
Thinning	A felling made in an immature stand usually for the purpose of improving the growth of trees that remain without permanently breaking the canopy and encouraging regeneration. Thinning can also have other purposes such as water production.
Timber harvesting	The cutting, felling, and gathering of forest timber undertaken as part of a planned sequence of silvicultural activities including the regeneration of the forest.
Topsoil	The uppermost layer of soil beneath the litter that is darkened by the organic matter which has been incorporated into the soil and contains the majority of fine roots.
Turbidity	Discoloration of water due to suspended solids, dissolved solids, chemicals, algae etc.

[1] Department of Science, Bureau of Meteorology 1975, "Manual of Meteorology (Part 1) - General Meteorology", Australian Government Publishing Service, Canberra.

Appendix 2: Soil disturbance limits prescribed in the Forest Management Plan 2004-2013.

Type of disturbance	Measure	Limit
Very severe soil disturbance Visual soil disturbance - defined as the subsoil removed and parent material exposed or subsoil mixed with parent material.	For all areas other than landings, the percentage of the total area impacted.	0 per cent
	For landings, the area of landings impacted as a percentage of the total harvest area.	1.5 per cent in jarrah
		1 per cent in karri thinning
		3.5 per cent in karri clearfall
		No soil mixing to occur
	For rutting, the depth and length of the rutting.	150mm maximum depth for gravel and sand soils, 300mm maximum depth for other soils; depths not to be exceeded over a cumulative length of 20 metres of extraction track for the feller's block.
	Erosion	Erosion control measures installed as per Contractors Timber Harvesting Manual for South West Native Forests and only minor erosion occurs and is limited to between erosion control measures.
Severe soil disturbance* Visual soil disturbance - defined as the topsoil completely removed and the subsoil exposed or the topsoil mixed with subsoil (B horizon), or the subsoil disturbed, or the subsoil mixed with parent material, or the subsoil partially removed.	For all areas other than landings the percentage of the total area impacted.	2 per cent in jarrah
		1 per cent in karri thinning
		1 per cent in karri pre-logging
		2 per cent in karri clearfall (including pre-logging)
	Landings, rutting and erosion.	As for the limits of the "very severe visible soil disturbance" category.
Moderate soil disturbance* Visible soil disturbance - defined as the topsoil mixed with subsoil (A horizon) or the topsoil partially removed.	For all areas other than landings the percentage of the total area impacted.	8 per cent in jarrah
		8 per cent in karri thinning
		5 per cent in karri pre-logging
		15 per cent in karri clearfall (including pre-logging)
	Landings, rutting and erosion.	As for the limits for the "very severe visible soil disturbance" category.

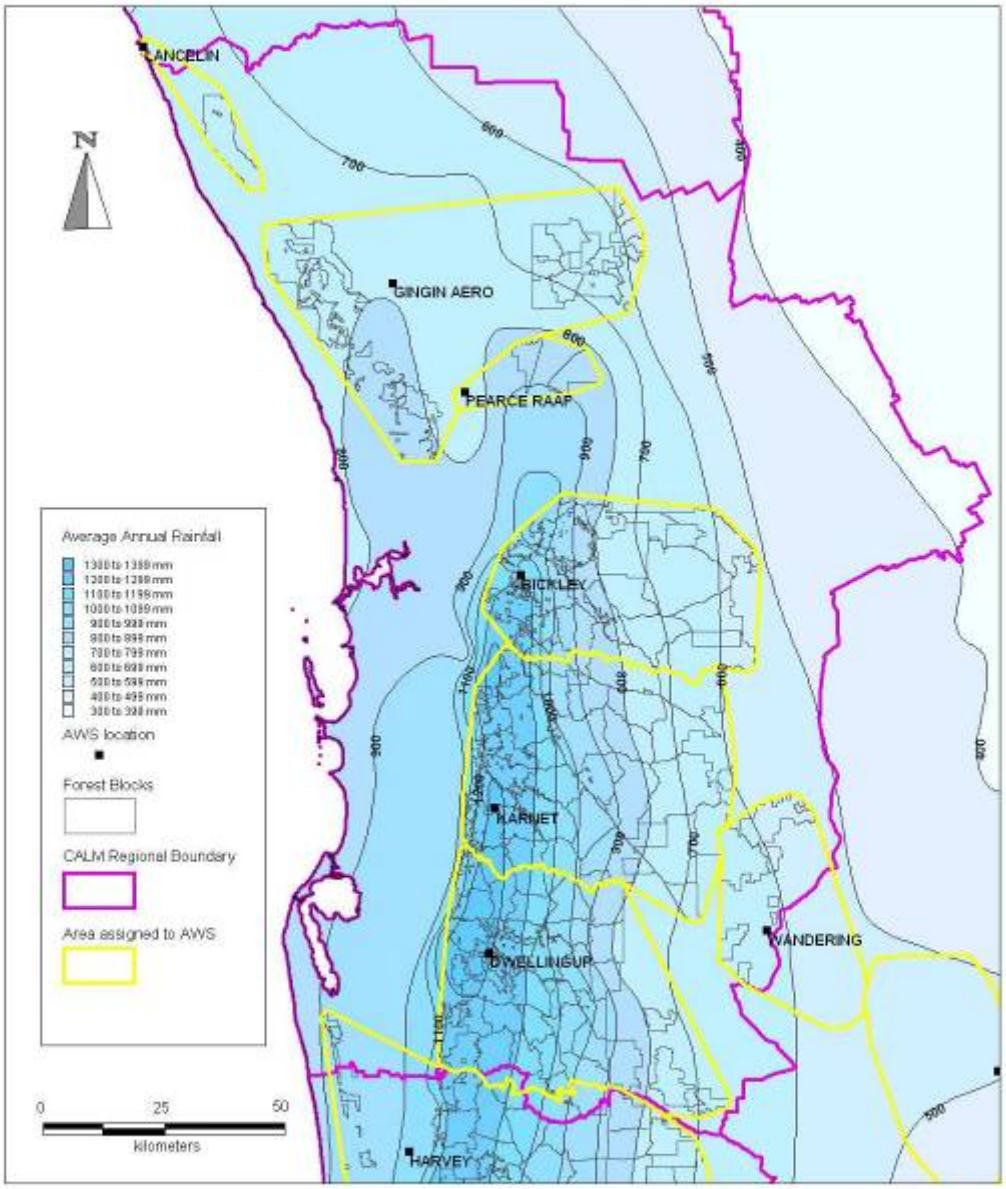
* Allowable limits are inclusive of those for higher levels of soil disturbance i.e. 8 per cent of moderate soil disturbance in jarrah is to include any occurrence of severe or very severe soil disturbance.

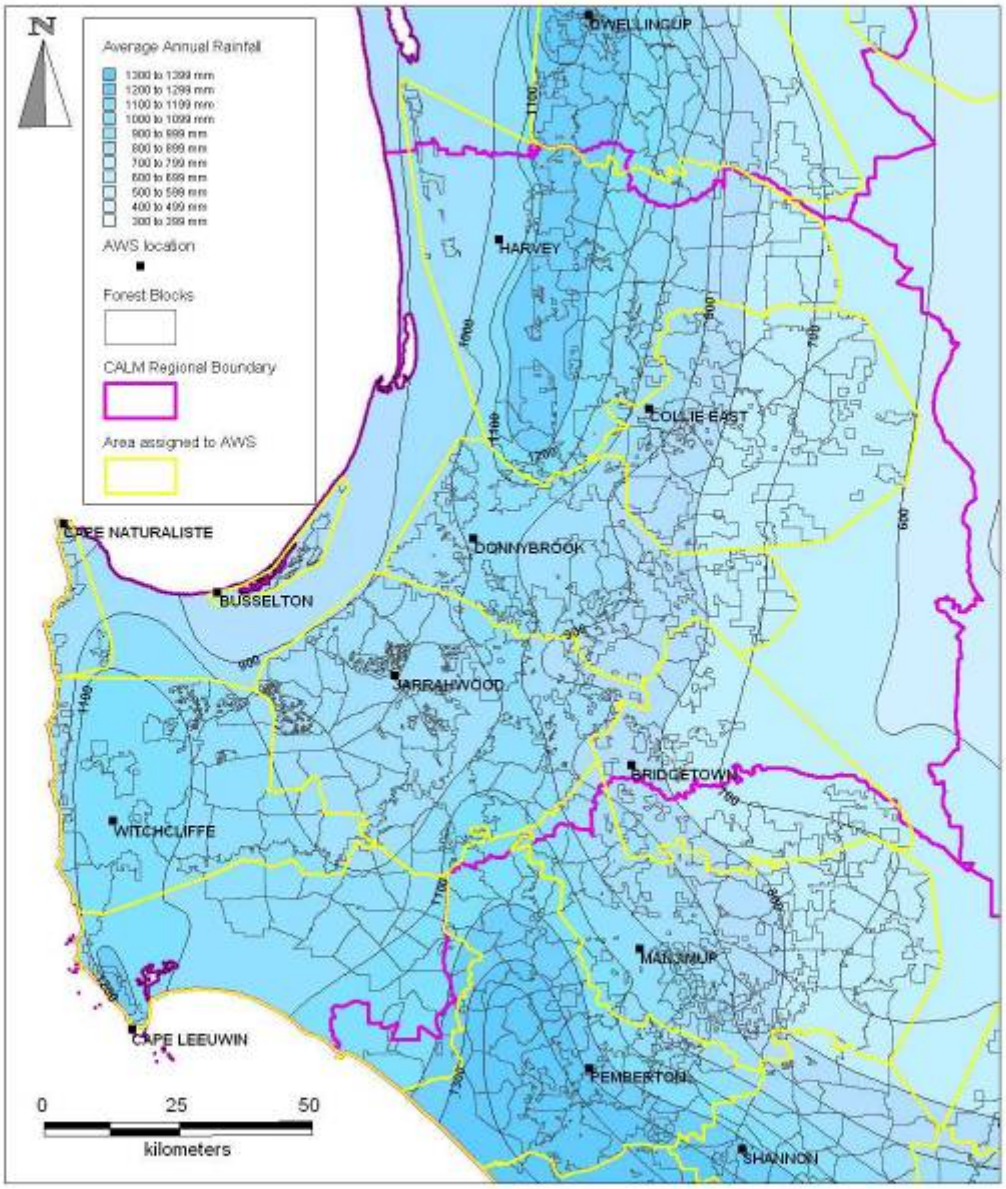
The Director, Sustainable Forest Management Division or a delegate will have the authority to set more specific rutting depth thresholds for particular soil types, and the Conservation Commission will be notified when this occurs.

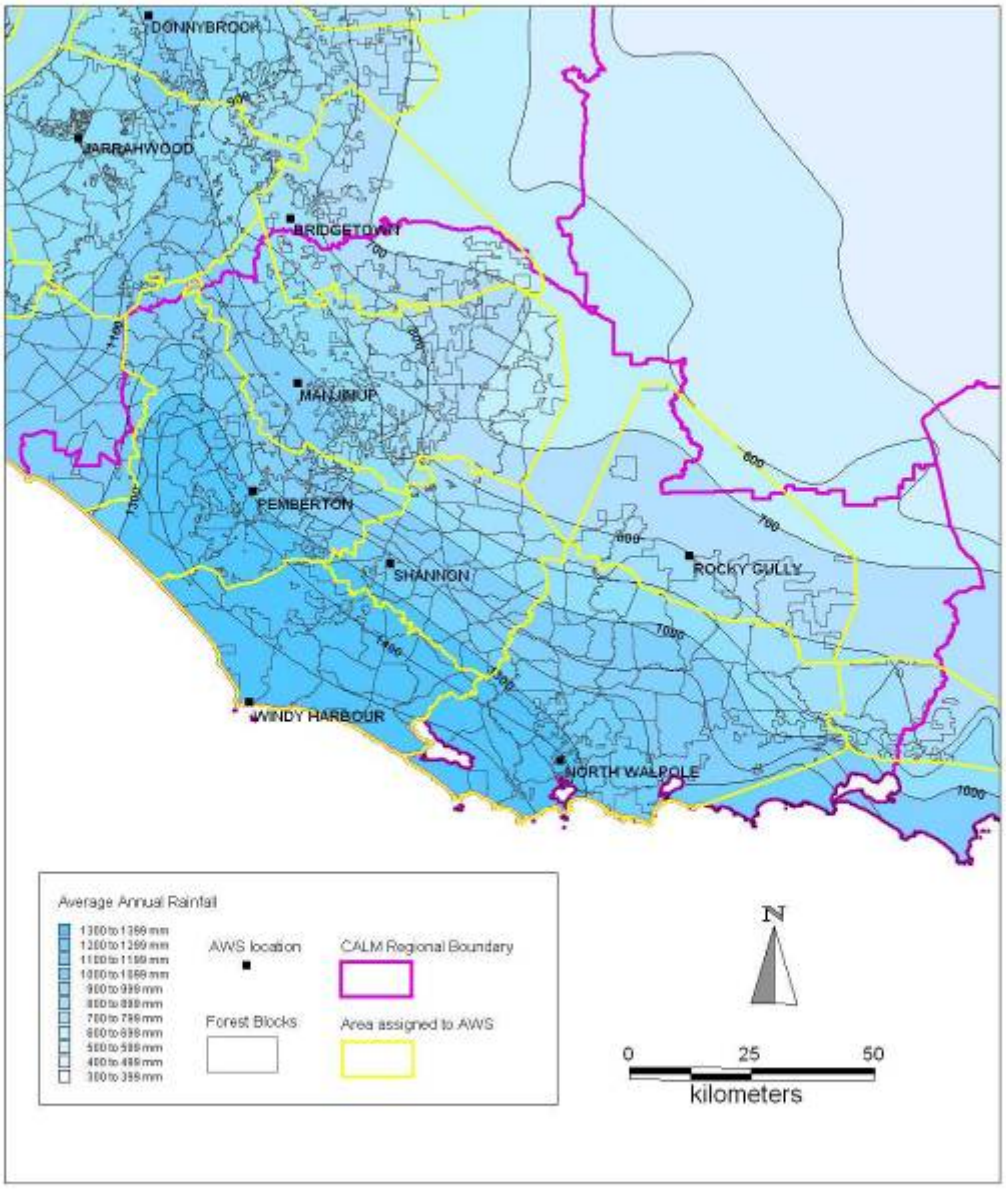
Appendix 3: Summary of very severe soil disturbance thresholds.

Type	Situation	Threshold
Rutting	Gravel and sand soils	A cumulative length of 20 metres of significant ruts on extraction tracks for an individual feller's block (Significant ruts are those with a maximum depth greater than or equal to 150mm which occur over a length greater than or equal to 5m).
	other soils	A cumulative length of 20 metres of significant ruts on extraction tracks for an individual feller's block (Significant ruts are those with a maximum depth greater than or equal to 300 mm which occur over a length greater than or equal to 5m).
Erosion	Rill erosion: in harvest cell (excluding extraction track)	>20mm deep; and >10m in length; or >100m^2 in extent.
	Rill erosion: extraction tracks	>50mm deep; and >15m in length; or >100m^2 extent; or Erosion has breached the erosion control barriers.
	Rill erosion: Roads, boundary tracks and table drains	>10cm deep that are not controlled, repaired or maintained
	Gully erosion: In coupe / extraction tracks	>30cm deep
	Gully erosion: Roads, boundary tracks and table drains.	>30cm deep
Deposition		A single deposition >30m^2 in extent; or any deposition from major erosion.
Turbid runoff		Where turbid runoff is not contained within the coupe, or within the filter strips, and reaches the watercourse.
Scalping	Shallow scalping over an extensive area	Unauthorised removal of the topsoil over an area > 50 m^2
Hole from tree pulling or pushing		Repeated exposure of soil to a depth of >50cm caused by unauthorised pulling or pushing of a tree e.g. > 10 x per fellers block.

Appendix 4: Weather stations used to estimate the Trafficability Index (TI_{SDI}) across the Swan, South West and Warren Regions.




N
Average Annual Rainfall
1300 to 1399 mm
1200 to 1299 mm
1100 to 1199 mm
1000 to 1099 mm
900 to 999 mm
800 to 899 mm
700 to 799 mm
600 to 699 mm
500 to 599 mm
400 to 499 mm
300 to 399 mm
AWS location
Forest Blocks
CALM Regional Boundary
Area assigned to AWS
DWELLINGUP
HARVEY
COLLIE EAST
CAPE NATURALISTE
DONNYBROOK
BUSSELTON
JARRAHWOOD
BRIDGETOWN
WITCHCLIFFE
MANJIMUP
CAPE LEEUWIN
PEMBERTON
SHANNON
0
25
50
kilometers


DONNYBROOK
JARRAHWOOD
BRIDGETOWN
MANJIMUP
PEMBERTON
SHANNON
ROCKY GULLY
WINDY HARBOUR
NORTH WALPOLE
Average Annual Rainfall
AWS location
CALM Regional Boundary
Forest Blocks
Area assigned to AWS
N
0
25
50
kilometers

Appendix 5: Visual soil disturbance types.

Soil disturbance type	Code	Dominant soil layer	Level of mixing/removal
Undisturbed	D0	Litter	Litter layer intact.
Lightly disturbed	D1	Litter	Litter layer broken/partially removed.
		Topsoil	Litter completely removed and topsoil exposed.
		Topsoil	Litter mixed with topsoil.
		Topsoil	Topsoil disturbed.
Moderately disturbed	D2	Topsoil	Topsoil mixed with subsoil.
		Topsoil	Topsoil partially removed.
Severely disturbed	D3	Subsoil	Topsoil completely removed and subsoil exposed.
		Subsoil	Topsoil mixed with subsoil.
		Subsoil	Subsoil disturbed.
		Subsoil	Subsoil mixed with parent material or a soil layer below 50cm.
		Subsoil	Subsoil partially removed.
Very severe disturbance	D4	Parent material or subsoil below 50cm depth	Subsoil removed and deeper soil layer exposed, or subsoil mixed with parent material or soil layer below 50cm. See categories of very severe disturbance in Appendix 3.

Appendix 6: Photographic examples of classification of soil disturbance.

Undisturbed (D0) level of soil disturbance
- characterised by an intact litter layer

Lightly disturbed (D1) level of soil disturbance
- characterised by the litter layer being disturbed or a light disturbance to the topsoil; see Appendix 5: Visual soil disturbance types

Moderately disturbed (D2) level of soil disturbance
- characterised by the topsoil mixed with subsoil or the topsoil partially removed; see Appendix 5: Visual soil disturbance types

Severely disturbed (D3) level of soil disturbance
- characterised by the topsoil completely removed and subsoil exposed or disturbance involving the subsoil or involving soil at greater than 50cm depth; see Appendix 5: Visual soil disturbance types

Very severely disturbed (D4) level of soil disturbance
- disturbance that involves parent material or soil layers that are greater than 50cm below the soil surface (excluding caprock), or meets any of the definitions of very severe soil disturbance in Appendix 3 or Appendix 5

Primary extraction track – default rating is severely disturbed (D3)

Secondary extraction track – default rating is moderately disturbed (D2)

Tertiary extraction track – default rating is lightly disturbed (D1)

Mounding resulting in lightly disturbed (D1) level of soil disturbance

Mounding resulting in moderately disturbed (D2) level of soil disturbance

An example of major water related erosion

An example of major water related deposition

Appendix 7: Excerpt from the Forest Products Commission *Contractors' Timber Harvesting Manual, South West Native Forest*

(January 2003 with subsequent amendments)

Section 4.2.2 Soil

EROSION CONTROL

1. Harvesting contractors must be aware of the potential for soil erosion along firebreaks, extraction tracks and roads during wet weather.
2. Erosion control work will be carried out at any time during the course of harvesting, if rainfall is imminent. Erosion work will be carried out on at the cessation of extraction if rainfall is imminent.
3. When extraction is completed in any feller's block or during temporary cessation of extraction, and prior to machinery leaving, interceptor banks and drains must be constructed across all extraction tracks and disturbed firebreaks with exposed soil, to the standards tabled below.
4. The purpose of these standards is to reduce the speed of water running uninterrupted down extraction tracks, firebreaks and temporary roads. The erosion control specifications are designed to reduce flow and turbidity.

EROSION CONTROL BARRIERS

Specifications for Spacing of Erosion Barriers (metres)		
Slope	**On lateritic gravelly Soils**	**On all other soils**
0-2°	Nil	Nil
3-5°	200	100
6-10°	100	50
11-15°	60	30
16°+	30	15

Specifications for Size and Angle of Erosion Barrier			
Size		**Angle**	**Water Dispersal**
Height	**Width**		
40 cm	40 cm	3%-5%°	Water directed from extraction track into nearby vegetation or trash that can slow the movement of water.

Appendix 8: Sketch map for monitoring of soil disturbance

District:_____ **Block/ Coupe:** _____ **Cell No.:** _____

Contractor: _____ **TI_{SDI}:** _____ **Risk Period:** _____ **Page _ of ___**

Provide a sketch map of the feller's block, landing, extraction tracks, transects and other key features.

Prepared by: Date:

Last updated: 17 November 2010
Custodian: Manager, Forest Policy and Practices Branch
Approved by: Director, Sustainable Forest Management Division

Appendix 9: Surveillance of soil disturbance

Department of Environment and Conservation	SURVEILLANCE OF SOIL DISTURBANCE	DECSFM005

District:_____ **Block/Coupe:**_____ **Cell N°** _____

Contractor:_____ **Type of Operation** (specific to the cell being monitored)**:**_____

Officer:_____ **Agency:** _____

Cell Layout and Planning	Yes	No	Comment
Is the extraction network planned on a sketch map?			
Is the extraction network demarcated in the field?			

Landing Management	No. 1	No. 2*	No. 3*
Area of Feller's Block(ha)			
Av width of landing (m)			
Av length of landing (m)			
Landing area (ha)			
Landing as % of feller's block			
Is the landing area outside the allowable limits? If yes, indicate reasons and any action required			

*K thin only

Total landings %

GPS Co-ordinates of each landing	
No. 1	
No. 2*	
No. 3*	

Allowable limits for landing area (%):		
Karri thin 1.0	Karri C/F 3.5	Jarrah 1.5

TI_{SDI}										
Risk Period										
Date										

Landing Management	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Is the landing ineffectively drained?										
Is there erosion or deposition at the landing? If yes, complete survey of rutting and erosion										
Is there rutting or soil mixing on the landing? If yes, complete survey of rutting and erosion										
Is landing management unsatisfactory? If yes explain why										
Is remedial action required? If yes, specify										

Condition of Extraction Tracks	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Is there rutting on the extraction tracks? If yes, survey of rutting and erosion is required										
What type of rutting is occurring? If yes, circle compression/failure of soil strength										
Is there erosion/deposition on extraction tracks? If yes, survey of rutting and erosion is required										
Are there gouges on extraction tracks?										
Are there areas of cording in poor condition?										
Are operations compliant with the demarcated layout?										
Is remedial action required? If yes, specify										

In Coupe	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Is there any severe/very severe soil disturbance? If severe, long formal survey. If very severe, stop										
Is there significant rutting? If yes, circle - compression/ failure of soil strength										
Is there major erosion or deposition? If yes, stop										
Is turbid water exiting the feller's block?										
Is remedial action required? If yes, specify										

Road and Perimeter Tracks	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Is there evidence of poor drainage? If yes circle – Erosion/ Debris/ Siltation/ Channels/ Deposition										
Is there major erosion or deposition? If yes, stop										
Is remedial action required? If yes, specify										

Approved Plan	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Is the operation compliant with the approved plan/conditions?										
If no, specify action required										

Appendix 10: Survey of rutting and erosion

District:_____ **Block/ Coupe:** _____ **Cell No.:** _____

Contractor: _____ **Risk Period:** _____ **Page ___ of ___**

		Rut Number[1]											
Coordinates		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Coordinates**	
MGAE												**MGAE**	
MGAN												**MGAN**	
Soil Type												**Soil Type**	
Date	**TI_{SDI}**	**Length of Significant Rut (m)**										**Total**	**Officer**

[1] **Once a rut becomes a "significant rut" then a rut number will be assigned. Non-significant ruts may be mapped at the officer's discretion.**

Coordinates		**Erosion Number** [2]															
		1			**2**			**3**			**4**			**5**			
MGAE																	
MGAN																	
Erosion Type																	
Date	**TI_{SDI}**	**Depth (cm)**	**Length (m)**	**Area (m2)**	**Depth (cm)**	**Length (m)**	**Area (m2)**	**Depth (cm)**	**Length (m)**	**Area (m2)**	**Depth (cm)**	**Length (m)**	**Area (m2)**	**Depth (cm)**	**Length (m)**	**Area (m2)**	
Remedial action																	
Date Completed																	

[2] **Record occurrences of both minor and major requiring remedial action (see Table 5)**

Is the use of old extraction tracks being maximised? Yes / No (Please circle)

Officer_____ Agency:_____ Date: _____

DEC SFM 006

Appendix 11: Soil disturbance types and booking codes for use in a long transect survey of visible soil disturbance

Booking Code	Soil disturbance types
	Visible soil disturbance categories
DU	Unharvested patch
D0	Undisturbed soil
D1	Lightly disturbed
D2	Moderately disturbed
D3	Severely disturbed
D4	Very severely disturbed
	Extraction tracks
EP(*)	Primary extraction track, including corded and brushed, and /or those sections of a secondary extraction track that are >300m in length when measured from the back of the coupe.
ES(*)	Secondary extraction track, including corded and brushed, as designated by coupe concept plan or extraction track 'hierarchy', as well as by usage of machine harvesters to access areas of the coupe.
EX(*)	All other extraction tracks
(*)	* number entered if non-default rating (see Appendix 12)
	Rutting
RT2	Rut shallower than the allowable depth threshold
RT3	Rut deeper than the allowable depth threshold, but shorter than the length threshold
RT4	Single rut greater than the allowable threshold
	Erosion or Deposition (water related)
ED1	Minor erosion or deposition
ED2	Minor erosion or deposition requiring action
ED4	Major erosion or deposition
	Other Mechanical Disturbance
RK2	Displaced rock
ST3	Uprooted or displaced stump
M1	Mounding involving deposited topsoil < 15cm in depth
M2	Mounding involving deposited topsoil > 15cm in depth or deposition of any subsoil
M3	Mounding involving topsoil and subsoil deposition > 40cm in depth.
	Current Timber harvest disturbance
R	Road/Turnaround (part of the current timber harvesting activity)
L	Current landing
ON0	Other non-soil types (such as undisturbed rock, log or stump)
	Non-current timber harvest activity
OET	Old extraction track
OR	Old road / tramway
OL	Old landing
O	Other

Appendix 12: Default and potential categories of soil disturbance on extraction tracks

Extraction track booking codes	Soil disturbance categories				
	Undisturbed (D0)	**Lightly disturbed (D1)**	**Moderately disturbed (D2)**	**Severely disturbed (D3)**	**Very severely disturbed (D4)**
EP (*)				**Default-EP3**	Potential – EP(4)
ES (*)		Potential – ES(1)	**Default – ES2**	Potential – ES(3)	Potential – ES(4)
EX (*)		**Default – EX1**	Potential – EX(2)	Potential – EX(3)	Potential – EX(4)

* number entered if non-default rating

EP: Primary extraction track is the main extraction track leading into a landing, and /or those sections of a secondary extraction track that are >300m in length from the back of the harvest cell. The default category of soil disturbance is severely disturbed (D3). Soil disturbance may also be upgraded to D4 – EP(4) where higher levels of disturbance are observed to have occurred.

ES: Secondary extraction track is defined by extraction track layout as well as by usage of machine harvesters to access areas of the harvest cell. The default soil disturbance category is moderately disturbed (D2). If visual inspection of soil disturbance clearly shows the disturbance to be lightly disturbed (D1), the soil disturbance category may be downgraded to D1 on the transect survey e.g. recorded as ES(1). Soil disturbance may also be upgraded to D3 – ES(3) or D4 – ES(4), where higher levels of disturbance are observed to have occurred.

EX(*): All other extraction tracks. The default soil disturbance category will be lightly disturbed (D1) however soil disturbance can be upgraded to D2 – EX(2), D3 – EX(3) or D4 – EX(4), where higher levels of disturbance are observed to have occurred.

The use of the default code for primary and secondary extraction tracks enables the assessed values of a transect survey to remain relevant as harvesting continues through a fellers block. If harvesting progresses from the roadside towards to back of the block, it is likely that the intensity of disturbance on the major extraction tracks will increase over the course of harvesting. The use of the default code for primary and secondary extraction tracks enables the assessed values of a long transect survey to remain relevant as harvesting continues through a fellers block. If harvesting progresses from the roadside towards to back of the block, it is likely that the intensity of disturbance on the major extraction tracks will increase over the course of harvesting. The alternative of using the observed value (e.g. ES(1)) in a long transect survey of visible soil disturbance means that the results cannot be “re-used” as part of a subsequent long transect survey of visible soil disturbance, as it may understate the subsequent level of disturbance. Therefore the transect will have to be surveyed again resulting in a duplication of effort in completing transect surveys of visible soil disturbance.

Appendix 13: Field booking sheet for long transect survey of visible soil disturbance

District:_____ **Block/ Coupe:** _____ **Cell No.:** _____

Contractor: _____ **TI_{SDI}:** _____ **Risk Period:** _____ **Page** ___ **of** ___

Transect No.	GPS start				Bearing (^{0})	GPS finish				Length (m)
	MGAE		MGAN			MGAE		MGAN		

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125
126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175
176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200
201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225
226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250
251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275
276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300
301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325
326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350
351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375
376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400
401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425
426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448	449	450
451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475
476	477	478	479	480	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500

Officer:_____ **Agency:** _____ **Date:** _____

DEC SFM 007

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Custodian: Manager, Forest Policy and Practices Branch
Approved by: Director, Sustainable Forest Management Division

Appendix 14: Analysis sheet for a long transect survey (data from *Long transect survey of visible soil disturbance* Appendix 13)

Date:	**District:**	**Block/ coupe:**
Officer:	**Agency:**	**Cell no.:**
TI_{SDI}:		**Risk Period:**

Disturbance Category and Booking Codes			**Transect Number**				
			1	**2**	**3**	**4**	**5**
Unharvested, previous disturbance or current harvesting infrastructure excluded from calculations.		DU					
		OET					
		OR					
		OL					
		O					
		L					
		R					
Undisturbed	D0	D0					
		ON0					
Total[1]							
Lightly disturbed	D1	D1					
		ED1					
		ES(1)					
		EX1					
		M1					
Total[1]							
Moderately disturbed	D2	D2					
		ES2					
		EX(2)					
		M2					
		RT2					
		RK2					
		ED2					
Total[1]							
Severely disturbed	D3	D3					
		EP3					
		ES(3)					
		EX(3)					
		RT3					
		M3					
		ST3					
Total[1]							
Very severely disturbed	D4	D4					
		EP(4)					
		ES(4)					
		EX(4)					
		RT4					
		ED4					
Total[1]							
Total[2]							

[1] Sum Count for the particular disturbance types within the category

[2] Sum count for all disturbance categories (D0+D1+D2+D4) on the transect

Data from this summary can be transferred to Appendix 15 - DEC SFM 009 for calculation of disturbance level.

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Appendix 15: Summary sheet for a long transect survey of visible soil disturbance (data from *Long transect survey of visible soil disturbance* Appendix 13)

Date:	**District:**	**Block/ coupe:**
Officer:		**Cell no.:**
TI_{SDI}:		**Risk Period:**

	Unharvested previous disturbance or landing.	**Undisturbed**	**Lightly disturbed**	**Moderately disturbed**	**Severely disturbed**	**Very severely disturbed**
		D0	**D1**	**D2**	**D3**	**D4**
Applicable booking codes	DU, OET, OR, OL, O, L, R	D0, ON0	D1, ED1, ES(1), EX1, M1	D2, ES2, EX(2), M2, RT2, RK2, ED2	D3, EP3, ES(3), EX(3), RT3, M3, ST3	D4, EP(4), ES(4), EX(4), RT4, ED4
Transect						
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						
31						
32						
33						
34						
35						
Sum Count						
Sum Count				D2 to D4=	D3+D4=	
Total % [1]				D2 to D4=	D3+D4=	

[1] Total % = Sum Count for the particular disturbance category / Sum count for all disturbance categories (D0+D1+D2+D3+D4)* 100

Appendix 16: Verification of plan to access areas in the Medium to high (not transitional) and High risk periods

District:_____ **Block/ Coupe:** _____ **Cell No.:** _____

Contractor: _____ **TI_{SDI}:** _____ **Risk Period:** _____ **Page _ of __**

Before Commencement (Recommended for FPC use)

	Yes	No
Are special treatments to protect soil (cording, matting, brushing or avoidance of susceptible areas) that are required by the approved plan are in place?		
Is the method of harvest as required by the approved plan?		
Are the heavy vehicles being used for harvesting as required by the approved plan?		
Is the management of landings as required by the approved plan?		
Is the use of old extraction tracks maximised?		

Weekly (For FPC or DEC use)

	Yes	No
Are the silvicultural methods as required by the approved plan?		
Is dieback management as required by the approved plan?		
Are access routes as required by the approved plan?		
Is the condition of landings as required by the approved plan?		
Is the management of landings as required by the approved plan?		
Are the heavy vehicles being used for harvesting as required by the approved plan?		
Is the method of harvest as required by the approved plan?		
Are the special treatments to protect soil required by the approved plan in an appropriate condition?		
Is the use of old extraction tracks being carried out as planned?		

Is the extraction track pattern compliant with the approved plan? (tick one of the following three options);

1. Compliant;	
2. Variation that <u>does not threaten</u> disturbance limits or cause duplication, parallel or criss-crossing tracks unless under exceptional circumstances; or	
3. Variation that <u>does threaten</u> disturbance limits or cause duplication, parallel or criss-crossing tracks unless under exceptional circumstances.	

Officer:_____ **Agency:** _____ **Date:** _____

Officer:_____ **Agency:** _____ **Date:** _____

Officer:_____ **Agency:** _____ **Date:** _____

Officer:_____ **Agency:** _____ **Date:** _____

Officer:_____ **Agency:** _____ **Date:** _____

DEC SFM 010

Appendix 17: Verification of plan to access landings in the High risk period

District:_____ **Block/ Coupe:** _____ **Cell No.:** _____

Contractor: _____ **TI_{SDI}:** _____ **Risk Period:** _____ **Page _ of __**

Before Commencement (Recommended for FPC use)

	Yes	No
Is the management of landings as required by the approved plan?		

Weekly (For FPC or DEC use)

	Yes	No
Is the condition of landings as required by the approved plan?		
Is the management of landings as required by the approved plan?		
Are the heavy vehicles / machinery used on the landing as required by the approved plan?		
Is dieback management as required by the approved plan?		
Are access routes as required by the approved plan?		

Officer:_____ **Agency:** _____ **Date:** _____

Officer:_____ **Agency:** _____ **Date:** _____

Officer:_____ **Agency:** _____ **Date:** _____

Officer:_____ **Agency:** _____ **Date:** _____

Officer:_____ **Agency:** _____ **Date:** _____

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Approved by: Director, Sustainable Forest Management Division

Appendix 18: List of equipment for a long transect survey of visible soil disturbance

The transect survey of visible soil disturbance requires the following equipment and items:

- GPS;
- Marking paint if required;
- Compass;
- 100 m tape or hipchain;
- Soil disturbance categories (Appendix 5);
- Field booking sheet for a long transect survey of visible soil disturbance (Appendix 13);
- Sketch map for transect survey of visible soil disturbance (Appendix 8)
- Soil disturbance categories and booking codes for use in a long transect survey of visible soil disturbance (Appendix 11);
- Extraction track default categories and booking codes (Appendix 12);
- Summary sheet for a long transect surveys of soil disturbance (Appendix 15);
- Flagging tape; and
- Map of feller's block.