

# **Code of Practice for Timber Harvesting**

**2nd edition**



**Guyana Forestry Commission**

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# **I INTRODUCTION**

## **1.1 Sustainable Forest Management**

Traditionally, sustainable forest management meant that no more timber should be harvested than what would be accumulated naturally between successive cuts thus focusing on yield regulation but not on harvesting methods. Forestry has changed a lot in recent times: the trade in wood products has expanded enormously, new wood-based products have been developed and timber extraction has become increasingly mechanised. These changes led to higher logging intensities and to more damage to the forest.

This in turn led to global concerns regarding tropical forest degradation and tropical forest harvesting practices in particular because of perceived negative impacts on the forest ecosystem and environment, particularly with respect to the residual stand and soil, as well as to the regeneration capacity and water quality. On the other hand, the concept of sustainable forest management now recognises the importance of other products and services provided by the forests, such as protection of water quality, soils, biodiversity, and the livelihood of people that live or work in the forest. One of the consequences to these concerns is that the international marketplace is becoming increasingly sensitive to wood products being certified or not. Consumers and retailers alike around the world are now seeking reassurance about the management of the forest that supply the wood products they are purchasing.

Guyana's response to these concerns has been to develop principles, policies and guidelines for improved forest management and timber harvesting practices. This is reflected in the new forest policy, forest legislation, forest management guidelines and codes of practice.

In itself, a Code does not ensure sustainable forest management. However, with effective implementation through reduced-impact logging guidelines, participation in the planning process by all stakeholders, and integration with other sustainable forest management instruments – particularly yield regulation, the Code will assist in minimising negative impacts of timber harvesting.

Many forest operators believe that environmental protection can only be achieved through expensive measures that will make timber harvesting uneconomic. However, the evidence from several studies and experienced operators elsewhere who carry out effective planning and undertake operations as specified in their plans, indicate that operational control is improved and environmental impact reduced. This in turn has been shown to lead to reduced costs and increased profits.

## **1.2 Development of the Code**

The Code contains practices and sets standards, which have been developed based on ongoing research and practical experience locally and abroad over a period of eight years.

The first draft of the Code was produced in 1994. After a process whereby views and inputs from various stakeholders were obtained and tests at the practical level conducted, the first Code of Practice for Forest Operations became operational on a voluntary basis in October 1998. The FAO Model Code of Forest Harvesting Practice and the Fiji National Code of Logging Practice formed the basic framework for the first edition. While the GFC continued to collect baseline data, Codes of Practices were being published in several parts of the world. Based on the new information the first edition was extensively reviewed and revised in 2001. The latest edition takes into account the results of experience, research, and independent reviews, most notably a field test of the Code carried out by Tropenbos in collaboration with Iwokrama and the GFC, which included cost monitoring of all stages.

The Code should not be seen as a static document. It is inevitable that the code will need to be updated as technical knowledge is augmented, new technologies are introduced and operating standards improve. Therefore, the Code will be kept under regular review and the results of research; field experience and public input will be used to make progressive improvements so that environmentally sound, socially responsible and economically acceptable production forestry can be maintained

## **1.3 Scope and Coverage of the Code**

The Code provides guidelines and standards that, if followed, will allow Guyana's forests to be harvested with minimal adverse impact on the forest environment. It provides the basis for ensuring that a continuing economic return can be obtained from forests on the long term and is designed to balance commercial considerations with protection of environmental and social values. Implementation of the guidelines and standards will help ensure that important resources and values are recognised and protected during timber harvesting operations.

The Code expresses GFC's vision for all logging operations in Guyana, including TSAs, WCLs and SFPs. The GFC wants all companies to show progress towards compliance to the provisions set out in this document. These will be legally binding for newly issued TSAs, whilst selected elements may be made mandatory for existing licences by order of the Commissioner of Forests. It should be realized that both TSA and WCL operations are legally covered by the Forest Management and Annual Operating Plans. These plans in turn shall be prepared in accordance with this Code. Forest operators that have not prepared any operational plans, or whose plans have not been approved, will be monitored against the provisions in this Code. Certain exemptions may apply to small-scale operators (SFPs).

In legal terms the Code should be regarded as:

- GFC's vision on what constitutes satisfactory felling, extraction, road building, and other timber harvesting practices
- GFC's requirements for preparation of Forest management and Operational Plans and implementation of these plans

Ground-based extraction by tractors (i.e. skidders, farm tractors, bulldozers), with truck transportation to log yards or river landings, is the standard timber harvesting technology for most of Guyana's forests. The provisions of the Code apply specifically to this kind of harvesting system. A considerable number of merchantable species are riparian species; e.g. Mora, Crabwood, White Cedar. Provisions of the Code put restrictions on harvesting from such areas. Extraction by hand or by way of floating of logs is occasionally applied in such cases and may be acceptable under certain circumstances.

This Code of Practice for Timber Harvesting does not cover the utilisation of non-timber forest products nor forest management for other purposes such as eco-tourism or 'conservation concessions'. Codes for the harvest of selected non-timber species; i.e. for Kufa, Nibi and Manicole, have been developed recently. Timber harvesting operations should recognise and consider the provisions of these codes in the preparation of their management and operational plans

There are two different types of statements in the code: 'shall' (in some cases phrased as an imperative) and 'should' statements. The 'shall' statements are to be applied in a practical manner to all logging operations. The 'should' statements show the desirable practice for most situations and should be interpreted taking account of local conditions.

The Code will not be applied with retroactive effect to past activities. However, operators that intend to move into an area that has been logged before should be aware that existing roads, log markets, bridges and other infrastructure that do not meet current Code provisions, and that are causing or likely to cause significant environmental damage, will have to be upgraded to rectify these problems. Significant environmental damage includes one or all of the following: an increase in watercourse turbidity, blockage of watercourse channels, slumping or deposition of sediment and/or other materials into watercourses, significant active erosion of road drainage facilities and/or road surface.

## **1.4 Objectives**

The objectives of the Code of Practice for Timber Harvesting are to:

- Safeguard the environment within Guyana's State Forest area and neighbouring and downstream resources
- Maintain a healthy and productive forest, with the capacity to regenerate high value species

- Protect soil and water resources
- Protect sites that have cultural, historic, spiritual and archaeological value
- Provide forest operators with a set of guidelines and standards for improved forest harvesting practices
- Improve the health and safety of forest workers
- Provide a framework for effective control of timber harvesting operations with predetermined guidelines and benchmarks

## **1.5 Implementation**

The Code will be implemented in stages. The Code will first be implemented on a voluntary basis to allow the industry time to adjust to the changes, to develop further management capacity and to train supervisors and operators. However, the GFC will monitor against the standards described in the Code immediately after its public release. The results of the monitoring will be evaluated to determine a forest operator's performance and will be made available to the public. Mechanisms will be put in place to reward compliance while non-compliance with critical standards may have penalties attached.

The final objective is to develop a feeling of ownership of the Code by all stakeholders, public recognition of what constitutes best practice, and a willingness among all forest operators to be subjected to external auditing to assess compliance. It is anticipated that through education on the required operating standards and the scientific reason behind these standards, operators gradually will become the supporters of improved forest practices and eventually self-regulation will occur.

The GFC realizes that the Code focuses on “what should be done” rather than “how to do the work”. The “how to” is the mechanism by which the Code is actually implemented in the field and involves for example, reduced-impact logging guidelines and silvicultural prescriptions for various forest types. The GFC is in the process of developing these additional mechanisms. Assistance in effecting training is another key component that is receiving attention from GFC.

## **II PLANNING REQUIREMENTS**

### **2.1 Forest Management Planning Hierarchy**

Forest Management Planning should be carried out across a range of hierarchical levels to ensure that the process is acceptable to all stakeholders. Broad scale planning is carried out by the GFC determining the boundaries of the State Forest Area, which areas may be allocated as TSAs, WCLs or SFPs, broad scale zoning of different land-uses, etc.

Sound planning includes biological, silvicultural, environmental, market, and financial and socio-economic considerations.

Forest Management Plans are required for TSAs and WCLs, whereas the GFC is in the process of preparing Area Management Plans for SFP areas. Planning at the concession level is a multi-tiered process in Guyana comprising three formal levels:

- Strategic planning covering the background, conditions and plans for the entire concession for the entire duration of the agreement, license or permit;
- Operational planning detailing the operations and activities to be carried out within a 5-year period; and
- Annual planning describing the previous year's activities and plans for the following year.

The Forest Management Plan Guidelines released by the GFC in 1999 provide a comprehensive basis for strategic and operational planning. All plans shall be made up in accordance with the Code of Practice for Timber Harvesting, whilst taking account of the Codes of Practice for Kufa, Nibi and Manicole Harvesting. Proper planning at both the strategic and operational level reduces environmental impact and operational costs.

Although not mandatory, it is recommended to undertake task planning describing the responsibilities of staff and how, where and when certain activities (e.g. road construction, inventory, felling, skidding) will be carried out.

## 2.2 Forest-Use Zoning

Forest-use zoning refers to the determination of land uses across forest areas and includes frameworks for deciding forest areas to be protected, areas available for timber production, as well as conversion to agriculture or multiple-use including NTFP extraction and (small scale) mining.

The 1997 National Forest Policy states that Guyana's forests should be divided into a number of classes to optimise the sustainable management of the country's forest resources. Seven classes are distinguished, including: permanent production, permanent protection, reserve, extractive (NTFPs), multiple-use, and permanent research and conversion forests. Extractive, multiple-use and permanent research forests can exist within permanent production forests.

Integrated land-use planning will recognise the multiple outputs of the permanent production forests and factor these into land-use decisions. Sustainable forest management involves protecting ecological, soil and nutrient resources so that the areas remain productive implying that there are limitations for sustainable use. These limitations depend on among others its biological value, its susceptibility to degradation, and how it is managed.

The first of these, the biological value, should determine whether a forest requires protection. Maintenance of biodiversity is of primary importance in flora and fauna conservation. It is dependent on the maintenance and restoration of habitat, enhancing opportunities for re-colonisation of disturbed areas, and by linking exclusion areas to allow genetic interchange. This may be achieved in the following ways:

- Setting aside formal and informal reserves within permanent production forests large enough to maintain viable populations of plants and animals
- Retaining areas of unlogged forest to maintain habitat diversity, connecting any formal or informal reserves. This could be based on streamside buffer strips but including corridors up slopes and across ridges to connect with watercourses in adjoining catchments. (Non-productive forest could be designated as such as well).
- Retaining habitat trees with nesting hollows in production areas where appropriate for wildlife
- Protecting rare and endangered species by modifying harvesting regimes or maintaining sections of unlogged forest
- Protecting representative areas of all forest types in conservation or reserve forests

GFC's Forest Management Plan Guidelines state that provisions must be made for the allocation of protected areas and buffer strips within logging concessions. There is an ongoing debate on the minimum size of each area as well as the total area of protection forest mainly related to a lack of comprehensive baseline data. It is possible that protection forests within permanent production forest will become part of the National Protected Area System. In the meantime, it is recommended to leave 4.5% of the forest untouched in blocks

exceeding 1000 ha. This fraction of 4.5% would include formally protected areas (biodiversity reserves) as well as streamside buffer strips, non-productive forest and areas excluded from logging due to a high risk of site degradation (see below).

Susceptibility to site degradation is another important criterion in determining whether there are limitations to the sustainable use of a forest area. Site degradation risks to consider are soil erodibility, susceptibility to nutrient loss, landslides and compaction (risk of loss in soil structure and/or strength). Soils with a high risk to degradation are soils with a low load bearing capacity when wet (high clay, low gravel content), poorly drained soils and soils falling in the high erodibility category.

As the susceptibility of sites to degradation increases, the upper slope limit, at which land can sustain any particular use, will decrease. Upper slope limits may be based on the results of soil loss modelling which account for the erodibility of a particular soil type, character and stability of the topography and the selected land-use option.

Site susceptibility to degradation is not too well known for Guyana's soils, but susceptibility to erosion and compaction can be considered high for most soils, except laterite and white sand soils. Until further research produces conclusive upper slope limits for different soil types for different landscapes and types of land-use, a uniform upper slope limit will be prescribed.

Poorly drained soils loose soil structure and strength when near saturation. Such sites should have strict wet weather restrictions.

Consultation with local stakeholders during the planning process is required to identify whether and where certain tree species are in demand for their use as NTFP-producers. Species to consider are: Bulletwood, Crabwood, Hog plum, Kokoritiballi, Sawari nut, Ubudi, while consultation may identify other NTFP-producing species. Similarly, consultation should take place in relation to harvesting of Kufa and Nibi. The Code of Practice for Kufa and Nibi Harvesting sets standards on the felling of host trees and sharing of information on the planned coupe six months in advance to allow harvesting of these NTFPs before logging.

## 2.3 Yield Regulation

In selective logging, harvesting is the main practical silvicultural tool where professional forester's inputs can be provided to ensure sustainable forest management. The current Forest Management Plan Guidelines prescribe an annual allowable cut of  $\frac{1}{3}$  m<sup>3</sup>/ha/yr with a maximum yield of 20 m<sup>3</sup>/ha on each occasion. This implies that a cutting cycle of 60 years is required to sustain a cut of 20 m<sup>3</sup>/ha. Inversely, to sustain a 25-year cutting cycle a maximum cut of 7½m<sup>3</sup>/ha is suggested for every cut. It is also suggested to limit the average logging intensity to 10 trees/ha – which translates to about 20 m<sup>3</sup>/ha, as well as to preserve certain species identified as 'keystone' species. These cutting levels are currently being applied to SFPs through the quota system.

However, these measures alone are insufficient to ensure sustained productivity of the (remaining) forest and to retain sufficient growing stock of most of the desirable, high value species.

Instead, sustained yields can only be ensured if a minimum stocking is retained after logging for each individual desirable species. GFC recently developed growth and yield models that can assist in determining the number of trees that can be felled per ha as well as the minimum size (diameter) for each individual species. This means that individual tree-marking rules need to be developed for each particular forest type under different stand conditions. Yield regulation is an area of active GFC policy and research.

The retention of habitat, NTFP-producing and seed trees needs also to be considered. In general, the retention of habitat trees does not interfere with logging practice at present, due to the current low logging intensity and the fact that hollowed trees are left untouched. In general, at least two trees per hectare of seed tree quality of each desirable, high value species should be retained per hectare. Quality seed trees are over 40 cm in diameter, well formed, straight with a bole length of at least six metres, free of defect and disease and undamaged. Refer to section 2.2 for retention of NTFP-producing trees.

## **2.4 Forest Harvest Planning**

### **Long-term planning**

Harvesting operations will be conducted according to approved Forest management Plans or Area Management Plans based on the guidelines and standards of this Code.

To carry out a logging operation at minimum cost and with minimum adverse impact on the environment, it is necessary to plan the operation in detail. Figure 1 shows the order of operations in a well-planned operation. It is important to realise that a logging operation is a chain of interlinked activities. This is what makes planning indispensable in any logging operation.

Planning can only commence when information on the resource is available. Proceeding from long-term to annual planning, the required detail of the information increases progressively. The Forest Management Plan Guidelines describe information required to prepare the 5-year management plan.

It is recommended to conduct a 2% management-level inventory to identify areas to be excluded from logging, non-productive areas, to demarcate annual coupes and to obtain information on the volume per unit area that can be expected in each compartment.

Roads should be planned to minimise the sum of skidding and road construction impacts, which in turn will also lead to cost minimisation. Once volume to be harvested per hectare and unit costs are known for felling, skidding, loading, transport and road construction and

maintenance, the most efficient spacing of roads can be derived by looking at the cost tradeoffs between skidding distance and road spacing.

Once roads have been planned, the optimum spacing of log markets can be derived as well, based on factors such as road density, topography, volume to be harvested, log size, storage time and logging equipment used.

## Annual planning

Besides the long-term forest management plan, which has to be updated every 5 years, TSA and WCL holders are required to submit an annual plan of operations to the GFC that sets out the main activities to be undertaken in the upcoming calendar year. The annual plan of operations guidelines for timber harvesting (see separate document) should be applied when submitting an annual plan. A review of the previous year's activities is also required to put the upcoming year's plan into context.

The annual plan shall include two maps using the published 1:50,000 scale topographic map sheets as base map: a logging map and a forest inventory map and infrastructure map. Tables should be included where appropriate:

- Introduction
  - Forest licence number and name of licence holder
  - Period covered by the plan, author, and date of writing
  - Brief background of the company/individual
- Review of work undertaken during previous 1-year period
  - Area (ha) logged by compartment and felling block on map 1
  - Number of trees and volume (in m<sup>3</sup>) felled per species by compartment (felling block), and mean annual volume felled per hectare (in m<sup>3</sup>/ha)
  - Forest inventories completed (at stated intensity e.g. 2%, 5% management-level or 100% pre-harvest inventory). Tree data information to be tabulated and indicated on map 2. Inventory methods and complete results to be appended
  - Describe biological. Ecological or other surveys methodologies, and summary of results to be appended.
  - Road construction or access completed (in km), to be indicated on map 2; including the location of culverts, bridges and borrow pits.
  - Road and or waterway access maintenance and/or rehabilitation undertaken (in km), to be indicated on map 2.
  - Base camps/cabins completed, to be indicated on map 2

- List number of employees, and list the number of work-related accidents and or industrial disputes, if any
- Describe the status of any community or regional initiatives
- Infrastructure work projected for upcoming year
  - Infrastructure Projected road construction (in km), to be indicated on map 3, including culverts, bridges and borrow pits
  - Projected road and or waterway access maintenance and/or rehabilitation undertaken (in km), to be indicated on map 2
  - Projected forward logging camps, to be indicated on map 2
- Forest inventory activities projected for upcoming year
  - Forest enumeration or other biological, ecological cultural surveys/inventories to be undertaken by compartment/block/area in the upcoming year, at stated intensity (e.g. 2%, 5% management-level or 100% pre-harvest inventory). Describe methods and measurement standards (e.g., plants, animals, all commercial species of 35 cm dbh and over) and indicate area on map 2
  - Describe plans for tree marking and presentation of tree location map
- Logging operations projected for the upcoming year
  - Area projected to be logged by felling block and compartment. Information to be indicated on map 1
  - Number of trees and volume (in m<sup>3</sup>) projected to be felled per species
- Other operations planned for the upcoming year
  - Describe plans for delineation of concession boundaries on the ground on map 1
  - Describe plans for monitoring of the concession area
  - Describe plans for waste disposal produced during processing
  - Provide a list of all records or registers to be maintained by the company/individual
  - Provide a list of equipment/machinery to be used by the company/individual
  - Indicate number of consultants/contractors to be employed, a summary of consultant/contractor background and resume, and theme of employment
- Social issues to be addressed in current year
  - List numbers of workers, contractors and sub-contractors employed
  - Describe company procedures for occupation health and safety

- Describe any company outreach programme with nearby community
- Describe efforts to prepare and implement public awareness programme
- Describe any proposal for contributing to the development of any stakeholder community
- Indicate any new strategic measures considered by the company since submission of its forest management plan
- Provide copies of contract document used by contractors/sub-contractors for review by GFC
- Interagency collaboration
  - Describe collaborative activities with other resources or non-resources agencies planned for current year

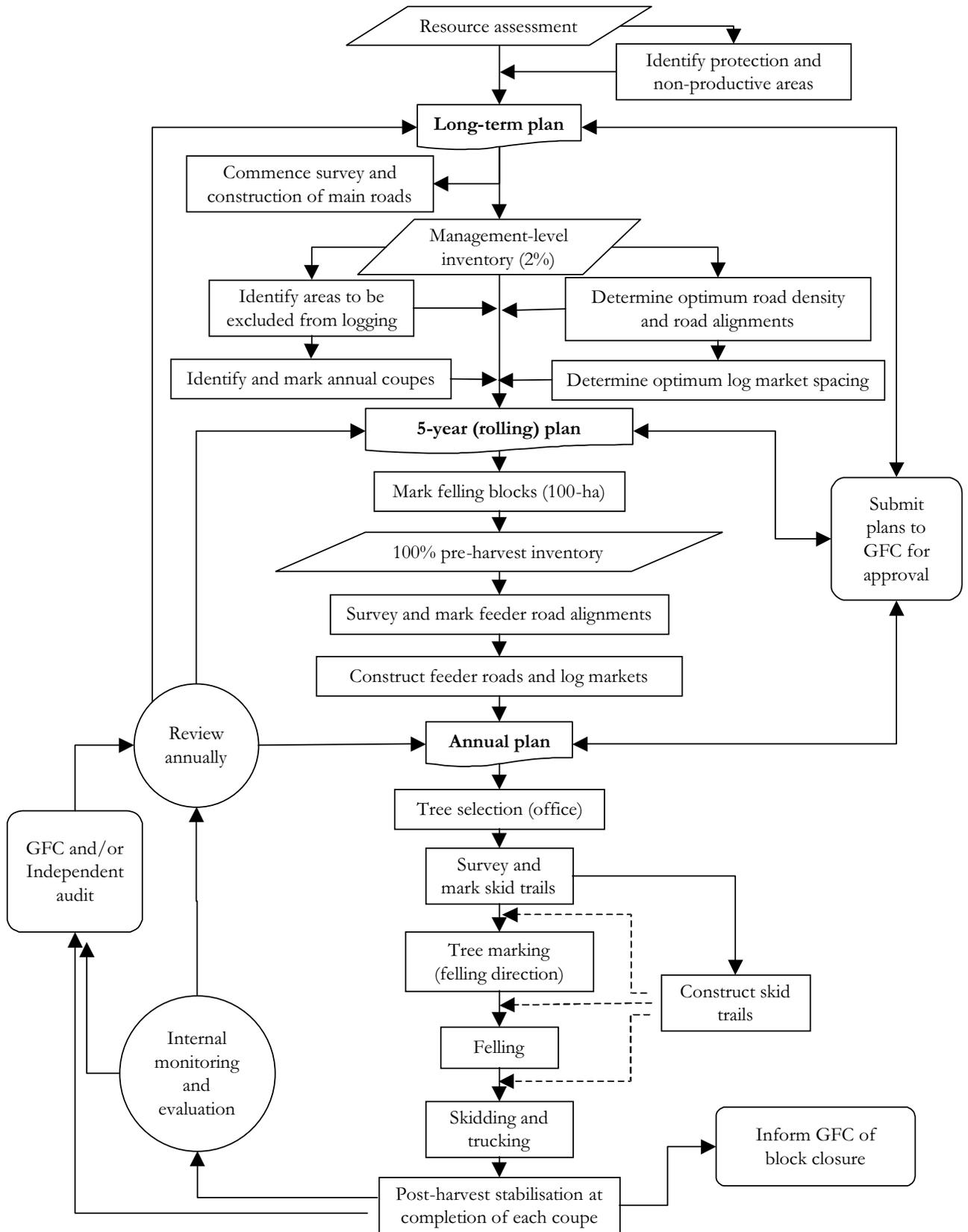


Figure II-1 Order of operations in well-planned harvesting

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## Pre-harvest inventory

Pre-harvest inventories (also called stock surveys) are surveys conducted in areas about to be harvested. Their aim is to provide information that facilitates the planning and control of an efficient harvesting operation. The following minimum requirements apply for all pre-harvest planning beyond the stage of block demarcation, and primary and secondary road alignment and construction:

- Each compartment should be divided into blocks of 100 hectares (1000 m x 1000 m), and marked on the ground and on maps. The use of natural or artificial (e.g. roads) features to demarcate blocks is recommended, in which case the size of the blocks should be close to the before-mentioned 100 hectares
- A 100% pre-harvest inventory is required for each block that will be harvested
- A map at a minimum scale of 1:2,500 (1:1,000 recommended) shall be produced that shows:
  - Compartment and block identification (name/number)
  - Dates of the inventory
  - The location of all trees intended to be harvested
  - All watercourses, including creeks and waterways, and their streamside buffer strips
  - All terrain with slope > 40% shall be identified as no logging zones
  - All existing roads, permanent water crossings and skid trails
  - All projected roads and skid trails
  - All projected permanent and temporary watercourse crossings
- The data collected shall be accurate and reliable. A 2.5% random consistency check by dividing the block into 40 half-strips should produce the results set out in the following table to be considered acceptable.

Phase of survey	Element checked	Required consistency
Strip establishment	Bearings and horizontal distances	All bearings at the starting of strip lines within 2 degrees Strip width does not diverge by more than 5m at any point
Picket establishment	Horizontal distances	99% accuracy between each picket
Topographic mapping	Mapped features	90% of required features are mapped and can be relocated within 5m of stated location
Tree enumeration	Number of trees	90% consistent
	Species identification	90% consistent
	Dbh measurement	90% within 5cm
	Log length estimation	90% within 2m
	Tree coordinates	90% within 5m

## Recommended practices

The GFC has recently released an updated procedures manual for conducting pre-harvest inventory. This manual is meant to provide guidance and a possible procedure for concession holders to assist their planning of harvesting operation. However, the procedures set out are not mandatory. If desired, the GFC is able to provide assistance in all aspects of these procedures, including planning, field implementation, data processing and mapping.

Ideally, the pre-harvest inventory should be conducted one year in advance of felling in order to inform the annual plan. The GFC recognises that this may not be feasible under certain circumstances, but wishes to emphasise that the pre-harvest inventory should be completed at least six months before harvest to allow time for compilation of the tree location map, planning of skid trails, identification of exclusion areas, etc.

## III EXCLUSION AREAS AND BUFFER STRIPS

### 3.1 Protected Areas

Conservation of environmental diversity (biodiversity, including flora, fauna, threatened species, and genetic resources; landscape; cultural heritage) is of great importance in sound forest management. Maintenance of genetic resources can be assisted by the retention of flora and fauna in formal and informal reserves including wildlife habitat strips and watercourse buffer strips dispersed throughout the forest. Wildlife habitat strips can be based on watercourse buffer strips. Ideally, links up slopes and across ridges should be included to connect with watercourses in adjoining catchments; non-productive forest could perform this function. Planning for flora and fauna conservation should initially be carried out at the regional and strategic (management plan) level

#### **Areas to be excluded from logging**

- 3.1.1 Conservation areas (e.g. biodiversity reserves)
- 3.1.2 Declared protected areas under national legislation
- 3.1.3 Areas of cultural importance (historical, archaeological and spiritual sites, settlements and farms)
- 3.1.4 Areas required for community needs

### 3.2 Sites susceptible to degradation

Site degradation risks to consider are soil erodibility, load bearing capacity, susceptibility to nutrient loss, landslides and compaction. Soil erodibility depends on soil type, but increases in all cases with increasing steepness of terrain. Site susceptibility to degradation is not too well known for Guyana's soils, but susceptibility to erosion and compaction can be considered high for most soils, except for laterite and white sand soils. Once more detailed information becomes available, standards will be adapted to soil type.

Field inspection during pre-harvest forest inventory to identify steep terrain is required for all forest operations.

#### **Upper slope limit**

- 3.2.1 No logging on slopes > 40% (22°) for all ground based extraction systems

### 3.3 Watercourses

Water quality and flow are affected by natural factors such as annual rainfall; vegetation type and cover; soil type and exposure; topography; wildfires and storm events; and by human factors such as road construction and maintenance, timber harvesting, dam construction and chemical use. Maintenance of acceptable water quality and flow; and catchment and channel stability is of major concern. This can be achieved by minimizing disturbance to watercourse channels and riparian zones, and by reducing soil disturbance in and near watercourses.

All watercourses require protection during forest operations; the type of protection required depending on the nature of the catchment, size and permanence of the watercourse and the volume of water carried.

#### **Watercourse Definitions**

Watercourses	<p>Watercourses are natural channels, which carry water for some period in most years. Flows may be periodic or permanent</p> <p>Watercourses include rivers, creeks, gullies and waterways. Classes are defined in terms of permanency of flow, bed material, width and bank slope</p> <p>The width of a watercourse is the bank-to-bank distance during normal wet season (peak) flow, and may include a flood plain area. This adjacent flood plain may be a swamp or a stream meander</p>
Rivers	Rivers are those watercourses where water flows all year round in most years and that are depicted and named as such on the 1:50,000 Lands and Surveys maps
Creeks	Creeks are those watercourses where water may flow or pond for more than six months in most years, or whose beds are of stony, gravelly, or exposed bedrock materials.
Gullies	Gullies are steep-sided channels. The slope of at least one bank exceeds 30%; the depth of the bank next to the bed may be 30 cm or more. Beds are of soil and may be covered with vegetation. Water will flow or pond for less than six months in most years.
Waterways	Waterways are stable, non-incised depressions. The slope of both banks is less than 30%. Beds are of soil and often covered with vegetation. Water will flow or pond for less than six months in most years.
Swamps	Swamps have (standing) surface water present for six months or more in most years.
Lakes	Lakes have surface water present all year round for most years

### 3.4 Buffer Strip Protection

Buffer strips are required, irrespective of whether a feature is identified on available maps of any scale. Field inspection during pre-harvest forest inventory to identify buffer strips is required for all forest operations.

Buffer strip widths depend on the nature of the protected area or watercourse.

Type	Minimum required buffer strip protection	
Conservation and declared protected areas	20 metres	
Cultural areas	Villages, farms, settlements and cultural, spiritual or historical heritage areas	20 metres
Sites susceptible to degradation	No additional buffer required	
Watercourses	<p>Buffer width is measured horizontally from the top of the watercourse bank, or the edge of the flood plan when present, or the point above the high bank where the slope becomes less than 50% (27°) - whichever provides the greatest distance from the edge of the watercourse bed.</p> <p>Rivers            30 metres each side. Retain vegetation on both sides (felling not allowed)</p> <p>Creeks            20 metres each side. Retain vegetation on both sides (felling not allowed)</p> <p>Gullies            Merchantable trees may be felled but extraction equipment is not permitted within 10 metres of either side</p> <p>Waterways        Merchantable trees may be felled but extraction equipment is not permitted within 5 metres of either side</p>	
Lakes, swamps and other wetlands	20 metres from the peak level mark or edge of typical wetland vegetation	

## **3.5 Management of Exclusion Areas and Buffer Strips**

### **Exclusion areas shall be managed as follows**

- 3.5.1 No trees shall be felled within exclusion areas or their buffer strips, except for gully and waterway buffer strips.
- 3.5.2 Machine access within exclusion areas and their buffer strips is not allowed, except at designated watercourse crossing points. Where permitted, access should be by the shortest possible distance
- 3.5.3 No earthworks, or spoils from earthworks, shall end up in a exclusion area or its buffer strip
- 3.5.4 No harvesting debris shall be pushed into exclusion areas or their buffer strips.
- 3.5.5 Trees should be felled away from buffer strips and watercourses
- 3.5.6 Where trees inadvertently fall into a watercourse or its buffer strip, the head as well as any accompanying logging debris should be pulled clear, unless unacceptable damage to the bank or buffer strip is likely to occur.

### WATERCOURSES AND BUFFER STRIPS

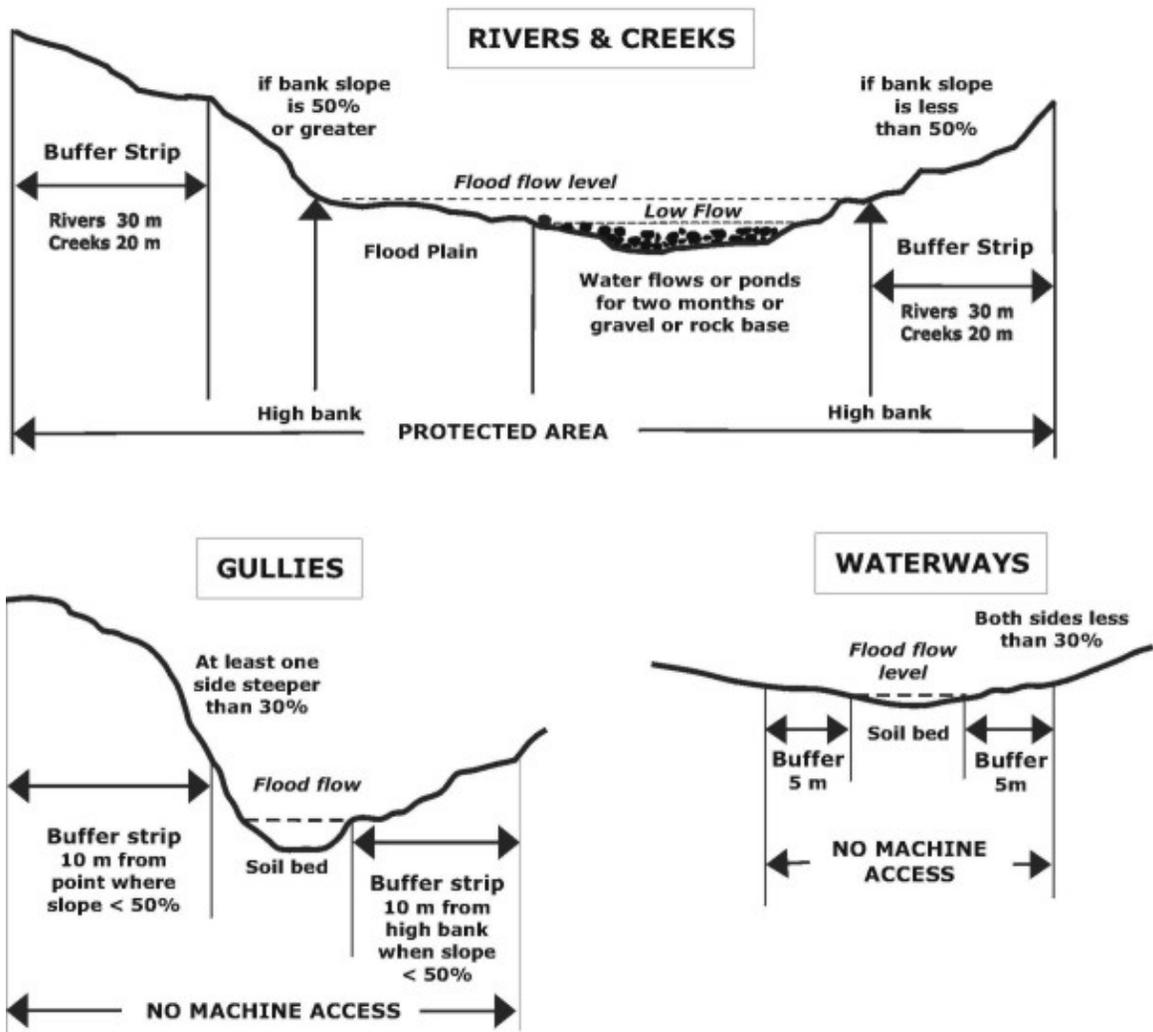


Figure III-1 Buffer strips along watercourses

## IV CONSTRUCTION WORKS FOR LOGGING

### 4.1 Roads

Roads provide needed access to the forest. At the same time, roads can produce significant amounts of sediment and can be one of the greatest adverse impacts on the local environment, on water quality and on aquatic life. Roads can produce significant erosion, cause gullies, and have an impact on groundwater, wildlife and vegetation.

Road planning is key to ensuring that a road meets the current needs of the user, that it is not overbuilt, that it minimizes impacts on the environment and to the people along the road. A well planned, located, designed and constructed road will be cost-effective in the long term by preventing road failure, eliminating repair needs, and reducing maintenance.

Roads should be planned to minimise the sum of skidding and road construction impacts, which in turn will also lead to cost minimisation. The most efficient spacing of roads can be derived by looking at the cost tradeoffs between skidding distance and road spacing.

#### **Road classification**

Main or primary roads	Permanent, all-weather roads that make up the basic forest road network. They will carry log volumes of 2,000 m <sup>3</sup> (≈ c. 60 truck loads) or more per week and will be in service during the entire logging operation.
Secondary roads	All-weather roads that provide access to a logging compartment, connecting feeder roads and log markets to main roads. They will carry log volumes of 1,000 to 2,000 m <sup>3</sup> per week and will be in service for a (small) number of years only.
Feeder or spur roads	Temporary roads or tracks that provide access to a (small) number of 100-ha blocks. They will carry log volumes of less than 1,000 m <sup>3</sup> per week and will be in service for a short period only.

## Road Planning

### Location

- 4.1.1 Avoid protected/exclusion areas and buffer strips
- 4.1.2 Locate roads on well-drained soils and slopes where drainage will move away from the road
- 4.1.3 Locate roads to follow the natural terrain by conforming to the contour, rolling the grade and minimizing cut and fills

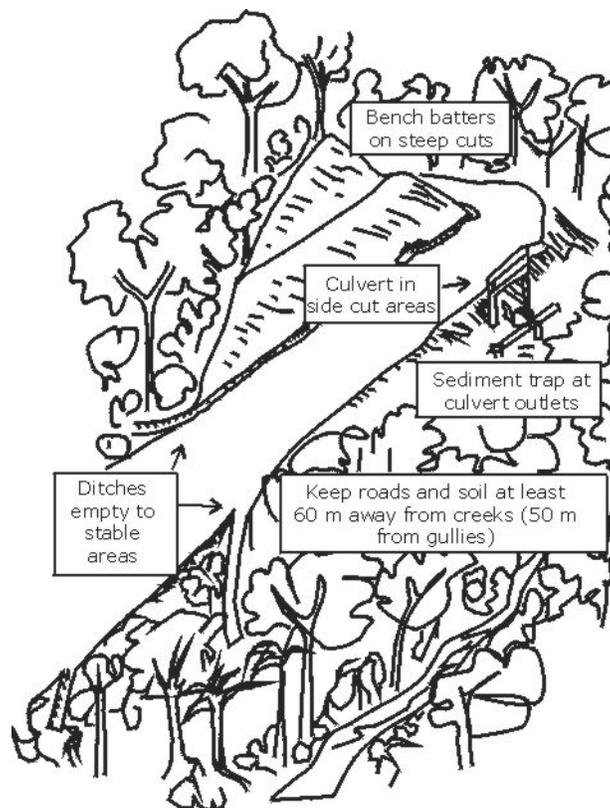


Figure IV-1 Road location and drainage

- 4.1.4 Avoid locations that require box cuts
- 4.1.5 Avoid steep and very flat terrain where drainage is difficult to control
- 4.1.6 Avoid unstable and problematic locations such as swamps, marshes, landslides, steep slopes, massive rock outcrops, flood plains, and highly erosive soils

- 4.1.7 Keep roads at least 40 m away from the edge of buffer strips (e.g. 60 m from the banks of creeks, 50 m from the edges of a gullies), except at designated watercourse crossing points
- 4.1.8 Locate roads on ridges as much as possible
- 4.1.9 Minimise the number of watercourse crossings

### **Survey requirements**

- 4.1.10 Inspect, survey and mark the centre line of roads on the ground
- 4.1.11 Locate and mark all watercourse crossings and culverts clearly
- 4.1.12 Mark the total road clearing using the defined specifications
- 4.1.13 Locate and mark log markets

## **Road Construction**

Road construction costs are mostly influenced by the standard of road built, particularly road width, type of surfacing, and the steepness of the terrain. A road with cuts and fills on steep cross slopes greatly increases the time of construction, amount of earthwork, the areas of clearing, and adds length to cross-drains and other drainage structures

### **Timing of construction**

- 4.1.14 Primary and secondary roads should be completed 3 months before logging
- 4.1.15 Construction should commence within 12 months before logging
- 4.1.16 Preliminary roadway clearing should take place within 1 month of final construction to reduce sedimentation from undrained sites
- 4.1.17 Construction should take place in the dry seasons only
- 4.1.18 Wet weather restrictions apply

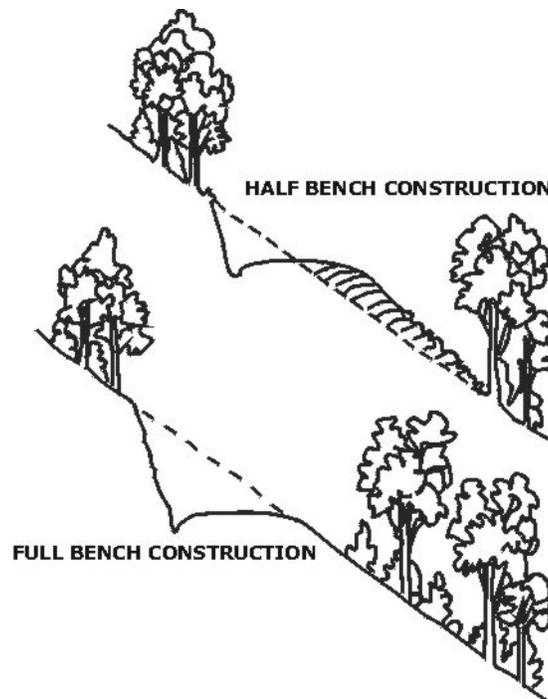
### **Roadway development**

- 4.1.19 Merchantable stems along the road reserve should be felled and preferably extracted before clearing
- 4.1.20 While clearing, trees should be pushed into the road reserve and not into the adjacent forest

- 4.1.21 Soil heaps, berms and debris stockpiling along the roadway are not permitted; instead topsoil should be stockpiled for use in cut and fill batters and/or in borrow pits
- 4.1.22 Organic debris should not be used as fill
- 4.1.23 Gravelling is recommended for primary and secondary roads, especially of bridge approaches and culverts
- 4.1.24 All road fill and paving material shall be compacted
- 4.1.25 Minimum compacted gravel thickness is 15 cm
- 4.1.26 All road drainage works shall be completed before gravelling work commences
- 4.1.27 Hazardous trees, which have a significant probability of falling onto the roadway, should be removed during construction

**Side slopes**

- 4.1.28 Side cut roads shall not be located on slopes greater than 50% (27°)
- 4.1.29 Full bench construction should be adopted instead of half bench construction on slopes steeper than 25%



**Figure IV-2 Half and full bench construction**

4.1.30 Cuts and fills should be balanced in gentle terrain so that as much of the excavated material as is practical can be deposited in the roadbed fill sections

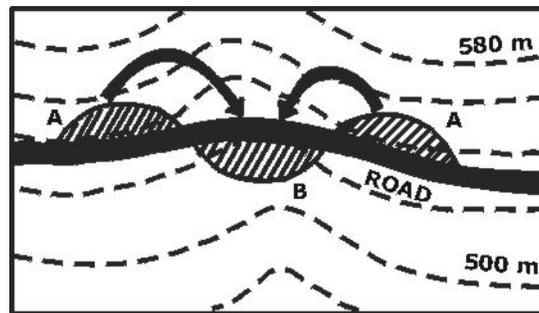


Figure IV-3 Balance cuts and fills

4.1.31 Maximum fill batter slope 50% (27°)

4.1.32 Cut batter slopes should be benched at 3 m vertical intervals

4.1.33 Trees at the top of steep cut batters should be cleared where erosion or wind-blow is liable to occur

### **Road grades**

4.1.34 Construct roads as much as possible with grades of 12% or less. On steep roads, drainage is difficult to control

4.1.35 Steeper grades (up to 20%) for short sections (maximum 200 m) would be acceptable, once this shortens construction significantly or reduces earthworks, provided that adequate drainage is installed

4.1.36 Any two sections of road at maximum gradient should be separated by 100 m of level gradient

4.1.37 Maximum road grades

<b>Road class</b>	<b>Favourable grade (%)</b>	<b>Adverse grade (%)</b>
Main road	10	8
Secondary road	15	10
Feeder road	18	12

**Road widths**

- 4.1.38 Where side cutting is not necessary, earthworks should be limited to the width for the roadbed plus ditches (table drains) on either side
- 4.1.39 Feeder roads shall be located on ridges wherever possible to minimise side casting
- 4.1.40 Primary and secondary roads on clay and loam soils should have trees removed alongside the road to allow sunlight onto the road to dry the surface quickly after rain. Roads on white sand soils should be protected from rain and direct sunlight by limiting clearing to the roadbed and ditches to maintain trafficability
- 4.1.41 On primary and secondary roads, tree stumps should be grubbed on at least one side of the road to allow for movement of tractors and other heavy machinery that would damage the road surface
- 4.1.42 Passing spots shall be provided on roads with a roadbed narrower than 7 m, at least every 500 m and at bridge approaches and hillcrests.
- 4.1.43 Maximum road widths in metres for loam/clay soils

<b>Road class</b>	<b>Limit Clearing</b>	<b>of Limit Roadway</b>	<b>of Limit Bed</b>	<b>of Road Way</b>	<b>Limit of Travel Way</b>
Main road	25	20		9	6
Secondary road	20	15		8	5
Feeder road	15	10		7	4

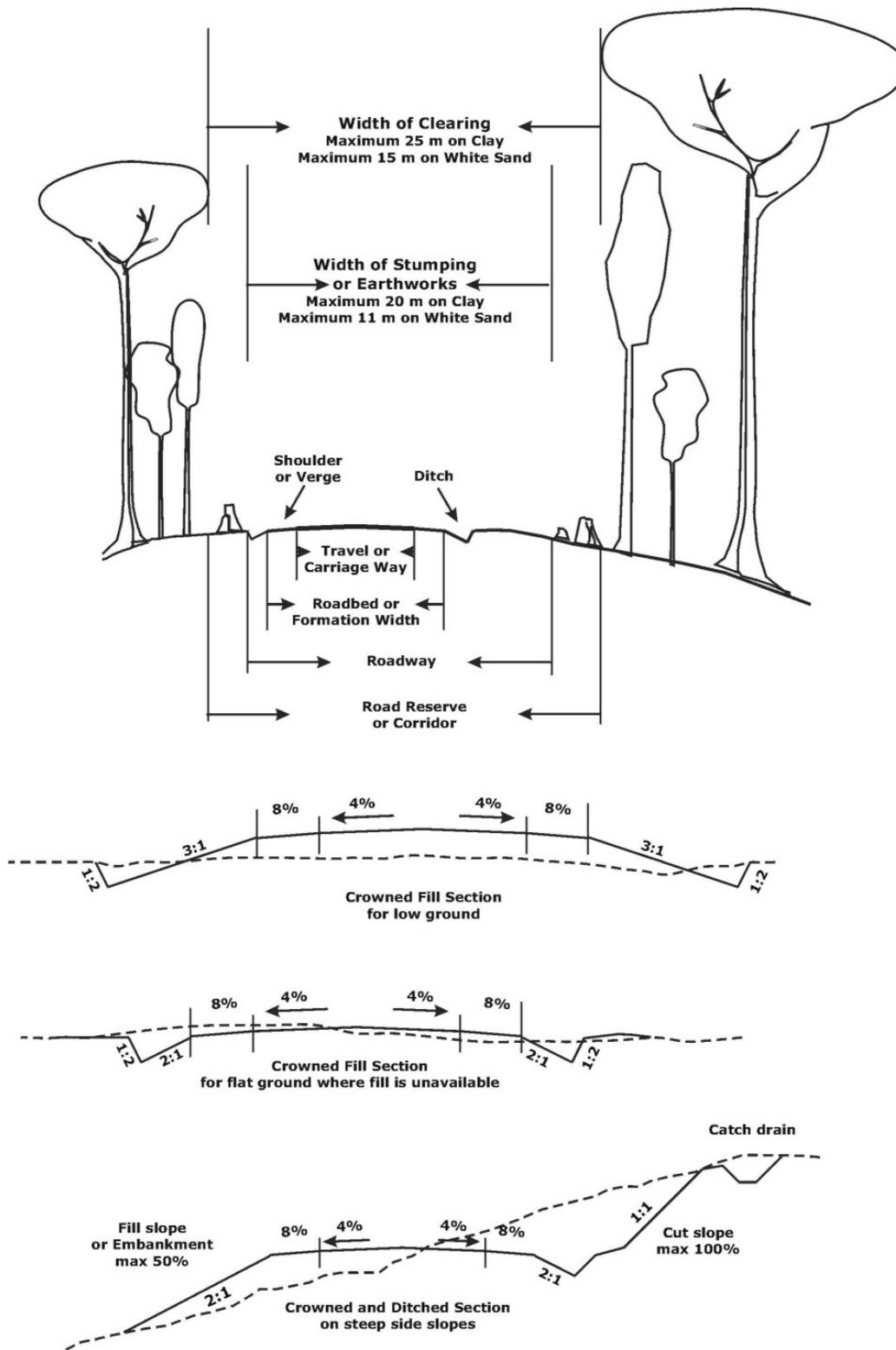


Figure IV-4 Road width limits and cross sections

## 4.1.44 Maximum road widths in metres for white sand soils

<b>Road class</b>	<b>Limit Clearing</b>	<b>of Limit Roadway</b>	<b>of Limit Bed</b>	<b>of Road</b>	<b>Limit of Travel Way</b>
Main road	15	11		9	6
Secondary road	15	10		8	5
Feeder road	10	9		7	4

4.1.45 Widths of roads on laterite and brown sand should be intermediate between the limits given in the tables above

**Curves**

4.1.46 Fit curves to the topography; i.e. along the contour

4.1.47 Curve widening is required on corners to allow for off-tracking of trailers

4.1.48 To increase vehicle stability on a bend, banking (raising) the outer part of the curve is recommended below a radius of 50 m. (On a banked curve the roadway is not crowned but in-sloping = constant side slope)

4.1.49 Shoulders may need to be cleared on the inside of the curve to obtain the required sight distance

4.1.50 The minimum radius of the curve is related to the visibility and the speed the vehicles will be travelling on the road:

<b>Road class</b>	<b>Design (km/h)</b>	<b>speed</b>	<b>Minimum distance (m)</b>	<b>sight</b>	<b>Minimum (m)</b>	<b>radius</b>
Main road	70		100		50	
Secondary road	50		60		30	
Feeder road	30		30		25	

## 4.2 Drainage

Drainage problems often cause the largest impacts from roads with regard to erosion, sedimentation, and degradation of water quality. Poor drainage will also lead to rutting, scouring and gullyng, while standing water and seepage under the roadbed may lead to road failure; in all cases necessitating extensive maintenance or even expensive repairs or diversions. These aspects make road drainage the single most important aspect of road construction and maintenance.

### **General**

- 4.2.1 In all phases of construction, adequate drainage will be provided to achieve the stability of the road formation.
- 4.2.2 Wherever practicable, permanent drainage should be installed in advance of other construction to keep works as dry as possible. Temporary drainage shall be provided where there is likely to be a significant delay in installing permanent drainage

### **Methods of drainage**

- 4.2.3 A crowned road surface with a cross-fall of 4%, especially on clay/loam soils
- 4.2.4 Ditches (table drains) alongside all roads, constructed to a minimum depth of 30 cm below the level of the crown of the road. Ditch grade (longitudinal) 1-5%.
- 4.2.5 Turnout drains (side drains/outlets) at specified spacing. Turnout drain grade 1-3%
- 4.2.6 Crossroad drainage (pipes or culverts) should be used where turnout drains are not possible. (Ref: 4.4.18 – 4.4.27)

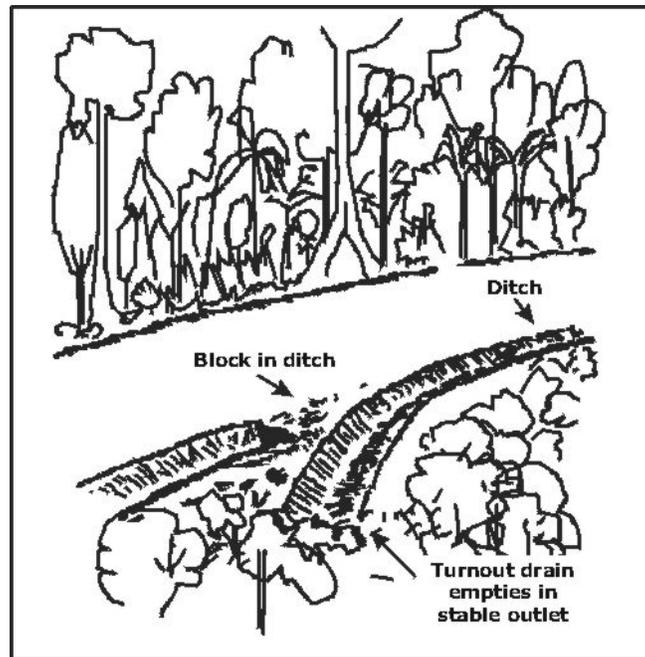


Figure IV-5 Turnout drains

#### **Additional requirements**

- 4.2.7 In high erodibility soils on slopes  $> 5\%$ , drains require special treatment such as lining with gravel or stones; log or rock bars; stepping and frequent outlets to reduce scouring
- 4.2.8 Earth fills are to have adequate drainage through the fill (culverts) to prevent water build up and ponding behind the fill
- 4.2.9 Side cuts are to be provided with catch drains along the top side to collect surface runoff

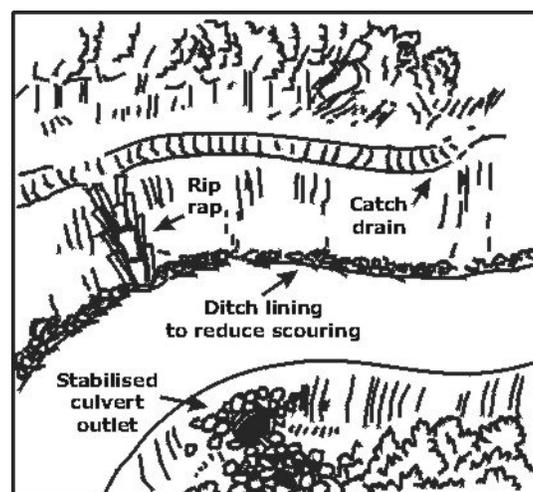


Figure IV-6 Additional drainage requirements

**Spacing between drains**

4.2.10 Turnout drains or culverts shall be constructed:

- a) at changes of slope
- b) within 50 m of watercourse crossings
- c) additional drains to meet the maximum spacing requirements

4.2.11 Maximum drain spacing†

Gradient (%)‡	Drain spacing (metres)
0-5	80
5-10	40
10-20	30

† Ditches adjacent to roads that have been box cut should be stepped or provided with rock or log bars at half the maximum drain spacing

‡ Roads should not be built with grades exceeding 20% (max unloaded truck grade is about 23%)

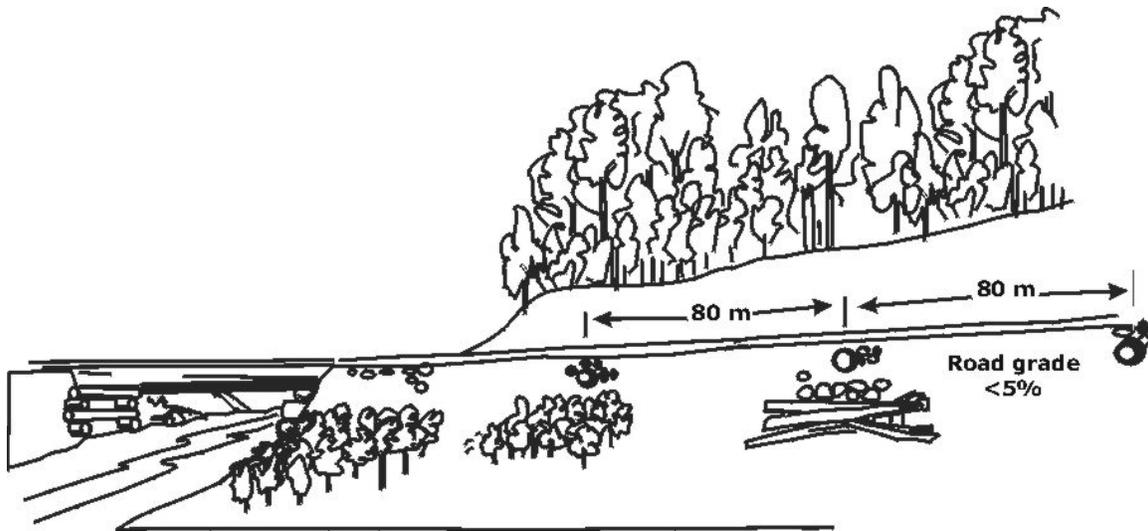


Figure IV-7 Drain spacing

**Drain out-flow**

4.2.12 Ditches shall not drain directly into watercourses. Turnout drains (outlets) shall be installed at least 50 m before meeting a watercourse to divert water into surrounding vegetation. Where turnout drains are not practicable, drainage diversion by means of a culvert should be considered

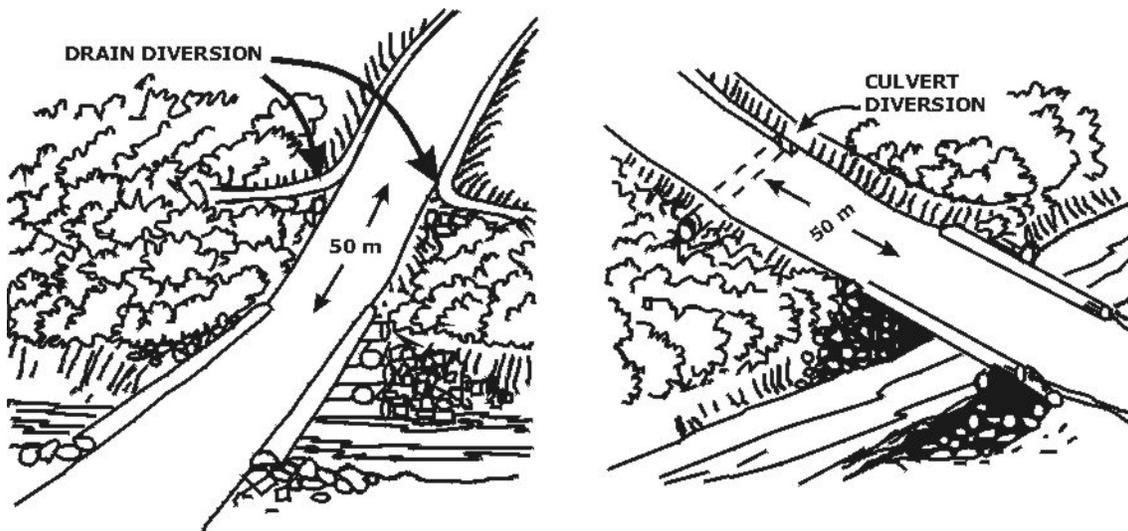


Figure IV-8 Drain diversion by turnouts or culvert

- 4.2.13 All drains shall have stable outlets, protected by vegetation or rock or log barriers, particularly in fill areas and shall never directly enter watercourses.
- 4.2.14 In steep terrain silt traps should be constructed at the end of turnout drains
- 4.2.15 Sumps or silt traps shall be constructed in ditches at all four corners of watercourse crossings

### 4.3 Road maintenance

- 4.3.1 Soil, vegetation and other materials that would obstruct water flow, shall be cleared from ditches
- 4.3.2 Turnout drains, culverts and bridges shall be kept clear and in a good working condition at all times
- 4.3.3 Road surface maintenance should be performed as needed. Cross-fall and road shape should be maintained to allow effective drainage
- 4.3.4 Surfacing gravel or loam should not be pushed to the road edge or into drains
- 4.3.5 Bridge decking foundations and side walls should be checked regularly
- 4.3.6 Any debris that has been pushed into the watercourse shall be removed
- 4.3.7 Water should flow freely under bridges
- 4.3.8 Silt traps should be cleaned regularly

## 4.4 Watercourse Crossings

### Types of Crossings

Bridges	Bridges shall be used for road crossings of all creeks. They may also be used to cross other watercourses
Culverts or pipes	Culvert or pipes should be used for crossing gullies and waterways (if bridges are not used)
Fords/low-level crossings	Fords are only permitted on feeder roads. They are only acceptable if: <ul style="list-style-type: none"> <li>– Bank height is less than 1 metre</li> <li>– Approaches to the watercourse are less than 10%</li> <li>– Depth of normal water flow is less than 0.5 m</li> <li>– The bed is stable (gravel or sand)</li> </ul> It is always desirable to corduroy fords
Corduroy with earth fill	Corduroy with earth fill is not allowed for crossing any watercourse in any situation because this would effectively block the water flow and may divert the course

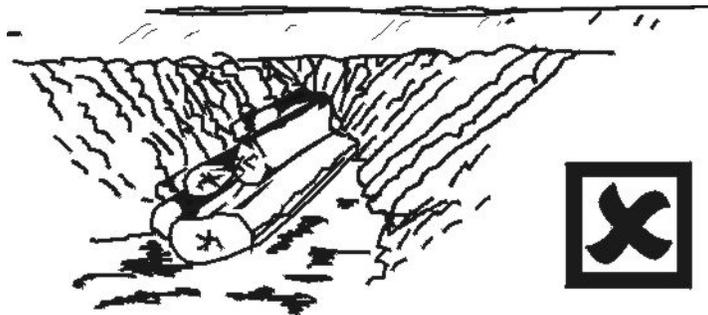


Figure IV-9 Log clusters with earth fill are not allowed

### **Construction of Watercourse Crossings**

#### Location of crossings

- 4.4.1 Select crossing points which
- a) are immediately downstream of straight and stable watercourse sections
  - b) have easy high bank access
  - c) do not require deep box cuts
  - d) require minimum alteration to the high bank

## 4.4.2 Cross watercourses at right angles

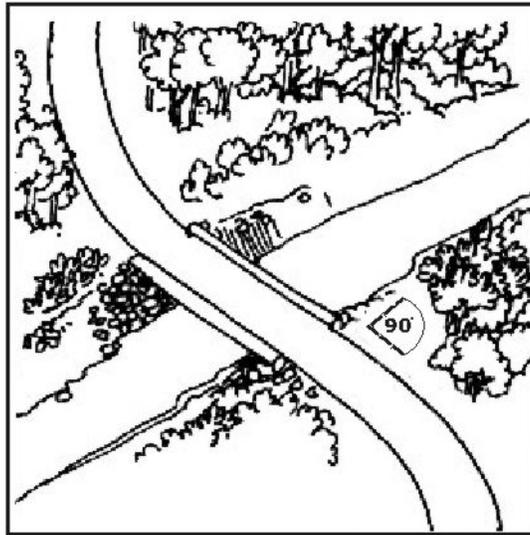


Figure IV-10 Cross watercourses at right angles

**Earthworks**

- 4.4.3 In the construction of roads and bridges creek beds shall not be filled in
- 4.4.4 During bridge construction oil, chemicals, excess concrete and other waste shall not enter the creek
- 4.4.5 All earthworks shall be carried out so as to prevent soil from entering the watercourse
- 4.4.6 All spoil should be removed to outside the buffer strip or placed in road fills where possible
- 4.4.7 Watercourse buffer strip vegetation should be retained to the edge of the crossing
- 4.4.8 Temporary crossings are permitted to allow equipment involved with the construction of the crossing to be moved to the other side, provided that:
- the width of the temporary crossing is limited to 4 metres; and
  - the temporary crossing is made on the final crossing alignment, so as to reduce disturbance to watercourse banks and buffer strip vegetation
- 4.4.9 Wet weather restrictions apply

## Bridges

- 4.4.10 Bridges should be sufficiently elevated to allow wet season flood flows to pass without damage to the crossing or its foundation
- 4.4.11 The bridge should span at least 120% of the width of the watercourse measured from bank to bank; i.e. extend beyond the creek channel by 10% on either side
- 4.4.12 Approaches should have a straight and level alignment for a minimum of 20 metres on either side

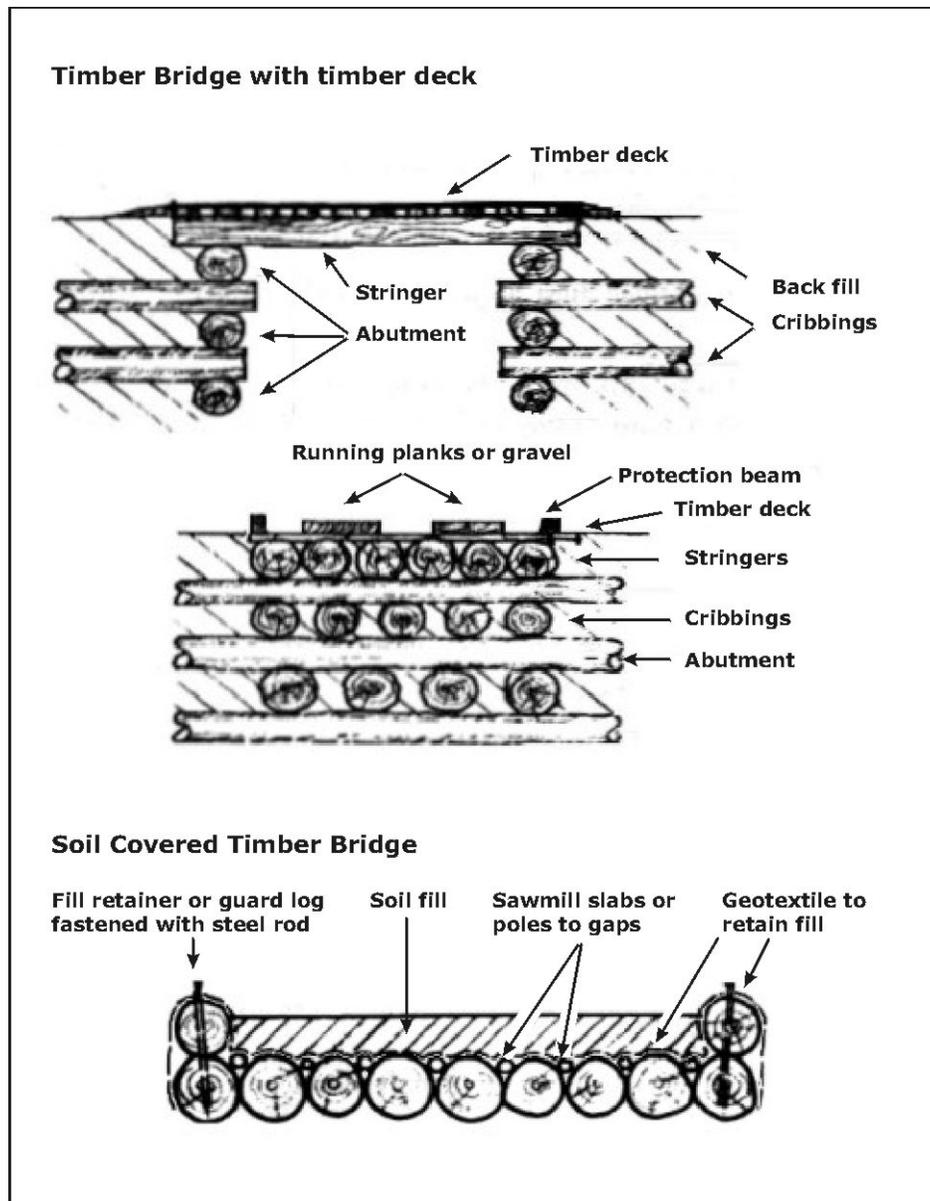


Figure IV-11 Bridge construction

- 4.4.13 Foundations should be excavated to a solid base and not formed by pushed material

- 4.4.14 All parts of the bridge shall be well anchored to prevent their washing away
- 4.4.15 Decks should be constructed of durable sawn timber. Soil fill or covering is not allowed unless the stringers are completely covered with a material such as geotextile and have guard logs on both sides
- 4.4.16 The stream banks adjacent to the bridge should be stabilised using wing walls of durable logs or other equivalent construction
- 4.4.17 Silt traps shall be provided at the four corners of bridges

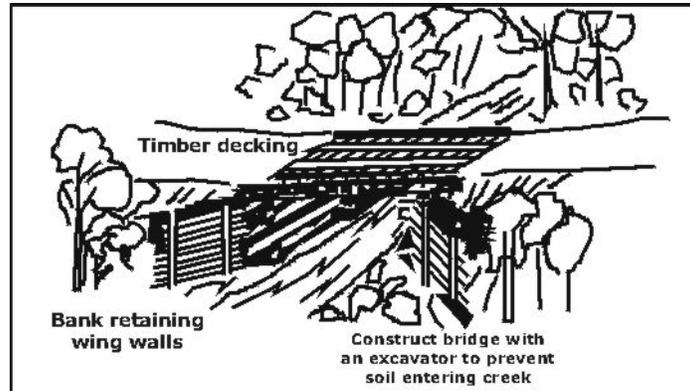


Figure IV-12 Stabilising bridge abutments and stream banks

## Culverts

- 4.4.18 Culverts should be set at or marginally below the level of the natural watercourse bed

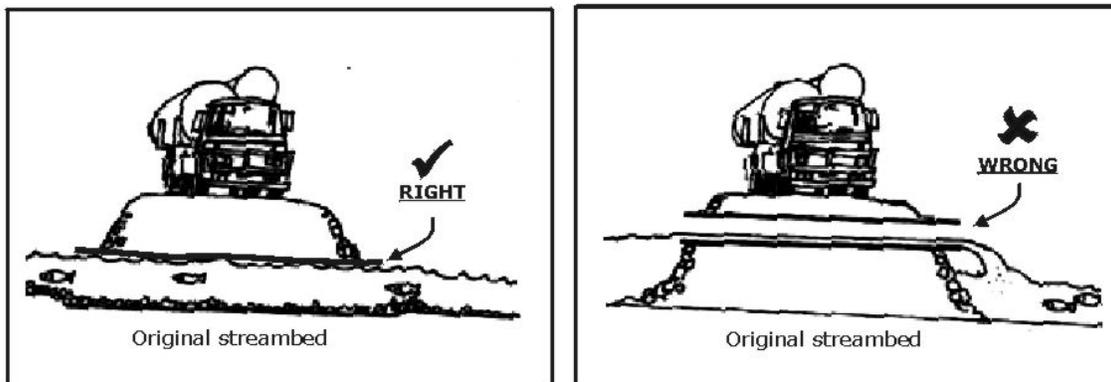


Figure IV-13 Culvert should be set at the level of the streambed

- 4.4.19 may have an earth fill but are to have stable abutments to the level of the running surface to prevent soil entering the watercourse

- 4.4.20 should be laid at a grade of 1-3% to minimize silting up and excessive scouring at the discharge end
- 4.4.21 should have a headwall to prevent erosion under the pipe
- 4.4.22 should have an opening with a diameter of 45 cm or larger depending on the wet-season flood-flow level. In case of log culverts it is recommended to use more than one log culvert if high flood flows are expected
- 4.4.23 should have a earth fill of 30-60 cm to prevent pipe breakage
- 4.4.24 Provisions shall be made at culvert inlets and outlets to minimise erosion caused by flow entering or discharging; sediment traps of logs, rocks, straw bales, etc. will be required in place where high water flows are expected

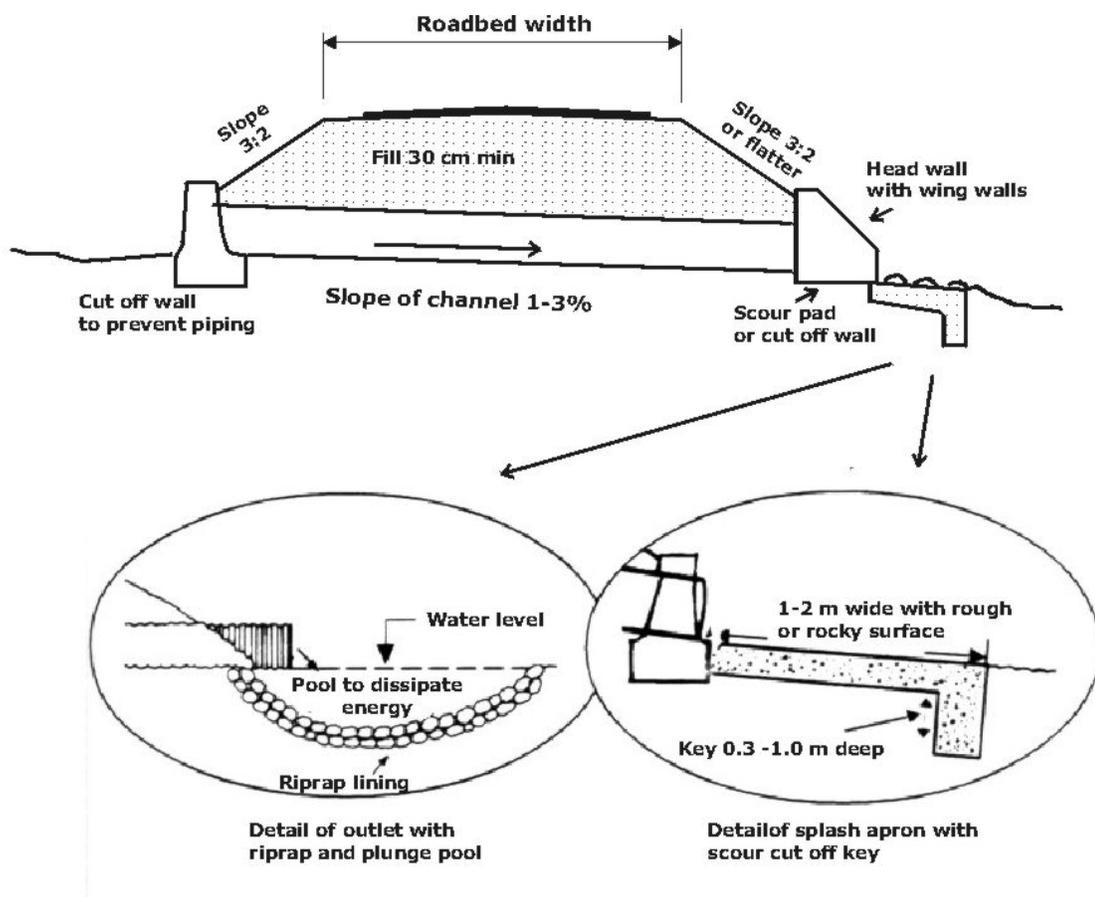
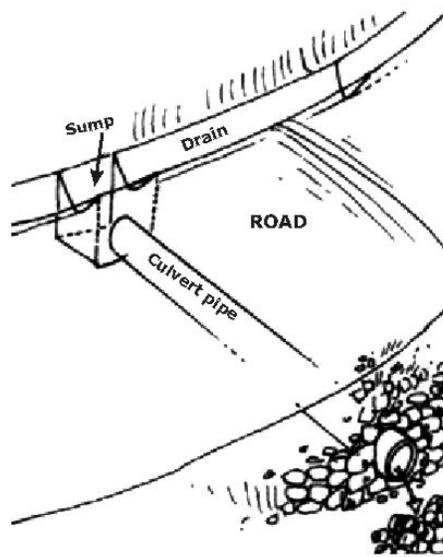
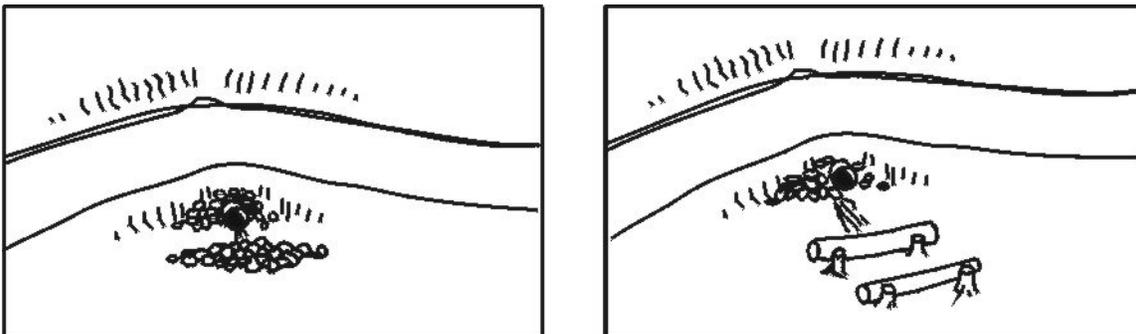


Figure IV-14 Culvert installation and outlet protection details with splash apron or riprap lined plunge pool for energy dissipation and scour control



**Figure IV-15 Provisions at culvert inlets (sumps) and outlets (energy dissipaters) to minimise erosion caused by flow entering or discharging**

- 4.4.25 Culverts shall not discharge over fills without adequate protection (e.g. rip rap, geotextile)
- 4.4.26 Sumps or silt traps shall be constructed in ditches at all four corners of culverts to prevent siltation and blocking
- 4.4.27 Log culverts require geotextile or another retaining mechanism to retain backfill



**Figure IV-16 Sediment traps of logs; rocks, etc. will be required in places where high water flows are expected**

### **Low-level watercourse crossings (fords)**

- 4.4.28 Construction shall minimise earthworks and impact on streambed
- 4.4.29 Shall be built to allow water to flow

- 4.4.30 Should provide protection against scouring below crossing unless the bed is solid gravel or stone
- 4.4.31 Should be corduroyed to minimise impact on creek bed; corduroy is to be removed after use

## 4.5 Log Markets (Landings/Ramps)

Log markets should be constructed to facilitate log sorting and loading activities. Spacing and size of log markets depend road density, topography, volume to be harvested, projected skid trail pattern, log size, storage time and logging equipment used. Hence, spacing and size of log markets should be determined during the planning phase. Remember that roads should be planned to minimise the sum of skidding and road construction impacts, which in turn will also lead to cost minimisation.

### **Location of log markets**

- 4.5.1 Log markets should be sited at such intervals to minimise the number and total length of skid trails; but should normally not be less than 250 m and not more than 1000 m.
- 4.5.2 They should be located:
- a) at least 40 m from the edge of buffer strips (e.g. 60 m from the bank of a creek, 50 m from the edge of a gully) so that mud and debris do not enter watercourses
  - b) at sites that accommodate efficient skidding patterns and directions
  - c) on a gentle sloping elevated areas (up to 3°) or on ridges or benches to:
    - facilitate free drainage at all times
    - reduce the amount of side cutting
    - encourage uphill skidding to disperse runoff into surrounding vegetation
- 4.5.3 Log markets should not form part of the roadway since this would lead to deterioration of the road formation and road drainage facilities, except when this would significantly reduce earthworks while maintaining adequate drainage of both road and market

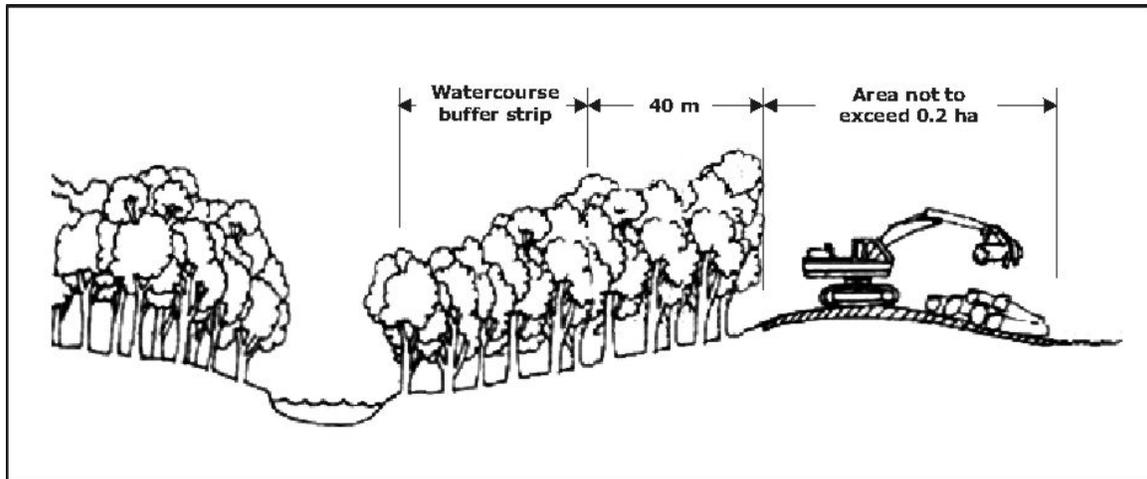


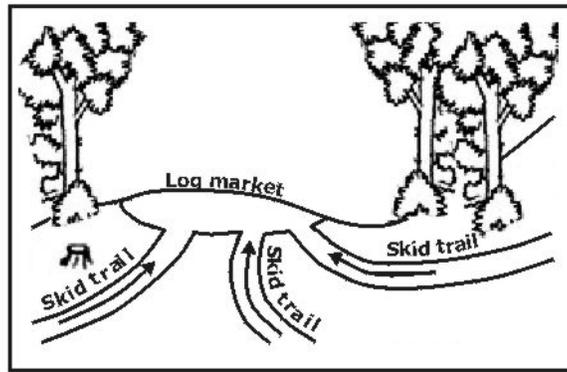
Figure IV-17 Location and size of log markets

### **Size of log markets**

- 4.5.4 The size of the log market would depend on the volume and number of logs to be stockpiled
- 4.5.5 The market should be large enough to facilitate sorting of logs, to allow for entry (skidder) and exit (loader) points and to prevent excessive stacking of logs
- 4.5.6 Log markets should not exceed 2000 m<sup>2</sup> (40 m x 50 m) in size, the total area occupied by markets not exceeding 0.8 ha per unit area of 100 ha

### **Log market construction**

- 4.5.7 All merchantable trees shall be felled and extracted before clearing
- 4.5.8 Log markets shall be well drained. Proper drainage requires:
- a) a domed surface to prevent the ponding of water
  - b) ring drainage around the perimeter to prevent surface ponding
  - c) drains to channel runoff to vegetated areas; the slope of the drains should be 1-3%
- 4.5.9 Log markets should have designated entry (skidder) and exit (log loader) points



**Figure IV-18 Landings should be located on gently sloping elevated areas, with skid trails approaching from below**

### **Log market operations**

- 4.5.10 Mud and water shall be prevented from entering log markets from skid trails or roads
- 4.5.11 Skid trails should therefore approach landings from below to avoid directing runoff of water to the landing
- 4.5.12 Avoid skidding across the roadway because this would lead to deterioration of the road formation and (road) drainage facilities
- 4.5.13 Avoid the use of heavy machinery on saturated soils to minimise erosion, ponding, rutting, mixing and compaction of the soil
- 4.5.14 Avoid hauling on wet roads to minimise erosion, ponding and rutting, and deterioration of the road formation
- 4.5.15 Log markets should not be bladed off to keep them operational
- 4.5.16 Debris and waste should be placed so as not to restrict drainage of the landing
- 4.5.17 Wet weather restrictions apply

## 4.6 Borrow Pits

Forest roads are typically built from local materials that must support heavy logging trucks and should have a surface that, when wet or when extremely dry, will provide adequate traction for vehicles. In many cases, the native soil material is too soft, too unstable or impossible to compact (white sand). Surfacing both improves structural support and reduces road surface erosion. Gravel, crushed aggregate, or loam are the most common improved surface materials used.

Use of local material sources, usually borrow pits, can produce major cost savings, compared to the cost of hauling materials from distant sources. Typical borrow pits can have major adverse impacts, including sediment from a large denuded area and impacts on wildlife. Thus borrow pit planning, location and development should be done with care.

- 4.6.1 Extraction of gravel or loam from road cutting areas during the formation of the road is preferred to the development of large borrow pits
- 4.6.2 All merchantable trees shall be harvested on the proposed borrow pit site
- 4.6.3 Catch drains should be constructed around the uphill side of the pit to prevent runoff entering the area
- 4.6.4 The base of the pit shall be drained at all times. Drains shall not directly enter watercourses
- 4.6.5 The face of the pit shall be maintained in a stable condition at all times
- 4.6.6 At least one side of the pit shall have a gentle slope to allow easy wildlife access

## V LOGGING OPERATIONS

Logging operations have various impacts on the forest. Openings (gaps) are formed in the forest canopy causing drastic changes in the microclimate near the forest floor. Adjacent trees break, uproot or are damaged by the trees that are felled. Heavy machinery used during extraction compacts the soil and crushes seedlings and saplings. The impact on regeneration and on trees available for a next harvest may be considerable. Removal or destruction of too many trees, exposure, compaction and tilling of the soil result in nutrient losses essential to the long-term growth and regeneration of the forest.

Large canopy openings incite the development of lower-value pioneer tree species such as Congo Pump, vines and weeds, changing the species composition of the forest in that location for decennia to come. As a rule of thumb, the disturbance to the canopy is to be kept below 25%, whilst the size of individual canopy openings should not exceed 400 m<sup>2</sup>. However, assessing canopy openings is a laborious and subjective task. Therefore, a proxy standard – 10-m proximity rule – is set as standard.

Properly planned and executed logging operations, which include pre-harvest forest inventory; application of tree marking rules; marking (constructing) skid trails before felling; and directional felling, can mitigate most of these impacts. Proper felling techniques (directional felling and cross-cutting) will reduce splitting and breaking of logs, and hang-ups, thereby increasing volume recovery and improving felling efficiency. Efficiency of skidding is greatly enhanced by pre-constructing skid trails and aligning logs for easy extraction.

### 5.1 Tree Marking

- 5.1.1 Selection for harvesting should depend on the cutting limits for individual species developed for the particular forest type and stand condition (refer to forest management plan)
- 5.1.2 Mark only those trees for felling that will provide logs suitable for processing. These should be suitable species, have the minimum specified log length and be free of defect
- 5.1.3 The size of individual canopy gaps shall be kept to a minimum by keeping the distance between stumps above 10 metres so as to safeguard successful regeneration of desirable species and control the establishment of undesirable vines, weeds and lower-value pioneer tree species
- 5.1.4 All trees to be felled should be marked in the field with paint, flagging tape or blaze by the tree marker before felling

- 5.1.5 The tree marker should mark the felling direction by blazing or painting a vertical line to the root of the tree (see 5.3.3. for the particulars of directional felling)
- 5.1.6 Potential crop trees and trees belonging to protected species should be marked for retention and protection within a radius of 30 m around the tree to be felled
- 5.1.7 All vines attached to the selected trees or trailing from the canopy should be cut

## 5.2 Skid trail construction

### Classes of skid trails

Major or main skid trails	Will have more than 10 passes of skidding machinery along each trail. They should be located along ridges to facilitate drainage. Normally two to four major skid trails suffice per unit area of 100 ha. They are to be marked on the ground – preferably constructed – before felling. They may require minor earthworks.
Minor or branch trails	Will have less than 10 passes of skidding machinery along each trail. Spacing between branch trails should normally be 100 m but may be less to fit to topography. They are to be marked on the ground – preferably constructed – before felling. They should not require any earthworks
Skid tracks	Normally have less than 3 passes of skidding machinery. They are usually constructed after felling

### Location

- 5.2.1 Design of the skid trail network should be based on an assessment of the following factors:
  - a) Location and density of roads and log markets
  - b) The number and location of trees to be harvested
  - c) The logging equipment used
  - d) Minimization of watercourse crossings
  - e) Avoidance of soils with low load bearing capacity
  - f) Uphill skidding, giving better control over the movements of the log, and tending to disperse runoff water into the surrounding area and not onto the skid trail
- 5.2.2 Soil types, gradients and soil conditions will affect machine traction, hence efficiency
- 5.2.3 Skidding in areas excluded from harvesting and buffer strips is not allowed, other than at designated watercourse crossing points

- 5.2.4 Location of log markets should be undertaken prior to the location of skid trails
- 5.2.5 Locate major skid trails:
- a) at least 50 m away from watercourses and unstable areas
  - b) on ridges where possible to allow proper drainage
- 5.2.6 Maximum allowable grades for skid trails are:
- a) Major skid trails (20%)
  - b) Minor skid trails and tracks (40%)
  - c) Gradients > 20% are only allowed for short distances (<30m) where adequate provision for drainage is possible to prevent excessive erosion
- 5.2.7 The total area occupied by skid trails should not exceed 8% of the total area of the block or compartment (or a total linear distance of 200 m per hectare)
- 5.2.8 All skid trails should be as straight as possible to minimise damage to residual trees, to prevent damage to the log being extracted, and to maximise skidding efficiency.
- 5.2.9 Minimum curve radius is 25 m; tracks should join minor trails and minor trails major trails in an angle < 60°.
- 5.2.10 Vines and boles lying across the trail alignments should be cross-cut before construction

### **Timing of construction**

- 5.2.11 Major and minor skid trails shall be marked – preferably constructed – before the start of the felling operation to assist the feller in determining the direction of fall and to improve safety and efficiency of the logging operation
- 5.2.12 Skid tracks may be marked after felling
- 5.2.13 Wet weather restrictions apply

### **Survey requirements**

- 5.2.14 Major and minor skid trails shall be inspected and marked in the field prior to construction, using flagging tape, paint marks or by blazing
- 5.2.15 Skidder and chain-saw operators (and their assistants) should inspect the proposed alignments prior to commencing construction
- 5.2.16 Watercourse crossings shall be marked as such on the tree location map and on the ground

**Construction**

- 5.2.17 No blading if slope is less than 20%
- 5.2.18 Construct skid trails in dry weather
- 5.2.19 Maximum trail width is 4 metres
- 5.2.20 Avoid side cutting on major trails wherever possible; side cuts should have an out-slope of 2-4%
- 5.2.21 Maximum slope for side cutting is 50%
- 5.2.22 Side cutting is not allowed for minor trails and tracks
- 5.2.23 Box cuts or berms along trails are not allowed

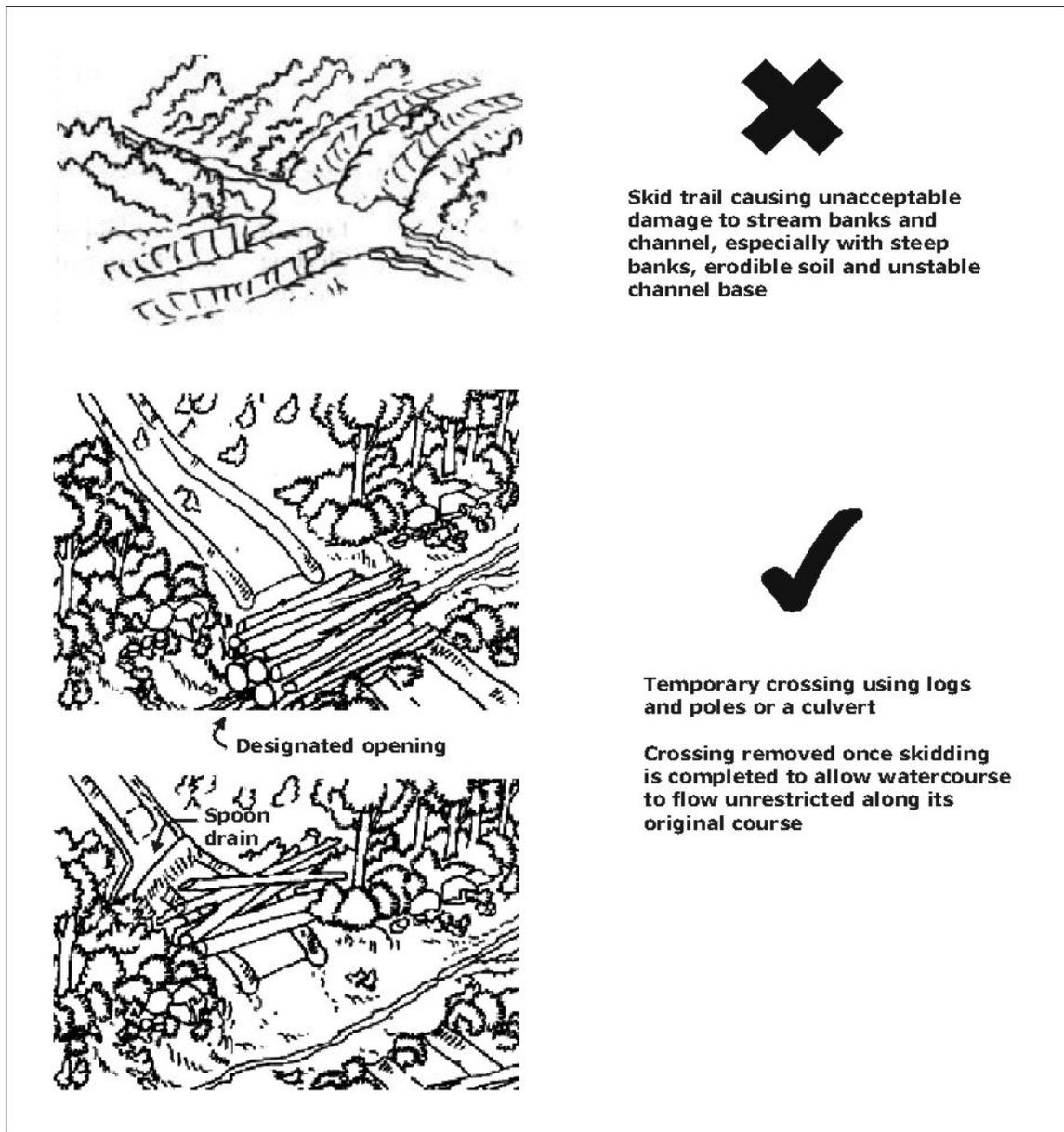


Figure V-1 Skid trails crossing gullies and waterways

### **Watercourse crossings**

5.2.24 Watercourse crossings shall be marked on the tree location map

5.2.25 Skid trails should not cross any creeks

5.2.26 Select crossing points of gullies and waterways in places where:

- a) bank slope is less than 15%
- b) the bed is firm

- 5.2.27 Skid trails shall cross waterways and gullies at right angles with straight approaches of at least 10 m on either side
- 5.2.28 Temporary crossings (log culvert with corduroy) shall be provided to cross gullies in any situation, and waterways if water is flowing at the time of operation
- 5.2.29 Crossings should be constructed in dry weather
- 5.2.30 Width of the crossing should be less than four metres. Buffer strip vegetation shall not be otherwise disturbed
- 5.2.31 Use non-commercial logs for crossings where appropriate
- 5.2.32 Abutments and approaches should be higher than the stream banks
- 5.2.33 Soil should not be pushed:
  - a) past the high bank
  - b) into watercourses
  - c) onto the top of a crossing
- 5.2.34 Corduroy with earth fill is not allowed because this would effectively block the water flow and may divert its course
- 5.2.35 Crossings shall be removed after completion of the operation. Crossing material should be placed more than 10 metres away from the high bank
- 5.2.36 Removal should not disturb the watercourse banks

## **5.3 Felling**

### **Timing of operation**

5.3.1 Felling can commence once:

- a) road construction is completed
- b) major and minor skid trails have been marked on the ground or preferably constructed
- c) trees have been marked for felling and protection – including the predetermined felling direction
- d) all operators (skidding and chain-saw) are familiar with the harvest area and have discussed the operational plan with the supervisor

5.3.2 Adverse weather restrictions apply

### **Restrictions**

5.3.3 Felling is not allowed within protected/exclusion areas and buffer strips

5.3.4 Felling is not allowed on slopes steeper than 40%

5.3.5 Where trees fall inadvertently into watercourses or their buffer strips, the tree head as well as any accompanying logging debris should be pulled clear

5.3.6 Felling should commence at the rear end of the block and proceed along the main skid trail towards the log market

### **Directional felling**

5.3.7 Directional felling is required to:

- a) avoid damage to the felled tree (by cross-felling, falling on obstacles, down-slope felling)
- b) minimise damage to potential crop trees and other protected trees
- c) facilitate easy log extraction, thereby minimising ground disturbance
- d) avoid disturbance to watercourses, exclusion areas and buffer strips
- e) prevent trees from hanging up in adjacent canopy trees
- f) minimise canopy openings by felling into gaps formed by previous felled trees or natural tree fall
- g) avoid blocking the skid trail
- h) increase work safety

- 5.3.8 Chain-saw operator and assistant should be trained in directional felling
- 5.3.9 Felling crew should be equipped with at least two felling wedges, a sledgehammer or hatchet and a cutlass

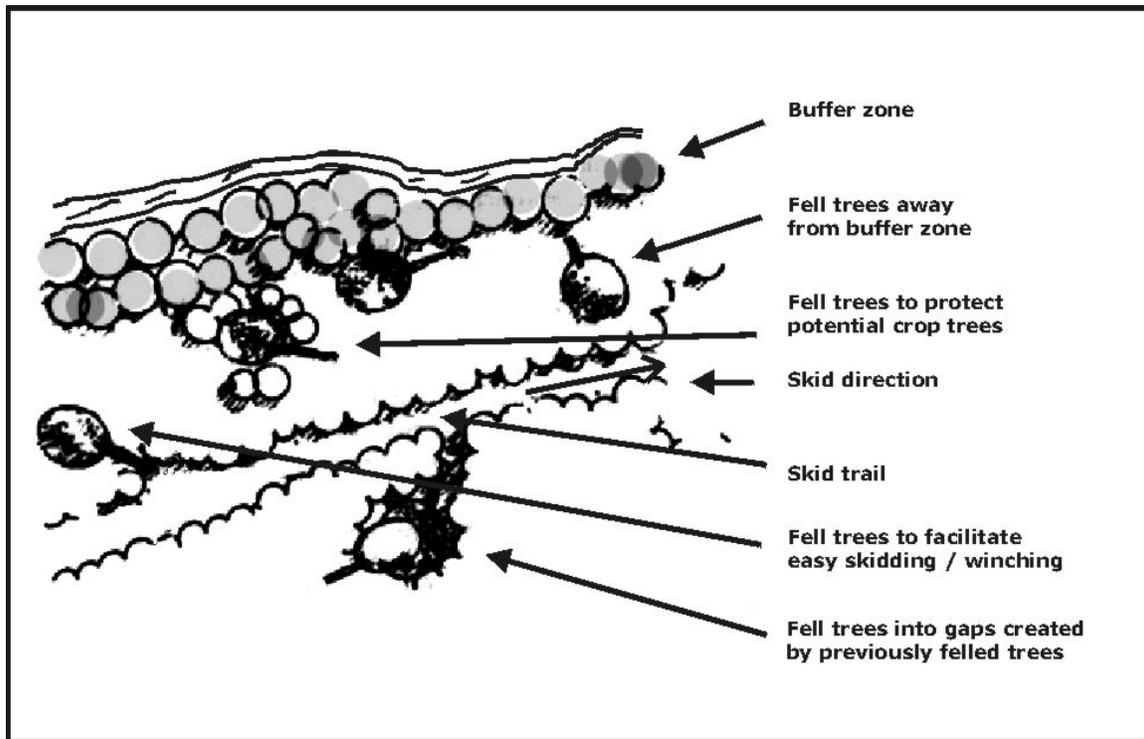


Figure V-2 Directional felling and skid trail location

### **Felling**

- 5.3.10 Trees suspected of being unsound should be tested before felling
- 5.3.11 Appropriate controlled felling techniques shall be used
- 5.3.12 Once cutting of a tree is started, that tree should be felled, also when it is unsound
- 5.3.13 Stump height should be as low as practicable (c. 30 cm) to maximise saleable volume
- 5.3.14 Stump heights over 30 cm are acceptable:
- where butt defect is obvious; or
  - in case of a buttressed tree, cutting should not be higher than the point at which buttresses can be trimmed to provide a diameter equal to that immediately above the buttressed section
  - When it is not appropriate to trim the buttresses the tree should be cut immediately above the buttress

## **5.4 Log Presentation**

- 5.4.1 All log preparations should be carried out at the stump, to ensure that nutrients from non-utilisable parts of the tree remain in the forest
- 5.4.2 Completely cross-cut (top and junk) logs so that splitting does not occur when the log is moved during extraction
- 5.4.3 Top and junk boles to obtain the maximum volume, consistent with highest value of saleable logs
- 5.4.4 Trim all buttress flutes, knots and branches flush with the main stem to:
  - a) gain maximum log quality and volume
  - b) reduce soil disturbance and assist skidding
- 5.4.5 Use S-hooks or plates on log ends to avoid end splitting and to maintain quality (before extraction or at the log market)

## **5.5 Skidding**

### **Restricted areas**

- 5.5.1 Machine access is prohibited in areas excluded from logging and their buffer strips
- 5.5.2 Logging machinery is not allowed to cross watercourses, swamps or enter their buffer strips, except for gullies and waterways at approved and properly constructed crossing points
- 5.5.3 Trees felled inadvertently into a buffer strip should be extracted using a winch
- 5.5.4 Machine access is prohibited within 10 metres of roads with berms or side cuts more than 1 metre high
- 5.5.5 Avoid skidding along or across primary and secondary haulage roads

### **Operation**

- 5.5.6 Logs should be winched the maximum distance possible, to reduce soil disturbance associated with skidding
- 5.5.7 Winches shall be fitted to all machines with a minimum length of wire rope of 40 m (19-22 mm diameter)
- 5.5.8 Skidder and tractor blades shall be raised when travelling and skidding

- 
- 5.5.9 Pushing soil on skid trails < 20% slope should be avoided
  - 5.5.10 Retain vegetation litter on skid trails
  - 5.5.11 Reverse along skid tracks towards the log
  - 5.5.12 Head or butt haul to reduce travel distance
  - 5.5.13 Machines shall be equipped with an integral arch or similar device to lift the end of the log off the ground to avoid soil damage and an increase in skidding resistance
  - 5.5.14 Avoid damage to soil and standing trees and regeneration along skid trails
  - 5.5.15 Skidding should commence at the rear end of the block and proceed along the main skid trails towards the log market
  - 5.5.16 Cross-cut long logs (>15 m) to reduce skidding damage consistent with highest value of saleable logs
  - 5.5.17 Wet weather restrictions apply

## **5.6 Log Storage**

- 5.6.1 The logging supervisor shall ensure that all felled, saleable timber is extracted from the stump area
- 5.6.2 Stockpile logs at well-drained log markets
- 5.6.3 Avoid stockpiling logs for more than one month; logs susceptible to blue stain no longer than five days after felling
- 5.6.4 Avoid stockpiling logs at markets that are poorly accessible in wet weather prior to the onset of a wet season
- 5.6.5 Sort logs at market before loading

## **5.7 Truck Loading, Hauling and Unloading**

- 5.7.1 Excavator type or rubber-tired or tracked front-end loaders should be used for loading and unloading logs where possible
- 5.7.2 Trucks should not be loaded in excess of their capacity
- 5.7.3 Protruding limbs, bark or trailing material should be removed before the truck departs the loading point

## 5.8 Weather Limitations on Logging Operations

Road construction and maintenance, skidding, loading and hauling when conditions are wet cause extreme damage to soil and water. It is also inefficient and often dangerous. Areas most likely to be workable in wet weather are those with less than 20% slope on stable soil types such as brown / white sand and laterite

The annual plan should specify wet and dry weather coupes

### **Felling**

5.8.1 Felling should cease when:

- a) wind force prevents accurate and safe directional felling
- b) ground conditions are too slippery to allow the felling crew to move safely and quickly away from the falling tree
- c) extraction or hauling is not possible due to weather and/or soil conditions

5.8.2 During short period of inclement weather, felling should be limited to ensure volumes cut at any one time can be promptly skidded and hauled

### **Road construction and skidding**

5.8.3 Skidding or road construction operations should cease when:

- a) soils are saturated and turbid water or mud is flowing down a skid trail for more than 10 metres; or
- b) soils are rutted to a depth of more than 30 cm below the original ground level over a section of 20 metres or longer; or
- c) puddles, sludge or slurry are formed along a skid trail or road to a depth of more than 20 cm over a 20 m section or longer; or
- d) turbid water or mud is flowing from a skid trail or road into a watercourse; or
- e) blading of mud or soil is necessary to maintain trafficability of a skid trail or road

5.8.4 The affected section of the trail or road should not be by-passed by opening up a new trail/road alongside or close by if on similar saturated ground conditions

### **Log market operations**

5.8.5 Construction or operations on log markets should cease when:

- a) water is ponding on the surface of the log market; or
- b) soils are rutted to a depth of more than 30 cm over more than 50% of the market area

## **Trucking**

5.8.6 Trucking should be halted when:

- a) trucks can not move unassisted along the roads because of slippery conditions;  
or
- b) turbid water or mud runs in wheel ruts, which are more than 10 cm below the road surface, for a length of 20 metres or more

## **Recommencement of operations**

5.8.7 Soils need to be allowed to drain after heavy rainfall events before forest operations recommence

5.8.8 Skidding in a section of a coupe may recommence only after water or mud ceases to flow on trails in that section of the coupe

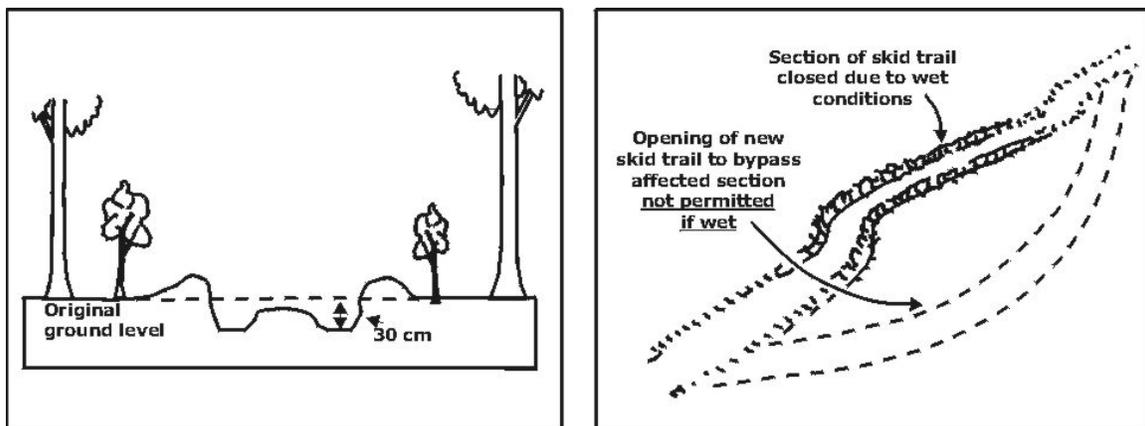


Figure V-3 Weather limitations on skidding

## **VI POST-HARVEST ACTIVITIES**

Rehabilitation of logged areas is required to prevent further deterioration of the logged area and downstream soil and water values, and to encourage forest regeneration. All areas should be left in a clean and tidy condition

### **6.1 Block closure**

- 6.1.1 Blocks should be closed once logging has been completed. A block that has been closed should not be re-entered and should remain closed until the next scheduled cutting cycle
- 6.1.2 An exception to this rule may be applied if no market exists for all harvestable timber at the time. The block may then be re-entered when a market for these species emerges at a later stage under the condition that a tree location map is available for the particular block and the annual plan amended

### **6.2 Roads**

- 6.2.1 The road surface should be maintained in good condition so the road can be reopened when required. There should be no ruts in the surface and the road surface should be crowned: cross-fall (camber) should be 4%
- 6.2.2 All ditches, turnout drains and cross-road drainage that will not be removed shall be left in good working condition
- 6.2.3 Remove log culverts and temporary bridges on decommissioned roads to allow unobstructed water flow
- 6.2.4 Check all bridges and culverts that will not be removed, including decking foundations and side walls
- 6.2.5 All debris that has been pushed into the watercourse shall be removed
- 6.2.6 Water should flow freely beneath a bridge or through a culvert
- 6.2.7 Clear all silt traps

## 6.3 Log Markets

- 6.3.1 Log market should be restored so that proper drainage occurs
- a) Drain all areas where water may pond.
  - b) Install drains with a gradient of 1-3%
- 6.3.2 Log markets on clay or loam should be ripped to a depth of 50 cm at 90° to the drainage direction to promote natural re-vegetation
- 6.3.3 Bark and debris should be disbursed evenly across the site to assist in stabilisation
- 6.3.4 The site shall be cleaned of all refuse; including oil/fuel drums and wire rope (see section 7.4)



Figure VI-1 Drain log markets and divert water flowing to markets once logging is completed

## 6.4 Skid Trails

- 6.4.1 Temporary skid trail crossings of waterways and gullies shall be removed after completion of the operation.
- 6.4.2 Removal should not disturb the watercourse banks
- 6.4.3 Place material at least 10 metres away from the watercourse
- 6.4.4 Spoon drains should be constructed to divert water away from the skid trail depending on the gradient of the trail section and erodibility of the soil with a maximum spacing of:

<b>Gradient (%)</b>	<b>Cross-drain spacing (metres)</b>
0-5%	Not required
5-10%	80
10-20%	40
>20%	20

6.4.5 Spoon drains should have:

- a) a bank height of at least 30 cm and a batter length of 1.5 m
- b) the bank is to be accompanied by a cut into the surface of the trail
- c) a cross-fall of 1-3%
- d) an angle of 45° to the trail alignment

6.4.6 Where skid trail are rutted to a depth of more than 30 cm below the original grounds level, over a section of 20 m or longer, the skid trail should be restored by filling in and draining

6.4.7 Do not increase the width of the trails by blading material from the side

6.4.8 Where a watercourse is diverted onto a skid trail at a crossing point, action shall be taken to restore water flow to its original watercourse

## **6.5 Borrow Pits**

6.5.1 Remove all non-biodegradable material and bury all biodegradable waste

6.5.2 Stabilise steep cuts

6.5.3 Re-grade the drain on the uphill side and ensure that runoff cannot enter the pit

6.5.4 Drain the surface of the pit if water is likely to pond

## **6.6 Field Camps**

6.6.1 Remove all rubbish (see section 7.4)

6.6.2 Drain all areas where water is likely to pond. Drains are not to empty directly into watercourses

6.6.3 Leave the area in a tidy condition

## VII OPERATIONAL HYGIENE

Maintenance, servicing and fuelling of logging equipment involves materials which could cause serious harm to soils and waters if released; pollution of groundwater or watercourses by oil, fuel, lubricants or other hazardous materials will eventually affect all flora, fauna and humans not only near the spill but also downstream.

Not maintaining a clean and tidy operation is a sign of poor worker attitude, careless management and disrespect for the environment

### 7.1 Workshop Facilities

- 7.1.1 Locate workshop facilities at least 100 m away from any watercourse or water body
- 7.1.2 Non-toxic solid waste should be removed or buried and covered with at least one (1) m of soil
- 7.1.3 Provide sullage pits for fuel and oil waste. Sullage pits are to be constructed so that:
  - a) they are at least three(3) m above the groundwater table
  - b) runoff water does not enter
  - c) they are at least 100 m from a watercourse or water body
- 7.1.4 Workshops, garages, schools and community centres and as far as practicable all other buildings must be approved by a public health inspector prior to their use
- 7.1.5 Electrical wiring and accessories in any building or structure shall be approved by the competent authority

### 7.2 Field Servicing and Maintenance

- 7.2.1 Field fuel tanks, refuelling points, chemical mixing points and maintenance areas shall be located:
  - a) in well-drained areas such as log markets or road junctions
  - b) outside areas excluded from harvesting and their buffer strips
  - c) more than 100 m away from any watercourse
- 7.2.2 Care shall be taken to prevent spillage during refuelling or repairs; adequate equipment – e.g. hand pumps – should be provided and used

- 7.2.3 Sump oil shall not be dumped in the harvesting areas, but collected and removed to the main disposal facility
- 7.2.4 All containers used in the transport, storage and use of toxic materials shall be leak proof, marked as “hazardous” and clearly labelled with the contents’ name.

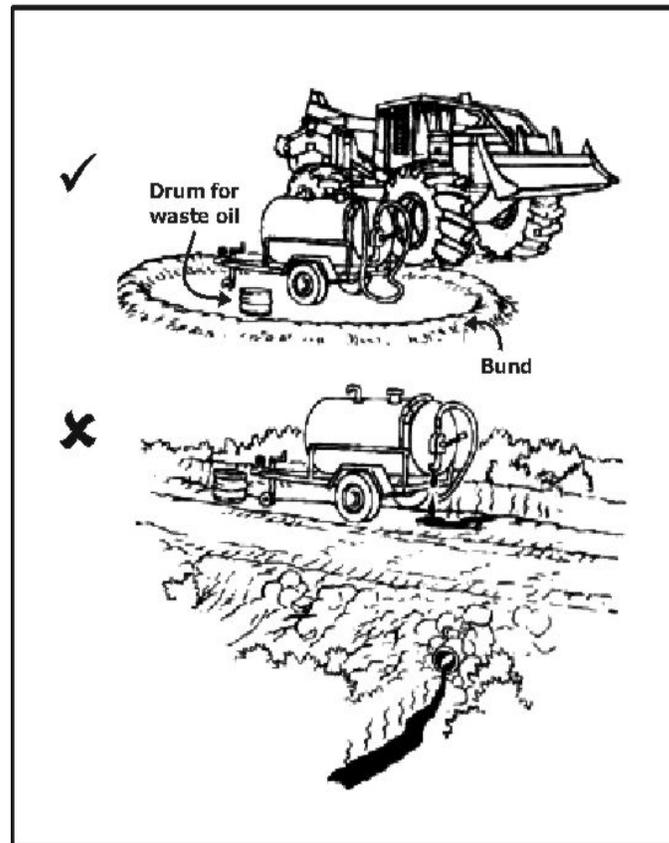


Figure V11-1 Care shall be taken to prevent spillage during refuelling; equipment maintained to minimise leaks

## 7.3 Fuel, Oil and Hazardous Chemical Handling and Storage

- 7.3.1 Hazardous chemicals includes preservatives, pesticides and herbicides
- 7.3.2 The GFC must be notified and give approval before a company starts using any pesticide or preservative in or near the forest. The company must obtain the relevant “Chemical Technical Data Sheet” and submit a copy to the GFC as part of the annual plan.
- 7.3.3 Chemicals must only be used when necessary to achieve defined management aims described in the Management and/or Annual Plan, or subsequently approved by the GFC, and in accordance with the manufacturer’s instructions.

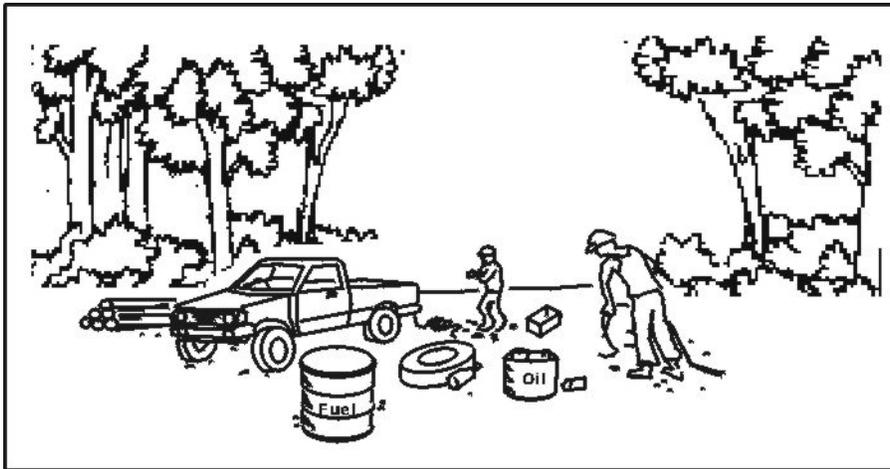
- 7.3.4 The types of chemical to be used, concentrations and application levels must be specified in the Annual Plan.
- 7.3.5 Locate main fuel, oil and hazardous chemical storage:
- a) in a well drained area at least 100 m from any watercourse; and
  - b) no closer than 100 m to any habitation
- 7.3.6 Drains are to be directed to a closed, stable and flood free disposal pit, situated at least 50 m from a watercourse or water body
- 7.3.7 Toxic materials are to be stored in a locked, dry, well-ventilated storeroom. Wet products are to be effectively separated from dry products. All entrances are to be clearly marked with a sign reading “warning – hazardous chemical storage - authorised persons only” or equivalent
- 7.3.8 Containers should not be stored on the floor, but are to be elevated above the floor on pallets or other means, to allow regular inspection and rapid identification of leaks
- 7.3.9 All containers used in the transport, store and use of toxic chemicals are to be leak proof, marked as “hazardous” and clearly labelled with the contents’ name
- 7.3.10 Concrete bunds with a capacity of twice the storage capacity of the largest storage container are to be provided around all storage facilities
- 7.3.11 Access to the storerooms of toxic materials should be restricted to authorised personnel
- 7.3.12 Smoking is not allowed in or adjacent to any storeroom of toxic material

**See 9.6 for further guidance**

## **7.4 Waste Management**

- 7.4.1 Toxic substances include (spent) hydraulic fluid, coolant, lubricants, fuel (gasoline/diesel/kerosene), industrial cleaners, paints and resins, preservatives (including timber treatment chemicals), distillates, insecticides and herbicides, and workshop waste, waste oil and contaminated sludge
- 7.4.2 The use of toxic substances is to be minimised and wherever possible biodegradable substitutes used
- 7.4.3 Toxic materials shall be collected in containers securely sealed and either dumped at a designated disposal facility, returned to the supplier or buried in an appropriately lined waste pit

- 7.4.4 All waste pits are to be covered with at least one (1) m of soil and located at least 100 metres from any watercourse or water body and at least one (1) m above the groundwater table. Signs should be erected identifying the waste pits.
- 7.4.5 Excess chemicals are to be either removed from the forest or chemically treated (neutralised)
- 7.4.6 Empty containers are to be safely disposed and not reused
- 7.4.7 Toxic materials shall never be disposed of into watercourses or lakes. Equipment used for applying chemicals shall not be washed in watercourses.
- 7.4.8 All refuse introduced to the forest e.g. pieces of wire rope, packing material, bottles, containers, etc. shall be removed from the forest, placed in a refuse pit, buried and covered to a level surface
- 7.4.9 Fuel and oil drums, used oil filters, oily rags, empty grease gun cartridges, worn machinery parts, paint tins, etc. shall be removed to a designated disposal area; or returned to the supplier
- 7.4.10 Discarded machinery shall be removed to the base camp



**Figure V11-2 All rubbish, e.g. wire ropes, plastic wrappings, fuel and oil drums, and oily rags should be removed regularly to a collection depot**

## VIII CAMP HYGIENE

Maintenance of safe, healthy and pleasant living and working conditions for personnel is a prerequisite for a motivated and fit workforce, hence productivity

### 8.1 Camp Design

8.1.1 Site plans should include designs for sewage, water supply, waste water and waste disposal

### 8.2 Water Supply and Domestic Waste Water

8.2.1 Camps are to be supplied with potable water obtained from running streams, rainwater or wells

8.2.2 Water storage tanks should be properly screened to prevent the breeding of mosquitoes

### 8.3 Waste and Refuse Disposal

8.3.1 An adequate number of plumbed toilets or pit latrines (one per household) shall be provided; plumbed toilets should drain into a septic tank.

8.3.2 Pit toilets shall be located at least 100 m away from watercourse and water bodies

8.3.3 Sewage shall be discharged so it does not enter:

- a) the catchments of drinking water supplies or intakes
- b) into a stream

8.3.4 Domestic waste water shall be directed to a disposal area (or septic tank) at least 20m away from the nearest building

8.3.5 All drains (waste water and sewage) should be kept covered

8.3.6 Provide refuse disposal areas:

- a) in pits that are above the groundwater table
- b) where runoff water cannot enter

- c) at least 100 metres away from watercourses, habitation or farmland
- 8.3.7 Cover refuse with soil to depth of 30 cm at least once per week

## **8.4 Water Ponding**

- 8.4.1 Camp areas shall be well-drained so that water does not pond or create mosquito breeding areas
- 8.4.2 The camp shall be checked regularly for any areas where stagnant water can accumulate

## **8.5 Additional Facilities**

- 8.5.1 Medical care should be provided if public health services are not available in the area where workers and their families live
- 8.5.2 Educational, recreational and spiritual services should be provided, where such services are not available nearby

## IX HEALTH AND SAFETY

Forestry is one of the most hazardous industrial sectors in most countries. Around the world, there have been discouraging trends of rising accident rates and a high incidence of occupational diseases and of early retirement among forest workers. However, good safety and health performance in forestry is feasible. Safety at work is not only an ethical imperative, but it also makes “dollars and sense”, by reducing e.g. sick leave, medical bills and down time

The practices and standards set out in this chapter are based on Code of Practice for Safety and Health in Forestry Work of the International Labour Organisation, Geneva and on the Occupational Health and Safety Laws of Guyana

### 9.1 General

- 9.1.1 Employers have the main responsibility for safety and health in forestry work; hence for installing and maintaining work systems and methods which are safe and without risk to health
- 9.1.2 Any kind of machine or mechanical device can be hazardous if not kept in good condition, or if operated by careless or improperly trained operators, or if operated in an irresponsible manner. All operators should therefore receive all necessary training and instruction to ensure competency to safely operate equipment for the job they are assigned to do.
- 9.1.3 Operators should know what the job requirements are, what other machines are working in the area, and be aware of any hazardous conditions that may arise
- 9.1.4 Be sure operators are alert and in proper physical and mental condition to perform work assignments safely. No machine should be operated by a person who is drowsy, under the effect of alcohol, medicine or drugs, suffers blackouts, or is suffering from any physical or mental distraction that could contribute to unsafe operation
- 9.1.5 Basic first-aid training (and refresher courses) should be provided to all personnel involved in field operations, log yard, workshop, etc.
- 9.1.6 All logging companies shall install a system whereby accidents, dangerous occurrences and occupational diseases are reported, recorded and investigated, and ensure that the necessary adjustments are made to prevent or reduce the incidence of these accidents, dangerous occurrences and occupational diseases in the future

- 9.1.7 Working hours should not exceed the number prescribed by national law or collective agreements. Working hours should be arranged to provide adequate periods of rest, which include: short breaks during work hours, sufficient breaks for meals, nightly rest and weekly rest. Operators should be encouraged to take short breaks during working hours to recover their vigilance and physical fitness.

## **9.2 Emergency Rescue**

- 9.2.1 Provision should be made for the quick evacuation of a person in the event of an injury or illness which requires medical assistance
- 9.2.2 Transport or a means of communication should be available at the worksite to contact rescue services in case of an emergency
- 9.2.3 At permanent worksites a place should be provided where an ill or injured person might rest in comfort until the evacuation is under way
- 9.2.4 Where professional help is not available within a reasonable distance, consideration should be given to the creation of the necessary dispensing and health-care facilities

## **9.3 Felling**

### **Protective Clothing and Safety Equipment**

- 9.3.1 A first-aid kit should be provided to every felling crew and located close to where felling crews are working
- 9.3.2 All felling crew members shall be provided with and wear:
- a) safety helmet not more than two years old;
  - b) ear defenders (e.g. earmuffs or –plugs)
  - c) safety boots with steel toe caps
- 9.3.3 Chain-saw operators should be provided with and wear:
- a) chain-saw gloves lined with cut-resistant material
  - b) eye protection (e.g. mesh face guard, goggles)
  - c) leg protection lined with cut-resistant material (e.g. chain-saw chaps)

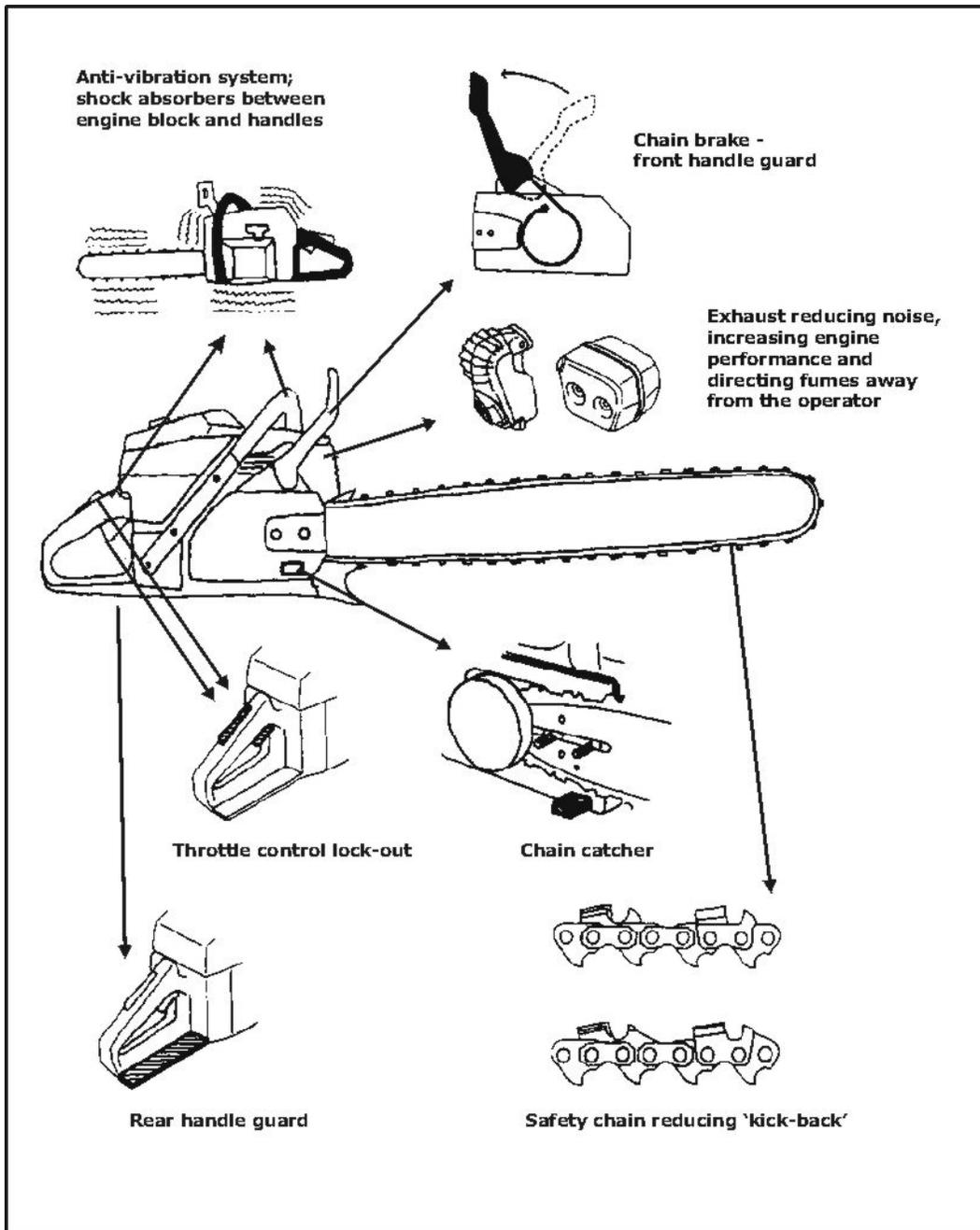
### **Equipment Safety**

- 9.3.4 All chain-saws shall be maintained in good working order and all safety devices shall be operational at all times. Specifically all chain-saws should be equipped with:

- a) a chain brake, which is activated manually by the front handle guard
- b) a front handle guard for protection of the left hand from the chain
- c) an on/off switch which is reachable with the right hand on the throttle
- d) a throttle control lock-out which prevents the chain-saw from being started unexpectedly, because two levers have to be pressed simultaneously
- e) a rear handle guard for protection of the right hand in case of chain breakage
- f) an anti-vibration system, consisting of rubber shock absorbers between the engine block and handles
- g) a chain catcher
- h) a spiked bumper (for safe and accurate cross-cutting)
- i) exhaust which directs fumes away from the operator
- j) a chain guard for avoiding injuries and protecting the chain during transportation
- k) chain-saw toolkit for corrective and preventative maintenance and adjustments.

### **Safe working practice**

- 9.3.5 Chain-saw operators should always have an assistant and shall never work alone in case of accidents.
- 9.3.6 No persons should approach closer to the feller than twice the height of the tree being felled, unless the feller has acknowledged that it is safe to do so.
- 9.3.7 Clear two alternative escape routes one at 135° and one at 215° to the intended felling direction
- 9.3.8 Make sure that there are no dead limbs or “hung-up” branches overhead
- 9.3.9 Clear saplings and debris away from the base of the tree to provide an adequate and safe working space
- 9.3.10 Chain-saws should not be operated above shoulder height because of the risk of kick-back and the resulting backward rotation of the guide-bar
- 9.3.11 Chain-saws should always be switched off or on the chain brake when moving about
- 9.3.12 The use of machines to pull trees while they are being cut is not allowed
- 9.3.13 When the tree begins to fall, step back and to the side into the escape route. Beware of falling branches and tops



**Figure IX-1 Safety devices on chain-saws**

9.3.14 Every effort shall be made to dislodge hung-up trees immediately

9.3.15 If hung-up trees can not be removed immediately, the surrounding area should be well marked with flagging tape to signal the danger

9.3.16 Do not fell the supporting tree nor fell another tree across the hung-up tree in an attempt to dislodge the hung-up tree

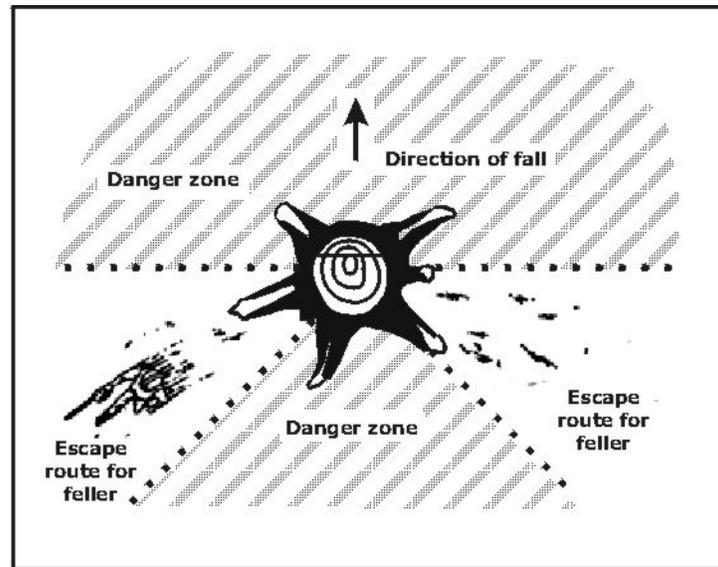


Figure IX-2 Clear two alternative escape routes

- 9.3.17 Only machines fitted with approved safety cabs should be used to dislodge hung-up trees. This should be done by pulling (winching) the tree off the stump and never by pushing against it or against supporting trees
- 9.3.18 When winching down hung-up trees the distance from the tree to the machine should be one and a half times the height of the tree
- 9.3.19 Beware of tension while cross-cutting logs and if necessary make a cut on the compression side to reduce tension
- 9.3.20 Do not stand on the trunk of the tree being cross-cut
- 9.3.21 When making the final cut always stand on the compression side of the log

## 9.4 Heavy Machinery

### **Definition**

- 9.4.1 Heavy machinery includes bulldozers, bucket and log loaders, skidders, motor graders, excavators, etc.

### **Protective Clothing and Safety Equipment**

- 9.4.2 Operators of heavy machinery and their assistants (choker man) shall be provided with and wear:
- a) a safety helmet not more than two years old;

- b) ear defenders (e.g. earmuffs or –plugs)
- c) safety boots with steel toe caps
- d) heavy duty work gloves (for handling wire rope)
- e) dust masks or respirators when appropriate

### **Equipment Safety**

9.4.3 All heavy equipment, including bulldozers, bucket and log loaders, excavators, skidders, tractors and motor graders, require:

- a) Regular maintenance to achieve and maintain safety standards and good working condition
- b) A safety cab which conforms to the Roll Over Protection Structure (ISO 3471 and ISO 8082) and Falling Object Protection Structure (ISO 8083) standards
- c) Access to and exit from machinery should be designed to provide hand and footholds of a convenient height and spacing
- d) Securely mounted seats and seat belts
- e) Rear portion of cabs fitted with protective wire mesh (except loaders, excavators and graders)
- f) Reversing alarms to alert people machines are backing up
- g) Securely guarded pulleys, shafts, belts and fan blades
- h) Engine emergency stopping devices that are not self-returning, clearly marked, and easily accessible from the normal operating position. The engine starter should be interlocked with the transmission or clutch to prevent the engine from starting when left in gear
- i) Parking brakes must be capable of keeping the machine and its rated load stationary on all slopes likely to be encountered
- j) First-aid kit and fire extinguisher (operators should be trained in their use)
- k) Exhaust systems fitted with spark arrestors

9.4.4 Farm tractors not equipped with the provisions listed above should not be used for timber extraction

9.4.5 No modifications shall be made to a machine that:

- a) interfere with operator visibility
- b) interfere with access to and exit from the machine
- c) exceed the rated payload or gross combination weight of the machine resulting in overloading the braking and/or steering system or the ROPS capacity rating

9.4.6 Do not place objects in the cab that intrude the operator's space or that are not firmly fixed into place

- 9.4.7 The safety cab shall not be modified, drilled, welded or altered in any way nor should any attempt be made to straighten any part of the frame when it has suffered damage

### **Skidding**

- 9.4.8 Skidding should not be carried out in site conditions where the stability of the machine cannot be assured. Equipment should not be operated on slopes exceeding 25% for a 2WD farm tractor, 30% for a 4WD farm tractor, 35 % for a rubber-tired skidder, and 40% for a crawler tractor (bulldozer)
- 9.4.9 Park the machine on level ground if possible. When parking on slopes apply the parking brake and lower the blade
- 9.4.10 Skidding across slopes should be avoided because of the significant decrease in skidder stability
- 9.4.11 No person other than the operator should be authorised to operate the machine
- 9.4.12 Do not carry passengers on the skidder unless a seat or is provided for that purpose
- 9.4.13 Do not carry objects (equipment) on the skidder unless a space is provided for that purpose and the object can be firmly fixed into place
- 9.4.14 While the skidder is moving or the winch cable is taut no worker shall:
- a) adjust or remove the attachments of logs
  - b) loosen chokers
  - c) cross or pass over the winch cable
  - d) be close to or touch the winch cable
- 9.4.15 When logs are skidded around a bend, workers on the ground should stand on the inside of the curve
- 9.4.16 No person should sit or stand on a moving load
- 9.4.17 Do not attempt to jump clear of an overturning machine – hold on tight and get out only when it is in a stable position

### **Loading and unloading**

- 9.4.18 Vehicles being loaded should be parked safely and braked securely
- 9.4.19 All persons other than the loader operator are to stay at least 20 metres from the truck during loading
- 9.4.20 No person should be in the cab or on the platform of the truck while loading is in progress, unless the cab is adequately protected

- 9.4.21 The grapple or fork should encircle the load completely
- 9.4.22 The load should be carried as close to the ground as possible
- 9.4.23 No person should walk or work under a raised load
- 9.4.24 During operations all four wheels should remain on the ground
- 9.4.25 No loading should take place over the cab of trucks

## **9.5 Vehicles**

### **Equipment Safety**

- 9.5.1 All vehicles, including logging trucks, dump trucks, fuel tankers and personnel carriers, require:
  - a) regular maintenance to achieve and maintain safety standards and a roadworthy condition
  - b) compliance with national requirements for fitness and safety
  - c) securely mounted seats and seat belts
  - d) securely guarded pulleys, shafts, belts and fan blades
  - e) first-aid kit
  - f) fire extinguisher
- 9.5.2 To protect the cabin from penetration by an unsecured load, logging trucks shall incorporate an adequate log barrier or guard between the load and the cabin
- 9.5.3 Logging machinery and vehicles using public roads should have an amber flashing light on top of the cab or other prominent point installed which is switched on when appropriate

### **Safe Working Practice**

- 9.5.4 Trucks should not approach a log market when there is danger from incoming logs
- 9.5.5 Trucks should not be overloaded
- 9.5.6 Riding on any part of a logging truck other than in the cab is prohibited
- 9.5.7 Side stanchions on trucks and trailers should be vertical after loading and bunks aligned properly
- 9.5.8 All loads should be secured with at least two approved load binders

- 9.5.9 Protruding limbs, bark and trailing material (e.g. vines) should be removed before the truck leaves the log market

## **9.6 Hazardous Chemicals**

- 9.6.1 Workers applying hazardous chemicals must receive training and full information on the risks involved in the use of protective equipment and first-aid techniques.
- 9.6.2 Protective clothing, as recommended on the container label, must be worn by workers handling chemicals. It is the company's responsibility to ensure that all protective clothing provided is used by its workers.
- 9.6.3 Chemicals must always be utilised with the proper equipment, as recommended by the manufacturer. The equipment must function properly and be free from leaks and blockages.

## **9.7 Workshop and Log Yard Workers**

- 9.7.1 Workshop mechanics and other workers, and workers in log yard areas should be provided with and wear protective clothing, ear defenders, eye protection, respirators, and/or gloves, as appropriate for the equipment being used (e.g. welding, angle grinding, spray painting)

## **9.8 Fire Precautions**

- 9.8.1 Operations should cease in times of high fire risk
- 9.8.2 Machinery should be clear of surplus oil and fuel
- 9.8.3 Remove trash (leaves, twigs, paper, etc.) from machines that may accumulate near surfaces that will become heated by the engine or exhaust system
- 9.8.4 Do not operate machinery if leakage of flammable fluids is noticed. Most fluids used in heavy machinery should be considered flammable
- 9.8.5 Avoid attaching electrical wiring to hoses and tubes that contain flammable or combustible fluids
- 9.8.6 Replace any rubbing, damaged, frayed, kinked or leaking hydraulic hoses and fittings
- 9.8.7 Refuelling shall only be carried out in areas where the ground is clear of all inflammables for a distance of 3 metres in all directions from the machine

- 9.8.8 All welding activity shall be done at least 3 metres away from flammable materials
- 9.8.9 No fire shall be left unattended in the forest
- 9.8.10 Fires for cooking or other purposes shall only be lit in areas cleared of flammable material within a 3-m radius around the fire
- 9.8.11 All machines and chain-saws should be fitted with spark arrestors

## **X SOCIAL ISSUES**

Sustainable forest management is ultimately about people. Healthy social practices in managing forests promises to foster sound business as well as to improve Guyana's economy. The forests need to be socially beneficial to contribute to the objective of sustainable development. The benefits derived from the existence and management of the forests, and accruing to people living in and around them may be a precondition for the conservation of the forest.

The practices and standards set out in this chapter are based on the land and forest use rights and responsibilities; and community and work place relations, rights and responsibilities.

### **10.1 Land and forest use rights and responsibilities**

#### 10.1.1 Respect for legal or customary rights to land

- a) Forest operators shall have legal evidence of their right to operate in a given area
- b) Forest operators shall restrict their forest operations to the area to which they are legally entitled
- c) The GFC should be informed of any illegal forestry activity

#### 10.1.2 Rights of Amerindians

- a) The legal, social, and ecological integrity of all Amerindian lands shall be respected
- b) Disputes over Amerindian land tenure and use rights should be brought to the attention of the Ministry of Amerindian Affairs and Guyana Lands and Surveys commission

#### 10.1.3 Commercial contracts with Amerindian communities

- a) Persons desirous of negotiating commercial forestry contracts with an Amerindian Council should contact the relevant Amerindian Council and the Ministry of Amerindian Affairs
- b) Amerindian Village Councils that are desirous of entering into commercial forestry contracts should seek advice from the Ministry of Amerindian Affairs, and the Guyana Forestry Commission

#### 10.1.4 Conflict management between forest operations and local communities

- a) Forest operators and elected or recognized community representatives should use methods of consultation as a first step to resolving any conflict(s) that might arise before exploring other legal options

- b) A neutral third party should be invited to facilitate negotiated agreements between forest operators and communities

## **10.2 Community and work place relations, rights and responsibilities**

### 10.2.1 Respect for cultural and traditional values

- a) Forest operators should give special regard to the cultural and traditional values of the communities in and adjacent to their operations

### 10.2.2 Building mutually beneficial partnerships

- a) Forest management operators should adopt a mechanism for engaging the local communities, community base organisations and other interest groups in a dialogue that is aimed at ensuring that socio-economic benefits accrue to the local population
- b) All parties have copies of a joint plan
- c) Local representatives are present at meetings and participate in decision making
- d) Attention is given to such critical areas as health, education, transportation
- e) Local population is not totally dependent on the forestry operation and the services that they provide

### 10.2.3 Terms and conditions of employment

- a) Employers shall inform employees of the terms and conditions of service prior to or at the time they are hired
- b) Prior to or upon assumption of duties, an employer shall document and inform an employee of his/her wages by task or by day
- c) Contractors are obliged to adhere to conditions applicable to employers/concessionaires
- d) Employers/concessionaires should develop a contract agreement between the concessionaire/employer and the contractor to include the following:
  - i. The parties agree that a written agreement between the concessionaire/employer and any contractor shall be the basis of any engagement with any such contractor for the purpose of conducting forest operations on the concession area
  - ii. The employer/concessionaire shall provide a copy of any written agreement with any contractor(s) for the consideration of the Commissioner of Forests at least one month prior to the desired date of commencement of work by the contractor(s)
  - iii. The parties agree that any agreement regarding contractual work in which the employer/concessionaire is engaged must include the following:

- 
- a. an explicit statement that the employer/concessionaire is responsible directly for all actions of the contractor
  - b. an explicit statement committing the employer/ concessionaire and the contractor(s) to full compliance with the terms of the concession agreement, the provisions of the most recent Forest Management Plan and the provisions of the most recent Annual Operational Plan
  - c. an explicit statement committing the employer/concessionaire to responsibility for the social welfare of contractors and their families, while such contractors are engaged in the approved contractual operations
  - d. an explicit provision making clear that there shall be no transfer whatsoever of the concession, the concession area or any part thereof
- iv. The contractor agrees that it will maintain registers of all employees, together with employment records (including PAYE and NIS contributions) and that such registers will be available for scrutiny by the Guyana Forestry Commission and concessionaire, and such other agencies approved by the Guyana Forestry Commission

#### 10.2.4 Equal opportunity employment

- a) Women and men shall be paid equal remuneration for the same work or work of equal value
- b) Employees shall not be discriminated against based on race, sex, religion, colour, ethnic origin, etc.

#### 10.2.5 Prohibition against forced labour

- a) Employers shall ensure fair remuneration and humane working conditions in return for all services rendered
- b) Employers shall observe ILO Convention 182 on forced labour

#### 10.2.6 Employment Opportunities for local and forest-dependent populations

- a) Management should give priority to employing equally qualified persons who live in communities within or adjacent to the forestry management operation

#### 10.2.7 Education and training for workforce and local populations

- a) A range of educational and skills training programmes for the purpose of enhancing workers' job performance and promotion within the workplace should be made available on an appropriate basis
- b) Educational and vocational skills programmes should be made available to communities within or adjacent to the forest management operation
- c) Wherever possible, certification for educational and skills training programmes should be issued by a recognized institution or body

#### 10.2.8 Social security benefits

- a) Employers shall provide employees with information on the NIS
- b) Employers shall make the necessary arrangements for NIS coverage for their employees
- c) Employers should inform employees about the procedures for recovering damages in respect of personal injury or in respect of death resulting from personal injury

#### 10.2.9 Recreation

- a) Employees shall have the benefit of adequate rest and recreation time and facilities in keeping with the labour laws of Guyana

#### 10.2.10 Prohibition against child labour

- a) Employers shall not knowingly employ persons under the age of 14 in keeping with the International Labour Organization Convention 182

#### 10.2.11 Workers right to union representation

- a) Employees shall not be prevented from joining a union or association or from negotiating for wages and conditions with their employers as stipulated under the Trade Union and Recognition Act No: 32 of 1997

#### 10.2.12 Conflict management in the workplace

- a) In the event of an industrial dispute, the relevant parties should first explore to resolve through management/shop steward discussions. If this step fails then the parties involved should seek to utilise the mechanisms of conciliation and arbitration

#### 10.2.13 Regulation of occupational safety and health

- a) Stipulation in the 1997 Occupational Safety and Health Act shall be observed

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## XI GLOSSARY

Abutment	End support for bridge culvert or similar structure
Adverse grade	Grade up which a loaded logging truck must travel
Batter	Inclination or shape of a cutting beside a road or track
Berm	Ridge of soil typically along the outside edge of a road shoulder or skid trail. It intentionally or unintentionally directs surface runoff onto or alongside the roadbed or skid trail
Biodegradable	Capable of being decomposed by bacteria, fungi or other living organisms
Biodiversity	The range of diversity of plants or animals, including the diversity of different species, the variation found within species and the variety of ecosystems
Borrow pit	An area where excavation takes place to produce materials for earthwork, such as fill material for embankments and surfacing material. It is typically a small area outside the roadway for obtaining sand, gravel, laterite, or loam without further processing
Box cut	A road cut through a hill slope or, more commonly a ridge, in which there is a cut slope on both sides of the road. Also called <b>through cut</b>
Bucking	Cross-cutting of a log in shorter sections
Bridge	A structure that provides for vehicle access over a watercourse
Buffer strip	Strip of vegetation left intact along a watercourse or other sensitive area or site during and after logging.
Buttress	A ridge of wood that develops in the angle between a lateral root and the base of a stem to provide lateral root stability to the stem
Camber	The amount of cross-fall on a road
Catch drain	A drain constructed above a batter to prevent erosion of the batter by surface water
Catchment	An area or basin of land bounded by natural geomorphologic features such as hill crests and ridges from which water drains and flows to a watercourse, lake, wetland or estuary
Chain brake	A safety device on a chain-saw designed to stop the chain in the event of a kick-back

Channel	A waterway that contains flowing water either periodically or continuously. A channel has a defined bed and banks that confine the water
Chaps	Chainsaw chaps are half-trousers which contain material designed to protect against chain-saw cuts
cm	centimetre
Compaction	The process of reducing the apparent volume of the soil, by reducing the empty spaces between particles and increasing the density of the soil under the influence of pressure. Compaction is desirable when a soil is to be used as the base of a road, because it improves stability and reduces infiltration. For the same reasons, compaction is undesirable in the forest, because it has a negative effect on plant growth and survival and soil life
Compartment	A sub-division of a concession frequently of several thousand hectares. It is normally defined along natural boundaries
Competency	A concept that focuses on what is expected of a person in the workplace rather than on the learning process. It embodies the ability to transfer and apply skills and knowledge to new situations and environments
Corduroy	Cording or matting involving the use of suitable logs to spread the weight of the load and separate machine tyres or tracks from direct soil contact during harvest operations, thus reducing ground pressure and rutting
Coupe	A defined area of forest of variable size, shape and orientation, on which harvesting takes place; usually to be harvested over one year
Cross-cutting	Cutting through a felled log. Sometimes called <b>bucking</b>
Cross-drain	A ditch and earth bank constructed at approximately right angles to a track, preventing water from building up speed along the track and allowing redirection of running water into surrounding areas
Crown	A crowned road surface has the highest elevation at the centre line (convex) and slopes down on both sides. Crown is used to facilitate draining water off the road surface
Cultural area	Area of social, cultural, historical, religious, spiritual, archaeological or anthropological importance to forest dwellers; usually to indigenous populations. Includes villages, farms, gardens and sites which are culturally sensitive
Culvert	A conduit, typically of made of metal, concrete, plastic or (hollow) logs, set beneath the road surface, to move water from the inside of the road to the outside of the road. Culverts are used to drain (inside) ditches and watercourses (commonly gullies) that cross the road. Also called <b>koker</b>

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Cut-and-fill	A method of road construction in which a road is built by cutting into the hillside and spreading the spoil materials in adjacent low spots and as compacted or side cast fill slope material along the route. A <b>'balanced cut-and-fill'</b> utilizes all of the 'cut' material to generate the 'fill'. In a balanced cut-and-fill design, there is no excess waste material and there is no need for hauling additional fill material. Thus, cost is minimised.
Cut slope	The artificial face or slope cut into soil or rock along the inside edge of the road
Cutting cycle	In selective (polycyclic) harvesting systems: the planned number of years between successive harvests on an area of forest. It is also referred to as felling cycle
Dbh	Diameter at breast height; 130 cm above the ground
Debris	Organic material, rocks and sediment (leaves, brush, wood, stones, rocks, rubble, etc.) often mixed, that is undesirable in a channel or drainage structure. Compare <b>sediment</b>
Directional felling	A concept that focuses on predetermining the final direction of fall of a felled tree. It includes selecting a particular direction of fall based on a predefined set of criteria and the felling techniques and aids involved in felling the tree in the selected direction
Ditch	A channel or shallow canal along the roadbed intended to collect water from the road and adjacent land for transport to suitable point of disposal. Also called <b>table drain</b> or (incorrectly) <b>side drain</b>
Erodibility	See <b>soil erodibility</b>
Erosion	See <b>soil erosion</b>
Exclusion area	Area which is excluded from harvesting
Favourable grade	Grade down which an unladen logging truck must travel
Feeder road	A road connecting log markets to a secondary or primary road; also called <b>spur road</b>
Fill	Excavated material placed on a prepared ground surface to construct the road sub-grade and roadbed template. Also called <b>embankment</b>
Fill slope	The inclined slope extending from the outside edge of the road shoulder to the toe of the fill. Also called <b>embankment slope</b>

Flood plain	A level or gently sloping area on either side of a watercourse contemporary channel that is submerged at times during high water of periods of flooding.
Ford	A rock, other hardened or corduroy structure that is built across the bottom of a watercourse channel that is usually dry, to allow improved vehicle passage during periods of low water or no flow and minimises channel disturbance or sediment production
Geotextile	Any permeable textile material used with soil, rock or any other geotechnical engineering related material, as an integral part of a man-made product, structure or system, usually related to the passage of water
Grade	The slope of the road along its alignment. This slope is expressed in percent – the ratio of elevation change compared to distance travelled. Also called <b>gradient</b>
Groundwater	The part of the subsurface water that is in the zone of saturation, including underground streams
Guard log	Log along the outside of a bridge, above the main stringer logs to prevent gravel from falling off the bridge into a watercourse
Gully	Steep sided drainage channel where water may flow during a wet season or only after a rainfall
Gullying	Scouring of the soil by high velocity water flow resulting in channels where water runs down a slope, embankment or roadbed
ha	hectare
Habitat tree	A habitat tree is a mature living tree selected to be retained during harvesting because it has features of special value for wildlife (e.g. hollows).
Harvesting debris	Broken logs, branches, twigs, vines, epiphytes and other tree related vegetative material brought down as a result of felling or skidding
Hauling	Transport of forest products, particularly logs, from the log market to the processing facility, commonly by way of logging trucks
Headwall	A concrete, masonry or timber wall built around the inlet or outlet of a culvert to increase inlet flow capacity, reduce risk of debris damage, retain the fill material and minimise scour around the culvert inlet or outlet
Hung-up (trees)	A tree which has not completely reached the ground following cutting

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Inlet	The opening of a drainage structure or culvert where the water first enters the structure
In-slope	The inside cross-slope of a road surface, typically measured in percent. In-slope is used to facilitate the draining of water from a road surface to an inside ditch. An in-sloped road has the highest point on the outside edge of the road and slopes downward to the ditch at the toe of the cut slope, along the inside edge of the road
Integral arch	An extension to the body of extraction equipment, which raises the anchor point of the wire rope and thereby lifting the load off the ground, also called <b>logging arch</b>
Junking	Trimming of the butt end of a felled log. Also (incorrectly) called <b>bucking</b>
km	kilometre
Landing	See <b>log market</b>
Logging	Logging is the process of harvesting timber from trees. This includes felling, skidding, loading and transporting forest products, particularly logs. Pre-harvest inventory, tree and skid trail marking can be part of the process
Log deck	See <b>log market</b>
Log market	A cleared area, usually adjacent to the roadbed where logs are assembled after being skidded, awaiting subsequent handling, loading and transport. Also called <b>ramp, log deck</b> or <b>landing</b>
Logging arch	See <b>integral arch</b>
m	metre
mm	millimetre
m <sup>2</sup>	square metres
m <sup>3</sup>	cubic metres
Outlet	The opening of a drainage structure or culvert where the water leaves the structure. The outlet should be lower than the inlet to ensure that water flows through the structure
Out-slope	The outside cross slope of a road surface, typically measure in percent. Out-slope is used to facilitate the draining of water from a road or trail directly off the outside edge of the road or trail. An out-sloped road or trail has the highest point on the uphill or inside of the road or trail and slopes down to the outside edge of the road

Potential crop tree	Stems of commercial species remaining after the cut and forming the basis of subsequent cutting cycles
Riprap	Layer of large, durable materials (usually stone or rock) used to protect exposed soil to minimise erosion
Roadbed	The formation between the ditches or tops of embankments, including the travel way and shoulders
Roadway	The formation between the extreme limits of the earthworks, from the top of the cut slope to the toe of the fill or graded area. Also called <b>road formation</b> or <b>width of earthworks</b>
Road reserve	The area that corresponds to the limit of the ground affected by the road, usually equals the width of clearing
Rutting	Road or skid trail surface damage in the form of deep tracks made by the passage of wheels or tracks. This typically a result of high wheel pressure on saturated or low load bearing soils. These conditions worsen with heavy loads, high traffic volumes and inclement weather conditions
Scour	Erosion or soil movement in a watercourse bed, bank, channel, or behind a drainage structure, typically caused by increased water velocity or lack of protection
Sediment	Fragments of rock, soil, and organic material transported and deposited in bed by water, wind or other natural phenomena
Sedimentation	Deposition of material suspended in water or air, usually when the velocity of the transportation medium drops below the level at which the material can be supported
Sediment trap	See <b>silt trap</b>
SFP	State Forest Permit; non-exclusive permit allowing the holder to remove a certain quota of timber from an area, valid for one year
Shoulder	The strip along the edge of the travel way on either side of the road, commonly flush with the travel way for roads on stabilised soil. It is generally only used by passing vehicles but may be used for travel by track machines. Also called <b>verge</b>
Side cast	Road construction material that is not used for fill and is pushed to or placed on the down slope side of the road. Such material may travel long distances down slope before coming to rest
Side drain	See <b>ditch</b>

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Silt trap	Hole created to divert sediment laden water, creating enough residence time to allow solid material in suspension to drop out, before it is diverted back into a body of water or drainage structure
Sight distance	The distance along a road or track that a driver can see other objects (usually other vehicles)
Skidding	A method of ground-based extraction in which logs, poles or whole trees are dragged from the felling point to the log market, commonly by means of a tractor equipped with a cable-arch or a grapple known as a skidder, but also by means of farm tractors, crawler tractors, or bulldozers equipped with a winch or chains. Also called <b>yarding</b>
Skid trail	Trail along which a log is dragged by a extraction machine to the log market
Soil erodibility	The inherent susceptibility of a soil to erosion
Soil erosion	The process by which soil particles and aggregates are worn away and moved by the actions of wind or water in the form of raindrops, surface runoffs, and waves
Spoon drain	A shallow open drain, normally traversable by vehicles designed to carry water to the side of a road or skid trail
Stakeholders	Individuals or groups of individuals who have an interest in, or an impact on, the outcomes of a decision as well as groups or individuals dependent to some degree on the outcome for their personal or institutional goals
Stanchions	Upright posts or supports for confining logs on trucks, trailers or other vehicles
Strategic plan	Long term plan, which provides a broad description and broad details of future harvesting and management.
Sustainable forest management	The process of managing forests to achieve one or more clearly specified objectives of management with regard to the production of a continuous flow of desired forest products and services, without undue reduction of its inherent values and future productivity and without undue undesirable effect on the physical and social environment.
Swamp	A generally or permanently waterlogged area which may or may not have associated tree or palm vegetation; or a tract or low, poorly drained ground with patches of open water in which reeds, rushes and sedges occur. Swamp sediments are dominated by still water deposits, commonly with high organic content
Table drain	See <b>ditch</b>

Temporary crossing	A crossing of a watercourse by a skid trail or road construction equipment designed for removal following short term use, having a designated opening to take typical peak flows, e.g. a log culvert, and a cover of slash or small stems for a running surface
Topping	Severing the crown of a felled tree from the usable stem, usually at the first heavy branch. Also called <b>junking</b>
Travel Way	That portion of the road constructed for use by moving vehicles (excluding shoulders). Also called <b>Carriageway</b>
TSA	Timber Sales Agreement; concession with a duration of $\geq 20$ years and a total area $\geq 24,281$ ha
Turbid water	Water bearing significant quantities of soil particles
Turnout drain	Excavations designed to divert water away from the ditch and roadway in order to reduce the volume and velocity of roadside ditch water. Also called <b>outlet, lead-off, mitre</b> or <b>side drain</b>
Unstable areas	Sites susceptible to one of the forms of mass soil movement or accelerated soil erosion as a result of the interaction of such factors as steepness, soil properties, parent and surface geology and the position in the land form profile
Verge	See <b>shoulder</b>
Washboard	A series of ridges and depressions across the road caused by soil and aggregate road surfaces by the lack of surface cohesion. This typically is a result of the loss of fines in the road surface caused by dry conditions or poorly graded material. These conditions worsen with excessive vehicle speeds and high traffic volumes
Water body	Watercourses and surface water such as lake, lagoon, sea or ocean
Watercourse	Defined depression or channel that receives and conducts perennial or intermittent flows of surface water for part or all of the year in most years. Watercourses includes rivers, creeks, gullies and waterways
WCL	Wood Cutting Licence; concession with a duration of 3-10 years and a total area 8,093-24,281 ha
Wedge	A high impact plastic, aluminium or hardwood wedge driven into the back-cut to assist felling
Wire rope	Flexible twined metal alloy or steel rope to tie, pull or lift loads; in this context the cable by which logs are winched or attached to the skidder. Also cable

Winch	A rotating powered drum used to haul in or pay out a cable (wire rope)
Wing wall	Masonry, concrete or timber structures built onto the side of culvert inlet and outlet headwalls or bridge abutments, designed to retain the roadway fill and direct water into or out of the drainage structure or underneath the bridge while protecting the road and fill from erosion

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## XIII APPENDIX 1

### Converting Factors for Common Units of Measurement

Length	cm	m	km	in.	ft	yd	chain	mile
1 centimetre	1	0.01	0.00001	0.39370	0.03281			
1 meter	100	1	0.001	39.370	3.2808	1.0936	0.04971	0.00062
1 kilometre	100000	1000	1	39370	3280.8	1093.6	49.710	0.62137
1 inch	2.54	0.0254		1	0.08333	0.02778		
1 foot	30.48	0.3048	0.00030	12	1	0.33333	0.01515	0.00019
1 yard	91.44	0.9144	0.00091	36	3	1	0.04545	0.00057
1 chain	2011.7	20.117	0.02012	792	66	22	1	0.0125
1 mile	1609.3	1609.3	1.6093	63360	5280	1760	80	1

Area	m <sup>2</sup>	ha	km <sup>2</sup>	sq. in.	sq. ft	sq. yd	acre	sq. mile
1 metre <sup>2</sup>	1	0.0001	0.000001	1550.0	10.764	1.1960	0.0002	
1 hectare	10000	1	0.01	15500031	107639	11960	2.4711	0.0039
1 kilometre <sup>2</sup>	1000000	100	1		10763910	1195990	247.11	0.3861
1 square inch	0.0006			1	0.0069	0.0008		

1 square foot	0.0929		144	1	0.1111			
1 square yard	0.8361		1296	9	1			
1 acre	4046.9	0.405	0.0040	6272640	43560	4840	1	0.0016
1 square mile	2589988	258.999	2.5900	27878400	3097600	640	1	

1 hectare = 100 are  
 1 square foot per acre = 0.2996 square metres per hectare  
 1 square metre per hectare = 4.3560 square feet per acre

Cubic measure	cm <sup>3</sup> (=cc)	m <sup>3</sup>	cu. in.	cu. ft	Hoppus	BM	cu. yd
1 centimetre <sup>3</sup>	1	0.000001	0.06102	0.000035	0.000045	0.00042	0.000001
1 metre <sup>3</sup>	1000000	1	61024	35.315	44.964	423.78	1.3080
1 cubic inch	16.387	0.000016	1	0	0.00074	0.00694	
1 cubic foot	28317	0.02832	1728	1	1.2732	12.0000	0.03704
1 Hoppus foot	22240	0.02224	1357.2	0.78539	1	9.4248	0.02909
1 board foot	2359.7	0.00236	144	0.08333	0.10610	1	0.00309
1 cubic yard	764555	0.76455	46656	27	34.377	324	1

1 cubic foot per acre = 0.06997 cubic metres per hectare

1 cubic metre per hectare = 14.29 cubic feet per acre

Capacity measure	ml	l	US fluid oz	US fluid qt	US gal	Imp fluid oz	Imp pint	Imp gal
1 millilitre	1	0.001	0.0338	0.0011	0.00026	0.0352	0.0018	0.0002
1 litre	1000	1	33.814	1.0567	0.26417	35.197	1.7598	0.2200
1 US fluidounce	29.574	0.0296	1	0.0313	0.00781	1.0409	0.05204	0.0065
1 US fluid quart	946.35	0.9464	32	1	0.25	33.308	1.6654	0.2082
1 US gallon	3785.4	3.7854	128	4	1	133.23	6.6617	0.8327
1 Imp fluidounce	28.412	0.0284	0.9607	0.0300	0.00751	1	0.05	0.0063
1 Imp pint	568.24	0.5682	19.214	0.6005	0.15011	20	1	0.125
1 Imp gallon	4545.9	4.5459	153.72	4.8036	1.2009	160	8	1

## XIV APPENDIX 2

### Slope Angles in Degrees and Per Cent

Degrees (°)	Per cent (%)	Per cent (%)	Degrees (°)
1	2%	1%	0.6
2	3%	2%	1.1
3	5%	3%	1.7
4	7%	4%	2.3
5	9%	5%	2.9
6	11%	6%	3.4
7	12%	7%	4.0
8	14%	8%	4.6
9	16%	9%	5.1
10	18%	10%	5.7
11	19%	12%	6.8
12	21%	14%	8.0
13	23%	16%	9.1
14	25%	18%	10.2
15	27%	20%	11.3
16	29%	22%	12.4
17	31%	24%	13.5
18	32%	26%	14.6
19	34%	28%	15.6
20	36%	30%	16.7
21	38%	32%	17.7
22	40%	34%	18.8
23	42%	36%	19.8
24	45%	38%	20.8
25	47%	40%	21.8
26	49%	42%	22.8
27	51%	44%	23.7
28	53%	46%	24.7
29	55%	48%	25.6
30	58%	50%	26.6
31	60%	55%	28.8
32	62%	60%	31.0
33	65%	65%	33.0
34	67%	70%	35.0
35	70%	75%	36.9
36	73%	80%	38.7
37	75%	85%	40.4
38	78%	90%	42.0
39	81%	95%	43.5
40	84%	100%	45.0
41	87%		
42	90%		
43	93%		
44	97%		
45	100%		