Republic of Liberia

Forestry Development Authority

CODE OF FOREST HARVESTING PRACTICES

- 2nd Edition as Amended on 31 May 2017 -

Co-funded by

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ACRONYMS AND ABBREVIATIONS

CFMA	Community Forest Management Agreement
cm	centimeter
dbh	diameter at breast height (130 cm above the ground)
DFID	UK Department for International Development
ESIA	Environmental and Social Impact Assessment
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FDA	Forestry Development Authority
FMC	Forest Management Contract
FOPS	Falling Object Protective Structures
ha	hectare
HIRAC	Hazard Identification, Risk Assessment and Control
km	kilometer
m	meter
m^2	square meters
m^3	cubic meters
mm	millimeter
MPW	Ministry of Public Works
OPS	Operator Protective Structures
PDCA	Plan-Do-Check-Act
PPE	Personal Protective Equipment
PUP	Private Use Permit
ROPS	Roll Over Protective Structures
SPEQS	Safety, Productivity, Environment, Productivity and Social
TSC	Timber Sales Contract
VPA	Voluntary Partnership Agreement under the EU Forest Law Enforcement, Governance and Trade (FLEGT) Action Plan

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Mailing address: Whein Town, Mount Barclay, Montserrado County, Monrovia, Liberia

Website: http://www.fda.gov.lr/

Compilers of this 2nd edition: Michal Brink and Andrew Mc Ewan of CMO, and Wolfgang Thoma of DAI Europe Ltd.

Artwork: Sonja van Dyk

FOREWORD

By Darlington S. Tuagben
Managing Director, Forestry Development Authority

Liberia is endowed with extensive forest resources that provide important environmental, social and economic benefits to its people. The wise use of these resources is essential if their multiple values are to be maintained for the benefit of present and future generations.

Forest harvesting can generate many economic and social benefits. However, poor practices can lead to serious environmental degradation and adverse impacts on forest dependent communities.

Our National Forest Policy aims *"to conserve and sustainably manage all forest areas, so that they will continue to produce a complete range of goods and services for the benefit of all Liberians and contribute to poverty alleviation in the nation, while maintaining environmental stability and fulfilling Liberia's commitments under international agreements and conventions"*. Therefore, this Code is an important part of our national approach to sustainable forest management. It provides practical guidance to forestry officers, landowners, contractors and the forest industry on how forest harvesting should be conducted so as to achieve best practice and minimize any adverse impacts.

This 2nd edition of the Code puts social and environmental values in the forefront of forest harvesting. It highlights that our harvesting operations must be well planned and supervised in order to minimize intolerable high risks, and that our forest workers work in a safe environment while having the right skills and knowledge to achieve good practices.

The Code applies to all harvesting operations within Liberia's natural forests. However, the Code by itself will not bring about changes in forest management. It will be the people who are using the Code that will shape the forests for future generations to come. This is a responsibility that extends to every person in Liberia who has an involvement or an interest in the sustainable management of our natural forests.

1 INTRODUCTION

1.1 Towards Best Practice Timber Harvesting

The Forestry Development Authority (FDA) published their first Liberian Code of Practice for Timber Harvesting (**referred to as the "Code" hereafter**) in September 2007. The FDA developed the first Code to provide a clear set of guidelines to help foresters and logging companies select practices to be followed when carrying out harvesting operations.

The purpose of the original guidelines was to prescribe a code of timber harvesting practice, to which the FDA required all forest operators to adhere and thus meeting the requirements of responsible forest management while simultaneously meeting legal requirements.

The goal of responsible forest management cannot be reached unless improved harvesting practices are widely adopted by loggers. The emphasis in this document is on the harvesting practices themselves. If these are improved, then it is more likely that the economic, environmental and social values of the country's forests will be maintained while at the same time providing sustainable yields of commercial timber from those forests.

1.2 Development of the Code

The Code contains practices and sets standards, which have been developed based on research and practical experience in tropical forests. A literature research was completed to review a number of existing codes to help guide approaches, illustrations and content. Documents that were referenced are listed in the Bibliography. After completion of the initial desktop study and updating the Code accordingly, the initial draft underwent robust field testing with inputs given by a wide range of representatives, from FDA, other ministries, civil society and the logging industry.

The Code should be reviewed at least every 10 years by the FDA following consultations with the timber industry and other interested parties.

1.3 Objectives

The Code applies to all natural forest areas in Liberia[1]. The objectives of the Code are to:

- Provide forest operators (FMCs, TSCs, PUPs, and CFMAs) with a set of guidelines and standards for improved forest harvesting practices that improve standards of logging/utilization and reduce environmental impacts, and so contributing to the conservation of forests.

  This is achieved primarily by giving guidance in mitigating intolerable risks in logging operations.
- To provide a sound foundation to comply with Liberian legality requirements related to forestry.

[1] Liberia has drafted a National Forest Definition with the following thresholds: 30% minimum forest canopy cover, 5 m minimum tree height and 1 ha minimum area. Once endorsed, the Code shall apply to all forests that are consistent with this definition.

There are three different types of statements in the Code:

- 'shall' statements (in some cases phrased as an imperative) are to be applied to all logging operations;
- 'should' statements show the desirable practice for most situations and should be interpreted by taking into account local conditions;
- "may" statements are recommendations, which serve as suggested approaches for logging operators.

2 FOREST MANAGEMENT PLANNING

2.1 Harvesting Practices and the Management of Risk

This Code follows a risk-based approach in managing performance indicators in forestry. In recent years, a "triple bottom line" approach in business has become standard practice for companies striving to manage their business responsibly. The three factors encompassing the triple bottom line are economic, environmental and social values. These values have thus also been adopted in the Code, but are further refined as follows:

- Economic values: Subdivided into Productivity [P] and Quality [Q]
- Environmental values [E]: No further subdivision
- Social values: Subdivided into Safety and health [S], and Social [So]

The five refined values are in fact a reflection of the key performance areas in any logging operation. If an organization performs according to desired outcomes (targets), then the company is in fact acting responsibly and adhering to the triple bottom line principle. The five performance areas identified have been configured into the acronym SPEQS, for ease of use:

These performance indicators are largely also reflected in the internationally defined Reduced Impact Logging (RIL) guidelines that are used to describe most harvest codes today. Compliance with safety, environmental and social regulations are also required by forestry operations in Liberia. Table 1 below summarizes these requirements:

Table 1: Obligatory risk assessments for various performance areas in forestry

Key Performance Area	Legislative Requirement	Responsible Government Ministries/ Departments	Risk Management Tool
Safety and health	Occupational Health and safety Act	Ministry of Labor Forestry Development Authority	Safety risk assessment
Environment	Environment Protection and Management Law EIA regulations	Environmental Protection Agency Forestry Development Authority	Environmental Impact assessment (EIA)
Social	Community Rights Law Social agreement	Forestry Development Authority	Social risk assessment (SIA)

Operators are thus obliged to comply with the above requirements. As explained above, the Code also addresses the key performance areas of productivity and quality. As these do not necessarily relate to legal requirements, the productivity and quality guidelines mostly have the status of a recommendation. Throughout the Code every guideline has been tagged with the performance indicators relevant to it in parentheses at the end of the sentence, e.g.:

"The chainsaw operator shall ensure that trees are not felled into buffer strips [E];"

[E] in this case refers to "Environment"

2.1.1 A risk-based approach to forestry

The Code considers three inputs in harvesting operations, which are combined to produce a desired output:

- Men (Humans)
- Machines
- Materials

These three inputs (known as the 3M's) are always present in the work environment in the forest. The risks in the work environment are placed in one of three categories:

- Climate
- Site features
- Terrain

Table 2 below summarizes hazards in the work environment under the three categories identified above:

Table 2: Hazards occurring in the forest workplace

Climate	Site features	Terrain conditions
Humidity-high Humidity-low Lightning Strikes Dew (Mist) Rainfall Temperature-high Temperature- low Wind-direction Wind-speed Wind-gusts	Animals / insects, Buildings/Dwellings Forest boundary line, Community activities, Compartment boundary line- undefined, Cultural / sacred sites, Roads -dead ends, Trees – seed, Trees - dead standing, Gullies and tunnel erosion, Dust, Birds - endangered Mammals – endangered, Plants-endangered, Excessive undergrowth, Falling rocks, Grave sites, Gravel pits, Trees - hang ups, Fuel load - high, Tree stocking – high, Inadequate or sub-standard turning circles, Landing space - insufficient Mine Shafts, Roads-narrow, Protected forest areas, Noise, Roads - Obsolete, One way traffic restrictions, Roads - overgrown, Pipeline on surface, Plants - poisonous, Power lines, Public access, Roads - Public Railway line, Recreation activities (picnic, hiking, cycling, fishing, hunting, etc.), Research plot, Road alignment / design, Road embankment, Road surface, Road traffic / transport, Rocky Outcrops Stumps/logs-rotten, Sharp stubs, Slippery surface, Smoke, Stray animals, Swamps, Roads-traversing corners, Tree form (forked/ crooked), Trees – undersized, Trees-oversized, Trees damaged by fire, Water bodies, Trees - wind thrown, Crop damage, Trees - wind damaged	Aspect Distance Ground roughness (boulders, depressions) Soils-Muddy Soils-sensitive Soils-slippery Steep Slopes

The work environment thus consists of hazards that pose various levels of risk to each harvesting job in the forest. Safety, Environmental and Social Risk Assessments are tools used to control intolerably high risks by defining mitigation measures for such hazards. Separate to the Code, such a baseline risk assessment exists for key harvesting jobs in the forest. The Code compliments the baseline risk assessment by elaborating and expanding on control measures that are required to mitigate intolerably high risks. The Code shall thus be used as a reference document in all cases when on-site risk assessments are completed for logging operations, as it contains control measures to mitigate intolerably high risks encountered in the field. This risk management approach is typically referred to as “Hazard Identification, Risk Assessment and Control Measures”, or abbreviated to HIRAC.

The operators use defined control measures in their harvesting operations during the full management cycle. The management cycle typically consists of four elements, known as the Demming model:

- Planning;
- Doing (implementing);
- Checking (monitoring);
- Acting.

This is abbreviated to the PDCA management cycle in the Code. Figure 1 below combines the concepts of SPEQS, HIRAC and PDCA to facilitate and guide high-performing harvesting operations in Liberia.

Figure 1: The risk-based performance management system

2.2 Planning Requirements

Broad scale planning or land use validation is carried out by the FDA in consultation with concerned stakeholders prior to forest resource allocation in order to determine forest areas which may be designated as commercial forest areas, protected areas or multiple use forest areas.

Forest areas designated for sustainable forest management by applying the Liberian selective cutting system (i.e. FMC and CFMA areas) must be managed according to a 25-year rotation/ cutting cycle. For these areas, the following planning levels are obligatory:

- Strategic planning (25 years) covering the background, conditions and plans for the entire contract area;
- Detailed planning for operations covering activities to be carried out within a 5-year period; and
- Annual planning covering the previous year's activities and operational plans for the following year including block plans.

All these planning activities shall be made in accordance with this Code. Good planning at the operational level has been shown to significantly reduce both operational costs of the operator and the environmental, social and safety risks of timber harvesting.

Two types of field inventories shall be required for proper sustainable forest management planning:

- First, the forest operator shall complete a general inventory of the entire contract area to provide basic data on forest resource and sustainable forest management practices including yield regulation.
- Second, the operator shall complete pre-harvesting enumeration to define the harvestable trees and associated risks to achieve annual harvesting targets.

Respective planning guidelines, standard operation procedures, work instructions and mapping requirements for each planning level are issued by the FDA.

For forest areas designated for conversion into another land use (TSC and PUP), the Code requires operators to prepare at least annual harvesting plans defining trees to be harvested in compliance with environmental, social and safety planning requirements as set out herein. For these areas, other planning requirements are issued by the FDA.

2.3 General Safety and Health Planning Requirements

2.3.1 Camp hygiene

a) Semi-permanent logging camps (usually no more than 5 years)

Logging camps shall comply, as a minimum, with the requirement of the ILO Code for Safety and Health in Forestry. This includes the following [S]:

- Housing for single workers without families shall not exceed two people, to allow workers a minimum of privacy;
- Houses need to be safe, dry, with sufficient ventilation and have lockers for keeping personal belongings;
- Canteen, taking into consideration the size of the camp;
- Covered kitchen facilities;
- Storage facility for food;
- Sufficient supply of potable water;
- Sufficient sanitary facilities (bathrooms, showers, toilets or latrines), separated from sleeping and dining areas and from kitchen facilities and storage areas for food, complying with hygienic requirements, equipped and located in accordance with the cultural environment of the workers;
- Facilities for washing and drying clothes;
- Storage facility for general materials;
- Separate storage facility for any inflammable, chemical or explosive substances at a safe distance from the living quarters;
- Recreational facilities considering scale and intensity and agreed in collaboration with workers;
- Means of control of rodents and harmful insects in case of infestation outbreaks;
- Lighting in houses with safe and legal electrical wiring; generators should be repaired as soon as practicable;
- Waste disposal facilities (See paragraph 2.3.4: waste management);
- First aid facility for emergencies with a nurse/ first aider available.

b) Survey camps and mobile camps (several weeks)

Survey camps are temporary camps constructed in the forest and are usually only used for a few weeks while survey teams are at work. Mobile camps are often used during road construction. The following rules apply to survey and mobile camps [SE]:

- Sleeping quarters shall be constructed at least 20m from the nearest water body;
- A waste pit shall be dug at least 50m from the stream and all waste shall be dumped in the waste pit. The waste pit shall be covered with at least 30cm of soil when the camp is abandoned;
- Toilet facilities shall not be closer than 50m from the nearest water body.

2.3.2 Construction of workshops

Workshops shall be constructed according to the specifications set out in the approved ESIA prepared for the company. Additionally:

- Workshops shall be located at least 100 m away from any watercourse or water body on a stable surface;
- For toxic waste, see waste management under paragraph 2.3.4;
- Hydrocarbon (fuel and oil) storage shall include bunding as shown in Figure 2 below. The bund wall shall allow for containment of at least the contents of the largest tank within the bunded area [SE].

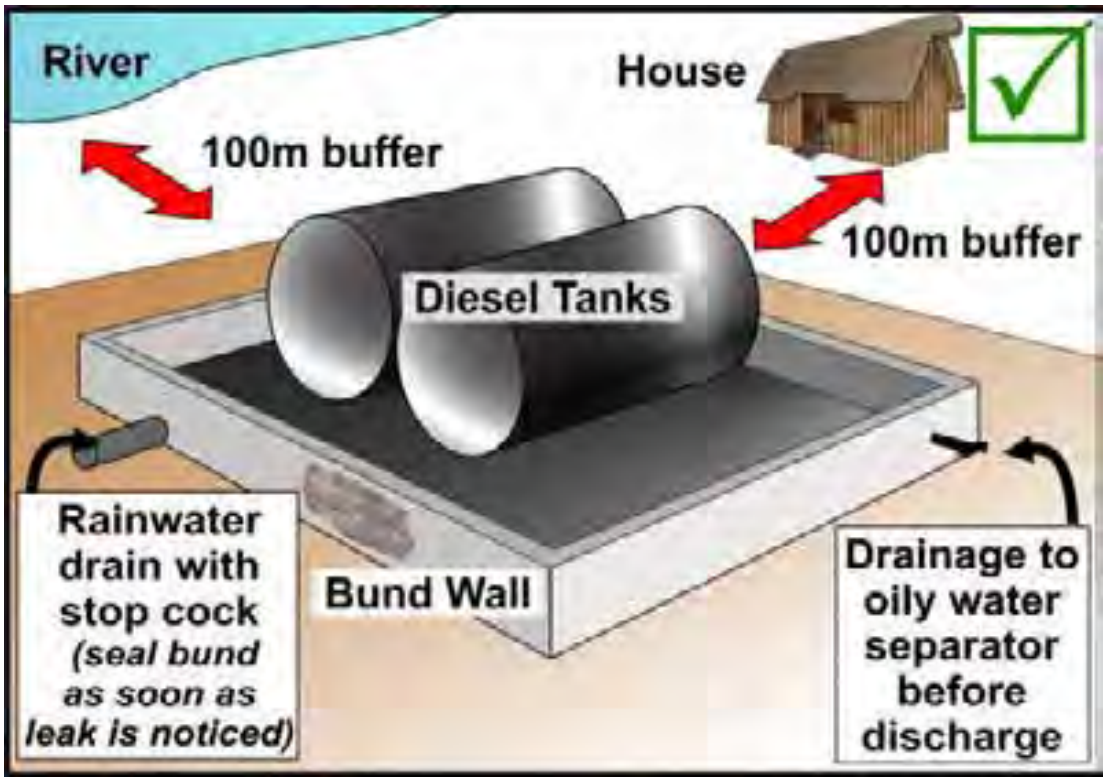

Figure 2: Fuel and oil storage facility requirements

2.3.3 Hazardous chemicals (spraying of logs with pesticides)

All pesticides (e.g. preservatives, pesticides and herbicides) shall be used in accordance with the Material Safety Data Sheets (MSDS) for the particular chemical. Chemicals shall only be used when necessary to achieve defined management aims and in strict accordance with the manufacturer's instructions. Furthermore [SE]:

- Hazardous chemicals shall be stored in a well-drained area at least 100m from any watercourse or any inhabited building;
- Hazardous chemicals shall be stored in a locked, dry, well-ventilated storeroom. Wet products are to be stored separately from dry products;
- All entrances shall be clearly marked with a sign reading "warning – hazardous chemical storage - authorized persons only" or equivalent;
- All containers used in the transport, storage and use of toxic chemicals shall be leak proof, marked as "hazardous" and clearly labeled with the contents' name.
- Access to the storerooms of toxic materials should be restricted to authorized personnel;
- Recommendation: 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;
- Recommendation: Concrete bunds with a capacity of twice the storage capacity of the largest storage container be provided around all storage facilities;
- Equipment used for applying chemicals shall not be washed in watercourses;
- Excess chemicals are to be either removed from the forest or chemically treated (neutralized) in an approved manner;
- Empty containers shall be safely disposed and not reused:
    - Triple rinse the container;
    - Punch holes in it;
    - Flatten the container (optional).

2.3.4 Waste management

Waste management shall be dealt with according to the specifications set out in the approved ESIA prepared for the company. Furthermore [S]:

- Hazardous waste (hydrocarbons, batteries and fluorescent tubes/bulbs) shall be specifically addressed in the waste management plan (Figure 3);
- Waste pits shall be used for non-hazardous inorganic waste disposal (e.g. plastic, metal, glass);
- Waste pits should be used for organic waste disposal (food waste and paper);
- Waste pits should be burnt out from time to time to prolong their useful life.
- Waste pits shall be located at least 100 meters from any water body and at least 1m above the groundwater table;
- The area should be fenced off and signs should be erected identifying waste pits;
- Waste pits should be covered with at least one (1) m of soil once they reach the end of their useful life;
- Toxic materials shall never be disposed of into watercourses or lakes.

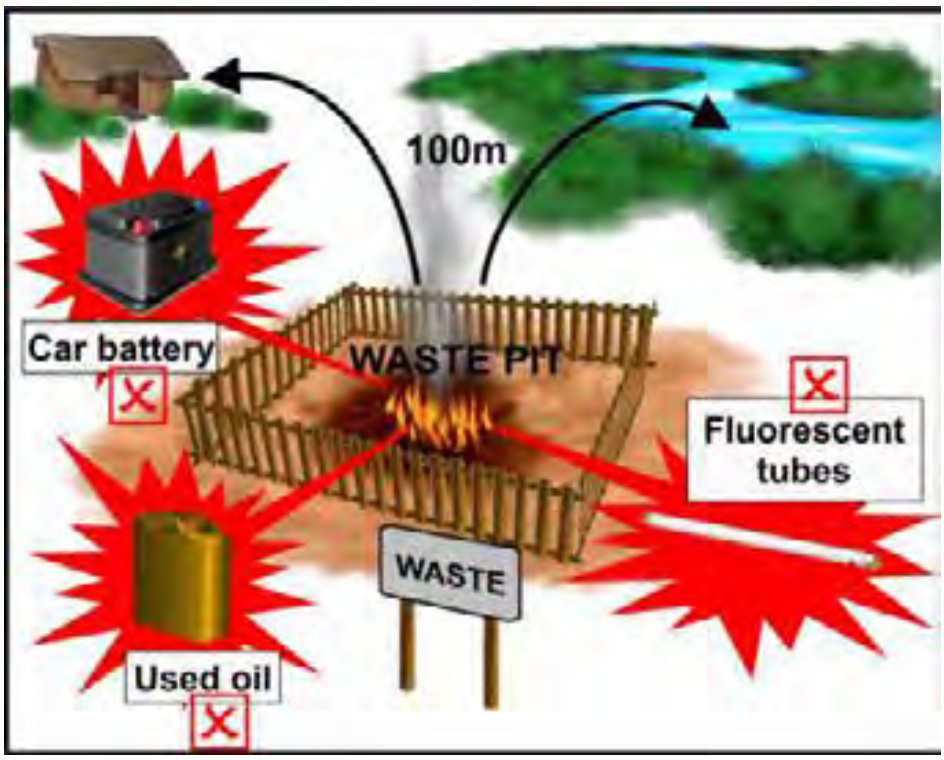

Figure 3: Treat hazardous waste with caution

2.3.5 Lightning strikes

When caught in a thunderstorm, run to the nearest building, motor vehicle or fully enclosed ROPS equipment cab immediately. Being anywhere outside is not safe. Furthermore [S]:

- If inside a motor vehicle or fully enclosed ROPS equipment cab, do not step outside of the vehicle or off the equipment to move to another shelter;
- Shut down all operations, turn off the engine, close all doors and raise all windows.
- Do not touch any radio or telephone;
- Sit squarely in the seat with your hands in your lap and your feet flat on the floor mat;
- Do not touch any metallic objects connected to the outside of the vehicle. Do not touch any door or window handles, control levers, foot pedals, steering wheels, cab interior walls and any other metal objects;
- Remain in your safe location for 15 minutes after the last sight of lightning or the last sound of thunder.

2.3.6 First aid and emergency response

Employers have the main responsibility for safety and health in forestry work. They shall install and maintain work systems and methods which are safe and without risk to health. Employees shall take responsibility for their own safety and those of others at the worksite. Furthermore [S]:

- Each logging team shall be familiar with the emergency response procedure in the case of accidents;
- All machine operators shall receive the necessary training and instruction to ensure competency to safely operate equipment for the job they are assigned to do;
- 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;

- A fully equipped first-aid kit shall be provided to every logging crew and located close to where felling crews are working;
- At least one formally trained First Aider shall be present at each worksite at all times.

2.3.7 Protective clothing (PPE) and safety equipment

PPE requirements shall meet the requirements stipulated in the ILO - Code of Practice on Safety and Health in Forestry Work. Table 3 below shows PPE requirements related to all logging activities [S].

Table 3: PPE requirements for forestry workers (adapted from FAO)

Parts of the body to be protected:	Feet	Legs	Trunk, arms, legs	Hands	Head	Eyes	Eyes / face	Hearing
PPE normally appropriate:	Safety boots or shoes	Safety trousers[1]	Close-fitting clothing	Gloves	Safety helmet	Goggles	Visor (mesh)	Ear muffs[2]
Operation								
Weeding/ cleaning with cutlass	✓			✓		✓		
Felling[3] with chain-saw	✓[4]	✓	✓	✓[5]	✓		✓	✓
Pesticide application	To comply with those specified for the particular substance and application technique							
Manual debarking	✓			✓				
Extraction with - skidder/ dozer	✓			✓[7]	✓			✓[6]
Stacking/ loading	✓			✓	✓			✓[6]

Notes: [1]Safety trousers incorporating clogging material, in hot climates/weather chain-saw leggings or chaps may be used. Safety trousers and chap contain fibers that are inflammable and melt, and should not be worn during fire-fighting.

[2]Ear plugs and ear valves not generally suitable for forestry because of risk of infection.

[3]Felling includes debranching and crosscutting.

[4]Chain-saw boots with protective guarding at front vamp and instep.

[5]Cut-resistant material incorporated in the back of the left hand.

[6]When noise level at work position exceeds 85dB (A).

[7]Only if manipulating logs; gloves with heavy-duty palm if handling wire choker rope or tether line.

2.4 Productivity Performance Guidelines (recommended)

Productivity requirements stipulated in the Code are not compulsory to follow, but rather recommendations to guide operators in improving their efficiencies. Productivity is defined as outputs/inputs and the following is recommended for each of these:

Outputs:

Outputs can be identified for each job. Some examples of outputs are [P]:

- Felling: Trees/day;
- Log production: m^3/species/day;
- Transport: Loads/day;

- Right of way felling: meters per day;
- Bulldozer right of way route opening up: km's per day;
- Grader blading: km's per day.

Inputs:

- Humans:
    - Chainsaw and machine operators that are well trained and skilled in the competencies of felling, extracting and loading of tropical timber.
- Machines:
    - Chainsaws, skidders and loaders are correctly specified for the tree/log size in the forest;
    - Chainsaws are checked for operability prior to leaving the camp each morning and unserviceable saws are not sent to the forest;
    - Forest machines undergo a pre-startup inspection every morning and faults are addressed;
    - Daily targets are set for chainsaw operators, skidding machines operators and loader operators for the felling/crosscutting of trees, extracting tree lengths and loading of logs.
- Materials:
    - Operators are advised to closely monitor fuel consumption. A suggested ratio to measure fuel use by various equipment types is m^3 of logs or km's of road per liter of fuel consumed.

2.5 Environmental and Social Performance Requirements

Environmental and social performance requirements are based on the different functions Liberian forests provide. Basically, there are three main groups of functions, i.e. economic, ecological and social, each one including a number of sub-functions as shown in Table 4. Forest functions have different impacts on forest management. Some functions exclude all types of forest operations, others only commercial timber harvesting or road construction, and others impose only minor management restrictions.

Table 4: Forest function groups and sub-functions

Economic Functions	**Ecological Functions**			**Social Functions**
	Soil	**Water**	**Biodiversity**	
Timber Production Areas	Soil Protection	Riparian Buffer Protection	Plant and Animal Protection	Local Use only
Non-Productive Forest Areas		Water Supply Protection	Rare Ecosystem Protection	Cultural Site Protection
		Flood Control Conservation	Protected Area Buffer Protection	
		Water Catchment Conservation	Wildlife Habitat Conservation	

Functions and sub-functions may overlap or exclude each other. But in general, all forest functions of strictly protective nature (herein named "protection") are not compatible with log production. Functions of restrictive nature (herein named "conservation") are partly compatible

with log production. If functions should overlap during identification, the more restrictive management prescriptions must be applied for mapping and planning.

The commercial forest area shall be divided into non-timber production and timber production zones according to the restrictive nature of the functions as shown in Table 5 below. The sub-functions listed in the table are not exhaustive. For particular situations, the FDA may require forest operators to observe additional functions or may impose stronger management restrictions for conservation areas.

Table 5: Forest zoning according to forest function

Non-Timber Production (Exclusion) Zone	**Timber Production Zones**	
	Restricted (recommended Conservation Areas)	**Unrestricted (Production Zone)**
Soil Protection	Flood Control Conservation	Timber Production Areas
Riparian Buffer Protection	Water Catchment Conservation	
Protected Area Buffer Protection	Wildlife Habitat Conservation	
Water Supply Protection		
Plant and animal Protection		
Rare Ecosystem Protection		
Cultural Sites Protection		
Local Use Only		
Non-Productive Forest Areas		

The identification of forest functions is done in an iterative planning process at all three planning levels, i.e. contract area, compartment and annual logging coup. It involves various steps and procedures as described in the forest management planning guidelines issued by the FDA.

2.5.1 Exclusion zones

Exclusion zones in commercial forests are areas where logging is strictly prohibited for the purpose to protect environmental and social interests. An example of identified exclusion zones is provided in Figure 4.

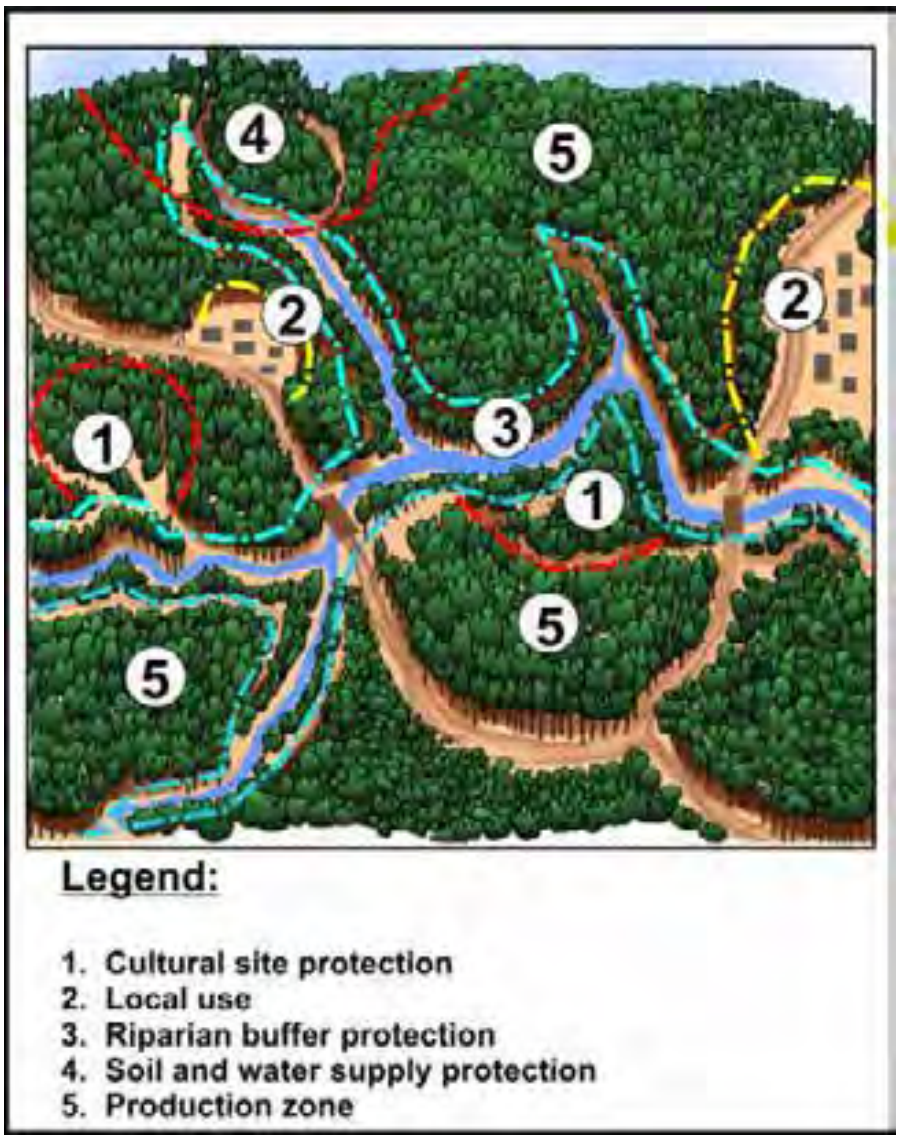

Figure 4: Forest zones

a) Soil protection areas [E]

Soil Protection areas are all areas with an average slope gradient above 40%. These areas are extremely sensitive to soil erosion and degradation. The disturbance to vegetation cover following timber harvesting could result in severe soil erosion, loss of nutrients, and siltation of down-stream water systems. Extreme forms of soil degradation may lead to landslides and flash floods.

The construction of access roads to adjacent harvestable areas is permitted within soil protection areas, if access is otherwise impossible. However, road construction has to follow particularly strict standards as reflected in the Code, including the use of excavators, establishment of extensive drainage system, etc. (See section 5)

b) Riparian buffer protection areas [E]

Riparian buffers are located along the banks of rivers and creeks, and around the perimeter of lakes and swamps. Streamside vegetation stabilizes banks and often contains a high plant and animal diversity. They provide critical habitats and migration corridors for many mammal and bird species, and maintain ecologically important vertical and horizontal linkages throughout the forest landscape.

The objective of the protection of riparian areas is to prevent the negative impacts of forestry operations on stream channel stability, water quality and aquatic ecosystem productivity and diversity, and to protect species diversity associated with riparian areas. Table 6 provides buffer strip distances.

Watercourses are divided into 3 categories:

- Permanent streams: <10m from bank to bank;
- Creeks: 10m to 30m from bank to bank;
- Rivers: >30m from bank to bank.

The width of a watercourse is to be measured from bank-to-bank during normal wet season (i.e. the period of peak water flow), and may include flood plains and swamps (also see water supply protection and flood control conservation areas).

Table 6: Buffer strip distances

Buffer type	**Minimum width**
Cultural, spiritual and historic sites	100 meters
Villages, farms, settlements	100 meters
Rare, endangered, mother/ seed trees	10-meter radius
Watercourses: Streams Creeks Rivers	 10 m on each bank[1] 20 m on each bank 30 m on each bank
Natural springs	50-meter radius
Lakes	20 meters from the water's edge[2]
Swamps and other wetlands	20 meters from the water's edge
Neighboring Protected Areas	50 meters from the boundary

Note: [1]Banks are defined as the permanent edge of the river regardless of the seasonal recession of the water levels.

[2]The water's edge is determined from where the water is at that given point in time.

All riparian buffers shall be identified during pre-harvest inventory work and must be indicated on block maps. Block inspections carried out by the FDA shall validate the location of the identified buffers before forest operations commence.

No logging and no skid trails shall be allowed in riparian buffers. Access roads are permitted as long as bridges are constructed. In the event of trees being accidentally felled into stream channels and other waterbodies, they shall be winched out.

Various waterbodies and their corresponding buffer strip width requirements are depicted in Figure 5 below.

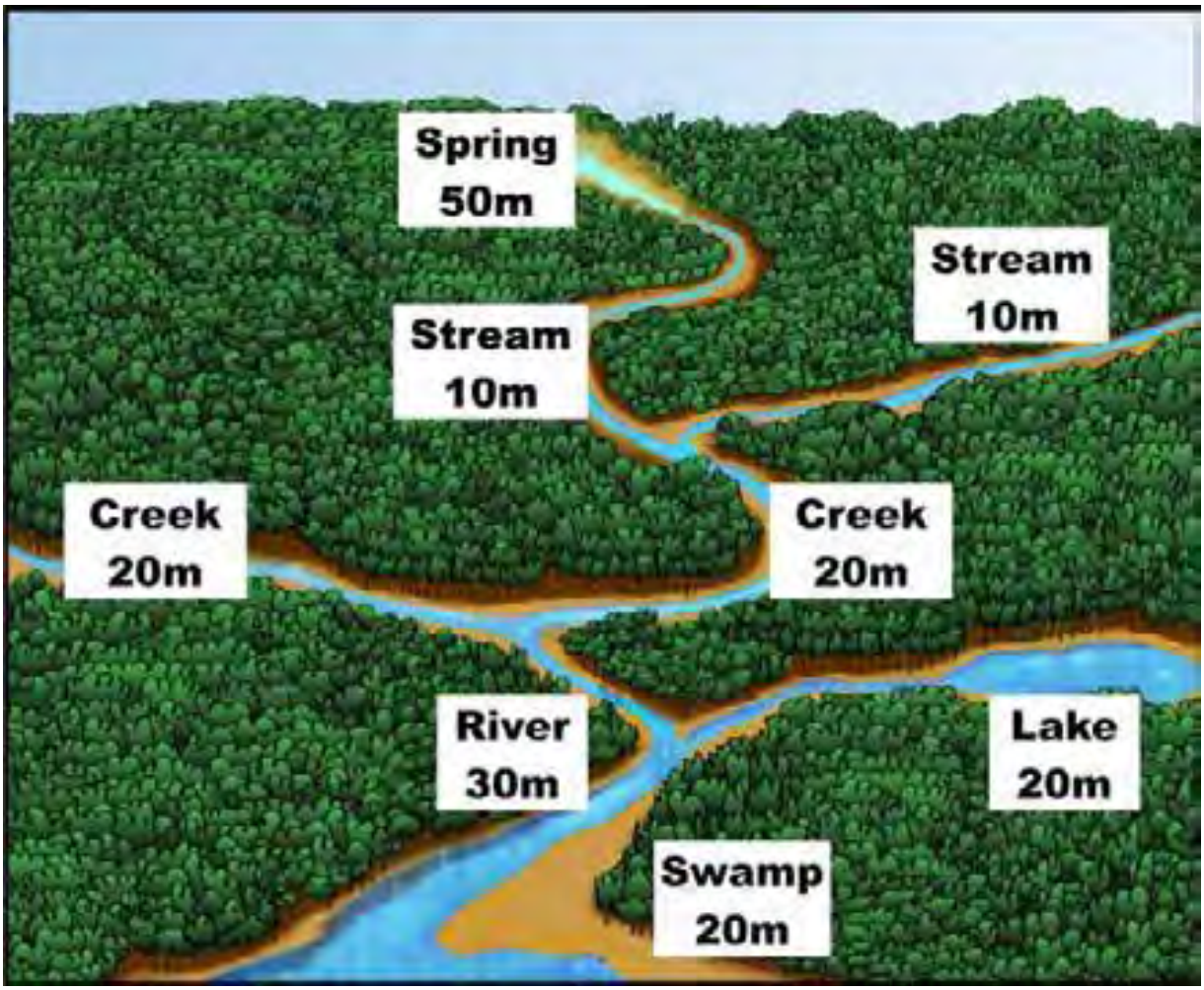

Figure 5: Buffer strips along watercourses

c) Ecosystem protection areas [E]

Ecosystem protection areas include High Conservation Value (HCV) forests and other areas which and contain rich ecosystems and ecological niches such as limestone or granite rocks, cliffs, swamps and wetland.

Ecosystem protection areas shall be identified during multi-resource inventory work with the help of remote sensing techniques and based on local knowledge.

d) Water supply protection areas [E, So]

Water supply protection areas are in the immediate vicinity of reservoirs, dams, springs, wells and other facilities for domestic water supply. They shall be identified and protected in order to prevent surface runoff, soil erosion, siltation and pollution of water resources.

Water is one of the most valuable natural resources and clean potable water is an indispensable asset for human society. The protection of water resources, therefore, is a priority in natural resource management. Water-related forest functions focus on the conservation of the cleanliness of the groundwater and surface water bodies, and the maintenance of continuous water supply.

A buffer zone with a radius of at least 50 m around the perimeter of the water source shall be established and indicated on block maps.

e) Plant and animal protection areas [E]

Plant and animal protection areas are areas where rare, threatened and endangered plants and animals (mammal and bird- fish, insects, invertebrates?) species occur. In the case of animal species, this refers to areas where such species breed, nest, reproduce or otherwise depend on and where their protection has highest priority.

Plant and animal protection areas shall be identified as defined by the FDA and/or based on wildlife studies undertaken during the multi-resource inventory. These studies shall include information provided by the local population, forestry staff and forest inventory teams.

Plant and animal protection areas shall be excluded from logging. Furthermore, no other human interferences shall be allowed except activities compatible with the purpose of protection.

f) Protected Area buffer protection [E]

Protected Area buffers are strips of forest along the periphery of Proposed and Declared Protected Areas neighboring the commercial forest area. Their purpose is to prevent negative impacts as a result of adjacent logging operations.

The location and width of the buffer depends on the type of the Protected Area: around National Parks and Nature Reserves, the buffer is 50 m. Around other protected areas the buffer is XXXX?

No felling and no skid trails are allowed in the buffer. Protected Area buffers shall be indicated on block maps. In the event that trees are accidentally felled into the buffer, they have to be winched out.

g) Local use areas [So]

Local use areas are forests which are, and have been, traditionally and intensively used by the local population, and which are an integrated and indispensable component of their subsistence. These areas include forest land reserved for community land allocation and areas that are traditionally used to provide resources for livelihoods.

The location and size of local use areas created for each community residing within or adjacent to commercial forest areas must be validated by the affected communities and approved by the FDA. A buffer of at least 100 meters in width shall be maintained to the edge of cultivated areas and settlements.

h) Cultural site protection areas [So]

Cultural site protection refers to areas which have a significant cultural value, e.g. religious sites, graveyards, archaeological sites, historical sites, rare topographic formations, viewpoints, waterfalls, etc.

These cultural places shall be protected from logging damages by a buffer strip around their outer perimeter at least 100 m in width.

2.5.2 Conservation zones

The identification of conservation zones is not mandatory but recommended. Forest operators interested in forest certification or who wish to benefit from payment for environmental services schemes may be requested to identify conservation areas. If so, the location of conservation zones must be justified in the long-term forest management plan.

Logging operations shall be restricted in conservation areas in terms of logging intensity (road construction and harvestable volume / tree species), logging equipment to be used and schedule of operations depending on the conservation objective. Recommended management restrictions are provided for each of the following conservation area.

a) Flood control conservation areas [E]

Flood control conservation areas include forests which are capable of storing excess water during the rainy season and to maintain the flow velocity of excess water below critical levels. The extensive exploitation of such forests would result in downstream flooding.

Flood control conservation areas include all areas along alluvial rivers subject to temporary flooding from the outer edge of the riparian buffer strips to the edge of the active flood plain. They also include inland fresh water swamps in catchment areas upstream of flood-prone areas.

Recommended management restriction: Reduced logging intensity (roads and harvestable volume)

b) Water catchment conservation areas [E, So]

Water catchment conservation areas include forests surrounding the headwaters of streams. The water retention capacity of these forests prevent high surface water run-off. Therefore, water catchment conservation is essential to ensure the continuous supply of clean water to meet downstream domestic, industrial and agricultural uses.

Identification criteria may include critical watersheds or catchment areas, water catchments feeding hydropower plants or water reservoirs, poorly drained or waterlogged sites, moist areas and swamps.

Recommended management restriction: No logging and machinery movement during the wet season (from May to November).

c) Wildlife habitat conservation areas [E]

This includes corridors for animal movement from the commercial forest areas to adjacent Proposed and Declared Protected Areas as well as between identified exclusion zones within commercial forest areas. Identification criteria should include: type and number of wildlife species and their protection status, habitat size (dependent on species), and actual habitat condition (degree of disturbance).

Recommended management restriction: No harvesting activities during breeding and mating season.

2.5.3 Protection of plant and animal species

The listing of Liberian protected plant and animal species is maintained, regularly updated and published by the FDA as the national focal point of the Convention on International Trade of Endangered Species (CITES). The listing considers IUCN's red list species including rare, threatened and endangered species.

Around all protected tree species identified in sustainably managed forest areas, a protective buffer of 10-meter radius the tree shall be applied.

The same protective buffer of 10-meter radius shall be applied to seed/ mother trees. A listing of seed/ mother tree species to be protected is provided by the FDA which may vary depending on the management objective and location of the commercial forest area.

The location of all protected and seed/ mother tree species shall be shown on block maps.

Furthermore, all forest operators shall apply appropriate measures aiming at mitigating illegal hunting practices and trade of bush meat of protected species by enforcing and monitoring directives prohibiting all employees and workers to -

- possess and/ or transport firearms, bush meat and/ or hunters in company vehicles, even outside the commercial forest area;
- hunt outside of any designated hunting area within the commercial forest area;
- hunt protected animals;
- use traps;
- engage in trade of bush meat in company camps, worksites or elsewhere.

2.6 Quality Performance Guidance (Recommended)

"Quality" encompasses 3 elements:

- Log specifications [Q]:
    - The operator should have a set of log specifications available for the products that he/she intends to produce in the forest. The log specifications make it possible to optimize value and minimize waste in the forest.
- Minimizing waste during logging operations (Figure 6) [Q]:
    - Minimization of wood waste during felling, extraction and log making;
    - Avoid leaving merchantable logs behind in the forest.

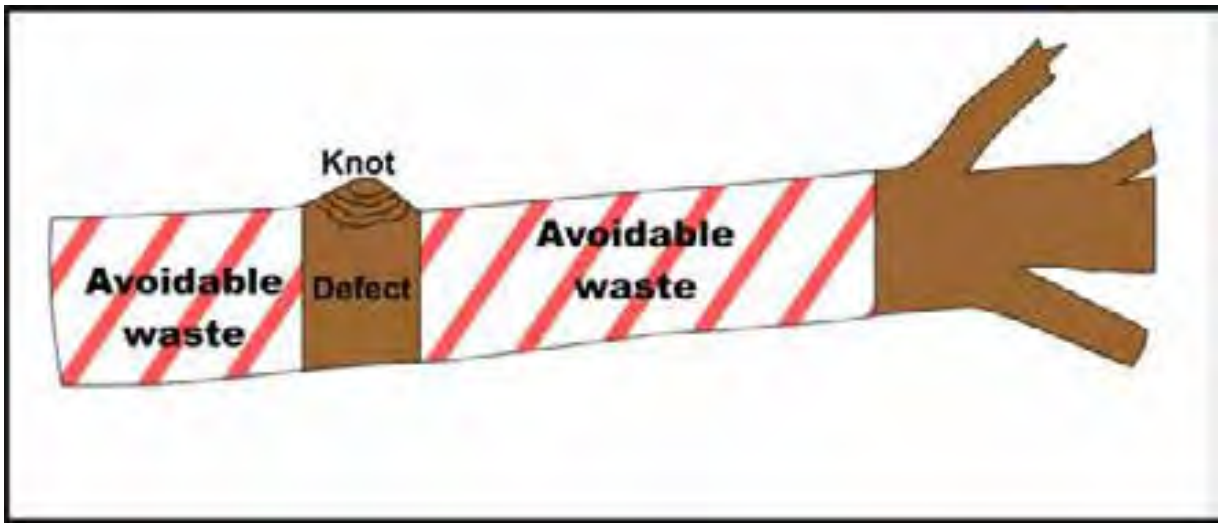

Figure 6: Avoiding waste during cross cutting

- Presentation of trees/logs [Q]:
    - Direction: This is the direction that trees/logs are placed from one job to the next. For example, the direction of felled trees in relation to complimenting the extraction distances;
    - Indexing: This refers to how good stacks are indexed from one job to the next. For example, the accuracy of indexing of a log load on a logging truck can influence the stability and safety of the logging truck;

- Size: This refers to the size of the piles, bunches, stacks etc. that is prepared from one job to the next. For example, the number of logs presented for extraction by a skidder in a single trip.

2.7 Social Responsibility Performance Requirements

2.7.1 Land and forest use rights and responsibilities

All forest operators shall be expected to respect legal or customary rights to land and forests, as well as respect for cultural, traditional and local values and customs. Refer to paragraph 2.5.1, Table 6 for buffer zone parameters for cultural, spiritual and historic sites, and villages, farms, settlements. This is also further described under section 2.5.1 g) Local use areas and section 2.5.1 h) Cultural site protection areas [So].

Forest Management Contracts and Timber Sales Contracts provide the contract holders and operators with a right to operate in a given area. Contract holders should immediately inform the FDA of any illegal forestry activity in their contract area.

Social agreements between contract holders and affected local forest communities define and describe the codes of conduct and other agreements concerning forest access, forest use rights and responsibilities, benefit sharing arrangements, the use of local labor, compensation for crop damage, etc., between the two parties. They also describe conflict management arrangements [So].

2.7.2 Cultural tenure areas

Areas that fall under cultural tenure of local communities shall be excluded from the harvesting plan area and in some cases depending on the size and location of the cultural tenure, they may be removed from the contract area prior to awarding a contract [So].

2.8 Planning Requirements Related to Tree Felling

2.8.1 Chainsaw safety

All chainsaws shall be maintained in good working order and all safety devices shall be operational at all times. Figure 7 illustrates the minimum safety features on a chainsaw, as contained in the ILO Code for Safety and Health in Forestry. Specifically, all chainsaws should be equipped with [S]:

a) separate handles for both hands when wearing gloves;
b) an on/off switch which is reachable with the right hand on the throttle whilst wearing gloves;
c) a throttle control lock-out which prevents the chain-saw from being started unexpectedly, because two levers have to be pressed simultaneously;
d) a rear handle guard for protection of the right hand;
e) an anti-vibration system, consisting of rubber shock absorbers between the engine block and handles;
f) a chain brake, which is activated manually by the front handle guard and by means of a non-manual mechanism in the case of kick-back;
g) a chain catcher;

h) a spiked bumper, which allows the weight of the saw to rest on the log securely during crosscutting;

i) a front handle guard for protection of the left hand from the chain;

j) a chain guard for avoiding injuries during transport (optional).

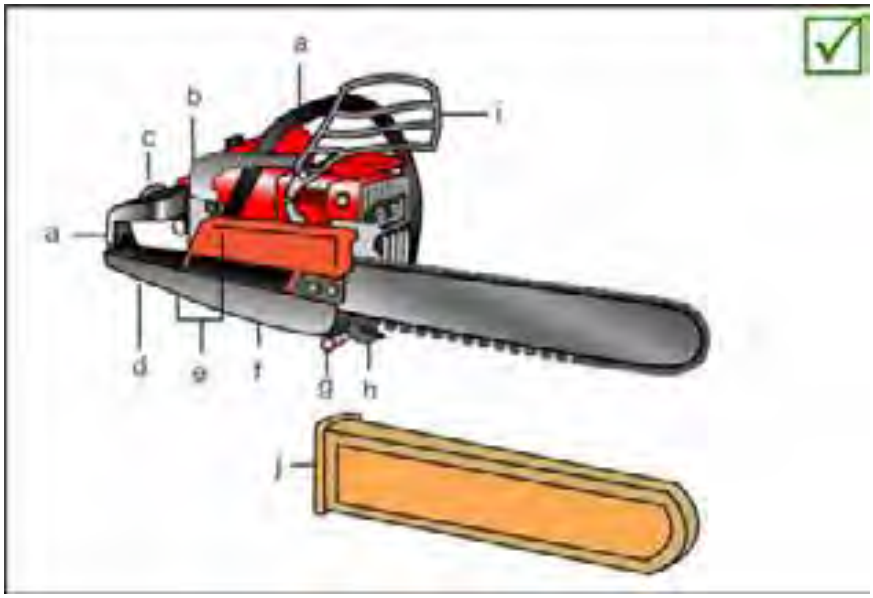

Figure 7: Chainsaw safety requirements

The relevant PPE has been defined and described earlier in Table 5. Figure 8 below gives a detailed illustration of the PPE required by the chainsaw operator [S].

Figure 8: Personal protection equipment required by the operator

Note that:

- Felling shall only commence once the FDA has given its authorization. All commercial trees included in the approved yield shall have been marked for felling and their predetermined felling direction indicated [SPEQ];
- Seed trees and protected trees shall also be marked [E];
- Each felling crew should include at least two members (main chainsaw operator and an assistant) [P];
- Felling shall commence when forest road and log landing construction is completed, and when skid trails have been marked on the ground [P];
- All chainsaw operators shall be familiar with the harvest area and have discussed the block plan with the bush manager and/or their supervisor [SPEQS];
- The felling crew shall take both the harvesting map and the file of information on trees to be harvested into the forest [SPEQS];
- Felling shall not occur within protected or exclusion areas and their respective buffer strips [E];
- Felling is not allowed on slopes steeper than 40% [E];
- Felling should commence at the far end of the block and proceed along the main skid trail towards the log landing [E].

2.9 Planning Requirements Related to Extraction Operation

2.9.1 Extraction equipment safety

All heavy equipment should undergo regular maintenance to achieve and maintain safety standards and good working condition [SP]. The main safety features are included in Figure 9.

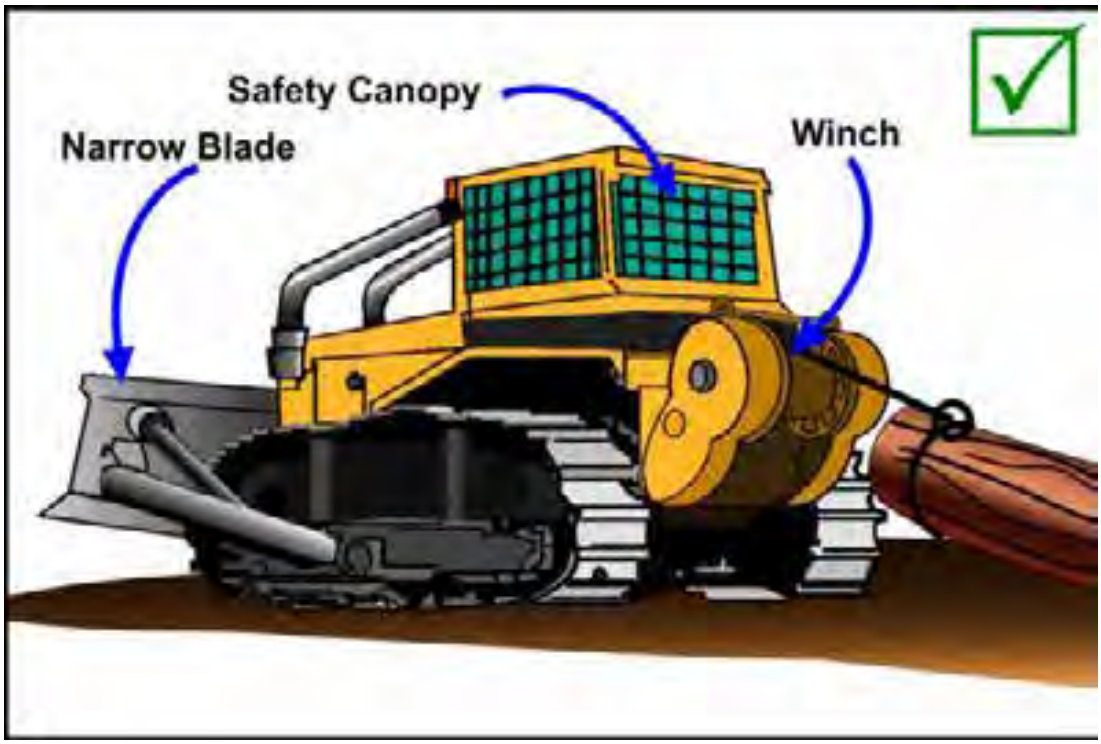

Figure 9: Safety features on a crawler tractor used for skidding

All heavy machinery shall be equipped with [S]:

- A safety cab with a Roll Over Protection Structure (ROPS) and Falling Object Protection Structure (FOPS) (see Figure 9);
- Access to and exit from machinery designed to provide hand and footholds of a convenient height and spacing;
- Securely mounted seats and seat belts;
- Rear portion of cabs fitted with protective wire mesh (except loaders, excavators and graders) (see Figure 9);
- Securely guarded pulleys, shafts, belts and fan blades;
- Engine emergency stopping devices that are clearly marked and easily accessible from the normal operating position;
- Parking brakes shall be capable of keeping the machine and its rated load stationary on all slopes likely to be encountered;
- Fire extinguisher or 5-gallon container filled with water (operators shall be trained in their use).

No modifications should be made to a machine that [S]:

- Interferes with operator visibility;
- Interferes with access to and exit from the machine;
- Interferes with the ROPS or FOPS structure of the cab.

2.9.2 Landing location

Landings are planned once the road network has been defined for log extraction. Landings are then placed at strategic locations along designated logging roads to facilitate extraction and improve skidder productivity, minimize environmental damage, facilitate cross cutting and allow for the safe loading of logs onto trucks. Furthermore:

- All merchantable trees shall be felled from the log landing site and extracted before clearing (these trees will be part of the approved yield from the block) [P];
- Log landings shall be well drained. Proper drainage requires [E]:
    - A domed surface to prevent the ponding of water;
    - Drains to channel runoff to vegetated areas;
- Log landings should have designated entry (skidder) and exit (log loader) points [SP];
- Skid trails should approach landings from below to avoid directing runoff of water to the landing. This will reduce the amount of mud and water entering log landings from skid trails or roads [PE];
- Debris and waste should be placed so as not to restrict drainage of the landing (Figure 10) [E].

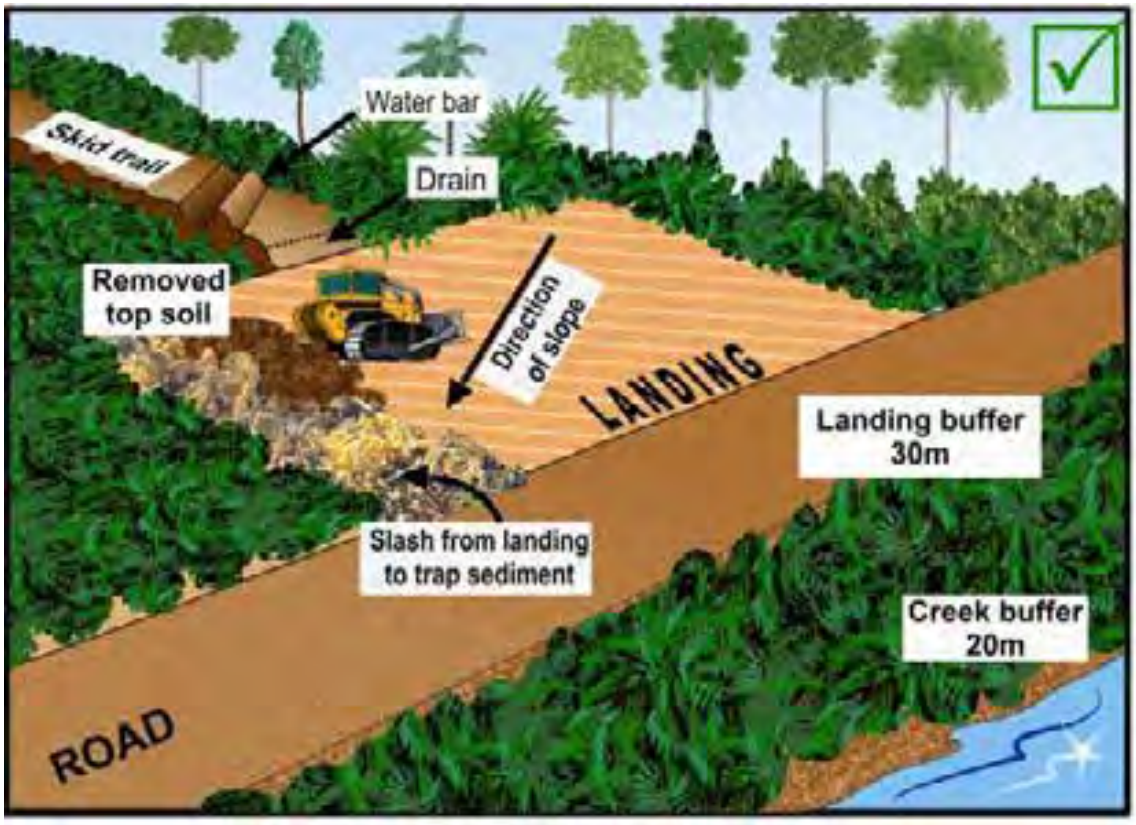

Figure 10: Landing layout and construction

- Log landings should be located at such intervals as to minimize the number and total length of skid trails, but they should normally not be less than 250 m and not more than 1000 m apart [P];
- Log landings should be located:
    - at least 30 m from the edge of buffer strips (e.g. 50m from the bank of a creek) so that mud and debris do not enter watercourses (Figure 11) [E];
    - on a gentle sloping elevated area, or on ridges or benches, in order to facilitate free drainage at all times, reduce the amount of side cutting, and encourage uphill skidding to disperse runoff into surrounding vegetation [E];

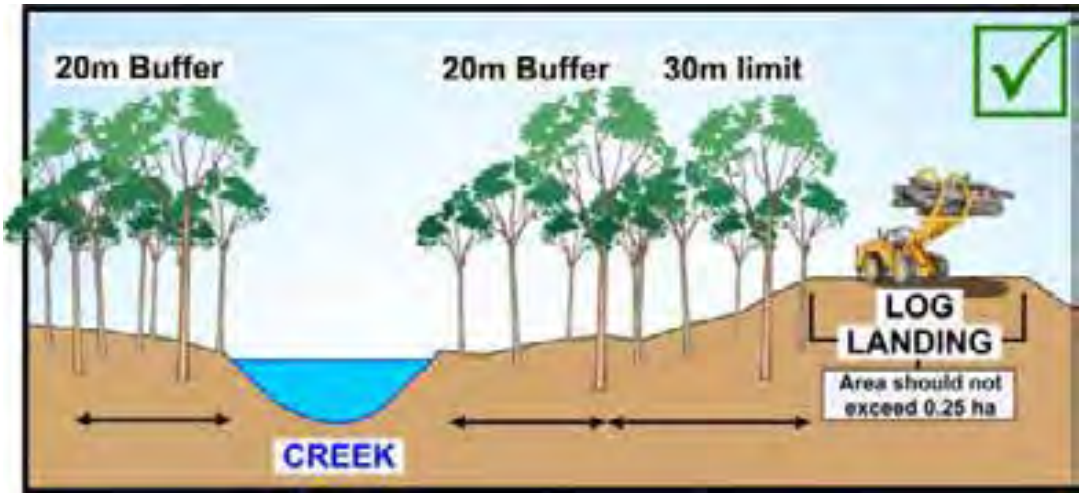

Figure 11: Landing location related to buffer areas

- at sites that accommodate efficient skidding patterns and directions [E];

- Trees on the road construction site that are marked and felled, should be deposited on a temporary roadside landing and integrated into the production process [P];
- The size of a log landing will depend on the expected volume and number of logs to be stockpiled. It should be large enough to facilitate the sorting of logs, to allow for entry (skidder) and exit (loader) points. A log landing should not exceed 2500 m^2 in size and a maximum of 4 landings within a 100 ha or 1 km^2 block (Figure 12) [E].

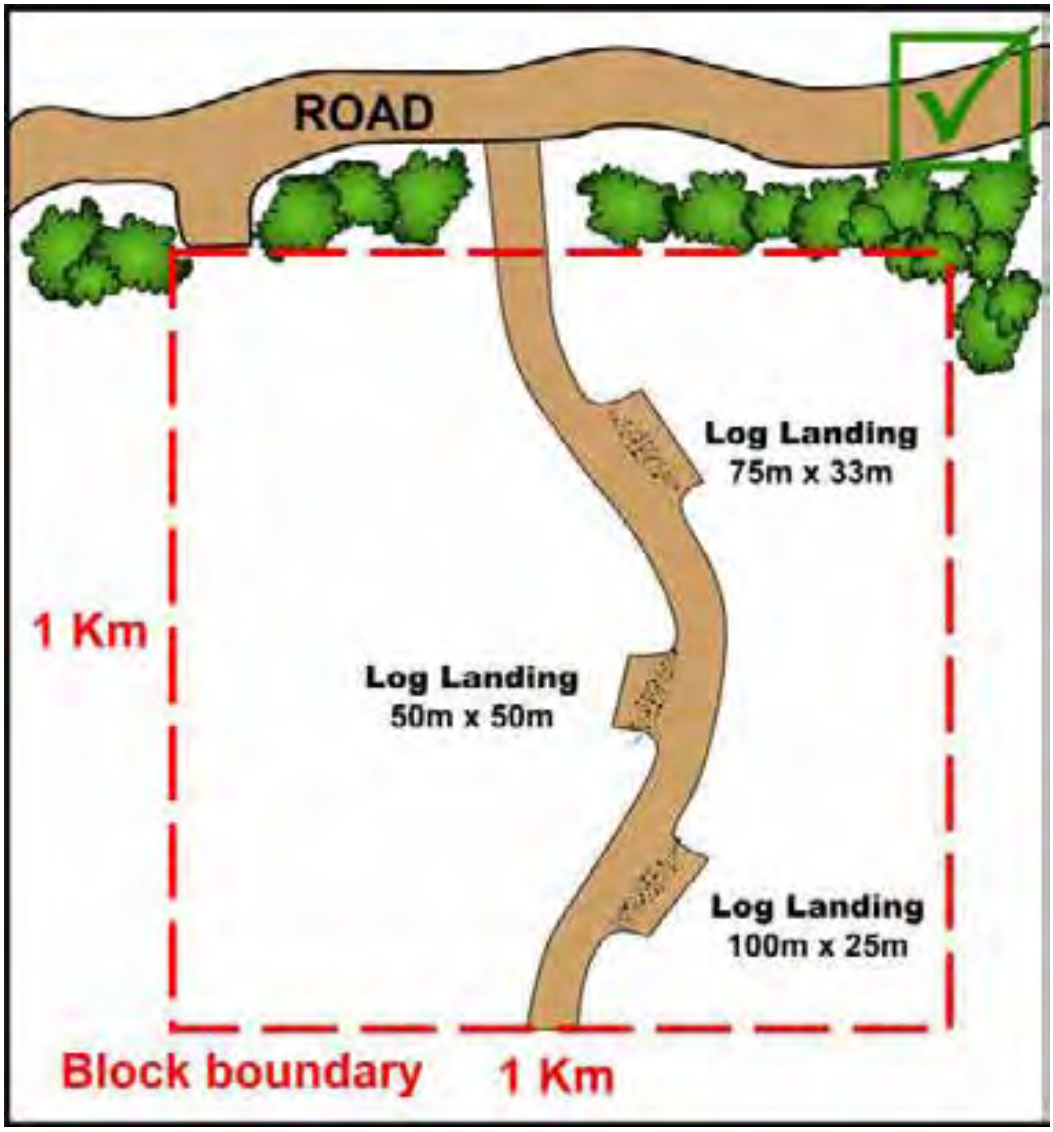

Figure 12: Landing number and size limits

2.9.3 Skid trail layout and construction

a) Skid trail location

Skid trail design and layout follows on from landing construction.

- The design of the skid trail network (Figure 13) should be based on an assessment of the following factors:
  - Location and density of roads and log landings [P];

- The number and location of trees to be harvested [P];
- The logging equipment used [P];
- The minimization of watercourse crossings [E];
- The avoidance of soils with low load bearing capacity [PE].

- The total area occupied by skid trails should not exceed a total linear distance of 200 m per hectare [E];

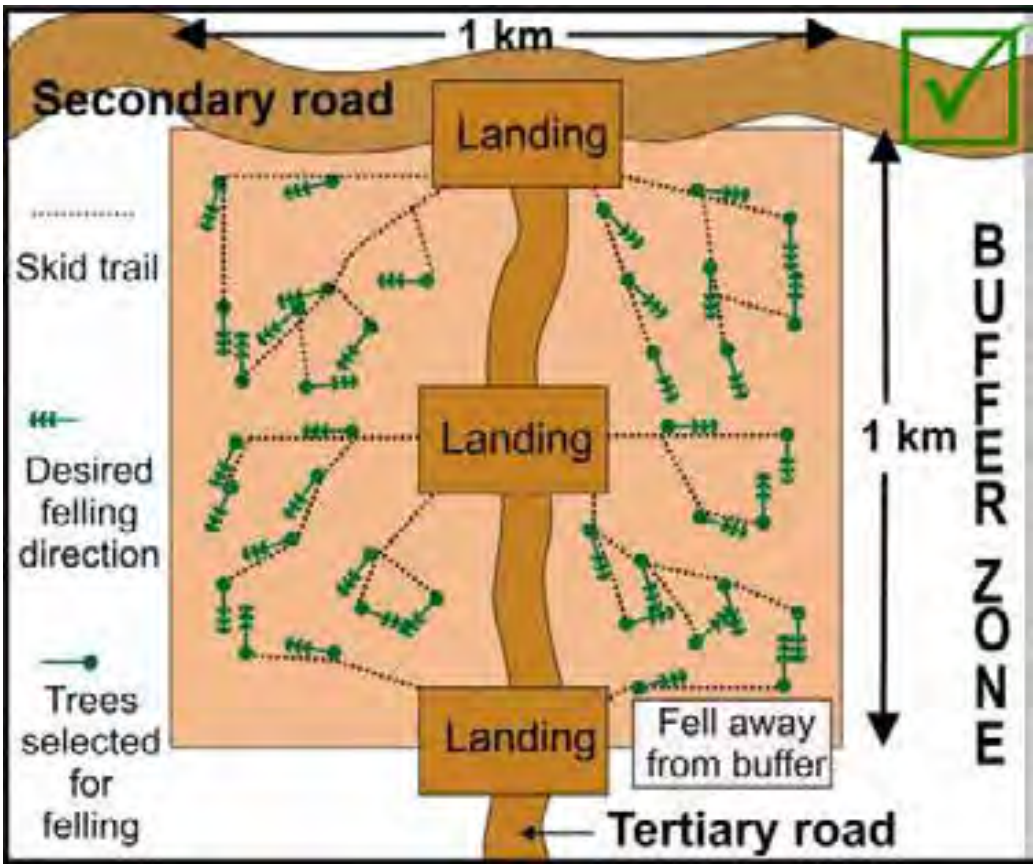

Figure 13: Skid trail layout for log extraction to landings

- Skid trails shall not be constructed in areas excluded from harvesting and buffer strips [E];
- The maximum allowable gradient for skid trails is 45% where a dozer and 6x6 skidder is used and 35% where a 4x4 skidder is used for extraction [E];
- Skidding on slopes greater than 45% (dozer) and 35% (skidder) is only permitted/ allowed for short distances (less than 20 m) where adequate provision for drainage is possible to prevent excessive erosion [E];
- Uphill skidding is recommended since this gives operators better control over the movements of the log, and also tends to encourage the greater dispersion of runoff water into the surrounding area and not onto the skid trail [PE];
- All skid trails should be as straight as possible to minimize damage to residual trees, to prevent damage to the log being extracted, and to maximize skidding efficiency [PE];

b) Preparing skid trails

Skid trails should be prepared as reflected in Figure 14 below. There are 3 key steps in preparing skid trails [SPESo]:

- The proposed skid trail layout in a block shall first be mapped (first picture);
- Skid trails are then marked in the field using tape (second picture). Watercourse crossings shall also be marked as such on the tree location map and on the ground;
- Skid trails shall be opened by a crawler tractor or skidder. The construction of skid trails should not require any earthworks and the maximum skid trail width is 4 meters. Avoid damaging trees above 20cm dbh during skid trail construction (third picture);

Figure 14: Key steps in preparing skid trails

c) Watercourse crossings

- Crossings should be constructed in dry weather [E];
- Watercourse crossings should be selected in places where stream banks are low and the watercourse bed is firm [E];
- Width of the crossing should be not more than four meters [E];
- Buffer strip vegetation should not be otherwise disturbed [E];
- Skid trails should cross waterways at right angles with straight approaches of at least 10 m on either side [E].

2.10 Weather Limitations on Logging Operations

Skidding, loading and hauling when conditions are wet cause extreme damage to soil and water, is inefficient and often dangerous [E]. Furthermore:

- Areas most likely to be workable in wet weather are those with less than 20% slope and on stable soil types (such as brown/white sand and laterite) [E];
- The annual plan should specify wet and dry weather blocks [E];
- Skidding, loading and hauling should be avoided during the peak of the rainy season (July to September) [E].

3 IMPLEMENTING (DOING) FORESTRY OPERATIONS

3.1 Field Servicing and Maintenance

Field servicing is required to allow for productive and safe operating conditions. Furthermore:

- Field fuel tanks, refueling points, chemical mixing points and maintenance areas shall be located:
  - In well-drained areas such as log landings or road junctions [E];
  - Outside areas excluded from harvesting and their buffer strips [E];
  - No closer than 100m to any habitation [SSo];
  - More than 50m away from any watercourse [E];
- Spillage should be avoided during refueling or repairs [E];
- Adequate equipment – e.g. hand pumps – should be provided and used [P];
- Engine oil shall not be dumped in the harvesting areas (Figure 15), but collected and removed to the designated waste disposal facilities [E];
- All containers used in the transport, storage and use of toxic materials shall be leak proof, marked as "hazardous" and clearly labeled with the contents' name [SE];

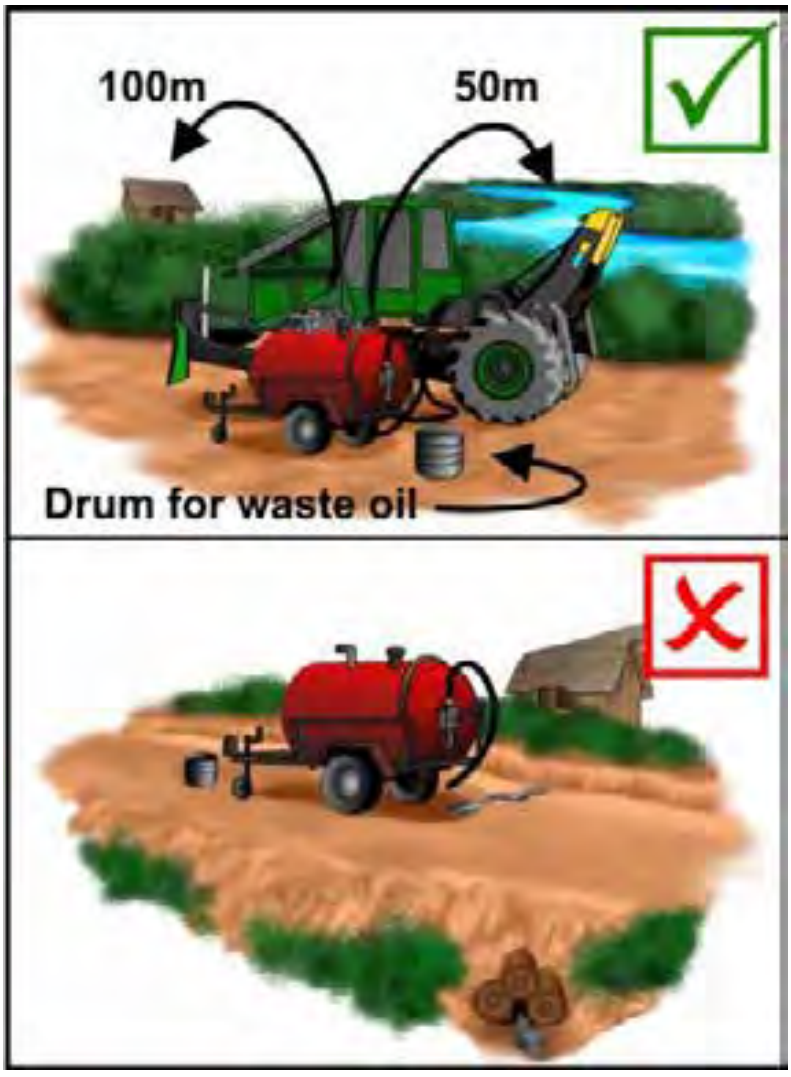

Figure 15: Correct and incorrect way of refueling vehicles in the field

- Workshop mechanics and other workers shall be provided with and wear protective clothing, hearing protection, eye protection, respirators, and/or gloves, as appropriate for the equipment being used (e.g. welding, angle grinding) [S];
- Fire risk shall be minimized by [S]:
    - All machines and chainsaws should be fitted with spark arrestors. Machinery should be clear of surplus oil and fuel;
    - Any rubbing, damaged, frayed, kinked or leaking hydraulic hoses and fittings should be replaced;
    - Refueling shall only be carried out in designated areas where the ground is clear of all inflammables for a distance of 5 meters in all directions from the machine;
    - All welding activities shall be done at least 10 meters away from flammable materials;
    - No fire shall be left unattended in the forest, and fires for cooking or other purposes shall only be lit in designated areas cleared of flammable material within a 5 m radius around the fire.

3.2 Felling

Figure 16 below describes the various parts of a standing tree.

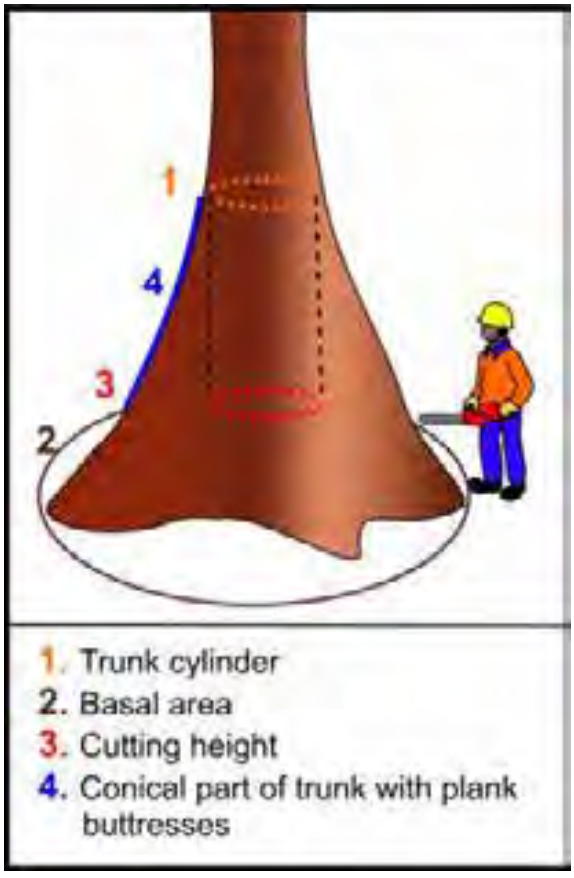

Figure 16: Description of tree base terminology

Felling operations create a working platform for extraction. Felling operations should thus follow the prescriptions given in the block plan. Furthermore:

- Felling should cease when [S]:
    - winds prevent accurate and safe directional felling;

- ground conditions are too slippery to allow the felling crew to move safely and quickly away from the falling tree;

- Felling tempo should always consider the stock in the forest to allow for timely removal of volumes cut at any one time [Q];
- Feller shall always keep the saw chain sharp before felling and sharpen regularly (Figure 17) [P];

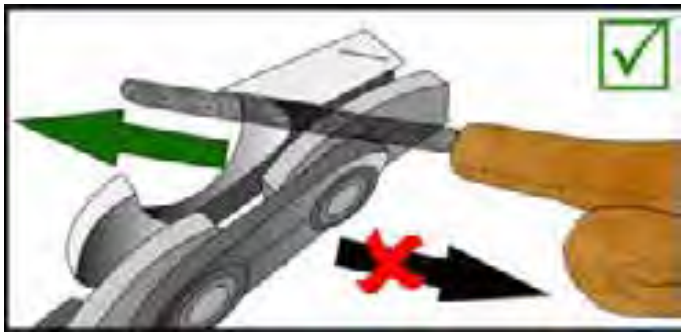

Figure 17: Sharpen chain regularly

- Depth gauges on saw chains shall not be filed down outside the prescribed manufacturer specifications (Figure 18) [S];

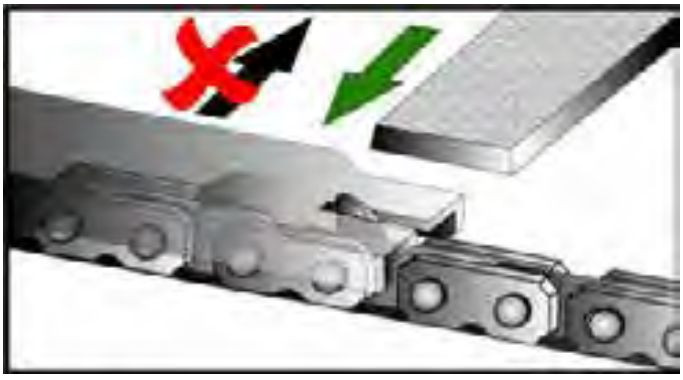

Figure 18: Use flat file to trim off the depth gauge

- Chainsaw operators should always have an assistant and shall never work alone in case of accidents [S];

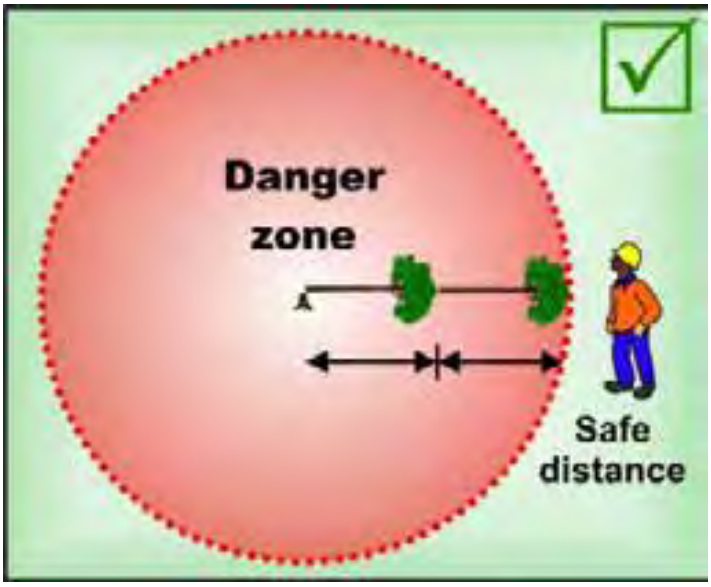

Figure 19: Safety distance during tree felling

- 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 (Figure 19) [S].

3.2.1 Directional felling

Chainsaw operator and assistant shall be trained in directional felling. Furthermore:

- The operator should, whenever practicable, apply directional felling to achieve the following objectives (Figure 20):
    - Fell trees away from exclusion zones, buffer strips and watercourses. If it is not possible to fell the tree away from the buffer strip or watercourse, then it shall not be harvested [E];
    - Where trees inadvertently fall into a watercourse or its buffer strip, the crown as well as any accompanying logging debris should be pulled clear, unless unacceptable damage to the bank or buffer strip is likely to occur [E];
    - Avoid damage to the felled tree (by cross-felling, falling on obstacles, down-slope felling), minimize damage to designated seed trees and other protected trees [EQ];
    - Facilitate easy log extraction, thereby minimizing ground disturbance [P];
    - Prevent trees from hanging up in adjacent canopy trees [SP];
    - Minimize canopy openings by felling into gaps formed by previous felled trees or natural tree fall [E];
    - Avoid blocking the skid trail [P];
    - Increase work safety [S].

Figure 20: Directional felling objectives

3.2.2 Sizing up the tree

- Felling crews should check trees suspected of being unsound before felling (Figure 21) [EQ];
- Once cutting of a tree is started, that tree should be felled, even if it is found during felling to be unsound [S];

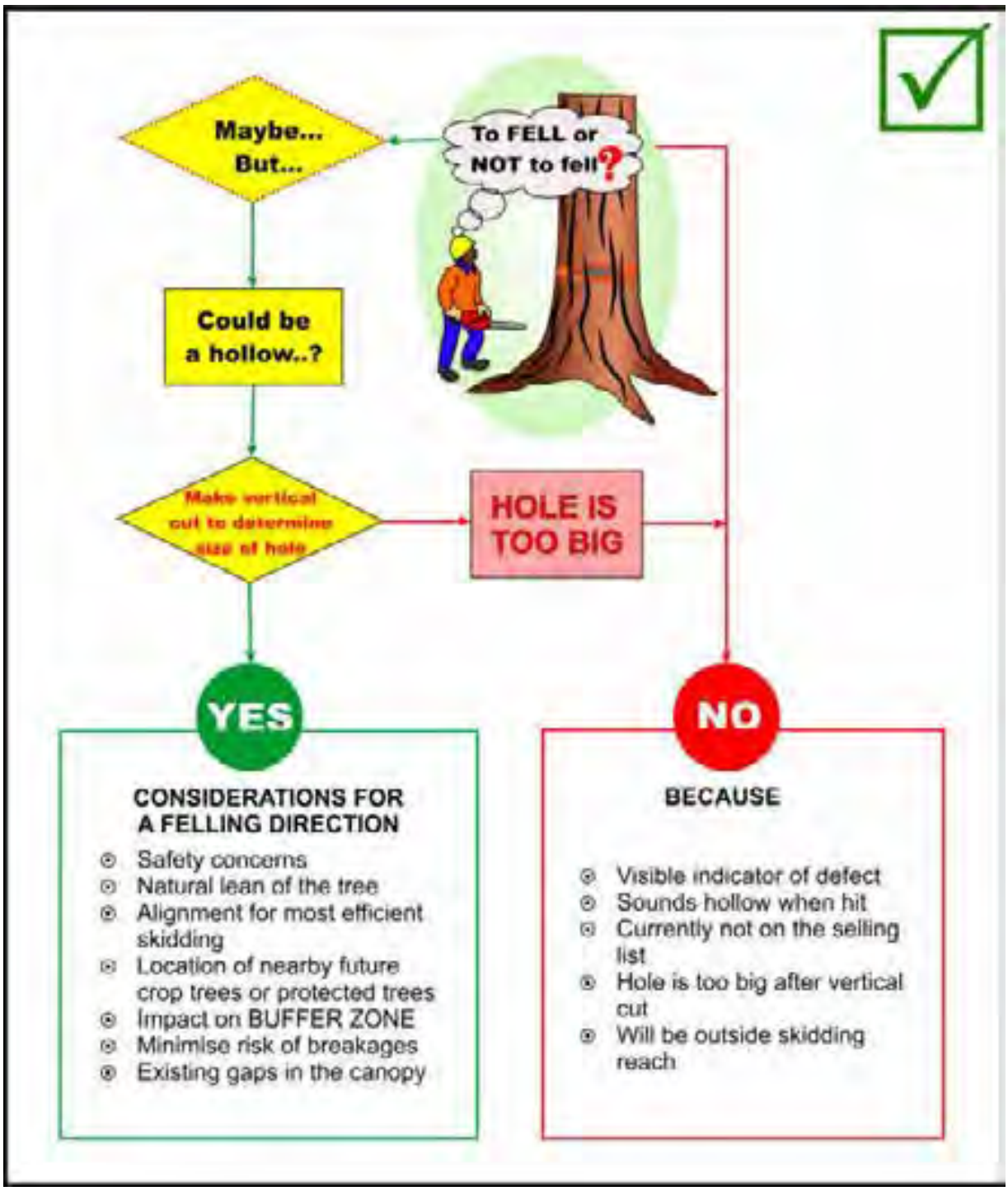

Figure 21: Assessing soundness of tree for felling

- Operators should clear undergrowth and debris away from the base of the tree to provide an adequate and safe working space. Clear two escape paths on the side opposite from the intended direction of fall and at about a 45° angle opposite the line of fall (Figure 22) [S];
- All vines/lianas attached to the selected trees or trailing from the canopy should be cut as far as practicable. This is to improve safety by preventing nearby trees from being pulled over or broken when the harvested tree falls [S];
- Felling direction and corresponding escape routes shall take into consideration vines that are attached to trees at canopy level [S];

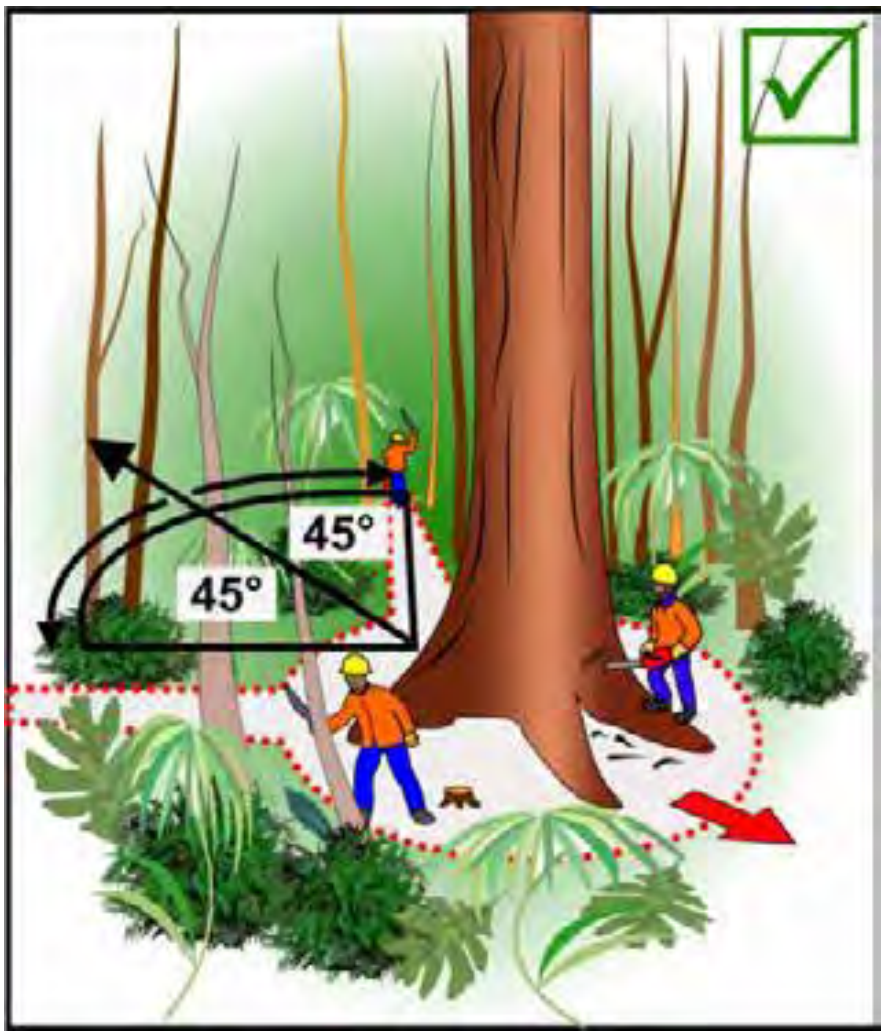

Figure 22: Clearing the base of the tree and opening up two escape routes

- The stump height should be as low as practical to maximize saleable volume [Q]:
  - In cylindrical trees without buttresses, approximately 30 cm (Figure 23);

Figure 23: Avoid wasting timber by unnecessary high felling cut.

  - Buttressed trees should be cut at a height not greater than the point at which buttresses can be trimmed to provide a diameter equal to that immediately above the buttressed section – normally around waist height;
- Chainsaws should not be operated above shoulder height because of the risk of kickback and the resulting backward rotation of the guide bar [S];

- The logs and the stump are numbered and recorded with species and number of the harvesting block according to the standard operation procedures issued by the FDA [Q].

3.2.3 Felling techniques

There are many techniques for felling a tree, each with specific cutting sequences and safety instructions depending on the shape and height of buttresses, trunk straightness, slope and terrain conditions, trunk decays, etc., which is reflected in literature. Any of these techniques may be used provided that chainsaw operators have been trained and found competent by an institution that is recognized in providing training for the felling of tropical trees.

The following illustrations show standard felling techniques for trees of various diameters.

(1) Felling trees should be done according to the standard cutting sequence as shown in Figure 24 [SPQ]:

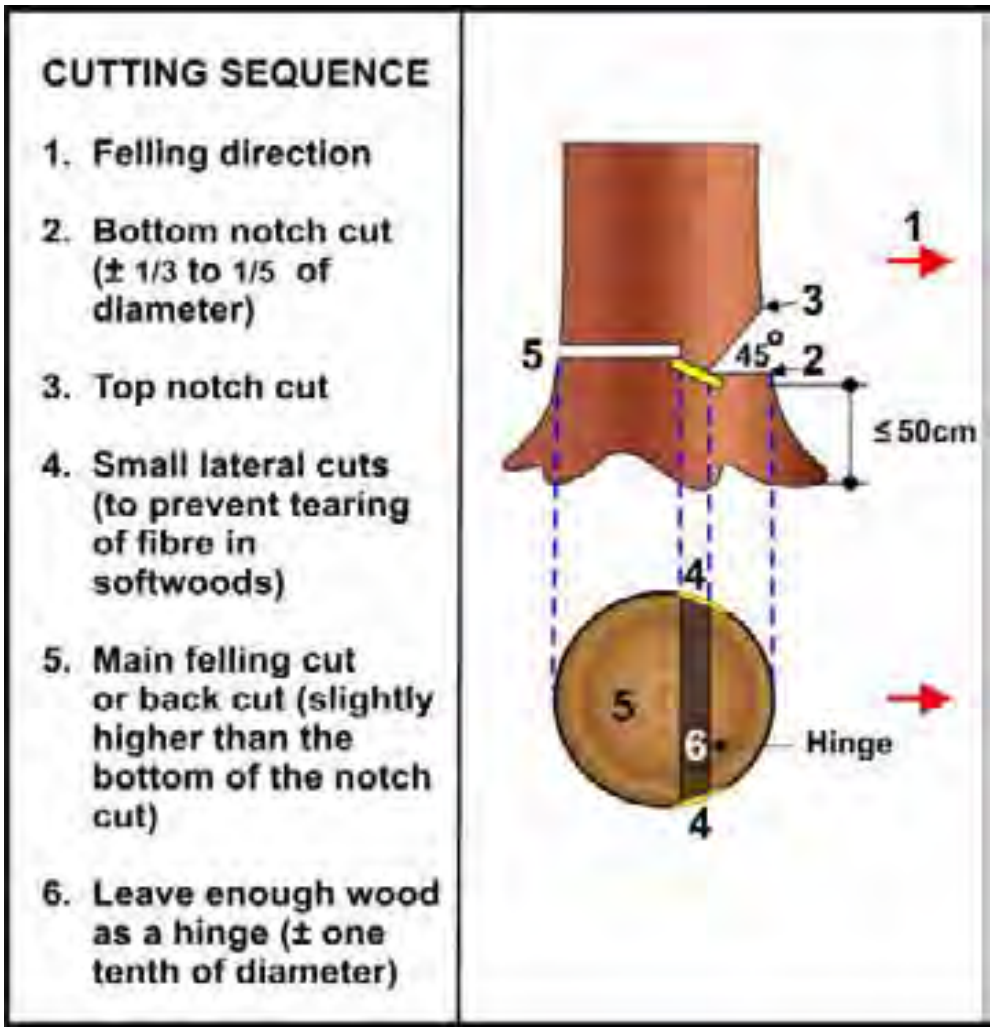

Figure 24: Standard tree felling technique

- Make the bottom notch cut. Stand facing away from the felling direction (Figure 25 left);
- Make the top notch cut in reverse order. Make sure that the cuts meet (Figure 25 right)

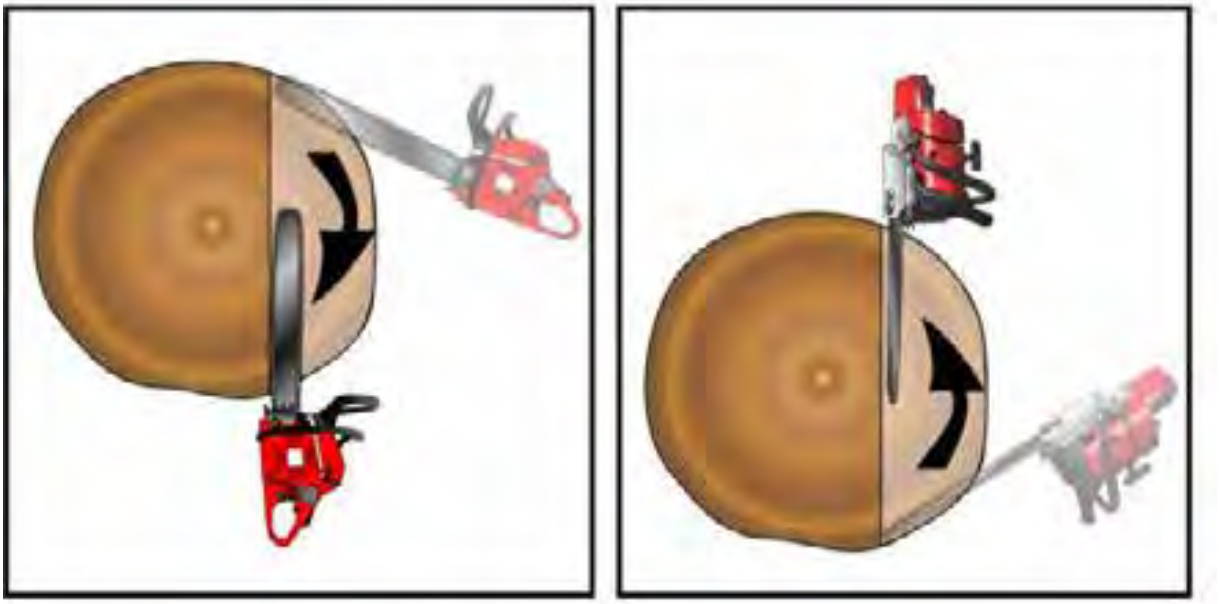

Figure 25: Bottom and top notch cut

(2) Making the back cut in trees with a diameter up to double the guide bar length as shown in Figure 26 [SPQ]:

- Insert the chainsaw, leading with the bottom edge of the bar (pulling chain) to avoid kickback (Figure 25 left)
- Continue the cut until the right hinge width is reached. Before making the swing part of the felling cut, saw back about the width of the guide bar. In this way the hinge will not be severed (Figure 25 center);
- Make the swing cut, being careful not to saw the hinge on the other side (Figure 25 right);

Figure 26: Felling cut

(3) Making the back cut in trees with a diameter more than double the guide bar length as shown in Figure 27 [SPQ]:

- Insert the chainsaw in the center of the directional notch, leading with the bottom edge of the bar (pulling chain) to avoid kickback (Figure 27 top);
- Continue with the back cut by inserting and swinging the chainsaw (Figure 27 bottom), and ensure that the hinge is thicker than normal to compensate for the insert cut into the notch;

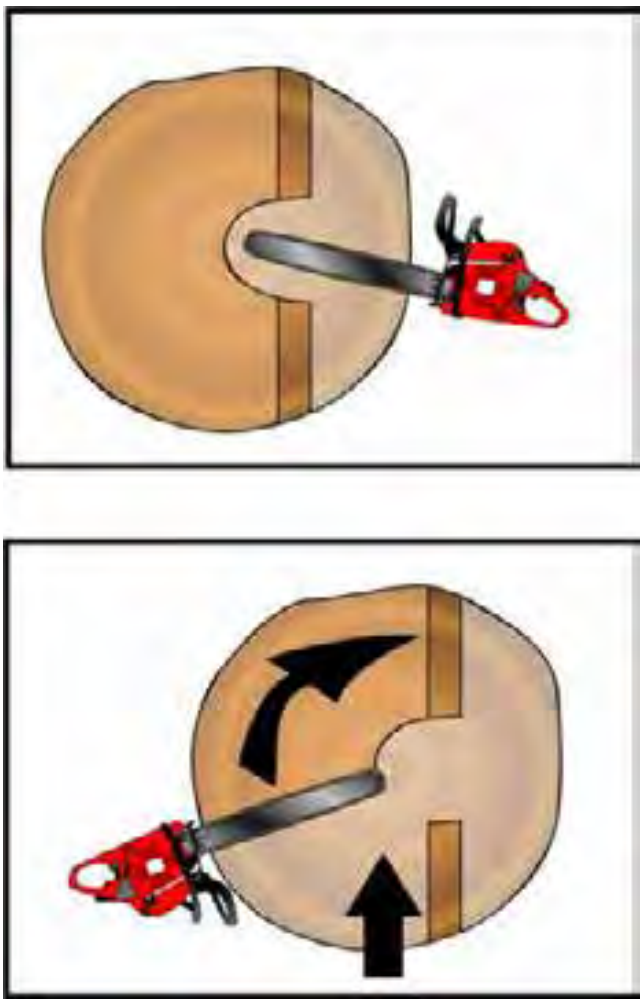

Figure 27: Felling cut in oversized trees

- The use of machines to pull trees while they are being cut shall never be permitted [S].

3.2.4 Hung-up trees

Cut-up and hung-up trees are a potentially fatal hazard, and should be taken down immediately using an authorized method. Failure to comply is extremely dangerous, as it increases the risk of serious injury. When taking down hung-up trees, workers should strictly observe the following. They should not (as indicated in Figure 28a) [S]:

- work under the hung-up tree;
- fell the holding tree;
- climb the hung-up tree;
- cut lengths from the butt of the hung-up tree except for small timber with less than 20 cm base diameter;
- fell another tree onto the hung-up tree.

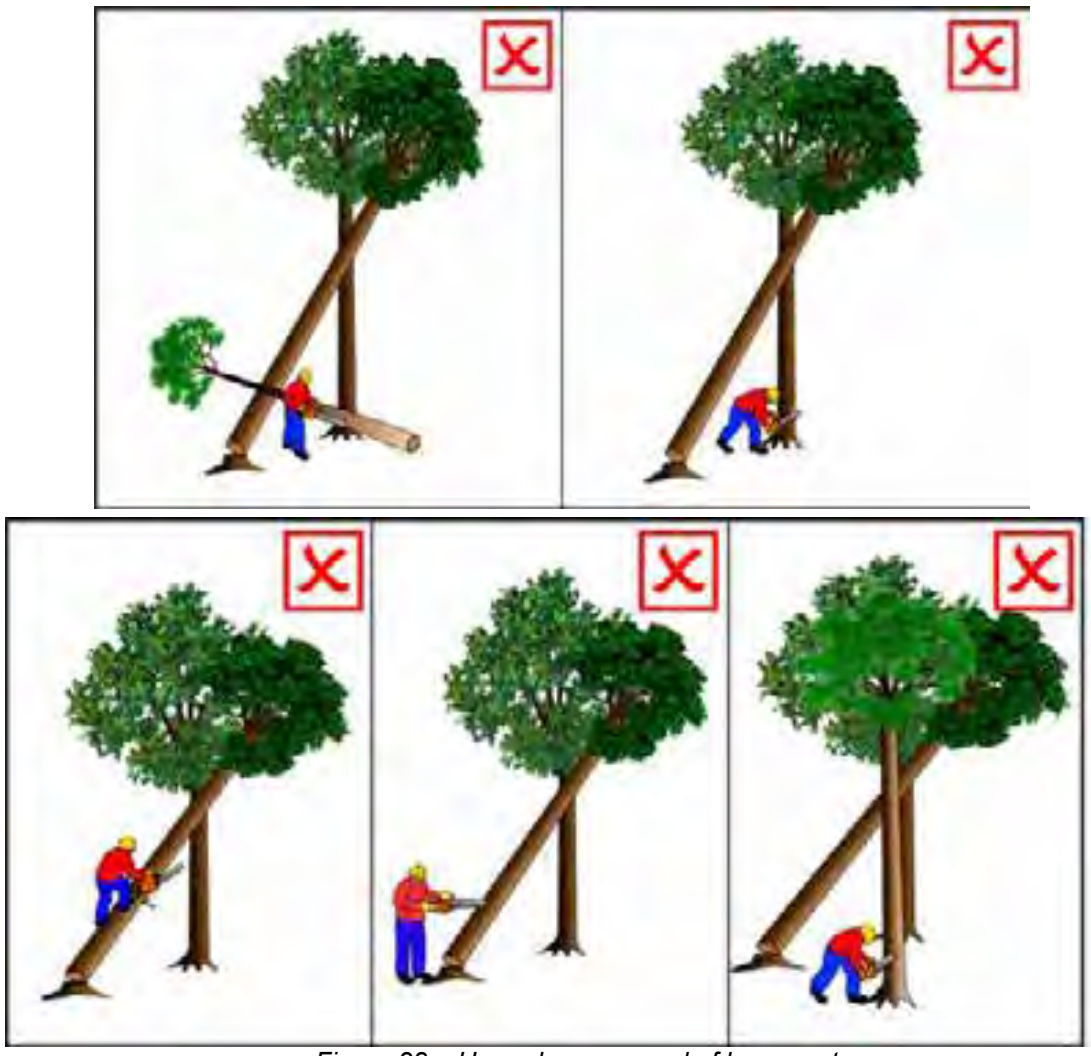

Figure 28a: Hazardous removal of hung-up trees

- For the safe treatment of hung-up trees, use a skidder or bulldozer winch to pull the cut-up or hung-up tree down (Figure 28) [S];

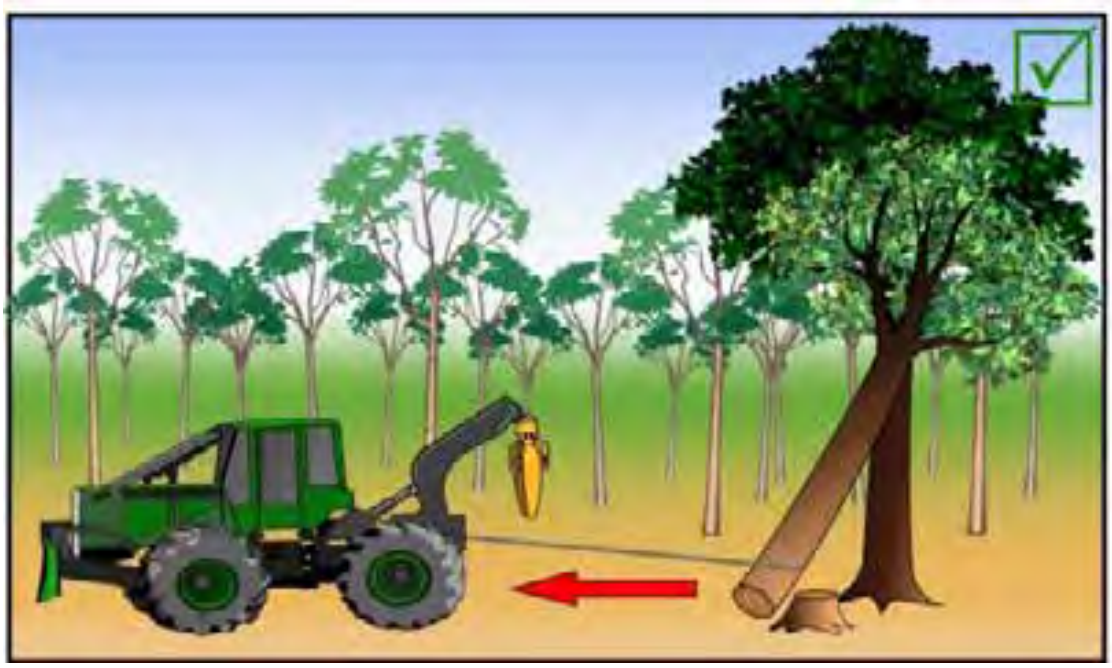

Figure 28b: Safe removal of hung-up trees using a skidder

- When felling wind thrown trees, the operator shall be trained in special cutting techniques for such trees. Figure 29 below illustrates the danger posed by such trees during cutting [S];

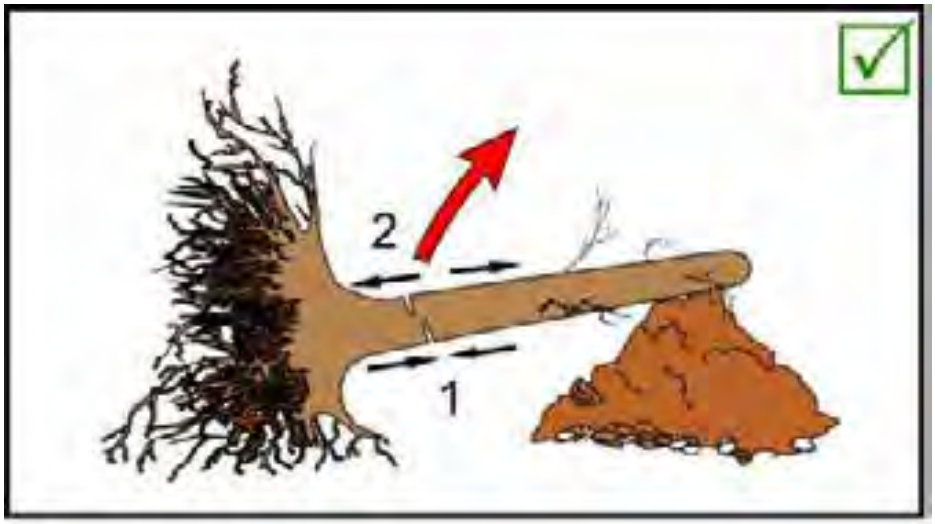

Figure 29: Big stems = big tension: place second cut slightly to the side of the first one

3.3 Log Preparation

The preparation of logs is at the core of the revenue that will be generated from the produced logs. Log preparation includes both the activity of cross cutting as well as log marking.

3.3.1 Cross cutting of logs

A great deal of revenue can be made or lost through the quality of cross cutting that takes place. Furthermore:

- Give clear instructions on qualities, lengths and diameter for bucking at felling site and conversion at landing [Q];
- Long log preparation should be carried out at the stump; thereafter shorter logs are prepared at the landing. This ensures that most of the non-commercial parts of the tree remain in the forest [PE];

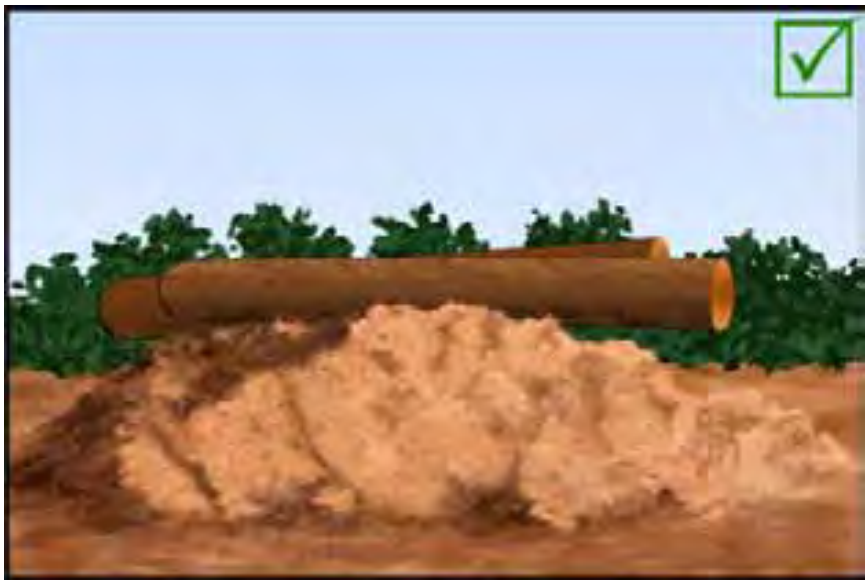

Figure 30: Elevated ramp on landing to facilitate cross cutting

- Where long logs may cause excessive damage to the forest during skidding, then the long log should be cross cut prior to skidding [E];
- Recommendation: Logs may be placed on an elevated area to facilitate cross cutting (see Figure 30) [PQ].
- The chainsaw operator shall ensure that any cross cuts on the felled tree are cut through so as to avoid splitting during extraction [Q];
- Operators should cross cut trees to obtain the maximum volume (see Figure 31), consistent with the highest value of merchantable logs. All buttress flutes, knots and branches should be trimmed flush with the main stem [Q];

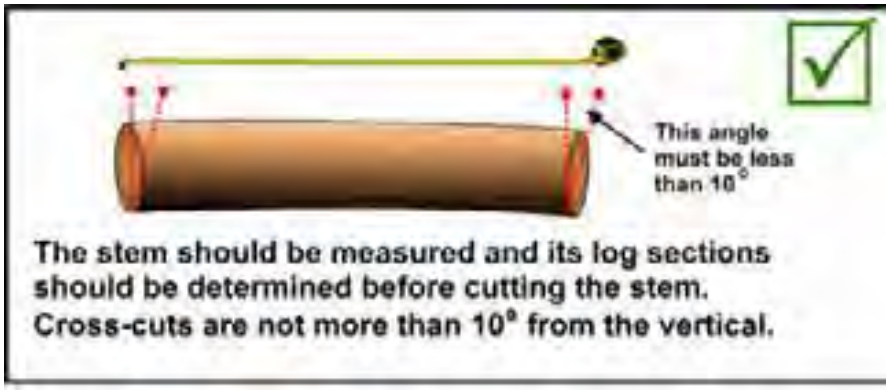

Figure 31: Stem measuring before cross-cutting

Recommendation: S-hooks or plates may be used before extraction as necessary on logs susceptible to end splitting and to maintain quality [Q];

- When cross cutting:
    - Avoid cutting with the upper tip of the guide bar (Figure 32) as kick-back is caused by this part of the guide bar being intercepted or accelerated by a stem, branch or another object [S];

Figure 32: Avoid cutting with the upper tip of the guide bar to prevent kickback

- Always evaluate the distribution of tension and compression at the crosscutting point before applying the cut and position yourself on the compression side (Figure 33) [SQ];

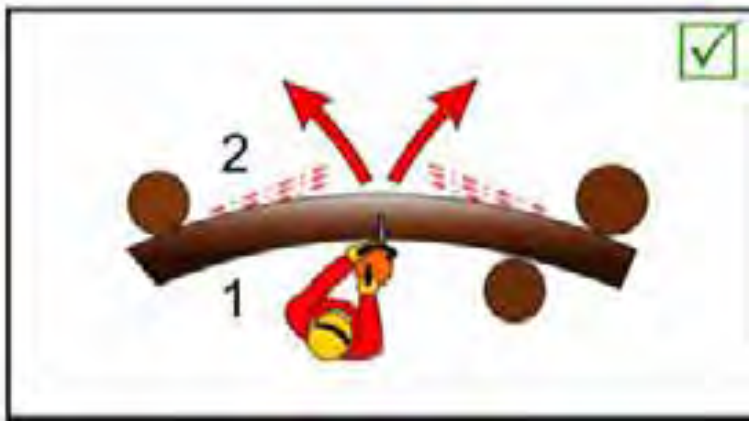

Figure 33: Lateral tension: operator always remains on the compression side

- Always cut first on the side which is under compression (1) and then the side which is under tension (2) as shown in Figure 34 below [SQ];

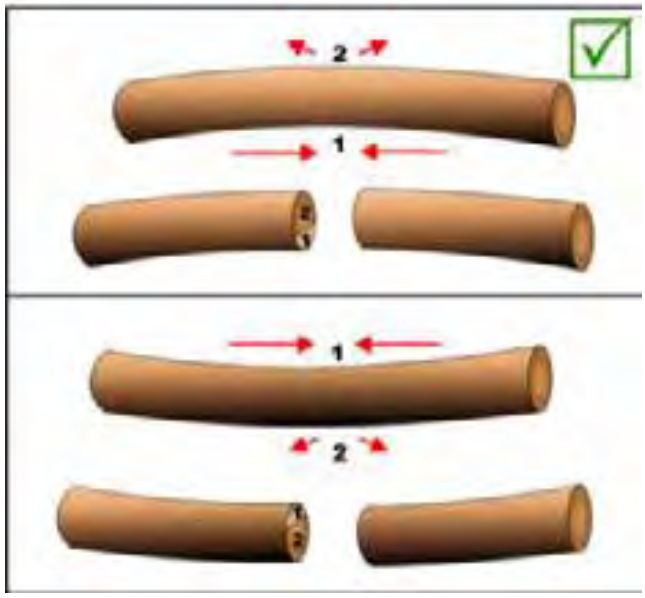

Figure 34: Cross cutting logs lengths that are under compression and tension

- Always work on the upside of the slope when cross cutting (Figure 35) [S];

Figure 35: Always work on the upside of the slope

- Use appropriate working techniques to avoid timber wastage through shattering or splitting of the trunk [Q].

3.3.2 Log marking

Log markings enable logging operators, service providers, and costumers to locate and control all harvesting and extraction activities over space and time. Logs shall be marked according to the applicable standard operation procedures of the FDA.

3.4 Skidding

Skidding follows after long logs have been prepared at the stump. Skidders and dozers are typically used for this function.

Recommendation: Figure 36 illustrates a set of hand signals that may be used by operators to improve safety and productivity during skidding operations.

Figure 36: Hand signals to improve safety and productivity during skidding

- Winches shall be fitted to all extraction machines [PE].
- The following rigging and chocking techniques should be applied:
  - 39m of 22mm or 31m of 25mm wire rope for the main cable on the winch drum of the extraction machine (independent wire rope core) [SP];

- A cast ferrule at the end of the cable on the winch drum (Figure 37) [SP];

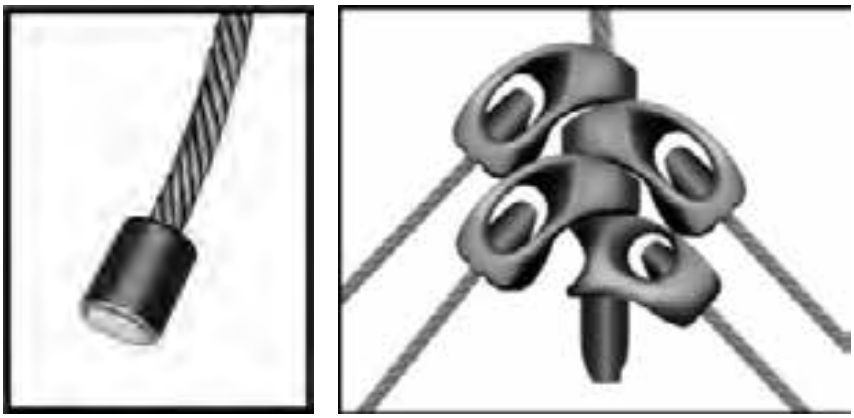

Figure 37: Cast ferrule used at the end of the main cable with 4 slider hooks to attach chockers

- Recommendation: Chockers should be long enough to cover the diameter of the largest tree being extracted, plus an additional 2m to reach the main cable. Cable diameter should vary from 22mm (39m in length) to 25mm (31m in length). Figure 38 below illustrates the recommended choker configuration [P];

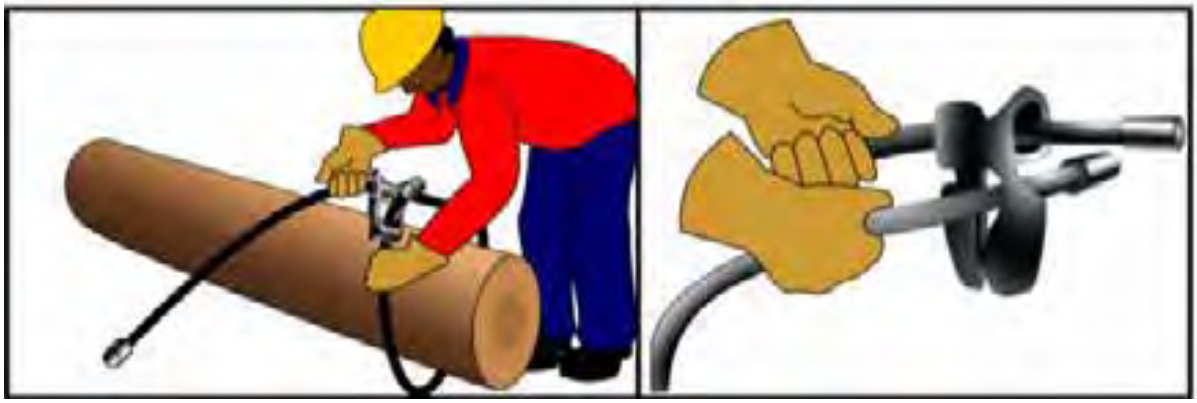

Figure 38 Choker configuration

- Always choke the log by threading the choke from top to bottom as illustrated in Figure 39 below (not the other way around) [P];

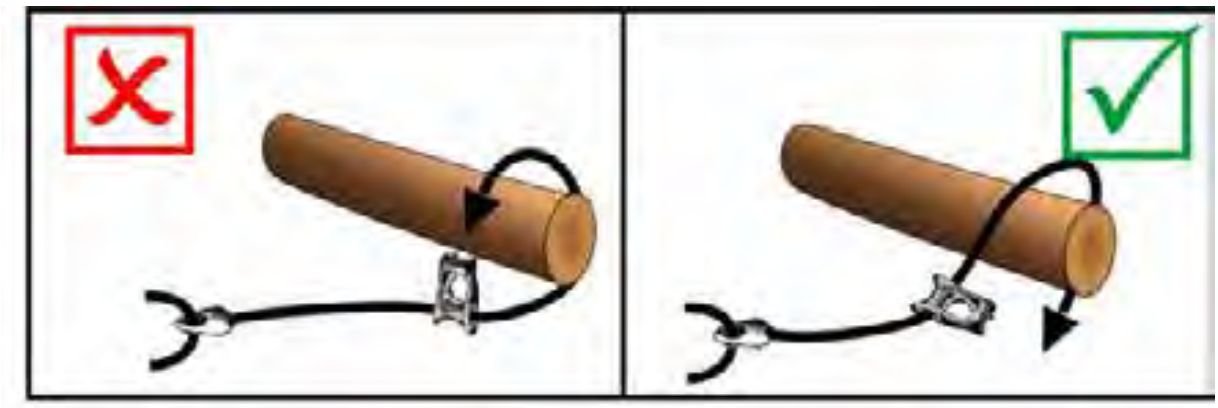

Figure 39: Correct and wrong choking techniques

- Recommendation: Use various choking configurations to move logs out of tight spots as illustrated in Figure 40 below [P];

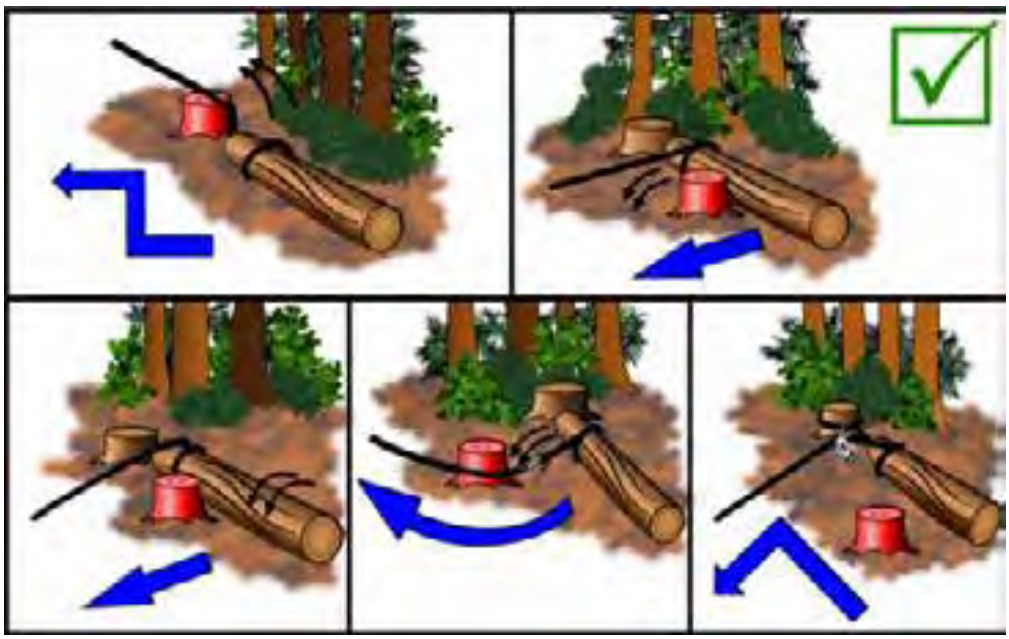

Figure 40: Various choking configurations to remove a log from a tight spot

- When winching in a load, the skidder should be directly aligned with the load being winched (Figure 41) [SP];

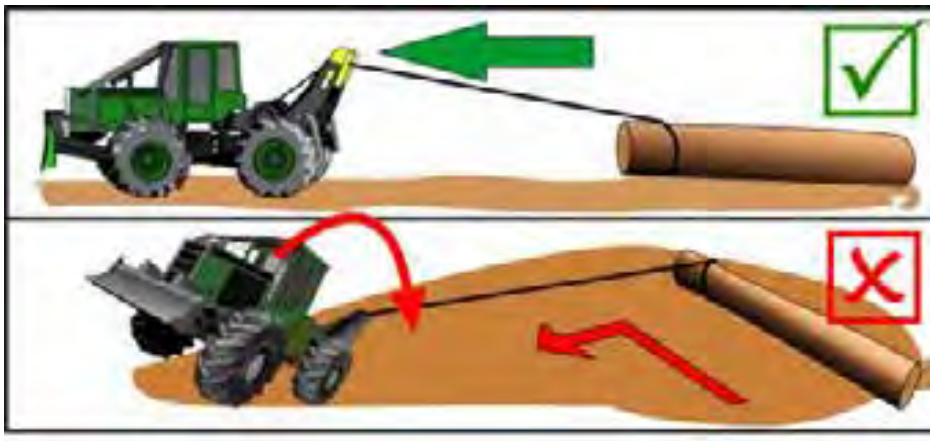

Figure 41: Skidder/dozer alignment when winching

- Recommendation: When winching the load, apply the 3 x H rule (Figure 42). The distance of the log load from the skidder should be 3 x the height of the distance from the ground to the winch drum. This improves the traction of the machine [P];

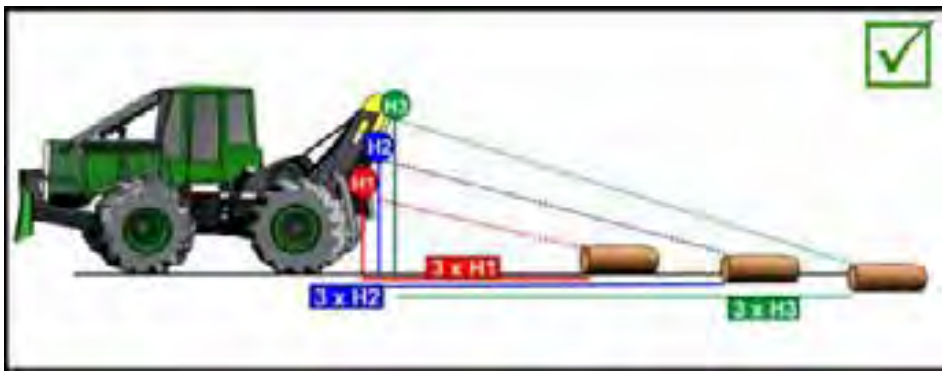

Figure 42: 3 x H rule for skidder/dozer stability

- Skidder and dozer blades shall be raised when traveling and skidding [S];
- Skidding should not be carried out in site conditions where the stability of the machine cannot be assured (see Figure 43) e.g.: skidding across steep slopes outside the design specification of the machine [S];

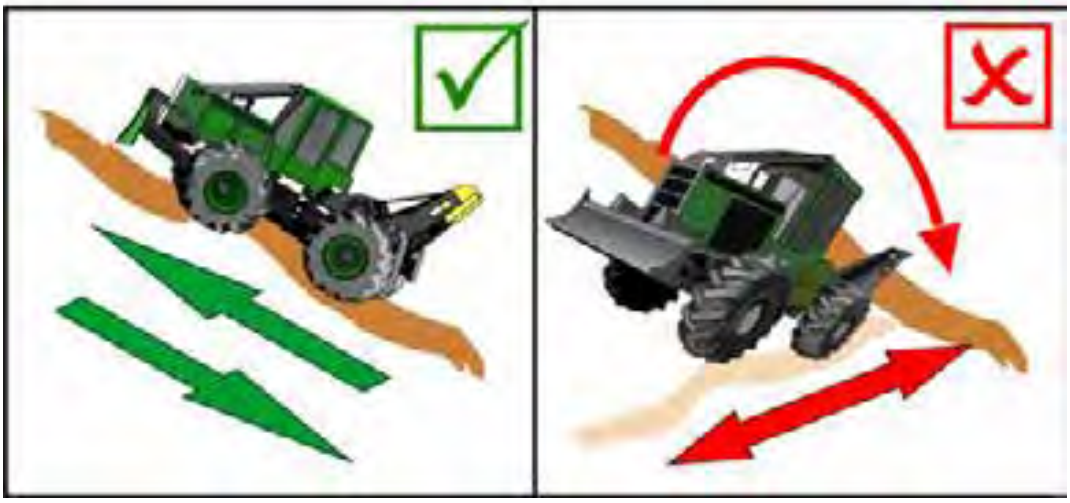

Figure 43: Maintain machine stability on slopes

- No loose objects should be carried on the skidder unless a space is provided for that purpose and the object can be firmly fixed into place [S];
- The operator shall always be on the lookout for people around the machine and shall immediately stop the operation when someone moves into the danger zone (Figure 44) [S].

Figure 44: Maintain safe distance from people around the machine

- Operators should reverse along skid tracks towards the concentrated log on the skid trail, and head or butt haul to reduce travel distance [P];
- Recommendation: Avoid skidding along or across primary and secondary forest roads [P];

- Skidding should be avoided during the height of the rainy season (July to September) [PE];
- Machine access shall be prohibited in all exclusion zones [E];
- Trees felled inadvertently into a buffer strip should be extracted carefully to minimize disturbance to the buffer strip (Figure 45). If trees fall inadvertently into watercourses or their buffer strips, the tree head as well as any accompanying logging debris should be pulled clear [E];

Figure 45: remove tree tops and debris from water bodies

- No harvesting debris shall be pushed into exclusion areas or their buffer strips [E];
- The wheeled skidder should never move off the skid trail, especially when all logs are concentrated along the skid trail during the pre-skidding [E];
- Logging machinery should not cross watercourses except where indicated in the annual operation and block plans and after crossing points have been properly constructed (Figure 46) [E];

Figure 46: Stream crossing during skidding operations

- Lesser value and/or lower grade logs shall be used in the construction of crossings where needed [P];
- Water crossings shall be controlled to minimize sedimentation of water bodies [E];
- Crossings shall be removed after completion of the operation. Crossing material should be placed more than 10 meters away from the high bank. Its removal should not disturb the watercourse banks [E];
- Skidding should cease when:
    - Soils are saturated and turbid water or mud is flowing down a skid trail [PE];
    - Turbid water or mud is flowing from a skid trail or road into a watercourse [PE];
    - Any affected section of the trail or road shall not be by-passed by opening up a new trail/road alongside or close by (Figure 47) [E].

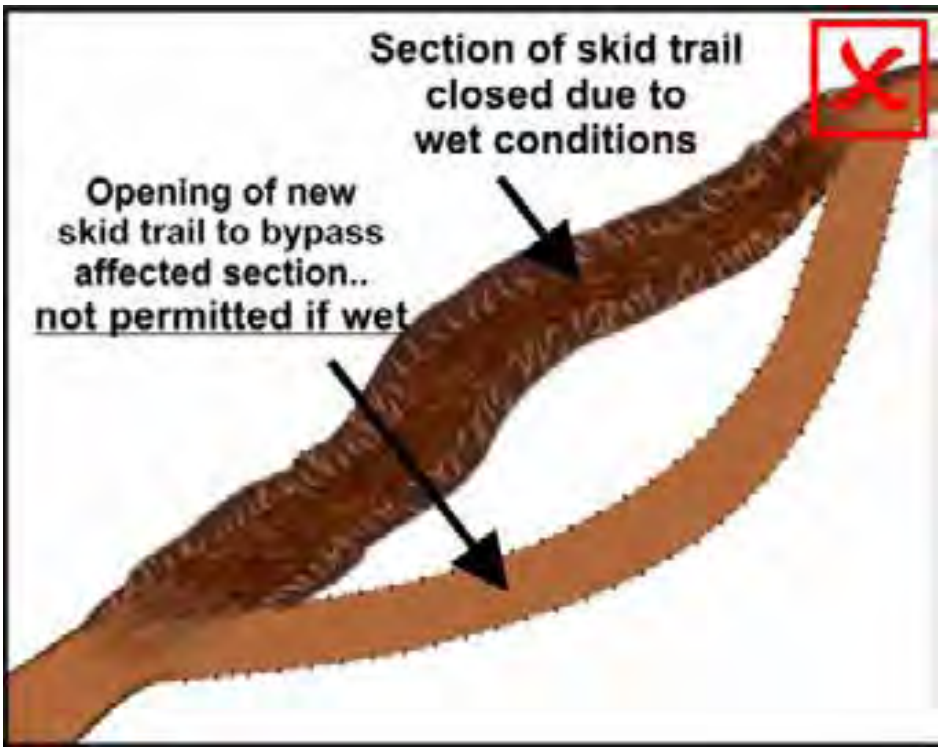

Figure 47: Avoid opening new skid tracks to bypass wet sections

3.4.1 Recommencement of operations

Soils need to be allowed to drain after heavy rainfall events before forest operations recommence. Furthermore:

- Skidding, loading and trucking operations may recommence only after water or mud ceases to flow on affected skid trails, landings and forest roads [PE].

3.5 Log Landing Operations

3.5.1 Log storage

- The logging supervisor shall ensure that only trees approved in the yield are felled, and all merchantable timber is extracted from the stump area and brought to the log landings before the logging season ends [PQ];

- Logs should be stockpiled in well-drained log landings and shall be sorted in such a manner as to facilitate their inspection and scaling by FDA chain-of-custody staff and other authorized monitors [Q];
- Logging operations on the landing shall cease when [E]:
    - Water is ponding on the surface of the log landing;
    - Soils are rutted to the extent that the depth of mud is greater than the rim of wheeled machinery or reaches the final drive on tracked machinery;
- Recommendation: Avoid skidding across the roadway because this may lead to deterioration of the road formation and (road) drainage facilities [PE];
- The use of heavy machinery on saturated soils should be minimized to limit erosion, ponding, rutting, mixing and the compaction of the soil [E];
- Log landings should not be bladed off to keep them operational [E];
- Logs stored at the landing should be sprayed with permissible fungicides and insecticides to protect against bio-deterioration. All pesticides shall be used in accordance with chemical use described in paragraph 2.3.3 [SQ];
- Furthermore:
    - Workers applying hazardous chemicals must receive training and full information on the risks involved and in the use of protective equipment and first-aid techniques [S];
    - Workers handling chemicals must wear protective clothing as recommended on the container label. It is the company's responsibility to ensure that its workers use all protective clothing provided [S];
    - Chemicals must always be utilized with the proper equipment, as recommended by the manufacturer [S];
    - The equipment must function properly and be free from leaks and blockages [S];
    - Worker should be allowed to bath or properly clean themselves with water immediately after returning from work [S];

3.5.2 Loading

Loading in forest harvesting is to facilitate the evacuation of extracted timber that has already been cross cut, classified, sorted and scaled. Furthermore:

- Vehicles with rubber tires or excavator type front-end loaders (Figure 48) should be used for loading and unloading logs [P];
- Trucks shall not be overloaded [S];
- Any protruding limbs bark or trailing material shall be removed before the truck departs the loading point [SQ];
- Pit loading is limited and shall only be permitted for logs that cannot be loaded or unloaded by vehilces with rubber tires or excavator type front-end loaders. The pit used shall immediately be refilled with the same excavated material removed [E];
- All loads shall be secured with at least two load binders [S];

Figure 48: Front end loader used to load trucks

- All employees shall keep a distance of at least 20 meters away from loading truck during loading operations (Figure 49) [S].

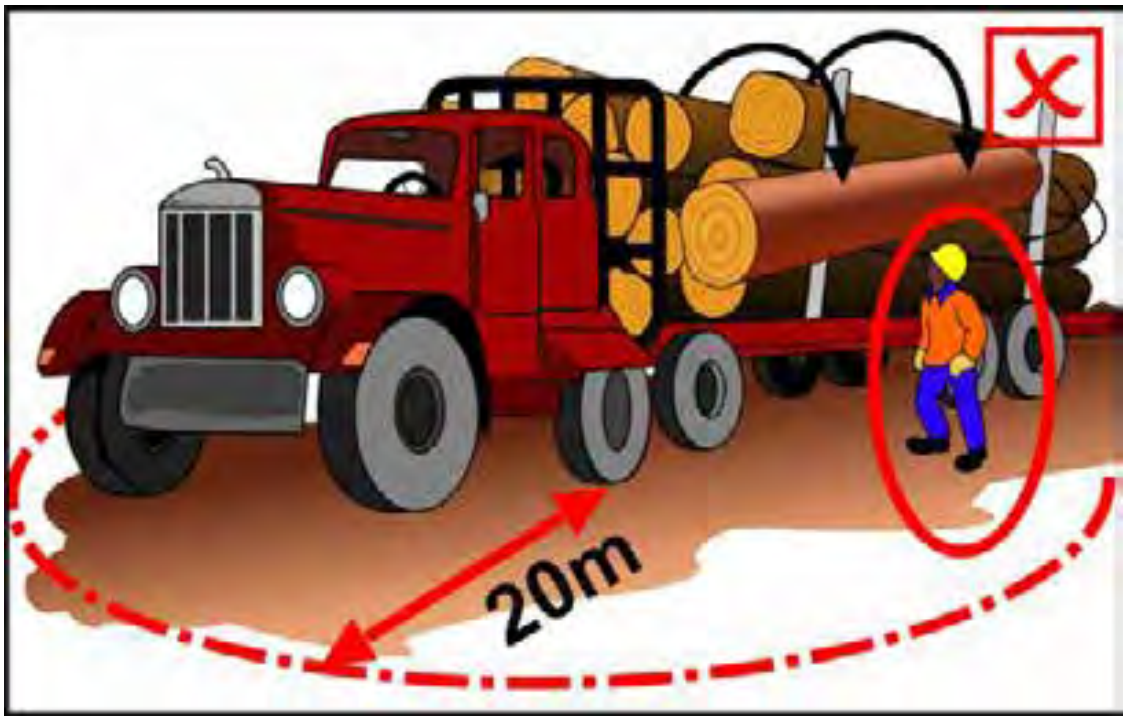

Figure 49: Stay out of the danger zone while loading

3.6 Road Transport

Transporting logs shall be completed by truck from the bush landing/processing sites to its final destination/point of delivery. Trucking is often the most expensive activity in logging and therefore efficient and effective use of trucks is economically advantageous.. Furthermore:

- Trucking shall be halted when:
    - Trucks cannot move unassisted along the roads because of slippery conditions [SPE];
    - Turbid water or mud runs in wheel ruts, and forestry roads are rutted to the extent that the depth of mud is greater than halfway of the rim of wheeled machinery [PE];
- For cost and safety reasons, the truck should be roadworthy and vehicle brakes and steering should always be in good technical condition [SP];
- Recommendation: Service trucks according to the service schedule recommended by the manufacturer and keep maintenance records thereof [SP];
- For efficiency and safety, the trailer unit should be loaded onto the tractor before traveling unloaded [P];
- Personnel should be able to operate equipement and vehicles without impediment (no vehicles or other operational equipment should be used if the operator has been drinking alcohol, taking drugs, or has a physical impediment or condition that may cause the driver to perform in an unsafe manner) [S];
- Unauthorized passengers, bush meat, fire arms or protected wildlife shall not be transported on logging trucks [E];
- Speed limits shall be observed [S].

4 HARVEST CONTROL, MONITORING, INSPECTION AND ASSESSMENT

Harvesting assessment is a systematic check en to determine or verify that harvesting operations followed the annual harvest plan and achieve its technical, financial and environmental objectives while complying with established standards of management plan guidelines [SPEQS]. Monitoring and assessment are thus key elements of responsible forest management for the forest operator to conduct. Furthermore:

- Recommendation: The forest operator identifies and monitors key performance indicators for all logging activities on the various logging teams. This includes the setting of SPEQS performance targets for each of the identified indicators and measuring actual performance against the set targets. Where there are intolerably high variations, it is recommended that the operator takes corrective steps [SPEQS];
- The FDA and forest operator shall provide opportunity for independent monitoring and evaluation [SPEQS]:
    - Before harvesting commences, to evaluate the quality of planning;
    - During harvesting through the monitoring and control of operations;
    - After harvesting by means of internal and external assessment.
- All monitoring requirements established in FMC, TSC, PUP, and CFMA shall be implemented and regulated under the supervision of the FDA contracting officers, the LVD inspectors and auditors and inspectors from the EPA and MOL [SPEQS].

5 ROADS USED FOR LOGGING

5.1 Introduction

Roads are vital for successful forest management. Roads allow access for the various forest management activities and allow the cost-effective transport of timber. However, roads can also cause large environmental impacts due to erosion of the surface and road drainage structures. Balancing the need for access into the forest, while minimizing environmental impacts, is one of the greatest forest management challenges.

With good planning and responsible management, it is possible to put in place a forest road network, which allows adequate access and minimises environmental impacts.

An acceptable forest road from an economic perspective is one that provides a suitable driving surface according to the traffic requirements, at a time when the traffic needs to use the road. An acceptable forest road from an environmental perspective is one that does not excessively erode and contaminate water sources. Because all roads cause impacts, it is always desirable to create surfaces that are stable to minimize erosion and keep the overall road density as low as is practically possible.

Roads in the Code are those purposely built to facilitate logging operations with their corresponding standards. Other roads may exist in the concession, (those specified in the social agreements for example). Other standards may apply in such cases, e.g. MPW road standards.

5.1.1 Road classification

Three road classes exist in Liberia logging operations. These are described below and illustrated in Figure 50.

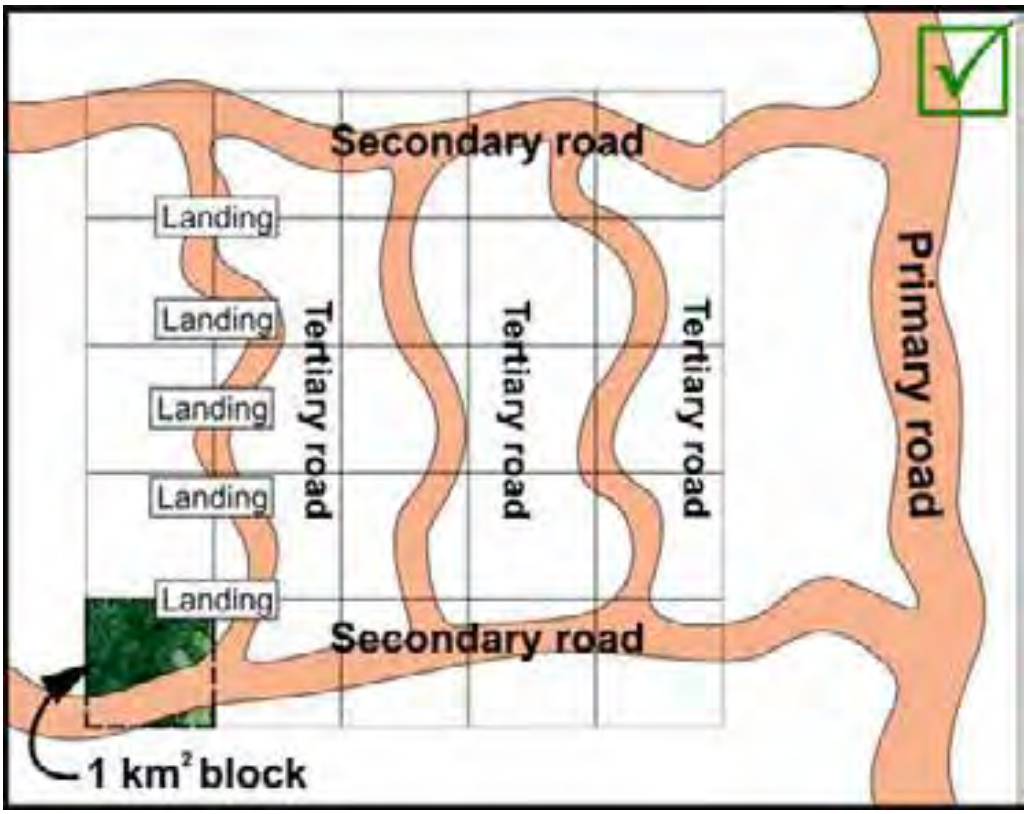

Figure 50: Typical layout of road classes and landings in larger commercial forest areas

a) Primary forest roads

As per Figure 51, these should be permanent, all-weather public roads that provide access to the FMC or CFMA area. Ideally, they should be capable of carrying high log volumes (>2000 m^3per week) and be in service throughout the year.

Figure 51: Example of a primary road

b) Secondary forest roads

These are roads that provide access to a logging compartment, connecting tertiary roads and log landings to primary roads. They will carry log volumes of approximately 1,000 to 2,000 m^3 per week and can be either permanently in service or for a few years.

c) Tertiary roads

These are roads that are used for the extraction of timber from the block and that provide access to neighboring blocks between secondary roads. They are usually of a temporary nature, and are constructed according to the specific needs of a block.

5.1.2 Road planning

Road planning should focus on locating the road in the most appropriate location (Figure 52), minimizing the density of roads as far as possible, creating a road surface condition suitable for log transport and minimizing erosion from the road surface and drainage structures. In planning the location of roads the following factors shall be considered:

- Secondary and tertiary forest roads shall avoid all protected and exclusion areas and their respective buffer strips [E];
- Roads should preferably be kept away from the edges of buffer strips unless not practically or environmentally possible, except at designated watercourse crossing points. No part of the road reserve or corridor should be in the buffer strip [E];

- Where possible, secondary roads shall be located on well-drained soils and slopes where drainage will move away from the road. This will help to ensure that the road surface maintains sufficient strength to carry log trucks over time [E];
- Roads should preferably follow the natural terrain to minimize steep road gradients and the use of cuts and fills [PE].

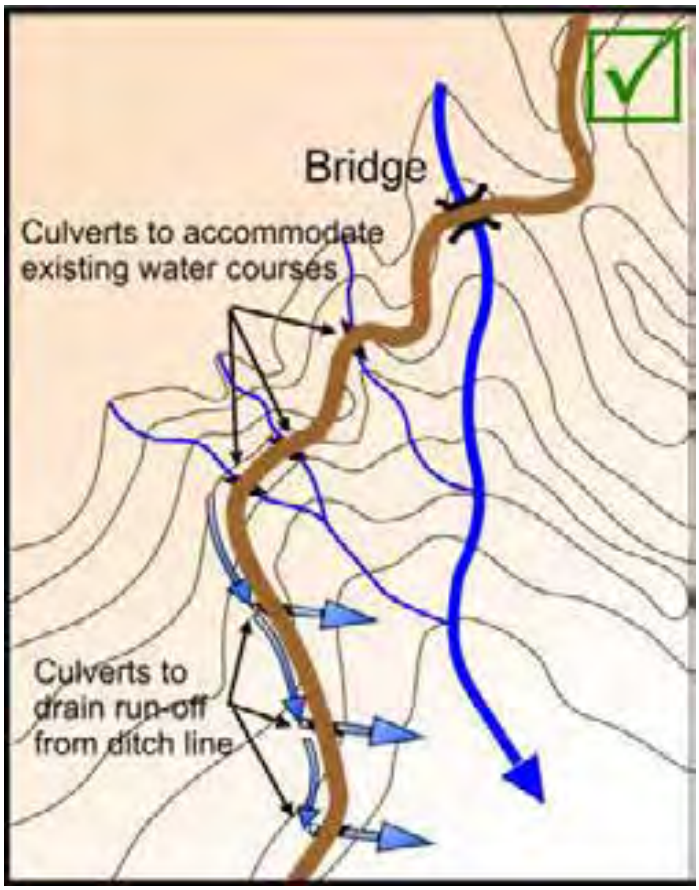

Figure 52: Road location and drainage

- Roads should be located on ridges as much as possible. This also facilitates uphill skidding [PE];
- Efforts should be made to avoid the following locations [E]:
  - areas that require full bench cuts;
  - steep (>45%) areas;
  - very flat terrain where drainage is more difficult to control;
  - water bodies such as swamps, marshes, landslides;
  - highly erosive soils;
- Efforts should be made to minimize the number of watercourse crossings [E];
- If possible, secondary roads should be constructed a few months ahead of log truck use to ensure that the road has time to stabilize [PE].

5.1.3 Survey requirements for inspection

The contractors responsible for the road construction shall survey and mark the center of proposed roads and all proposed watercourse crossings on maps and in the field [QE].

a) Road standards

Road construction costs are influenced by the standard of road being built. Road standards are the parameters which determine into which class a road will fall. Road standards need to be viewed as guidelines, as the specifications for each road will differ depending on the local conditions, season and log transport requirements. The guideline standards given in Table 7 will apply:

Table 7: Road class standard guidelines

Class	Primary	Secondary	Tertiary
Traffic direction	2 lanes	1 or 2 lane	1 lane
Recommended maximum speed (km/h)	70	50	40
Maximum road width (m) • Road reserve • Roadway • driving course	 10 each side 2 each side 8	 10 each side 1 each side 5	 9 6 4
Minimum sight distance (m)	100	60	NA
Minimum curve radius (m)	50	30	NA
Desirable maximum gradient (%)	10	15	15
Camber - cross fall (%)	3 to 4	3 to 6	NA
Min side drain depth below road camber (cm)	30	30	NA
Surfacing	Imported load bearing material	Imported load bearing material (where required)	Insitu or load bearing material
Sufficient turnout drains and culverts should be used where appropriate to prevent erosion. This will be influenced by factors such as road gradient, erodibility of soil and volumes and speed of water. Water exiting drainage structures should not flow directly onto exposed and erodible soils, or directly into water bodies.			

b) Timing of construction

The opening of primary and secondary forest roads shall take place in the dry season. Final shaping and grading should be carried out towards the end of the rainy season [PEQ].

c) Roadway construction

Bulldozers and excavators are used for road construction. Bulldozers can generally be used where side slopes are not excessive as the loss of side-cast material is not a concern. Modern bulldozers can create satisfactory road templates. Excavators are more suitable on steep slide slopes as it is easier to control the movement of cut soil, and can load material onto trucks for movement if necessary. However, excavators cannot push material like a bulldozer can. Therefore careful attention must be given to machine selection.

The construction of primary and secondary forest roadways should consider the following:

- All trees within the clearing width should be felled. Merchantable stems should be processed and stored for extraction if possible. Non-merchantable stems and logging residues should be removed outside of the planned roadway and preferably placed in the road reserve [P];
- Where residues are excessive, some material may need to be placed outside of the road reserve. Care should be taken not to damage trees outside of the road reserve [PE];
- Trees outside of the road reserve which have or could become hazardous due to the road construction activities (damaged roots or unstable) should to be felled [S].
- Stumps within the roadway shall be removed and placed in a suitable location as per the other biomass indicated above [Q];
- Organic material should not remain in the roadway. This material cannot be compacted and results in road failure when it decomposes. Organic material also absorbs moisture which reduces road strength [Q];
- Topsoil may be stockpiled for use in road stabilization (cut and fill batters) or road rehabilitation [PQ];
- Before earthworks, the road center line shall again be established [PQ];
- Drainage structures should be completed immediately after the earthworks [P];
- Where necessary, soil stabilization should take place throughout the entire road construction process [E];
- All road drainage works shall be completed before gravelling work commences [PE];
- Gravelling should be added to primary roads and recommended for secondary roads [Q];
- Where possible, gravel should be compacted with appropriate compaction equipment. If this is not possible, the road should either be given sufficient time to settle before use, or wheeled machines and trucks should try and travel over the entire width of the carriage way when the road is first used [Q].

d) Side slopes

Even though the road itself should not have a gradient steeper than 15%, the side slopes of roads may be steeper (not exceeding 45%). In such circumstances, additional construction is required to mitigate the impact of the roads:

- When constructing side cut roads, the maximum slope upon which they can be built shall depend on how stable the soils are and which soil stabilization techniques are used, but it should not exceed 45% slope [E];
- Recommendation: Use excavators for road construction in steep areas [PEQ];
- Full bench construction should be adopted instead of half bench construction (cut and fill) when there is a high risk of cut material being lost down the fill slopes (see Figure 53) [EQ];

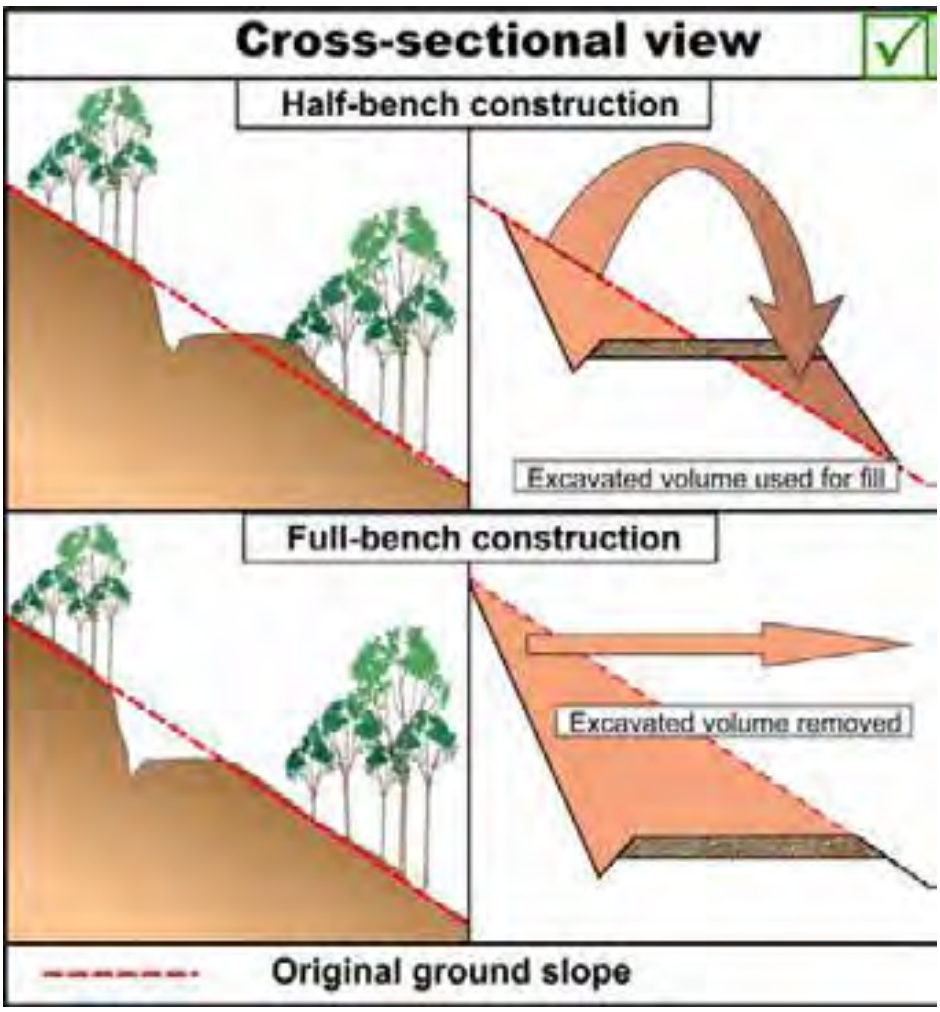

Figure 53: Half and full bench construction

- 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 (see Figure 54) [PE];

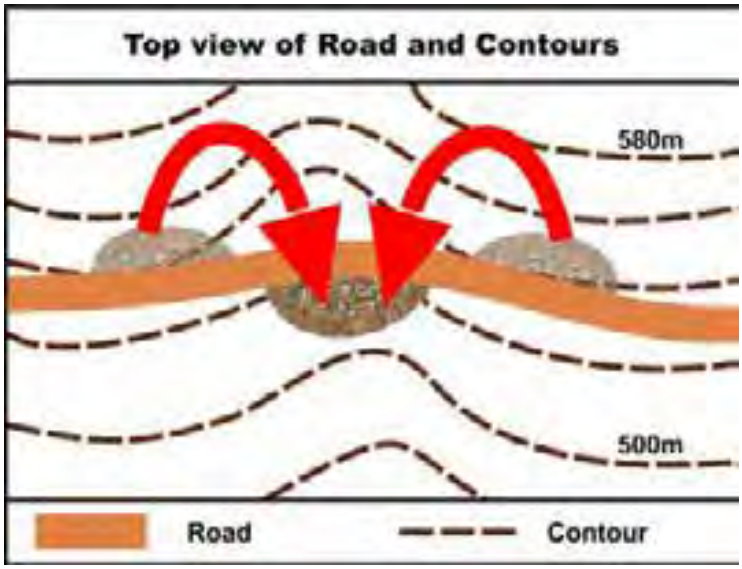

Figure 54: Balance cuts and fills

- The cut and fill batter angles should not be so steep that soils cannot be stabilized, resulting in possible erosion. The angle will depend on the inherent erodibility of the

soil and possible fill batter stabilization methods used. Long, erodible batter slopes could possibly be benched if required [E];

- Recommendation: Trees at the top of steep cut batters should be cleared given that erosion or wind-blow is likely to occur [SE].

e) Road grades

- Primary and secondary forest roads shall not be constructed with grades (slopes) of more than 10% and 15% respectively since drainage is difficult to control on steep slopes [EQ]. However:
- Steeper grades are permitted for short sections (<20m) if this shortens construction significantly or reduces earthworks, provided that adequate drainage or other acceptable water slowing or soil stabilization techniques are used [P].

f) Road widths

Every effort shall be made to minimize the width of forest roads. Road widths depend on the class of road, the type of soils and the forest through which the roads are to be constructed. The widths of the various components of the roads are included in Table 8, above [E]. Figure 55 gives an example of a road cross section on steep side slopes.

- Passing spots shall be provided on narrow roads where necessary [P];
- Where side cutting is not necessary, earthworks should be limited to the width for the roadbed plus side drains on either side [P].

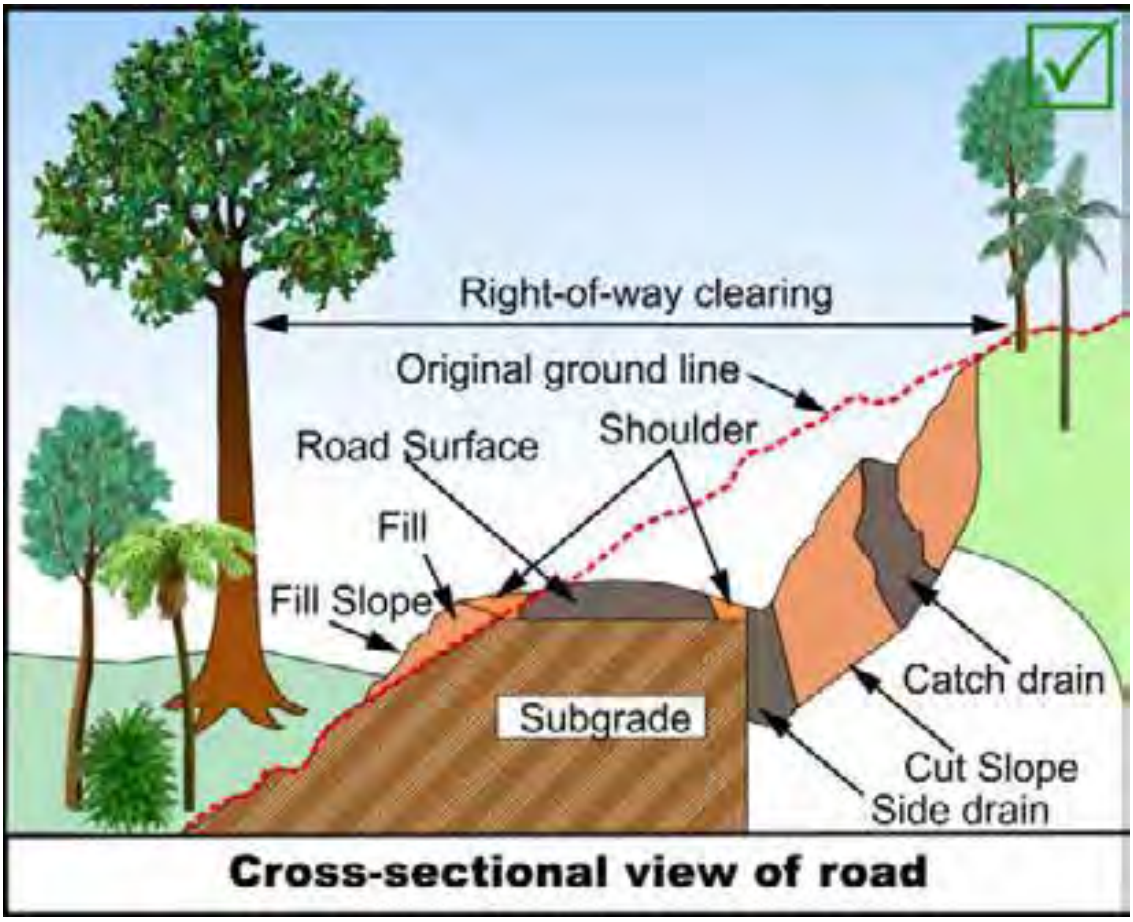

Figure 55: Road standards and terminology

g) Curves

On all primary and secondary roads, curves should follow the topography; i.e. along the contour.

- Curve widening (Figure 56) may be required on corners to allow for off-tracking of trailers [S];

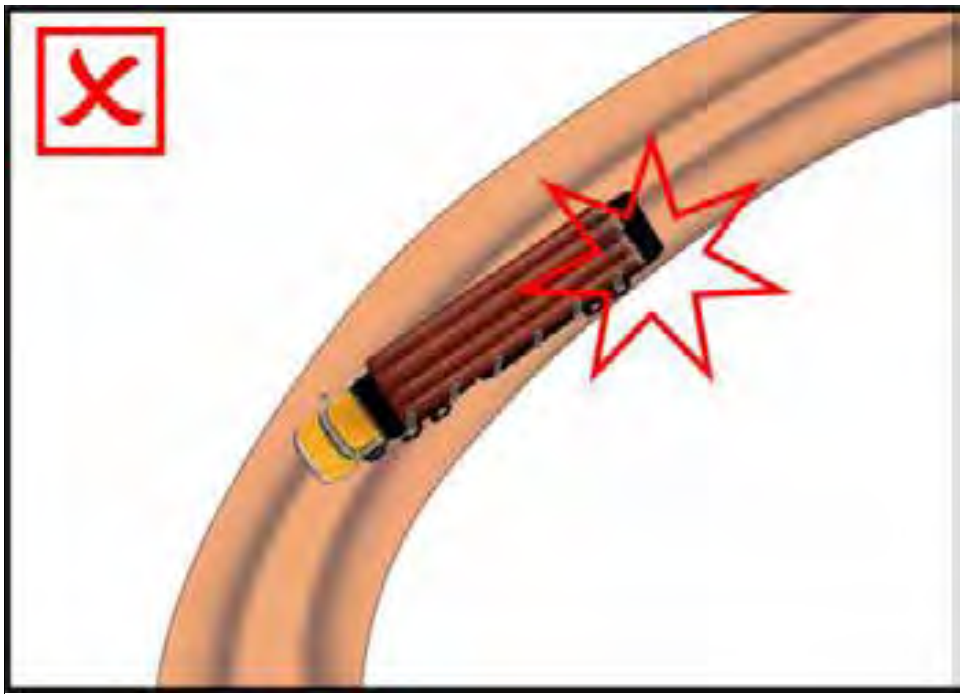

Figure 56: Consider trailer off-tracking

- Recommendation: Shoulders may need to be cleared on the inside of the curve to obtain the required sight distance to ensure traffic safety [S];
- The minimum radius of the curve is related to the visibility and the speed the vehicles will be traveling on the road [S].

Refer to Table 7 for the guidelines for recommended design speeds, minimum sight distance and minimum curve radius.

5.2 Drainage

Completed roads can quickly be destroyed through a lack of drainage or drainage maintenance. Soil damage is caused by one or a combination of two factors, namely speed and volume of water. The objective of drainage systems is to mitigate either the velocity of water, or the volume of water, or both. Water thus needs to be removed from the road surface as quickly as possible and then diverted away from the road at regular intervals.

5.2.1 General

In all phases of forest road preparation, adequate drainage shall be constructed to ensure the stability of the roads and so to reduce their impact on the environment. Wherever practical, 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. Figure 57 provides examples of road surface templates to ensure adequate drainage off the road.

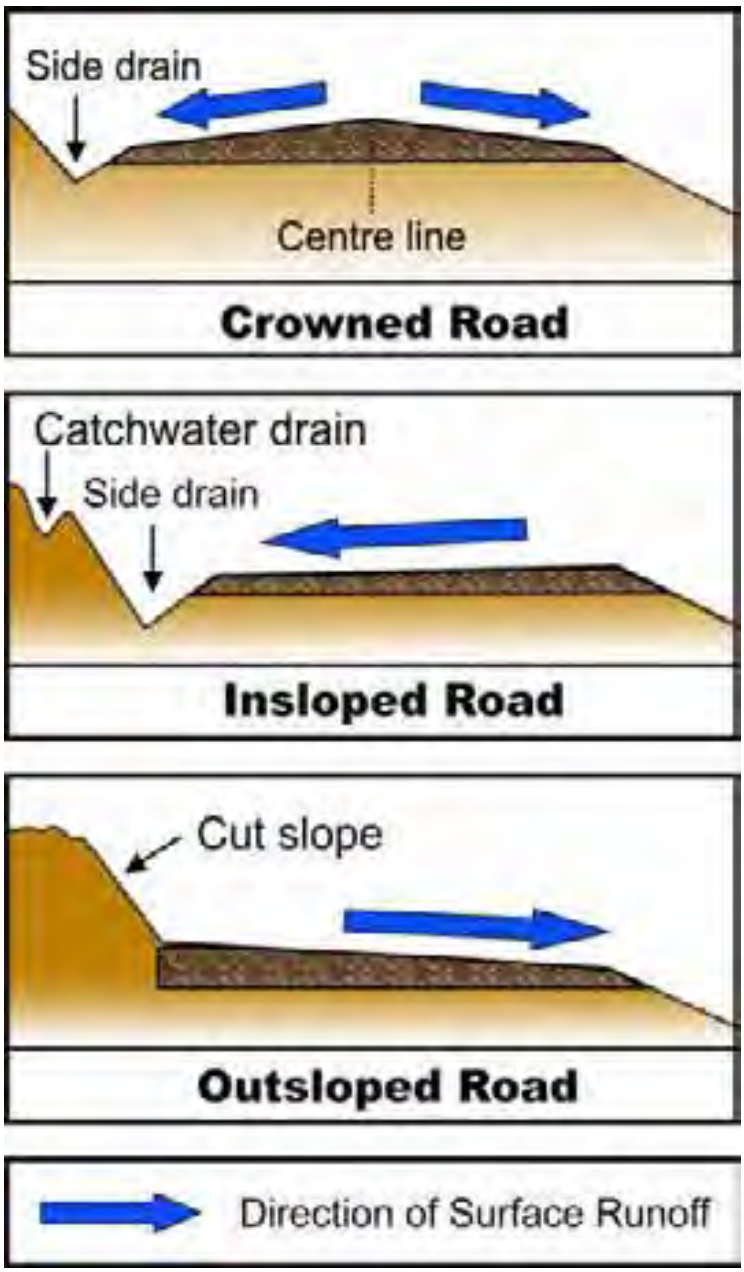

Figure 57: Road surface templates

5.2.2 Methods of drainage

On both primary and secondary roads, a crowned road surface shall be required. This is to ensure that water drains freely from the road. Additionally:

- Side drains shall be installed alongside all roads, constructed to a minimum depth of 30 cm below the level of the crown of the road. This removes water that has collected from the road surface or from the cut batter [EQ];
- Turnout drains shall be constructed at an appropriate spacing. Turnout drains are used to remove water from side drains before the water has gained excessive speed or built up excessive volume (Figure 58) [EQ];
- Crossroad culverts should be used where turnout drains are not possible. They are used to remove water from side drains before the water has gained excessive speed or built up excessive volume [EQ];

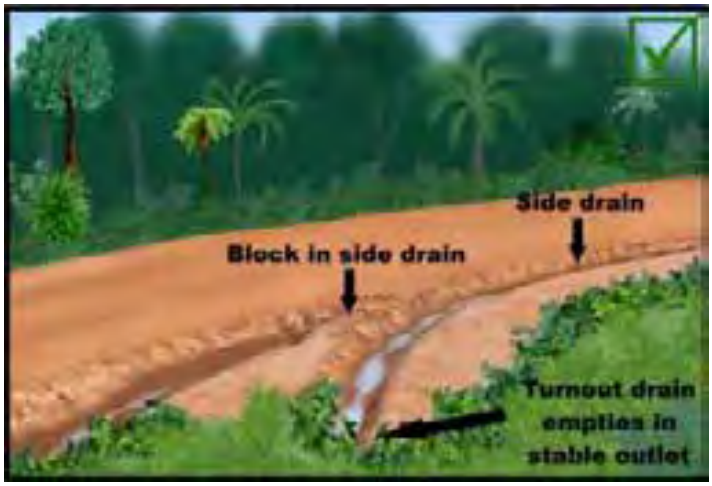

Figure 58: Turnout drains

- For roads constructed on highly erodible soils on slopes, drains may require special treatment such as lining with gravel or stones, log or rock bars, as well as stepping and frequent outlets to reduce scouring (Figure 59). Besides preventing erosion, many of these interventions also slow water down and therefore reduce its erosive forces. Installing protective devices or obstacles that slow water down should always be regarded as secondary to installing sufficient turnout and culvert drains [EQ];
- Earth fills should have adequate drainage to prevent water build up and ponding behind the fill [EQ];
- Where unstable cut batters occur, it may be necessary to install catch drains above the cut batter to intercept surface runoff and prevent it eroding the cut batter [EQ].

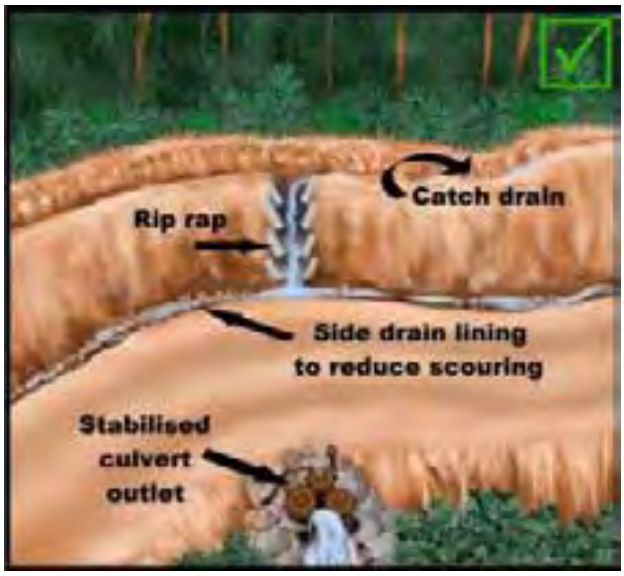

Figure 59: Additional drainage requirements

5.2.3 Location and spacing between drains

Turnout drains or culverts shall be spaced to remove water from the side drain before excessive volume and speed occur. Culverts are typically installed where it is not possible to install turnout drains – usually due to topographic restrictions, where water needs to be channeled to the downslope side of the roadway. Turnout drains and culverts thus fulfil the same function –

to divert water away for the side drain. Before spacing is considered, the following locations should require turnout drains or culverts:

- Immediately below areas of seepage into side drains – this prevents constant water from flowing in the side drain, which will eventually penetrate into the road surface [EQ];
- Immediately prior to the road going down a steep grade – this prevents excessive water from flowing down steep grades and causing erosion [EQ];
- Immediately above bedrock that limits side drain depth – when water in the ditch erodes to the bedrock, the water then begins to erode the cut batter and road shoulder. Therefore, a minimum quantity of water should be allowed to flow in this section of the side drain [EQ];
- Culverts are required immediately above areas of cut batter instability – this prevents water from eroding the toe of the cut batter and causing the cut batter to fail [EQ];
- Low points in the road [EQ];
- 20-50 m before watercourse crossings [EQ].

Once the above locations have been determined, additional turnout or culvert drains need to be installed according to local conditions (Figure 60). The distance between drains is influenced by the erodibility of the soil in the side, the grade of the road, the type of rainfall occurring and the size of culverts used.

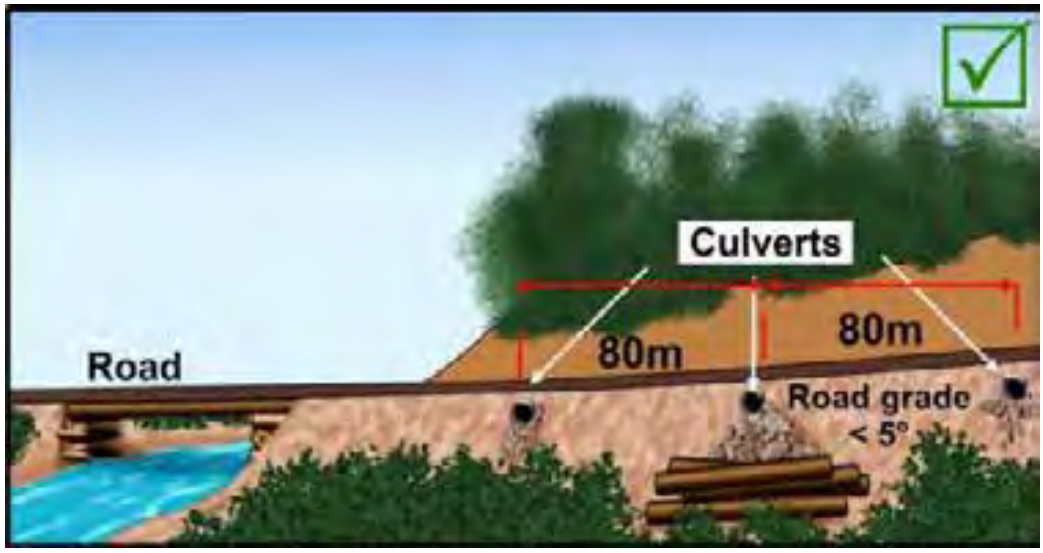

Figure 60: An example of drain spacing

5.2.4 Drain out-flow

- Turnout drains should be used to avoid side drains from draining directly into watercourses. Rather turnout drains should be installed some 20-50 m before meeting a watercourse to divert water into the surrounding vegetation (Figure 61). Where turnout drains are not practicable, drainage diversion using culverts shall be used [EQ];
- Recommendation: Silt traps may be considered in side drains at all four corners of watercourse crossings if sediment flow into water courses will be problematic [EQ];
- Recommendation: In steep terrain, silt traps may be considered at the end of turnout drains if appropriate [EQ].

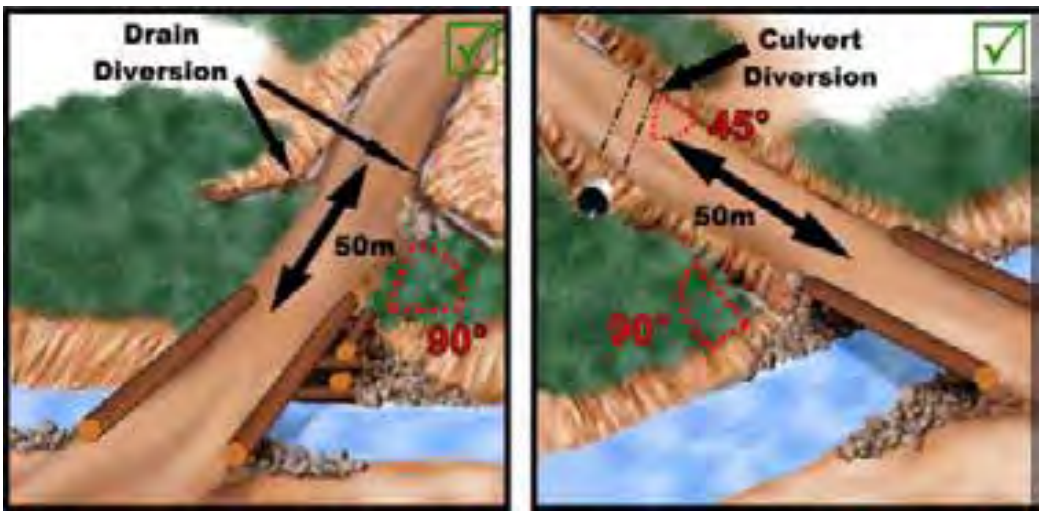

Figure 61: Drain diversion by turnouts or culvert

5.3 Road Maintenance

For all primary and secondary forest roads, maintenance shall be carried out regularly using a grader, as per Figure 62.

Figure 62: Transport costs are reduced by having a good road surface

Road maintenance is divided into preventative and on-demand maintenance. Preventative maintenance is important for primary roads, as the roads need to be passable throughout the year. Secondary roads should have a combination of preventative and on-demand maintenance, while tertiary roads will have on-demand maintenance. Before roads can be maintained, one needs to be able to identify road defects and understand the underlying causes of the defects. Defects can occur on the roads travelling surface (e.g. potholes, corrugations, erosion, loss of surfacing material, oversize material), in the drainage structures (e.g. erosion, siltation, blocked culverts, damaged structures) and on the roadside (e.g. failing cut or fill batters, excessive vegetation). Figure 63 shows failure of the road surface and subgrade. These are defects which are expensive to repair.

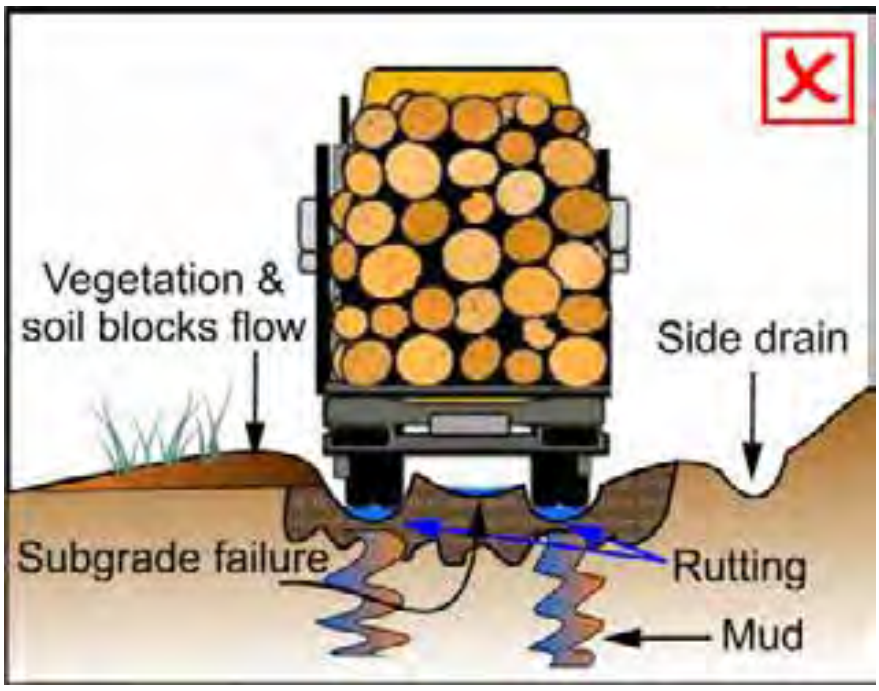

Figure 63: Road surface failures

Road defects should be addressed while they are still small, and this also reduces the potential environmental impact. Figure 64a shows an example of a preventative maintenance program, while Figure 64b shows an example of an on-demand maintenance program.

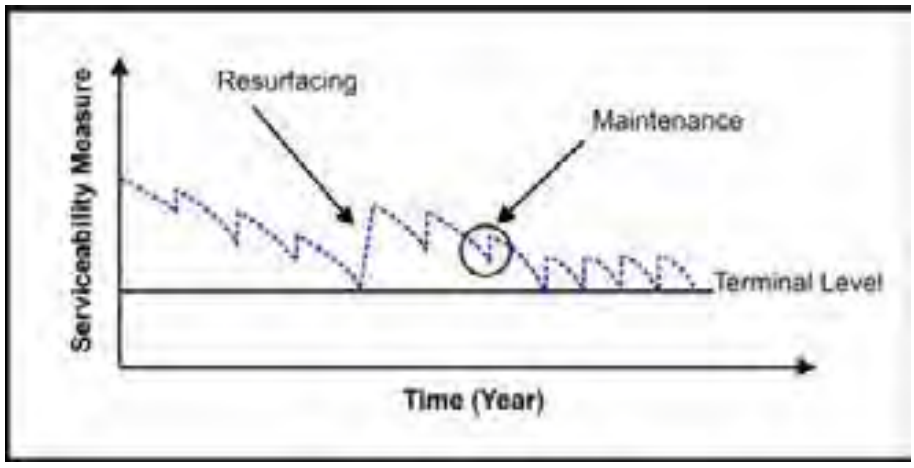

Figure 64a: A preventative maintenance program

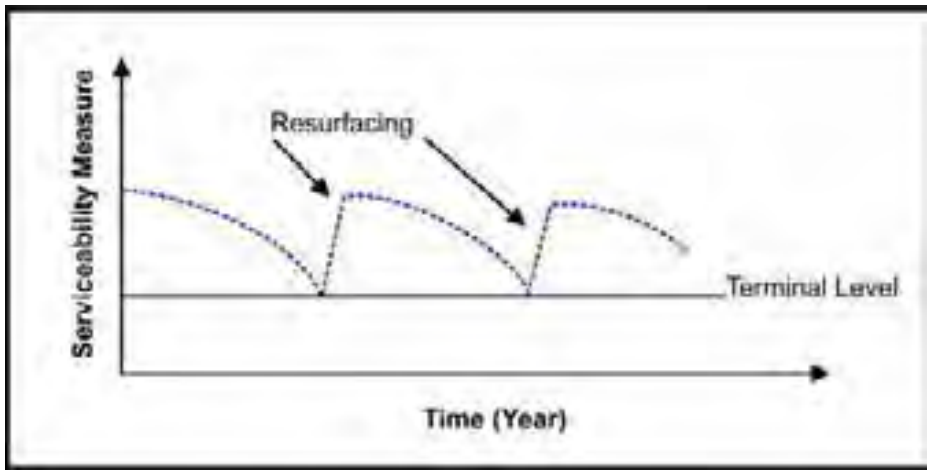

Figure 64b: An on-demand maintenance program

Furthermore:

- The camber on the road surface shall always be maintained, using the correct blading techniques. Figure 65 below illustrates the difference between light blading and heavy blading using a grader. [Q];

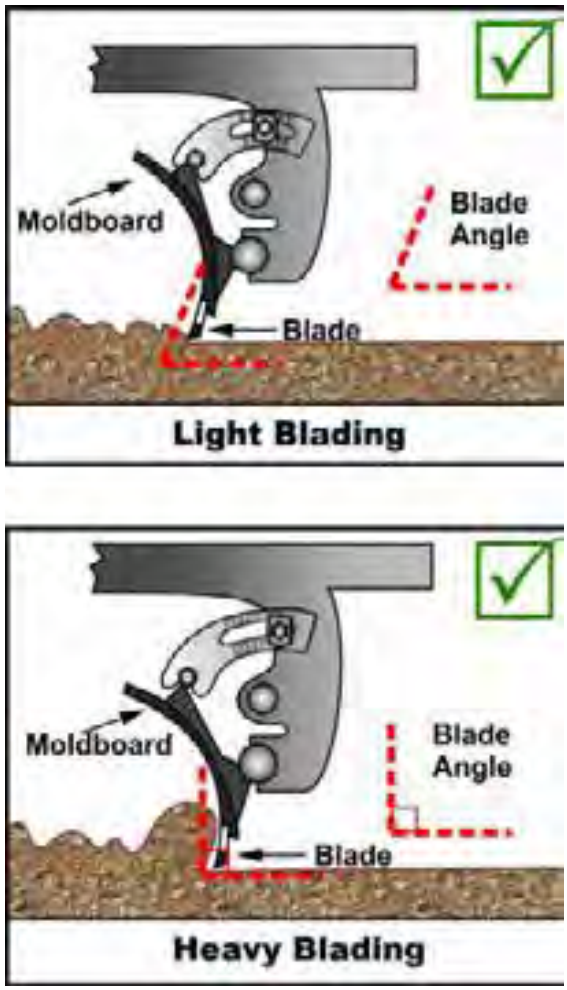

Figure 65: Light vs heavy blading techniques

- Surfacing gravel or loam should not be pushed to the road edge or into drains [EQ];
- Soil, vegetation and other materials that would obstruct water flow should be cleared from side drains [Q];
- Turnout drains, culverts and bridges shall be kept clear and in a good working condition at all times [EQ];
- Bridge decking, foundations and sidewalls should be repaired when faulty [E];
- Any debris that has been pushed into the watercourse shall be removed [E];
- Water should flow freely under bridges [E].

5.4 Watercourse Crossings

5.4.1 Types of crossings

Table 8 shows the classification of watercourse crossings.

Table 8: Classification of watercourse crossings

Type of crossing	Description
Bridges	Bridges shall be used for road crossings of all rivers and creeks. They may also be used for other watercourses.
Culverts (or pipes)	Culverts shall be used for crossing gullies and other waterways if bridges are not constructed.

Log clusters are not permitted for crossing any watercourse in any situation (Figure 66).

Figure 66: Log clusters with earth fill are not allowed

5.4.2 Construction of watercourse crossings

a) Location of crossings

Watercourses shall always be crossed at right angles to the watercourse direction (Figure 67). Additional criteria for selecting the location of crossing points are that sites:

- are immediately downstream of straight and stable watercourse sections [E];
- have easy high bank access [E];
- do not require deep box cuts [E];
- require minimum alteration to the high bank [E].

Figure 67: Cross watercourses at right angles

b) Earthworks

- In the construction of roads and bridges, river and creek beds shall not be filled in [E];
- All earthworks shall be carried out so as to minimize soil from entering the watercourse [E];
- All soil shall be removed to outside the buffer strip or alternatively should be placed in road fills [E];
- Temporary crossings are permitted to allow equipment involved with the construction of the crossing to be moved to the other side, provided that:
    - If possible, the width of the temporary crossing should be limited to 4 meters [E];
    - The temporary crossing is made on the final crossing alignment, so as to reduce disturbance to watercourse banks and buffer strip vegetation [E];
- During bridge construction; oil, chemicals, excess concrete and other waste should not enter the watercourse [SE].

5.5 Bridges

- Bridges should be sufficiently elevated to allow wet season flood flows to pass without damage to the crossing or its foundation [PE];
- The bridge span should extend at least 120% of the width of the watercourse measured from bank to bank; i.e. extend beyond the river or creek channel by 10% on either side [Q];
- All approaches shall have a straight and level alignment for a minimum of 20 meters on either side [Q].

5.5.1 Bridge construction

Figure 68 and Figure 69 give examples of a large timber bridge.

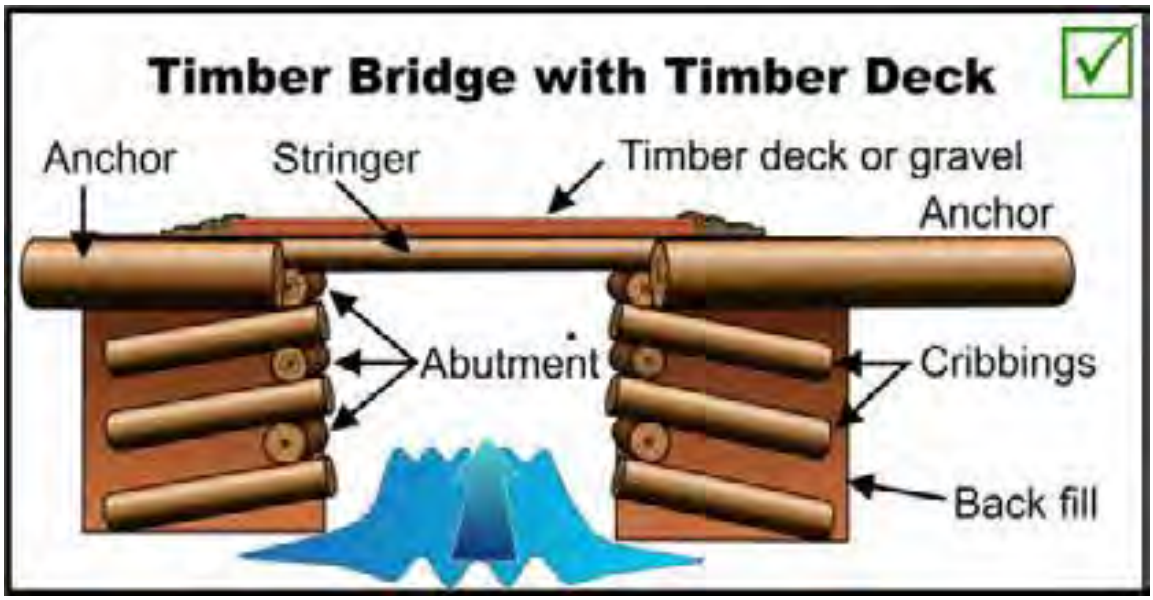

Figure 68: Example of large timber bridge

If the river is wider than the length of the logs forming the roadway, then the cribbings can be tapered towards the top (Figure 69 below).

Figure 69: Tapered cribbings

Figure 70 gives two different configurations (a & b) of a simple, low level timber bridges.

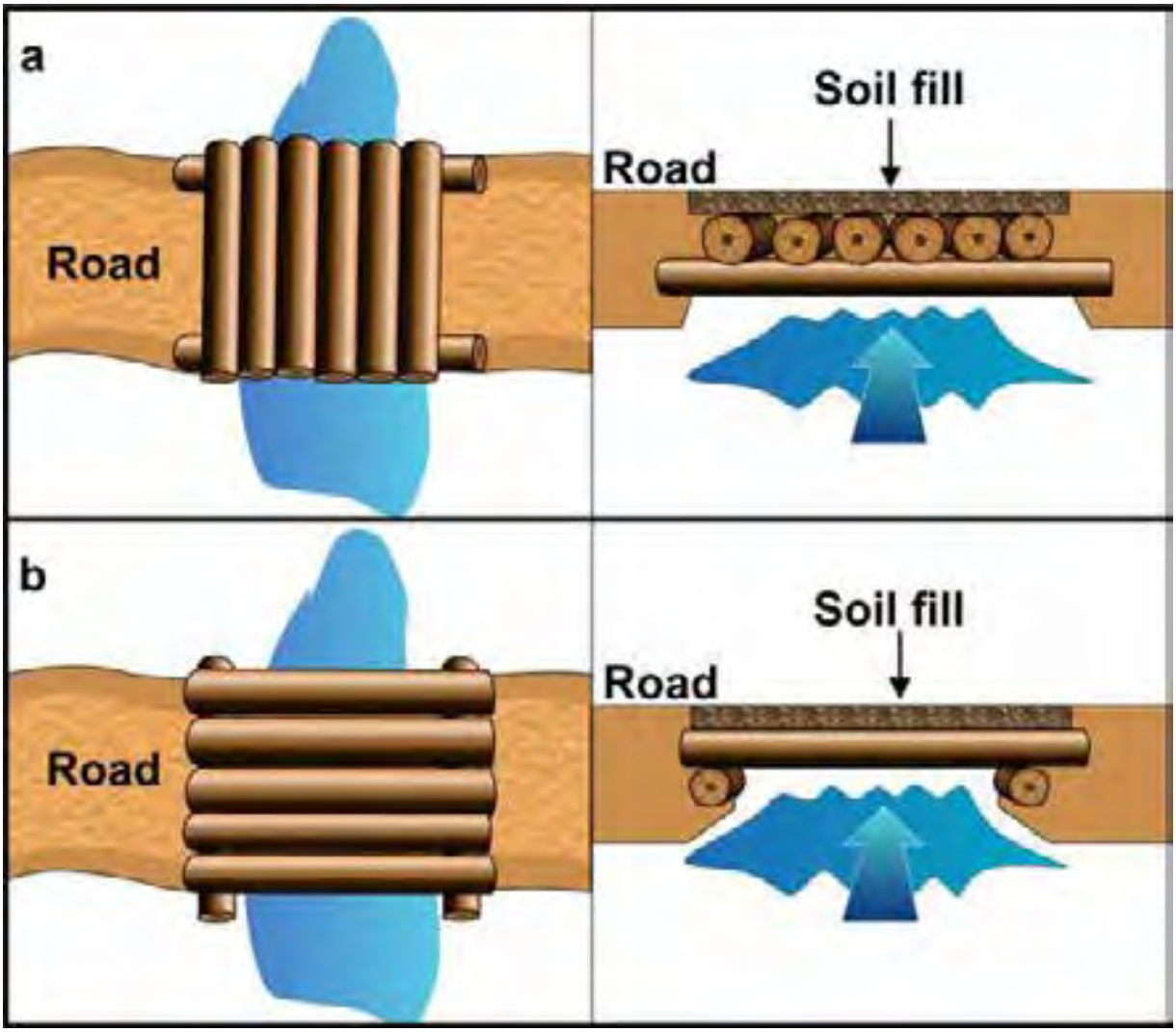

Figure 70: Two simple bridge configurations

In constructing timber bridges, the following criteria shall be considered:

- All parts of timber bridges should be constructed using durable timbers with high strength such as Dahoma, Irvingia, Klainodoxa, Ekki, or other species as recommended by the FDA. Decks should be constructed with durable sawn timber of the same species [Q].
- Soil fill or covering shall not be used unless the stringers are completely covered with branches and leaves and have guard logs on both sides [E].
- Recommendation: Foundations may be excavated to a solid base and not formed by pushed material [Q]
- The bridge shall be well anchored to prevent it from washing away (see Figure 71) [Q]
- The stream banks adjacent to the bridge should be stabilized using wing walls of durable logs or other equivalent construction where there are signs of scouring and excessive erosion [EQ].

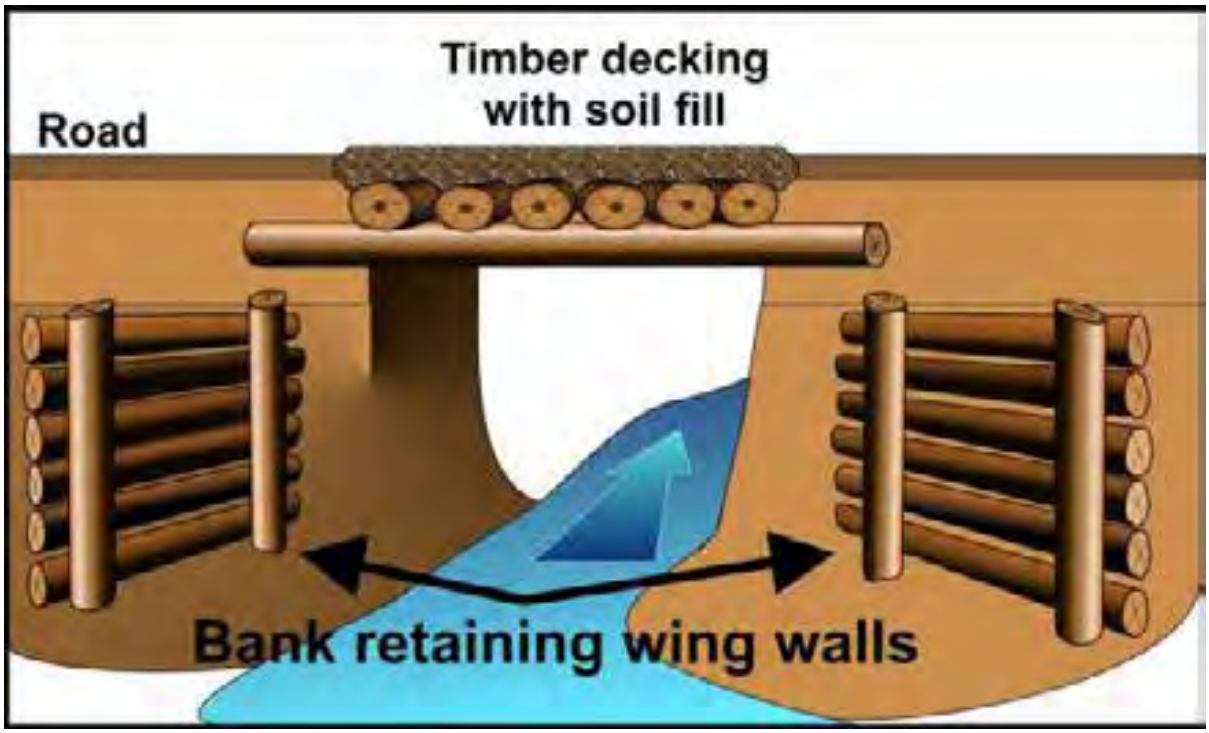

Figure 71: Stabilizing bridge abutments and stream banks

5.5.2 Culverts

- Culverts should be set at or marginally below the level of the natural watercourse bed (see Figure 72) [EQ];
- They may have an earth fill but are to have stable abutments to the level of the running surface to prevent soil entering the watercourse [E];
- Simple log culverts should be constructed for small seasonal water flow crossing the road. They should consist of a minimum of three logs, of which two are the basic layer with the third log on top and covered with gravel [PEQ];
- Straight logs and durable species shall be used for the construction of log culverts [EQ];

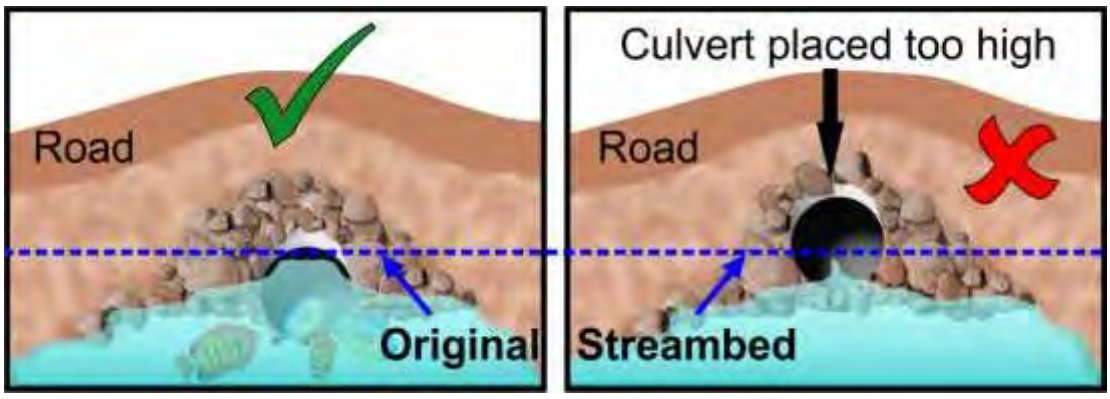

Figure 72: Culvert should be set at the level of the streambed

- Culverts shall be laid at a grade that will minimize silting up and excessive scouring at the discharge end [EQ];
- They should have an opening with a diameter of 45 cm or larger depending on the wet-season flood-flow level [Q];
- In flat, swampy areas log lengths used for culverts shall be at least 120% of the width of the roadway to minimize siltation of the culvert [EQ];
- In steep areas where there is a risk of erosion at the culvert outlet, this shall be mitigated by the use of logs or rocks, as illustrated in Figure 73 below [EQ];

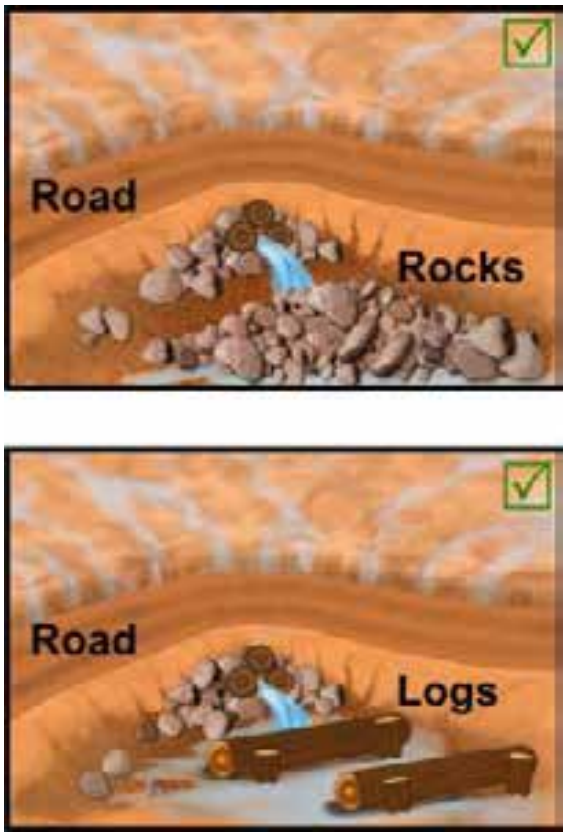

Figure 73: Installed sediment traps in places where high water flow is expected

- Recommendation: Provisions may be made at culvert inlets and outlets to minimize erosion caused by flow entering or discharging; silt traps of logs and/or rocks may be required in places where high water flows are expected (see Figure 74) [EQ];

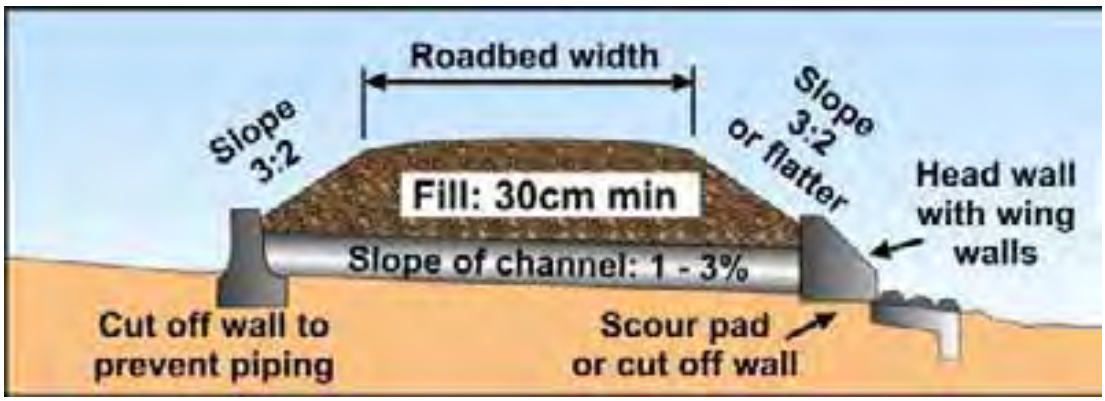

Figure 74: Culvert installation and outlet protection details with splash apron or riprap lined plunge pool for energy dissipation and scour control

Figure 75 shows logs used to provide overfill for culverts

Figure 75: Log culverts

- Recommendation: Culverts may not discharge over fills without adequate protection (e.g. rip rap, geotextile) (Figure 76). If required, silt traps may be constructed in side drains at culverts to prevent siltation and blocking. Log culverts shall ensure that backfill is retained;

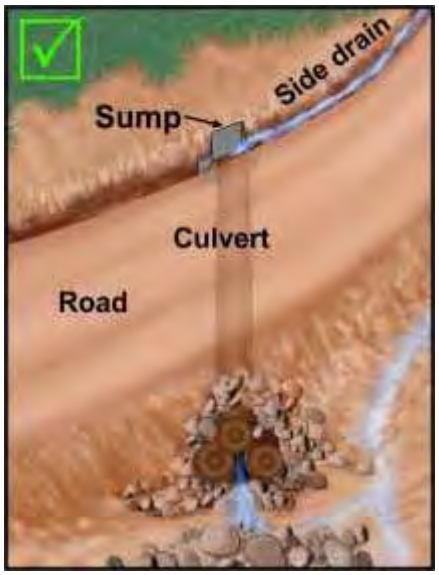

Figure 76: An example of provisions at culvert inlets and outlets to minimize erosion caused by flow entering or discharging

- As per Figure 77, culverts shall be kept open during the rainy season [EQ];

Figure 77: Keep culverts clean during the rainy season

5.6 Gravel Pits

Forest roads are typically built from local materials that must support heavy log 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 is the most common improved surface materials used.

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

- The extraction of gravel or loam from road cutting areas during the formation of the road is preferred to the development of large gravel pits [PE];
- All merchantable trees shall be harvested on the proposed gravel pit site (these will be included in the approved yield) [P];
- When opening the pit, topsoil should be stored for later use during rehabilitation [E];
- When planning the pit operation, thought should be given as to the sequence of operation during the pit, the calculated the quantity of material available, space for loading machines and haulage vehicles, safety aspects and pit rehabilitation [SP];
- The base of the pit shall be drained at all times. Drains shall not directly enter watercourses, and due to the area exposed, it may be necessary to use a silt trap where water exits the pit [PE];
- The face of the pit shall be maintained in a stable condition at all times. Steep unstable slopes may need to be benched [S];
- At least one side of the pit shall have a slope gentle enough to allow wildlife that has entered the pit to safely exit it again [E].

6 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

Blocks shall be closed once the logging of the approved yield has been completed. Furthermore:

- No re-entry permit shall be issued for a compartment that has reached its expiry date after 5 years [E];
- However, in a 5-year compartment period, a re-entry permit can be issued for blocks not completed in the previous year [E];
- Logging operations in a specific block should be completed in a single logging season. The only exception to this rule that may be applied is when weather or market conditions have prevented the approved yield to be felled and extracted. In such cases the FDA shall provide an extension to complete harvesting operations [E];
- 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 [SE];
- 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 (Figure 78) [E].

Figure 78: Remove all waste from the block

6.2 Road Closure

- The primary and secondary forest road network shall be maintained in good condition [EQ];
- There should be no ruts in the surface and the road surface should be crowned [EQ];
- Likewise, all side drains, turnout drains and culverts that will not be removed shall be left in good working condition.
- Roads not to be used until the next rotation shall be closed to all traffic by placing a large log across the roadway across the roadway. For roads that are being decommissioned log culverts and temporary bridges shall be removed to allow unobstructed water flow [E].

6.3 Log Landings

All closed log landing sites should be restored so that proper drainage occurs. Furthermore:

- All areas where water may pond shall be drained [E];
- Bark, debris and topsoil should be disbursed evenly across the site to assist in stabilization (Figure 79) [E].

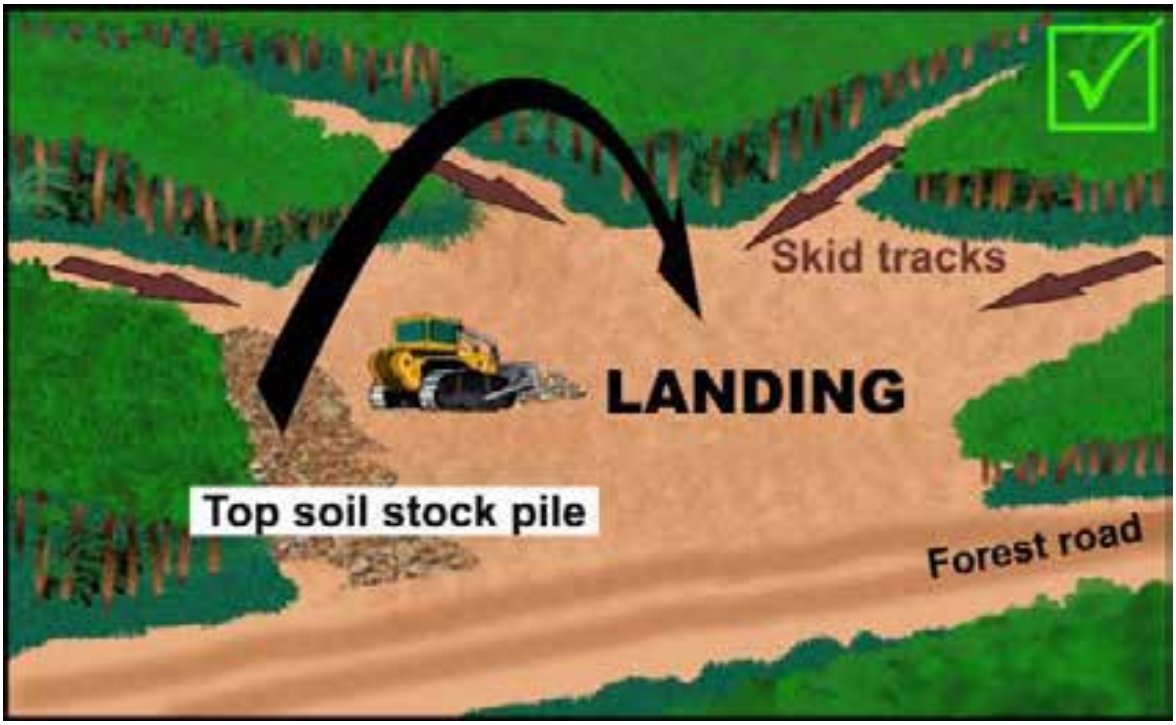

Figure 79: Drain landings and divert water flowing to landings once logging is completed

- The site shall be cleaned of all refuse including oil/fuel drums, wire rope, tires and machinery parts [E].

6.4 Temporary Stream Crossing Closure on Skid Trails

- Temporary skid trail crossings of waterways and gullies shall be removed (Figure 79) after completion of harvesting operation in the block [E];

Figure 80: Remove logs from stream crossings used during skidding

Removal should not disturb the watercourse banks [E];

- All material used in the construction of temporary crossings (Figure 81) shall be moved at least 10 meters away from the watercourse [E];
- Action shall be taken to restore water flow to its original watercourse where necessary [E];

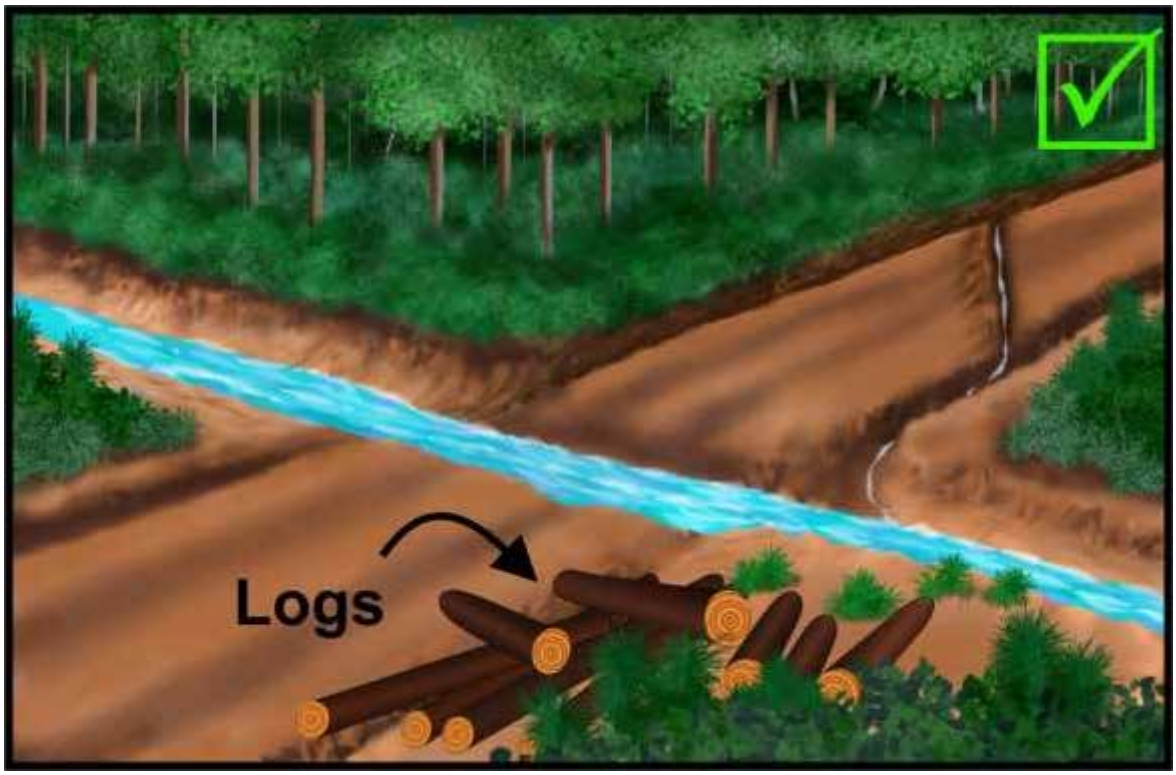

Figure 81: Ensure that the stream can flow freely

- On steep gradients and sensitive soils, water bars (Figure 82) may be required until skid trails have stabilized [E].

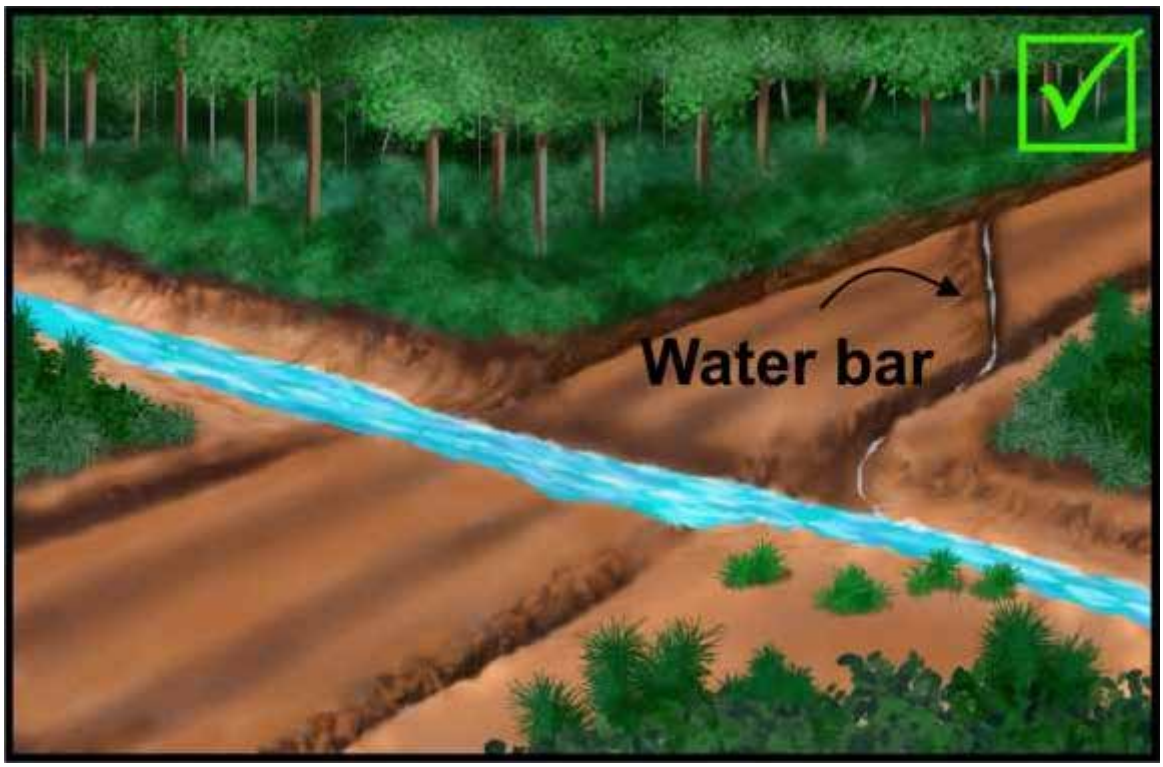

Figure 82: Place water bars on steep areas close to the stream crossing

6.5 Gravel Pits

Gravel pits shall be decommissioned by:

- Stabilizing steep cuts (Figure 83) [E];
- Re-grading the drain on the uphill side and ensuring that runoff cannot enter the pit [E];
- Draining the surface of the pit if water is likely to pond [E].

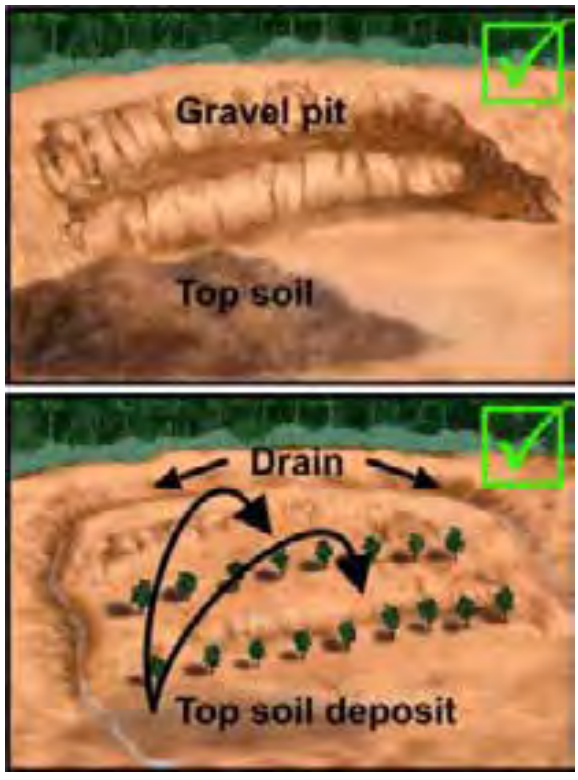

Figure 83: Gravel pit closure

6.6 Logging Camps

Logging camps shall be closed by taking the following steps:

- The site shall be cleaned of all refuse including oil/fuel drums, wire rope, tires and machinery parts, as well as building materials, and all biodegradable waste shall be buried (Figure 84) [SE];
- All areas where water may pond shall be drained (but drains are not to empty directly into watercourses) and drains shall be cleared regularly until the campsite has stabilized [E];
- Recommendation: Campsites may be ripped at 90° to the drainage direction to promote natural re-vegetation. Bark and debris should be disbursed evenly across the site to assist in stabilization [E];
- Discarded machinery shall be removed from the contract area to the designated waste disposal facilities [E].

Figure 84: Leave the area in a clean and neat state when packing up camp

7 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.

Gravel 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 Through Cut).

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 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

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 on soil biodiversity.

Compartment: A sub-division of a concession frequently of several thousand hectares. It is normally defined along natural boundaries and covers an area set aside for harvesting for a 3 to 5-year period.

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.

Coupe: A defined area of forest of variable size, shape and orientation, on which harvesting takes place; usually to be harvested over one year.

Creek: Creeks are watercourses in which water may flow or pond for about six months in most years and whose beds are made of stony, gravely or exposed bedrock materials.

Cross-cutting: Cutting through a felled log. Sometimes called Bucking.

Cross-drain: A side 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 center 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) side drains and watercourses (commonly gullies) that cross the road.

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 ‘balanced cut-and-fill’ 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 minimized.

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.

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 with Sediment.

Directional:	Predetermining the final direction of fall of a 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.
Erodibility:	See Soil Erodibility
Erosion:	See Soil Erosion
ESIA:	Environmental and Social Impact Assessment.
Exclusion area:	Area which is excluded from harvesting.
Feeder road:	A road connecting log markets to a secondary or primary road; also called spur road.
Fill:	Excavated material placed on a prepared ground surface to construct the road sub-grade and roadbed template. Also called embankment.
Fill slope:	The inclined slope extending from the outside edge of the road shoulder to the toe of the fill. Also called Embankment slope.
Flood plain:	A level or gently sloping area on either side of a watercourse that is submerged at times during high water.
Ford:	A rock, other hardened or concrete?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 minimizes channel disturbance or sediment production.
Forest operator:	Any person or entity that is legally operating in a forest concession, such as a contract holder or a subcontractor
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 Gradient.
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
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).
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 minimize scour around the culvert inlet or outlet.

Heavy Machinery: Includes bulldozers, skidders and log loaders, motor graders, excavators, etc.

Hung-up trees: A tree which has not completely reached the ground following cutting

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 side. An in-sloped road has the highest point on the outside edge of the road and slopes downward to the side 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 logging arch

Lake: Body of (typically) freshwater. Lakes have surface water all year around for most years.

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 landing: A cleared area, usually adjacent to the roadbed where logs are assembled after being skidded, awaiting subsequent handling, loading and transport. Also called Ramp, Log Deck or Landing.

Logging arch: See Integral arch.

Merchantable: Forest products that have a market value and can be sold.

Notch cut: The front cut when felling a tree with a chainsaw to assist in felling the tree in the desired direction

Outlet: The opening of a drainage structure or culvert allowing water to exit. 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: Stems of commercial species remaining after the cut and forming the basis tree of subsequent cutting cycles

Riprap: Layer of large, durable materials (usually stone or rock) used to protect exposed soil to minimize erosion

River: Water courses where water flows all year around most years.

Roadbed: The formation between the side drains 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 Road Formation or Width of Earthworks

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 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 Silt Trap

Shoulder: On stabilized soil, the strip along the edge of the road, commonly flush with the travel way. It is generally only used by passing vehicles but may be used for travel by track machines. Also called Verge.

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: 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 Table Drain or (incorrectly) Side Drain.

Silt trap: Hole created to divert water, allowing flow to slow enough for 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 Landing, 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.

Skid trail: Trail along which a log is dragged by an extraction machine to the landing.

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.

Spoon drain: A shallow open drain, normally traversable by vehicles designed to carry water to the side of a road or skid trail

Spring: A natural spring is a place where groundwater flows out of the ground. A spring may be intermittent or continuous (perennial).

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 individual's 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.

Stream: Streams are watercourses in which water may flow or pond for about six months in most years. Beds are of soil and banks are often covered with vegetation.

Sustainable forest management: The process of managing forests to achieve one or more clearly specified objectives of management with regard to the production 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: Swamps have standing surface water for six months or more in most years.

Table drain: See Side

Topping: Severing the crown of a felled tree from the usable stem, usually at the first heavy branch. Also called Junking.

Travel Way: That portion of the road constructed for use by moving vehicles (excluding shoulders). Also called Carriageway.

Turbid water: Water bearing significant quantities of sediment.

Turnout drain: Excavations designed to divert water away from the side and roadway in order to reduce the volume and velocity of roadside side water. Also called Outlet, Lead-off, Miter or Side drain

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 Shoulder

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 lakes, lagoons, seas or oceans
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
Wedge:	A high impact plastic, aluminum 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.
Winch:	A rotating powered drum used to haul in or pay out a wire rope (cable)
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.

8 BIBLIOGRAPHY

The following documents were consulted during the revision of this Code:

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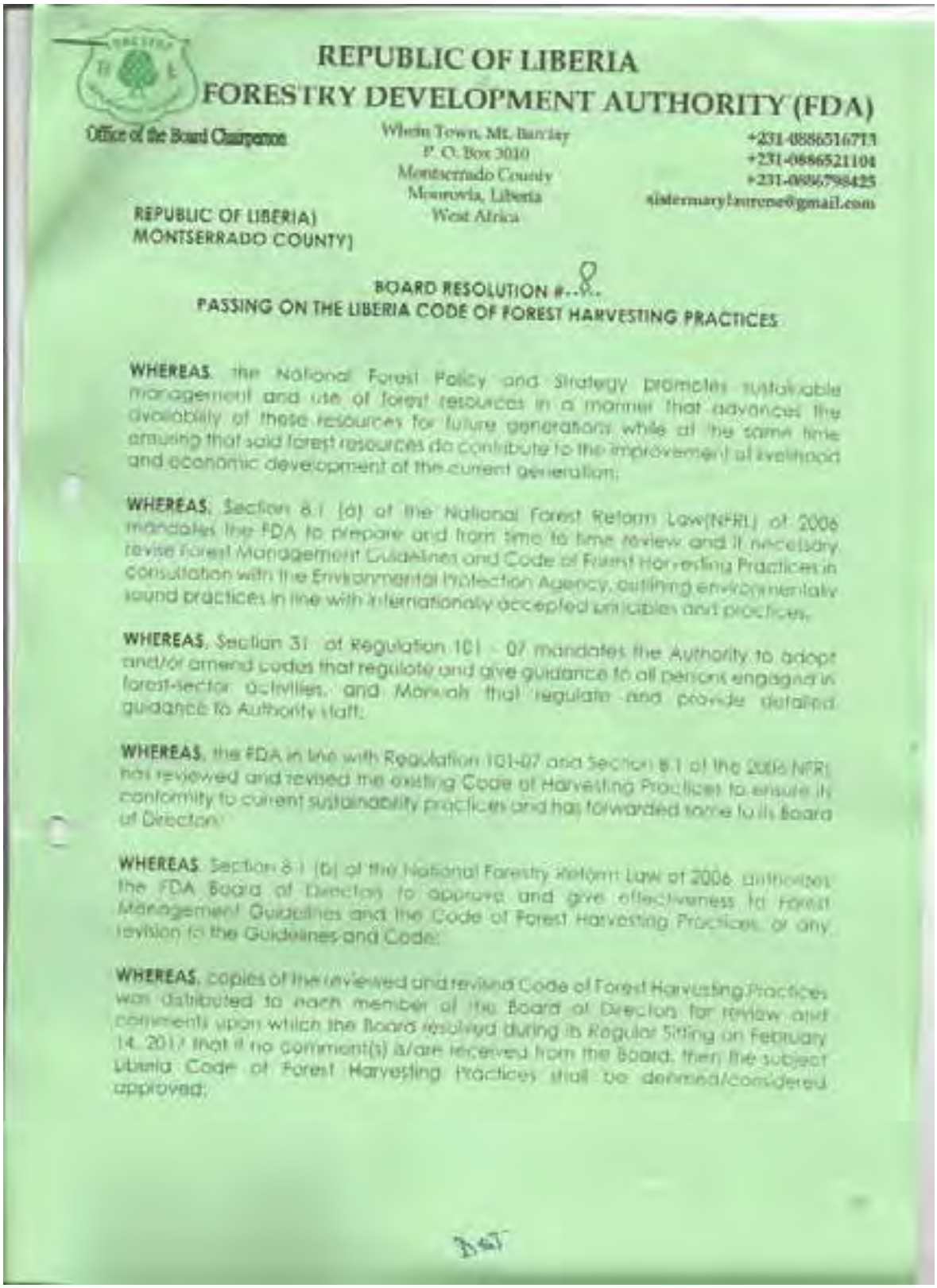
9 FDA BOARD RESOLUTION #8 PASSING ON THE LIBERIA CODE OF FOREST HARVESTING PRACTICES



REPUBLIC OF LIBERIA
FORESTRY DEVELOPMENT AUTHORITY (FDA)

Office of the Board Chairperson

Whein Town, Mt. Barclay
P. O. Box 3010
Montserrado County
Monrovia, Liberia
West Africa

+231-886516713
+231-886521104
+231-886798425
sistermarylaurene@gmail.com

REPUBLIC OF LIBERIA)
MONTSERRADO COUNTY)

BOARD RESOLUTION #...8...
PASSING ON THE LIBERIA CODE OF FOREST HARVESTING PRACTICES

WHEREAS, the National Forest Policy and Strategy promotes sustainable management and use of forest resources in a manner that advances the availability of these resources for future generations while at the same time ensuring that said forest resources do contribute to the improvement of livelihood and economic development of the current generation;

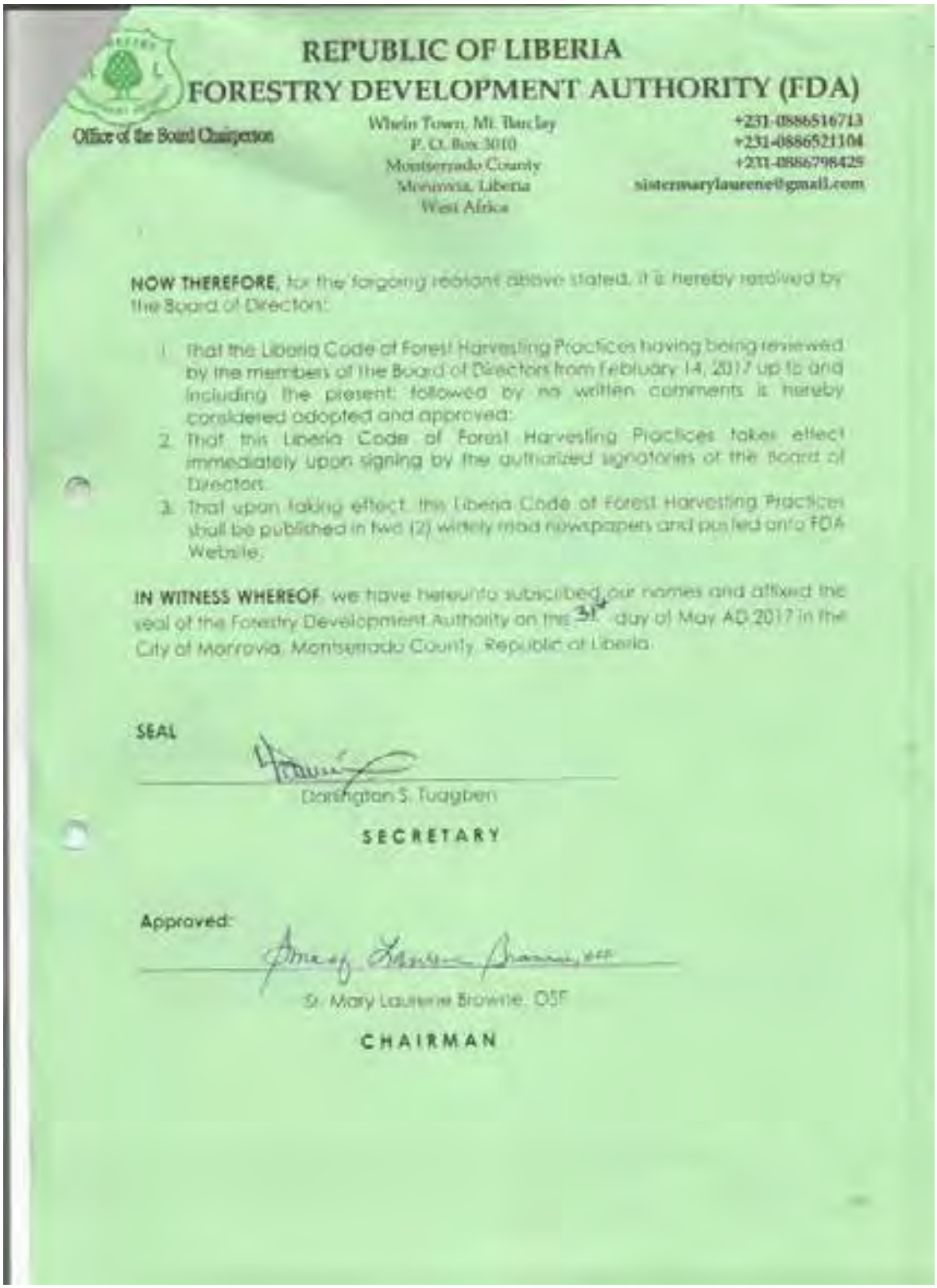
WHEREAS, Section 8.1 (a) of the National Forest Reform Law(NFRL) of 2006 mandates the FDA to prepare and from time to time review and if necessary revise Forest Management Guidelines and Code of Forest Harvesting Practices in consultation with the Environmental Protection Agency, outlining environmentally sound practices in line with internationally accepted standards and practices;

WHEREAS, Section 31 of Regulation 101 – 07 mandates the Authority to adopt and/or amend codes that regulate and give guidance to all persons engaging in forest-sector activities, and Manuals that regulate and provide detailed guidance to Authority staff;

WHEREAS, the FDA in line with Regulation 101-07 and Section 8.1 of the 2006 NFRL has reviewed and revised the existing Code of Harvesting Practices to ensure its conformity to current sustainability practices and has forwarded same to its Board of Directors;

WHEREAS, Section 8.1 (b) of the National Forestry Reform Law of 2006 authorizes the FDA Board of Directors to approve and give effectiveness to Forest Management Guidelines and the Code of Forest Harvesting Practices, or any revision to the Guidelines and Code;

WHEREAS, copies of the reviewed and revised Code of Forest Harvesting Practices was distributed to each member of the Board of Directors for review and comments upon which the Board resolved during its Regular Sitting on February 14, 2017 that if no comment(s) is/are received from the Board, then the subject Liberia Code of Forest Harvesting Practices shall be deemed/considered approved;



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FORESTRY DEVELOPMENT AUTHORITY (FDA)

Office of the Board Chairperson

Whein Town, Mt. Barclay
P. O. Box 3010
Montserrado County
Monrovia, Liberia
West Africa

+231-0886516713
+231-0886521104
+231-0886798429
sistermarylaurene@gmail.com

NOW THEREFORE, for the forgoing reasons above stated, it is hereby resolved by the Board of Directors:

1. That the Liberia Code of Forest Harvesting Practices having being reviewed by the members of the Board of Directors from February 14, 2017 up to and including the present; followed by no written comments is hereby considered adopted and approved;
2. That this Liberia Code of Forest Harvesting Practices takes effect immediately upon signing by the authorized signatories of the Board of Directors.
3. That upon taking effect, this Liberia Code of Forest Harvesting Practices shall be published in two (2) widely read newspapers and posted on the FDA Website.

IN WITNESS WHEREOF, we have hereunto subscribed our names and affixed the seal of the Forestry Development Authority on this 31st day of May AD 2017 in the City of Monrovia, Montserrado County, Republic of Liberia.

SEAL

Darlington S. Tuagben

SECRETARY

Approved:

Sr. Mary Laurene Brownie, OSF

CHAIRMAN