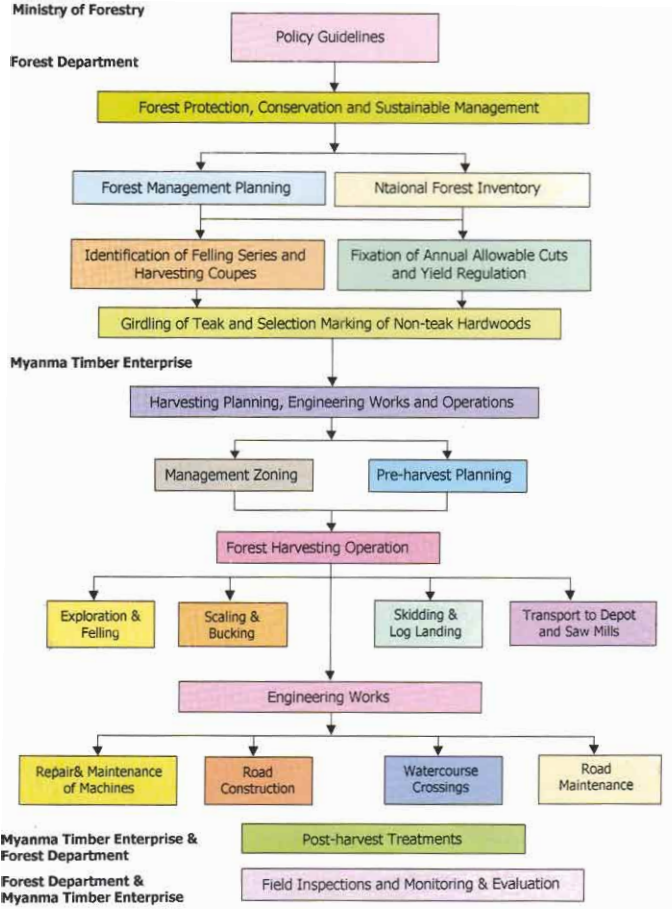
UNION OF MYANMAR
MINISTRY OF FORESTRY

NATIONAL CODE OF FOREST HARVESTING PRACTICES IN MYANMAR

Prepared by
Forest Department, Myanma Timber Enterprise and
Planning and Statistics Department
Yangon, 2000



Front Cover : (Outside)
Elephant Logging in Natural Forest

NATIONAL CODE OF FOREST HARVESTING PRACTICES IN MYANMAR

PREFACE

Forest harvesting has always been the essential means for realizing the satisfaction of people's basic needs and economic development, and it will remain so, as long as the demand for diverse forest products continues to exist.

Up to the last decade, forest harvesting, particularly timber extraction in the tropics was generally perceived as one of the most destructive human interventions that led to the impairment of ecosystems integrity and environmental balance. Many environmentalists considered that conventional practices of forest harvesting disturbed the forest floor and soil structure, and accelerated soil erosion, runoff and sediment movement, resulting in quick peak flow, flood and water pollution. These implications were claimed to be more pronounced in the tropics of harsh climatic conditions.

The deliberations and agreements made at the UNCED in 1992 have highlighted that both the environment and development aspects of forestry should be paid equal attention. Since then, attempts have been made to introduce environmentally sound forest harvesting practices in many parts of the world. In this regard, FAO took the lead role by publishing the Model Code of Practice for Forest Harvesting in 1996 and the Asia-Pacific Forestry Commission also developed the Code of Practice for Forest Harvesting in Asia-Pacific in 1997. And, it has started to view that forest harvesting could be an effective tool for achieving sustainable development of forests provided it is well designed, planned and implemented, taking into account social and environmental values.

Systematic forest management and timber harvesting for local needs, and for domestic as well as international markets have a very long history in Myanmar. However, until the late 1980s, timber harvesting had been focused mainly on its increased production with least attention being paid to the social and environmental dimensions of the country's most valuable natural resources. In this context, Myanmar Forest Policy, Forest Act, Wildlife Act and Forest Rules, and Community Forestry Instructions were either totally formulated anew or updated in the early 1990s. Thus, the existing legal framework promotes participatory approach and effectuates environmental and ecological integrity.

The development of this National Code of Forest Harvesting Practices in Myanmar is a major step forward in the attempt to sustain increasing production in an environmentally friendly manner. However, this document is not intended to stand exclusively on its own. Rather, it is meant to complement the existing legal framework and other contributions towards sustainable forest management.

The Code has been prepared by the Forest Department in cooperation with the Myanma Timber Enterprise and the Planning and Statistics Department of the Ministry of Forestry with FAO's financial and technical assistance.

The Code, with the primary objective of enhancing the multi-resource character of forests, integrates environmental conservation measures with country-specific harvesting practices, in compliance with regional and international forestry concepts. It is, therefore, expected to satisfy the dual purposes: sustainable flow of forest produce and upkeep of environmental stability.

Dr. Kyaw Tint
Director-General
Forest Department

PREFACE

Forest harvesting has always been the essential means for realizing the satisfaction of people's basic needs and economic development, and it will remain so, as long as the demand for diverse forest products continues to exist.

Up to the last decade, forest harvesting, particularly timber extraction in the tropics was generally perceived as one of the most destructive human interventions that led to the impairment of ecosystems integrity and environmental balance. Many environmentalists considered that conventional practices of forest harvesting disturbed the forest floor and soil structure, and accelerated soil erosion, runoff and sediment movement, resulting in quick peak flow, flood and water pollution. These implications were claimed to be more pronounced in the tropics of harsh climatic conditions.

The deliberations and agreements made at the UNCED in 1992 have highlighted that both the environment and development aspects of forestry should be paid equal attention. Since then, attempts have been made to introduce environmentally sound forest harvesting practices in many parts of the world. In this regard, FAO took the lead role by publishing the Model Code of Practice for Forest Harvesting in 1996 and the Asia-Pacific Forestry Commission also developed the Code of Practice for Forest Harvesting in Asia-Pacific in 1997. And, it has started to view that forest harvesting could be an effective tool for achieving sustainable development of forests provided it is well designed, planned and implemented, taking into account social and environmental values.

Systematic forest management and timber harvesting for local needs, and for domestic as well as international markets have a very long history in Myanmar. However, until the late 1980s, timber harvesting had been focused mainly on its increased production with least attention being paid to the social and environmental dimensions of the country's most valuable natural resources. In this context, Myanmar Forest Policy, Forest Act, Wildlife Act and Forest Rules, and Community Forestry Instructions were either totally formulated anew or updated in the early 1990s. Thus, the existing legal framework promotes participatory approach and effectuates environmental and ecological integrity.

The development of this National Code of Forest Harvesting Practices in Myanmar is a major step forward in the attempt to sustain increasing production in an environmentally friendly manner. However, this document is not intended to stand exclusively on its own. Rather, it is meant to complement the existing legal framework and other contributions towards sustainable forest management.

The Code has been prepared by the Forest Department in cooperation with the Myanma Timber Enterprise and the Planning and Statistics Department of the Ministry of Forestry with FAO's financial and technical assistance.

The Code, with the primary objective of enhancing the multi-resource character of forests, integrates environmental conservation measures with country-specific harvesting practices, in compliance with regional and international forestry concepts. It is, therefore, expected to satisfy the dual purposes: sustainable flow of forest produce and upkeep of environmental stability.

Dr. Kyaw Tint
Director-General
Forest Department

ABBREVIATIONS

AAC	Annual Allowable Cut
APFC	Asia-Pacific Forestry Commission
AWR	All-Weather Road
DI	Departmental Instructions
DWR	Dry-Weather Road
DZGD	Dry Zone Greening Department
FAO	Food and Agriculture Organization
FD	Forest Department
FREDA	Forest Resource Environment Development and Conservation Association
FRH	Forest Rest House
FS	Felling Series
GIS	Geographic Information Systems
GPS	Global Positioning System
IOF	Institute of Forestry
ITTO	International Tropical Timber Organization
MOF	Ministry of Forestry
MSS	Myanmar Selection System
MTE	Myanma Timber Enterprise
NFMP	National Forestry Master Plan
NFP	National Forest Programme
NGO	Non-Governmental Organization
NWFP	Non-Wood Forest Products
PSD	Planning and Statistics Department
PAS	Protected Areas System
RS	Remote Sensing
SF	Selection Felling
SFM	Sustainable Forest Management
UNCED	United Nations Conference on Environment and Development
UNDP	United Nations Development Programme
WC	Working Circles

CONTENTS

1. INTRODUCTION

1.1. Background

Myanmar has been streamlining its national forest programmes in the 1990s to achieve sustainable development of the forestry sector. Many in-country reforms have been made, reflecting not only the country-specific conditions but also regional and international concerns in forestry. Forest Policy, Legislations and Rules have been updated and revised in compliance with Agenda 21 and Forest Principles adopted by UNCED, 1992.

The Government of the Union of Myanmar promulgated the new Myanmar Forest Policy in 1995. This Forest Policy was formulated in line with the Forest Principles adopted by UNCED, 1992 and other international forestry obligations. It is the testimony of the government and people of Myanmar to ensure sustainable development of forest resources within the bounds of social, environmental and economic aspects.

The Myanmar Policy Statement 1995, has identified six imperatives as follows:

(i) PROTECTION	Protection of soil, water, wildlife, biodiversity and environment
(ii) SUSTAINABILITY	Sustainability of forest resources to ensure perpetual supply of both tangible and intangible benefits accrued from the forests for the present and future generations
(iii) BASIC NEEDS	Supply the basic needs of the people for fuel, shelter, food and recreation
(iv) EFFICIENCY	Efficiency to harness, in a socio-environmentally friendly manner, the full economic potential of the forest resources
(v) PARTICIPATION	Participation of the people in the conservation and utilization of the forests
(vi) PUBLIC AWARENESS	Public awareness about the vital role of the forests in the well being and socio-economic development of the nation

Myanmar produces timber for the domestic market and for export, while conserving the soil and water of the forest environment. Myanmar's economy is agriculture-based and, therefore, soil and water conservation and maintaining the environmental stability are of prime importance not only for the forestry sector, but also for agricultural sustainability.

In managing forest resources, it is perceived that forest harvesting could be the most environmentally damaging component, unless it is carried out with due concern for environmental values. In Myanmar various departmental regulations and instructions have been adopted covering a wide range of forest harvesting, fixation of AACs, silvicultural treatments, harvesting planning, road construction for timber extraction and draught animal management and health care. However, many of these regulations and instructions obviously need to be revised in line with the currently prevailing sustainable forestry concepts, both national and international. In addition, the Code of Practice for Forest Harvesting for Asia-Pacific Region was recently developed as a guidance document for the countries concerned.

Myanmar considers that developing a national code of practice for forest harvesting for Myanmar is essential and urgently needed. Following the guidance prescribed by the national code, the government is confident that harvesting activities will be conducted in an environmentally friendly manner within the bounds of AACs and silvicultural environmental aspects.

1.2. Review of Existing Harvesting Practices

1.2.1. Institutional Structure

The Ministry of Forestry of Myanmar consists of 5 governmental institutions, of which 4 are primarily concerned with forestry (see Fig.1-1), as follows:

1. Forest Department (FD) is responsible for protection, conservation and sustainable management of forest resources.
2. Myanma Timber Enterprise (MTE) is responsible for timber harvesting, milling, downstream processing and marketing of forest products.
3. Dry Zone Greening Department (DZGD) is responsible for reforestation of degraded forest lands and restoration of the environment in the dry zone of Central Myanmar.
4. Planning and Statistics Department (PSD) is responsible for coordinating and facilitating the task of FD, MTE and DZGD following the directives of the Ministry of Forestry, and acts as a forum on policy issues in forestry.

MTE is comprised of 7 departments. Timber Extraction, Milling and Marketing (Export), Milling and Marketing (In-country Sales) are the 3 key departments, directly engaged and responsible for production and financial earnings.

FD has to undertake the selection of marketing and girdling of trees for harvesting and MTE has to harvest these selectively marked teak trees and teak trees which were girdled 3 years ago.

Every year, FD and MTE have to discuss matters such as teak trees to be girdled, teak trees to be green felled, non-teak hardwoods to be selectively marked for felling and the respective localities for girdling, green teak marking and the selective marking of non-teak hardwoods.

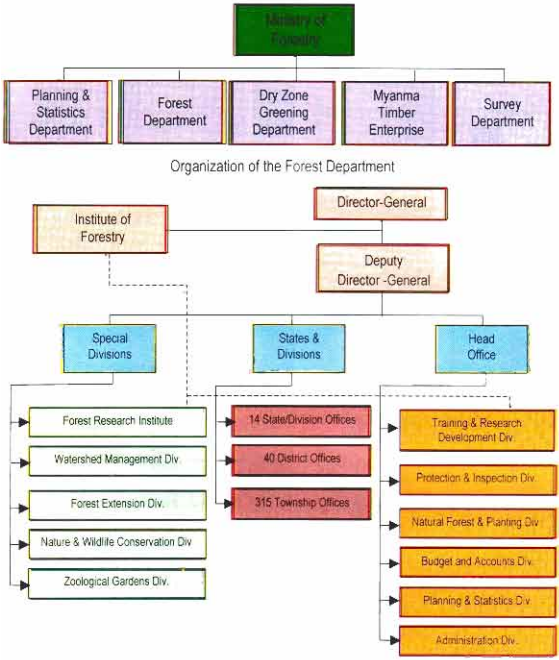


Figure 1-1. Organization of Forest Department

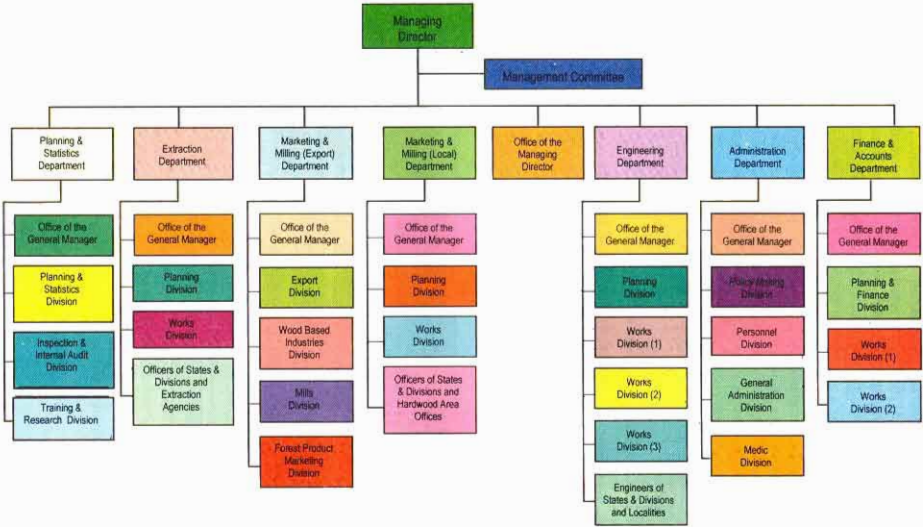


Figure 1-2. Organization Chart of Myanma Timber Enterprise

1.2.2. Regulations

- Myanmar Forest Policy, 1995

  The new Myanmar Forest Policy was formulated and promulgated in 1995, adapting the concepts from UNCED's Agenda 21 and Forest Principles and other international forestry protocols. Forest Policy focuses on the protection of land, water, vegetation and wildlife, sustainability of forest resources, satisfying the basic needs of the people, efficiency in harnessing the full economic potential of the forests, people's participation in forest management and biodiversity conservation, and raising awareness of the people and the decision-makers in forestry.

- Departmental Instructions for Forest Officers in Burma, 1955

  Departmental instructions of 1955 include, among others, the procedures for the following activities:

  1. Forest reservation;
  2. Working plans preparation and updating;
  3. Maintenance and review of girdling;
  4. Registers including future yield trees;
  5. Climber cutting and improvement felling;
  6. Selection marking of non-teak hardwoods, reporting keeping, and
  7. Measurement and royalty marking of and logs extracted under long-term agreement.

- Working Plans Manual, Burma, 1938

  To realize the key role of working plans (Forest Management Plans), the Working Plans Manual was first published in 1938 and revised in 1957. The Manual has highlighted the importance of full utilization of existing data, working circles formation, repeated improvement fellings for better condition of the forests and calculation of yields for both teak and other hardwoods. The revised Working Plan Manual was reprinted in 1961.

  The FD has completed updating and reformulating the working plans and Forest Management Plans for the district level covering the entire country were finalized by the end of 1998. For this process to be consistent, the Forest Department, in consultation with concerned organizations and their professionals, developed the "Format and Guidelines for District Forest Management Plans" in 1996, in line with the SFM principles and other international forestry protocols.

- Standing Orders for Subordinates, Forest Department, 1959

  The Standing Orders provide prescriptions for subordinate staff to carry out forest works including, among others, the following:

1. Girdling of teak and selection marking of non-teak hardwoods;
2. Climber cutting, improvement felling and boundary maintenance and repairs;
3. Measuring and hammering of timber and other forest products;
4. Inspection of harvesting coupes under long-term leases;
5. Stump inspection after felling; and
6. Maintenance and up-keep of compartment registers.

It is perceived that the "Standing Orders for the Subordinates of the Forest Department" need to be updated to be in conformity with the changing concepts in forestry at local, national and international levels. The FD has been introducing the participatory and partnership approaches and has been focusing on ecosystem management rather than timber production.

- Forest Law, 1992

  Replacing the Burma Forest Act 1936, the new Forest Law was enacted in 1992, with adequate provisions for increased private sector involvement, community participation, biodiversity conservation and increased forest resource security.

- Protection of Wildlife and Wild Plants and Conservation of Natural Areas Law, 1994

  The "Wildlife Protection Act, 1936" was replaced by the new "Protection of Wildlife and Wild Plants and Conservation of Natural Areas Law" in 1994. Under the new Law, the modern concept of biodiversity conservation was introduced and the need for extended formulation of the protected areas system was also highlighted.

- Forest Rules, 1995

  The Forest Rules, prescribed in 1902 were replaced by the new Forest Rules in 1995, issued by the Ministry of Forestry.

  In order to facilitate the implementation of the 1992 Forest Law, the new Rules also place emphasis on increased formation and protection of reserved forests and protected public forests, sharing of forest management responsibility with local communities, establishment of fast-growing plantations on degraded forest lands to conserve soil, water and biodiversity, and harvesting of timber and other forest products in an environmentally sound manner.

- Community Forestry Instructions, 1995

  Community Forestry Instructions were issued by the FD in 1995 and marked a significant development in the aspects of partnership, participation and

decentralization in managing the forests in Myanmar. The instructions grant the local communities tree and forest land tenurial rights for an initial 30-year period, which is extendable. The FD provides technical assistance and plays the leadership role in the exercise of community forestry.

- Existing Timber Extraction Manual, Logging Rules and Procedures

  Regarding teak logs, FD and MTE jointly apply the Logging Rules and Standard for Jungle Rejection of Teak Logs which were issued by the Chief Conservator of Forests, Burma in 1936. Also in existence were the Grading Rules for Teak Conservations based on MTE practices and FAO's general guidelines.

  The Extraction Department of MTE has adopted the following:

  - State Timber Board Extraction Manual, issued in 1948 by the Extraction Department, MTE.
  - Standing Orders for Extraction Staff issued by the Extraction Department, MTE in 1970.
  - Departmental Instructions (Seri No. 1 to 120) for Extraction Department, MTE issued by the Extraction Department, MTE in 1986.

  Since UNCED, 1992 the forestry sector in Myanmar has been reorienting its goals and objectives towards ecosystems management in compliance with general principles of sustainable forest management. The presently existing manuals, rules and instructions need, therefore, to be reviewed and updated as appropriate.

1.2.3. Myanmar Selection System

The exploitation-cum-cultural system known as the Myanmar Selection System (MSS) has been the main silvicultural system practiced in managing Myanmar's natural forests.

The MSS involves adoption of a felling cycle of 30 years, prescribing harvestable diameter limits of tree species, girdling and green-felling of teak, selection marking of other hardwoods, felling of less valuable, mal-formed and diseased trees which interfere with the growth of teak, thinning of congested teak stands, enumeration of future yield trees down to fixed sizes, and fixing annual allowable cuts (AACs) for teak and other hardwoods. For teak, harvestable diameter limits vary with the type of the forests. In moist teak forests, the diameter limit at breast height of 1.3 m is 73 cm, and in dry teak forests, is 63 cm. The fixed diameter limit for other hardwoods varies with the species, but mainly 40-60 cm and up. Simple copping or cuppicing with standards systems are also applied in reserved forests which are designated to meet the basic needs of local communities.

The essence of MSS is to enhance natural regeneration and growth of forest with particular emphasis on commercially important tree species, while maintaining the ecosystem's integrity, and to exploit only the interest without tapping the forest capital, ensuring that the volume of timber to be extracted is kept within the limit of the AAC prescribed.

1.2.4. AAC Fixation and Felling Series

- AAC Fixation

Under MSS, Working Circles (WC) are formed, consisting of a group of reserves. These WC are further divided into Felling Series (FS) for the convenience of working. The FS are divided into 30 annual coupes or blocks of approximately equal yield capacity. Each year, selection fellings are carried out in one of these blocks and the selection felling will have covered the whole FS over the felling cycle of 30 years. All marketable trees which have attained the prescribed diameter are selected for felling. The prescribed harvestable diameter varies with the type of forests and species. Unhealthy trees that have not attained the prescribed harvestable sizes, but are marketable, are also selected for felling if they are unlikely to survive through the subsequent felling cycle. If seed-bearing trees are scarce, a few high quality stems are retained as seed trees. Myanmar has completed updating and reformulating 62 Forest Management Plans covering the whole country and each management plan includes AACs for teak and other hardwoods.

Later in the 1920s, 100 % enumeration of teak was carried out with annual girdling. A forest inventory was also carried out by the FD, starting in 1963 on a trial basis. In the early 1980s, National Forest Management and Inventory Projects assisted by UNDP/FAO were conducted and at present the forest inventory has become a routine, annual operation in addition to the 100% enumeration done during the girdling operation. Data obtained by the forest inventory and the 100% enumeration provide the basis for AAC estimates. According to the newly formulated Forest Management Plans, a pre-harvest inventory has to be conducted to estimate AACs more reliably.

$$AAC = ARR + \frac{CI}{LP} - \frac{1/2\ FC.ARR}{LP}$$

where: ARR = annual rate recruitment of class II trees to class I

CI = original no. of trees in class I

FC = felling cycles (i.e. 30 years)

LP = decided period to liquidate original WS (usually 60 years)

AACs are revised as necessary, depending on new data and information.

- Felling Series and Annual Coups

  All natural production forests are placed in one of the Production Working Circles. In forming working circles, similar forest types, economic feasibility, volume of timber that could be extracted, and terrain conditions are the important criteria. Each WC is then divided into FS. The felling cycle was fixed at 30 years for one felling series. Each FS is then divided into 30 annual coups or blocks of more or less equal size. In forming annual coups, a system of "equal area with tree number check" is practiced to ensure that the number of trees selected does not exceed the AAC.

1.2.5. Teak Girdling and Non-Teak Hardwoods Selection Marking

- Girdling of Teak

  Girdling Rules were issued by the FD in 1936, and provide prescriptions for the selection of teak trees for girdling, enumeration of future yield of teak, records of seed trees to be left ungirdled and girdling techniques for minimum timber waste. Girdling Rules place emphasis on silvicultural reasoning when selecting teak trees to be girdled.

  Girdling officers have to adhere to the Girdling Rules as a general guide in field operations. In addition, Divisional Forest Officers have to issue detailed instructions for girdling operations every year. The instructions primarily include how to determine the target number of teak trees to be girdled, girth limits or harvestable sizes for good and poor forests, compartments and reserves as areas of operation, complete enumeration of future teak yield trees down to certain size and labour charges for different girth classes. The instructions also include how to carry out silvicultural operations such as climber cutting, Nyaung-bat (*Ficus* spp.) felling, regeneration improvement felling and compartment boundary repair, all of which are important for the betterment of forest growth and health condition. Until the last two decades, girdling operations were the major routine practice among the various aspects of forest management, in terms of sustained flow of teak log production.

  However, it has been given less and less priority in recent years due to the FD's increasing workload, insufficient man power, increased daily administrative work and reduced time available for field operations. Unrealistically low labour wages allotted for girdling and its associated activities need to be reviewed and increased, and frequent and regular inspections by higher-level forestry officials need to be carried out.

  Mature teak trees selected for harvesting are normally girdled and left standing for 3 years before being felled and extracted. This is to season the standing timber naturally and make it floatable down the streams and rivers. However, in accessible areas, selected teak trees are sometimes felled and extracted when still green, without girdling.

In the present day, the FD needs to reconsider whether girdling teak trees and leaving them for 3 years' seasoning is a worthy process to continue. If natural seasoning and artificial seasoning do not differ too much in the resulting timber quality, leaving girdled trees in the field for 3 years has the following risks:

- Loss of growth of girdled trees for 3 years;
- Risk of damage by wildfire;
- Risk of loss by illegal cutting;
- Economic return is delayed;
- Waste of timber along the girdling ring.

Thanks to improved techniques in tree felling, damage to trees at the moment of ground impact can be minimized even if they are green-felled. Therefore, review of the practice of teak girdling is necessary, particularly in accessible regions close to the final destination and in the absence of economically feasible rivers for floating.

- Non-teak Hardwood Selection Marking

The non-teak hardwoods are also worked under the selection marking with 30 years felling cycle, the same as for teak. Complete or 100 % enumeration was also done to collect data for future yield estimates.

1.2.6. Timber Extraction

- Draught Animals

Elephants are the most important draught animals in Myanmar, while buffaloes are occasionally used for skidding in undulating areas. Of about 10,000 elephants in Myanmar,

- some 3,000 elephants are government-owned;
- some 2,000 are private-owned; and
- around 5,000 are in the wild.

Although special attention is given to the conservation of wild elephants and the systematic care of working elephants, both FD and MTE are now becoming concerned about some indications of dwindling populations of both wild and domesticated elephants. Improved health care and working conditions for elephants and the creation of special areas for wild elephants might be explored in time.

- Mechanical Extraction

Mechanical extraction of timber is limited due to Myanmar's rugged terrain. In addition, the advantages of traditional utilization of draught animals for timber skidding and constraints in financial resources for purchasing

adequate machineries and heavy equipment for skidding would limit the use of mechanical extraction. One important reason for the limited practice of mechanical extraction is that MSS has been the only system consistently practiced in managing the forests and obviously, mechanical extraction is not considered to be the best practice for the selection system, applied in uneven-aged natural forests.

1.2.7. Post-harvest Inspection

Standing Orders and Departmental Instructions for both FD and MTE staff include post-harvesting inspection activities such as:

- stump height inspection;
- inspecting whether any logs remain unextracted in the forest;
- checking whether logs at the dumping sites and depots are fire-protected; and
- checking whether there have been any violations against Standing Orders and Departmental Instructions.

In the Forest Management Plans which were recently formulated, detailed procedures for post-harvesting inventory are prescribed.

2. Scope and Objectives

2.1. Mission Statement

To protect, conserve, manage and utilize Myanmar's forest resources for sustainable development, taking into account of social, economic and environmental values of forests in an integral manner.

2.2. Scope

The code provides guidelines and standards to be followed in forest harvesting for all types of production forests so that environmentally and socially undesirable impacts, if any, are kept within acceptable limits. However, the guidelines stipulated in the code can be adjusted to the existing capacity and resources of the responsible institutions and because they are country-specific, implementation of the code will help to maintain the environmental balance and ensure social benefits.

2.3. Objectives

The objectives of the code are:

- To provide guidelines and prescriptions to all stakeholders so that the forest environment, particularly the remaining stands, soil, and water are least disturbed during and after the course of forest harvesting; and
- To maximize economic returns from forests while maintaining the forest's regenerative capacity and species diversity, ensuring the health and safety of forest workers, and protecting culturally and biologically significant sites.

3. Forest Harvesting Planning

Objectives:

- To ensure forest harvesting is carried out within the carrying capacity of the forests and forest land;
- To ensure forest harvesting is carried out in an environmentally responsible manner;
- To ensure forest harvesting is done within the fixed AACs;
- To direct planning to be based on and field data and information;
- To identify protected areas under the Protected Areas System (PAS) which must be excluded from harvesting; and
- To make harvesting planning flexible enough as an on-going and day-to-day activity as necessary and appropriate.

3.1. Planning Levels

Myanmar began streamlining its national forest programme (NFP) in the 1990s to achieve sustainable development of the forestry sector. As an exercise of NFP, the National Forestry Master Plan (NFMP) is currently under preparation with the involvement of all stakeholders concerned, for a 30-year period starting from 2001-02 to 2030-31. Therefore, harvesting plans will have to be composed of:

- a 30-year plan (long term)
- a 5-year plan (mid term) as phase by phase planning; and
- an annual or one-year plan

3.1.1. Long-term Planning

Long-term plans provide a strategic framework for a period of 30 years, in compliance with the policy goals of the forestry sector. They also serve as a guide to future activities for all major components of the forest harvesting operation. Due to the time span involved, details of the plan are subject to changes as necessary, although the primary objective of implementing the SFM principles will remain unchanged. The long-term plan should be reviewed periodically and amended as necessary.

Long-term plans are prepared by the Forest Authority and should include, but not be restricted to, the following:

- Identification and mapping of areas scheduled for timber harvesting;
- Identification and mapping of areas under PAS;
- Identification and mapping of areas to be reserved for biodiversity conservation;
- Identification of future harvest areas and an approximate time schedule for harvesting;
- Identification of the approximate size and boundaries of each harvest area;
- Identification of maximum harvesting intensity per hectare;
- Identification of the number and volume of trees to be harvested on the basis of AACs, taking into account girdling and selection felling (SF) marking data;

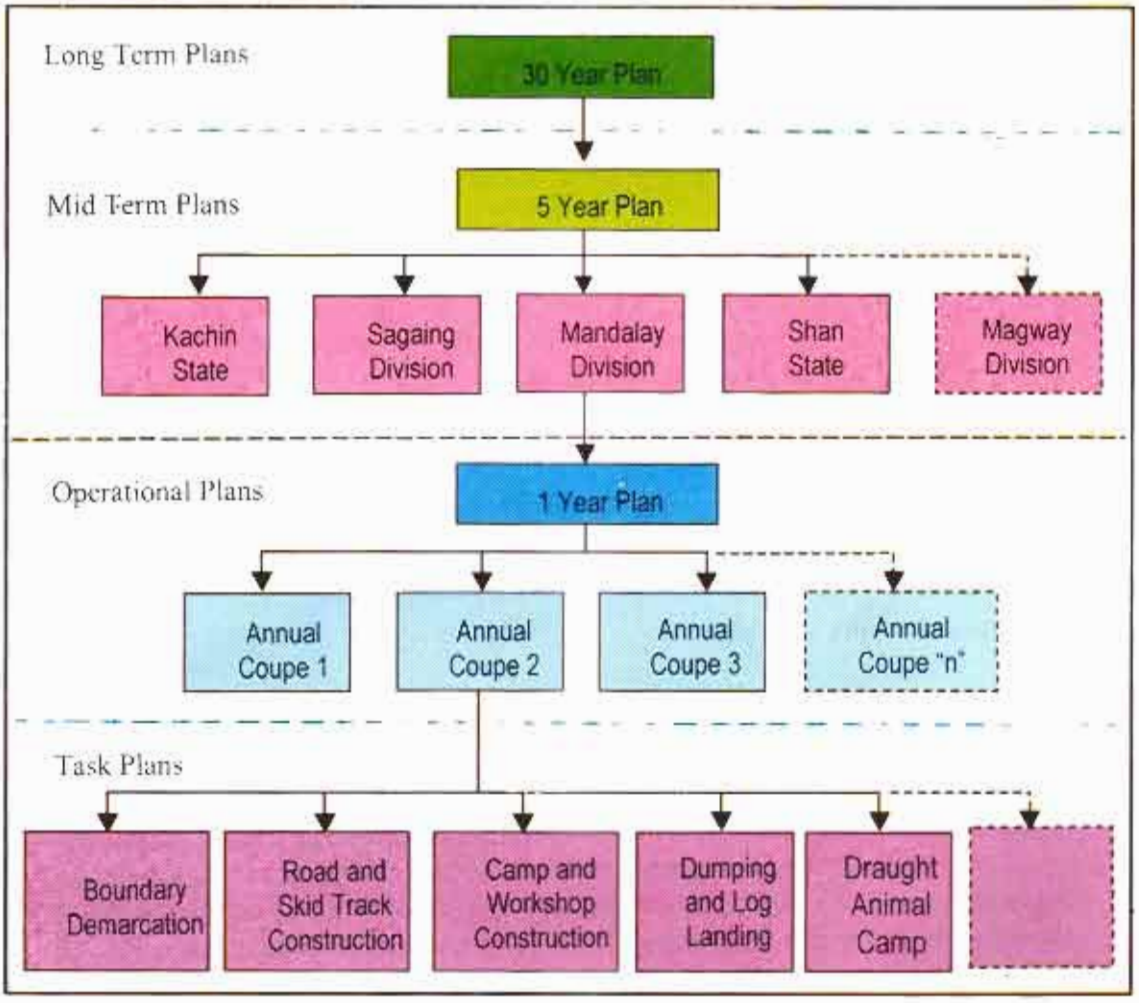


Figure 3-1. Hierarchy of Planning

- Scheduling of pre- and post harvest inventories for each year's harvesting;
- Scheduling of girdling and tree marking selection;
- Prescription of major silvicultural treatments after each harvest;
- Lay out of all-weather and dry-weather road;
- Estimate of required machineries and heavy equipment needed for harvesting;
- Estimate of the total number of stream crossings;
- Draught animal care, training and cultural programmes;
- Requirement of trained staff, technicians, operators and skilled labourers;
- Identification of sites for extraction camps, workshops and elephant camps;
- Arrangements for improved health conditions for staff, labourers and the draught animals; and
- Estimate of investment and costs, although they may be subject to change over time.

Although the primary focus of the code is placed on timber harvesting at this very initial stage, general directions concerning the harvest of other forest products are also touched upon with environmental considerations.

3.1.2. Mid-term Planning

Mid-term plans should provide more details than long term plans. Mid-term plans must be formulated within the context of long term plans. Cost estimates, staff, equipment, requirements, maximum harvesting intensity and the targets of harvested timber should be realistic and reflect the prevailing conditions.

3.1.3. Operational Planning

Operational plans are prepared for each annual harvest coupe based on a pre-harvest inventory and on-site inspection. This plan prepared by MTE is a written description of action plans on forest harvesting plan maps, on a scale of 1:10,000 and 1:2,000. Operational plans shall include:

- Description of the coupe area/block as the annual work plan area (location, subblock, compartments, etc.) and boundaries;
- Demarcation of annual coupe boundaries, which should follow topographic or natural features;
- Number of trees to be harvested and volume of timber to be removed by species and size class;
- Maximum harvesting intensity (stems per hectare) should not exceed the maximum harvesting intensity prescribed in the Forest Management Plans.

- Design, lay-out, construction and maintenance of dry-weather road and skid tracks;
- Construction of bridges and culverts;
- Cultural, historic and other designated significant sites to be excluded from harvesting;
- Naturally protected areas to be excluded from harvesting;
- Location and construction of extraction camps, elephant camps and fuel storage areas;
- Labour recruitment and staff assignment;
- Requirements of machineries, equipment and tools;
- Requirements of MTE-owned and privately owned draught animals;
- Prescriptions of environmental guidelines;
- Requirements of rations, fuel and medicine;
- Requirements of staff, including technicians and operators; and
- Inspection, monitoring and reporting systems.

The forest harvesting plan maps consist of maps at scales of 1:10,000 and 1:2,000. The forest harvesting plan map (scale 1:10,000) shall include:

- Land ownership boundaries;
- Protected areas;
- The entire area to be harvested, including its location and borders;
- Contour lines with an interval of 5-10 m;
- Existing and prospective road networks;
- Landings and log depots locations;
- Rivers used as transportation routes;
- Location of wet and dry areas;
- Watercourse crossings (permanent and temporary); and
- Timber transport system.

The forest harvesting plan map (scale 1:2,000) shall include:

- Contour lines (with an interval of 5-10m);
- Compartment boundaries;
- The entire areas excluded, including their locations and borders;
- Existing and prospective road networks and landings;
- Skidtrack networks and skidding directions;
- Harvestable trees locations and planned felling directions;
- Future trees and protected trees locations; and
- Watercourse crossings.

3.2. Available Information and Resources

- For Timber Harvesting:
  - Planning staff and office facilities
  - Forest management plan, adopted for the Forest Management Unit (District)
  - Maps with watercourse, contour lines, forest types boundaries of annual harvest coupes, compartments, reserves, felling series and working circles;
  - Forest management plan map (scale 1:250,000-1:50,000);
  - Annual forest harvesting plan map (scale 1:10,000);
  - National inventory data, pre-harvest inventory data, and AACs;
  - Tree location and contour map (scale 1:2,000);
  - Girdling data and SF marking data;
  - Post-harvest silviculture treatments, including those for plantation forest;
  - Identification of areas to be excluded from harvesting;
  - Future harvesting and development plans; and
  - Existing extraction facilities, including draught animals.
- Of Water Impoundment:
  - Impounded areas with dams and reservoir;
  - Inventory data and base maps;
  - Topographic maps of dam sites and surroundings;
  - Demarcation of boundaries of water-impounded areas (reservoirs);
  - Existing road maps of the area;
  - Available equipment and heavy machineries for felling, skidding, log-landing, construction, loading and unloading, and transportation;
  - Details of areas previously harvested.
- For Rattan and Bamboo Harvesting:
  - Maps showing eco-regions and localities where rattan and bamboo occur;
  - Topographic maps that also show the existing road system;
  - Inventory data at national (reconnaissance) and management levels;
  - Estimates of AACs, demand and export potentials;
  - Social and economic information about the area concerned;
  - Regenerative capacity, silvicultural requirements and growth behaviour of the species concerned; and
  - Existing practice used in harvesting of rattan and bamboo.

3.3. Management Information Systems and Planning Process

3.3.1. Forest Management Plans

Forest management plans for 62 districts covering the whole country have been reformulated in line with SFM principles. The forest management plans include AACs for teak and other hardwoods, define the maximum harvesting intensity (stems/hectare), prescribes the minimum number of future trees to be left after harvesting, calls for the formation of working circles, felling series and silvicultural treatments after harvesting. Pre-and post-harvest inventories are also prescribed, so as not to overlog the forest and to restore and enhance the growth, health and good condition of the harvested forest.

3.3.2. Mapping Systems

In Myanmar, the base maps (scale 1:100,000 – 1:50,000) are topographic with a detailed description of contour lines. In 1980, a forest cover appraisal was done for the whole country using aerial photographs, and forest type maps were accordingly produced. In the mid 1990s, land use and land cover maps (scale 1:250,000 – 1:100,000) were developed based on satellite data, using GIS technology. Retrieval of required data from the GIS data bank is of practical use in forest management and harvest planning.

3.3.3. Forest Management Maps

Forest management maps, showing management zones, annual coupe boundaries, existing road systems and other relevant information concerning forest harvesting should be prepared at appropriate scales (1:250,000 – 1:50,000). Newly formulated Forest Management Plans provide forest management maps for the districts concerned and they could be modified with new information for harvest planning.

3.3.4. Forest Inventory

The FD has been conducting forest management inventories as an on-going annual field operation, using a forest inventory map at a scale of 1:10,000. Based on inventory data, AACs are estimated for each township, felling series or reserve. Currently, the systematic line plot sampling method with 0.1% sampling intensity at the management level is being used.

In fixing AACs, data from the 100% enumerations of future yield trees that are undertaken during girdling and SF marking operations are of great value. Therefore, a Tree Location and Contour Line Map (scale 1:2,000) made by counting all trees with diameters 20 cm below the diameter limit and up, plus a topographical survey are necessary. The suggested contour line interval is 5 m.

In the newly formulated or updated Forest Management Plans, conducting a pre-harvest inventory one year ahead of harvesting is an essential activity in order to make a realistic fixation of AACs towards SFM.

3.4. Staff and Training

3.4.1. Planning Staff

- The planning division at the Headquarters Office, and officials in charge of states/divisions, districts and township should take responsibility for planning.
- The planning staff should have skills in:
  - Planning for large scale forest management and harvesting operations;
  - Surveying the boundaries of annual harvest coupes, areas under PAS, and designated areas to be excluded from harvesting;
  - Mapping, map reading, and contour line surveying;
  - Laying out road alignment and construction;
  - Skid track network and felling direction planning;
  - Plan preparation and reporting; and
  - Communication with and information gathering from field staff and operators and local people.

- Duties and responsibilities of the planning staff are as follows:
  - To prepare and review long term and mid term plans;
  - To prepare and review annual (operational) plans for each annual coupe;
  - To prepare and review task plans for each work component or activity;
  - To submit the plans for discussion and comments made by FD and MTE higher authorities;
  - To supplement and amend the plans as appropriate in compliance with the comments made by FD and MTE;
  - To discuss and give an overview, together with field staff, operators and local communities, of the problems that could possibly arise from the implementation of the operational plans;
  - To get approval of the plans from the concerned authorities of FD and MTE;
  - To get a consensus from local communities on forest harvesting and to make sure that forest harvesting has no adverse impacts on the local people and forest dwellers;
  - To ensure that standards and guidelines prescribed in the operational plans are implemented to protect environmental values;
  - To inspect the applicability of plans.

3.4.2. Training

Training exercises are necessary. Apart from those regularly provided by the FD and MTE, the planning staff should also organize and conduct training on the following:

- Forest harvesting planning;
- Mapping and surveying;
- Computer programming and application systems;
- Forest inventory methods and resource assessment in support of developing a forest management information system;
- Application of RS/GIS/GPS in support of land management planning;
- Handling, operating and maintenance of machineries;
- Road alignment demarcation and road construction;
- Felling techniques, scaling and bucking;
- Elephant care and working in timber harvesting;
- Log scaling and grading;
- Silvicultural treatment of MSS;
- Monitoring, evaluation and report writing and submission;
- File keeping and record system;
- Budget and accounting system; and
- Environmental conservation and ecosystems integrity.

3.5. Involvement of Stakeholders

Involvement of all stakeholders (FD and MTE personnel, logging sub-contractors, elephant owners, local communities, forest dependents and NGO's) is of prime importance for the development of well-formulated harvesting plans, ensuring social, environmental and economic benefits. Given Myanmar's present condition, the participation of these stakeholders will be integrated during the course of formulating the plan. However, the consultation process should be established to gather opinions and views from all the stakeholders prior to plan formulation. When the plan is first drafted, it is recommended that it be put forward to the public, particularly to the forest dwellers, NGOs, relevant professionals and the administrative bodies before finalizing the draft. Comments and opinions given in response to the consultation process must be accounted for, and the final draft of the harvesting plans should not undermine the interests expressed by the local communities, forest dwellers and the NGOs.

In the newly formulated or updated Forest Management Plans, conducting a pre-harvest inventory one year ahead of harvesting is an essential activity in order to make a realistic fixation of AACs towards SFM.

3.4. Staff and Training

3.4.1. Planning Staff

- The planning division at the Headquarters Office, and officials in charge of states/divisions, districts and township should take responsibility for planning.
- The planning staff should have skills in:
  - Planning for large scale forest management and harvesting operations;
  - Surveying the boundaries of annual harvest coupes, areas under PAS, and designated areas to be excluded from harvesting;
  - Mapping, map reading, and contour line surveying;
  - Laying out road alignment and construction;
  - Skid track network and felling direction planning;
  - Plan preparation and reporting; and
  - Communication with and information gathering from field staff and operators and local people.
- Duties and responsibilities of the planning staff are as follows:
  - To prepare and review long term and mid term plans;
  - To prepare and review annual (operational) plans for each annual coupe;
  - To prepare and review task plans for each work component or activity;
  - To submit the plans for discussion and comments made by FD and MTE higher authorities;
  - To supplement and amend the plans as appropriate in compliance with the comments made by FD and MTE;
  - To discuss and give an overview, together with field staff, operators and local communities, of the problems that could possibly arise from the implementation of the operational plans;
  - To get approval of the plans from the concerned authorities of FD and MTE;
  - To get a consensus from local communities on forest harvesting and to make sure that forest harvesting has no adverse impacts on the local people and forest dwellers;
  - To ensure that standards and guidelines prescribed in the operational plans are implemented to protect environmental values;
  - To inspect the applicability of plans.

3.4.2. Training

Training exercises are necessary. Apart from those regularly provided by the FD and MTE, the planning staff should also organize and conduct training on the following:

- Forest harvesting planning;
- Mapping and surveying;
- Computer programming and application systems;
- Forest inventory methods and resource assessment in support of developing a forest management information system;
- Application of RS/GIS/GPS in support of land management planning;
- Handling, operating and maintenance of machineries;
- Road alignment demarcation and road construction;
- Felling techniques, scaling and bucking;
- Elephant care and working in timber harvesting;
- Log scaling and grading;
- Silvicultural treatment of MSS;
- Monitoring, evaluation and report writing and submission;
- File keeping and record system;
- Budget and accounting system; and
- Environmental conservation and ecosystems integrity.

3.5. Involvement of Stakeholders

Involvement of all stakeholders (FD and MTE personnel, logging sub-contractors, elephant owners, local communities, forest dependents and NGO's) is of prime importance for the development of well-formulated harvesting plans, ensuring social, environmental and economic benefits. Given Myanmar's present condition, the participation of these stakeholders will be integrated during the course of formulating the plan. However, the consultation process should be established to gather opinions and views from all the stakeholders prior to plan formulation. When the plan is first drafted, it is recommended that it be put forward to the public, particularly to the forest dwellers, NGOs, relevant professionals and the administrative bodies before finalizing the draft. Comments and opinions given in response to the consultation process must be accounted for, and the final draft of the harvesting plans should not undermine the interests expressed by the local communities, forest dwellers and the NGOs.

3.6. Consensus and Commitment

Consensus regarding harvesting plans must be reached among all stakeholders. Commitment must be made by all parties and should be accordingly translated into action on the ground. The plan, once approved by the authorities concerned, must be respected by all parties, particularly by the FD and MTE. While inspecting and monitoring implementation of the plan's key elements, departmental decrees and instructions should be issued to ensure the implementation of the plans as agreed and adopted.

4. MANAGEMENT ZONING

Objectives:

- To exclude protected areas from harvesting;
- To identify areas to be harvested;
- To identify and protect sensitive areas within annual coupes to be harvested; and
- To identify and exclude over-logged areas from harvesting.

4.1. Protected Areas

Maintenance of biodiversity is of primary importance in flora and fauna conservation areas. Towards this end, areas under the PAS will be excluded from harvesting and managed as follows:

- Declaring protected areas under any national or provincial legislation;
- Identifying and delineating protected areas on maps at scales of 1:250,000 1:50,000;
- Retaining habitat areas in production forests when appropriate for wildlife;
- Maintaining patches of forests that connect protected areas as corridors which will not be harvested;
- Protecting endangered species in production forests by modifying harvesting areas or maintaining sections of unlogged forest;
- Field inspections by a Forest Authority Officer are an important part of harvesting planning and operations to ensure that protection area and buffer zones are well managed.

4.2. Harvesting Areas

Harvesting areas include all productive reserved forests and protected public forests which are incorporated into felling series in forming a working circle. Areas under PAS, over-logged areas and critical watershed areas are excluded from harvesting. Buffer zones within production forests are excluded from harvesting as follows:

- Cultural areas, including village areas, gardens;
- Shorelines, lagoons, lakes and water storage areas;
- Designated areas; and
- Specific wildlife habitats and areas containing endangered species.

4.3. Buffer Strips and Watercourses

- Buffer strips are required, irrespective of whether the feature is being identified on available maps.
- Field inspections by a Forest Authority Officer are an important part of harvesting planning to determine protection areas and buffer zones.
- Watercourses to be crossed should be identified.
- Crossing points at watercourses should not be at bends or curves, and the banks of both sides should be stable.
- Buffer zones and crossing points to be designated should be:
  - Shown on forest harvesting plans and marked in the field before harvesting operations commence.
  - Approved in the field by a Forest Authority Officer before harvesting operations commence.

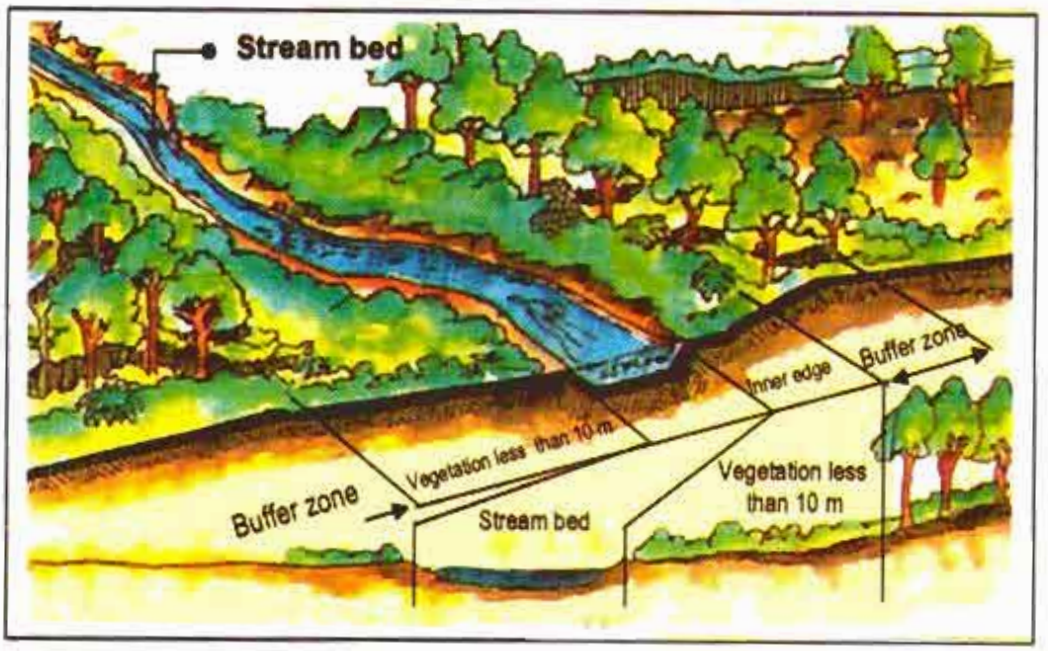


Figure 4-1. Buffer Zone Protection

Definition and classification of watercourses are provided in Figure 4-2. Table 4-1 provides information of minimum required buffer zone protection. Buffer zones to be designated are shown in Figure 4-3.

Ask these questions.

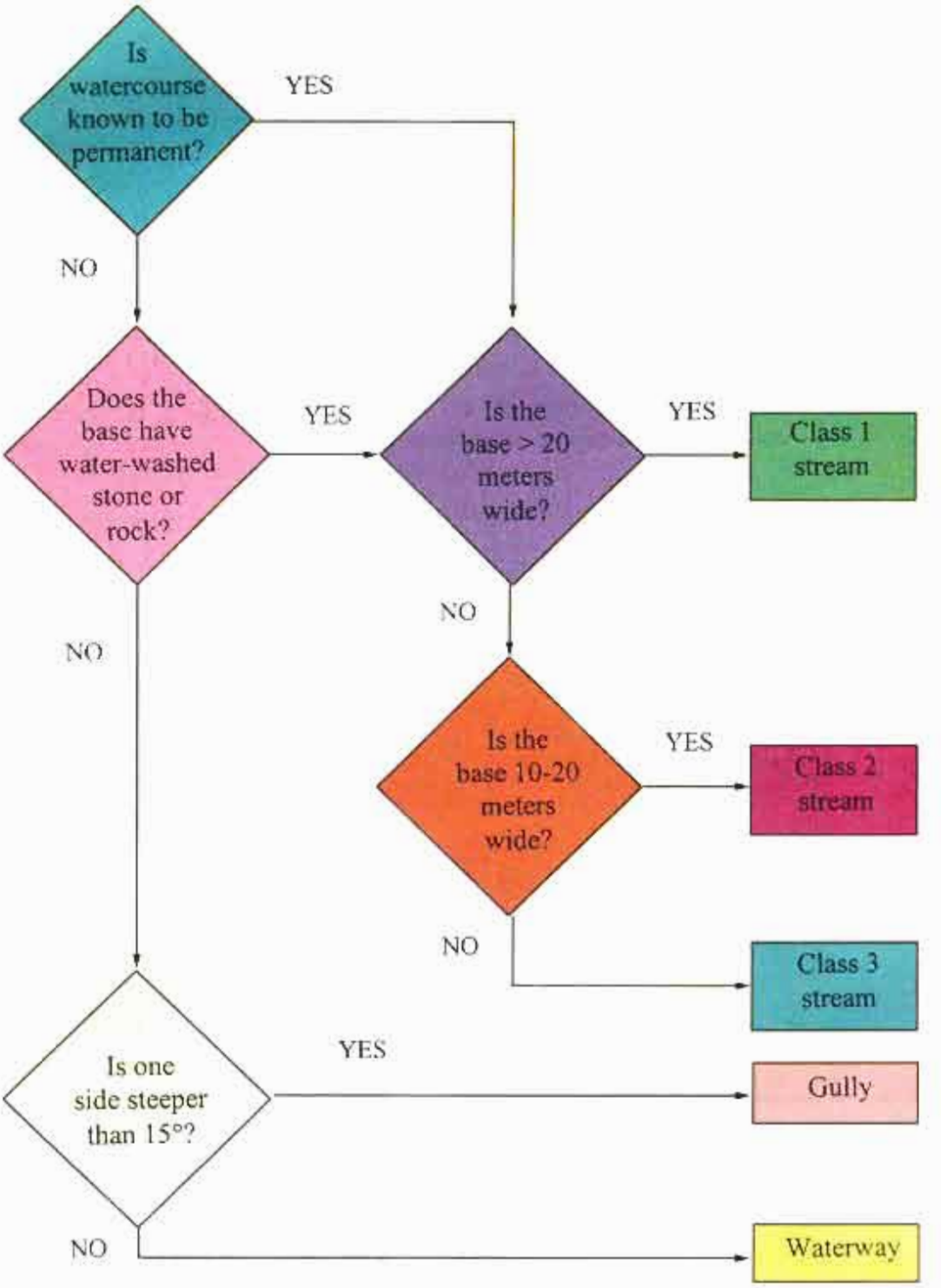


Figure 4-2. Watercourse Definition and Classification

Table 4-1. Buffer Zones Protection

Area	Minimum Requirements for Buffer Zone Protection
Cultural areas	Buffer zone width of 30 m
Buffers around: • Lakes • Lagoons • Shoreline • Water storage areas	The buffer width is measured from the high water mark or edge of the mangrove vegetation if this occurs above the high water mark. The minimum width depends on the slope: • where slope is ≤ 17%, buffer width = 50 m • where slope is > 17%, buffer width = 100 m The only exceptions are: • for log ponds, where the buffer may be reduced to 50 m • for wharfs, associated with log ponds and ship loading area protection to the seaway where vegetation may be cleared to the water's edge for the width of the wharf, to a maximum of 100 m.
Landslip areas	The area of the landslip, the landslip spoil, and the catchment of the landslip and spoil.
Designated water-courses (Defined in Section 4.3)	Retain vegetation on both sides of the watercourse. Delineation of the buffer zone will start where the vegetation is 10 m high or greater. • Class 1 streams (width of stream base > 20 m) : 30 m each side • Class 2 streams (width of stream base 10-20 m) : 20 m each side • Class 3 streams (width of stream base < 10 m) : 10 m each side Gullies: Merchantable trees may be felled; extraction equipment are not permitted within 10 m on either side of gullies Water ways (catchment area 2 ha): Merchantable trees may be felled; extraction equipment are not permitted within 5 m on either side of waterways.

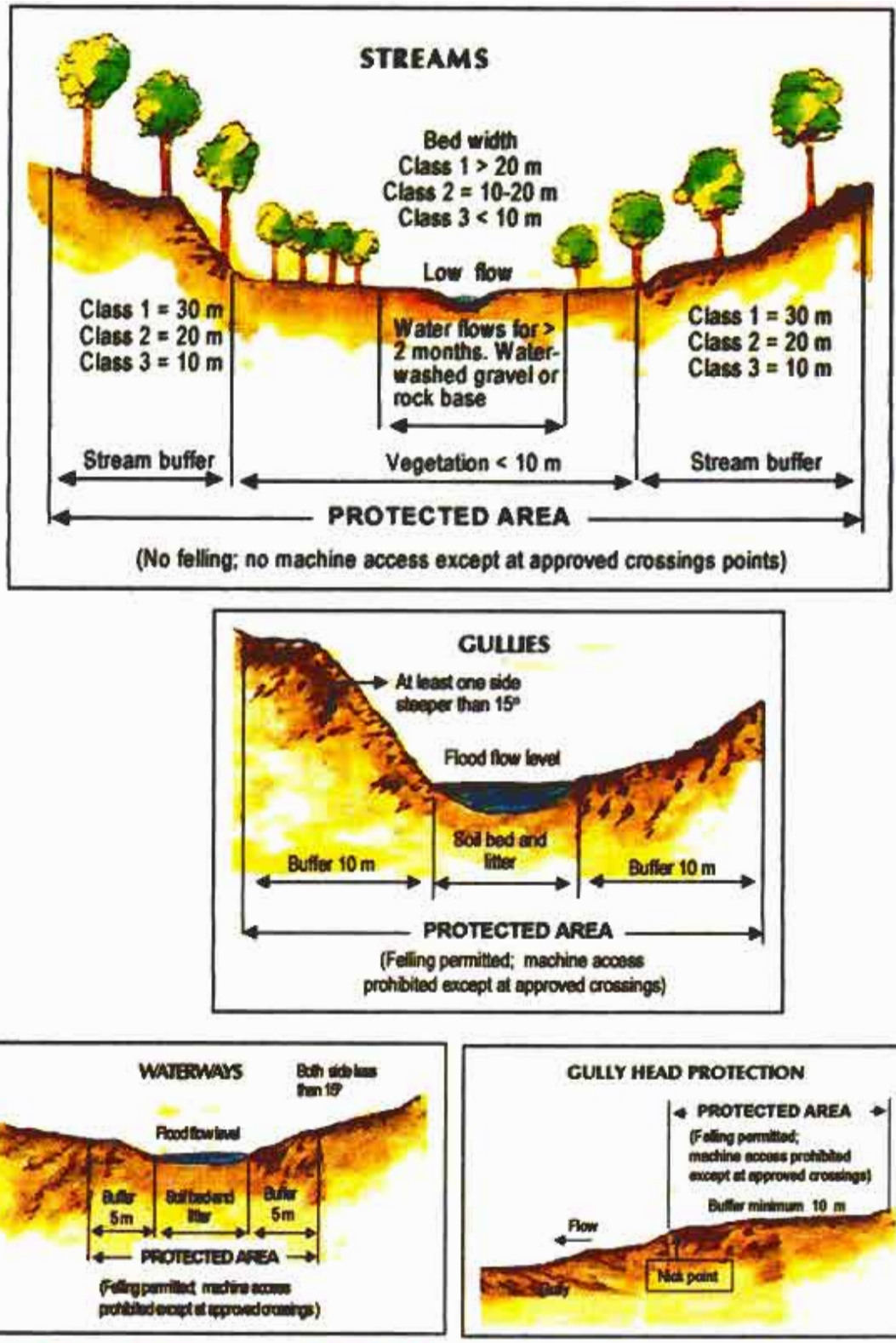


Figure 4.3. Watercourses and Buffer Zones

4.4. Over-logged Areas

Over-logged areas will be excluded from harvesting and managed as follows:

- Declaring over-logged areas under any national or provincial legislation;
- Identifying and delineating over-logged areas on available maps;
- Prohibiting tree felling, machine access and earthworks within a designated over-logged area;
- Prescribing management activities to be performed and cultural operations to be conducted to enhance the status of over-logged areas; and
- Developing a system of monitoring and evaluation of the progress made in over-logged areas.

Objectives:

- To sustain production of forests through suitable silvicultural practices;
- To ensure the least impact on the forest environment; and
- To minimize impact on the residual forest stand and soil and water values.

5.1. Tree Selection and Marking

Tree selection and marking are allowed under a selection harvesting system with the following objectives:

- To ensure that only designated trees are harvested (this practice is consistent with maintaining vigorous forests);
- To maintain species composition of the forest after harvesting and a viable residual stand; and
- To minimize canopy openings.

The number of trees selected should be within the bounds of annual allowable cuts (AACs) prescribed for each management planning unit. Both teak and non-teak hardwoods having reached fixed harvestable diameter limits are eligible to be selected and girdled/marked. Teak may be felled green as required. Harvestable diameter limits for both teak and non-teak hardwoods may vary depending upon condition and type of the forest. According to MSS Standard, in moist teak forests, the diameter limit at breast height of 1.3 m is 73 cm, and in dry teak forests is 63 cm. The fixed diameter limit for other hard woods varies with the species, but mainly ranges between 40-60 cm. At the time of selection, teak trees and other hard wood trees with diameters of less than 20 cm of the prescribed limit diameter are recorded. Any changes concerning harvestable diameter limits and maximum harvesting intensity must be approved by the Director-General of the Forest Department prior their implementation.

5.2. Buffer Zone Demarcation

Buffer zones to be marked by FD/MTE should be done according to the Harvesting Plan. Buffer zone demarcation should be marked on the tree's stems with paint on the side of the trees facing the harvesting area. Marked trees should be spaced at not more than 20 m.

5.3. Forest Infrastructure Planning

5.3.1. Road Design

- Road type

  Roads should be classified into three types, namely:

  - all-weather roads;
  - dry-weather roads; and
  - skid tracks.

- Road location

  Roads should be designed taking into consideration the following:

  - The Forest Authority should be responsible for the co-ordinated development of infrastructure, including the locations of roads.
  - Inspection and approval of the road location by a Forest Authority Officer is required before the construction commences.
  - Roads should be located on ridges, natural benches, or in areas of low side slopes.
  - Roads should be located where no earthworks or soil spills will fall into watercourse buffer areas along the watercourse.
  - The number of stream crossings should be kept to a minimum.
  - Cuts and fills should be balanced to minimize transport of dirt as road construction material.
  - In swamp forests, roads are inappropriate in most cases. So some other low impact transportation system located on a grid pattern should be planned for log harvesting.

  The road network plan should be designed on a contour line map (scale 1:10,000) and then transferred to the field using compass, clinometer, measuring tapes and red paint. The result of this activity will be red marks on trunks of the trees along the central line of the planned road.

- Areas to be avoided in road construction

  Areas where roading should be avoided are:

  - Areas excluded from harvesting (if unavoidable, approval must be acquired from the Forest Authority);
  - Locations which require double cuttings;
  - Areas subject to flooding;
  - Steep and unstable areas;
    - Gullies
    - Swamps and mangroves
    - Wetlands/watercourses
    - Conservation/reserve areas.

- Road grade specification

Road Class	Preferred Maximum Allowable Grade (%)	Preferred Maximum Adverse Grade (%)
All-weather	10	8
Dry-weather	15	10
Skid track	18	12

  - Steeper grades (up to 20%) for short sections (maximum 500 m) would be acceptable if this reduces the disturbance in road construction.
  - Any two sections of road at absolute maximum gradient should be separated by 100 m of level or low gradient portion.
  - Road width should be kept to a minimum, but will depend on the truck width and travel speed.

- Road widths

  Maximum road widths are:

Road Type	Road Width
All-weather	6-8 m
Dry-weather	4-6 m
Skid track	3-4 m

- Curves
  - Adequate curve widening will be required on bends to allow for off-tracking trailers.
  - Fit curves to the topography. The minimum radius of curves are related to visibility and speed of vehicles travelling on the road. These are shown in the table below.

Design Speed	30 kph	50 kph	80 kph
Minimum radius (use may require signs)	25 m	30 m	55 m
Desirable minimum radius	35-75 m	75-120 m	140-300 m
Minimum sight distance required	30 m	64 m	120 m
Meeting sight distance	50 m	100 m	220 m

5.3.2. Watercourse Crossings

- Watercourse crossings should be at right angles to the streams.
- All watercourse crossings should be shown on the harvesting plan and approved by the Forest Authority in field inspections.

- Select crossing points on waterways in place where:
  - the bank slope is less than 18% (preferably less than 9%); and
  - the bed is firm.
- Skid tracks should not cross streams that are more than 10 meters wide.
- Temporary crossings are to be provided for gullies, or waterways if water is flowing at the time of operation.
- Permanent crossings must be of a size which allows wet season floods to pass safely without causing damage to the crossing or its foundations.

5.3.3. Log Depots and Log Landings

- Areas selected as Log Depots should be in compliance with the following requirements:
  - Accessible to all-weather roads or rivers in case rafting is the only option for log transportation;
  - Not too close to villages or any other human settlements;
  - A buffer area at least 15 m wide should be designated and cleared around log depots to protect the surrounding area from spreading fires; and
  - The site should not be a water-logged area.
- Log depot locations must be approved by the Forest Authority before construction commences.
- Landing locations depend on factors such as terrain conditions, timber yield available, log size, skid track location and extraction method. Other factors to be considered include:
  - landings should be located on slightly sloping ground;
  - landings should not be located any closer than 20 m to a watercourse or gully;
  - landing areas should be well drained.

5.3.4. Harvesting Camps

- Careful planning of harvesting camp locations can create a healthy and happy environment and reduce hazardous situations.
- Permanent harvesting camp locations must be approved by the Forest Authorities before construction commences.
- The area selected should be in compliance with the following requirements:
  - The site should not be too far from or too close to streams or wells from which clean and adequate water is available. If the site is selected on the bank of a stream, it should be on the upper part of the village.

- Areas of muddy soils and poor drainage should be avoided. The site selected should be free from surface runoff during the rainy season.
- If the site is selected on the bank of a stream, it should be well tested against erosion risk. If erosion is likely to occur, the site should be somewhat far away from the stream bank.
- The site should be on a high hill with a good view facing either the upper or lower part of the stream. If the site is selected for a Forest Rest House (FRH), it should be peaceful and free from disturbance and noise.
- The site should face either east, south-east, or north-east to receive the warm morning sun light. It should not face south or southwest to avoid raindrops during the monsoon season, or north from where the cold north wind blows during the winter season, or west towards the intense evening sun.
- The camp site should be on a moderately level surface with a little shade. However, if the building is constructed right under big trees, there are risks of falling branches which could damage the roofs. The camp site should be free of dead and dried trees.

• Selection for temporary camp site during the winter season:

- The camp site should be free from waterfalls during unexpected rains.
- The camp site should have a good view and other requirements such as mentioned above.
- The site for temporary tents should be located only on the upper side of streams where staff and workers' camps are constructed.
- Tents should be attached to nearby trees or bushes. It should be noted that insects such as ants and red ants can enter the tent along the ropes attached.
- Trees and bushes around the tent, except for those used as tent anchors, should be removed from an area about 7 m in diameter and burned.

5.4. Skid Tracks and Felling Direction Planning

• The objectives of skid tracks and felling directions planning are:

- to minimize damage to productive forest areas;
- to reduce damage to residual stands and regeneration on the ground;
- to reduce skidding distance and soil damage along skid tracks; and
- to locate skid tracks where they will:
  - minimize the number of water course crossings; and
  - improve the economics of harvesting.

5.4.1. Skid Track Planning

- Skidding direction

  Skidding directions are decided based upon an assessment of the following factors:

  - road and landing location (upper slope, lower slope);
  - watercourse crossings (to be minimized);
  - minimizing potential damage to soil caused by skidding;
  - safety;
  - soil type and conditions that will affect skid direction;
  - skidding in areas excluded from harvesting (other than at defined watercourse crossing points) should not be permitted.

- Design
  - The skid track network is planned and outlined on a tree location and contour line map (scale 1:2,000).
  - The locations of landings should be plotted prior to the locations of skid tracks.
  - Locations of skid tracks:
    - Should be away from waterways and unstable areas.
    - Should be on spur lines where possible, to allow good drainage.
    - Where they will not damage retained trees. (A sacrificial tree which is already targeted for removal can be used to protect retained trees.)
  - Watercourse crossing points for major skidding are to be shown in the harvesting plan and approved by the Forest Authority. An increase in the number of watercourse crossings will require approval of the Forest Authority Officer in field inspections.
  - Where major skid tracks must cross slopes, the angle of the skid track to the contour line should not exceed 45°.
  - Advisable maximum slope for side cutting is 50%.
  - Advisable maximum allowable grade for skid tracks is 35%, or 19°.

- Marking of skid tracks
  - Skid tracks and landing locations as shown on the harvesting plan map should be transferred into the field using compass, clinometer, measuring tapes and red paint. The results will be red marks at the edges of landings and on the trunks of trees along the skid tracks.

5.4.2. Felling Direction Planning

- Felling directions

  Felling directions are planned considering the following factors:

  - Feller's safety
  - Field situation to avoid damage to the remaining stand, felled trees, or to protected areas.
  - Log skidding efficiency.
  - Skidding method/system.

- Design
  - Felling directions should be planned on a tree location and contour lines map (scale 1:2,000).
  - The best felling direction is toward or away from a skid track forming an angle with the skid track of 30° to 50° (fish bone pattern).
  - Another possibility is to fell the trees in parallel positions on the skid track, with the felling direction towards the end of the skid track or to the side of the skid track, away from the skidding direction.
  - The felling direction should avoid disturbance to buffer areas, watercourses and exclusion areas.

- Marking of felling directions

  The felling directions are marked in the field coinciding with the marking of the skid tracks. Tools necessary are a timber harvesting plan map (scale 1:2,000), compass, paint and brush.

6.1. Road Construction

Road construction should be finished before harvesting operations commence.

6.1.1. All Weather Roads

- All weather roads will be used for both major transportation of logs and by local communities and should be constructed with the main purpose of serving annual harvesting operations.
- All weather roads must be constructed to meet the following specifications:
  - Location

    All weather road should be located along the contour and upper side of ridges so that it will require minimum maintenance and long term low cost utilization could be achieved.
  - Road grade specifications:
    - maximum road grade should be no more than 10%;
    - maximum adverse grade should be no more than 8%; and
    - maximum length at maximum grade should be no more than 1,000 m.
  - Road width

    Maximum road width should be no more than 8 m and 10 m for gravel-tar and compacted clay surface respectively
  - Off-tracking road specifications:
    - Road curve for off-tracking trailers should be calculated with a flexible proportion of curve and curvature according to the length of vehicles which will be used in haulage units. The recommended values for off-tracking specifications are as follows.

Off-tracking on curves (meters vs radius of curvature) based on a vehicle with overall length of 14 m.

Radius	25	30	40	50	60	75	100	150	200
Off-tracking	1.65	1.20	0.95	0.80	0.70	0.55	0.40	0.35	0.20

6.1.2. Dry-Weather Roads

- Dry-weather roads should be constructed with the aim to be used during harvesting and by local communities for access during dry weather. They consist of seasonal and temporary feeder roads.

- All dry-weather roads must be constructed to meet the following specifications:

  - Location

    Dry-weather roads should be located between the main or all-weather road in the harvesting area. It should be maintained annually and repaired as needed.

  - Road grade specifications:
    - maximum road grade should be no more than 18%;
    - maximum adverse grade should be no more than 8%;
    - maximum length at maximum grade should be no more than 600 m.

  - Road width

    Maximum width should be no more than 6 m for all conditions.

  - Road off-tracking specifications:
    - Road off-tracking should comply with the all weather road specifications.
    - All-weather roads and dry weather roads should introduce specific curve and drainage construction specifications (see sub-chapter 6.2).

6.1.3. Skid Tracks

- Skid tracks will be used to skid the logs using elephants. Elephant skidding does not need the construction of paths or small roads. Foot paths and small lanes could be used as elephant skidding tracks.

- Skid track construction should be limited to hand-cutting of brush and trimming of stumps to ground level.

- The brush cuttings and wooden rollers should be placed onto the skidding path to reduce friction during skidding.

- Skid tracks should generally be as straight as possible, but curving is allowed when necessary to avoid wet or unstable soils and steep hillsides.

- Skid tracks should be angled across the slope rather than running straight up and down when slopes are steeper than 30% or 17°.

- Skid tracks should not be constructed on or near tight corners.

- Maximum skid track width should not be more than 3 m.

- Skid tracks should never cross streams or gullies, unless absolutely unavoidable.
- Maximum slope should not be more than 25-35% (14°-19°) when skidding downhill, or more than 10-15% (6°-9°) when skidding uphill.
- Undergrowth should be cut close to the ground and the path cleared of obstacles.
- Stumps in the path should be trimmed to ground level.
- Skid track rehabilitation:

  As soon as skid tracks are no longer required for harvesting, a proper drainage system using cross-drains should be installed to divert water away from the skid track.

- The distance between cross-drains should be decreased as:
  - gradient of the skid track increases;
  - soil erodibility increases;
  - during wet season harvesting; and
  - in areas of higher rainfall.

6.2. Curves and Drainage

- Curves

  Curves should be fitted according to the terrain and topographically favourable conditions. The minimum radius of the curve should be flexible to allow visibility and to reduce the risk factors for the speed of vehicle while travelling on the road.

- Drainage

  Regular drainage is essential for the upkeep and maintenance of all harvesting roads and tracks.

  - Road drains should be constructed as follows:
    - at changes of slope; and
    - within 50 m of watercourse crossings.
  - Additional drains should be constructed if necessary to meet the maximum spacing requirement.
  - Side drains adjacent to roads that have been box-cut should have rock bars at half the maximum drain spacing.

- Drain spacing (DS) should be designed to minimize sediment production and gully erosion. Maximum drain spacing is determined by the following formulae:

$$\text{Max. DS} = \frac{300}{\text{center line gradient (\%)}} \quad \text{(m)}$$

Center line gradient (%)	Max. drain spacing (m)
0-5	60
6-10	30
11-15	20
16-20	15

- Method of drainage
  - All harvesting roads should follow the suggestions given below to promote suitable road drainage patterns:
    - There should be side drainage for table drains (side drain grade is 1-3%).
    - The drains may require special treatment such as lining with stones, concrete, grass, etc. to reduce scouring, especially, in high water flow areas.
    - The catch drains should be constructed along the top sides of the cuttings to collect surface run-off to protect the surface soil layer from scouring, particularly on hydrological sensitive soils.
    - Table drains should be dish-shaped and constructed to a minimum depth of 30 cm below the level of the top of the formation at the outer edge of the shoulder.
    - Adequate provision should be made at culvert inlets and outlets to protect the soil and minimize soil erosion caused by the flow entering or discharging from the drain.
    - Adequate provision of swamps or silt traps should be made to prevent siltation and blocking of culverts on highly erodible soils.

- Drain out-flow
  - Drains should not be allowed to enter watercourses and should be diverted into surrounding vegetation at a minimum distance of 50 m from the watercourse.
  - Drains should have stable outlets and vegetative cover, rocks or log barriers as soil cover to protect erosion near or into fills.

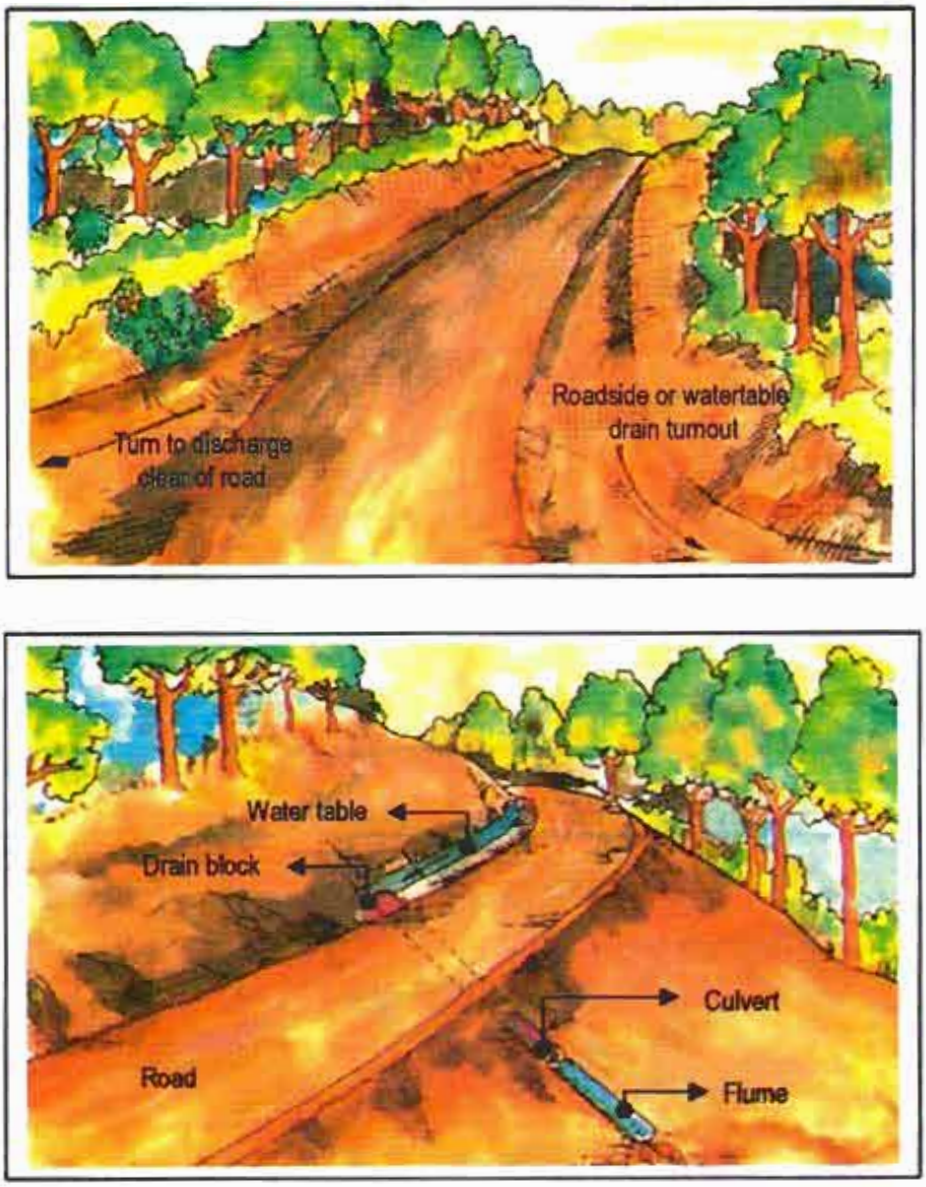


Figure 6-1. Road Location and Drainage

6.3. Watercourse Crossing

The most suitable type of watercourse crossing is constructed according to the pre-harvest plan and the common crossing types are bridges, culverts or pipes, fords, and other crossing structures. Silt traps are to be provided at the four corners of bridges and culverts.

- Bridges : are to be constructed for all-weather road (AWR) and dry-weather road (DWR) crossings of all mainstreams with a minimum approach width of 5 meters and a minimum water depth flow of 2 meters.
- Culverts or pipes : are to be used to save costs and working-time for construction and must be applicable in the field to easily cross small gullies and waterways.
- Fords : must be constructed with particular specifications and flexible structures for effective transportation.
- Others : must be used for short-term accessibility during harvesting periods depending on local weather conditions, facilities and availability of construction materials.
- Construction
  - Construct crossings in dry weather.
  - Use unmerchantable logs for the crossing where appropriate.
  - Abutments and approaches should be higher than the stream banks.
  - Coding of the approaches to the crossings may be required within 2 meters of the high bank.
  - Soil is not to be pushed:
    - past the high bank;
    - into water courses; or
    - onto the top of the crossings.
- Removal of temporary crossings
  - Crossings should be removed in dry weather
  - Crossing materials are to be placed more than 10 m away from high banks
  - Removal must not disturb watercourse banks.
- Limits to construction
  - Wet weather restrictions apply
  - Crossings should not be constructed during wet periods.

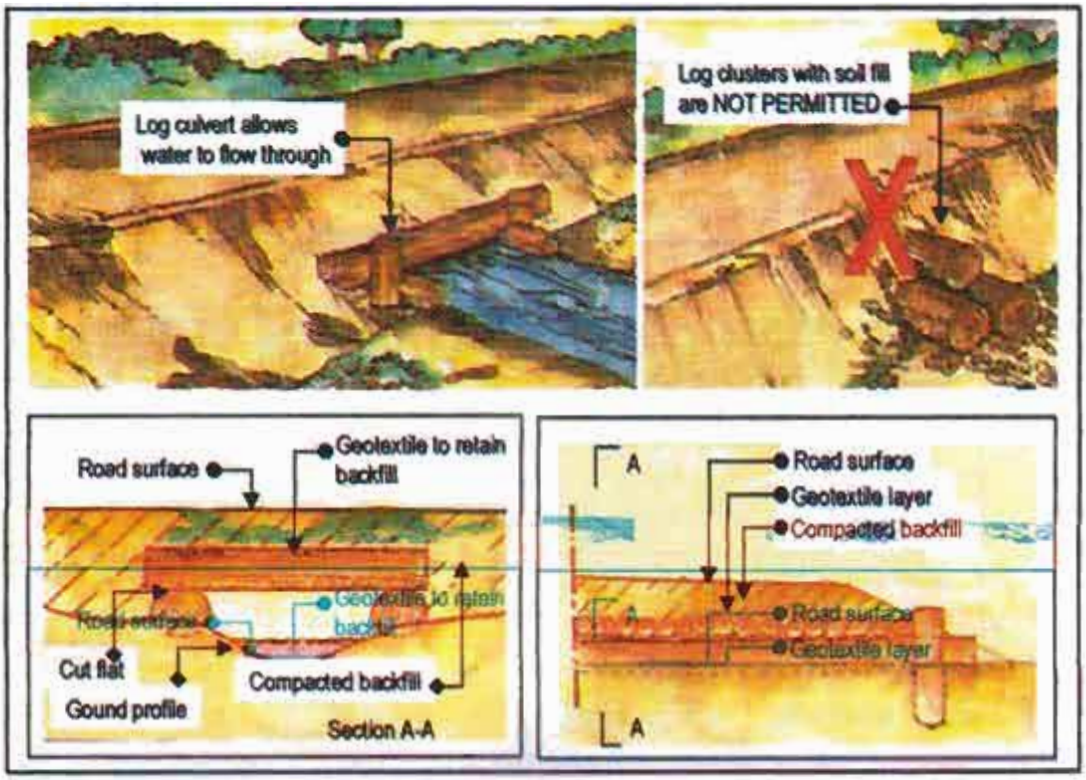


Figure 6-2. Watercourse Crossings with Log Culvert

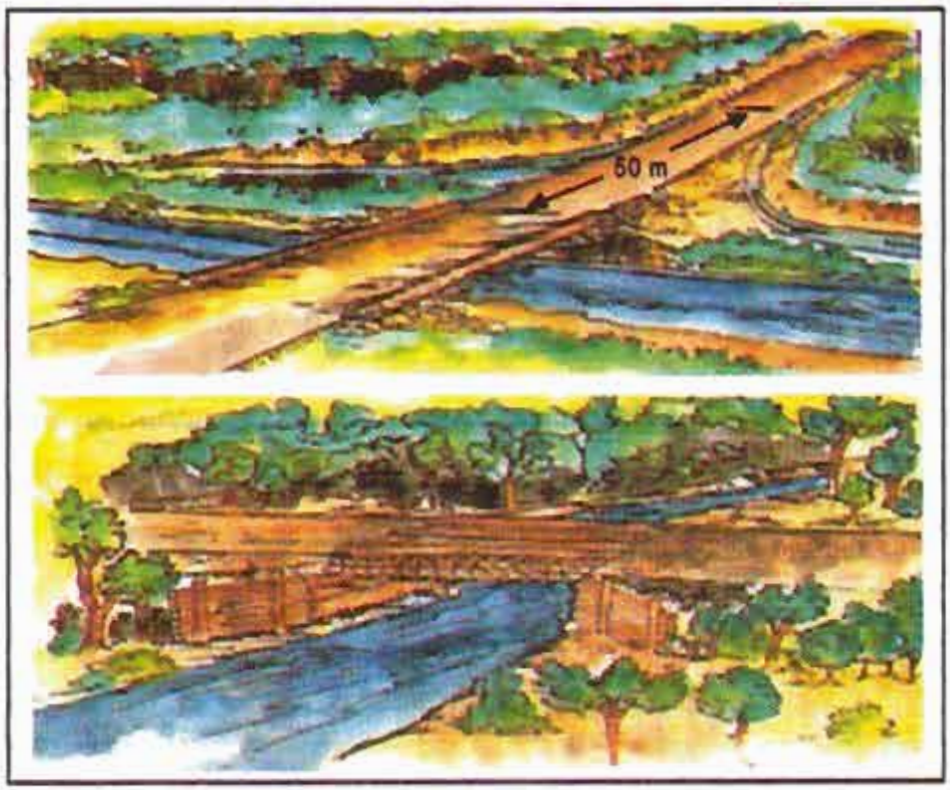


Figure 6-3 Watercourse Crossings with Timber Bridge

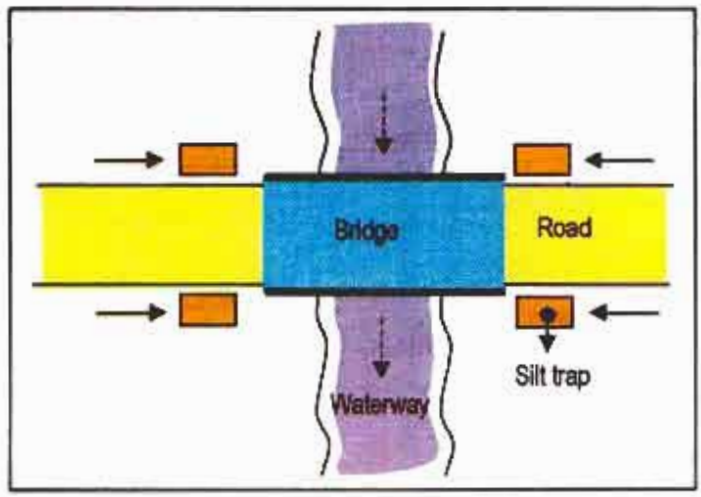


Figure 6-4. Silt Traps

6.4 Road Maintenance

- All drainage, pipes, culverts and bridges are to be kept open at all times.
- Inspections for road maintenance should be carried out thoroughly and repairs made as necessary before the onset of the wet season/monsoon and after every heavy rain.
- Removal of soil from the road surface, except during initial construction, is not permitted
- Road surface maintenance should be carried out as necessary and appropriate.
- The drainage pattern should be maintained to allow effective drainage for stable conditions of crossfall and road shape.
- Good surfacing gravel should not be pushed to the road edge or into drains.
- Necessary repairs to bridges, water crosses and culverts have to be done by replacing them as required and as best as possible.

6.5 Quarry Management

- Harvest all merchantable trees on the proposed quarry area;
- Drains are to be constructed around the up-hill side of the quarry to prevent run off entering the area. All drains are directed to runoff away from the quarry site to shed water to stable disposal areas.

- The base of the quarry is to be kept drained at all times. Drains must not enter directly into watercourses.
- Overburden is to be stockpiled for spreading in the quarry area when operations are completed. Run off should not be directed into ponds within the stockpile area.

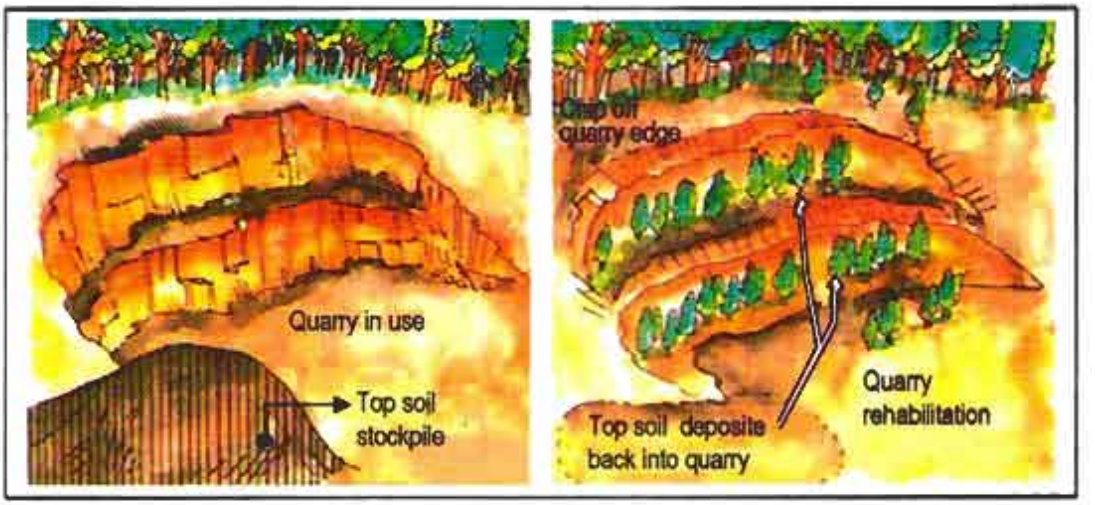


Figure 6-5. Quarry Management

7. HARVESTING OPERATIONS

Harvesting operations can commence when:

- the operational plan has been signed by the Forest Authority and MTE;
- tree girdling and tree marking have been completed;
- marking of skid track locations and felling directions of girdled and marked trees have been completed;
- all operators are familiar with the harvest area and have discussed the operational plan with forest supervisors; and
- each personnel knows his job thoroughly and is expected to work according to standards.

Felling operations should not be carried out under the following weather conditions:

- when wind velocity prevents accurate and safe directional felling;
- when ground conditions are too slippery to allow harvesting workers (fellers) to move safely and quickly away from falling trees; and
- skidding and road construction should not be done when the soil is still wet after rain.

Harvesting operations should be conducted according to the Harvesting Plan, which states that:

- Only girdled teak trees and other marked hardwood trees can be harvested.
- Timber harvesting should not exceed the maximum harvesting intensity and should leave a sufficient number of future trees.
- Damage to future trees and protected trees should be avoided as much as possible.

7.1. Felling

Trees are assessed according to the following procedures:

- Testing Soundness
  - Trees suspected of being unsound should be tested before felling by sounding with an axe. The purpose is to assess if the trees are marketable or not.

- Felling Direction
  - Felling directions must be as directed in the pre-harvest plan.
  - Minimize damage to standing trees left for the next cutting cycle, to the trees being felled, and to the trees already felled and lying on the ground.
  - Prevent felled trees from hanging-up.
  - Avoid disturbance to buffer areas, watercourses, and exclusion areas.
  - Use felling wedges to assist directional felling.

- Preparation
  - Make sure that there are no dead limbs or "hung-up" branches.
  - Cut climbers attached to the stem or trailing from the canopy.
  - Clear two alternative escape routes away from the tree to be felled.
  - Clear shrubs and saplings from the base of the tree to provide an adequate working space.
  - Ensure that escape routes are clear of obstructions.

- Felling
  - Felling is done manually with chainsaw, handsaw, axe, hammer and wedges.
  - Scarf and back-cuts must be made properly.
  - Retain the hinge wood.
  - Once started, the felling of a tree must be completed.

- Stump height
  - Stump height should be as low as practicable (< 15 cm is preferable) to maximize merchantable volume.
  - Stump heights over 15 cm are acceptable under the following conditions:
    - where butt defect is obvious and the tree can be cut immediately above this defect;
    - where a buttress exists (and it is not appropriate to trim) and the tree may be cut immediately above the buttress; or
    - to retain the Forest Department marking for felling on the stump. (Therefore, the FD's marking should be as low as possible).

- Limitations
  - Adverse weather restrictions apply.

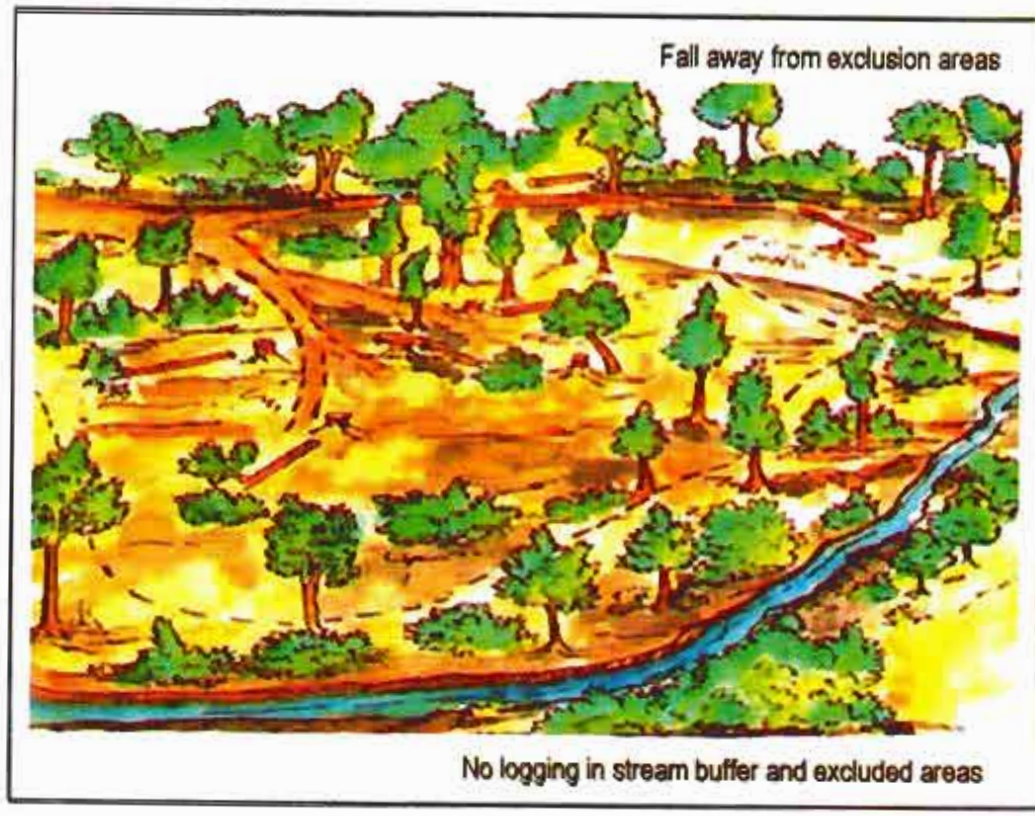


Figure 7-1. Directional Felling

7.2. Scaling and Bucking

- Scaling Practice for Teak Log
  - Teak log scaling must be carried out according to the Logging Rules and Standard for Jungle Rejection of teak log, adopted in 1936. The rules must be reviewed and updated as appropriate.
- Scaling Practice for Other Hardwoods
  - Scaling practice for other hardwoods may be changeable and specifications to meet local users' requirements must take precedence over scaling the logs of non-teak hardwoods.
  - Departmental Instruction No. 88 of MTE has already prescribed to scale the hardwood logs systematically, and this instruction must be followed. The instruction for scaling the hardwood logs must be reviewed and updated as appropriate.

- Bucking
  - Complete bucking must be done to prevent splitting when the log is moved during skidding.
  - Log nails or nails on logs-end must be used to control and avoid end splitting and hence, to help maintain quality.

7.3. Skidding

- Draught Animal Skidding
  - Maximum downhill slope of between 25% and 35% and maximum uphill slope of between 10% and 15% are recommended for elephant skidding.
  - Proper harnesses are essential to prevent injury to animals.
  - Skidding pans, sledges and sulkies should be used to increase skidding efficiency.
  - Adequate water, food and veterinary care must be provided for the animals.
  - Two elephants in tandem are required for dragging heavy logs which are too heavy for one single elephant.
  - The tusker must be ahead while dragging a log in tandem operation using two elephants.

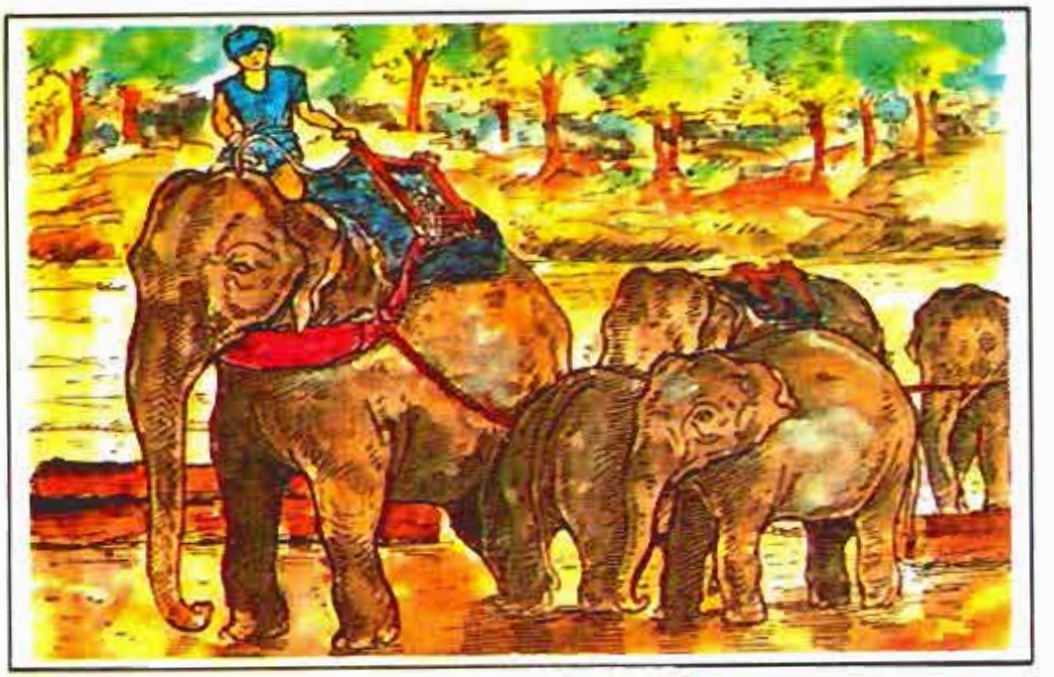


Figure 7-2. Elephant Skidding

- Mechanical Skidding
  - The maximum slope of skid tracks should be no more than 30% for rubber-tired skidders and crawler tractors and 50% for light floatation forwarders.
  - The skid track width should be no more than 4 m.
  - Skidding activities are not allowed during rain or on wet soil.
  - During their skidding activities, tractors are limited to moving along the skid tracks.
  - Tractor blades should be raised or removed when travelling and skidding.
  - Use winches to pull trees from stumps to skid tracks.
  - Lift the ends of logs off the ground, to avoid soil damage due to log drag. Logging arches will assist this action.
  - Avoid damage to soil and standing trees and regeneration along skid track edges. Sacrificial trees may be used to minimize damage.

7.4. Temporary Log Dumps and Log Landing

- Temporary Log Dumps
  - If skidding tracks are long, temporary log dumps are required to reduce prolonged dragging time by elephants to avoid overworking the animals.
  - After collecting up to about 10 logs, sulkies (gindate) should be used to drag the logs to the jungle depot according to topographic conditions as flexible as possible for elephants.
  - Logs which are at temporary log dumps should be carried to the jungle depots as soon as possible because leaving logs at temporary log dumps for extended periods could result in damage to the logs, caused by insects (white ants) and fungal attacks.
  - Wet soil may also cause deterioration of log quality.
- Log Landing
  - Log landings and dumpings are for the ease and flexibility of transportation to the notified depot.
  - Dump the logs in parallel arrangement and the distance should be a minimum of 1.65 m. The distance between logs should be 66 cm for proper measuring and marking on royalty purposes.

- In log landing and dumping, small poles and branches should be laid down between the logs which were dumped pole by pole and log by log on the ground.

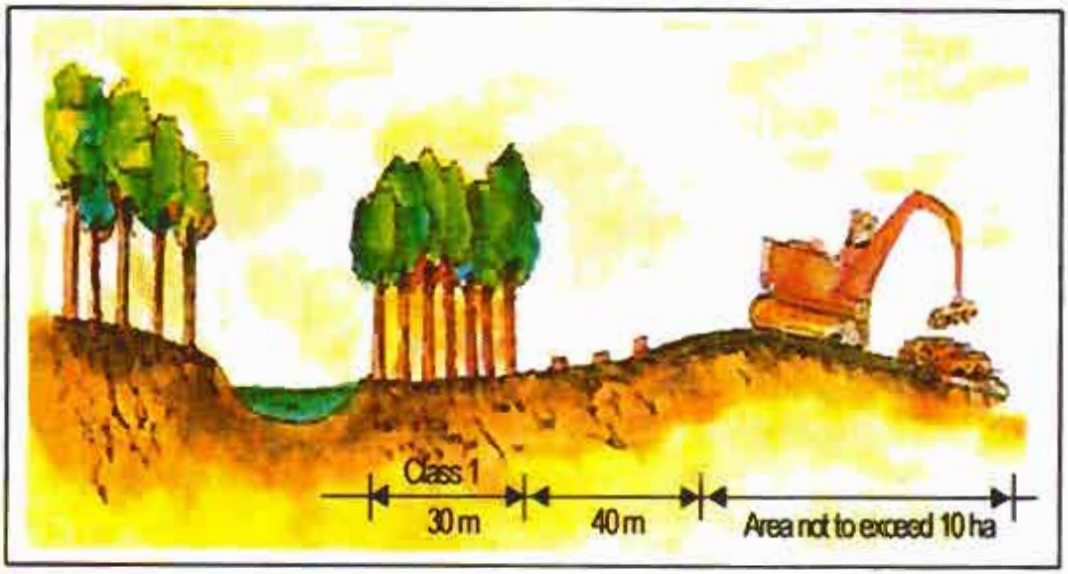


Figure 7-3. Log Landing

7.5. Loading and Unloading

- Trucking to Notified Depot
  - Loading and unloading of logs should be by loader where possible.
  - A trucking vehicle with reduced ground pressure and suitable for the harvesting area should be used so that impacts on the forest soil of harvesting coupes will be minimized.
  - The load should be checked regularly enroute.

- Loading
  - The allowable load-bearing capacity for trucks must be specified and followed.
  - Vertical side stanchions must be checked to ensure safe loading during trucking.
  - All loads are to be secured with at least two approved log binders.

- Unloading
  - Check that the side stanchions are secured before removing log binders.
  - All logs are to be unloaded by loaders or grapple excavators.

- All people other than the loader operator are to stay at least 20 meters from the truck during unloading.

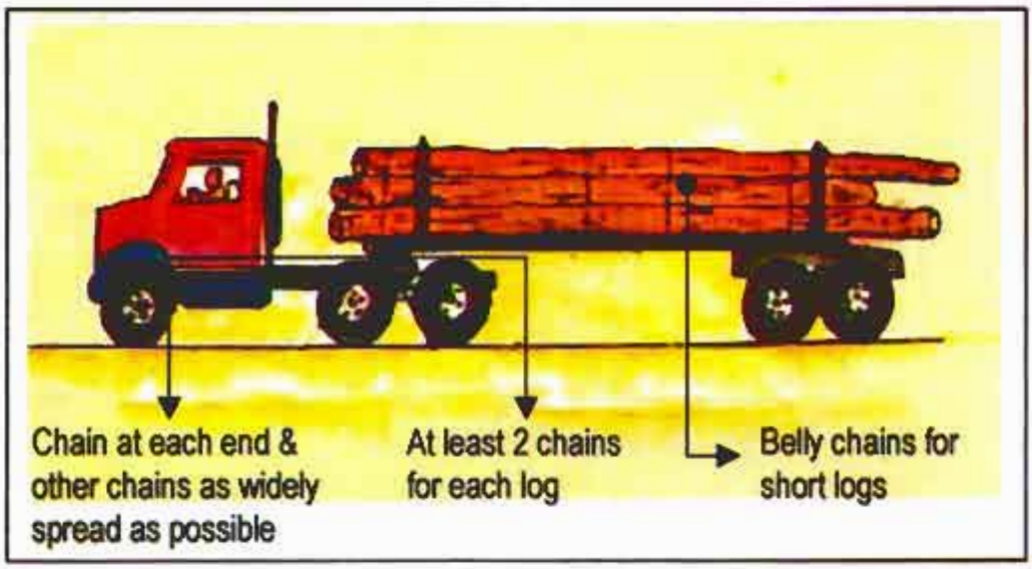


Figure 7-4. Truck Loading

7.6. Log Transportation

- Road Transport
  - Loaders should be used for loading and unloading logs where possible.
  - Trucking should be done within the limits of speed and maximum weight allowance for roads.
  - The load should be checked regularly enroute.

  Transportation of logs by trucks to depots is the most expensive means of operation, but it ensures quick arrival of logs to the depots.

- Railway Transport
  - Transporting logs by railway should be in line with Departmental Instruction No. 20, issued by Extraction Department of MTE.
  - The weight of the logs must be within the allowable load bearing capacity of wagons.
  - Vertical side stanchions must be checked to ensure safe loading.

  Although railway transportation is cheaper than road transport, it is more costly than water transport.

• Water Transport

- General descriptions

- The use of waterways for transportation should consider local water way conditions.
- If possible, transport sinker logs by barge to reduce excessive use of non-commercial buoyant species.
- Discarding log off-cut and barks in rivers must be avoided to protect waterbodies against possible pollution.

- Free floating

- Free floating is allowed only for dry teak logs from the feeder streams into the main river. Dry or girdled teak logs can be floated freely and easily, thanks to their buoyancy.
- Navigable streams used to float logs must be cleared off before the rainy season.
- Dry teak logs which are blocked by obstacles along the stream must be dragged back into the waterway by powerful elephants.

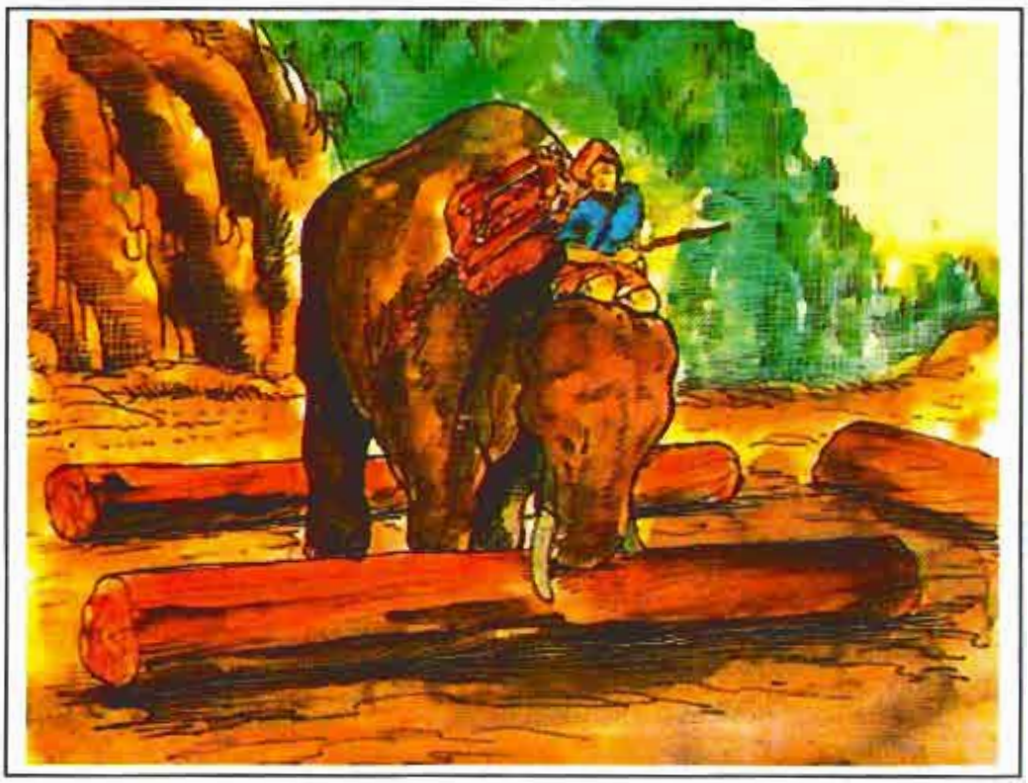


Figure 7-5. Dumping of Log for Free Floating

- Controlled floating

- Dry teak logs entering the main river from a feeder stream must be collected systematically and lashed into rafts without losing any.
- Rafting materials such as steel cables and spikes should be introduced in rafting practice to reduce the use of NWFPs as rafting materials.
- If hardwoods and non-girdled green teak logs are to be floated down, they should be rafted with floatable materials for secure rafting.
- Logs should be tied together securely into rafts to minimize loss and damage to other vessels by loose logs along the waterway.

Transportation of logs by waterway is cost-effective and the cheapest means, but the arrival of logs may be delayed due to weather conditions and other factors.

7.7. Preliminary Post-harvest Assessment by MTE

The post-harvest assessment should describe all activities at every level of the harvesting operation.

- Logged over area
  - Any hang-up tree should be removed.
  - Harvesting camps should be moved only after the site and its immediate surrounding are cleared of debris and all kinds of waste to avoid pollution.
  - Removal of all debris (bark and log ends) from the wharf and log landing areas must be carried out thoroughly.
  - The drainage pattern of the logged-over area must be left in good condition.

- Skid tracks and roads
  - To minimize erosion, care should be taken that skid tracks and roads do not impair the original soil structure.
  - All bridges and culverts including decking foundations and side walls must be checked to secure safety.
  - Any debris or fallen logs on the forest roads must be removed and cleared off. Local people can use these roads for their own transportation needs, and the roads can also serve as forest fire breaks if properly maintained.
  - Ruts should be smoothed out and the road surfaces should be re-dressed.
  - Surface grading and compaction must be done at road sections when deemed necessary.
  - Regrade the drain on the uphill side and make sure that runoff do not enter quarries or borrow areas, but are instead diverted to stable outlets.

- Watercourses and waterways
  - Harvesting debris that has entered buffer zones and/or designated watercourses should be removed.
  - Water must flow freely beneath the bridges.
  - Soil, vegetation or other materials which would obstruct the flow of road drains should be removed and cleared off.
  - Logs which remain in the waterways or streams after the rainy season must be removed.
  - Regular maintenance of the riverbanks to stabilize them after dumping and rafting near the riverbanks is required.

7.8. Harvest Completion

- After the harvesting periods, the responsible person from MTE must inspect the harvested area and submit a report known as the AJ Form for completion of harvesting operation, according to DI No. 19, and sent it to the FD and MTE Headquarters. This practice must be continued and enforced by modifying or updating the AJ Form as necessary.

7.9. Post-Harvest Assessment by FD and MTE

An inspection team jointly organized by both FD and MTE will undertake the following activities:

- Stump height inspection;
- Inspect whether any logs remain unextracted in the forest;
- Inspect whether logs at the dumping sites and depots are fire-protected;
- Inspect whether there has been any violation of the Standing Orders and Departmental Instructions.
- Inspect whether harvesting operations are being conducted according to the harvesting plan.

7.10. Social Factors

- MTE should provide social welfare facilities to the workers who are involved in the harvesting operations (such as schools for children, a dispensary, and cultural promotion).
- The following social welfare services are provided by MTE:
  - Yearly/monthly medical-check up for malarial infection, depending on the degree of infection.
  - Local-wise provision of dispensary, vaccine and first-aid medical care sets.

- Schools for children are an essential component.
- Readjustment for low-salary forest workers according to local tariffs/standards.
- Increased incentives/rewards.
- Improvement of health conditions of seasonal and permanent forest workers.

8. Machineries, Equipment Maintenance and Servicing

- All machineries and equipment are to be formed into three units to manage them easily and effectively. The three main units are as follows:

  (1) Mechanical extraction unit

  (2) Road construction unit

  (3) Timber haulage unit

  All units have extraction machines and equipment which need to be maintained with regular servicing according to procedures and work plan in the Departmental Instructions. Departmental Instruction No. 106 prescribes maintenance and servicing procedures and guidelines in detail for all machineries and equipment, including instructions.

- Mechanical extraction unit

  - Fuel or oil spillage to be avoided during transport.
  - All machineries and trucks must be maintained every day as indicated in the work plan. Daily servicing must be a regular practice.
  - Overall checking of all machineries, including trucks, must be carried out thoroughly step by step by the responsible staff.
  - All responsible maintenance and servicing staff must check on and report the need for essential parts and tools for extraction machineries and equipment on a regular basis.
  - The need for replacement of old parts should be noted and reported immediately.

- Road construction unit

  - The road construction unit consists of heavy machineries and equipment which are to be used for road construction and road maintenance.
  - All heavy machineries (tractor, grader, and taper) should be maintained at least once a week.

- Timber haulage unit

  Six hauling trucks make up one haulage unit, which is maintained and serviced regularly and systematically according to a certain schedule. While five hauling

trucks are being used in timber transportation, one hauling truck is being serviced.

- General maintenance of moving equipment
  - All equipment are to be washed thoroughly before being moved to a new operation area to prevent the spread of weeds, pests and diseases.
  - Fuel or oil spillage is to be avoided while moving into another area.
    - Heavy equipment must be maintained and serviced regularly.
    - All equipment must be maintained and serviced every day as indicated in the work plan.
  - Regular inspections must be carried out by the concerned authorities to ensure that individuals adhere to their responsibilities.
- Main fuel and oil storage
  - The main fuel and oil storage facilities must be located in well-drained areas that are:
    - at least 100 m away from any watercourse;
    - at least 100 m away from any village; and
    - located outside the areas excluded from harvesting.
  - Wet or swamp areas must not be selected as storage sites.

Figure 8-1 Fuel Storage

- Bunds (preferably concentrate mounds) with a capacity of twice the storage capacity must be provided around the storage.
- Fencing with fire-proof materials must be used to resist fire outbreaks around the fuel storage area.
- The persons responsible must check the main fuel and oil storage containers daily.
- Care should be taken to prevent spillage during refueling.
- All solid waste should be placed in a refuse pit and buried.

9. General Hygiene Standards of Working Environment

9.1. General Hygiene Standards

- Adverse environmental impacts from pollution caused by harvesting equipment and machineries must not be permitted to occur in the working environment.
- Debris and logging waste must be removed to a safe approved disposal area and must not be kept in forests which are accessible and important for watershed control.
- Water pollutants must not be allowed to accumulate and remain in the forests after the completion of the harvesting operation.
- All refuse introduced into the forest as a result of harvesting operations is to be removed from the forest. Used oil filters, empty grease gun cartriges, drums, spray paint tins, etc. shall be removed to a safe disposal area.

9.2. Camp Hygiene

9.2.1. Camp Design Plans

- Hygiene requirements for all camp design plans should be standardized according to the recognized and accepted norms.
- Annual harvesting plans must include comprehensive designs for sewage, water supply, waste water and rubbish disposal for new camp areas proposed for construction or expansion in one year.

9.2.2. Water Supply

- A source of safe and clean water should not be too far from the selected camp area so that clean water is adequate and easily available.
- During the rainy season, the collection of rain water could be done by using clean galvanised iron roofs or appropriate traditional roofs which are easily available from nearby.
- The prevention of mosquito breeding places has to be carried out properly by placing covers or lids on water containers or water-storage tanks.

- Bunds (preferably concentrate mounds) with a capacity of twice the storage capacity must be provided around the storage.
- Fencing with fire-proof materials must be used to resist fire outbreaks around the fuel storage area.
- The persons responsible must check the main fuel and oil storage containers daily.
- Care should be taken to prevent spillage during refueling.
- All solid waste should be placed in a refuse pit and buried.

9. General Hygiene and Environment

9.1. General Hygiene Standards

- Adverse environmental impacts from pollution caused by harvesting equipment and machineries must not be permitted to occur in the working environment.
- Debris and logging waste must be removed to a safe approved disposal area and must not be kept in forests which are accessible and important for watershed control.
- Water pollutants must not be allowed to accumulate and remain in the forests after the completion of the harvesting operation.
- All refuse introduced into the forest as a result of harvesting operations is to be removed from the forest. Used oil filters, empty grease gun cartriges, drums, spray paint tins, etc. shall be removed to a safe disposal area.

9.2. Camp Hygiene

9.2.1. Camp Design Plans

- Hygiene requirements for all camp design plans should be standardized according to the recognized and accepted norms.
- Annual harvesting plans must include comprehensive designs for sewage, water supply, waste water and rubbish disposal for new camp areas proposed for construction or expansion in one year.

9.2.2. Water Supply

- A source of safe and clean water should not be too far from the selected camp area so that clean water is adequate and easily available.
- During the rainy season, the collection of rain water could be done by using clean galvanised iron roofs or appropriate traditional roofs which are easily available from nearby.
- The prevention of mosquito breeding places has to be carried out properly by placing covers or lids on water containers or water-storage tanks.

9.2.3. Water Disposal and Sewage

- Pit toilets near water supply sources for camps are not allowed.
- Sewage disposal within 300 m from surface water bodies used for drinking water supply is not allowed.
- Sewage is not to be discharged in the following areas:
  - into the catchment area of drinking water supplies;
  - into the stream or watercourses;
  - near village communities.
- All drains are to be covered and maintained to facilitate regular flow of sewage drainage.
- Disposal areas must be located at more than 20 m from the nearest building.

9.2.4. Rubbish Disposal

- Rubbish disposal areas must be provided with safety measures and should be located:
  - on the upper parts of the slope where runoff cannot enter;
  - at least 300 m from any water body or watercourse;
  - at least 300 m from any source of water used by communities;
  - in pits which are above the water table.
- Discharged rubbish is to be covered with soil at least once a week.

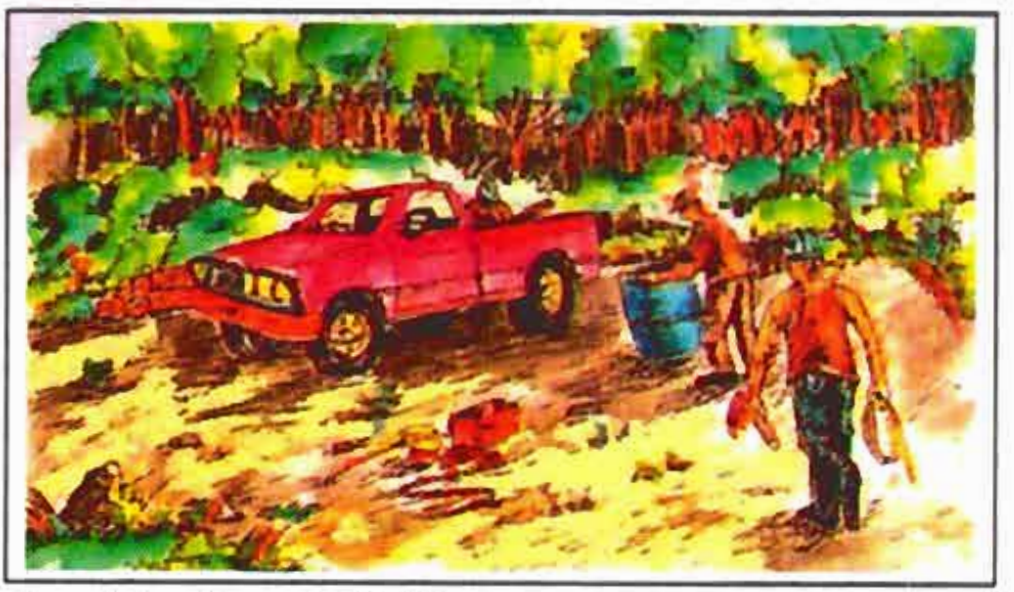


Figure 9-1 Removal of Debris

9.2.5. Water Ponding

Camp areas located in well drained areas will have no water ponding. But care must be taken to prevent mosquito breeding areas which may be created after heavy rains.

9.2.6. Vegetation Management

Vegetations around the camp must be well managed to promote healthy conditions and to reduce fire and malaria risks in infested areas.

10.1. Use of Chainsaw

- All chainsaws must be licensed by the Licensing Authority.
- All chainsaw operators (fellers) employed must be trained in the operation and maintenance of chainsaws. They must have a license or at least obtain the training certificate provided by FD and MTE before they are employed in tree felling.

All chainsaws should be equipped with:

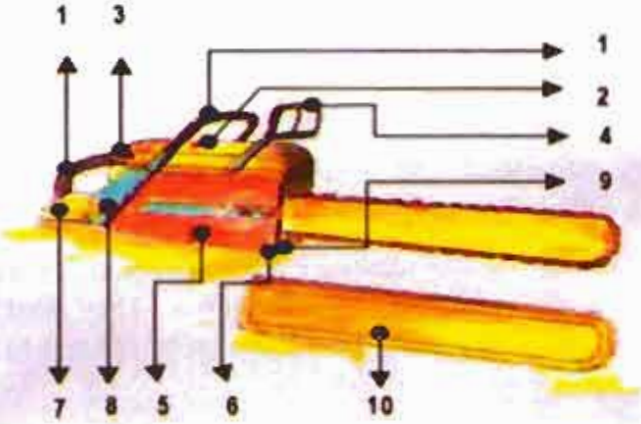
- an on-off switch;
- a safety throttle catch;
- an anti-vibration system;
- an exhaust system to direct CO_2 gas;
- a tool kit for corrective and preventive maintenance.

10.2. Use of Harvesting and Roading Equipment

- All heavy harvesting and roading equipment must be licensed by the Licensing Authority.
- All heavy harvesting and roading equipment operators must be trained in the operation and maintenance of their machines. They must have a license or at least obtain the training certificate provided by FD and MTE.
- Equipment should have:

– regular maintenance to achieve registered road;
– should not roll over protection structures;
– should have protection from falling objects;
– should have securely mounted seats and seat belts;
– rear of cab or frame should be fitted with protective wire mesh;
– should have reverse alarms;
– Suitable fire extinguisher firmly fixed and easily retrievable; and
– Exhaust system fitted with a spark arrestor.

- Parking must be stabilized on level ground if possible.
- When parking on slopes, apply parking break and lower logging blade.
- Ensure that the machine is in a stable situation before dismounting.
- Do not operate any machine controls except from the driving seat.



1. Handles for both hands wearing gloves
2. On/off switch
3. Throttle control lock-out
4. Front handle guard for protection of the left hand against the chain
5. Chain brake
6. Chain catcher
7. Rear handle guard for protection of the right hand
8. Anti-vibration system
9. Spiked bumper, which allows the weight of the saw to rest on the log securely during cross cutting
10. Chain guard

Figure 10-1. Safety Measures

- Ensure that while the parking break is being applied all gears are in neutral.
- Roll Over Protection Structure (ROPS) and Falling Object Protection Structure (FOPS) must be fitted as safety cab which must conform with international standards.
- The cab must have a safe and securely mounted seat and seat belt.
- The machine should be inspected daily for potential fire hazards and any necessary repairs should be made immediately.

10.3. Protective Clothing and Safety Equipment Requirements

The following protective clothing and equipment are required for personal safety:

- safety helmet;
- eye protection;
- ear defenders;
- leg protection;
- safety boots with steel toe caps;
- first aid kit;
- high visibility jacket (red or orange colour);
- gloves (when handling chemicals);
- respirators (when required); and
- fire extinguisher.

10.4. Measures to Minimize Risks of Injuries Facing Elephant's Pilots

- Do not abuse drug and alcohol to avoid unnecessary injuries while carrying out duties.
- Be prepared to take safeguard measures against elephants of bad character, particularly while they are being released, being taken back from the grazing ground, or while working implements are being put on.
- During the musth period, elephant bulls must be tied with big chain-links and kept in a well-shaded area and given food and water until the end of musth.
- No one should stay in front of an elephant when it is dragging logs.
- While logs are being dragged by elephants, do not stand at the lower side of the slope.
- Daily checks should be made to ensure that the dragging equipment is put on the elephant's body in a safe and correct position.

- When dragging practices are done by using chains and pulleys, no one should stand between the log and the tree that the chain is tied to, except the responsible persons.

10.5. Draught Animal Care

10.5.1. Workload and Working Conditions

- Skidding of teak logs: 100 to 180 tons/year/elephant.
- Skidding of other hardwoods: 100 to 240 tons/year/elephant.
- Skidding of all hardwood logs: 140 to 210 tons/year/elephant (on average).
- At no time should workloads exceed more than 10% of the above limits.
- Work for the day should stop about an hour before noon. The general rule is only 5 working days a week (about 160 to 180 days a year) with a break of two months for the animals to rest in hot weather (summer months).
- In principle, after every three working days, elephants must have one day of rest. Sunday and Wednesday are recommended if the pasture is not in the immediate surroundings, or two consecutive rest days must be given.
- Even in October, which is the working season, one-week rest should be given every year.
- Starting time for the day's work should be at early morning. Before leaving for work, elephants must be given a bath in a nearby stream. Only after the bath may the saddle and other skidding equipment be put on for work. Before putting on the equipment, the neck, chest and other body parts of the elephant that are in contact with the equipment must be greased with pig oil to prevent skin friction during the skidding of logs.
- After every 3 working hours, the elephants must be given rest for about half an hour.
- At the end of a day's work, saddle and skidding equipment must be removed, and the portion of the elephant's body on which the saddle has been placed should be pressed and squeezed with salt to relieve possible pain and stress.
- After the above treatment, the working elephants must be guided to the pasture and left to their own feeding, with their two forelegs chained.

- The trained timber elephants must be between 18 years and 60 years of age.
- Before becoming a timber elephant at the age of about 18 years, the calf must be trained starting from when it is 5-year old

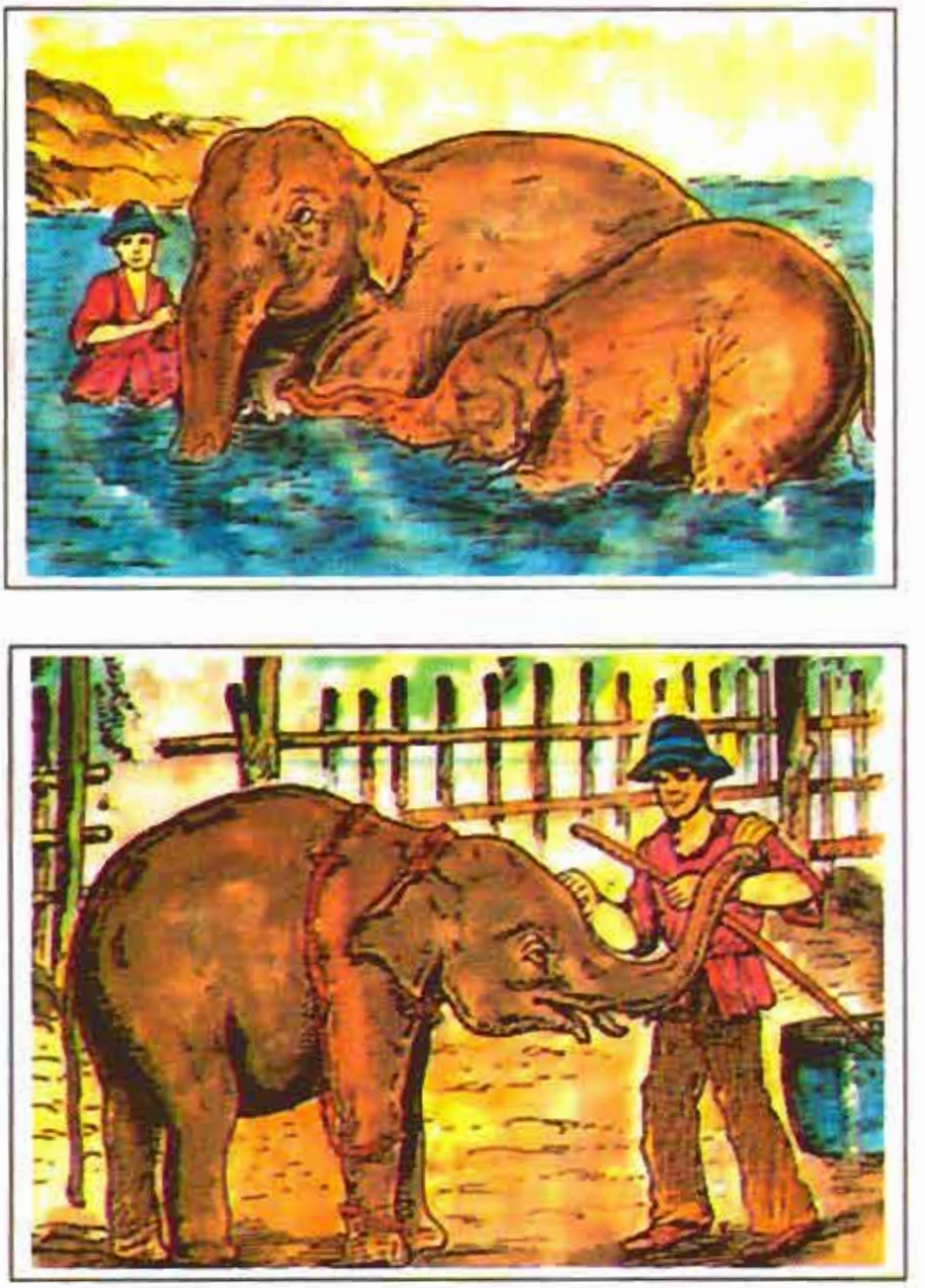


Figure 10-2. Elephant Care and Training

10.5.2. Medical Care

- Inoculation against anthrax
  - All elephants, except those unsuitable for inoculation, must be given treatment once every year during their rest period at the rest camp. Elephants considered to be unsuitable for inoculation include female elephants with 14-month's pregnancy, sick and/or injured animals, weak or tired animals, or females with calves at heel.
  - Before inoculation, elephants must be given rest for a minimum period of 5 days.
  - After inoculation, elephants must be given rest for about 14 days.
  - Inoculation must be done only by responsible veterinary assistants or by authorized officials.

- Inoculation against haemorrhagic septicaemia
  - Trace the symptoms of haemorrhagic septicaemia attacking the elephants.
  - Report to the Timber Extraction Agency managers concerned.
  - Inoculation must be done by veterinary assistants as necessary.
  - Report the progress to the managers concerned.

- Moving elephants to a new camp away from an infectious area

  If an elephant dies of an infectious disease, or if there is a possible outbreak of infectious disease from cattle of near-by villages, all the elephants must be moved to a new camp and should be watched without letting them work.

11.1. Protection of Logs Against Fire and Others

11.1.1. Legal Aspects

Departmental Instructions (DI) and legislation measures have been adopted to protect logs and harvested areas from fires that may be caused by humans and machineries. Summary of legislation, manual and instructions pertaining fire protection include the followings:

- Extraction Manual (1939) and revised in 1945;
- Departmental Instruction (DI) No. 77;
- Standing Order for Extraction Staff (1970);
- Forest Department Standing Order for Subordinates (1995); and
- Section 3(f), 40(f), 42(a), 43(a) of Forest Law (1992).

11.1.2. Operational Requirements

Fire protection plans must be drawn up with detailed prevention measures to protect logs against forest fires. Detailed instructions with operational scale are given as follows :

- Fire protection works must begin from about 15 January or 1 February, or as early as possible before the dry season, to prepare against forest fires;
- Fire watchers and safeguarding arrangements must be prepared in the log-yard area;
- Supervisors or responsible persons must inspect all of the activities of the fire protection system at least monthly during harvesting, or extraction time;
- Bushes, shrubs and flammable materials must be cleared off around the log-yard;
- The logs must be in parallel dumping and the distance between logs should be two feet at the measurement points. The logs must not be in contact with the ground in order to protect them from fungal and insect attacks;
- Fire-lines of at least 30 m width must be constructed around each log-yard; and
- Fire-watch towers must be constructed at each log-yard.

11.2. Protection of Machineries Against Fire

- Fuel tanks and fuel lines of extraction machines and logging trucks must be secured by using anchors and caps to avoid spilling of fuel or other flammable oil.
- The electrical system of machineries must be kept in good condition by using safeguarding equipment.
- Any flammable materials within 3 m from the machineries should be removed during fuel refilling time.
- Operators should inspect the machines after finishing the daily work, whether machines are in normal running condition or not.
- Chainsaws and machines to be used in harvesting operation should be fitted with fire covers and spark arrestors.

11.3. Protection of Work Environment Against Fire

- Fires for cooking or any other purposes shall only be set in an area which is cleared off flammable materials in the surroundings.
- All fires must be put out completely before leaving the harvesting area.
- No smoking is permitted within a forest during high fire danger periods, except on the roadways.
- It is strictly prohibited to keep kindling, carry any fires, or leave any fire burning which may be spread into surrounding forests.
- Fire protection and fire fighting equipment must be easily accessible for quick use to suppress fires.
- Local people in the surrounding area should be warned not to set or carry fires into the harvesting area.
- Public participation must be sought as much as possible in fire prevention and suppressing measures.
- Extension services and open dialogues with local people must be strengthened to raise awareness about fire prevention, protection and fire-fighting measures.

12. Monitoring and Evaluation of Forest Harvesting

Objectives:

- To ensure that the benefits of forest harvesting are twofold: i) harvesting the increment of the forest capital for sustained development with reduced impact on environmental stability; and ii) giving the best silvicultural treatment to the forest stands for improved health and growth conditions.
- To check and review compliance with the Code of Practice for Forest Harvesting.
- To check the effectiveness of procedures and practices mandated in the Code.
- Make amendments to the Code for increased effectiveness.
- To make improvements in future planning and implementation of harvesting operations.

12.1. Evaluation Procedures

- All evaluations will require ground inspections in addition to a review of reports and plans.
- Forestry authorities assigned by the FD and MTE for evaluation are to be accompanied by a representative of the logging company if it is subcontracted by MTE.
- Reports, maps and comments of the last inspection should be studied before doing the next evaluation.
- Occasional involvement of forest-related NGOs (e.g. FREDA) in the evaluation mission is encouraged.
- It is preferable to invite local communities to participate in monitoring and evaluating the impact of harvesting operations on watercourses. Together with local communities, evaluation should be made as to whether the presence of threat imposed by the working and grazing of timber elephants on human life and cultivated crops.
- Areas to be inspected and evaluated will include a representative sample of:
  - Current harvesting operations;
  - Areas completed since the last inspection;

- Areas that need to be completed to the required standard as per the instructions of the previous inspections; and
- Areas where actual implementation has not yet started, but have been designated for a specific activity.

- During the inspection, all areas of non-compliance with the Code or harvesting sub-contract are to be explained in detail to the harvesting (extraction) staff or private company.
- The responsible harvesting MTE staff and sub-contract owners are to be requested to sign the evaluation findings and comments and also to sign the work suspension order for necessary correction if it occurs.
- The workload and heath conditions of draught animals must be evaluated on-site at each inspection.

12.2. Distribution of Evaluation Reports

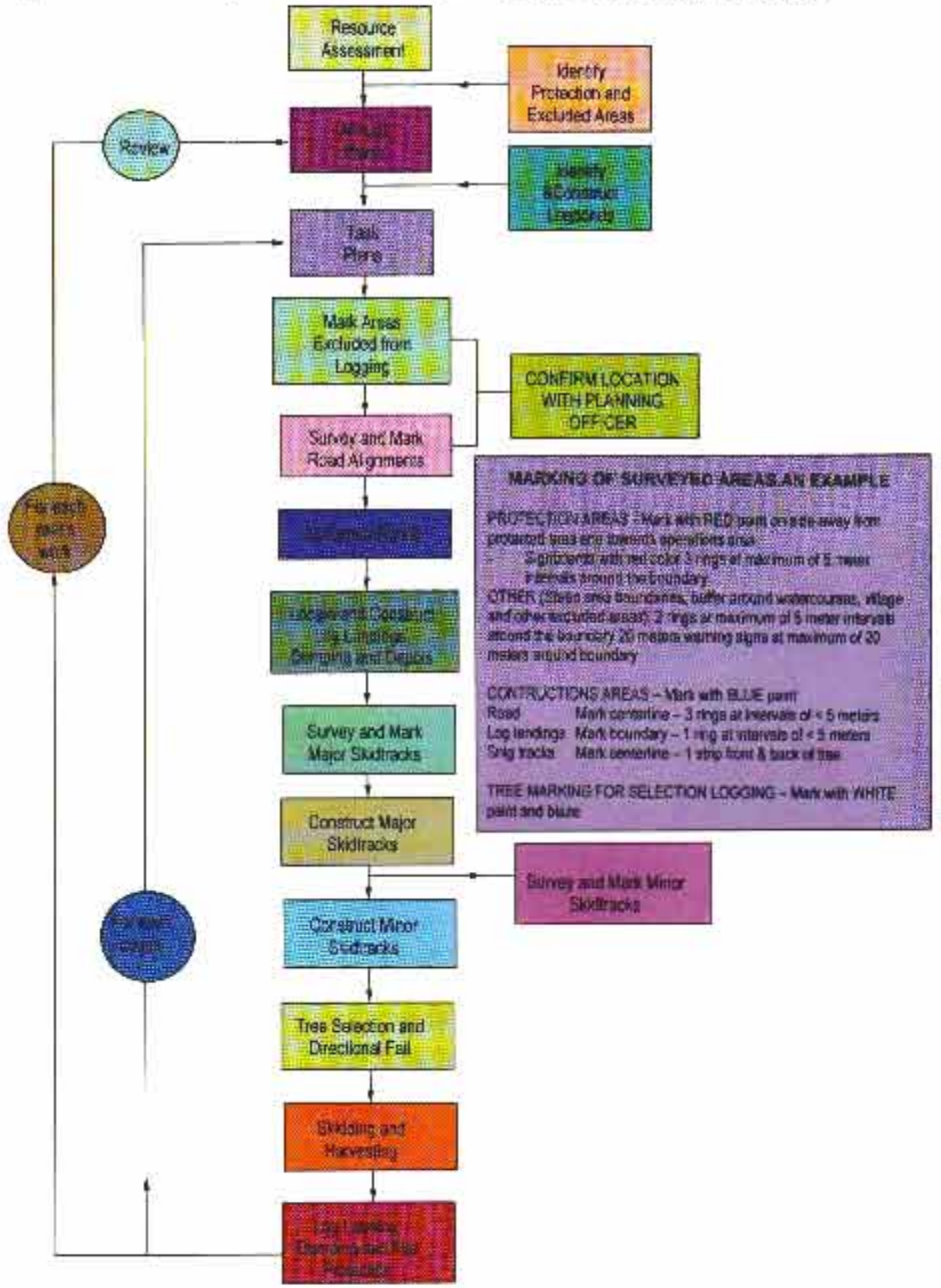
- Evaluation reports should be copied and sent to :
  - District Forest Office, FD and District Extraction Agency, MTE;
  - Head Offices whose representatives are involved in evaluation;
  - Divisional/State Forest Office, FD and Divisional/State Extraction Agency, MTE;
  - In charge of the harvesting area, Extraction Agency, MTE; and
  - Private timber concession manager, if any, on the basis of sub-contract agreement with MTE.

- Evaluation Officials
  - Forestry authorities from the FD and MTE should make a formal evaluation of the harvesting operations.
  - Loggers or forest concessionaries, i.e. MTE staff, should undertake on-site evaluations at any time in the course of harvesting to check on the performance of operations and whether they are in compliance with the Code or not.

- Timing of Evaluations
  - Evaluation at each inspection.
  - Maximum time interval between two consecutive evaluations should not be more than 3 months. Monthly inspection is preferable.
  - For construction works, evaluation should be undertaken before the actual construction is started.

- Penalties
  - If the evaluation results in suspension of operations, a further evaluation will be carried out to confirm that all the work is completed to the required standard before the suspension will be lifted.
  - If it is not sufficient, the FD should take action in line with the Forest Law 1992, and MTE should take action according to the Forest Harvesting Agreements with the Forest Harvesting Contractors.

Figure 12-1. An Example of the Order of Operations in Well Planned Harvesting



13. Possible Future Harvesting Systems and Other Matters

13.1. Helicopter Logging

Helicopter logging is one of the timber harvesting systems that could become common practice in the near future. Logs are extracted vertically from stumps and flown to a road side landing or drop zone, causing only small damage to either residual stands, forest floor, surface soil or water courses.

Commercial helicopter logging has been carried out for many years in the Pacific forests of Canada and Northwest USA and elsewhere. In tropical forests, on of the first attempts at helicopter logging was made in Sarawak, Malaysia in April 1993. With increasing pressure from environmental activists and when consumers are ready to pay green premium, helicopter logging may become an attractive harvesting system in the near future.

- Advantages of Helicopter Logging
  - Ground-based logging practices tend to be concentrated in relatively accessible forest, leaving areas with difficult terrain for work with draught animals and tractors unharvested. In contrast, helicopter logging can extract logs from virtually any site in the area.
  - Helicopter logging can be operated in all weather conditions except for turbulent winds or if there is poor visibility due to fog or mist.
  - Reduced damage to the residual stands, lower road density, careful cutting of trees and reduced exposure of surface soil, all encourage environmental conservation.
  - Factors such as a high production rate (about 13-15 times the timber volume per day than by conventional tractor), and reduced time between felling and delivery at roadside landing, minimized timber quality deterioration and timber loss, may attract higher prices due to freshness
- Disadvantages of Helicopter Logging
  - The potential for designating remote pristine forests as nature reserves could be at risk due to extensive intervention.
  - Tree removed from hydrologically sensitive and steep slopes may serve as a point source and trigger soil and water erosion.
  - Extraction cost per unit volume is high, capital investment is intensive, less timber per unit area is extracted, employment opportunity for local

people is limited, and more logging waste occurs due to increased rejected logs which are disqualified for helicopter logging.

- It is difficult to carry out monitoring activities and silvicultural treatments in small gap sizes which result from helicopter logging in difficult terrains.
- Any mechanical breakdown can be associated with a discontinuity of production and can also result in loss of human life.

13.2. Cable Logging System

The primary goals of cable logging are to minimize soil erosion, damage to residual stands and soil compaction, and also to reduce harvesting costs on steep slopes. Careful planning, understanding of the right techniques and the use of appropriate equipment are essential for successful implementation of the cable logging system. Accurate topographic maps are an essential requirement for efficient cable planning, while road engineering, designing and correct location of roads are also another major undertaking.

Minimizing the roading cost is also one of the primary goals in implementing cable logging. Skyline systems, including both single-span and multispan configurations, are the only types of cable systems that are generally applied in selection harvesting. Skyline systems reduce the density of haul roads and the impact of harvesting on the soil is, therefore, much reduced. While a cable logging system could be used in steep areas, it could also be used in wetland and swamp areas, as well.

13.3. Harvesting of Plantation Forests

Plantation forests provide two types of yields, i.e. an intermediate yield at the time of thinning operations and a final yield from clear cutting at the end of a predetermined rotation.

In extracting thinning poles and posts, extreme care should be taken not to damage left trees which are of better growth. It is possible to use buffaloes as draught animals because of the small-size timbers and thus lessen soil compaction and reduce damage to the existing undergrowth. Directional felling is an important element in order to facilitate the extraction of thinning products, and to avoid damage to left trees.

At the time of final harvest, all the remaining planted trees are usually cut and extracted. Strip-wise felling is recommended to avoid over-lapping of felled trees and to make extraction systematic and easy. Log landings should be large-enough and well-drained to accommodate a large number of logs and able to endure the repeated pressure exerted by trucks and loading machines.

13.4. Harvesting of Trees from Home Gardens and Other Non-forest Areas

Trees grown on home gardens and other non-forest areas are used for a number of purposes, e.g. food, spices, medicines and other agricultural products, fire wood, house posts, or timber for sawmilling. They also serve as wind-breaks or shelter-belts for agricultural crops and as natural habitats or nesting places for wildlife species. In effect, trees from both home gardens and other non-forest areas are part of the traditional living environment in Myanmar.

Tree species such as mango, tamarind, coconut, cashew, durian, jackfruit, etc. belong to agriculture and are common in home gardens, and they all finally end up as wood either in the form of fuelwood or sawn timber. Rubber trees are an important agricultural crop, but their final product as timber is also an excellent commodity in the timber trade. Planting of these trees appears to be expanding, depending on land availability and various social and economic forces.

In the past, felling was done only at the time when their physiological functions became least active. Most of the timber is used as fuelwood. Recently, the utilization trend has changed towards the production of sawn timber and the felling of these trees seems to have accelerated due to increase in timber demand. Accordingly, it has become necessary to pay more attention and make sure that the felling or harvesting of the trees from home gardens and non-forest areas is sustainable and systematic.

Concerned with the harvesting of trees from home gardens and non-forest areas, following recommendations are made:

- MTE can provide equipment and advice for directional felling of trees;
- Institutional support should be made available upon request for transporting the logs obtained from the felled trees to the sawmills;
- Coppicing should be made if felled trees have the coppicing power;
- Technical advice should be provided to enhance the physiological functions of the trees before they are felled;
- Extension services should be made available to raise awareness about the value of trees for the nesting of birds, honey bees, etc. before being felled;
- Healthy plus trees should not be harvested but should be kept for future production of quality seeds.

AAC
Annual allowable cut. The volume of timber that may be harvested from a particular area of forest in any one year.

Advantage regeneration
Small trees (seedlings and saplings) that are already present in the forest.

All-Weather Road (AWR)
An All Weather Road (AWR) is a main road that can carry trucks loaded with large log volumes not only in the dry season, but also in other seasons without any difficulties.

Buffer zone
An area of forest, usually around settlements, streams, lakes, park, major highways or other protected areas from which all harvesting equipment and operations are excluded. Also called filter strips.

Cable
A flexible steel rope made up of numerous wire stands that are twisted helically together around a core of wire, wire rope, fiber, plastic or other material.

Cable yarding system
Any of a variety of terrain transport systems in which suspended cables are used to convey logs to a landing.

Cableway
The pathway along which logs are yarded with a cable yarding system. Also referred to as the cable corridor or skyline corridor.

Cable logging
Any haul system using a machine with powered drums, spars, blocks, wire ropes and buttrigging to haul logs from the felling site to the landing. Also called a cable yarding system.

Camber
The amount of crossfall on a road.

Catch drain
A drain constructed above a batter to prevent erosion of the batter by surface water.

Catchment
The area which yields run-off water to a given point.

Canopy
The part of the forest formed by the crowns of the dominant trees.

Clear felling
Felling and removal of all or nearly all commercial trees, and the trees in the size classes immediately below the merchantable category which provide the net harvest, from a specific area in one operation.

Conservation area
Area protected from harvesting by national legislation.

Corduroy
Laying of suitable logs, bark or vegetation on the soil to separate machine wheels or tracks from direct soil contact.

Designated watercourses
Those watercourses that are required to be marked on harvesting plans. They include all classes of streams and gullies where vegetation buffers are to be marked and retained.

Directional felling
Felling a tree in a particular direction.

Dominants
Trees which crowns are in or above the forest canopy.

Drilling
Inserting a vertical cut into the stem with a chainsaw to determine the presence of internal defects. Defects are indicated by discoloured saw dust or soft wood.

Dry-Weather Road (DWR)
A Dry Weather Road (DWR) is a seasonal transportation road that can carry trucks with moderate log volume (as a guide between 1,000 and 2,500 m^3 per week averaged over the time that they are in operation).

Endangered species
Flora and fauna species in danger of extinction.

Enrichment planting
Planting trees within a partial forest canopy to increase the representation of the selected species in the forest.

Environmental sensitivity
Classification of the importance of a particular area of land or forest to degradation.

Exclusion area
Area which is excluded from harvesting.

Felling cycle
In a selection felling system; the planned, recurring number of years between successive harvests on a specific, physical area of land.

Feeder road
A road connecting landings to a main road.

Felling jack
Tool inserted into the backcut during the felling to provide leverage to force the tree to fall in a particular direction.

Flume
An open channel or conduit of timber, concrete, metal or flexible material such as plastic to carry water across unstable areas.

Formation width
The width of a road, excluding batters.

Geographic Information System
A computerised mapping system and data base to store information which can be retrieved as required.

Guard log
Log placed along the outside of a bridge, above the main stringer logs, to prevent gravel from falling from the bridge into a watercourse.

Gully
Gullies are steep-sided channels. The slope of at least one bank exceeds 15°. Depth of the bank adjacent to the bed may be 30 cm or more. Vegetation may be growing in the gully bed. Water will flow for less than 2 months in most years.

Habitat tree
Tree used primarily for animal dwellings.

Harvesting
The aggregation of all operations, including pre-harvest planning, post-harvest assessment, related to the felling of trees and the extraction of their stems or other usable parts from the forest for subsequent processing into industrial products. Also called timber harvesting.

Harvesting contract
Legal agreement negotiated between landowner (state, private or customary) and harvesting companies for the harvesting of forests.

Harvesting debris
Broken logs, branches, vines or other tree material created as a result of felling and skidding.

Harvesting supervisor
Company officer responsible for the management of harvesting operations in the field.

Head wall
A retaining wall at the inlet end of a culvert.

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

Landing
Area where logs area stored prior to transport to the log pond or log yard.

Log cluster
Group of three or more logs placed in triangular fashion to act as a culvert.

Main road
A permanent or semi-permanent road carrying large volumes of timber.

Management information system
A computerised system involving GIS used for the management of a forest enterprise.

Operational plan
Plan providing precise details of harvesting proposals, including location of roads, landings and skid tracks. Operational plans usually cover relatively small areas.

Outlet wall
Retaining wall placed at the outlet of a culvert.

Out-slope
Sloping surface of a track to shed water to the down hill side.

Permanent road
A road which will be maintained after harvesting is finished.

Production forests
Forests which are being managed for the production of wood and other products on a sustainable basis.

Protected forests
Forest areas which are excluded from harvesting for any reason.

Regenerating forests
Forests which have been disturbed and altered from their natural state but are growing back to that natural state.

Regeneration
Seedling of tree species.

Road crown
Shape of a landing, road or track so that the center is higher than the outsides, allowing water to drain to the sides.

Road off-tracking
When the rear wheels of a logging truck wander off the road (track) on sharp curves

Rotation
The planned number of years between the formation or regeneration of a crop of trees and the time when the same crop is felled for final harvest.

Saddle
A low point on a ridge or spur.

Scarf
Two cuts to remove a wedge usually made to assist directional felling.

Selection harvesting
A harvesting system in which crop trees are removed based on cycle felling entries that occur more frequently than one rotation, based on cutting limits or other criteria.

Shifting cultivation
A method of cultivation in which a forest area is cleared of trees, burned to release mineral nutrients, farmed for a few years until the soil becomes too poor to sustain crops, and then abandoned.

Shoreline
Limit of high tide, limit of mangrove growth.

Side cast
Pushing material to the side, usually during road or track construction.

Side drain
Drain which diverts water from a table drain.

Sight distance
The distance along a road or track that a driver can see other objects (usually other vehicles)

Silt trap
Hole dug to catch sediment in run-off water flowing drains. Logs or rock bars may also be used.

Skidding
Pulling of logs from the felling point to a landing.

Skid track
Track along which a log is pulled by tractor or other means.

Strategic plan
Long term plan which provides a broad description and broad details of future harvesting and forest management plans. More than one strategic plan can be used to allow planning across a range of time periods.

Stream
A stream is watercourse where water may flow for more than 2 months in most years. The beals are generally characterised by the presence of clean, water-washed stone, gravel or exposed bedrock materials.

Class 1 stream : width of the stream base is more than 20 m
Class 2 stream : width of the stream base is 10 to 20 m
Class 3 stream : width of the stream base is less than 10 m

Susceptibility class
Land classification of susceptibility to degradation

Sustainable forest management
The process of managing permanent forest land to achieve one or more clearly specified objectives of management with regard to the production of a continuous flow of desired forest products and services without undue reduction in its inherent values and future productivity and without undesirable effect on the physical and social aspects.

Swamp
Surface water present for at least 6 months of the year.

Table drain
The drain parallel to and at the side of a road.

Temporary crossing
A watercourse crossing which will be removed after harvesting.

Tree crown
Leaves and branches which will be removed after harvesting.

Understorey
The part of the forest vegetation growing below the forest canopy.

V-drain
V shape table drain.

Verge
The part of the road construction which is continuous and flush with the pavement on either side. It is generally only used by passing vehicles but may be used for travel by track machines.

Water body
Surface water area such as a lake, lagoon or ocean.

Water course
Defined line that receives and conducts a concentrated overland flow for some period in most years. Flows may be permanent or periodic. A water course could be a stream, gully, or a water way. Class categories are defined in terms of permanency of flow, bed material, bed width and side slope.

Wedge
A high impact plastic or aluminium (or even hardwood) wedge driven into the back cut to assist directional felling.

Winch rope
Flexible wire rope used to winch logs towards the skidding tractor.

Wing wall
Side walls provided at a culvert or bridge to retain fill material.

Asia Pacific Forestry Commission, 1997. *Code of Practice for Forest Harvesting in Asia-Pacific*. Asia-Pacific Forestry Commission. 113p.

Department of Forests of Vanuatu and AusAID, 1995. *Code of Logging Practice for Vanuatu*. The Vanuatu Sustainable Forest Utilization Project. 75p.

Dykstra, D.P. and R. Heinrich, 1996. *FAO Model Code of Forest Harvesting Practice*. FAO, Rome. 85p.

Elias. 1999. *Reduced Impact Timber Harvesting in the Indonesian Selective Cutting and Planting System*. Bogor Agricultural University Press, Bogor. Indonesia. 76p.

Food and Agriculture Organization. 1994. *Putting UNCED to work in forestry*. Food and Agriculture Organization of the United Nations, Rome, Italy. 73p.

Forest Department. 1950. *Standing Orders for Subordinate Staff. Forest Department*. Forest Department, Ministry of Forestry, Myanmar.

Forest Department. 1997. *Country Report-Union of Myanma*. Asia-Pacific Forestry Sector Outlook Study. Working Paper No. APFSOS/WP/08. 35p.

Forest Department, 1999. *Forestry in Myanmar*. Forest Department, Ministry of Forestry, Myanmar. 19p.

Gale, Toke, 1974. Burmese Timber Elephants. Trade Corporation, Yangon.

Hlaing, C., 1998. *Status of Forest Land Allocation and Land Tenure Arrangements as well as Management of Resources Base in Myanmar*. Forest Department, Ministry of Forestry, Myanmar. 33p.

International Tropical Timber Organization, 1992. *ITTO guidelines for the sustainable management of natural tropical forests*. ITTO Policy Development Series 1. International Tropical Timber Organization. 18p.

Lair, Richard. C., 1997. *GONE ASTRAY: The Care and Management of the Asia Elephant in Domesticity*. FAO RAP Publication 1997/16. Bangkok. 300p.

Ministry of Forestry of Solomon Islands, 1996. *Code of Practice for Timber Harvesting*. Environment and Conservation, Ministry of Forestry of Solomon Islands. 80p.

Ministry of Forests of FIJI, 1990. *Fiji National Code of Logging Practice; Protect Your Forests*. Ministry of Forests, Suva-Fiji Islands. 58p.

Myanma Timber Enterprise, 1985. *Departmental Instructions*. Myanma Timber Enterprise, Ministry of Forestry, Myanmar. 435p.

Back Cover (Outside):
A Waterfall in the Natural Forest

A Giant Teak Tree in Myanma