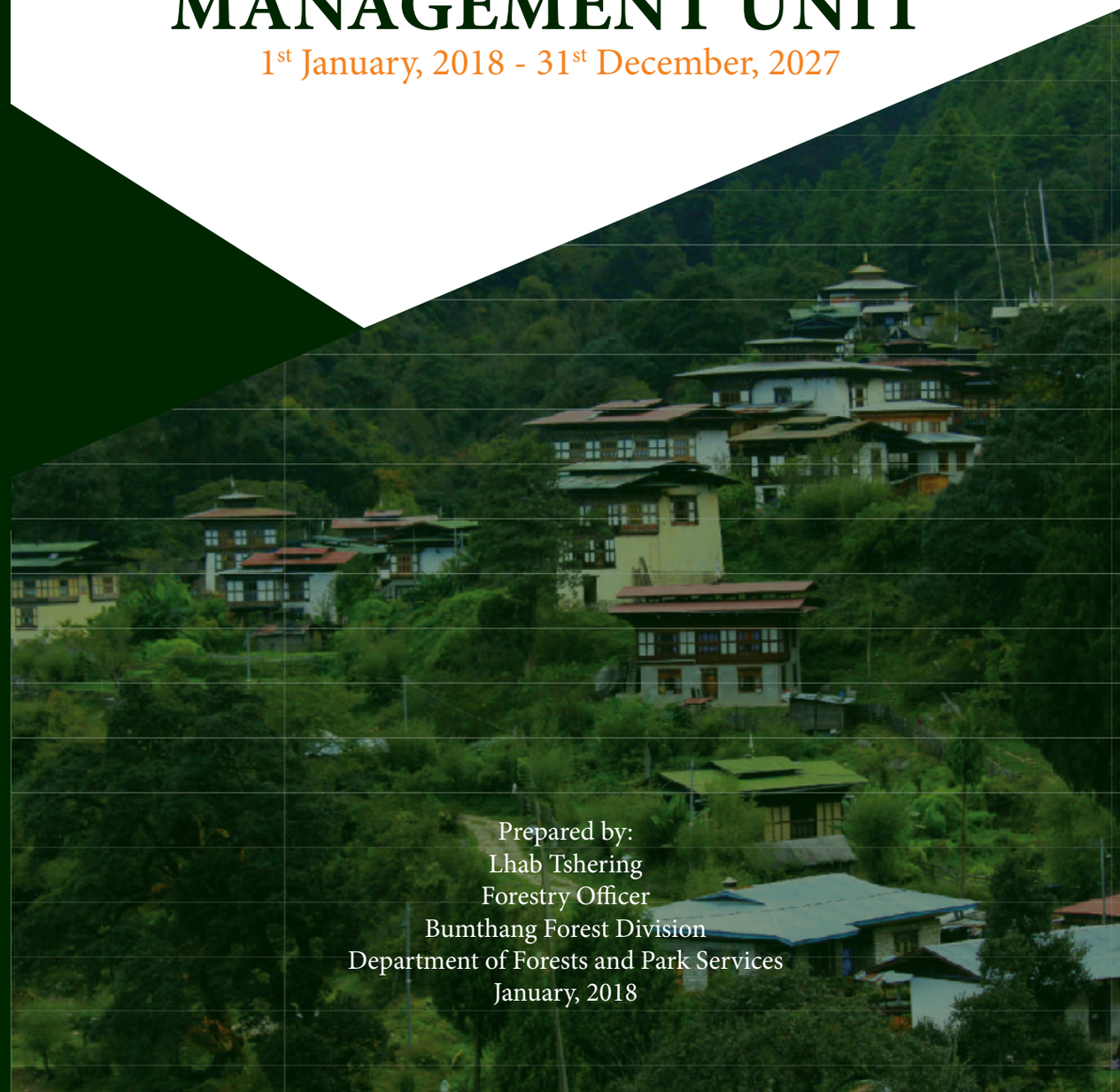
FOREST MANAGEMENT PLAN FOR CHENDEBJI FOREST MANAGEMENT UNIT

1st January, 2018 - 31st December, 2027



Prepared by:
Lhab Tshering
Forestry Officer
Bumthang Forest Division
Department of Forests and Park Services

January, 2018

Forest Management Plan
for
Chendebji Forest Management Unit

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AUTHORITY FOR PREPARATION, REVISION AND APPROVAL

PERIOD OF THE PLAN

This Plan is valid for the period of 10 years from 1st January, 2018 – 31st December, 2027.

AUTHORITY FOR PREPARATION, REVIEW AND APPROVAL

The authority for preparation of this Plan was given to the Divisional Forest Office (DFO), Bumthang, Department of Forests and Park Services (DoFPS), Ministry of Agriculture and Forests, Royal Government of Bhutan.

PROVISION FOR REVISIONS AND CHANGES

This Plan may be revised during the period when it is in effect. The Director, DoFPS has the authority to revise and approve Plan if major changes occur in the Forest Management Unit (FMU), or if new information becomes available that may have significant bearing on the implementation of the Plan. The CFO, Bumthang may be requested to prepare revisions and changes to the Plan for submission to the Director, DoFPS.

APPROVAL

This Plan was examined by a wide section of user groups, clients and organizations. The final version of the Plan was reviewed and technically cleared by the Head, FRMD and an environmental clearance was obtained from National Environment Commission Secretariat. It was then submitted to the Director, DoFPS, who, after further review and amendments, forwarded with his recommendation for approval to the Secretary, MoAF. The Secretary, MoAF, further reviewed and submitted the Plan to the Minister, MoAF for his approval for implementation.

Submitted for Approval:

Chief Forestry Officer,
Forest Resources Management Division,

Recommended for Approval:

Director
Department of Forests and Park Services

Recommended for Approval:

Secretary
Ministry of Agriculture and Forests

APPROVED

Hon'ble Minister
Ministry of Agriculture and Forests
Date:.....26/03/18

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དཔལ་ལྡན་འབྲུག་གཞུང་།
National Environment Commission
Royal Government of Bhutan

NECS/EACD/Dzo-Trongsa/3581/2018/6 (1 May 31, 2018

ENVIRONMENTAL CLEARANCE

In accordance with Section 34.1 of the Environmental Assessment Act 2000 this Environmental Clearance (EC) is hereby issued to Forest Resources Management Division (FRMD), Department of Forests and Park Services for the operation and management of Chendebji Forest Management Unit (FMU) measuring an area of 7852.98 hectares at Chendebji under Sephu Gewog, Trongsa Dzongkhag with the following terms and conditions:

I. General

The holder shall:

1. comply with provisions of the National Environment Protection Act 2007, Environmental Assessment Act 2000 and its Regulation 2016, Waste Prevention & Management Act of Bhutan 2009 and its Regulation 2012 (Amendment 2016), The Water Act of Bhutan 2011 and its Regulation;
2. ensure that the operation and management of FMU is in line with Environmental Impact Assessment and Management Plan submitted for EC;
3. ensure that Annual Allowable Cut is fixed to 6,700m^3 (Six Thousand Seven Hundred Meter cube);
4. ensure that no extraction of timber is carried out at the critical watershed;
5. ensure that local communities, properties and any religious, cultural, historic and ecologically important sites are not adversely affected by the operation and management of FMU;
6. restore the damage to any public or private properties caused by the operation and management of FMU;
7. inform NECS and any other relevant authorities of any unanticipated or unforeseen chance-find of any precious metals or minerals or articles, that have economic, cultural, religious, archeological, and/or ecological importance; and
8. erect a signboard at the take-off point of the main entry of the FMU stating the name of the FMU and contact address.

II. Environmental standards

The holder shall comply with the Environmental Standards 2010.

III. Import and use of secondhand equipment and ODS

The holder shall:

1. ensure that import and use secondhand equipment and machineries are strictly prohibited; and
2. ensure that import and use ODS are in line with the Revised Regulation on the Control of ODS 2018.

NEC, PO Box 466, Thimphu, Bhutan
Tel: (975-2) 323384/325855/324323/326993 Fax: (975-2) 323385
www.nec.gov.bt

IV. Protection and management of water resources

The holder shall:

1. ensure that operation and management of FMU does not disrupt the water flow and pollute the water bodies; and
2. ensure that 30 meter or 100 feet buffer is maintained from the water resources at all times.

V. Waste prevention and management

The holder shall manage wastes generated from the project (labour camps, offices etc.) with the application of 4R (Reduce, Reuse, Recycle, Responsibility) principle and other environmentally friendly methods of waste management.

VI. Management of excavated materials and run-off

The holder shall:

1. dispose excess excavated materials generated during construction of access road and operation and management of FMU only at the pre-identified approved dumpsite; and
2. put appropriate measures for management of surface run-off to avoid erosion and landslides.

IX. Implementation plan

The holder shall prepare a detailed implementation plan focusing on the implementation of terms and conditions of this EC and submit to NECS within three (03) Months from the date of issue of this EC as per the reporting format attached herewith.

X. Monitoring and reporting

The holder shall ensure that the effective day-to-day monitoring of the EC terms and conditions are carried out by the environmental unit or designated environment focal person;

XI. Renewal and modification

The holder shall:

1. ensure that renewal of this EC is processed at least three months prior to its expiry along with a copy of EC and a report on the implementation of its terms and conditions as per the format attached herewith; and
2. obtain prior approval from NECS for any modification to the existing proposal/application.

Reservation

1. The NECS may stop the activity or impose additional terms and conditions, as may be deemed necessary; and
2. The EC shall be subject to periodic review and modifications as per Article 25 of the EA Act 2000, without any liability on the part of the Royal Government.

The holder may adopt best practices in executing these terms and conditions to avoid adverse environmental impacts.

Failure to comply with any of the above terms and conditions shall constitute an offence and the proponent shall be liable in accordance to the Environmental Assessment Act 2000 and/or existing environmental laws.

Validity:
This EC is issued with valid from May 31, 2018 until May 30, 2023.

Officiating Secretary

To,
The Chief Forestry Officer
Forest Resources Management Division
Department of Forests and Park Services
Thimphu

Copy to;
1. The Director, Department of Forests and Park Services, Ministry of Agriculture and Forests, Thimphu for kind information.
2. The Regional Manager, Natural Resource Development Corporation Limited, Trongsa for necessary action.
3. The Dzongkhag Environment Officer, Trongsa Dzongkhag for necessary action.
4. Guard File, Dzo-Trongsa/3581/2018/ for record.

LIST OF ABBREVIATIONS

%	Percent
AAC	Annual Allowable Cut
CF	Community Forest
CFMU	Chendebji Forest Management Unit
CFO	Chief Forestry Officer
CGI	Corrugated Galvanized Iron
cm	Centimeter
DBH	Diameter at Breast Height
DFO	Divisional Forest Office
DoFPS	Department of Forests and Park Services
EIA	Environmental Impact Assessment
FMP	Forest Management Plan
FMU	Forest Management Unit
FNCA	Forest and Nature Conservation Act
FNCRR	Forest and Nature Conservation Rules and Regulation of Bhutan
FRMD	Forest Resources Management Division
GIS	Geographic Information System
Ha	Hectare
JSWNP	Jigme Singye Wangchuck National Park
km	Kilometer
LULC	Land Use and Land Cover
m	Meter
m^3	Cubic Meter
MC	Management Circle
mm	Millimeter
MoAF	Ministry of Agriculture and Forests
NEC	National Environment Commission
NRDCL	Natural Resources Development Corporation Limited
Nu.	Ngultrum
NWFP	Non-Wood Forest Product(s)
OP	Operational Plan
RGoB	Royal Government of Bhutan
RM	Regional Manager
RME	Reliable Minimum Estimate
RNR	Renewable Natural Resources
sp.	Species
TMB	Tree Marking Book
UIC	Unit-In-Charge
UWICER	Ugyen Wangchuck Institute for Conservation and Environmental Research
WC	Working Circle

ACKNOWLEDGEMENT

I would like to express my gratitude and appreciation to all the people who are involved in making this plan writing process a success. An immense appreciation goes to the Unit staffs (both Territorial and NRDCL counterpart) of Chendebji Forest Management Unit for their assistance and support during data collection and information gathering.

Special thanks are due to Mr. Kinzang Gyeltshen, Chief Forestry Officer, Bumthang for providing immense support and guidance in the process of writing this plan. The technical advices received from the Chief Forestry Officer have helped me make this plan credible and moreover practically applicable in the field.

I also would like to thank the officials of Forest Resources Management Division, particularly Mr. Arun Rai, Deputy Chief Forest Officer and Mr. Dawa Zangpo, Sr. Forestry Officer for their technical guidance during various stages of plan writing. Immense gratitude is due to the Local Government Officials of Tangsibji and Sephu Gewog and local people of Chendebji, Nyala, Dangla and Setta Villages for their contribution and participation in various consultation meetings while writing this plan.

EXECUTIVE SUMMARY

This is the third Management Plan for Chendebji Forest Management Unit. The Plan structure is as per the guidelines on forest management plan reflected in the Forest Management Code of Bhutan, 2004. It comprises of three parts:

PART 1: GENERAL DESCRIPTION AND THE CURRENT SITUATION
PART 2: FUTURE MANAGEMENT
PART 3: IMPLEMEMTATION OF THE PLAN

PART 1: GENERAL DESCRIPTION AND THE CURRENT SITUATION

- The Chendebji Forest Management Unit is located in two Dzongkhags with the major portion situated in Trongsa Dzongkhag and a small portion in Wangduephodrang Dzongkhag. The Forest Management Unit falls within 90˚15′5″ and 90˚32′20″ East and 27˚26′5″ and 27˚32′20″ North. The FMU became operational in 1996.

- The total area of the FMU has been reduced to 7,852.98 ha after removing the areas of three Community Forests from within the FMU comprising of 270.95 ha.

- The general terrain of CFMU ranges from moderate to steep landscape. The elevation of CFMU ranges from 1,640 meters at the valley bottom to 4,100 meters at the ridge top. The average monthly rainfall is approximately 286.33 mm. Precipitation in the form of snowfall occurs in the winter.

- In total, there are five villages that falls within the FMU, namely Chendebji, Drangla, Nyala, Setta and Brogena Village. Out of the five villages, Setta and Brogena Village falls under Sephu Gewog of Wangduephodrang Dzongkhag. There are 87 households with a total population of 747 residing within Chendebji FMU.

- Forest in Chendebji FMU are broadly divided into four types; Blue Pine, Mixed Conifer, Mixed Hardwood and Fir Forest. Blue Pine occurs in the lower valleys while Mixed Conifer occupies the higher elevations. The Fir forest is found in the upper elevation and occurs in pure stand or mixed with other conifers. Most of the Broadleaf could be found in the eastern part of the FMU. Broadleaf in this region consist of *Quercus* sp., *Alnus* sp, *Populus* sp., *Betula* sp., *Rhodrodendron* species, etc.

- The AAC of the last Management Plan have been set at 1,100 m^3, including 300 m^3 standing volume for local use. The total commercial timber harvested for the last 10 years is 7,757.11 m^3 and rural volume is 5,776.81 m^3 in Standing Volume. This shows that commercial extraction is undercut by 242.89 m^3 of total AAC for ten years and rural extraction exceeded by 2,776.81 m^3.

- A total of 20.56 km of forest road have been constructed in FMU during the last two Plan periods. The road network has immensely benefitted the local people of Setta Village.

PART 2: FUTURE MANAGEMENT

- The overall Goal of the Management Plan is *"**to manage the forest on a multiple use, sustained yield basis for the production of timber, fuel wood and other forest products and for watershed, wildlife and environmental protection**"*.

- To facilitate the planning, implementation and recording of activities, the Chendebji FMU is divided into blocks, compartments and sub-compartments, which will remain the same as in the last management plan. There are six blocks; Brogena-Sekche, Medta, Jawang, Setta, Danglajem and Nalajem, which have been further divided into compartments and sub-compartments.

- Chendebji FMU has been divided into three Management Circles using forest function mapping and they are Protection, Production and Non-production Management Circle. The Production Management Circle has been divided further into Working Circles so that the objectives are tailored to the type of stand being harvested. The objectives for each management circles have been listed in a logical framework along with the management options and responsibility for easy reference by implementers and monitoring agency.

- The prescribed Silvicultural System for the commercial harvesting is the Group Selection System with natural regeneration in Mixed Conifer Working Circle and Seed Tree System in Blue Pine Working Circle. Group openings will be created in the stand allowing optimum quantity of light to reach the forest floor and creating conductive micro climatic conditions for seed germination and establishment of seedlings. Criteria for opening the groups and laying out annual coupes are given in detail in the Plan. For local use area, single tree selection system will be used.

- Annual Allowable Cut for the previous plan was set at 1,100 m^3 but for this new plan, the AAC is fixed at 6,700 m^3. The increase in the AAC for this plan is attributed to the use of different method of forest function mapping using

GIS which resulted in increase in the production area. Moreover, the forest management inventory result also shows the increase in volume per hectare compared to the last management plan. Out of the total AAC of 6,700 m^3, 4,700 m^3 has been allocated to commercial use and 2,000 m^3 has been allocated to local use.

- In the Production Management Circles, four regular Working Circles and one Overlapping Working Circle has been formed in this plan. The four Working Circles in this management plan are Mixed Conifer, Blue Pine, Fir and Mixed Broadleaf and one overlapping Working Circle is Non-wood Working Circle.

- In collaboration with the NRDCL, the Divisional Forest Office, Bumthang carried out detailed EIA and its findings are incorporated in preparing the Forest Management Plan. Using a series of environmental criteria outlined in the Environment Assessment Act, 2000 and adopted by the National Environment Commission, the guidelines recommended have been examined to ensure that the practice within CFMU meets the requirement. The Environment Statement includes the effects of previous activities within the FMU along with recommended mitigation measures for future management actions.

- A 10 years financial forecast has been prepared for the FMU summarizing the total cost, revenue and royalties for NRDCL and the treasury (via CFO) for the plan period. The forecast is a projection based on the plan prescriptions and may not reflect the actual workings during the plan period.

PART 3: IMPLEMENTATION OF THE PLAN

- The CFO, Bumthang will be responsible for the implementation of this management plan and he will be assisted by the Forest Management Planner, Unit In-charge and other Unit staffs.

- A rolling biennial Operational Plan will be prepared by the Unit In-charge in consultation with the CFO, Bumthang and NRDCL counterpart to facilitate the timely implementation of this management plan.

- FMU-level Management Committee chaired by CFO, Bumthang has been established to assist in objective setting and to ensure the smooth implementation of the Management Plan. The FMU-level Management Committee is comprised of the stakeholders of the FMU and each member has an equal right to say in the recommended management and implementation of the FMP. Planned activities to achieve the FMU management objectives will be discussed in the FMU-level Management Committee meetings.

- The Operational Plan activities will be reviewed annually whereas the mid-term review will take place after five year of plan implementation. The final evaluation shall be carried out during the final year of plan implementation. FRMD will be responsible to initiate evaluation of activities in the FMU.

- Unforeseen circumstances may warrant deviations from Plan prescriptions and in such an event the CFO, Bumthang must obtain prior written approval from the Head of the Department. The reasons for the deviations must be fully justified by the CFO in this respect and such approved deviations entered into the Management Plan during the next scheduled revision.

Actions Required by the FMU Plan	Responsibility
Implementation and Review	
The CFO Bumthang, as the senior territorial officer will be responsible for the implementation of this Management Plan, assisted by Forest Management Planner, Unit-In-charge and other Unit staffs.	CFO
A FMU-level Management Committee chaired by the CFO, will be established to ensure the smooth implementation of the Management Plan.	CFO
The CFO and UIC will ensure that only the silvicultural systems described for each working circle are used for that working circle, and they are implemented thoroughly and correctly.	CFO & FMU UIC
The Head, FRMD, will ensure that the Plan is reviewed five years after implementation (mid-term review), and at the end of the plan period (end-of term review)	Head, FRMD
Monitoring and Evaluation	
The CFO will ensure that monitoring is carried out on an annual basis according to the guidelines issued by FRMD	CFO
The Head FRMD will ensure that evaluation is carried out at five year intervals, based on the information collected by annual monitoring and other necessary information.	Head, FRMD
Operational Planning	
A bi-annual Operational Plan will be prepared by the CFO to facilitate the timely implementation of this Management Plan, and should be submitted to FRMD by 2nd October every year, before the start of operating year.	CFO RM, NRDCL
The budget in the operational plan should be jointly developed by the CFO and RM, NRDCL and agreed by both.	CFO RM, NRDCL
The UIC will determine the location and extent of cable lines in the Compartment to be harvested annually, in consultation with NRDCL staff, as prescribed in the Operational Plan.	FMU UIC
The CFO and the RM, NRDCL will cooperate and coordinate to ensure that the logging operation and log out turn are conducted smoothly and in accordance with local and other demands.	CFO RM, NRDCL
The FMU UIC will ensure that stocking regeneration surveys are conducted as and when required.	FMU UIC
Enrichment planting, if necessary, will be carried out by NRDCL.	NRDCL RM

Actions Required by the FMU Plan	Responsibility
Fencing or other action to protect regeneration will be carried out by NRDCL, in consultation with the FMU UIC.	NRDCL RM
The FMU UIC will inspect the coupes when harvesting is completed and will issue a Coupe Clearance Certificate only if all aspects of the operation are satisfactory.	FMU UIC
Road survey, design and construction will be carried out by NRDCL.	NRDCL
NRDCL road engineers must follow acceptable standards, designs, estimates and provide supervision during construction to ensure that the standards are met.	NRDCL staff
Regular inspection will be conducted by the FMU staff to detect and report any pest and disease outbreaks to enable earliest possible remedial or preventive measures to be initiated.	FMU staff
Participatory Forest Management	
Records of all trees marked and issued for local use or for conversion within the forest, by Blocks and Compartments will be maintained by the Unit staff and furnished monthly to the CFO Bumthang.	FMU UIC
Timber and non-wood products, including fuel wood, Daphne bark, and bamboo, can be allotted to *bona fide* local villagers.	FMU UIC, via Operational Plan
The views of stakeholder groups will be incorporated into the operational plans through the inclusion of stakeholder representatives in the FMU-level Management Committee.	CFO

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PART 1

GENERAL DESCRIPTION AND THE CURRENT SITUATION

1. LOCATION, AREA, BACKGROUND AND STATUS

1.1 Location and Extend

The Chendebji Forest Management Unit is located in two Dzongkhags with the major portion situated in Trongsa Dzongkhag and a small portion in Wangduephodrang Dzongkhag (Map 1). The Forest Management Unit falls within 90°15′5″ **and** **90**°32′20″ **East and 27**°26′5″ **and 27**°32′20″ North (Toposheet No. 781/6 and 781/7). The Thimphu-Bumthang National Highway runs through the middle of the Forest Management Unit. The altitudinal range of the FMU ranges from 1680 m to 4100 m above sea level.

1.2 Area Statement

As per the Land Use and Land Cover map (LULC) classification, majority of the FMU area is covered by forest (Map 2). Over 53% of the land is covered by mixed conifer forest followed by approximately 23% by broadleaf forest. The build-up area only forms over 1.285% of the total land cover (Figure 1).

Table 1: Area Statements by Land Use

Land Use	Area (Ha)	Percentage Area
Broadleaf	1,817.86	23.15
Mixed Conifer	4,163.94	53.02
Blue Pine	778.82	9.92
Fir	151.5	1.93
Shrubs	611.67	7.79
Rocky Out-crops	0.03	0.00
Meadows	167.79	2.14
Alpine Scrubs	8.57	0.11
Build Up	100.86	1.28
Kamzhing	51.94	0.66
TOTAL	**7,852.98**	**100.00**

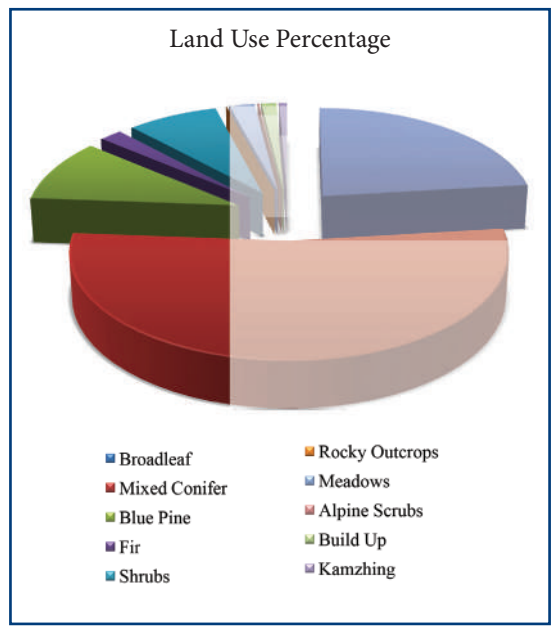
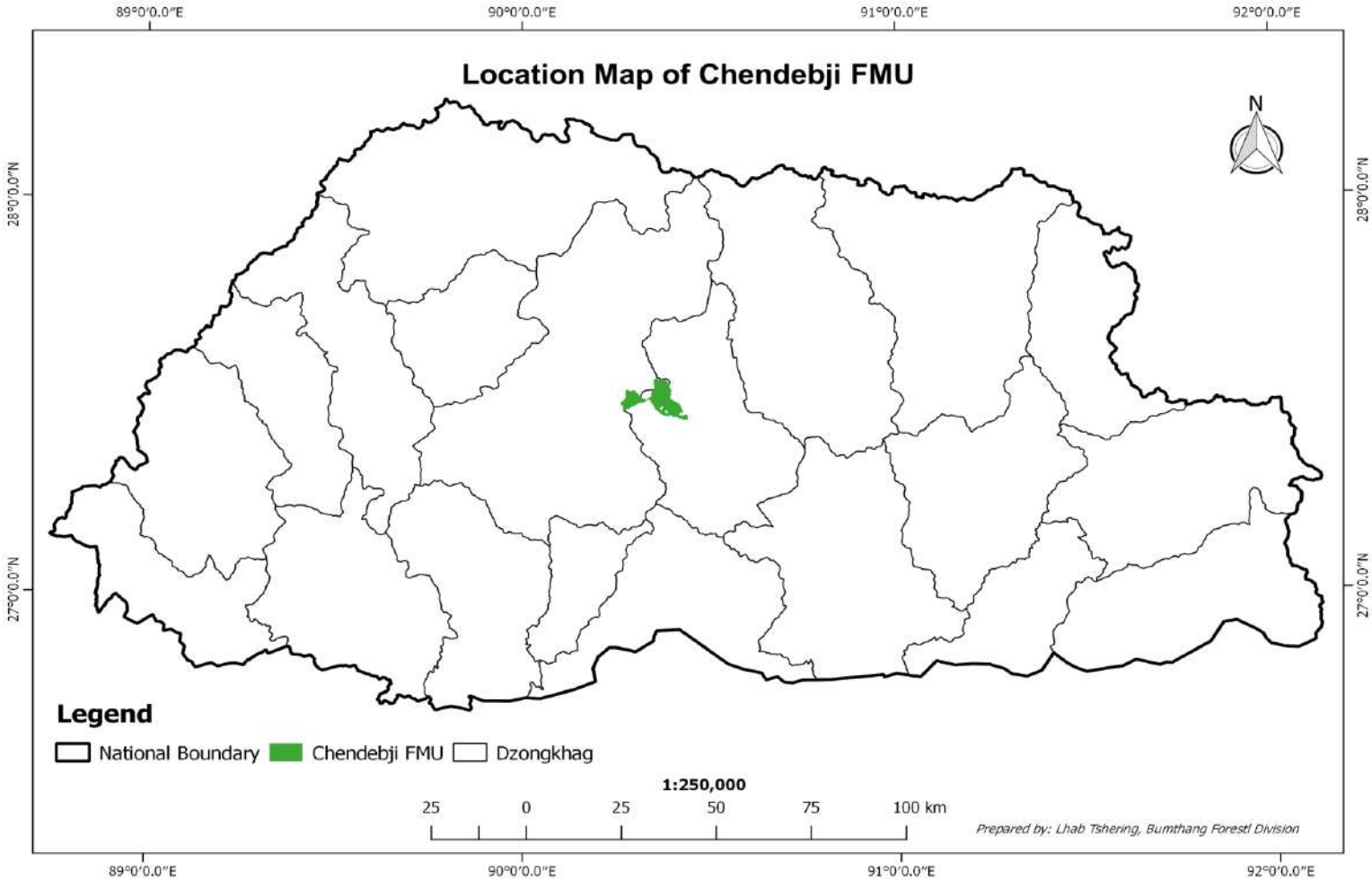
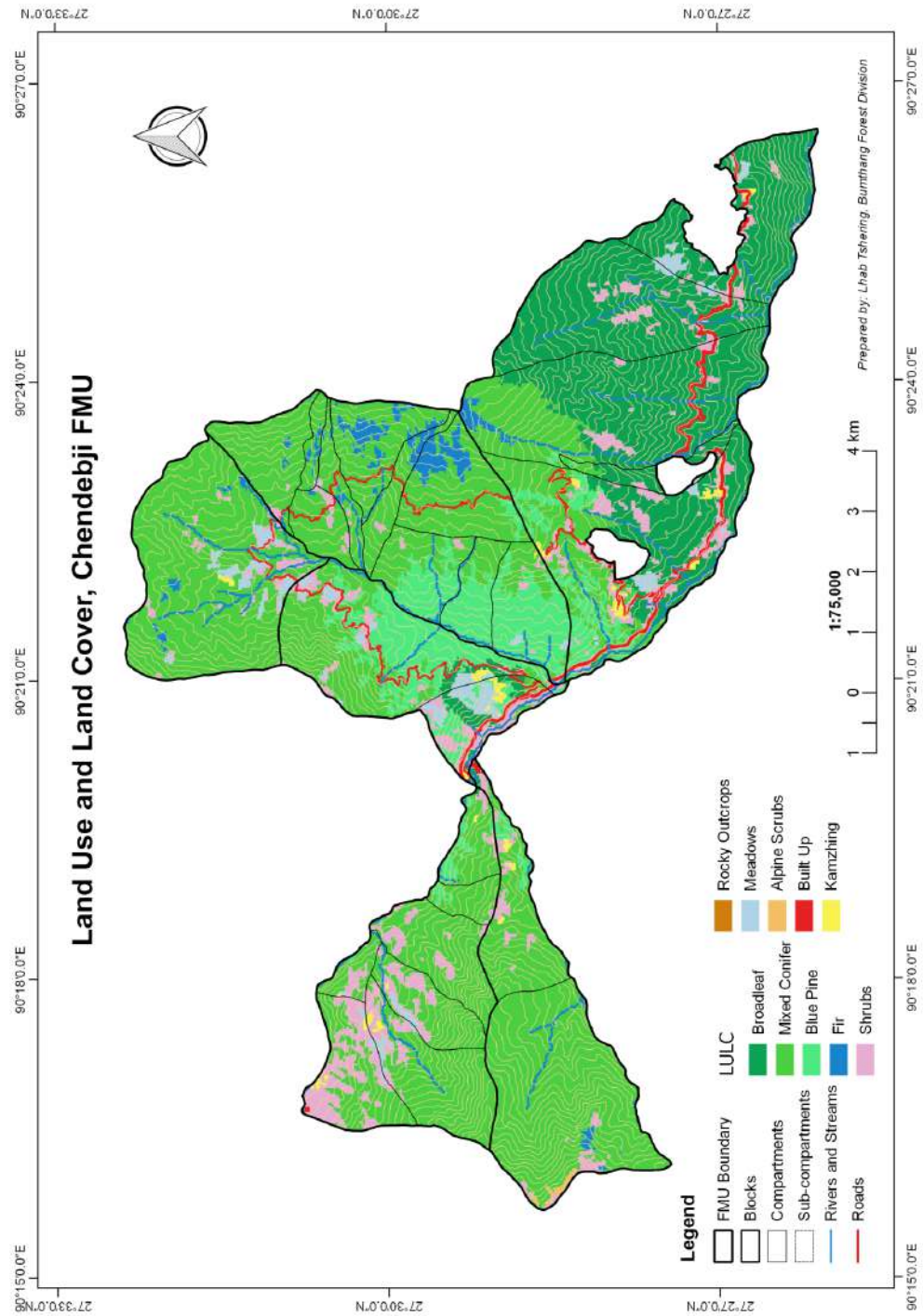


Figure 1: Figure Showing Land use by Percentage

Map 1: Location of Chendebji FMU



Map 2: Land-use and Land Cover



1.3 Historical Background

Chendebji Forest Management Unit at the time of inception was under the administrative control of Bumthang Forest Division but was brought under the jurisdiction of Zhemgang Forest Division later in the year 2003. In August 2016, the Forest Management Unit was remapped under the administrative control of Bumthang Forest Division following the Organizational Development Exercise by the Royal Civil Service Commission.

Most of the historical background was obtained during the socio-economic survey and consultation meeting with the local communities and stakeholders. The local communities has open unlimited access to the forest for timber, firewood and other non-wood forest produces before the creation of the Department of Forests in the mid-1950s. There were no written plans for scientific timber harvesting from the Forest Management Unit prior to 1996. Timbers marked for the villagers on an ad-hoc basis.

The first management plan for Chendebji Forest Management Unit was prepared in the year 1996 with a plan period of ten years (i.e. 1996 to 2006). In the first management plan, the total area of the FMU was 9,706.80 ha which was subsequently revised in 2005 to 8,123.98 ha after the creation of Jigme Singye Wangchuck National Park (JSWNP). The two blocks, namely, Tinji Pinchu and Semchylo was brought under the jurisdiction of JSWNP.

After the expiry of the first plan, the Second Management Plan was written and endorsed in the year 2006. The plan period for the second plan was from 2007 to 2017 for duration of ten years. The FMU was divided into six blocks which was further divided into compartments and sub-compartments based on natural features. For the purpose of management, the production forest was organized into five working circles, of which four were regular and one is overlapping. The working circles were Mixed conifer Working Circle, Fir Working Circle, Blue Pine Working Circle, Mixed Broadleaf Working Circle and Non-wood Working Circle (overlapping).

For Mixed Conifer Working Circle, group selection system was followed to carry out harvesting operations. Where the opening cannot be created as prescribed in group selection system, single tree selection system was prescribed. The single tree selection system was also prescribed for Mixed Broadleaf Working Circle. For Blue Pine Working Circle, seed tree system was followed and in areas with young Blue Pine stands, thinning was prescribed. All the harvesting operation was to be carried out by using cable crane logging system. The AAC for the last management plan was calculated to be 1,100 m^3 of which 300 m^3 was allocated to local use and remaining 800 m^3 for commercial harvesting by NRDCL. A total of 2.3 kms of road was constructed during the last plan period.

1.4 Forest Condition

Chendebji FMU was under commercial harvesting for the last twenty years and although the scientific silvicultural systems were used, some parts of the forest are exposed. Majority of the area were exposed during the first plan period where the annual allowable cut was quite high. However, during the second plan period, the AAC allocated was lowered and minimum areas were exposed due to commercial harvesting. The harvesting during the second plan period was concentrated to Danglajem Block, Compartment 1d. Good natural regeneration could be seen in the harvested cable lines and most of the regeneration consists of Hemlock species. Blue Pine colonization could also be spotted in the lower valleys of the FMU and is covering the open grasslands which were used as grazing ground by the locals. As the natural regeneration was profuse, no artificial regeneration in the form of plantation was carried out in the past operated areas.

1.5 Legal Status

1.5.1 Ownership

The Forest and Nature Conservation Act, 1995, defines forests as ***"any land and water body, whether or not under vegetative cover, in which no person has acquired a permanent and transferable right of use and occupancy, whether such land is located inside or outside the forest boundary pillars, and includes land registered in a person's name as Tsamdo (grazing land) or Sokshing (woodlot for collection of leaf litter)".*** All such areas are considered as Government Reserved Forest and the entire CFMU falls within this category of reserved forest, except for a small part of land classified as cultivations and some build-up areas which are privately owned.

1.5.2 Rights and Privileges

The right and the privileges of the local inhabitants, concerning the forest use is as per the Forest and Nature Conservation Act of 1995 and the National Forest Policy of 2011. According to the Forest and Nature Conservation Act, grazing, collection of firewood, fodder and leaf mold for the domestic use is allowed either free or on royalty basis. Collection of firewood is permitted from only dead and fallen trees. Timber trees are issued for *bona fide* domestic use, after they have been marked by a Forestry Officials and royalty has been paid. Hunting wild animals is completely prohibited in the forest.

1.5.3 Grazing Rights

The local communities have the traditional rights for grazing their cattle in the forest within the forest management unit. There were number of *Tsamdo* within the CFMU. These *Tsamdo* are either individually or community owned. However, as per the new regulation regarding *Tsamdo* and *Sokshing*, it has been taken over as government reserve forest land and should be subsequently leased for use. The local people who have traditional rights to use the land as *Tsamdo* and *Sokshing* were

adequately compensated by the Government. According to the Forest and Nature Conservation Act of 1995, there is a provision for regulating grazing in Government Reserved Forest.

1.5.4 Water Rights

Local population within the FMU has traditional rights to use water from rivers and perennial streams for domestic purpose, such as consumption, irrigation and other uses. Nyala Chhu, Khebar Chhu and Seb Chhu are the main source of water besides many small streams and creeks present within the FMU. These three rivers ultimately form the tributaries for Nika-chhu River.

1.5.5 Historical Monuments and Monasteries

Within the FMU, there are two Goenpas, one Lhakhang and one Chorten in total. These are Drangla Goenpa, Nyala Goenpa, Chendebji Lhakhang and Chendebji Chorten. A buffer of 100 meters in all the Goenpas and Chorten has been delineated. Beside these, there are various *Gney* (sacred sites) located in the high rocky outcrops which falls within the soil protection circle.

1.5.6 Proximity to Protected Areas

The total current area of the CFMU is 7,852.98 ha but the total area during the first plan was 9,706.80 ha. The reduction in the total area came as a result of two blocks coming under the jurisdiction of Jigme Singye Wangchuck National Park since 2005. These two blocks were namely Tinjipinchu and Semcheylo with the total area of 1,582.87 ha. Thus, toward the south of the CFMU lies Jigme Singye Wangchuck National Park. Nikachhu acts as a boundary between CFMU and the National Park. Further, three Community Forests (Nyala Phuntshok CF, Dangla Dekiling CF and Tangsibji CF) were also created inside the FMU which contributed to the reduction in size of the area designated as FMU.

2. PERMANENT SITE FACTORS

2.1 Topography and Slope

The general terrain of CFMU ranges from moderate to steep landscape. The lower slopes are moderately gentle and the upper slope being steeper. Most of the flattened area in the valley bottom has been converted to agriculture land. The terrain is moderate in some of the compartments however; most of the compartments are steep and mountainous. Rocky outcrops are present along the national highway in Nalajem block. The elevation of CFMU ranges from 1,640 meters at the valley bottom to 4,100 meters at the ridge top. The terrain is also dissected by three main rivers viz; Nyala Chhu, Khebar Chhu and Seb Chhu and many small rivulets, which flows into the main rivers of Nikachhu. The Management Unit is composed of sub-watersheds of Nyala Chhu, Khebar Chhu and Seb Chhu. Nikachhu River divides the Management Unit nearly into two halves.

Major part of FMU falls within 40 to 80% slope class. Slope classification was done with the help of Quantum GIS by using terrain analysis. Areas that were considered over 100% were delineated on the Function Map as SP-Soil Protection where no activities can take place. Slopes that ranged from 76-100% are classified as SC-Soil Conservation where limited activities can take place.

2.2 Climate

2.2.1 Meteorological Station

The climate and meteorology information of Chendebji FMU is collected by the only meteorological station located in Chendebji Primary School. The teachers of the school look after the meteorological station and collect data on regular basis. The station gives the representation climate data as it is located within the Forest Management Unit.

2.2.2 Temperature

The monthly maximum and minimum temperature of Chendebji FMU for the year 2016 is given in the following tables and graph.

Table 2: Maximum Temperature (Degree Celsius)

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
2016	3	4	8	17	20	18	22	22	20	16	10	7

Table 3: Minimum Temperature (Degree Celsius)

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
2016	-6	-5	-5	4	11	12	14	12	14	6	-1	-2

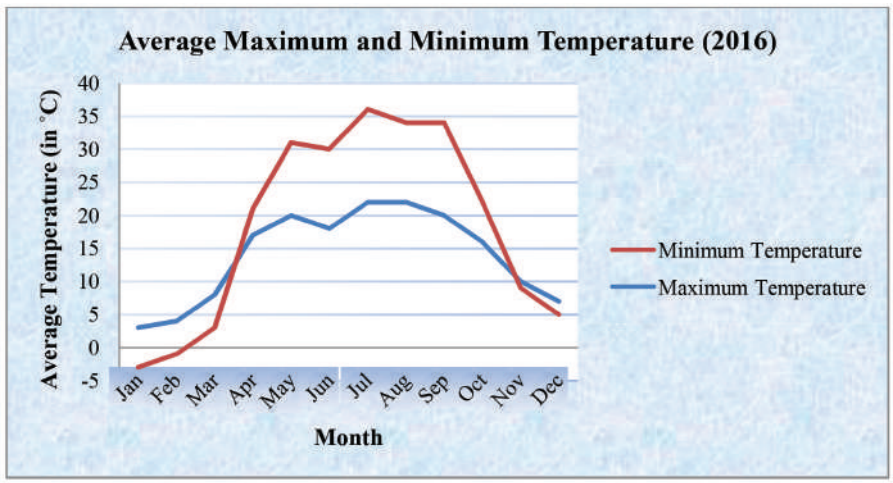


Figure 2: Graph showing Average Maximum and Minimum Temperature of 2016

2.2.3 Precipitation

The precipitation of Chendebji FMU is expressed in the following graph for the year 2016. During the monsoon, the rainfall can impact the commercial harvesting and transportation of timber to depot if the road is not maintained properly. Briefly during the months of winter, the area receives precipitation in the form of snow. Although affecting mainly high elevation sites, the snow can suspend logging operation and make travel through CFMU difficult.

Table 4: Average Monthly Precipitation (in mm)

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
2016	-	0	0	180	690	142	1017	554	665	188	-	-

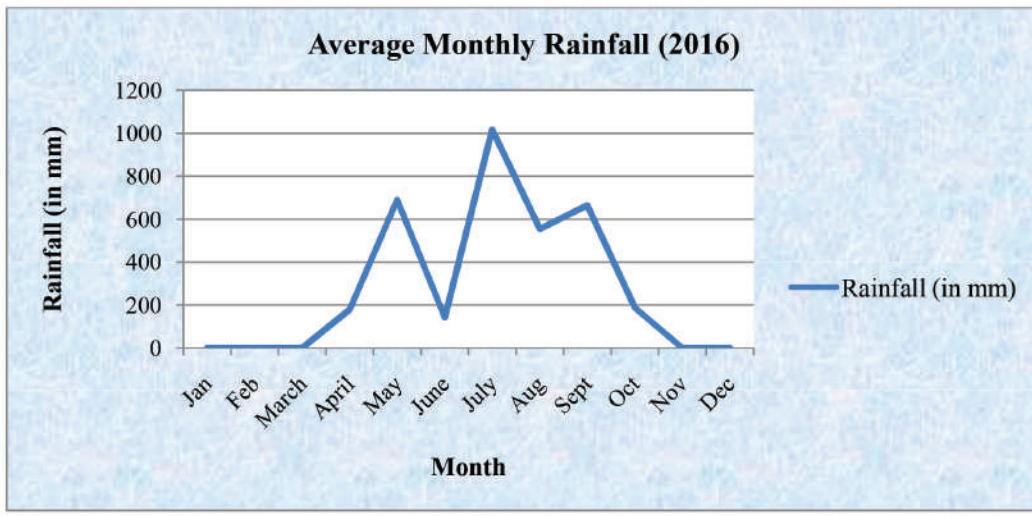


Figure 3: Graph Showing Average Monthly Rainfall of 2016

2.3 Geology and Soil

The rocks are of Thimphu Gneiss Complex. The formation is characterized by migmatites and biotite-gneisses with thin bed of quartzite, quartz-mica seists, calc-silicate rocks, marbles etc. (Atlas of mineral resources of the Escap region. Vol.8. UNDP Publication). Big rocks covering huge area is not found contiguously. However, about 18% of the area has rocks of less than 16 square meters. Major part of the FMU has smaller stones of size less than 70 cm × 70 cm. The soil is predominantly sandy loam and well drained in general.

2.4 Hydrology

Within Chendebji FMU, there are three main rivers and no lakes. These three main rivers are Nyala Chhu, Khebar Chhu and Setta Chhu or Seb Chhu which ultimately

joins the main river, Nikachhu. Beside these rivers, there are numerous perennial streams draining ultimately into the main river. Seb Chhu and Nyala Chhu run from North to South and ultimately join Nikachhu Chhu. Likewise Khebar Chhu runs from South-West to North and finally drains to Nikachhu. There is one mini-hydroelectric power established in Chendebji which is run by the water of Khebar Chhu. The power generated from this project is supplied to Chendebji Village.

3. VARIABLE SITE FACTORS

3.1 Population and Demography

Chendebji FMU is located within the two Dzongkhags of Trongsa and Wangduephodrang with the majority of area under Trongsa Dzongkhag. In total, there are five villages that falls within the FMU, namely Chendebji, Drangla, Nyala, Setta and Brogena Village. Out of the five villages, Setta and Brogena Village falls under Sephu Gewog of Wangduephodrang Dzongkhag. There are 87 households with a total population of 747 residing within Chendebji FMU. Out of the 747 total populations, 374 are male and 373 are female (Figure 4).

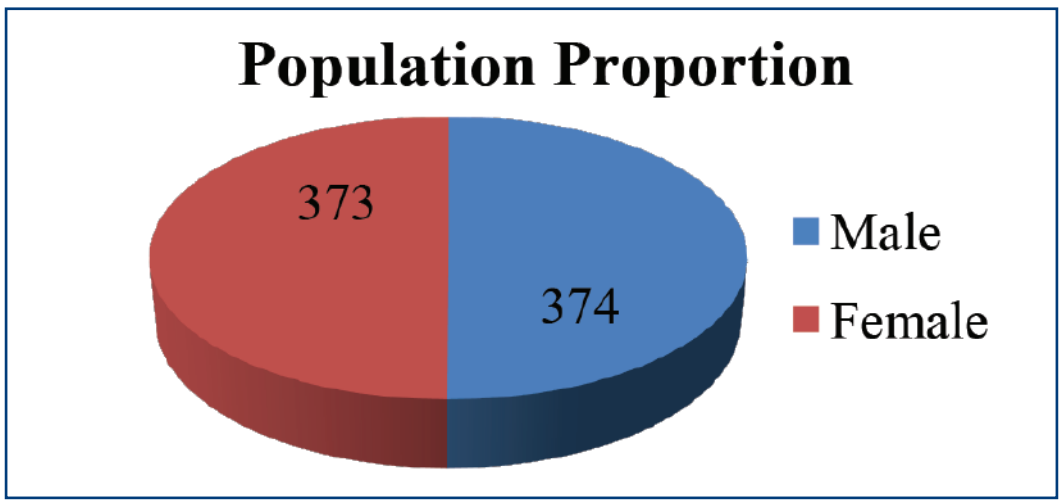


Figure 4: Sex Composition

3.2 Agriculture and Farming System

Main occupations of the people residing within CFMU are agricultural farming and livestock rearing. Potato is the main cash crops of Chendebji, Dangla and Nyala villages. Almost every household of these three villages grows potato and the harvest is taken to Phuentsholing for sale. The main winter crops grown are wheat, Buckwheat and Turnip while the summer crop is mainly Potato, Cabbage, Cauliflower and Chilli in addition to other vegetables grown in small scale. Vegetable like cauliflower, cabbage, beans, raddish etc. are also grown in small scale for family consumption.

3.3 Traditional Use of Forest

People residing within CFMU have been using the forest for multipurpose since their settlement in the area. Timbers required for house construction, shingles, house repairs and various other reasons were extracted from the forest within the FMU in the past and the very practice is continuing except for shingles extraction as it has been replaced by CGI sheets for roofing. After the FMU plan was endorsed, the rural timber demands were being met from the designated local use areas. Besides timber, other forest products like firewood, fodder and NWFPs are also extracted from CFMU by the local people.

3.4 Grazing

From the socio-economic survey and information from the Gewog RNR Office, it was found that there are about 682 cattle, 3 horses and 90 yaks owned by the people residing within CFMU (Table 5). The local cow herders mostly practice migratory grazing. During the winter, the cow herders move their cattle to the warmer places in the month of October and November and return during the summer months of April and May. However, livestock rearing being one of the main occupations of people, there is higher chances of increase in livestock population which ultimately creates pressure on the nearby forest. In order to reduce the grazing pressure on forest, introduction of improved varieties of livestock and awareness to the people may be looked upon by relevant agencies.

Table 5: Livestock Information

Village	Cow		Bulls		Horse		Yak	
	Improved	Native	Improved	Native	Improved	Native	Improved	Native
Chendebji	134	106	21	55	Nil	Nil	Nil	Nil
Nyala/ Dangla	148	35	38	22	Nil	Nil	Nil	Nil
Setta	Nil	36	5	10	Nil	3	Nil	90
Brogena	11	40	6	15	Nil	Nil	Nil	Nil
TOTAL	**293**	**217**	**70**	**102**	**0**	**3**	**0**	**90**

(Gewog RNR Livestock Extension Office, 2017) (Gewog RNR Livestock Extension Office, 2017)

3.5 Wildlife

Along with resource inventory, wildlife survey was also carried out in the year 2013-2014. The survey was mainly carried out through direct and indirect sighting method. In the indirect sighting method, the scats, pugmarks, shredded antlers and territory markings were observed and recorded. Frying signs on the trees and digging of roots indicates the presence of enough wild boars. Droppings of barking

deer and Sambar was also sighted during the transect walk in the forest. During the transect walk, pugmarks of Tiger and small cats were observed. Footprints of Himalayan Black Bears were also present in abundance. Even during the socio-economic meeting, status of the wildlife was discussed with the local people. According to the local people the population of wildlife has increases ever since the area is converted into FMU. People of Setta and Chendebji also raised the concern regarding the increasing number of wild dogs and Himalayan Black Bears and their attack to domestic animals. Few local people and logging laborers talk about spotting red panda in the forest. The different fauna present in Chendebji FMU as per the wildlife survey and information gathered from the local people is enlisted in Table 7 and Table 8.

3.6 Forest Fire

Until now, there is only one record of forest fire incidence in CFMU that happened in the year 2010. The fire destroyed 29.1 ha of forest and occurred in Setta Block. Around 13.4 ha of forests below forest road and 15.7 ha of forests above road were burned. Although, forest fire is not a regular phenomenon in CFMU, proper monitoring and awareness to the local people should be carried out considering the composition of the forest, i.e. Blue Pine and Mixed Conifers.

3.7 Pest and Diseases

Pest and diseases in reality are always present in any type of forest. However, CFMU being under commercial harvesting for last twenty years, there is no record of any pest and disease that has caused havoc in the forest.

3.8 Non-wood Forest Product

The main non-wood forest products extracted from CFMU are bamboo, boulders and sand. Growth of bamboo is confined to small pockets along the depression of the rivers and streams. However, due to gregarious flowering in the recent years, the bamboos in the whole range are dead. The new regeneration is coming up in the whole area and will be available for harvest in few years' time.

One of the important NWFPs collected by the local population is an Algae from Nikachhu River. It is collected for own consumption at home and remaining quantities are being sold in the local shops along the highway. Few Medicinal plant species are also found in the forest but the resources could not be found in a quantity that can be explored for commercial harvest.

Table 6: NWFPs found in this area

Name of the NWFP	Uses
Bamboo	For making bamboo mats, fencing, construction of houses and livestock shed
Daphne	Paper making
Mushroom	For food
Rubus sp.	Fruits are consumed
Berberis sp.	Dye
Freshwater Seaweed	Consumed as food
Gaultheria sp.	Fruits are consumed and oil is extracted from leaves
Rhododendron sp.	Medicinal value
Viscum nepalense	Medicinal value
Seaweed (Algae)	As food
Paris polyphylla (Satuwa)	Medicinal Value

3.9 Mineral Extraction

No record of mineral extraction from the FMU has been found.

4. ECOLOGY

4.1 Floral Association

Chendebji FMU is very rich in diverse plant species. Young immature Blue pine dominates the lower valley, either in pure stand or mixed with Hemlock and Broadleaf. As one ascend the hill, Hemlocks are found and finally Fir and stunted growth of Junipers. In the Eastern side of the management unit where Nalajem block falls, *Quercus* spp. dominates the area. Also in the entire area of the CFMU varieties of Rhododendron spp. are found. *Borinda grossa* bamboo is also present in Brogena Sekche and Jawang block. In the Nalajem block, the ground in most part is covered with thin bamboo spp.

4.2 Fauna

Following the inventory of 2005, most of the area of CFMU shows the presence of wildlife. Even the recent inventory did in 2013 also show the variety of wildlife presence in the entire area. The following mammals and large birds have been recorded in the Chendebji FMU during the inventories and reconnaissance visits:

Table 7: List of Wildlife

Common Name	Scientific Name
Tiger	*Panthera tigris*
Himalayan Black Bear	*Selenarctos thibetanus*
Sambar	*Cervus unicolor*
Barking deer	*Muntiacus muntjak*
Wild boar	*Sus scrofa*
Common Leopard	*Panthera pardus*
Gray Langur	*Presbytis entellus*
Rhesus macaque	*Macaca mulatta*)
Jungle Cat	*Felis chaus*
Red Panda	Ailurus fulgens
Red Fox	*Vulpes vulpes*
Wild Dogs	Cuon alpinus

Table 8: List of Birds

Common Name	Scientific Name
Yellow-billed Blue Magpie	*Urocissa flavirostris*
Alpine Accentor	*Prunella collaris*
Blue-capped Rock Thrush	*Monticola cinclorhynchus*
Blue-fronted Redstart	*Phoenicurus frontalis*
Blood Pheasant	*Ithaginis cruentus*
Large-billed Crow	*Corvus macrorhynchos*
Red-billed Chough	*Pyrrhocorax pyrrhocorax*
Yellow-billed Chough	*Pyrrhocorax graculus*

5. SILVICULTURAL ASSESSMENT

5.1 Present Forest Types

The main forest types of Chendebji FMU are;

Blue Pine

Blue Pine is mostly found in the lower valley. Most of the pastures and barren areas are being colonized by blue pine and the forest cover has subsequently increased due to this phenomenon. It occurs both in pure stand and mixed with Oak and

Poplar species. In the upper region, it is also found mixed with Hemlock. Blue Pine is generally immature, ranging in age from 30-50 yrs.

Mixed Conifer

Mixed conifer is found in the upper valley. This forest type is dominated by Hemlock, Spruce and Fir. Hemlock mostly occurs in association with Blue Pine and Spruce. Mixed Conifer forest forms the dominant forest type in Chendebji FMU.

Fir

Fir forest in Chendebji FMU is confined to the upper ridges up to the tree line and occurs mostly as pure stand, except for few Hemlocks. The dense canopy provides environment for luxuriant understory of Rhododendron and other shrubs. Most of the Fir at the higher elevations is over matured.

Mixed Broadleaf (Hardwood)

Most of the Broadleaf forest is located in the eastern part of Chendebji FMU. Broadleaf in this region consist of *Quercus* sp., *Alnus* spp, *Populus* sp., *Betula* Spp, *Rhododendron* sp., etc.

5.2 Past Silvicultural Treatment

Five working circles were established in the previous management plan, four regular and one overlapping. They were:

Regular Working Circles:

1. Blue Pine Working Circle (597.45 ha)
2. Mixed Conifer Working Circle (1,695.17 ha)
3. Fir Working Circle (134.00 ha)
4. Mixed Broadleaf Working Circle (850.04 ha)

Overlapping Working Circle:

1. Non-wood Working Circle

For Mixed Conifer Working Circle, group selection system was followed to carry out harvesting operations. Where the opening cannot be created as prescribed in group selection system, single tree selection system was prescribed. The single tree selection system was also prescribed for Mixed Broadleaf Working Circle. For Blue Pine Working Circle, seed tree system was followed and in areas with young Blue Pine stands, thinning was prescribed. All the harvesting operation was to be carried out using cable crane logging system. The AAC prescribed for the last management plan was 1,100 m^3 of which 300 m^3 was allocated to local use and remaining 800 m^3 for commercial harvesting by NRDCL.

5.3 Plantations

As the natural regeneration was profuse in the past operated areas, supplementation of stock through artificial regeneration was found unnecessary. Therefore, during the second plan period, no artificial regeneration in the form of plantation was carried out in the harvested area. However, 4 ha plantation was carried out in barren land under Jawang Block.

6. SOCIO-ECONOMICS

6.1 Common Source of Income

According to the information collected during the inventory and Socio-economic survey the main sources of income for the local communities within CFMU are agriculture and livestock rearing. The majority of local communities are farmers having individual landholdings. The main cash crop grown by the local communities is potato. Other vegetables like beans, cabbage, raddish, etc. are grown in small quantity for family consumption. Selling of potato and livestock products are the only source of income for the local communities within the CFMU.

7. CURRENT TIMBER DEMAND AND SUPPLY

The timber need for the rural communities residing within the FMU is being met from the Unit. The timber needs are mainly for rural house construction, renovation of rural house, cattle shed construction, fencing of farm lands and flag poles. Even the rural firewood demand for the locals is being met from the FMU.

Table 9: Rural Supply

Year	Quantity Supplied (m^3)										Total Quantity Supplied (m^3)
	Drashing		Chams		Tsims		Poles/ Dangchung		Firewood		
	Nos	m^3	Nos	m^3	Nos	m^3	Nos	m^3	Nos	m^3	
2007	24	48	237	94.77	219	21.89	181	9.02	NA	NA	173.68
2008	112	224	1,120	447.87	1,120	111.97	1,072	53.43	59	5.31	842.58
2009	96	192	960	383.89	842	84.18	1,000	49.84	41	3.69	713.6
2010	200	400	2,000	799.77	2,000	199.94	2,445	121.87	29	2.61	1524.19
2011	184	368	1,840	735.79	1,600	159.95	1,880	93.71	23	2.07	1359.52
2012	48	96	480	191.95	310	30.99	260	12.96	34	3.06	334.96
2013	32	64	320	127.96	310	30.99	250	12.46	34	3.06	238.47
2014	32	64	320	127.96	162	16.2	263	13.11	5	0.45	221.72
2015	42	84	30	12.00	30	3.00	533	26.57	16	1.44	127.01
2016	45	90	63	25.10	55	5.49	558	27.81	35	3.15	151.55
2017	30	60	4	1.60	-	-	535	26.67	14	1.26	89.53
TOTAL	**845**	**1,690**	**7,374**	**2,948.66**	**6,648**	**664.6**	**8,977**	**447.45**	**290**	**26.1**	**5,776.81**

When it comes to timber for commercial purposes, NRDCL is the sole agency which harvest timber from the cable lines and ad-hoc activities for commercial supply.

Table 10: Commercial Supply

Year	Quantity supplied from planned cable lines (m^3)				Quantity supplied from planned ad-hoc activities (m^3)					Total Standing Volume Marked (m^3)
	Standing Volume	Log Volume	Firewood	Wood Chips	Standing Volume	Log Volume	Firewood	Wood Chips	Others	
2007	688.59	513.55		72						688.59
2008	493.74	259.10		168						493.74
2009	1,039.68	652.55	112	88				433.02		1,039.68
2010	612.60	494.74	72	80				123.24		612.6
2011	1,093.02	893.27	200	283						1,093.02
2012	736.37	599.23	108	168				336.7		736.37
2013	1,148.12	643.44	96	30				92.29		1,148.12
2014	704.56	491.95					960		400	704.56
2015	485.48	382.21		17	110	47.18	768		768	595.48
2016	456.77	258.18	104						598.5	456.77
2017	-	-	-	-	188.18	-	384	-	-	188.18
Total	**7,458.93**	**5,188.22**	**692**	**906**	**298.18**	**47.18**	**2,112**	**985.25**	**1,766.5**	**7,757.11**

8. ORGANIZATION AND ADMINISTRATION

8.1 Organization

Chendebji FMU falls within the jurisdiction of Bumthang Forest Division and is directly administered by CFO, Bumthang. A Unit In-charge has been assigned to look after daily activities in Chendebji FMU. Under him, there are two Foresters who assist him in the implementation of the management plan.

8.2 Health and Safety

At present, health and safety measures are poor and sometimes absent altogether. Site specific Risk assessment seems necessary if not generic risk assessment. The major risks involved in the forestry operations are during:

a. Harvesting and
b. Transportation

Actions can be initiated with little or no expenditure to ensure health and safety of the field staffs. Following are the few recommendations to minimize hazards in the field:

- Ensure chain saws equipped with full functioning chain breaks
- Always ensure feller to keep two tree lengths apart while felling.
- Deploy only trained power chain saw operators for felling operations.
- Explain the dangers of falling timbers and overhead cable lines.
- Stack timbers in the same direction and not to stack the logs too high.
- Never approach or climb the log pile from the bottom of the slope.
- Always dismantle a stack from the top rather than from the bottom.

It is recommended that NRDCL should initiate long term safety measures and ensure its improvement which would one day become mandatory at any costs.

8.3 Record Keeping

Maintenance of record in the FMU office was identified as concern. Some important information were lost, otherwise would be very useful for the planning and management purposes. The Unit Office shall maintain the records of all the activities within the FMU as per the record-keeping format reflected in the Forest Management Code of Bhutan, 2004 and other guidelines issued by the Department.

9. INFRASTRUCTURE, TRANSPORT AND EQUIPMENT

9.1 Road

The Thimphu-Bumthang National Highway passes through the Chendebji FMU. Currently, due to East-West highway widening project, the condition of the road is not good, although it is pliable. The road widening is due for completion by the mid of 2018. A total length of 18.26 kms of forest road was constructed during the first plan period. The road passes through Jawang Block (Compartment 1 and 2), Sette Block and Dranglajem Block (Compartment 2d and 3a). During the second plan period, a total additional road length of 2.3 km was constructed which passes through Danglajem Block, Compartment 1d. The construction of forest road has facilitated in extraction and transportation of commercial timber as well as rural timber. The forest road has immensely help in transportation of livestock and agricultural products for people living in Sette Village. In addition to the forest road, few farm road (Ngala-Drangla farm road) were also being constructed within the FMU by the Gewog Administration.

9.2 Buildings

The Forest Management Unit is run from a Unit Office which is located near the highway around two kilometers from Chendebji Village towards Trongsa. The Unit Office cum residence was constructed in the year 2007 through funding support from RGoB. The residence is used by the Unit In-charge. There is a two unit quarter (temporary hut) built by NRDCL for their staffs which is being used as office of the Production In-charge and, residence of the Production In-charge and the Unit staffs.

9.3 Transport

Due to the lack of budget, Division has not provided any kind of locomotives for the Unit staffs. Unit In-charge owned his personal vehicle which he uses to travel to the production and other areas for monitoring the activities.

9.4 Equipment

The office is well equipped with all the necessary equipment that is required to carry out their duty. Through the funding support from RGoB and Tangsibji Hydro Energy Limited, the office equipment and electronics were procured and distributed. The equipment and instruments of the Chendebji FMU Office includes;

- Computer Set- 1
- Printer- 2
- Xerox Machine- 1
- Laptop- 1

- Clinometer- 3
- Altimeter- 1
- Diameter tape- 4
- Measuring tape- 8
- Compass- 3
- GPS Garmin- 1
- Walkie Talkie Sets- 4
- Binocular- 1
- Digital Camera- 1
- Tents- 5

10. EVALUATION OF PREVIOUS PLAN (2007-2017)

The past harvesting activities and other associated activities in Chendebji Forest Management Unit was guided by the Forest Management Plan prepared in line with the Forest Management Code of Bhutan, 2004 and all the operations are based on the scientific forest management principles. However, it is mandatory to review the activities carried out during the last plan period to assess whether the activities are in line with the prescriptions of the previous plan or not. Moreover, it is important to review whether or not the goals and objectives of the previous plan have been achieved. The review will also highlight the areas of improvement and will subsequently help address those issues in the future.

This review process will look at the Goals and Objectives, Harvesting operations and AAC prescription, road building and reforestation activities. These reviews should be referred by the implementers so that such short comings are not repeated in the future operations. This review is based on the management plan from 2007 to 2017.

10.1 Review of Goals and Objectives

The Chendebji Forest Management Plan was written considering its importance to various stakeholders and most importantly to maintain healthy forest through extraction of resources on sustainable basis. Although, the operations within the FMU were carried out as per the provisions of the Forest Management Code of Bhutan, 2004, many areas of improvements were seen in the field. As the first plan has prescribed higher AAC for commercial harvesting; due to lying of shorter cable lines, a significant amount of production areas were covered. The cumulative impact of the first plan period was felt during the second plan period in which the annual allowable cut was drastically reduced to compensate the higher area

coverage during the first plan period. On average, only one cable line was laid and harvested in one year during the last plan period.

Although, the sustainable harvesting of timber was mainly aimed during the second plan period, the economic feasibility was overlooked. The current plan will help address the problem by considering various ways to balance sustainable harvesting of timber as well as make the FMU operations economically feasible for NRDCL.
A brief review of the Goals and Objectives from the last management plan is given below. The review will highlight on areas which were neglected during the implementation of last plan period.

Goal

To manage the forest on a multiple use, sustained yield basis for the production of timber, fuel wood and other forest products and for watershed, wildlife and environmental protection.

Although, the goal of managing the forest on a multiple use, sustained yield basis for the production of timber, fuel wood and other forest products was not achieved completely, the activities implemented in the last plan period was geared towards achieving this. As the goal is usually considered as a long-term objective of the management, it is unlikely to consider that it should be achieved in the short period of time. The sustainability aspect of the goal has been taken care properly while implementing the activities in the FMU.

Objectives

To meet the local requirements, as priority, for timber, fuel wood and other forest products on a sustainable basis.

In general, Chendebji Forest Management Unit has been catering to the need of local people residing within the FMU through supply of rural timbers, fuel wood and other forest produce. However, concerns were raised by the local leaders that the FMU is not able to cater to the need of local people with respect to demand for required type of timber. In this regard, even if the unit is being managed on sustainable basis, it is not able to cater to the type of services required by the local people. Therefore, this objective is not fully achieved and this plan should probably look into the issue and suggest measures so that the local demand is being met for the FMU as per the requirement and priority.

To manage the commercial timber production on sustainable basis.

The AAC for commercial harvesting in the last plan was set at 800 m^3, which totals to 8,000 m^3 for period of ten years. As per the data obtained from the Unit Office, the actual commercial harvesting during the last plan period was 7,757.11 m^3. The commercial timber harvesting was found to be as per the prescription and has not exceeded for ten years. However, the areas for commercial harvesting were not properly utilized as some cable lines were shorter besides the fact that it could

have been extended for proper area utilization. This practice leads to exhausting the production area before the speculated time, resulting in compromising the sustainability principle for the Forest Management Unit. Moreover, the financial sustainability may be questioned as the AAC prescribed is very less and not economically feasible for operation. Taking this into consideration, the objective to manage the commercial timber production on sustainable basis was not achieved.

To maintain and improve the forest conditions for conservation of wildlife habitats, water catchment functions and biodiversity.

The FMU was divided into three working circles based on the nature of topography and stock density. The protection working circle is mainly being managed to improve the forest condition for use by wildlife and to enhance water catchment functions. It was found that the protection working circle was not disturbed by the commercial harvesting and has been kept exclusively for wildlife and watershed protection function. However, when it comes to improving the forest conditions, no interventions were carried out specifically to improve wildlife habitats. As per the local people, the wildlife population has drastically increased in the FMU as a result of which increased cases of livestock depredation and crop damage has being reported.

To regulate grazing in sustainable manner to benefit the local people.

Currently, the free grazing system still exists in the FMU whereby the people leave the cattle to graze openly in the forest area. This has resulted in increased grazing pressure in the FMU. However, as per the observation of few local people, the grazing land has decreased subsequently due to colonization by Blue Pine. Even though the area of tree cover has increased due to this phenomenon, it has led to decrease in grazing grounds for cattle and hence they are freely left in the forest areas to graze. The improved varieties of livestock were also being reared by the local people and these varieties of livestock are being stall-fed, resulting in lower grazing pressure in the forest. Lopping of *Quercus* tree branches as fodder for livestock were also observed in the FMU which needs to be monitored.

To involve local people in the management of forest by providing employment opportunities and raising awareness programs.

Although, all the technical works are being contracted to the eligible business firms, the firms hire the local people as laborer to carry out the works within the FMU. This way, it helps in creating employment opportunity for the local people and the social mandate of the FMU is also being achieved. Moreover, three community forests were also established within the FMU which is aimed at giving opportunity to the local people to manage resources for themselves and also to carry out interventions to improve the forest cover and conditions. The local people were also involved in the management of FMU through FMU level meetings in which their opinions and suggestions are being incorporated for proper management of the Unit.

To protect the forest from fire and illegal activities.

Awareness programs were initiated by the Unit to sensitize the local people on importance of preventing forest fire and other illegal forestry activities. During the last plan period, there was only one forest fire incidence recorded which burned a total of 29.1 ha of forest. The number of illegal activities within the FMU was also on rise. Therefore, the objective to protect the forest from fire and illegal activities was not achieved and more interventions (other than awareness programs) should be initiated henceforth.

10.2 Review of Harvesting Activities

The commercial harvesting of timber in the FMU is carried out by skyline cable system. This system has helped in transportation of logs from the cable corridors without causing major disturbance to existing regeneration and ground cover. Further, the technique has helped extract the logs within limited timeframe and therefore, reducing the chances of timber damage at site.

Figure 5: Improper disposal of lops and tops from cable lines

However, some issue has been recorded within the production areas which need to be addressed in the future so that the operation is as per the standard set in the Forest Management Code of Bhutan, 2004.

Figure 6: Width of the Corridor larger than the prescribed 4 m

1. The residue in the form of lops and tops which are left after extraction of logs are not being disposed properly (Figure 5). The lops and tops are found lying at the road site and it is not

converted into firewood for supply on commercial basis. These residue needs to be disposed immediately so that outbreak of pest and diseases is prevented.

2. Some of the cable lines were found to be very short even when the topography of the site allows for extension (Map 3). Such practices results in exhaustion of area faster and make the management of forest unsustainable.

3. The width of the cable corridors are found to be greater than 4 m which has been prescribed in the management plan (Figure 6). This lead to increase in the clear cut area and therefore, creates undesirable precedence.

10.3 Review of Road Construction Activities

Construction of road for the timber extraction is considered very essential but at the same time it is important to ensure that minimal environmental damages are caused due to this activity. A total of 18.2 kms of forest road has been constructed in the Chendebji FMU during the first plan period. An additional 2.3 kms of road was constructed during the second plan period (Table 11). The overall condition of the forest road was found to be good and pliable. However, the road drainage was not maintained along the forest road with major sections having no side drains at all and most of the existing drains were blocked by wood debris and soil (Figure 7). The terminal evaluation report of Chendebji FMU suggested that NRDCL should provide adequate budget for maintenance of road (particularly for side drains and construction of culverts/cross drains where required) in the FMU. It is also recommended to correct the road gradient if it is more than 13% which is too steep and difficult for the vehicles to ply.

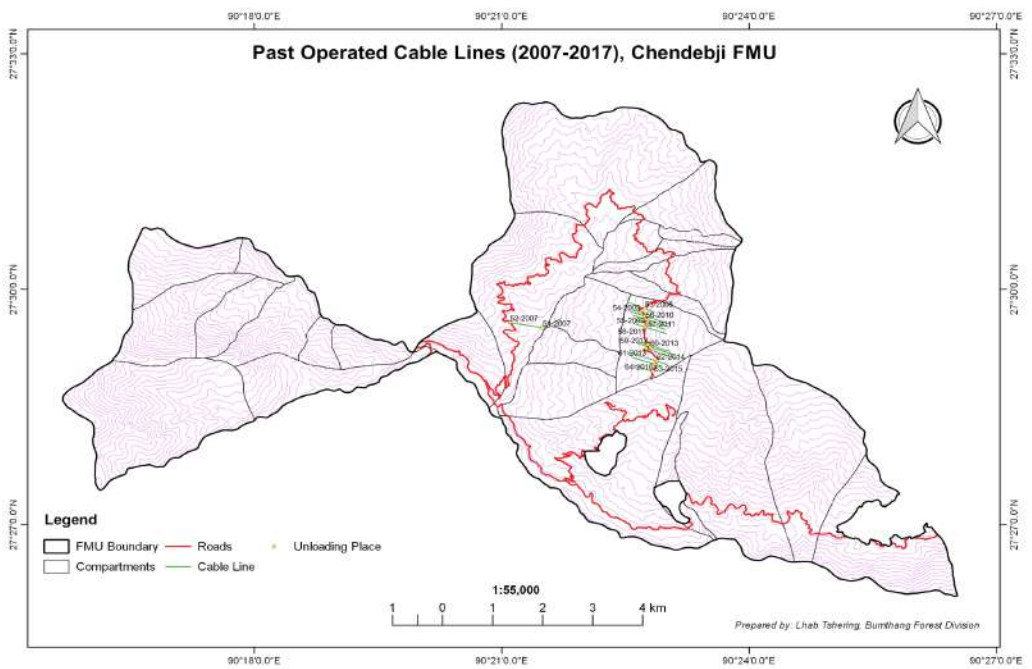
Figure 7: Lack of side drains along forest road

Table 11: Road Construction Information

Block and Compartment	Year of Construction	New Road Construction Implemented (kms)
Jawang II	1997	4.149
Jawang I	1998-1999	4.055
Setta	2000-2001	6.034
Danglajem III a	2002	2.010
Danglajem II d	2004	2.010
Danglajem I d	2008	1.000
Danglajem I d	2012	1.300
TOTAL		**20.56**

Source: Chendebji FMU Office

Map 3: Past Operated Cable Lines from 2007-2017



10.4 Review of Reforestation

The regeneration survey in the harvested areas was periodically carried out by the Unit. As per the regeneration survey, the regeneration of desired tree species is found to be adequate in the harvested areas. Due to this, artificial regeneration in the form of plantations was not carried out. However, it is recommended that NRDCL should carry out soil disturbance works in the harvested lines so that it will be easier for the seeds to come in contact with the soil to ensure germination. Although, few barren areas are found within the FMU, no reforestation activities were carried out (except 4 ha plantation in Yaphranglingju, Jawang Block in 2012 through RGoB funding) as the focus was mainly given to the cable corridor.

10.5 Annual Allowable Cut

The Annual Allowable Cut (AAC) of the last management plan is very less and is not found to be economically feasible. Hence, the AAC needs to be reviewed and ascertained for the next plan.

PART 2

FUTURE MANAGEMENT

11. INTRODUCTION

The Constitution of Bhutan has the provision to maintain 60% of the total land as forest (Royal Government of Bhutan, 2008). This is reflected in the National Forest Policy, 2011 and also forms an important aspect of the developmental process of the country. This constitutional provision can be fulfilled by following scientific sustainable forest management practices which not only help us manage and utilize the forest, but also look into fulfilling the social, economic, ecological and cultural needs of present and future generations.

11.1 Forest Policy

Over the years, there has been increasing pressure on the environment and the natural resources, the alarming consequences of which are becoming evident in the increasing propositions. The National Forest Policy of Bhutan, 2011 consists of a long term goal, major policy objectives and specific statements to enable various aspects of forest production, use and management (Royal Government of Bhutan, 2011). It has five guiding principles i.e. equity and justice in terms of access, poverty alleviation through integrated approach, deregulation and devolution, integration of science and indigenous knowledge, and allowing import of logs and sawn timber (Department of Forests and Park Services, 2011).

According to the FNCA (1995) and FNCRR (2017), Management Plan needs to be prepared for all Protected Areas and for all forests where commercial logging is to be undertaken and needs to be approved before implementation (Department of Forests and Park Services, 2017). FNCA (1995) provides the legislative framework for the community participation in the forest management and streamline the preparation of supporting forest rules and regulations. The regulation lay out the best practices that apply nationwide. This plan has been prepared in line with the Act and the Forest and Nature Conservation Rules and Regulations of Bhutan.

11.2 Goals

To manage the forest on a multiple use, sustained yield basis for the production of timber, fuel wood and other forest products and for watershed, wildlife and environmental protection.

11.3 Objectives

The objectives of Chendebji FMU were framed based on the different management circles identified to ease the implementation of the plan. The three management circles identified are Protection, Production and Non-production Management Circles. As different management circles are managed for different purposes,

framing separate objectives can help manage, monitor and evaluate the areas with ease. However, there are instances where different management circles share similar objectives. The objectives for management of the three management circles are listed below:

Protection Management Circle

- To conserve and enhance wildlife habitats and biodiversity.
- To conserve and improve the health of the watershed.
- To meet the local demand for NWFP on sustainable basis in order to improve socio-economic status of the people.
- To prevent negative impacts due to forest resource use on religious sites and water quality.

Non-Production Management Circle

- To maintain and improve the forest condition.
- To meet the local demand for NWFP on sustainable basis in order to improve socio-economic status of the people.
- To ensure regulated grazing for livestock in the FMU.
- To conserve the water catchment function

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Production Management Circle

- To meet local requirements, as priority, for timber, fuel wood and other forest produce on a sustainable basis.
- To manage and harvest commercial timber on sustainable basis.
- To protect the forest from fire, illegal activities and grazing in regeneration areas.
- To create employment opportunities for local people.
- To maintain and improve health and safety measures during operation.
- To prevent negative impacts due to forest resource use on watershed functions and water quality.
- To conserve and enhance biodiversity within production areas.

11.4 Management Based on Forest Function

11.4.1 Introduction

Forest function mapping is the term used for grouping the different potential uses of the forest. The different forest potential includes soil conservation, watershed conservation, habitat for flora and fauna and resource based for many kinds of human needs. Forest function, in general, are not based only on subjective human demands, they are significantly and objectively limited by site condition of forest stand. For this reason, categorization of every forest stand into different forest function is mainly based on the dominant site, forest type, accessibility, slope, flora and fauna present. However, some forest function represents certain exception

to this rule and these functions are designated on the basis of social importance (Forest Resources Development Division, 2004).

Forest function defines all the ecological, environmental and social function within the FMU, so as to balance the often diverging interest of commercial logging. Alongside it identifies areas of Production forest, Limited production forest and Protected Areas. It also provides the UIC with firsthand information on the location of different forest functions in order to enable him/her to specify the required management prescriptions and to control its implementation.

11.4.2 The main objectives of Forest Function Mapping are:

- To define different environmental and social functions of the forest and depict them on the map.
- To identify Production, Non-production and Protection area within the FMU.
- To provide a tool for the management planner for balancing the requirement of nature conservation, environment protection, social forestry, commercial timber production and also to provide spatial information required to compute the sustainable AAC (Forest Resources Development Division, 2004).
- To provide the Unit In-charge with information on the location of different forest function in order to specify the required management prescriptions on the ground and to control its implementation.

11.4.2 Function Groups

The functions used in this management plan are listed in table below:

Table 12: Different Forest Function used in the Plan

Soil Conservation	Water and Watershed Conservation	Nature Conservation	Social Function	Road Buffer
SP Soil Protection	**WRR** Riparian Reserve Protection	**NWP** Wildlife Protection	**SocRS** Religious Sites Protection	**RB** Road Buffer
SC Soil Conservation	**WLS** Local Water Supply Protection	**NWC** Wildlife Conservation	**SocL** Social (Local Use Only)	
	WSh Watershed Conservation			

11.4.3 Mapping Forest Functions

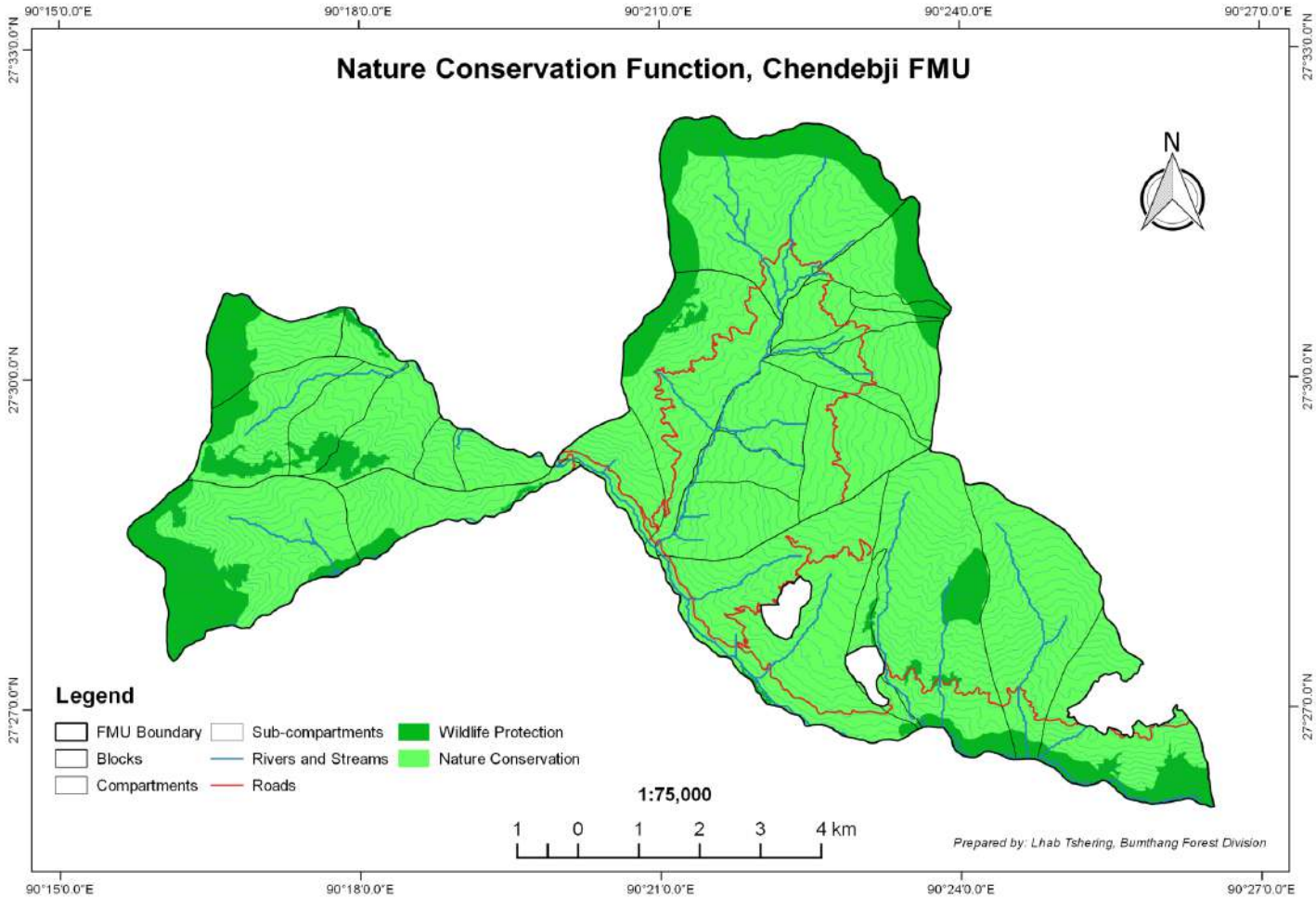
The forest function mapping was carried out to differentiate the forest area based on the function it caters. The mapping is carried out as per the criteria set for mapping based on the function groups. The details of criteria used to prepare forest function map for Chendebji FMU is given in Table 13. In this table, information for some criteria is not available or cannot be mapped at the scale used for planning. These criteria are indicated in italics. When Operational Plans are prepared new detail is to be collected and these criteria should be implemented.

Table 13: Criteria for Mapping Forest Functions

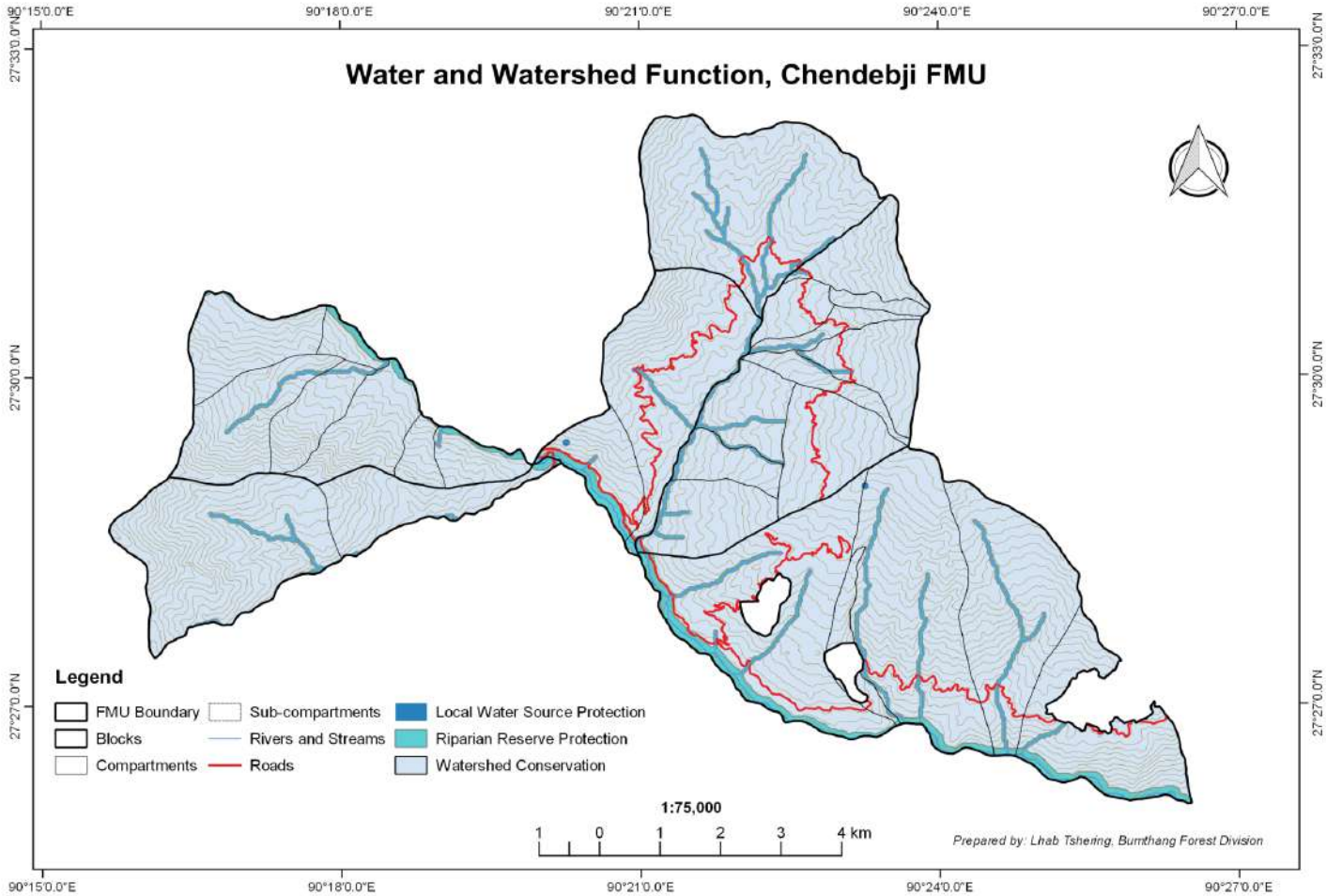
Function Group and Codes	Criteria for Mapping
Soil Conservation	**SP:** Very steep areas (slopes of greater than 100%), *areas with indication of slight to moderate erosion*. **SC:** Steep or sensitive areas (slopes of 76 - 100%)
Water and Watershed Conservation	**WSh:** Catchment areas of water courses, water retention areas. **WRR:** Areas within 30 m along all perennial streams, water logged areas, swamp etc. **WLS:** Upper catchment areas of streams serving as drinking water supply for settlement downstream.
Nature Conservation	**NWP:** Alpine areas, Red Panda territory, *ecosystems of high conservation value*. **NWC:** Areas identified as biological corridors and all areas rich in wildlife, both in species and in number.
Social Function	**SocL:** Area close to or accessible to settlement or village, the areas traditionally used already, with definite boundaries. **SocRS:** Lhakhangs/ Goenpas, Gney and other religious sites.
Road Buffer	**RB:** 200 m uphill and 100 m downhill for motorable public road, 30 m uphill and 10 m downhill for unstable forest road.

(Forest Resources Development Division, 2004)

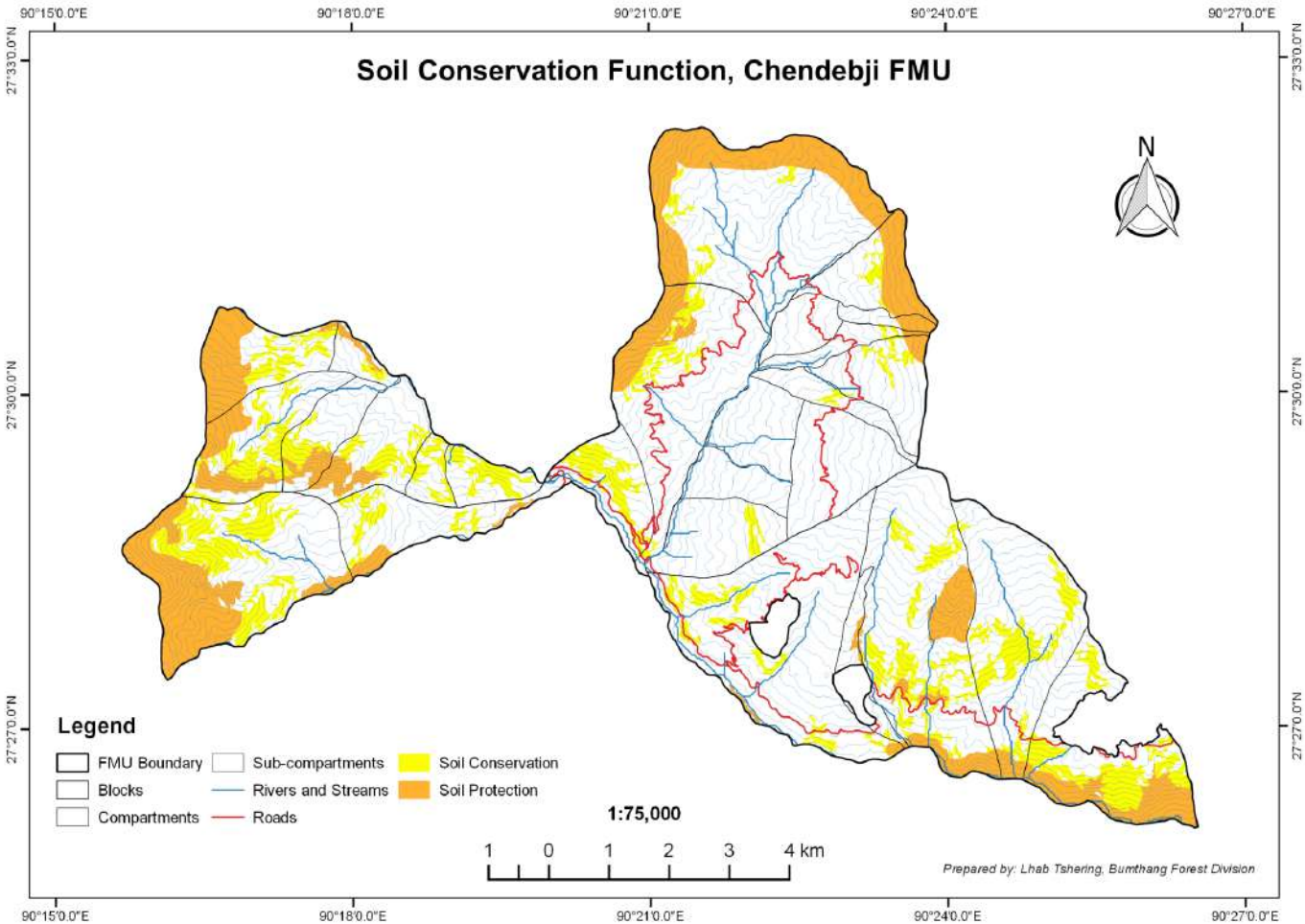
Map 4: Nature Conservation Function



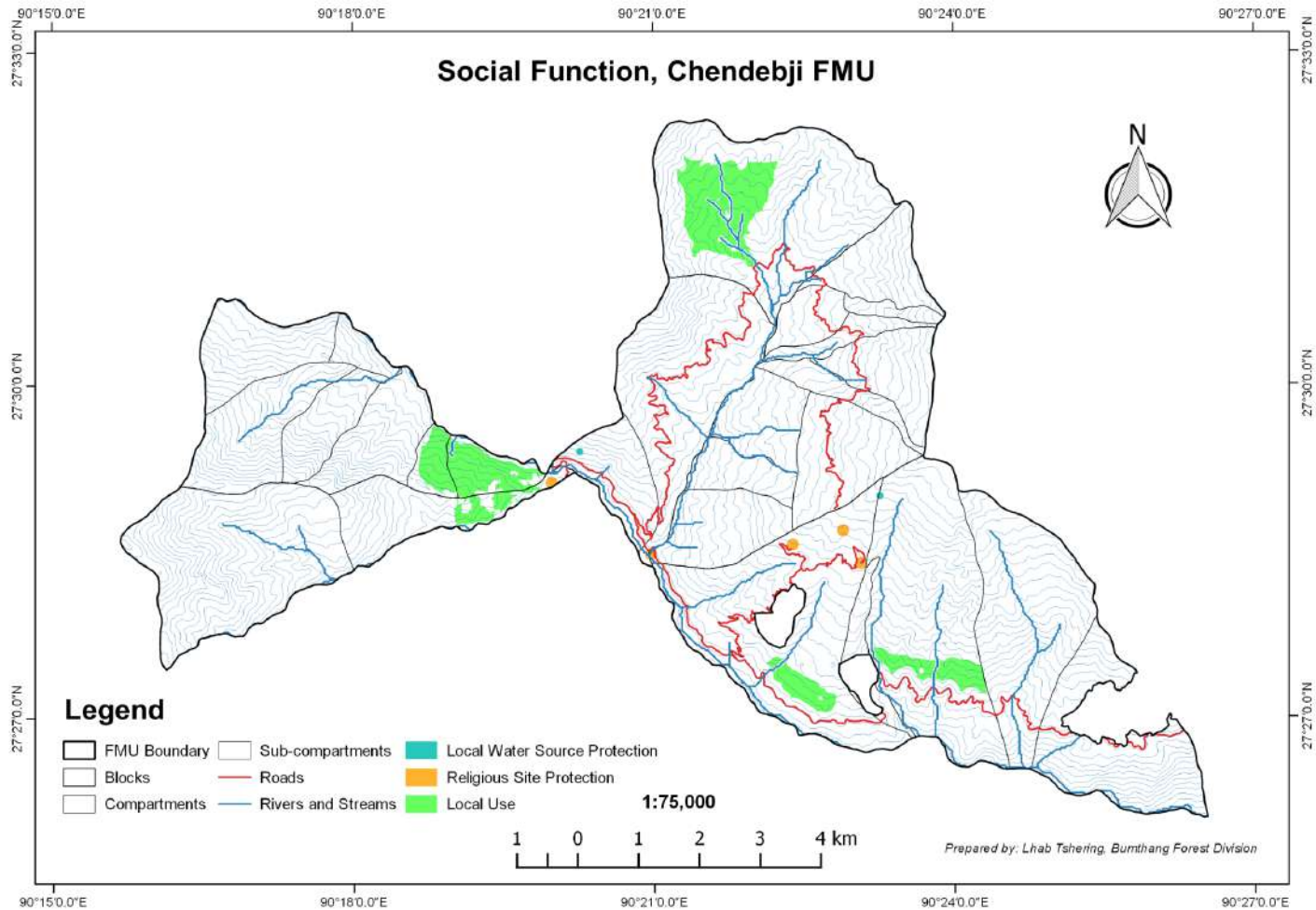
Map 5: Water and Watershed Conservation Function



Map 6: Soil Conservation Function



Map 7: Social Function



11.4.4 Restrictions of Forest Functions

The specific restriction to be applied to forest in the various function categories are summarized in table below:

Table 14: Forest Function Restrictions

Sl. No.	Code	Function	Restriction on Commercial Use	Restriction on Local Use
1	SP	Soil Protection	No commercial use	No tree felling, minimize human interference
2	WRR	Riparian Reserve Protection	No commercial use	Only collection of NWFP; no *tsamdrog*; no *sokshing*
3	RB	Road Buffer	No commercial use	No tree felling
4	NWP	Wildlife Protection	No commercial use	Restriction to activities that do not change habitat quality and disturb wildlife
5	WLS	Local Water Supply Protection	No commercial use	Low impact use only; no cattle grazing
6	SocRS	Religious Site Protection	No commercial use	Only uses which do not disturb the sanctity of the place
7	SocL	Social (Local Use Only)	No commercial use	No restriction
8	SC	Soil Conservation	No clear cutting; no conversion into plantation; extension of rejuvenation periods	Low impact local use; no intensive cattle grazing
9	WSh	Watershed Conservation	No clear cutting; no conversion into plantation; minimize disturbance to understory vegetation	No intensive cattle grazing; low impact local use
10	NWC	Wildlife Conservation	No clear cutting; no conversion into plantation; leave snags; leave some undisturbed patches; minimize disturbance to understory vegetation (bamboo)	Low impact local use
11		Production	No restriction	No restriction

(Forest Resources Development Division, 2004)

12. QUANTITATIVE RESOURCE ASSESSMENT

12.1 Forest Management Inventory

Inventory Design of Chendebji Forest Management Unit

The forest management inventory of Chendebji FMU was conducted in 2013-2014 for the preparation of the third management plan. The standard FMU inventory technique was used, with data being collected for trees >10 cm DBH (OB). A total of 242 plots were laid in the operable areas of the FMU at a more practical spacing of 500 m × 425 m, thus a plot representing an area of 21.89 ha. The inventory was designed with target sampling error of +/- 10% at 90 % confidence level using the coefficient variation of 79.3%. About 55 numbers of the plots were designated as special plots.

The general objective of the inventory was to make available essential background information for preparation of Management Plan. The inventory was carried out to provide accurate overview of the growing stock and regeneration potential of the natural forest in the area, according to major forest types. Further, it was also intended to provide an overview of the general characteristics of the natural forest, indication of timber quantity and furnish essential data on tree height to generate local volume table for main species.

12.2 Forest Management Inventory Result

The data obtained from the forest management inventory was analyzed using statistical software called 'R'. As per the forest management inventory of the FMU carried out in the year 2013-2014, the average standing volume per hectare was found to be 232.28 m^3/ha with a standard error of 17.05%. As the inventory was carried out four year prior to plan writing, the removal of trees from the FMU was also accounted for by obtaining the data of tree harvested from 2014 till 2017. This was mainly done so as to reduce the error in the estimated of volume per hectare in the FMU. The average number of trees per hectare in the FMU was estimated at 193 with a standard error of 4.49%. The basal area per hectare was estimated to be around 22.17 m^2 with a standard error of 1.43%. The summary of the inventory results is shown in the table below:

Table 15: Summary of Inventory Results for overall FMU area

Result Type	Results	Standard Error	Margin of Error	Confidence Interval Low at 90%	Confidence Interval High at 90%
Total Area of FMU (ha)	5296.67	NA	NA	NA	NA
Number of Plots	242	NA	NA	NA	NA
Total Number of Trees After Removal	1023956	50251.84435	8	940980.12	1106931.9
Total Basal Area (m^2) After Removal	117440	7588.810247	11	104909.33	129970.63
Total Growing Stock After Removal (m^3)	1230309.7	90329.82182	12	1081157.07	1379462.42
Number of Trees per Hectare	193	9.487441043	8	177.66	208.99
Basal Area per Hectare (m^2)	22.17	1.43275119	11	19.81	24.54
Volume per Hectare (m^3)	232.28	17.05407772	12	204.12	260.44

13. AREA ORGANIZATION

13.1 Spatial Organization

The strategy for forest resource management begins with the formation of working circle and miscellaneous regulation. Therefore, the formation of working circle is an important step in planning process. The working circle is further divided into blocks, compartments and sub-compartments. The blocks have been demarcated according to natural drainage and terrain features whenever possible. The composition of the blocks, compartments and sub-compartments is given in Table 16:

Table 16: Block, Compartments and Sub-compartment Information

Sl. No.	Block	Compartment	Sub-compartment	Area (ha)	Block Area (ha)
1	Brogena Sekche	1	-	102.75	1,125.83
		2	-	63.63	
		3	-	222.39	
		4	-	154.69	
		5	-	289.66	
		6	-	56.12	
		7	-	236.59	
2	Danglajem	1	a	221.64	1,460.95
		1	b	114.16	
		1	c	176.19	
		1	d	274.19	
		2	a	87.84	
		2	b	198.26	
		3	a	68.6	
		3	b	96.69	
		3	c	38.59	
3	Jawang	1	-	598.83	785.9
		2	-	187.07	
4	Medta	4	-	184.79	959.01
		1	-	251.39	
		2	-	707.62	
5	Nalajem	1	-	415.69	2,663.55
		2	-	574.73	
		3	a	64.53	
		3	B	791.49	
		4	-	817.11	
6	Setta	1	-	857.74	857.74
	TOTAL			**7,852.98**	**7,852.98**

Cable lines are usually aligned along the stable, well-stocked ridges and slopes and away from environmentally sensitive gullies and valley bottoms. According to the Forest Act, the felling of trees along the river banks, streams and in steep gullies is not permitted. The block boundary, as far as possible, follows permanent ridges and waterways to a point where a spur easily recognizable on the ground leads to a ridge top. This will facilitate the recording of removals by cable lines and blocks (Rai, 2007).

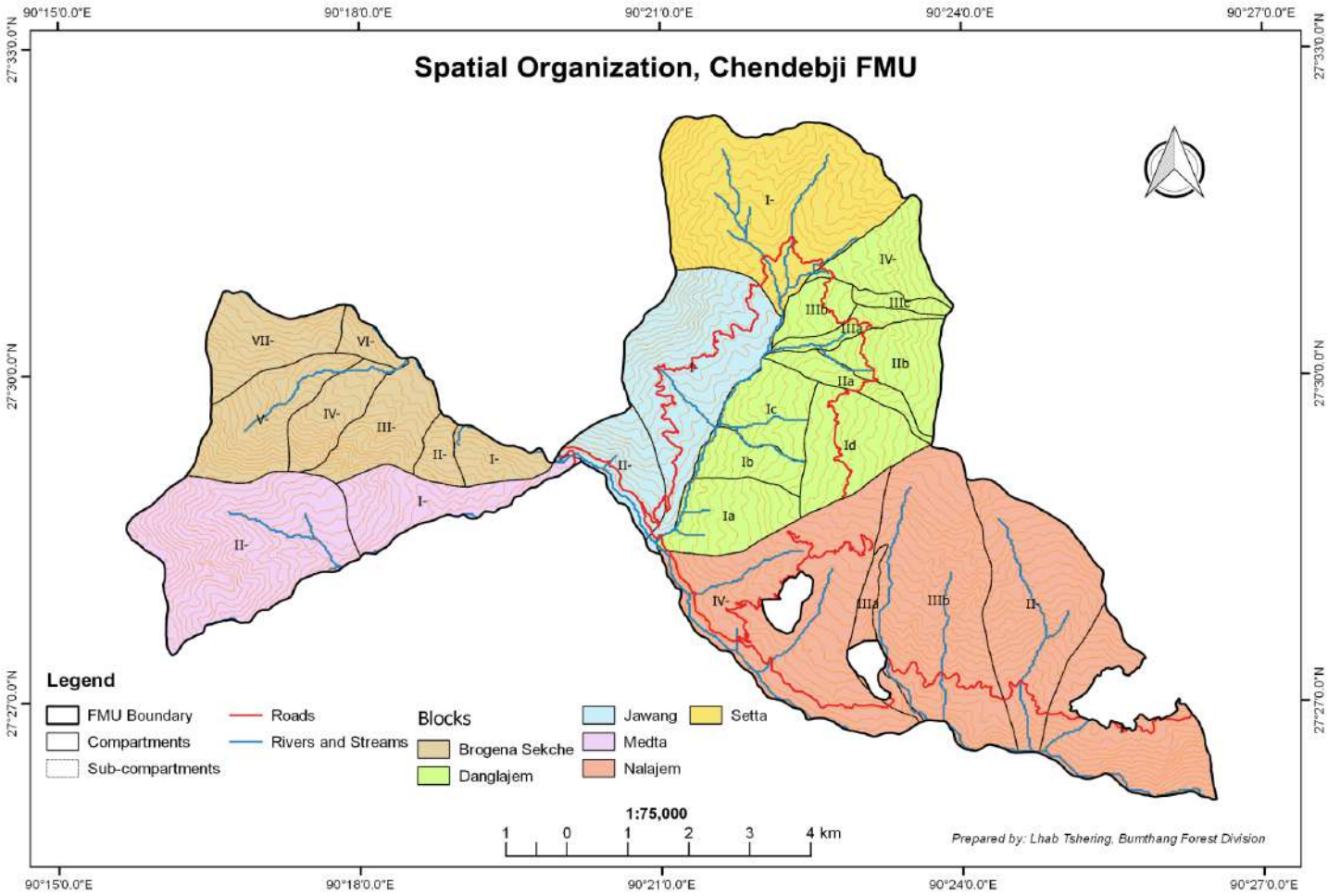
During the Forest Function Mapping, the production areas have been separated for local use and commercial use. In the FMU-level Management Committee meeting, it was agreed that demarcation of separate areas will be done, and production forests will be shared. However, preference will always be given to native inhabitants for rural timber and NWFPs.

13.2 Determining Operable Area

Forests are managed for multiple purposes. The role of forest in serving people assumes utmost significance. The multiple uses of forests are generally protective, climatic, productive, scientific, recreational, etc. But while managing a unit area of forest, all such purposes cannot be equally harmonized. One purpose has to take precedence over the other. The area for commercial and rural forestry activities are those that are left after areas for other critical functions were identified and mapped out, using GIS and inventory information. The functions that take precedence over commercial and rural forestry activities are:

- Soil protection areas (slopes greater than 100%)
- Soil conservation
- Agricultural uses
- Riparian buffers and zones
- Local water supply protection
- Biodiversity areas (wildlife conservation and protection)
- Religious site protection
- Road buffers.

Map 8: Spatial Organization of Chendebji FMU



13.3 Organization into Management Circles and Working Circles

Function mapping was used to delineate three broad management circles for Chendebji FMU. The three broad management circles for Chendebji FMU are Protection, Production and Non-production Management Circles.

Table 17: Area Statement for Management Circles and Working Circles

Management and Working Circles	Area (ha)
Protection Management Circle	
Soil Protection	1306.62
Local Water Source Protection	2.22
Wildlife Protection	1306.62
Riparian Reserve Protection	533.40
Religious Site Protection	15.12
Road Buffers Protection	327.39
Non-production Management Circle	
Shrubs	406.88
Build-up Areas	1.44
Agricultural Land/ Cultivated Land	37.43
Meadows	151.21
Production Management Circle	
Blue Pine Working Circle	670.06
Mixed Broadleaf Working Circle	1,253.44
Fir Working Circle	136.07
Mixed Conifer Working Circle	3,011.70

13.4 Management Circles

13.4.1 Protection Management Circle

The Protection Working Circle is the sum of all protection functions; wildlife protection, soil protection, riparian reserve protection, religious site protection, road buffer protection and local water supply protection. Commercial harvesting activities are strictly prohibited in this management circle. The total area under protection management circle is 2,184.75 ha. The removal of trees may be permitted in the Protection Management Circle to deal with outbreaks of pest and diseases. The outline of management objectives and options of the protection management circle are given below.

Table 18: Protection Management Circle

Management Objectives	Management Options	Responsibility
To conserve and enhance wildlife habitats and biodiversity.	• Avoid disturbance • Promote research and habitat improvement activities	All Parties Territorial Division
To conserve and improve the health of the watershed.	• Minimal intervention	All Parties
To meet the local demand for NWFPs on sustainable basis in order to improve socio-economic status of the people.	• Regulate extraction of NWFP on sustainable basis • Carry out resource assessment	Territorial Division
To prevent negative impacts due to forest resource use on religious sites and water quality.	• No interventions	All Parties

13.4.2 Non-production Management Circle

The Non-production Management Circle includes area where production is not economically feasible. It comprises of non-forest areas, build-up areas, agricultural land and rocky outcrops. The total area under non-production management circle is about 596.96 ha.

Table 19: Non-production Management Circle

Management Objectives	Management Options	Responsibility
To maintain and improve the forest condition.	• Silvicultural Operations • Regeneration	Territorial Division NRDCL
To meet the local demand for NWFP on sustainable basis in order to improve socio-economic status of the people.	• Encourage people's participation in resource management and extraction • Promote community monitoring	Territorial Division
To ensure regulated grazing for livestock in the FMU.	• Encourage high yielding livestock varieties • Fodder tree plantation • Involve local communities	Territorial Division and Local Government
To conserve the water catchment function.	• Plantations • Keeping check on over exploitation of resources	Territorial Division, NRDCL and Local Government

13.4.3 Production Management Circle

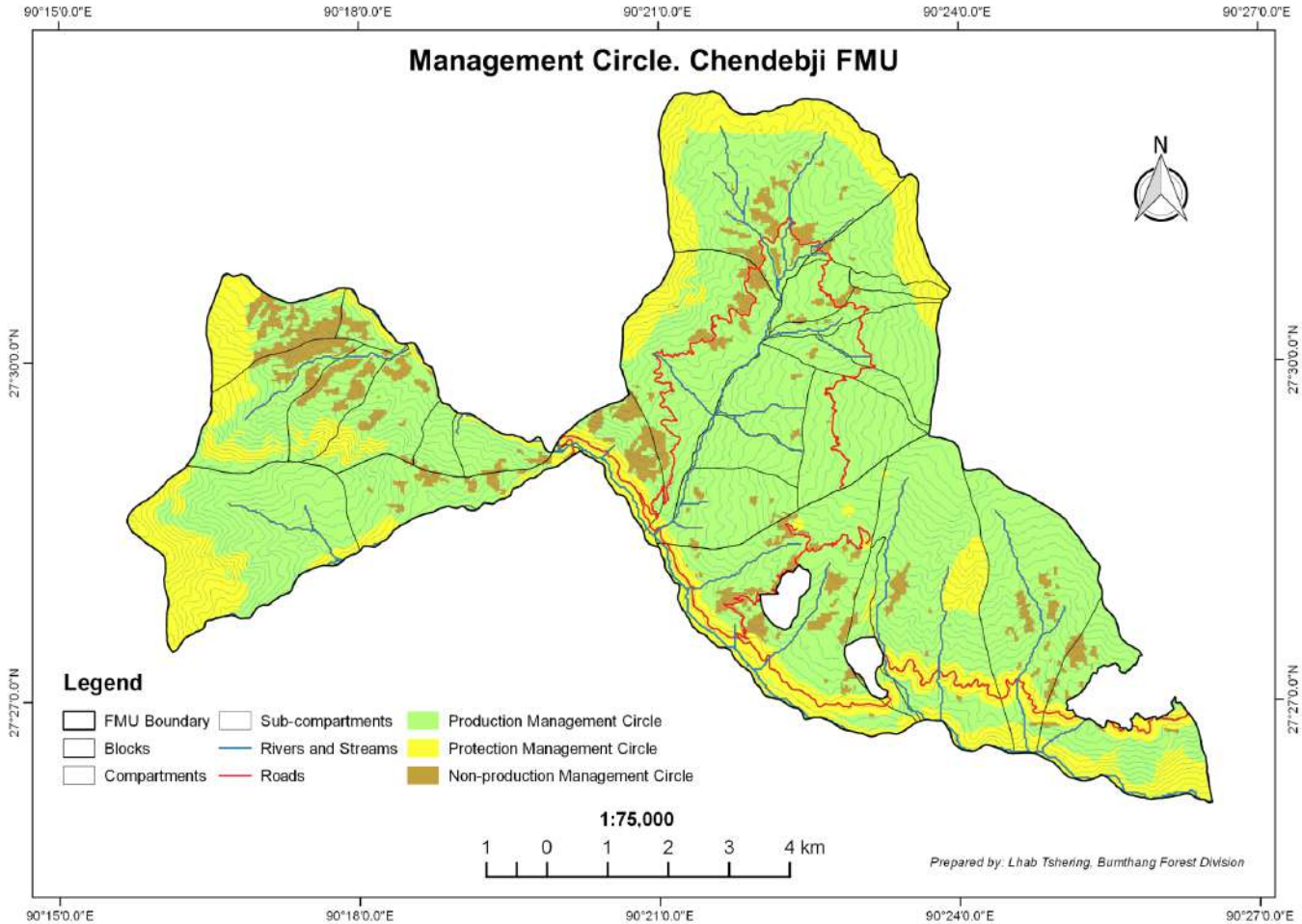
The Production Management Circle comprises of the area that has the potential for harvesting operations. It is the area left after delineation of protection and non-

production management circles. This management circle comprises of areas which are well stocked with species which can be harvested on sustainable basis for both local and commercial uses. The total area under this management circle is 5,071.27 ha.

Table 20: Production Management Circle

Management Objectives	Management Options	Responsibility
To meet local requirements, as priority, for timber, fuel wood and other forest produce on a sustainable basis.	On the basis of single tree selection system from the identified local use area	Territorial Division
To manage and harvest commercial timber on sustainable basis.	Group selection system in mixed conifer, seed tree system in blue pine working circle and patch-cut system for mixed broadleaf working circle.	Territorial Division and NRDCL
To protect the forest from fire, illegal activities and grazing in regeneration areas.	Surveillance and community monitoring Regulated grazing	Territorial Division and Local Government
To create local employment opportunities for local people.	Involvement of local people in FMU activities	Territorial Division and NRDCL
To maintain and improve health and safety measures during operation.	Enforce use of safety gears during harvesting work and road construction	NRDCL and Logging Contractors
To prevent negative impacts due to forest resource use on watershed functions and water quality	Minimal disturbance and plantation wherever required	Territorial Division and NRDCL
To conserve and enhance biodiversity within production areas.	Monitoring and research activities	Territorial Division

Map 9: Management Circle under Chendebji FMU



13.4.4 Non-wood Management Circle (Overlapping)

In rural communities, non-wood forest produce forms a very important element to secure the livelihood of the people. It can also be an incentive for the local communities to conserve forests and take ownership of the resources for its sustainable management. The sustainable harvesting of NWFPs can help people generate income through selling these products in raw form as well as through value addition. However, it is important to introduce the scientific harvesting techniques and create awareness to the people on its harvest and marketing. This will contribute towards sustainable harvest of the available resources and sustain it for the future generations. Although, this management plan does not reflect detailed methods for harvesting of the NWFPs (except for bamboo harvesting), the Interim guidelines for harvesting and marketing of non-wood forest produce can be the basis to ensure its sustainability.

Viewing the contribution of NWFPs to uplift the living standard of the local people, the Non-wood Management Circle has been integrated in this management plan. It is designed as an overlapping management circle and the harvesting can be carried out as per the sustainable principles from all other management circles. The Territorial Division should monitor the collection and processing of the NWFPs from the FMU on regular basis to ensure its sustainability. As per the provisions of FNCRR, 2017, the communities should form NWFP Management Groups and by-laws should be developed accordingly for sustainable management and harvest of NWFPs. The groups should take full responsibility for managing the resources in close consultation with the Divisional Office.

Bamboo

One of the most important bamboo species found in the CFMU is *Borinda grossa* (Figure 8). The presence of *Borinda grossa* is mostly concentrated in Brogena Sekche and Medta Block of CFMU. However, many household in Setta and Nala Village have these species grown around their surroundings. These species is mainly used for weaving mats and fences.

Figure 8: Clump of Borinda grossa

Plant Profile

Scientific Name: *Borinda grossa*
Common Name: Baa (Dzongkha)
Family: Gramineae

Habitat: Wetter temperate mixed coniferous forests often associated with hemlock, at altitude of 1,800 m to 3,200 m.

Physical Characteristics

This is the clumping and frost-hardy mountain bamboo. It is grown in the temperate zone from 1,800 m to 3,200 m above the sea level. It is considered to be the largest clump forming bamboo that is found in the temperate forest. It has internode that reaches up to 50 cm in length. This species is found mostly in association with hemlock. It has dense clumps and they are straight and tough measuring up to 10 m in height. Its clump diameter is around 4-5 cm. Besides being naturally found in the forest, it is also cultivated within the homestead of the village.

This species grows well in moist depression with sandy loam soil. Though, its growth is gregarious in open and light exposed areas but it get matured with a very small culm diameter. The young shoots develop from March till July (General guidelines for Management of Bamboo in Bhutan). Economically, this bamboo species is very important. This species is usually used for weaving mat and fencing lattices. Some basket and decorative items are also made out of this species.

Management

Very little information on this species regarding the management technique is known. However Mr. Prabhat Kumar Mukhia has collected some of the indigenous method of harvesting and planting technique regarding *Borinda grossa*.

Harvesting

During the months of December to March, matured bamboo is collected by the farmers. Usually the matured culm of around one to two years old bamboo is cut with sharp knife (patang) at about 0.6 to 0.9 meter above the ground level (sometimes even cut 1metre above the ground level). The utilized portion of the bamboo measures only around 4 to 5 meter long and rest of the portion is discarded. The main problem is that the discarded potions of the bamboo are thrown there in the field itself. This negligence of the people might lead to the outbreak of the diseases which will have devastating effect on the healthy clumps. Therefore, Unit In-charge must give some awareness regarding the proper harvesting and sanitation of bamboo.

Planting

As observed in the field, most of the farmers do not plant or cultivate this bamboo since this species is readily available in the wild and to the nearest of 2 to 3 hours walking distance to reach the actual bamboo growing area. Those few farmers, who cultivate, do practice the traditional planting method i.e. rhizome cuttings. The whole rhizome along with 1 to 2 meter height of culm is dig out and planted in the desired site especially during the rainy season.

General Harvesting Guidelines of Bamboos

Harvesting guidelines will differ with species. The following general guidelines may be applied.

- Immature culms less than 1 year old should not be cut.
- Immature culms of 1-2 years have very high water content and shrivel up when cut, which makes them useless for construction. Speed of development depends on the condition of the clumps and the position of the culm: If the clump is vigorous and the culm is in exposed position, it matures much sooner. The culms at the center of the poor clump mature more slowly (Haun et al.-1961 and Storey-1998, written in Bradshaw paper 2001).
- In a clump containing 12 culms or more, at least 6 mature culms over 1 year old should be retained, and in a clumps containing less than 4 mature culms over 1 year old, all mature should be retained during felling. Mature culms should be evenly distributed throughout the clump to provide mechanical support as well as nourishment (Gautam 1988).
- All culms older than 4 years should be removed.
- Culms should never become so overcrowded that they touch one another at the base. There must be sufficient space between them to allow movement of the cutting instrument (Sharma, 1988).
- The culms should not be cut lower than the first node above ground level, to ensure that the rhizome is not damaged and not higher than 30 cm (Gautam, 1988). Thinning the clumps reduces rhizome overcrowding and encourages the production of new culms in the center of the clump (Sharma, 1988).
- Damaged culms, debris and cut branches which may have become infested with shoot-boring moths (family: Pareuplexia) should be removed (Bahadur et al., 1980; Stapleton, 1985a) and burnt (Storey, 1988a), along with all dead and dry culms (Gautam, 1988).
- The culms should be severed by cutting round once with the blade of a patang (or any sharp knife) angled at 45 degrees to the stem, then again with it angled the opposite way to produce a wedge-shaped notch. This avoids splitting the culm (Storey, 1988b).

13.5 Management of Working Circles

The Production Management Circle has been divided into four regular working circles (Map 10). The prescription in each working circles will differ and need to be adhered to strictly. The basis for formation of different working circle is purely on the forest composition and is grouped accordingly as per similar silvicultural treatments and requirements. The four working circles under the Production Management Circle are:

1. Mixed Conifer Working Circle
2. Blue Pine Working Circle
3. Fir Working Circle
4. Mixed Broadleaf Working Circle

The objectives, management options, responsibilities, monitoring and evaluation, and silvicultural systems specific to each working circle is given below:

Map 10: Production Management Circle

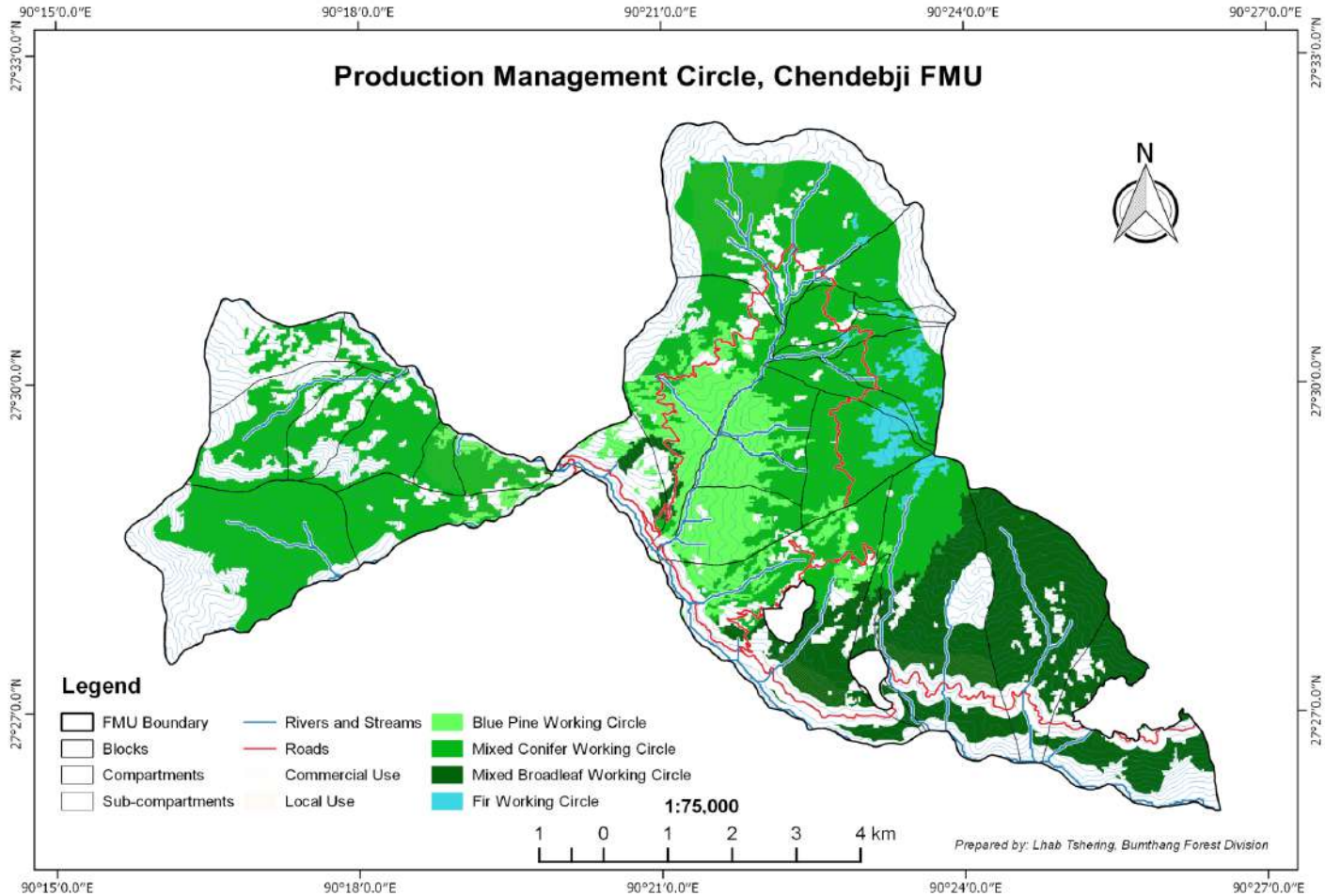


Table 21: Blue Pine Working Circle

WORKING CIRCLE: BLUE PINE				
Management Objectives	**Management Options**	**Responsibility**	**Monitoring**	**Silvicultural Systems**
To meet local requirements, as priority, for timber, fuel wood and other forest produce on a sustainable basis.	1. Controlled marking of trees 2. Systematic thinning	1. Territorial 2. Territorial/ NRDCL	1. Territorial 2. Territorial	***Thinning*** The young Blue Pine stands will be worked under thinning. Marking trees will depend on the number of stem per hectare, age or size class and spatial distribution. The detailed marking guideline for thinning in Blue Pine stand is given in Annexure 3. Dead, dying, malformed and diseased trees will be thinned on priority basis.
To manage and harvest commercial timber on sustainable basis.	1. Encourage use of small diameter wood 2. Promote commercial harvesting	1. NRDCL 2. NRDCL/ Territorial	1. NRDCL 2. Territorial	
To enhance and improve forest productivity	1. Mark trees for rural use as planned thinning exercise. 2. NRDCL to commercially thin stand. 3. Use appropriate logging and silvicultural methods. 4. Restock logged areas (if natural regeneration fails) or barren areas. 5. Create favorable conditions for regeneration and growth. 6. Involve local communities for planting and restocking activities. 7. Use stand tending techniques, such as bush clearing and spacing. 8. Harvest all areas regardless of financial returns	1.Territorial 2. NRDCL/ Territorial 3. NRDCL 4. NRDCL 5. NRDCL/ Territorial 6. NRDCL/ Territorial 7. NRDCL/ Territorial 8. NRDCL	1. Territorial 2. Territorial 3. Territorial 4. Territorial 5. Territorial 6. Territorial 7. Territorial 8. Territorial	

WORKING CIRCLE: BLUE PINE				
Management Objectives	**Management Options**	**Responsibility**	**Monitoring**	**Silvicultural Systems**
To maintain biodiversity within the production area	1. Low impact silvicultural system	1. Territorial/ NRDCL	1. Territorial	***Seed Tree System*** For cable harvesting, felling areas of 1000 m × 30 m can be logged, leaving 20-25 trees/ ha as a seed source. The cable line should be laid to the full length and not to be limited to 1000 m. Harvesting line must not run directly downhill. Lines must be 90 m apart to allow two interlines operation. On exposed or sensitive sites harvesting must leave 40-50 trees/ha and all under-story vegetation. Seed tree must be of good form, not over matured and representative of existing stand. In mixed stand, equal distribution of seed tree must be left (Forest Resources Development Division, 2004).
To create local employment opportunities	1. Employ local contractors and people. 2. Provide proper training.	1. NRDCL 2. NRDCL/ Territorial	1. NRDCL 2. Territorial	
To protect the forest from overgrazing, fire and illegal activities	1. Control overgrazing, poaching, prevent fire and illegal activities with local participation	1. Territorial	1. Territorial	
To conserve the water catchment functions.	1. Minimal intervention. 2. Abide by stream buffer regulations	1. Territorial 2. NRDCL/ Territorial	1. Territorial 2. Territorial	

Table 22: Mixed Conifer Working Circle

WORKING CIRCLE: MIXED CONIFER				
Management Objectives	**Management Options**	**Responsibility**	**Monitoring**	**Silvicultural Systems**
To manage the commercial timber production on sustainable basis.	1. Use appropriate logging and silviculture method. 2. Ensure cable line layout allows interline logging. 3. Operate entire cable line. 4. Encourage cleaning of entire cable lines.	1. Territorial/ NRDCL 2. Territorial/ NRDCL 3. Territorial/ NRDCL 4. NRDCL	1. Territorial 2. Territorial 3. Territorial 4. Territorial	***Group Selection System*** The coupe sizes recommended by RNR-RDC Yusipang serves as a guideline to follow for each silvicultural system prescribed for each forest type. Cable lines will be laid to their full capacity. Cable corridors will be not more than 4 m wide. Group opening will not exceed 0.15 ha. The distance between the cable lines will be 60 m and between groups along cable line will not be less than 50 m (Forest Resources Development Division, 2004). All merchantable trees >10cm DBH will be felled. Dead, dying, malformed and diseased tree be felled by priority.
To enhance and improve forest condition and productivity.	1. Ensure that all barren areas are restocked with suitable native species if natural regeneration fails. 2. Use appropriate logging and silvicultural method. 3. Monitor on the attack of pest and disease. 4. Involve local communities.	1.NRDCL/ Territorial 2.NRDCL/ Territorial 3.Territorial 4. NRDCL/ Territorial	1. Territorial 2.Territorial 3.Territorial 4.NRDCL/ Territorial	
To protect the forest from overgrazing, fire, illegal activities and from grazing in regeneration areas.	1. Control over grazing, fire, poaching and other illegal activities through community participation and proper fencing.	1. Territorial/ NRDCL	1. Territorial	
To create local employment.	1. Employ local people. 2. Employ local contractor.	1.NRDCL 2.NRDCL	1.NRDCL 2.NRDCL	

WORKING CIRCLE: MIXED CONIFER				
Management Objectives	**Management Options**	**Responsibility**	**Monitoring**	**Silvicultural Systems**
To maintain biodiversity within the production area.	1. Low impact silviculture system.	1. Territorial/ NRDCL	1.Territorial	Opening can be irregular shapes and should be based on terrain features and stand condition. Damage to residual tree must be minimized.
To conserve the water catchment functions.	1. Minimal intervention. 2. Abide by stream buffer regulation.	1.Territorial/ NRDCL 2.NRDCL/ Territorial	1.Territorial 2.Territorial	
To continually improve health and safety standards.	1. Provide training to contractors and machine operators. 2. Provide awareness to local community.	1.NRDCL 2.Territorial	1. Territorial 2. Territorial	

Table 23: Mixed Broadleaf Working Circle

WORKING CIRCLE: MIXED BROADLEAF				
Management Objectives	**Management Options**	**Responsibility**	**Monitoring**	**Silvicultural Systems**
To meet local requirements, as priority, for timber, fuel wood and other forest produce on a sustainable basis.	1. Consult with local community to ensure their needs for hardwood products (including lopping, etc.) are being met and resource is not diminished	1. Territorial	1. Territorial	***Patch-cut System*** The research finding has suggested that Patch Cut System is the appropriate silvicultural system apt for broadleaf forest. The patch will not exceed more than 0.25 ha and will be spaced in the interval of 50 m. 4 m cable corridor will be maintained (Wangdi, 2016). Artificial regeneration will be taken up immediately after coupe clearance is issued. NRDCL to maintain nursery at the site for artificial regeneration. Nursery to be stocked with local and commercial species.
To manage and harvest commercial timber on sustainable basis.	1. Operate entire cable length 2. Ensure cable line layout allows interline logging 3. Use prescribed silviculture method and appropriate logging method 4. Encourage cleaning of entire cable lines	1. Territorial/ NRDCL 2. Territorial/ NRDCL 3. Territorial/ NRDCL 4. Territorial/ NRDCL	1. Territorial 2. Territorial 3. Territorial 4. Territorial	
To improve forest condition and other vegetation cover of the area.	1. Minimal intervention	1. Territorial/ NRDCL	1. Territorial	
To create local employment opportunities for local people.	1. Employ local people. 2. Employ local contractor.	1.NRDCL 2.NRDCL	1.NRDCL 2.NRDCL	
To protect the forest from grazing, fire and illegal activities	1. Control grazing, fire, illegal felling through community participation	1. Territorial	1. Territorial	

WORKING CIRCLE: MIXED BROADLEAF				
Management Objectives	**Management Options**	**Responsibility**	**Monitoring**	**Silvicultural Systems**
To maintain biodiversity within the production area	1. Low impact silviculture systems	1. Territorial/ NRDCL	1. Territorial	
To conserve the water catchment functions	1. Minimal interventions 2. Abide by the buffers prescribed	1. Territorial/ NRDCL 2. NRDCL/ Territorial	1. Territorial 2. Territorial	

Table 24: Fir Working Circle

WORKING CIRCLE: FIR				
Management Objectives	**Management Options**	**Responsibility**	**Monitoring**	**Silvicultural Systems**
To meet local requirements, as priority, for timber, fuel wood and other forest produce on a sustainable basis.	1. Controlled marking of trees and proper monitoring	1. Territorial	1. Territorial	***Group Selection System*** The coupe sizes recommended by RNR-RDC Yusipang serves as a guideline to follow for each silvicultural system prescribed for each forest type. Cable lines will be laid to their full capacity. Cable corridors will be not more than 4 m wide. Group opening will not exceed 0.1 ha. The distance between the cable lines will be 60 m and between groups along cable line will not be less than 50 m (Forest Resources Development Division, 2004). All merchantable trees >10cm DBH will be felled. Dead, dying, malformed and diseased tree be felled by priority. Opening can be irregular shapes and should be based on terrain features and stand condition. Damage to residual tree must be minimized.
To manage and harvest commercial timber on sustainable basis.	1. Operate entire length of cable line. 2. Ensure cable line layout allows interline logging. 3. Use prescribed logging and silviculture methods. 4. Ensure cleaning of entire cable lines.	1. Territorial/ NRDCL 2. Territorial/ NRDCL 3. Territorial/ NRDCL 4. NRDCL	1. Territorial 2. Territorial 3. Territorial 4. Territorial	
To enhance and improve forest productivity	1. Ensure that barren areas are restocked sufficiently with desired species. 2. Plantation with protection. 3. Harvest all Fir (Dieback) areas to ensure the next rotation has less rot using full cable line lengths. 4. Work with local communities for planting/ restocking activities. 5. Use stand tending techniques. 6. Create favorable conditions for regeneration and growth.	1. NRDCL/ Territorial 2. NRDCL 3. NRDCL 4. NRDCL 5. NRDCL/ Territorial 6. NRDCL	1. Territorial 2. Territorial 3. Territorial 4. NRDCL 5. Territorial 6.Territorial	

WORKING CIRCLE: FIR				
Management Objectives	**Management Options**	**Responsibility**	**Monitoring**	**Silvicultural Systems**
To create employment opportunities for local people.	1. Employ local people. 2. Employ local contractors.	1. NRDCL 2. NRDCL	1. NRDCL 2. NRDCL	
To maintain biodiversity within the production area	1. Low impact silviculture systems	1. Territorial/ NRDCL	1. Territorial	
To protect the forest from fire, illegal activities and from grazing in regeneration areas.	1. Control grazing, fire, poaching and illegal felling with local community participation.	1. Territorial	1. Territorial	
To conserve the water catchment functions	1. Minimal intervention. 2. Abide by stream buffer regulation	1. Territorial 2. NRDCL/ Territorial	1. Territorial 2. Territorial	

13.6 Implementing Working Circle Management

The Forest Function planning has been used in this plan to allocate land use among the forests in the FMU, so that strategic planning for sustainable yield can be carried out. The problem still remains to implement these prescriptions on the ground. Later sections indicate that this will be done through an Operational Planning process whereby more detailed information is collected through inventory and discussions with stakeholders, primarily local communities and NRDCL. However, even when this more detailed data is collected, the requirement remains to locate individual Forest Functions on the ground so that the prescriptions given can be implemented. Although, maps have been prepared indicating the boundaries of Forest Functions, the map indicating all Functions is quite complex. In addition, experience in the field indicates that the bases for all maps are derived, from the 1:50,000 topographic maps, which is often inaccurate and inappropriate for implementing Operational Plans.

Therefore, the Unit In-charge will have to use the provided maps to the best of their ability. Areas should be observed on the forest function maps prior to going to the field. Once in the field, visual observation within the operable areas should be able to provide the needed information. For example, stream buffer will occur in all the perennial streams and steep slopes should be measured and observed for soil protection or conservation. The forest function maps will be updated accordingly as per the field observations.

14. YIELD REGULATIONS AND HARVESTING

14.1 Determination of Annual Allowable Cut (AAC)

14.1.1 Introduction

Forest management based on the principle of sustainability ensures sustainable utilization of forest resources by present as well as future generations. The principle of sustained yield ensures the stability and continuous supply of raw materials to the industries and meets the local needs of the people. The concept of Sustained Yield allows harvesting of forest resources by which annual cut and other losses of timber do not exceed the average annual growth. It also assures continuity of harvest without impairing the productivity of the soil. The calculation of sustained yield is expressed as AAC.

14.1.2 Increment Based AAC

In a perfectly structured normal forest, it should be possible to sustainably cut the annual increment each year. Some calculation methods rely heavily on increment.

Unfortunately, data on increment is still limited for Chendebji FMU and Bhutan in general, and it will be some time before valuable data from permanent plots are available. The forests are not perfectly structured, but have very varied natural growing stock (of different cohorts), some of which (particularly Fir zone) is actually in negative increment at present as the rate of decay exceeds new growth. In the long term, increment should increase as over matured stands are replaced by younger stocks, but it will be many decades before this second growth is available for harvest. There is an over-matured growing stock and too little and unreliable increment data to be used in determining AAC. Therefore, increment based AAC is currently unsuitable for Bhutan.

14.1.3 The Most Appropriate AAC Method

Annual Allowable Cut can be calculated using a wide range of formulae but the most suitable formulae used for the purpose of this management plan is the combination of area, rotational age and standing volume of species. The formulae used for calculation of AAC for Chendebji FMU is given below:

This method is applied for calculating AAC for each Working Circle and are added together to calculate the total AAC. Due to different rotation age used for different working circle, it is necessary to calculate the AAC for each working circle first and sum it all to obtain the total AAC of the FMU. However, it should be noted that the AAC for each working circle should not be the basis for annual harvest in the field due to the fact that one cable line may cross more than one working circle if it is laid to the maximum length. This will also enable the implementer to lay the cable lines to the maximum length and make the best use of available production area.

14.1.4 Calculation of AAC for Chendebji FMU

Net Operable Area

The total operable area is identified through mapping using GIS technique. But it has been observed that in most of the FMUs, the total operable area cannot be always subjected to harvesting. Within the mapped area there can be small rocky terrain, water bodies and other conservation areas which often prevent harvesting operations. This occurs mainly when the cable lines are being laid out. Beside this, Group Selection System almost inevitably leads to some patches of mature timber being left in later phases due to the presence of new regeneration and the possibility of damage.

In such challenging terrains in Bhutan, exact geometric-shape group layout is rarely possible. Due to the above inevitable fact, the past management plans practiced the method whereby around 20% of area from the gross operable area has been reduced to calculate the net operable area in commercial Working Circles. However, this practice has led to inefficient use of production areas and has affected the sustainability of FMUs in the country. Therefore, this management plan does

not prescribe the reduction in areas to calculate net production area as all areas which are inaccessible and inoperable are already mapped out as designated under protection working circle (Table 25). This prescription mandates the Unit In-charge and NRDCL to properly utilize the available production areas so that the area can be sustained for future harvesting operations. Any deviations from the prescribed cable line layout should be approved by the Department prior to implementation.

Table 25: Calculation of Net Production Area

Forest Types	Gross Operable Area (ha)	Calculation	Net Production Area (ha)
Mixed Conifer	3,011.70	In order to calculate the net production area, no area from the gross operable area has been reduced.	3,011.70
Blue Pine	670.06		670.06
Fir	136.07		136.07
Mixed Broadleaf	1,253.44		1,253.44
TOTAL	**5,071.27**		**5,071.27**

Rotation and Regeneration Period

The assumed rotation age for Mixed Conifer and Fir is 160 years. Consideration of regeneration period while calculating rotation age is very crucial. Therefore, while calculating AAC for Chendebji FMU, 20 years of regeneration period has been added to the rotation age of Mixed Conifer and Fir. As a result, the rotation age for Mixed Conifer and Fir is fixed at 180 years. The assumed rotation length for Blue Pine which grows at relatively lower altitude is 110 years. Therefore, the rotation age for Blue Pine is kept at 110 years. For Broadleaf forests, the regeneration period is rather very long, and particularly in Chendebji, problems of regeneration have been an issue. Therefore, a 10 year has been added to the rotation of broadleaf forests (100+10 years). The assumed rotation lengths for the calculation of AAC in Chendebji FMU are:

Mixed Conifer Working Circle= 160+20 Years= ***180 Years***
Blue Pine Working Circle= ***110 Years***
Fir Working Circle=160+20 Years= ***180 Years***
Mixed Broadleaf Working Circle= 100+10 Years= ***110 Years***

Average Standing Volume

The mature average standing volume is derived from management forest inventory data statistically analyzed using "R". The sampling error and RME for each stratum is given below (Table 26). The forest management inventory of Chendebji FMU is designed based on the entire forest type and not based on individual stratum. Therefore, the average standing volume obtained from the analyzed data is kept the same irrespective of the stratum. Hence, the average standing volume for all the

strata is considered as 232.28 m^3/ha with a standard error of 17.05%. The reliable minimum estimate of standing volume thus obtained was 192 m^3/ha for all stratum.

AAC for Each Working Circle

The AAC for each working circle is given in the following table (Table 26). Due to different rotation for each stratum, it is necessary to calculate the AAC for each stratum. However, while implementing practically in the field, it is essential to consider that one cable line may pass through more than one stratum. This makes it difficult to totally base the harvest as per individual stratum. Therefore, during implementation, the total AAC (sum total of AAC for each stratum) should be considered instead of AAC for each stratum.

Table 26: AAC for the Working Circles (Standing volume)

Stratum	Net Operable Area (ha)	Rotation (Years)	RME standing volume (m^3/ha)	AAC (m^3/yr)	Clear-cut Equivalent
Blue Pine	670.06	110	192.68	1,173.70	6.09
Mixed Conifer	3,011.70	180	192.68	3,223.86	16.73
Mixed Broadleaf	1,253.44	110	192.68	2,195.57	11.39
Fir	136.07	180	192.68	145.66	0.76
TOTAL	**5,071.27**			**6,738.79**	**34.97**

Therefore, the total workable AAC for Chendebji is fixed at 6,700 m^3 in standing volume. It is permissible to vary the AAC area by plus or minus 10% in individual years, but the volume cut in each five year period must be no more than five times the AAC. The AAC prescribed is not solely to be met from the cable lines. The volume obtained from ad-hoc logging and thinning within the FMU should be accounted for.

There is a substantial increase in the AAC allocation compared to last plan period. The last plan has allocated AAC of 1,100 m^3 of which 800 m^3 is allocated to commercial use whereas remaining 300 m^3 is allocated to rural use. The increase in the AAC for this plan period to 6,700 m^3 is mainly attributed by the change in approach during calculation of net production area.

While calculating the AAC for the last plan, only unlogged area was considered which reduced the overall production area of the FMU. Since the production areas decreased, the AAC for the FMU also fell down drastically. This was mainly done as a conservative approach to ensure the sustainability of the FMU. More production area was lost during the first plan period due to lying of shorter cable lines, leading to early exhaustion of overall production area. However, while writing this plan, the forest function mapping was carried out which included all logged and unlogged

areas under production management circle. This brought about substantial increase in the production area, thus increasing the AAC for this plan period. Further, the reduction of 20% area from gross operable area to calculate the net operable area was not considered by the Technical Review Committee of FRMD, stating that all inoperable areas are already being mapped out during forest function mapping and is put under protection management circle. These led to the drastic increase in AAC compared to the last management plan.

14.2 Recording and Accounting for AAC

Annual Allowable Cut will be monitored through the records of tree marked (Tree Marking Register) for both commercial and local use in all the Working Circles. AAC has been calculated as gross volume and this is the measure that should be totaled on annual basis from the Tree Marking Register.

14.3 Allocation of AAC

The allocation of AAC has taken into account the needs of both rural people (living within and near Chendebji FMU) and commercial demands. The AAC for rural use has been allotted based on the demand and the Local Use Area.

Table 27: Allocation of AAC

Standing Volume (m^3)	Allotted to
2,000 m^3	Local Use- Allocated to local villages and general public.
4,700 m^3	NRDCL- Allocated for meeting the timber demand in the market.

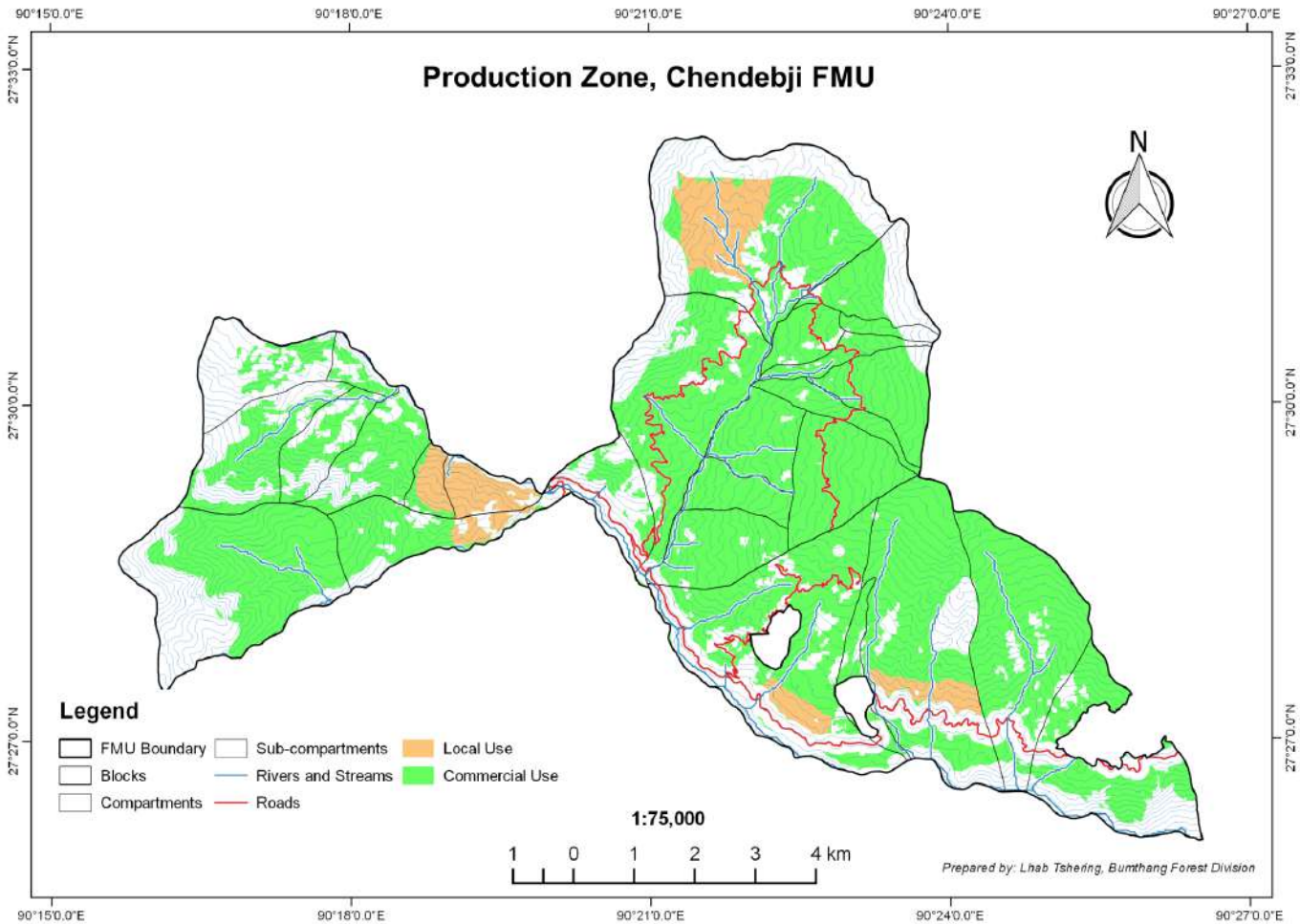
Note: The over harvest of the previous plan in case of rural allocation will also be adjusted in the current plan.

During the last plan period, there has been over-harvest from the FMU. A total standing volume of 2,533.92 m^3 has been over harvested and this needs to be adjusted in during the first year of implementation. Therefore, the AAC for the first year of this plan's implementation is prescribed as 4,166 m^3 for commercial harvesting and rural harvesting combined after the necessary adjustments.

14.4 Distribution of the Cut

AAC has been calculated by Working Circles. However, during the implementation, it should be noted that the distribution of cut will be considered as the entire FMU and not as individual working circle. If the operation area for a particular area falls completely under one working circle, the sum total of AAC for that year will be removed from this working circle. Therefore, the AAC for each stratum is mentioned purely for calculation purposes and not to be read as individual cut for each working circle. The number of cable lines to be harvested annually should be mentioned in the Annual Operational Plan.

Map 11: Production Zone



15. SILVICULTURAL SYSTEMS

15.1 Group Selection System

For the Mixed Conifer and Fir Working Circle in the FMU, Group Selection is the prescribed Silvicultural System. The particular Silvicultural System has been selected based on the ecosystem and natural regeneration system. Under the Group Selection System, small openings will be created in the stand allowing light to reach the forest floor and creating conducive micro climate for seed germination and establishment of seedlings. The opening will be no longer than one and half tree length in the Hemlock, Spruce and Fir Stand.

The groups will be opened along cable lines. The distance between cable lines will be not less than 60 meters, and between groups along cable line not less than 50 meters. The corridors should not exceed four meter widths. The effective area within the limit of standard cable length is 6 hectares (1000 meters x 60 meters), less the area of the corridor 0.40 hectares (1000 meters x 4 meters), thus the one third removal would be equivalent to (1.87 ha) which is the area available for opening groups. Thus, it would be possible to open up around 9 to 10 groups along the standard cable lines, if the average tree height is taken around 35 meters and further the diameter of any opening will not exceed 50 meters.

The individual openings need not be uniform in shape or size and systematically located along cable lines. In most cases the openings will be irregular in shape and systematic location of groups will be almost impossible. Aspect, slope and silvicultural requirement would influence the actual size of the groups. An average of 0.15 ha opening is recommended. However, group opening in fir working circle will not exceed 0.1 ha.

Existing opening in the stands which can be expanded, signs of existing windfall in the stands, stands which are mature or diseased, and stands infested with mistletoes should be chosen as groups as priority. In order not to lose the site protection effect of the surrounding trees it is necessary that the specified size for opening should be strictly adhered to. The tree should be felled towards the center of the group opening whenever possible to avoid damage to the unmarked trees. Terrain with steep slope and exposed South and South-West aspects should be avoided, or the opening should be smaller to match with the terrain and site conditions or the selection system should be applied.

In areas where opening cannot be created under Group Selection System (in between two cable lines) such areas should be operated under Single Tree Selection System. However, care should be taken that spatial distribution of the trees are strictly followed and should match with openings created under Group Selection System.

The Group Selection System has the following advantages:

- Regeneration in the small groups under even-aged condition gives better stem form.
- Larger openings in comparison to that under single tree selection system permit the establishment of intolerant species.
- Harvesting is more concentrated, so the logging cost is lower.
- Harvesting in group lower damages to residual stands.
- Intermediate cuts may be made less frequently.
- Aesthetically and environmentally more acceptable than clear cutting system.

15.2 Single Tree Selection System

The Single Tree Selection System will be applied to Local Use areas in case of rural marking for extraction of rural house building timber and firewood. Single tree selection system follows principles of nature that matured trees are selected and removed to enable regeneration to replace them. The felling should be scattered all over the operational area instead of confining to certain parts of forest. Felling should involve removing of trees or small groups of trees. This system helps to maintain uneven-aged character of the forest crop.

It is observed in most cases that the trees of best economic interest are selected and felled. Instead of following this, Unit In-charge of the particular FMU should judge and familiarize with the forest condition and silvicultural requirement of the species and do the selection with the interest of meeting the objectives of the system. As far as possible, selection of trees to be felled should be done for following categories first especially in young and immature stands.

- Dead, dying, diseased, misshapen or otherwise defective trees which interferes with the growth of neighboring vegetation.
- Trees of undesirable species.
- Immature tree which can be removed by judicious thinning.
- Mature trees above the exploitable diameter, which will leave gaps for regeneration to come up.

15.3 Seed Tree System

Blue Pine Working Circle will be worked under Seed Tree System as Blue Pine regenerate very easily under Seed Tree System. About 20 to 25 seed trees (plus tree or mother tree) per hectare should be retained as seed source. These trees must be of good health and vigorous in growth which would truly serve as good seed source. Slope characteristics, wind firmness and aesthetic value have to be taken into consideration while utilizing this system. Again in applying this system, site condition like aspect must be considered. For cable harvesting, felling areas of 1000 m x 30 m can be logged, leaving 20-25 trees/ha as seed source. Harvesting lines must not run directly downhill. Lines must be 90 m apart, allowing 2 interline

operations. Dead, dying, malformed and diseased tree will be cut on priority basis. On exposed or sensitive site, harvesting must leave 40 to 50 trees/ha.

15.4 Thinning

The young Blue Pine stands (Blue Pine Working Circle) will be worked under thinning. The thinning will be done by positive selection with due consideration to stabilize the structure of the stands. This type of thinning will be to direct the growth potential of the stand and site to the most promising individuals of the tree populations to maximize volume and quality production. The stand to be thinned will be identified from the treatment map and field visit. Pruning in the appropriate stands will also improve the value of the forests. Marking of trees will depend on the number of stem per hectare, age or size class and spatial distribution. The detailed marking guideline for thinning in Blue Pine stand is given in Annexure 3. Dead, dying, malformed and diseased tree will be thinned on priority basis. Large opening must not be created. Thinning area should be identified as per this plan and should be carried out annually in order to improve the existing stand.

16. FOREST PROTECTION

16.1 Fire

As per the record with the FMU Office, one fire incidence occurred in 2010 which burned down 29.1 ha of forest. However, the forest fire has not been a major threat in the FMU. As the FMU area is mostly covered with Mixed conifer and Blue Pine forest, it is essential to take preventive measures to reduce the risk of major forest fire in the future. The Unit In-charge and the Production In-charge of NRDCL will need to review forest fire protection programs at regular interval in consultation with the local communities and the various stakeholders involved with activities of FMU.

16.2 Pest and Disease Management

Till date, there is no record of any pest and diseases outbreak in Chendebji FMU. However, there can be chances of pest and diseases outbreak in the future. Therefore, periodic monitoring of the forests to check any outbreak of pest and diseases will be done. In order to detect and report any outbreak of pest diseases, the FMU staffs will conduct regular inspection to enable the initiation of earliest possible remedial and preventive measures. Report should be submitted to the CFO, Bumthang and also to the Specialist(s) with the Department.

The following are the control measures suggested:

- Regular periodic survey of the forest and removal of deformed trees.
- Regular survey of regenerated areas and burning of infected plants after slashing and debarking.

- Education extension program for the people and the workers in the forest to report symptoms of the disease will be part of the pest and disease management program within the FMU.

The planting stock at any nursery, which will be supplied to the Unit for further plantation, will need to be monitored for pest and diseases. The infected seedlings should not be supplied, instead destroy by burning at the nursery itself.

16.3 Grazing

In line with the multiple-use of the forests and as provided in the National Forest Policy of Bhutan, 2011, grazing will be allowed in some parts of the FMU. Grazing will not be permitted in areas identified as protection areas and light grazing will be permitted in areas identified as conservation areas. The local people are complaining about the reduction of their grazing land size due to the natural regeneration coverage of Blue Pine. In Setta Block, there are incidences where the natural regeneration of Hemlock being deliberately burned by the local people to protect their grazing land from tree coverage. Thus, a participatory approach to secure the co-operation of the local communities to manage the grazing land for their cattle will be adopted with high priority.

17. ENVIRONMENTAL STATEMENT

All developmental proposals in Bhutan have to fulfill certain environmental criteria as per the provision of the Environmental Assessment Act, 2000. The Chapter III, Section 18 of the Environmental Assessment Act necessitates obtaining environmental clearance prior to the commencement of the proposed developmental activity. To carry out any forestry activities, the National Environment Commission Secretariat has developed Regulation for Environmental Clearance of Projects in 2002, the procedures of which the applicant should meet. This section of the plan provides all necessary information required for environmental clearance which includes the perceived threats of the proposed project to the environment and necessary mitigation measures to minimize the impacts resulting from the planned activities. This section, altogether, meets the requirement of the Act to be fulfilled by the applicant concerned.

17.1 Project Description

17.1.1 Introduction

Chendebji Forest Management Unit was established in the year 1996 in line with the Department's aspiration to establish one FMU in each Dzongkhag to cater to the timber needs of the people of Bhutan on sustainable basis. The FMU was operational since 1996 till date and it was managed based on the two 10 year plans. Now the FMU will be managed with this plan which is the third one since its inception.

The harvesting operations were carried out generously during its first plan period and a huge volume of timber was extracted on a sustainable harvesting principles. However, during the second plan period, the harvesting of timber was drastically brought down to one cable line of harvest per year. This was done in order to protect the sustainability principle of the forest management. The harvesting carried out during the second plan period was not economically viable even though the operation was carried out by NRDCL to fulfill its mandate to manage the area. Chendebji FMU will be worked on the principle of sustainability to meet the timber for commercial as well as *bona fide* rural requirements. The FMU will be managed on the basis of sustainability principles which will ultimately improve the forest stands.

A total area of the FMU which sums up to 7,852.98 ha will be managed based on this principle out of which only 5,071.27 ha of forest will be subjected to harvesting operations. The broad objective of this project is to harvest the over matured and matured trees to improve the forest stands and also to make timber available in the market along with generation of revenue for the government. To enable transportation of logs from the forest, a total of approximately 15 kms of road and a bridge need to be constructed during this plan period of 10 years.

17.1.2 Objectives

- To improve the forest stand of Chendebji.
- To ensure sustainable supply of timber, fuel wood and non-wood forest produces.
- To regulate grazing in an organized manner and on sustainable basis.
- To support developmental activities through the construction of forest road.

17.1.3 Project Location and Area

The Chendebji Forest Management Unit is located in two Dzongkhags with the major portion situated in Trongsa Dzongkhag and a small portion in Wangduephodrang Dzongkhag. The Forest Management Unit falls within 90˚15′5″ and 90˚32′20″ East and 27˚26′5″ and 27˚32′20″ North (Toposheet No. 781/6 and 781/7). The Thimphu-Bumthang National Highway runs through the middle of the Forest Management Unit. The total area of Chendebji FMU is 7,852.98 ha. The entire area will not be subjected to harvesting. Only about 5,071.27 ha of area will be subjected to timber harvesting in a scientific and sustained manner. Rest of the area is categorized under various protection and non-production zones.

17.1.4 Benefits

Some of the mixed conifer stand in Medta Block and Fir Stand in Nalajem Block of Chendebji FMU are over matured, hence does not put on significant increment. Thus, these over matured stands can be harvested so that it creates space for regeneration to establish. This not only benefits in terms of generating revenues

but also help improve the forest conditions. The FMU activities can also contribute towards providing employment opportunities to the local communities. Local people can be involved as unskilled labor during maintenance of road, construction of forest road, extraction of timber and transportation. This will help uplift the livelihood of the people residing in and near by the Forest Management Unit.

The existing FMU road and the proposed new roads will benefit the settlements within the FMU. Newly proposed FMU road and bridge towards Medta Block, which passes through Chendebji Village, will benefit the people living there. It will also help them transport their farm products to the market and therefore contribute towards uplifting their living standard. The FMU road will also help people extract rural timber for their house construction and renovation purposes. The harvesting of matured trees as per the prescription of the plan will allow the extraction on sustainable basis and also contribute towards government revenues. Managed forest will definitely ensure future sustainability of the resources.

17.2 Forest Management Unit: Planning and Zoning

All the Management Plans will have to be prepared based on Forest Management Code of Bhutan, 2004. Very comprehensive and consultative land use planning has to be carried out while preparing the Forest Management Plan. The process is briefly outlined below:

The FMU resource inventory was carried out in 2013-2014 by FRMD Inventory Crew to provide the information about tree stocking, regeneration, timber volumes, site characteristics, wildlife presence and understory species. Consultation with the community was carried out to map out local use areas, drinking water sources, places of religious importance, among others.

Forests zoning is based on above data collected, using the forest function mapping prescribed in the Forest Management Code of Bhutan. The area is divided into different forest type called Working Circle and they are further divided into Blocks, Compartments and Sub-compartments. The protection areas such as soil protection, wild life protection, rivers and streams buffer protection, etc. are excluded from the net operable area.

The silvicultural system to be implemented is Group Selection System for Mixed Conifer and Fir Working Circle. For Blue Pine Working Circle, Seed Tree System and Thinning operations will be applied. No clear cutting will be permitted and all the trees will be harvested using the skyline cable crane. The opening of the group size can vary between 0.1ha to 0.15ha depending upon the stand composition and condition. The distance between the cable lines will be not less than 60 meters and distance between the groups will be not less than 50 meters.

17.3 Harvesting and Extraction

Fixed volume of timber expressed as Annual Allowable Cut (AAC) is prescribed in this Management Plan. The AAC prescribed is 6,700 m^3 in Standing Volume per year. This means that the maximum volume that can be harvested from Chendebji FMU will not exceed 6,700 m^3 per year. Out of 6,700 m^3, 4,700 m^3 will be allotted to NRDCL for commercial harvesting and 2,000 m^3 will be allotted for rural use.

However, mitigating measures will be employed during harvesting and extraction to minimize potential negative environmental impacts. Cable cranes would be used for harvesting operation and no manual logging would be permitted in the laid cable lines. Power chain saws would be used in place of the axe to reduce waste. The harvesting prescription and silvicultural treatment have been taken care of and described in detail in the Management Plan.

17.4 Road Construction and Maintenance

For the extraction of timber from the production site, it is necessary to construct all season road to transport the logs and firewood to the timber depot. The physical assessment for the road construction in Chendebji FMU was carried out by the team comprising of Planner, Engineer from NRDCL, Unit staffs both from NRDCL and Bumthang Territorial Division. During the assessment, two options were identified (Map 12). These two access road options are mentioned below:

Option 1: *Road extension from existing 20.56 kms forest road in Danglajem Block to enter Nalajem Block (approximately 3 Kms).*

Option 2: *Construction of new forest road from the Highway near existing Chendebji Village farm road towards Medta Block through Chendebji Lhakhang (approximately 12 kms). Construction of a bridge with a span of 12 meters across Nikachhu is also proposed.*

The forest road construction in Chendebji FMU is aimed at minimum negative environmental impacts. The proposed road has been aligned in such a way that none of the drinking water sources and settlement is affected. For stream crossings, culverts, side drains and hume pipe have been designed to minimize the pollution of the stream. In addition, a 12 meter span of bridge will also be constructed over Nikachhu about 50 meters from the road takeoff point from the highway, before reaching Chendebji Village Lhakhang towards Medta Block. It is proposed that the construction of forest road towards Nalajem Block will commence first and simultaneously, the road towards Medta Block and the Bridge Construction will began. This will help complete the proposed road within stipulated time and also contribute towards operating the area without having to wait for the completion of bridge and the road construction to Medta Block. The takeoff point of the road and the alignment has been agreed by the general public of Chendebji Village and the

Local Government Leaders of Tangsibji Gewog during the consultation meeting held at Chendebji Village on 15th of June, 2017.

During road construction, the NRDCL engineers will supervise and no deviation from the proposed road alignment should take place. As general rules, excavators will be deployed. Bulldozers shall not be permitted for use. Road Standards recommended by FRMD and the general principles and practices to be followed during forest road construction as identified by NEC Forestry Sectoral Guidelines will be followed. These will ensure that the road construction within the FMU will meet the recommendations and also ensure that any erosion or other negative impacts will be minimized or eliminated. Complete Road Standard is given in annex 4.

17.5 Regeneration and Post Harvesting Treatments

It is prescribed in the Management Plan that harvesting will be followed by natural regeneration. If the natural regeneration fails, artificial planting will be carried out with immediate fencing. 1,600 seedlings per hectare should be planted. Thereafter, weeding and tending operations should be carried out every year till the regeneration gets established. Regeneration is considered successful only if >80% of 1600 seedlings planted gets established. Therefore, establishment of a forest nursery of principal species by NRDCL is recommended in this Plan period. Besides, regular maintenance of the plantation will be done by NRDCL. CFO, Bumthang TD shall monitor establishment of regeneration in harvested areas at the end of first year. If the survival percentage is lower than the above prescribed number, immediate beating up will be carried out with the same local species. The established regeneration should be evenly distributed in the operated area and not concentrated in one particular place. Fencing could be removed once the regeneration gets established.

17.6 Existing Environment

17.6.1 Topography and Geology

The general terrain of CFMU ranges from moderate to steep landscape. The lower slopes are moderately gentle and the upper slope being steeper. Most of the flattened area in the valley bottom has been converted to agriculture land. The terrain is moderate in some of the compartments however; most of the compartments are steep and mountainous. Rocky outcrops are present along the national highway in Nalajem Block. The elevation of CFMU ranges from 1,640 meters at the valley bottom to 4,100 meters at the ridge top. The terrain is also dissected by three main rivers viz; Nyala Chhu, Khebar Chhu and Seb Chhu and many small rivulets, which flows into the main river of Nikachhu. Nikachhu divides the Management Unit nearly into two halves.

Major part of FMU falls within 40 to 80% slope class. Slope classification was done

with the help of Quantum GIS by using terrain analysis. Areas that were considered over 100% were delineated on the Function Map as SP-Soil Protection where no activities can take place. Slopes that ranged from 76-100% are classified as SC-Soil Conservation where limited activities can take place.

17.6.2 Hydrology

Within Chendebji FMU, there are three main rivers and no lakes. These three main rivers are Nyala Chhu, Khebar Chhu and Setta Chhu or Seb Chhu which ultimately joins the main river Nikachhu. Seb Chhu and Nyala Chhu runs from North to South and likewise Khebar Chhu runs from South-West to North and finally drains to Nikachhu.

The residents of the FMU are dependent heavily upon these water sources for drinking and cultivation. These smaller streams are also the source of water for the livestock.

17.6.3 Air Quality and Noise

The quality of air within the FMU is very good as the pollution is negligible. However, the undergoing east-west highway widening has impacted to the air quality in the settlements near the highway. Moreover, the ongoing Tangsibji Hydro Electric Limited construction also impacted the quality of air and also contributed to noise pollution due to heavy vehicle movement and earth-moving equipment operation.

17.6.4 Plant, Animal Species and Habitat

Multi-resource inventory was carried out by FRMD inventory crew from 2013-2014 in the operable area of 5,296.67 ha for the preparation of the third Management Plan. Chendebji FMU has good floral diversity, due to its altitudinal variation, aspects and different forest composition. Tiger and other small cat species have been recorded within the production area of the FMU which are enlisted in endangered and threatened category.

17.6.5 Scenic Qualities

The area has no popular sites with scenic beauty. However, the traditional route to Phobjikha passes through the Medta Block of the FMU.

17.6.6 Cultural Significant Sites

The historic Chendebji Chorten, Nyala and Drangla Goenpa fall within the boundary of the FMU. The chorten attracts a lot of tourist and pilgrims who visits the site while on the way to Bumthang. The annual tshechu in Nyala and Drangla Goenpa attracts lot of people from all over the country. The elderly people also narrate the presence of lot of sacred sites (*Nye*) within the FMU boundary, mostly in the protection areas.

17.7 Assessment of Impacts and Mitigating Measures

17.7.1 Impact on Water

Pollution

The FMU has a number of perennial streams, large and smaller ones. While carrying out the planned activities in the FMU, there are higher chances of polluting the water bodies within the FMU with garbage by workers engaged in road constructions and harvesting operations. Some harmful pollutants might include oil spills from vehicles and machineries.

Drying up of water source

Chendebji FMU forms the source of water for most of the major rivers and streams in the area. Any disturbance in the area by human intervention will adversely affect the water sources, increasing the probability of the streams and water sources drying up. The new proposed roads are aligned in such a way that no water source is being affected by the construction. However, it is essential to acknowledge the impact it has on the surrounding vegetation and device appropriate mitigation measures. Proper harvesting of timber as per the prescription of the management plan needs to be prioritized in order to minimize the impact of harvesting operations on water sources.

Mitigations

A buffer of 30 meters on the either of the main river, drinking water source and other perennial streams has to be maintained. The forested area where the drinking water source is located will not be subjected to commercial harvesting. The coupe will be laid in such a way that they are located away from the streams and rivers. Proper pit latrines and garbage disposal should be in place and the camp sites are at least 100 m away from the main streams.

During the road construction, NRDCL site engineer will monitor the construction activities. Moreover, the bulldozer will be replaced by excavator in order to avoid the blockage of river and streams from wind throw. At few places, forest road passes through streams and rivers sources but to mitigate the impacts, 100 meters buffer have been kept to prevent damage to the water source. Water pipes will be replaced, if damaged during road construction.

The rocks are of Thimphu Gneiss Complex. The formation is characterized by migmatites and biotite-gneisses with thin bed of quartzite, quartz-mica seists, calc-silicate rocks, marbles etc. (Atlas of mineral resources of the Escap region. Vol.8. UNDP Publication). Big rocks covering huge area is not found contiguously. However, about 18% of the area has rocks of less than 16 square meters. Major part of the FMU has smaller stones of size less than 70 cm × 70 cm. The soil is predominantly sandy loam and well drained in general.

17.7.2 Impact on Forest Resources

As the timber harvesting operation is the main activity in the FMU, it is evident that there will be impact on forest resources. Although, prescribed silvicultural systems are encouraged during harvesting operations, it will result in reduction of the forest cover within the FMU. Mixed conifer and Fir working circle will be worked under Group Selection System while the Blue Pine Working Circle will be worked under Seed Tree System. The opening of corridors and groups during the harvesting operation might open the area for grazing with less regeneration of principle timber species. This could result in exposing the site to various environmental and climatic conditions and thus affect the ecological processes in place. In certain forest type, openings can lead to increased undergrowth and hence regeneration of commercial native species will be affected.

Employment of untrained personnel during harvesting operations might lead to wastage of resources while felling trees such as increased number of splitting, breaking and other sorts of felling damages. Excessive collection of NWFPs may also lead to unsustainable harvesting of such resources in the future.

Mitigations

The management plan for the FMU is prepared for a period of ten years and before the commencement of harvesting operations. The harvesting will not exceed the prescribed AAC, nor will the size of the opening be larger than that prescribed in the management plan. If the natural regeneration fails to establish then the area will be planted with local principle timber species. However, natural regeneration is preferred over artificial regeneration considering its ecological as well as economic importance. The introduction of exotic species will not be allowed. For proper planning, implementation and monitoring of activities in the Forest Management Unit, a full time dedicated staff for the FMU will be required from both DoFPS and NRDCL. Only trained power chain saw operators will be allowed to carry out the felling and harvesting operations to reduce the felling damage within the FMU.

17.7.3 Impacts on the Faunal Diversity

Habitat fragmentation and disturbance to wildlife is one of the major threats as a result of operation in the FMU. Activities such as road construction and timber extraction will cause disturbance in the wildlife habitat and thereby increasing the chances of reduction in wildlife population. Construction of roads will also affect the movement of animals from one niche to another. Harvesting operations will adversely impact the prey base and may create imbalance in the food chain.

Mitigations

Certain areas within the FMU have been designated as wildlife protection areas while the remaining areas are designated as nature conservation areas. No harvesting operations will be allowed in area designated as wildlife protection function. As all

forest areas are not subjected to harvesting operations, enough areas have been kept for free movement of wild animals. Sufficient number of snag trees and fruit bearing trees will be retained to provide enough food for survival and reproduction of wild animals. Moreover, as certain portion of biological corridors also falls within the Forest Management Unit, these areas are excluded from commercial harvesting to enable movement of wildlife from one protected area to another.

In the interest of wildlife, clear felling of large stretch of forest will be avoided so that sufficient forest is retained for forage, shelter and cover. In operated areas, if natural regeneration fails to establish, artificial regeneration by native trees will be undertaken and subsequently fenced to avoid grazing by domestic as well as wild animals. Regular monitoring and patrolling of the forest area will be carried out in order to minimize poaching and other illegal activities within the FMU.

17.7.4 Impacts on Ecology (Flora)

One of the possible impacts of harvesting operations within the FMU is the change in present forest composition. There are higher possibilities of the harvested areas being invaded by non-native species of plants if proper monitoring of the area from time to time is not undertaken. Moreover, colonization of mixed conifer areas and natural grassland by Blue Pine is one of the perceived threats.

Mitigations

In order to retain the original forest composition in the harvested areas, the operation should follow the prescriptions strictly. Opening along the cable lines should be maintained as per the prescribed silvicultural systems so that it creates conducive environment for desired species to regenerate. Larger openings will be avoided in the mixed conifer stand in order to avoid its colonization by blue pine species. To ensure adequate regeneration of desired species, mother trees will be retained in sufficient numbers as a source of seed. Forest roads have been aligned in such a way that it does not pass through sensitive and critical areas. Proper monitoring should be ensured while constructing new forest roads to ascertain minimal damage to nearby vegetation.

17.8 Monitoring and Evaluation

The Management Plan, which is for the period of ten years, will be prepared by Territorial Divisional Office of Bumthang. It will be approved by the Minister, Ministry of Agriculture and Forests. The Plan will be implemented by CFO, Bumthang Forest Division, who will be engaging NRDCL for harvesting timber. Annual Operational Plans will be prepared by Bumthang Forest Division in consultation with the stakeholders, based on the Management Plan. The Operational Plan will be approved by the Head of the Department. Annual monitoring will be carried out by Bumthang Forest Division (CFO and Unit In-charge). A report will be submitted to FRMD, DoFPS, Ministry of Agriculture and Forests, Thimphu, based on the annual

monitoring forms. FRMD will also monitor the implementation of the activities. Mid-term evaluation will be done during the last quarter of the fifth year of the Plan period and final evaluation during the last quarter of the ninth year of the Plan period.

Table 28: Checklist of Environmental Parameters for Forestry Projects

	Adverse Environmental Impact	Preliminary Evaluation			
		No Significant Effect	Small Effect	Moderate Effect	Major Effect
I. COMMERCIAL LOGGING					
A. Environmental Considerations Regarding Project Siting					
1. Watershed Areas					
a) erosion	a) downstream economic losses	*			
b) siltation	b) downstream economic losses	*			
c) hydrology	c) increased peak and flood flows	*			
d) water quality	d) loss of downstream beneficial uses	*			
2. Relation to other dedicated land uses					
a) conservation areas	a) impaired ecological and recreational opportunities	*			
b) economic ventures	b) possible economic loss	*			
3. Traditional forest uses	3. Impaired beneficial uses	*			
4. Rehabitation	4. Social Problems	*			
5. Relation to regional/national forestry plans	5. Possible conflicts with established management policies	*			
6. Critical environmental areas	6. Downstream economic losses				
a) erosion	a) downstream economic losses	*			
b) siltation	b) downstream economic losses	*			

	Adverse Environmental Impact	Preliminary Evaluation			
		No Significant Effect	Small Effect	Moderate Effect	Major Effect
c) hydrology	c) increased peak and flood flows	*			
d) water quality	d) loss of downstream beneficial uses	*			
7. Precious ecology	7. Loss of ecological values	*			
B. Considerations Regarding Planning and Design					
1. Cost/benefit analysis					
2. Operations and maintenance	2. Diminished project efficiency and objectives if lack of funds			*	
3. Data based for decision making		*			
4. Road network design					
a) erosion	a) downstream economic losses		*		
b) siltation	b) downstream economic losses	*			
c) hydrology	c) increased peak and flood flows	*			
d) water quality	d) loss of downstream beneficial uses	*			
5. Design of logging activities	5. Unnecessary damage to residual stand			*	
6. Critical environmental areas					
a) erosion	a) downstream economic losses	*			
b) siltation	b) downstream economic losses	*			
c) hydrology	c) increased peak and flood flows	*			
d) water quality	d) loss of downstream beneficial uses	*			
7. Precious ecology	7. Loss of ecological values	*			

	Adverse Environmental Impact	Preliminary Evaluation			
		No Significant Effect	Small Effect	Moderate Effect	Major Effect
C. Considerations Regarding Project Operations					
1. Road Construction					
a) erosion	a) downstream economic losses		*		
b) siltation	b) downstream economic losses	*			
c) hydrology	c) increased peak and flood flows	*			
d) water quality	d) loss of downstream beneficial uses	*			
2. Felling					
a) erosion	a) downstream economic losses	*			
b) siltation	b) downstream economic losses	*			
c) hydrology	c) increased peak and flood flows	*			
d) water quality	d) loss of downstream beneficial uses	*			
3. Log conveyance and allocation					
a) erosion	a) downstream economic losses	*			
b) siltation	b) increased runoff	*			
c) hydrology	c) impede navigation	*			
d) water quality	d) less than optimum economic benefits		*		
4. Logging in riparian zones	4. Degradation of waterways/fisheries	**N.A**			
5. Socio-economic		*			
a) employment opportunities		*			
b) loss of traditional forest use	b) economic and cultural losses	*			
D. Considerations Regarding Post-Project Activities					

	Adverse Environmental Impact	Preliminary Evaluation			
		No Significant Effect	Small Effect	Moderate Effect	Major Effect
1. Rehabilitation and conservation		*			
2. Road shutdown		*			
II. REFORESTATION/AFFORESTATION					
A. Considerations Regarding Project Siting					
1. History of forest abuse	1. Negation of project goals if not effectively controlled			*	
2. Relation to other dedicated land uses					
a) conservation areas		*			
b) economic ventures	b) Interference with more profitable ventures	*			
c) regional/national forestry plans		*			
3. Rehabilitation	3. Social Problems	*			
4. Siting in degraded forest	4. Possible unnecessary loss of ecological values	*			
B. Considerations Regarding Planning and Design					
1. Cost/benefit analysis					
2. Selection of tree species	2. Diminished project objectives	*			
3. Precious ecology					
a) wildlife		*			
b) fisheries		*			
c) plants		*			
d) soil and water		*			
4. Allocation of benefits to locals		*			
a) employment opportunities		*			
b) training		*			
c) non-wood products		*			

	Adverse Environmental Impact	Preliminary Evaluation			
		No Significant Effect	Small Effect	Moderate Effect	Major Effect
5. Operation and maintenance	5. Diminished project efficiency and objectives if lack of funds			*	
6. Data base for decision making		*			
7. Project financing and reservoirs		*			
8. Appropriate technology	8. Diminished project objectives if inappropriate	*			
9. Relation to other dedicated land uses	9. Potential social and economic conflicts	*			
a) extensive land use modification		*			
10. Road network design	10. Increased erosion	*			
11. Use of grasslands		*			
C. Considerations Regarding Project Operations					
1. Commercial logging	1. Same as in Commercial Logging A and B	*			
2. Reduced water supplies	2. Socioeconomic losses	*			
3. Chemical and fertilizers	3. Impaired fisheries and aquatic systems	*			
4. First-year operations	4. Increased erosion due to soil disturbance		*		
5. Soil conservation benefits					
a) erosion			*		
b) sedimentation		*			
c) soil capacity		*			
d) soil surface moisture		*			
e) soil nutrients		*			
6. Socio-economic benefits		*			

	Adverse Environmental Impact	Preliminary Evaluation			
		No Significant Effect	Small Effect	Moderate Effect	Major Effect
a) employment opportunities		*			
b) fuel-wood		*			
c) enhanced fisheries		*			
d) enhanced recreational/ tourism		*			
7. Water resources benefits		*			
a) minimized overland flows		*			
b) reduced flood peaks		*			
c) water quality		*			

18. FINANCIAL AND ECONOMIC APPRAISAL

Table 29: Assumption used for financial Forecast

Assumptions	Figures
m^3 to cft	35.31
Recovery Volume (%)	60% (Conifers) and 40% (Broad-leaf)
Road Construction (Nu/Km)	2,260,000
Length of proposed new road	15
Road maintenance (Nu/km/yr)	12,000
Distance to Depot (km)	21
Cable craning (Nu/cft)	14.2
Rural allotment (m^3)	2,000
Regeneration maintenance (for cable line) (Nu/ha)	3,500
Artificial Plantation (ha)	10
Plantation cost (as per plantation norms and standard, SFED)	50,000

Table 30: Financial Forecast

Financial Forecast- Chendebji Forest Management Unit

	AAC (m^3)	Rec. Volume (m^3)	Nu/cft	Nu/m^3	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	10 Years
					Nu	Nu	Nu	Nu	Nu	Nu	Nu	Nu	Nu	Nu	Total (Nu)
Revenue: NRDCL															
Timber- Commercial	4,700	2,820	154.89	5,469.17	15,423,047.84	15,423,047.84	15,423,047.84	15,423,047.84	15,423,047.84	15,423,047.84	15,423,047.84	15,423,047.84	15,423,047.84	15,423,047.84	154,230,478.38
Timber- Rural	2,000														
Total Revenue NRDCL					**15,423,047.84**	**15,423,047.84**	**15,423,047.84**	**15,423,047.84**	**15,423,047.84**	**15,423,047.84**	**15,423,047.84**	**15,423,047.84**	**15,423,047.84**	**15,423,047.84**	**154,230,478.38**
Costs: NRDCL															
Bridge Construction						15,000,000.00									15,000,000.00
Road Construction		2,260,000			2,260,000.00	4,520,000.00	4,520,000.00	4,520,000.00	4,520,000.00	4,520,000.00	4,520,000.00	4,520,000.00			33,900,000.00
Road Maintenance			12,000		246,000.00	258,000.00	282,000.00	24,000.00	48,000.00	72,000.00	96,000.00	120,000.00	144,000.00	144,000.00	1,434,000.00
Marking Cost			0.08	2.82	13,254.00	13,254.00	13,254.00	13,254.00	13,254.00	13,254.00	13,254.00	13,254.00	13,254.00	13,254.00	132,540.00
Inventory Costs					30,000.00	30,000.00	30,000.00	30,000.00	30,000.00	30,000.00	30,000.00	30,000.00	30,000.00	30,000.00	300,000.00
Felling and Cross-cutting			4	141.24	663,828.00	663,828.00	663,828.00	663,828.00	663,828.00	663,828.00	663,828.00	663,828.00	663,828.00	663,828.00	6,638,280.00
Debarking			0.5	17.7	49,914.00	49,914.00	49,914.00	49,914.00	49,914.00	49,914.00	49,914.00	49,914.00	49,914.00	49,914.00	499,140.00
Cable Craning			14.69	519	2,439,300.00	2,439,300.00	2,439,300.00	2,439,300.00	2,439,300.00	2,439,300.00	2,439,300.00	2,439,300.00	2,439,300.00	2,439,300.00	24,393,000.00
Transportation to Depot					4,729,775.00	4,729,775.00	4,729,775.00	1,244,678.00	1,244,678.00	2,489,355.00	2,489,355.00	3,734,032.00	3,734,032.00	3,734,032.00	32,859,487.00
Stand Tending (Spacing etc.)															-
Coupe Regeneration															-
Regeneration Maintenance		3,500/ cable line			17,500.00	35,000.00	52,500.00	70,000.00	87,500.00	105,000.00	122,500.00	140,000.00	157,500.00	175,000.00	962,500.00
Creation of Plantation		50,000/ha				50,000.00	50,000.00	50,000.00	50,000.00	50,000.00	50,000.00	50,000.00	50,000.00	50,000.00	450,000.00
Plantation Maintenance		8,000/ha					8,000.00	16,000.00	24,000.00	32,000.00	40,000.00	48,000.00	56,000.00	64,000.00	288,000.00
Total Costs NRDCL					**10,449,571.00**	**27,789,071.00**	**12,838,571.00**	**9,120,974.00**	**9,170,474.00**	**10,464,651.00**	**10,514,151.00**	**11,808,328.00**	**7,337,828.00**	**7,363,328.00**	**116,856,947.00**
Total Revenue less Total Costs NRDCL					**4,973,476.84**	**(12,366,023.16)**	**2,584,476.84**	**6,302,073.84**	**6,252,573.84**	**4,958,396.84**	**4,908,896.84**	**3,614,719.84**	**8,085,219.84**	**8,059,719.84**	**37,373,531.38**
Royalty															
Royalty- Commercial			11	388.41	1,825,527.00	1,825,527.00	1,825,527.00	1,825,527.00	1,825,527.00	1,825,527.00	1,825,527.00	1,825,527.00	1,825,527.00	1,825,527.00	18,255,270.00
Royalty- Rural															
Total Royalty NRDCL					**1,825,527.00**	**1,825,527.00**	**1,825,527.00**	**1,825,527.00**	**1,825,527.00**	**1,825,527.00**	**1,825,527.00**	**1,825,527.00**	**1,825,527.00**	**1,825,527.00**	**18,255,270.00**
Revenue less Royalties NRDCL															
Timber- Commercial					13,597,520.84	13,597,520.84	13,597,520.84	13,597,520.84	13,597,520.84	13,597,520.84	13,597,520.84	13,597,520.84	13,597,520.84	13,597,520.84	135,975,208.38
Timber-Rural															
Total Revenue less Royalty NRDCL					**13,597,520.84**	**13,597,520.84**	**13,597,520.84**	**13,597,520.84**	**13,597,520.84**	**13,597,520.84**	**13,597,520.84**	**13,597,520.84**	**13,597,520.84**	**13,597,520.84**	**135,975,208.38**
Total Revenue less Royalty Less Costs					**3,147,949.84**	**(14,191,550.16)**	**758,949.84**	**4,476,546.84**	**4,427,046.84**	**3,132,869.84**	**3,083,369.84**	**1,789,192.84**	**6,259,692.84**	**6,234,192.84**	**19,118,261.38**

Table 31: Financial Forecast Summary (For this plan period)

Particulars	Amount (Nu.)
Total Revenue NRDCL	154,230,478.38
Total Cost NRDCL	116,856,947.00
Total Royalty NRDCL	18,255,270.00
Total Revenue less Royalty less Costs NRDCL	19,118,261.38

19. RESEARCH

Research programs will be in collaboration with UWICER. The Division and Unit staffs can also collaborate as appropriate. The prioritized areas for research are mentioned below:

- Determination of Annual Allowable harvest of NWFPs in the FMU.
- Colonization studies of Blue Pine Species.
- Light requirement for regeneration in Mixed Broadleaf forest.
- Impact of commercial harvesting on wildlife population.
- Timber recovery rate for particular FMU.
- Forest composition change overtime due to commercial harvesting.
- Human wildlife conflict.

PART 3

IMPLEMENTATION OF THE PLAN

20. IMPLEMENTING AGENCY

The Department of Forests and Park Services is vested with the responsibility of protection and management of forest resources in Bhutan. In the field, the territorial division is mandated by the Department to discharge the responsibility of implementing and monitoring all the activities mentioned in the plan. The Chief Forestry Officer of Bumthang Division will be responsible for implementation of this Management Plan. The Chief Forestry Officer, Bumthang will be assisted by the Unit In-charge and other staffs of the Forest Management Unit.

20.1 Cutting Cycle

For sustainability of the forest resources in the FMU, the cable line spacing must be properly laid to enable subsequent passes in the future. A minimum of 60 meters needs to be kept in between the cable lines so that two passes can be enabled in the future. Mixed Conifer Working Circle has a rotation period of 160 years with additional 20 years regeneration period, which means that the two cable lines that will be implemented in the future are occurring at year 61 and year 121. The original line will therefore, be harvested in year 180 (Figure 9). This gives sufficient time to the adjacent area to regenerate and also prevents the area from large opening.

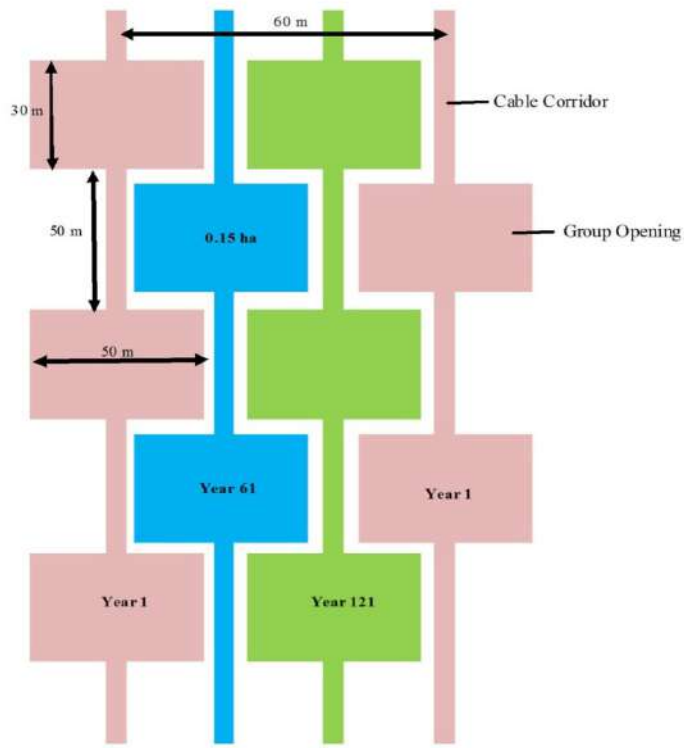


Figure 9: Layouts for Group Selection System

The same method of cable line layout is applied to the Fir Working Circle except that the size of the group opening will be no more than 0.1 ha.

The rough terrains of Bhutan possess challenge while laying cable lines in the field. Therefore, the layout in the field must be aligned to suit the terrain and to the best possible, guidelines must be followed. The Blue Pine Working Circle will be worked under Seed Tree System which requires 90 meters spacing between initial cable lines. Thus, the two interlines in the future will be harvested at year 36 and 72, with original line being harvested at year 110.

For the young stands of Blue Pine, thinning shall be carried out as per the prescription. The thinning will be done by positive selection with due consideration to stabilize the structure of the stand. The thinning will ensure the growth potential of the stand and site to the most promising individual of the tree population to maximize the volume and quality production.

The Mixed Broadleaved working circle will be worked under Patch-cut System. The patch will not exceed more than 0.25 ha and will be spaced in the interval of 50 m. 4 m cable corridor will be maintained. Artificial regeneration will be taken up immediately after coupe clearance is issued. NRDCL should maintain nursery at the site for artificial regeneration. Nursery should be well stocked with local and commercial species for replantation.

20.2 Annual Coupe

For the selection of annual coupe, accessibility, slope, stand condition and other environmental conditions should be considered. The annual coupe will follow the required spacing designed as per the prescribed silvicultural system of each working circle.

Coupes must comply with the following conditions:

- The Unit In-charge, in consultation with the NRDCL counterpart, will determine the location and extend of the cable lines in the compartment to be harvested annually. All prescription and restriction laid down in the plan must be considered and adhered to completely.
- The cable lines must be laid to the full length if the area is operable in order to avoid unnecessary loss of production area. This practice will also help cut down the expenditure for road construction.
- The Unit In-charge will arrange to mark the trees as per the approved annual Operational Plan.
- Cable line layout will be based on safety, stand composition, environment and cost consideration. This will be done in consultation with the Unit In-charge.
- The cable lines may traverse slopes greater than 100% but extraction is not allowed.

20.3 Tree Marking Guidelines

- Groups of matured and over-matured trees are selected systematically according to the group size given in the plan.
- Trees within stream buffer stripes and on slopes greater than 100% must not be marked.
- The direction of the tree lean and topography has to be taken into account to prevent large tree being felled on nearby advanced growth.
- Some dead, dying, malformed or damaged (snags, scars. conk, etc.) and fruiting trees will be retained in between groups, and in the interline spaces, to safeguard the niches or habitats for the flora and fauna, but not in the harvested group themselves, where there is risk of wind throw and danger to personnel working underneath.
- Diseased trees (bark beetle, mistletoe) will be removed to protect the quality of the remaining stand.
- All species listed for protection under the Forest and Nature Conservation Act (1995) must be protected if encountered.
- The trees selected will be marked with the authorized marking hammer close to ground level by Unit Staff, and diameter measurements, along with estimated total tree height and tree species, will be entered in the Marking register.
- The volume of each tree will be estimated using an appropriate Volume Table. The standing volume marked will be recorded in the Marking Register. Log volume at the NRDCL Depot will be recorded.

20.4 Harvesting

To reduce the negative impact to the forest and environment due to extraction, the hauling method for transporting logs from the coupe to road will be done by skyline crane system. This system will allow logs to be kept above the forest floor during extraction and will enable logs to be taken across sensitive ecological sites, gullies and riparian filter buffer zones. Cutting trees 10 cm above the ground level will be strictly followed to avoid the wastage. To maintain the sanitation and hygienic condition of the forest, the cut over debris must be disposed off and if possible burn in a proper place avoiding forest fire. The skyline cable system has the following advantages:

- Minimizes soil disturbance and initiation of soil erosion.
- Maximizes work safety (if used correctly according to the manufacturer's directions and according to the safety practices in the Code of Logging Practice).
- Avoid damage to residual reserve stands.
- Avoid disruption to wildlife corridors in the valley bottoms.
- Minimizes noise and dust pollution on any adjacent farmland and villages.
- Eliminates the need for log extraction tracks and feeder road construction.

Harvesting in the Working Circle is to be carried out in accordance with the following prescriptions:

- The layout of the cable lines should be planned and undertaken well in advance of the harvesting operations after the logging coupe has been demarcated. Suitable log landing site should be identified and incorporated into the forest road design.
- Care should be taken to avoid lines in and along gullies and other protected areas, but lines may cross these at an angle. Trees to be felled will be enumerated and marked in time so as not to delay harvesting operations.
- The cable corridor shall not exceed the prescribed width stated in the Silvicultural System for each working circle.
- Trees will be felled, de-limbed, crosscut, extracted on the cable, loaded and hauled to the log depot. Only chain saws and hand saws will be permitted in felling operations. Trees will be felled, where possible, into natural openings, into harvested openings or in a direction that will not damage residual stands. Damage to soil should be minimized at all times.
- The use of axes is discouraged except in fuel wood splitting.
- All infected Blue pine and Spruce, if any, will be debarked as soon as they are felled to avoid the spread of bark beetles.
- All logs will be measured and recorded in the Log Yard Register. This should be kept up-to-date and made available to inspecting officers as required. A copy of the list of log/timber entered in the Log yard Register will be submitted to concern CFO every month. This information will be used for royalty calculation and issuance of removal permits. Logs will be transported by private haulage contractors and all deliveries will be made to designated depots and/or sawmills.
- Records of all trees marked and issued for local use or for conversion within the forest, by blocks and compartments will be maintained by the Unit staff and furnished monthly to the concern CFO.
- The CFO and the Regional Manager, NRDCL will co-operate and co-ordinate to ensure that the logging operation and log outturn are conducted smoothly and in accordance with local and other demands.
- Fuel wood will be collected from harvesting residues. It is important that all lops and tops for fuel wood are collected along entire cable lines, not just the easily accessible areas. It is desirable that the trees to be used as fuel wood are extracted with the cable line and fuel wood conversion occurs at the designated log landing areas.

20.5 Reforestation of Harvested Sites

Natural regeneration is the preferred method of reforestation in the harvested areas of the FMU. Natural regeneration is the ecologically and economically viable method to ensure sustainable development of forest resources. Therefore, it is crucial that natural regeneration is given preference over artificial regeneration.

It is essential that the harvested areas are effectively regenerated as soon as the harvesting operations are complete. However, if the natural regeneration fails to get established in the harvested sites, restocking by means of artificial regeneration through plantation shall be carried out by NRDCL. It might be evident in some FMUs that the natural regeneration is either very poor or prove to be a complete failure because of site conditions, over grazing, prolonged disturbance due to protracted harvesting operations and overgrowth of weeds and other invasive plant species. These problems must be considered, analyzed and eliminated to successfully regenerate the operated areas.

It is prescribed that periodic tending activities such as weeding, brushing and fencing are carried out to increase the chances of natural regeneration establishment in the FMU. Such interventions will help cut down the plantation cost and ensure higher survival percentage of the forest crops. In case of natural regeneration failure, NRDCL should have a reserve of seedlings of locally viable species which can be done through establishment of forest nurseries. Care should be taken to plant commercially viable local species in the FMU to ensure sustainable harvest in the future. In areas where plantations are carried out, regular maintenance should be done for higher survival percentage. The maintenance of plantation should be carried out as per the Norms for Plantation and Nursery, 2016 and the concern CFO must monitor and evaluate the plantations on annual basis.

The past harvested cable lines should be monitored periodically and regeneration surveys should be conducted every three years until the regeneration has reached the height that will ensure its survival. If the second survey (6^{th} year) indicates poor stocking, remedial actions must be taken in the following plantation season. The Unit In-charge will ensure that stocking of natural regeneration is first monitored within three years following completion of the harvested operation. Enrichment plantation, if necessary, should be carried out by NRDCL. The NRDCL in consultation with the Unit In-charge should keep adequate budget provisions in the Operational Plan to carry out plantation creation and maintenance works.

20.6 Sequence of Operations Relating to the Annual Coupe

The sequence of operation relating to the annual coupe is given in the following table:

Table 32: Sequence of Operations Relating to the Annual Coupe

Operation Description	Timing (months) (- before felling; + after felling)
Unit In-charge describes regarding the location and size of annual coupe in accordance with the Biennial Operation Plan	-12
NRDCL and FMU In-charge prepares an estimate of human, material, equipment and financial resources required.	-10
Unit In-charge finalizes the annual coupe size, demarcates the coupe and instructs NRDCL to carry out pre-logging planning	-6
NRDCL prepares cable line layout and alignment plan, proposed log depot and log landing points and submits these to Unit In-charge for approval	-3
Unit In-charge marks the carriage corridor trees and the trees to be felled in the first sub-coupe	-2
NRDCL manually fells trees that are in the way of the skyline installation and installs the skyline and cable crane	-1
NRDCL commences systematic harvesting and extraction operation according to the approved sequence in the Biennial Operation Plan	0
NRDCL/Contractor completes harvesting and extraction	When completed
The Unit In-charge will inspect the coupe when harvesting is completed and will issue a Coupe Clearance Certificate only if all aspects of the operation are satisfactory.	When works completed
DoFPS assess success of natural regeneration	As per Guidelines
NRDCL completes post harvesting operation	As per the instruction by Unit In-charge

20.7 Road Construction

Despite the negative impact of forest road on forest and environment, still forms an essential part of managed forest estate, both for timber extraction and to provide for forest management and monitoring. Road construction in the FMU requires extra precautions to achieve environmental best practice. The necessity during the forest road construction is to avoid steep and fragile areas, to provide a proper drainage system, especially for safe discharge of run-off water during the monsoon, with enough culverts, and cross drains, to have an efficient draining compacted road surface.

A forest road of 20.56 km has already been constructed by NRDCL during the

implementation of the last two management plans. The existing road takes off from Wangdue- Trongsa Highway in Jawang Block and crosses Setta Block to enter the Dranglajem Block of the FMU. 18.2 kms of road was constructed during the first plan period (1996-2006) and the remaining 2.3 kms was constructed during the second plan period (2007-2017).

Through detailed field survey and consultation with the concerned stakeholders, it was decided that a total of 15 kms of forest road will be constructed during this plan period from 2018-2027. Around 3 kms of new road will be constructed in the Nalajem Block in continuation to the existing 20.56 kms road. As the operation area will be covered with this length of road in the Danglajem and Nalajem Block, the remaining 12 kms of road will be constructed in the Medta Block. The proposed take off point of the road will be near the start point of Chendebji Village farm road which will then pass through the village Lhakhang to the production site. In order to connect the production road to the highway, a bridge needs to be constructed across Nikachhu. Approximate span of the proposed bridge will be around 12 meters. The existing road should also be maintained on annual basis by NRDCL in order to facilitate safe transportation of logs to depot.

Road Standard

A set of road standards has been developed by Forest Engineers of TFDP. These road standards, although developed in the East, address policies that are required throughout Bhutan. These standards will be adopted for Chendebji FMU and NRDCL road engineers must follow these standards, given in annexure 2, during designing and estimating, and provide supervision during construction to ensure that the standards are met. Road design in Chendebji FMU should follow the recommended road profile given in Figure 10 to avoid excessive water pooling leading to rutted road surfaces that inhibit access during monsoon season. Improper drainage may lead to landslide.

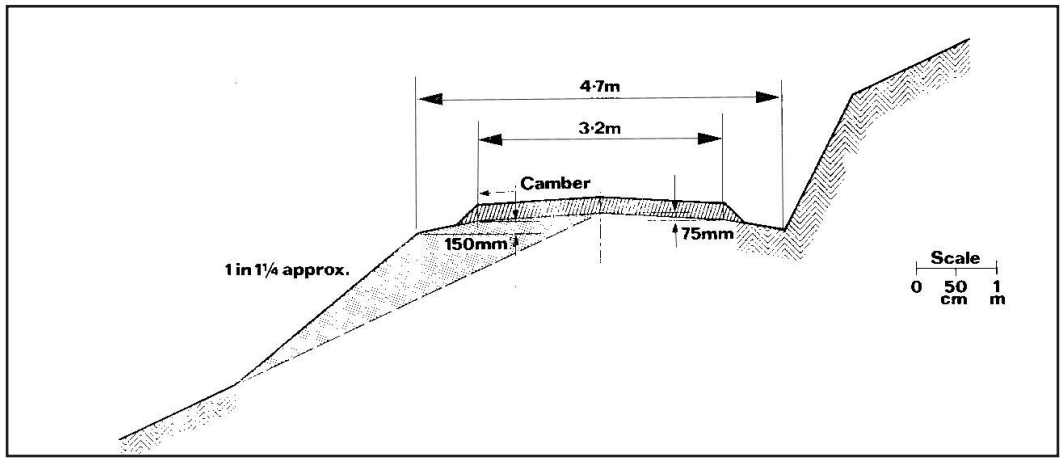
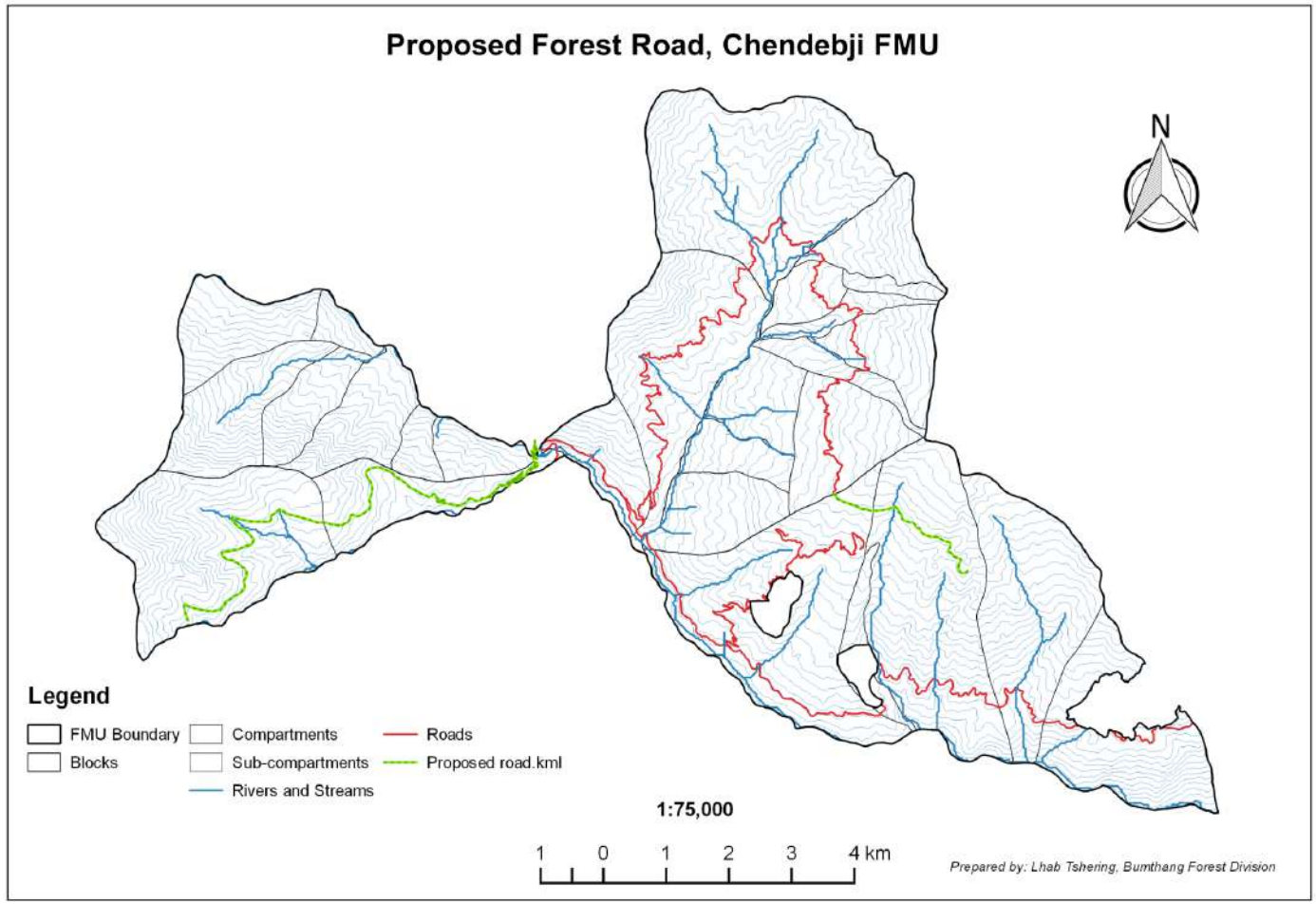


Figure 10: Recommended Road Profile

Map 12: Proposed FMU Road



21. PLANNING

21.1 Operational Plan

For facilitating the timely implementation of the Management Plan, a Biennial Operational Plan will be prepared by the CFO, Bumthang and the Unit In-charge. Guidelines for the preparation of the Operational Plan have been prepared by FRMD (2002) and a copy of each is available to all Territorial Division. The guidelines have been updated and will continue to be so. The Operational Plan is also the tool used to provide for changes that cannot be foreseen or allowed for in the FMU Plan, such as insect and disease outbreaks, severe fire, etc. If and when these occur, the current Operational Plan should be immediately reviewed and the areas and/ or methods of operation modified to deal most effectively with possible changes in the sustainable level of harvest.

The Operational Plan will be prepared in consultation with all the agencies and parties who will be using the forest. Inclusion of a consultation process with local communities in the preparation of the plan is particularly important so that potential issues concerning communities in the forthcoming operational areas are worked through before the plan is implemented.

The Operational Plan is meant to be a rolling one, i.e, Operational Plan is prepared annually but the plan period is for two year. Therefore, activities for the second year of the plan are carried forward into the first year of the next plan (Table 33). This has important implication on budgeting (since will then be possible to estimate well in advance of the start of the financial planning year) and for participatory process since these can be carried out a year before the start of activity. The primary aim in preparing the Operational Plan is to determine and co-ordinate the timely input of resources.

Table 33: Concept of Rolling Plan

Year 1	2	3	4	5	6	.....
	Detailed Outline	Detailed Outline		Detailed Outline		Etc
	Detailed Outline		Detailed Outline		Detailed Outline	

The process for preparing and implementing the Operational Plan is given in the Table 34.

Table 34: Preparation and Implementation of Operational Plan

Activity (Planning Step)	Objective	Output	Responsibility (Lead)	Comments
1. Approved FMP				
2. PRAs with local Stakeholders	To prepare participatory plan for fire management, grazing control and rural timber	Participatory plan for fire management, grazing management and rural timber harvesting (to be incorporated within the OP)	DoFPS/FMU In-charge	First step is to enter into discuss with stakeholders and their representatives
	To involve relevant stakeholders in planning for activities which have a direct impact in their "interest"			Use PRA technique to prepare the plan
				Plan cost are included in the OP
3. Operational inventory	To access the resource availability for the planned harvesting area	Site-level inventory data for the operational area to be harvested	FMU In-charge/ NRDCL	For the areas proposed for harvesting during the next two years
	Calculation of the harvestable volume	Precise estimate of volume to be removed during the coming year		May be combine with harvesting plan and cable line survey
4. Harvesting plan and cable line survey	To plan for harvesting and extraction activities	Agreed extraction and road plan	NRDCL	Within the selected identified harvestable area for the year
5. Preparation of Operational Plan	To prepare a plan for implementation during the next two years (involving stakeholders for some activities)	Approved operational plan with budget	FMU In-charge with stakeholders as required	Activities linked with objectives identified in the FMP and following options and guidelines in the FMP

Activity (Planning Step)	Objective	Output	Responsibility (Lead)	Comments
	To formalize local institutional responsibility for planned activities (e.g. grazing, fire management, rural timber distribution)	Identified responsibilities for each planned activities Calculate cost for each planned activities		Each activity with identified responsibility for implementation, estimated cost, and site-specific location
6. FMU annual report presented to the FMU-level Management Committee	To review process and identify and address any implementation problems	FMU Annual report endorsed by FMU-level Management Committee	FMU Manager presents to the FMU-level Management Committee	During FMU-level Management Committee meeting
	To identify any future actions necessary based on issues arising			Implementation problems need to be addressed before endorsing the new OP
7. OP review by FMU-level Management Committee and endorsed	For the FMU-level Management Committee to endorse the OP (prior to approval by DoFPS)	OP endorsed by FMU-level Management Committee	FMU Manager presents to the FMU Level Management Committee	During FMU Level Management Committee meeting
	To endorse expenditure estimates for the coming financial year			
8. NRDCL financial commitment within OP agreed	To ensure that NRDCL is committed to funding the agreed activities in the OP	Budget estimates for the OP endorsed by NRDCL and FMU-level Management Committee	FMU-level Management Committee	Meeting needs to take place by November to ensure that budget requirements can be included in the NRDCL APO for the next financial year

Activity (Planning Step)	Objective	Output	Responsibility (Lead)	Comments
9. OP approved by Director, DoFPS	To approve OP for implementation	Approved plan and budget	Approved by FRMD and Director, DoFPS	OP approved linked with sanctioned budget for all planned activities
10. OP implementation by NRDCL	To carry out planned activities	Harvested timber; protected area; roads; fuel wood, etc.	According to responsibilities identified in the OP e.g. FMU In-charge, NRDCL, etc.	Each activity with specific responsibility and budget
11. Monitoring of activities	To access the level of achievement for planned activities	Information for FMU annual report	FMU In-charge	DoFPS responsibility is to monitor the implementation of activities carried out by NRDCL
				Monitoring cost need to appear in the OP
12. DoFPS, Unit In-charge prepares FMU annual report	To report progress against planned activities	FMU annual report	FMU In-charge	Prepared annually
	To highlight any problems being encountered in implementation			Progress is reported against each FMP objective and the associated activities
13. Prepare the next years' OP (step 2-5)	To prepare the next OP taking into account progress over the past year	Operational Plan	FMU In-charge	OP may alter in response to FMU management committee suggestions and recommendations

21.2 Mid-term Evaluation of FMP

Based on the information collected by the annual monitoring and from other sources, the Chief Forestry Officer, FRMD, will ensure that the plan is evaluated at the interval of five years after the implementation. The results of mid-term review should be discussed with the FMU-level Management Committee.

21.3 FMU-level Management Committee

The FMU-level Management Committee will be established to ensure smooth implementation of the management plan. The committee will be chaired by CFO, Bumthang.

The committee shall consist of the following members:

- Chief Forestry Officer, Bumthang (Chairman)
- Regional Manager, Jakar Region, NRDCL
- Unit In-charge, Chendebji FMU
- Production In-Charge, NRDCL, Chendebji FMU
- Gup/Mangmi, Tangsibji and Sephu Gewog
- Tshogpa, Nyala-Drangla, Chendebji and Setta Chiwog
- FRMD Representative (if possible)

The Terms of Reference for the FMU-level Management Committee are:

During FMU Management Plan Preparation:

- To support the interest of identified stakeholder groups during the planning process for Forest Management Plan preparation.
- To agree FMU forest management objectives for different parts of the forest based on national priority and specific local condition and needs.
- To consult (along with FRMD) with specific groups of stakeholders likely to be significantly affected by proposed activities such as road construction and timber harvesting ensuring that their interest are effectively accommodated in the final plan.
- To review and endorse the draft Forest Management Plan before it is presented to Director, DoFPS and Minister of Agriculture and Forests for final approval.

During the Operational Planning, Implementation and Monitoring:

- To represent the interests of identified stakeholders group during planning and review of activities under Operational Plans.
- To review achievements during the past year (based on annual report submitted by the FMU Unit In-charge) and advice and act on any issue identified.
- To make recommendation for changes in the proposed Operational Plan for the coming year based on previous years' experience and on the need to achieve the agreed objectives in the forest management plan.

- To review and endorse the draft Operational Plan before submission to the Director, DoFPS for approval.
- To participate in the 5-year mid-term review of forest management plan.
- To hold any additional meeting as required in response to specific issue arising from Forest Management Plan and Operational Plan.

21.4 Staff

The Chief Forestry Officer, Bumthang is the overall controlling Officer of the area. The controlling and management of Chendebji FMU will be looked after by the FMU In-charge. They will be under the administrative control of the Chief Forestry Officer, Bumthang Division. The Chief Forestry Officer is the direct representative of DoFPS in the field and as such he is solely responsible for all forestry activities, both technical and administrative within his jurisdiction.

21.4.1 Responsibility

For the smooth monitoring and implementation of the plan in the FMU, following staff will be required (Table 35). It is also being recommended by the Organizational Development Exercise by Royal Civil Service Commission.

Table 35: Staff requirement in the FMU

Sl. No.	Designation	Numbers
1	Unit In-charge (Sr. Range Officer/ Forestry Officer)	1
2	Forest Ranger II/ Sr. Forester/ Forester	4

The Unit In-charge under the guidance of Chief Forestry Officer will be directly responsible for the day-to-day implementation of the plan. The Unit In-charge will keep records of all the works, supervise and initiate other silvicultural activities as envisaged in this plan. Unit In-charge will be responsible to report to the Chief Forestry Officer, Bumthang.

Forest Ranger II will be responsible for carrying out operational inventory, help to prepare the operational plan, supervise road construction and maintenance and keep the track of regeneration of the harvested areas. Forest Ranger II will also be responsible for supervising the tree marking and felling, timber extraction, transport of logs to depot and reporting the coupe clearance. He will be responsible for marking of thinning, fire prevention and monitoring pest/diseases outbreak. The Forester will be assigned to help the Unit In-charge and the Forest Ranger.

21.5 Buildings

Currently, the FMU has a Unit Office with the residence of the Unit In-charge attached to it. However, there is no proper accommodation for other FMU staffs. There is a two unit staff quarter of NRDCL which is in bad condition. If the funds are

available, it would be appropriate to construct new staffs quarter to accommodate the unit staffs as housing is a problem in this area.

21.6 Vehicles and Equipment

The FMU is currently equipped with the following equipment and instruments:

- Computer (Desktop) set- 1
- Printer- 2
- Xerox Machine- 1
- Laptop- 1
- Clinometer- 3
- Altimeter- 1
- Diameter tape- 4
- Measuring tape- 8
- Compass- 3
- GPS Garmin- 1
- Walkie Talkie Sets- 4
- Binocular- 1
- Digital Camera- 1
- Tents- 5

In order to ensure proper implementation of this plan, the Unit must be equipped with additional equipment as mentioned below:

- Two wheeler- 1 number
- Additional Garmin GPS- 2 numbers
- Laptop- 1 number
- Hypsometer- 2 numbers
- Crown densitometer- 2 numbers
- Bark gauge- 2 numbers

22. MONITORING AND EVALUATION

The primary focus of the Royal Government of Bhutan's forest policy is to ensure conservation of the environment and, only thereafter, to allow the derivation of economic benefits (such as commercial timber production) from the forest.

To ensure that this policy is being carried out in the management of FMUs, a two stage verification process is necessary. The first stage checks that on-ground activities are being carried out as planned in the short term, the second checks that the objectives of the plan are being achieved over the longer term. Monitoring

(checking on inputs on year to year basis) is the term used for first stage and evaluation (checking achievements against objectives over five year periods) is the second stage.

Standard forms for monitoring and evaluation were prepared and are available from the Forest Management Code of Bhutan. The forms for monitoring were subdivided into Physical, Financial and Environmental sections that contained an exhaustive set of questions and the forms for evaluation were also sub-divided into Evaluation form A and Evaluation form B.

22.1 Monitoring

Monitoring is the continuous/periodic review undertaken by management at every level of implementation of an activity to ensure that input deliveries, work schedules, targeted output and other required actions are proceeding according to the plan. The CFO, Bumthang will ensure that monitoring is carried out on an annual basis according to the guidelines issued by FRMD.

22.2 Evaluation

Evaluation is the examination of whether objectives are being achieved. In the context to FMU evaluation, sufficient time has to elapse before a realistic assessment can be made of progress towards fulfilling objectives (Incoll 1999). Evaluation should be carried out at the intervals of five year, based on the information collected by annual monitoring.

The Head, FRMD will ensure that evaluation is carried out at five-year intervals, based on the information collected by annual monitoring and other necessary information. Copies of necessary forms can be collected from FRMD. Corrective actions, if necessary, may require changes to a range of inputs or to implementation methodology. The evaluation will be carried out by staffs that are independent of the field implementation activities. The evaluation team will be appointed by the Director, DoFPS.

23. CONSTRAINTS AND RISKS

Constraint of forest conservation and management planning are:

- Lack of locomotives for field staffs, leading to an inability of the staff to supervise any management activities in the FMU.
- No regular training for field staffs on preparation of operational plans and other related surveys.
- Inadequately trained Unit staffs to carry out cable line profiling.
- Insufficient technical staff in the FMU.

- Increased illegal activities within the FMU.
- Financial feasibility for commercial extraction by NRDCL.
- Lack of research.

24. DEVIATION FROM PLAN PRESCRIPTIONS

The annual harvested area should be managed to allow for unforeseen situation. For these and other *bona fide* reasons, the annual coupe may vary +/- 10%. However, the total volume harvested over successive five-year period must be no more than five times the ACC volume.

Unforeseen circumstances may warrant deviation from the Plan prescription. In such an event, the CFO, Bumthang must obtain prior written approval from the Director, DoFPS. Any such request for plan deviation(s) must be fully justified and such approved deviation(s) entered into the Management Plan during its next scheduled revision. The NEC Secretariat must be informed of the plan deviations approved by the Head of the Department if any.

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ANNEXURE 1:
COMPARTMENT DESCRIPTION AND PRESCRIPTIONS

Block: Setta
Altitude: 2830 m - 3700 m
Aspect: South and South-East
Terrain: Moderate to steep
Total Area: 857.74 ha
Protection: 332.91 ha
Non-production: 64.87 ha
Production: 459.96 ha

Past Management
The compartment was exposed to commercial harvesting during the first plan period. Moreover, the forest area near the settlement was designated as rural use area and timber and firewood as rural allotment was given from this compartment to the people of Setta Village.

Forest Description
The higher ridges of the compartment have over matured fir and hemlock trees. The girth of these trees is harvestable. The areas near settlement are mostly barren and were used by the local as pasture. Few regeneration of Junipers could be seen in the open spaces.

Prescription for Future Management
The commercial harvesting was carried out in this compartment during the first plan period and rural allotments were also given from the local use areas to the people of Setta Village. In the next ten year, the area above settlement has been designated as local use area and rural timber and firewood can be extracted from this site as per single tree selection system. The past operated cable lines have been kept undisturbed for regenerations to establish.

Block: Jawang, Compartment I
Altitude: 2440 m - 3440 m
Aspect: Eastern
Terrain: Moderate to steep
Total Area: 598.83 ha
Protection: 147.42 ha
Non-production: 51.92 ha
Production: 399.49 ha

Past Management
Commercial harvesting was carried out in this compartment during the first plan

period. Some rural allotments were also met from this compartment. Poles were allotted on thinning basis in the blue pine forest.

Forest Description
The major forest type in this compartment is Blue Pine forest. Most of the blue pine in this compartment is immature and are of pole sized. The upper portion of the compartment has hemlock species in pure stand as well as mixed with blue pine. Some blank areas are also present in the compartment which is being colonized by blue pine regenerations. The compartment has very good blue pine regeneration.

Prescription for Future Management
As commercial harvesting was also carried out in this compartment, it is prescribed that thinning operations should be carried out in areas where blue pine regeneration is dense. Moreover, the past operated lines should be monitored periodically to ensure that adequate regeneration occurs in the harvested lines. Grazing should be minimized in this compartment to ensure proper establishment of regenerations in the operated sites.

Block: Jawang, Compartment II
Altitude: 2440 m - 2960 m
Aspect: Southern
Terrain: Moderate
Total Area: 187.07 ha
Protection: 81.03 ha
Non-production: 54.76 ha
Production: 51.28 ha

Past Management
Commercial harvesting operations were already carried out during the first plan period and few allotments to rural communities were also met from this compartment on thinning basis.

Forest Description
Immature stand of blue pine occupies most part of the compartment. The earlier open areas used by the local people as grazing land are also being colonized by blue pine regenerations. The regeneration of blue pine is very good in this compartment. Few blank areas are also present in the compartment.

Prescription for Future Management
In areas where dense regeneration of blue pine occurs, thinning is prescribed. This is mainly to improve the quality of the stand which can help obtain good timber in the future. The grazing intensity should be minimized so that regenerations are not

affected. The past operated lines should be regularly monitored so that regenerations are established adequately for future harvest.

Block: Danglajem, Compartment I a
Altitude: 2440 m - 3080 m
Aspect: South-East
Terrain: Gentle to Moderate
Total Area: 221.64 ha
Protection: 19.56 ha
Non-production: 9.20 ha
Production: 192.88 ha

Past Management
No management activities were carried out during the previous plan period.

Forest Description
The sub-compartment consists of immature blue pine stand in the lower elevation and Hemlock mixed with blue pine in the upper elevation. Few blank areas were also present in the sub-compartment. The blank areas are getting smaller due to colonization by blue pine regenerations. The undergrowth consists of bamboo species.

Prescription for Future Management
Commercial harvesting is not feasible as the crop is of relatively young age. Improvement operations such as thinning could be carried out in areas where blue pine regeneration is dense.

Block: Danglajem, Compartment I b
Altitude: 2560 m - 3080 m
Aspect: Western
Terrain: Gentle to Moderate
Total Area: 114.16 ha
Protection: 10.41 ha
Non-production: 0 ha
Production: 103.75 ha

Past Management
Commercial harvesting was not carried out during the previous plan period.

Forest Description
The upper half of the sub-compartment has immature stand of blue pine. Lower half of the sub-compartment consists of mixed conifer and broadleaf species.

Prescription for Future Management
Thinning is prescribed in the areas where blue pine growth is dense. The areas which fall under soil protection function should not be intervened by harvesting operations. Grazing should be controlled in the area where regenerations are coming up.

Block: Danglajem, Compartment I c
Altitude: 2640 m - 3020 m
Aspect: Western
Terrain: Gentle to Moderate
Total Area: 176.19 ha
Protection: 19.80 ha
Non-production: 3.50 ha
Production: 152.89 ha

Past Management
Some area in the western part of the compartment was subjected to commercial harvesting during the first plan period.

Forest Description
The upper region of the sub-compartment consists of Hemlock mixed with Blue Pine. The lower region of the sub-compartment consists of Hemlock mixed with broadleaf species.

Prescription for Future Management
As commercial harvesting was carried out in this sub-compartment in the first plan period, monitoring of harvest lines should be carried out. Grazing should be controlled in the harvested lines so that the regenerations will be established soon after harvesting.

Block: Danglajem, Compartment I d
Altitude: 2950 m - 3540 m
Aspect: South and South-East
Terrain: Gentle to Moderate
Total Area: 274.19 ha
Protection: 11.97 ha
Non-production: 0.27 ha
Production: 261.95 ha

Past Management
Commercial harvesting was carried out by cable crane during the previous plan period.

Forest Description
The sub-compartment consists of matured hemlock of harvestable girth in the upper region. The lower region consists of blue pine of relatively young age. The compartment also has *Betula* species in good numbers. All matured trees falling within the cable lines were harvested during the previous plan.

Prescription for Future Management
As commercial harvesting operation in this sub-compartment was completed during the previous plan period, the cable corridors and groups should be monitored regularly for regenerations. The grazing should be minimized in the sub-compartment so that regenerations are established within short period of time. Sanitary operations may be carried out if required.

Block: Danglajem, Compartment II a
Altitude: 2760 m - 3540 m
Aspect: North-West
Terrain: Moderate to steep
Total Area: 87.84 ha
Protection: 4.65 ha
Non-production: 2.09 ha
Production: 81.10 ha

Past Management
The commercial harvesting operations using cable crane was carried out during the first plan period.

Forest Description
Scattered Fir is present in the uppermost portion of the sub-compartment. Scattered Hemlock is present in the middle and broadleaf species such as Quercus sp. mixed with Hemlock in the lower part of the sub-compartment.

Prescription for Future Management
As commercial harvesting operation in this sub-compartment was completed during the first plan period, the cable corridors and groups should be monitored regularly for regenerations. The grazing should be minimized in the sub-compartment so that regenerations are established within short period of time. Sanitary operations may be carried out if required.

Block: Danglajem, Compartment II b
Altitude: 2900 m - 3540 m
Aspect: Western
Terrain: Moderate to steep
Total Area: 198.26 ha

Protection: 20.93 ha
Non-production: 0.18 ha
Production: 177.15 ha

Past Management
The commercial harvesting operations using cable crane was carried out during the first plan period.

Forest Description
Scattered distribution of Fir, Hemlock and immature Blue Pine occurs in the upper, middle and the lower portion of this sub-compartment respectively. *Betula* sp. and *Acer* sp. is found scattered in between the conifer species.

Prescription for Future Management
As commercial harvesting operation in this sub-compartment was completed during the first plan period, the cable corridors and groups should be monitored regularly for regenerations. The grazing should be minimized in the sub-compartment so that regenerations are established within short period of time. Sanitary operations may be carried out if required.

Block: Danglajem, Compartment III a
Altitude: 2760 m - 3500 m
Aspect: South-West
Terrain: Moderate to steep
Total Area: 68.6 ha
Protection: 14.81 ha
Non-production: 2.96 ha
Production: 50.83 ha

Past Management
The commercial harvesting operations using cable crane was carried out during the first plan period.

Forest Description
The upper most portions consist of scattered distribution of matured Fir. The middle portion consists of mature Hemlock. The lower portion consists of immature stand of Blue Pine mixed with few matured Hemlock.

Prescription for Future Management
As commercial harvesting operation in this sub-compartment was completed during the first plan period, the cable corridors and groups should be monitored regularly for regenerations. The grazing should be minimized in the sub-compartment so that regenerations are established within short period of time. Sanitary operations

may be carried out if required.

Block: Danglajem, Compartment III b
Altitude: 2780 m - 3100 m
Aspect: Western
Terrain: Moderate to steep
Total Area: 96.69 ha
Protection: 5.54 ha
Non-production:9.94 ha
Production: 81.21 ha

Past Management
The commercial harvesting operations using cable crane was carried out during the first plan period.

Forest Description
Hemlock in scattered form dominates the area, with immature Blue Pine in the lower region. *Quercus* sp. does exist there although not significantly in good quantities as that of Hemlock.

Prescription for Future Management
As commercial harvesting operation in this sub-compartment was completed during the first plan period, the cable corridors and groups should be monitored regularly for regenerations. The grazing should be minimized in the sub-compartment so that regenerations are established within short period of time. Sanitary operations may be carried out if required.

Block: Danglajem, Compartment III c
Altitude: 3040 m - 3530 m
Aspect: North-West
Terrain: Moderate to steep
Total Area: 38.59 ha
Protection: 14.42 ha
Non-production: 0.45 ha
Production: 23.72 ha

Past Management
The commercial harvesting operations using cable crane was carried out during the first plan period.

Forest Description
Scattered distribution of Fir is present in the upper portion of the sub-compartment. In the lower portion of the sub-compartment, Hemlock occurs in scattered manner.

Prescription for Future Management
As commercial harvesting operation in this sub-compartment was completed during the first plan period, the cable corridors and groups should be monitored regularly for regenerations. The grazing should be minimized in the sub-compartment so that regenerations are established within short period of time. Sanitary operations may be carried out if required.

Block: Danglajem, Compartment IV
Altitude: 2910 m - 3550 m
Aspect: North-West
Terrain: Moderate to steep
Total Area: 184.79 ha
Protection: 85.05 ha
Non-production: 3.19 ha
Production: 96.55 ha

Past Management
The commercial harvesting operations using cable crane was carried out during the first plan period.

Forest Description
Scattered distribution of Fir is present in the upper portion of the sub-compartment. The lower portion mainly consists of Hemlock. *Betula* sp. is found scattered in between the conifer species.

Prescription for Future Management
As commercial harvesting operation in this sub-compartment was completed during the first plan period, the cable corridors and groups should be monitored regularly for regenerations. The grazing should be minimized in the sub-compartment so that regenerations are established within short period of time. Sanitary operations may be carried out if required.

Block: Nalajem, Compartment I
Altitude: 1680 m - 2965 m
Aspect: South-East
Terrain: Moderate to steep
Total Area: 415.69 ha
Protection: 183.84 ha
Non-production: 22.90 ha
Production: 208.95 ha

Past Management
No rural markings were carried out in the compartment. Most of the area under

this compartment has been designated as Community Forest during the second plan period. Commercial timbers were also not extracted from this compartment as the species available were not of commercial value.

Forest Description
The compartment consists of broadleaf species mostly *Quercus lamilosa*, *Q. lanata, Betula* sp., *Alnus* sp., and *Acer* sp. The compartment area below the highway is leased by THyEL and few blank areas are also visible. Very few Hemlock species are also found distributed in the upper ridges.

Prescription for Future Management
The compartment is not feasible for commercial extraction as the species found in the compartment is not timber species. However, rural/commercial firewood marking can be done in the compartment mostly from areas below road. Such harvesting will ensure good quality crops in the future.

Block: Nalajem, Compartment II
Altitude: 2140 m - 3520 m
Aspect: Southern and South-East
Terrain: Gentle to Moderate
Total Area: 574.73 ha
Protection: 83.93 ha
Non-production: 37.36 ha
Production: 453.44 ha

Past Management
No commercial harvesting was carried out in this compartment. However, commercial firewood was extracted from the areas below the highway which are allotted to THyEL based on the forestry clearance.

Forest Description
The upper ridges of this compartment consist of Hemlock and Fir species which are of commercially harvestable girth. The lower portion ridges are covered with broadleaf species such as *Quercus lamilosa*, *Q*. lanata, *Michellia champaca, Betula* sp. *and Alnus* sp. Blue Pine growth in scattered form is found in the compartment but is mostly stunted. It is mostly found in the western side of the compartment along the ridge mixed with broadleaf species.

Prescription for Future Management
The upper ridges where mixed conifers are present can be taken up for commercial harvesting if it is economically feasible for NRDCL. However, the areas which are designated as Biological Corridor should be kept undisturbed for movement of the wild animals.

Block: Nalajem, Compartment III a
Altitude: 2260 m - 3040 m
Aspect: South-East
Terrain: Gentle to Moderate
Total Area: 64.53 ha
Protection: 18.44 ha
Non-production: 4.01 ha
Production: 42.08 ha

Past Management
Most of the area under this compartment, except for few pockets of forest area, was designated as Community Forest for the people of Nyala. The community forest was named as Nyala Phuntshok Community Forest.

Forest Description
The sub-compartment is covered with *Quercus* sps. and mixed with few matured Hemlock and patches of *Alnus* sp.

Prescription for Future Management
After establishment of Community Forest, very negligible area has been left aside. Therefore, this sub-compartment can neither be used for commercial harvesting nor be allotted for rural timber harvesting. The areas left after designation of Community Forest should be monitored properly so that the timber demand pressure is not felt in the surrounding GRF land.

Block: Nalajem, Compartment III b
Altitude: 2160 m - 3540 m
Aspect: South-West
Terrain: Gentle to moderate
Total Area: 791.49 ha
Protection: 239.57 ha
Non-production: 16.09 ha
Production: 535.83 ha

Past Management
Commercial harvesting activities were not carried out during the previous plan. Few rural firewood allotments were made from this area during the previous plan.

Forest Description
The lower portion of the compartment is covered with blue pine species. The areas near the highway are mostly open and are used as *tsamdro* by locals before. Some areas have blue pine forest mixed with broadleaf species. The upper ridges have

hemlock species of commercial girth. The undergrowth consists of bamboo species which are not yet of commercial diameter.

Prescription for Future Management
The compartment can be taken up for commercial harvesting given that it is feasible for NRDCL to extract timber. The commercial harvesting can be carried out only on the upper ridges where mixed conifers of commercial girth are available.

Block: Nalajem, Compartment IV
Altitude: 2260 m - 3400 m
Aspect: South-West
Terrain: Gentle to Moderate
Total Area: 817.11 ha
Protection: 267.47 ha
Non-production: 80.45 ha
Production: 469.19 ha

Past Management
Commercial harvesting was not carried out during the previous plan. Certain area under this compartment has been designated as Community Forest for the people of Dangla during the previous plan. The community forest was named as Dangla Dekiling Community Forest.

Forest Description
The compartment mostly consists of broadleaf species on the lower part and Hemlock mixed with broadleaf on the upper ridges. The areas below the highway are mostly covered with mixed broadleaf. The undergrowth constitutes mostly of bamboo species.

Prescription for Future Management
As most of the area with prime forest has been designated as community forest, no commercial harvesting can be carried out in this compartment. However, few rural markings could be carried out based on single tree selection system or thinning.

Block: Brogena Sekche, Compartment I
Altitude: 2500 m - 2880 m
Aspect: Northern
Terrain: Moderate to steep
Total Area: 102.75 ha
Protection: 13.79 ha
Non-production: 9.18 ha
Production: 79.78 ha

Past Management
During the previous plan, no commercial harvesting was carried out in this compartment.

Forest Description
The vegetation near the river bank and lower ridges consists of *Populus* sp. *Populus* sp. vegetation is mixed with Blue Pine species. The blue pines are mostly middle aged. The compartment is broadly the mix of immature and matured crops. In between the blue pine stands, scattered broadleaf species can also be seen.

Prescription for Future Management
As the compartment has lot of middle aged blue pine trees, it has been designated as local use area. The compartment will be used for allotment of rural timber and firewood for the local communities. The markings will be done as per the prescriptions of single tree selection system.

Block: Brogena Sekche, Compartment II
Altitude: 2520 m - 2940 m
Aspect: Northern
Terrain: Moderate to steep
Total Area: 63.63 ha
Protection: 0.75 ha
Non-production: 2.23 ha
Production: 60.65 ha

Past Management
No management activities during the previous plan period.

Forest Description
Populus sp. could be found in the lower elevation of the compartment, mostly along the river bank. The compartment was mostly covered with blue pine species of young as well as middle age. Few broadleaf species could also be found in the compartment mixed with blue pine species.

Prescription for Future Management
Commercial harvesting is not prescribed in this compartment as the crops are not of the harvestable girth. Time should be given for the crop to attend harvestable girth so that it can be harvested for use in the future. In case of higher demand for rural timber, this compartment can be explored for allotment on single tree selection system.

Block: Brogena Sekche, Compartment III
Altitude: 2540 m - 3400 m
Aspect: Northern
Terrain: Moderate to steep

Total Area: 222.39 ha
Protection: 41.46 ha
Non-production: 26 ha
Production: 154.93 ha

Past Management
No management activities were carried out during the second plan period.

Forest Description
Populus sp. could be found in the lower elevation of the compartment mixed with Blue Pine. The compartment was mostly covered with blue pine species of young as well as middle age. Few broadleaf species could also be found in the compartment mixed with blue pine species.

Prescription for Future Management
Commercial harvesting is not prescribed in this compartment as the crops are not of the harvestable girth. Time should be given for the crop to attend harvestable girth so that it can be harvested for use in the future. In case of dense growth of blue pine, thinning should be carried out to improve the health of the remaining stand.

Block: Brogena Sekche, Compartment IV
Altitude: 2620 m - 3460 m
Aspect: North-East
Terrain: Moderate to steep
Total Area: 154.69 ha
Protection: 31.41 ha
Non-production: 40.86 ha
Production: 82.42 ha

Past Management
No management activities were carried out during the previous plan period.

Forest Description
The tree cover could be found only in the North-East aspect of the compartment. The southern aspect is devoid of any vegetation cover. The vegetation cover mostly consists of blue pine and hemlock species. The compartment also shows the presence of hardwood shrubs with certain areas which are blank.

Prescription for Future Management
No commercial harvesting is prescribed as the harvestable trees are mostly confined to the upper ridges of the compartment. The steep terrain in most part of the compartment does not allow harvesting of trees in this compartment. Therefore, where the slopes are higher than 45 degree, protection should be ensured. Plantations

can be carried out in the barren areas if it is not used for other purposes by the local communities.

Block: Brogena Sekche, Compartment V
Altitude: 2740 m - 3740 m
Aspect: North-East and South-West
Terrain: Moderate to steep
Total Area: 289.66 ha
Protection: 90.56 ha
Non-production: 46.74 ha
Production: 152.36 ha

Past Management
No management activities were carried out during the previous plan period.

Forest Description
The upper half of the Northern aspect consists of over matured Fir. The lower portion has Hemlock mixed with hardwood species. Blue pine species could also be found in small pockets in the lower valley. Open areas could also be seen in some portion of the compartment.

Prescription for Future Management
As the over matured fir trees occupies the steep upper ridges of the compartment, no commercial harvesting could be prescribed. Most of the area under this compartment is designated as protection and non-production working circle. Plantations could be carried out in the blank areas so that the sustainability of timber could be assured in the future.

Block: Brogena Sekche, Compartment VI
Altitude: 2560 m - 2880 m
Aspect: Northern
Terrain: Moderate to steep
Total Area: 56.12 ha
Protection: 18.12 ha
Non-production: 12.61 ha
Production: 25.39 ha

Past Management
No management activities were carried out during the previous plan period.

Forest Description
There is mixture of conifer and broadleaf species in this compartment. At the higher elevation, there is mixture of Hemlock, Oak and Spruce. At the lower altitude, there

is mixture of Blue Pine and Hemlock. Although the area has good coverage of forest, most of the crops are pole sized.

Prescription for Future Management
Due to the steep terrain in the compartment, harvesting activities could not be prescribed despite the compartment having lot of immature stand. Therefore, the compartment is designated mostly under soil protection and soil conservation function. Minimum intervention is prescribed for this compartment.

Block: Brogena Sekche, Compartment VII
Altitude: 2620 m - 3320 m
Aspect: Northern
Terrain: Moderate
Total Area: 236.59 ha
Protection: 116.73 ha
Non-production: 66.78 ha
Production: 53.08 ha

Past Management
No management activities were carried out during the previous plan period.

Forest Description
Most of the areas in this compartment consist of pasture and the remaining area has trees and shrubs. Harvestable trees are almost absent in this compartment with some very young Blue pine stand. The undergrowth consists of bamboo and covers a vast area.

Prescription for Future Management
Harvesting of bamboo on sustainable basis may be prescribed in this compartment. The bamboo can be allotted to rural people. No commercial and rural harvesting shall be carried out in this compartment.

Block: Medta, Compartment I
Altitude: 2500 m - 3300 m
Aspect: South-East
Terrain: Moderate to steep
Total Area: 251.39 ha
Protection: 35 ha
Non-production: 28.41 ha
Production: 187.98 ha

Past Management
This compartment was not exposed to commercial harvesting during the previous

plan period. It was also not designated as local use area.

Forest Description

The lower part of the compartment consists of blue pine stand of middle age. The age of the blue pine trees increases as the elevation rises. In the higher elevation, the blue pine is found mixed with Hemlock species. The Hemlock and blue pine in the higher elevations are mostly of harvestable girth.

Prescription for Future Management

The lower portion of the compartment has been designated as local use area and it will be used for harvesting rural timber and firewood for people of Chendebji Village. As the road alignment fall through this compartment, the trees falling within the alignment will be marked and removed. The upper part of the compartment will be subjected to commercial harvesting.

Block: Medta, Compartment II

Altitude: 2960 m - 4100 m
Aspect: Eastern
Terrain: Moderate to steep
Total Area: 707.62 ha
Protection: 275.18 ha
Non-production: 0.01 ha
Production: 432.43 ha

Past Management

The compartment was not subjected to commercial as well as rural harvesting during the previous plan period.

Forest Description

The lower portion of the compartment is covered with blue pine and hemlock species. The hemlock and blue pine are of commercially harvestable girth. Some blue pines in the lower part of the compartment are young and requires thinning to improve the stand. The middle part of the compartment consists of mixed conifer, mostly matured Hemlock. The upper part of the compartment consists of matured Fir of harvestable girth.

Prescription for Future Management

Commercial harvesting is prescribed in this compartment and group selection system will be followed. The cable lines should be laid in such a way that maximum area can be covered. Harvesting operation should be followed by natural regeneration. If natural regeneration fails, the area should be reforested by means of artificial regeneration through planting.

ANNEXURE 2:
ROAD STANDARDS

The road standards developed in the east by TFDP will be implemented for design, drainage and construction of all forest roads in Chendebji FMU.

Road Design

- Road lengths and density should be minimized, consistent with access requirements to reduce environmental impacts and enhance access economics.
- Where possible, locate roads in areas with low side slopes. The maximum side slopes allowed in all areas, except rock, is 100%.
- Roads must be constructed in such a way that no earth works or soil spill into water courses or watercourse buffer areas. Care should also be taken to ensure that no earth works or soil is allowed to spill onto agricultural land, near houses or main roads.
- Roads should be planned in such a way that the cut and fill are balanced to minimize transport of construction materials.
- Roads should not be constructed in steep and unstable areas where there is the possibility of landslide. A thorough survey of any area suspected of being unstable should be undertaken prior to construction.
- Roads should be kept as narrow as possible to reduce damage to the environment and to reduce costs.
- Where possible, box cuts should be avoided, however they are acceptable for short distances (up to 300 m), if they reduce the length of the road, reduce environmental damage and are properly drained.
- Minimum radius formed by curves or corners should be 15 m and should where possible fit the topography of the land.
- Roads should be located on elevated areas, where possible, to minimize side cutting, width of clearing and drainage problems.
- Side cutting should be carried out leaving a stepped batter, each step no more than 3m in vertical height and no more than 100% gradient with a 1.5 m horizontal step.
- Convex road surface should be maintained at all times with the centre line 30cm higher than the edges.
- Stabilize and re-vegetate cut and fill slopes with shrubs, grasses and legumes as soon as possible after construction.
- Ensure proper maintenance of roads and enforce road use restrictions during critical weather conditions such as monsoon seasons.

Drainage

- Road planning should ensure that roads are located in such a way as to minimize stream river crossings and avoid areas which are prone to floods during monsoon.

- In areas where side slopes of 70% or greater extend for a distance of 100 m or more above the proposed road catch drains should be constructed to divert surface water into culverts. Side drains or table drains should be at least 40 cm deep and 65 cm wide and should drain into culverts of sufficient size and frequency.
- All culverts must have stone or concrete aprons at their exit points to prevent erosion by water. These aprons should be of suitable width and design to prevent any erosion, taking place and should extend down the slope for at least the length of the spill. They should divert the water back into the stream if the water came from a stream.
- Culverts of appropriate diameter (not less than 30 cm) should be placed at regular intervals along the road. The following table gives the minimum spacing required according to road gradient. Should the roadside drain be composed of erodable material then the distance between the culverts must be reduced by 50%.

Road Gradient (%)	Distance Between Culverts (m)
4	110
5-8	90
9-10	80
11-15	60

Culverts should be laid at 2 to 5 % gradient across the road to enable water to flow but should not exceed 6% as damage from erosion will result. Culverts pipes (Hume pipe) should be buried a minimum of 700 mm below the surface of the road.

- In areas of high seasonal rainfall, catch drains should be constructed above the road to collect surface runoff and prevent it from reaching the road.
- Drains should not be allowed to directly enter a watercourse but should be diverted into surrounding vegetation at least 50 m before a watercourse.
- Sumps or silt traps should be places in drains every 50 m in erodable soils and must be cleaned regularly.

Road Construction

- All timbers above 30 cm diameter must be felled and removed from the road alignment, the remaining timber should be cut and burnt (no organic material should be used as fill).
- Primary excavation should be done in such a manner as to remove the topsoil and place it on the downward slope of the road. This will allow vegetation to regenerate and stabilize the slopes.
- Where side slopes of 70% or more extend more than 100 m downhill no side casting of spoil should be allowed. In this situation end haul methods must

be used.

- Forest roads should only be constructed on stable soil types where there is no possibility of slippage.
- All road construction on side slopes of over 50% or difficult terrain, such as boulder fields, must be carried out using excavators.
- Batter and fill slopes should not exceed 100%.
- Where road construction is carried out on side slopes of over 90% rock or concrete wall should be built to support both batter and fill (this is not required in solid rocks).
- On side slopes of over 70% all of the load carrying surface of the road must be built on stable ground. The road should not be supported by fill.
- The adverse gradient should not exceed 10%. However, grades of up to 12% will be allowed for distances of up to 300 m if this substantially reduces road length. Following this incline, a minimum distance of 100 m of grades of 10% or less must be maintained.
- The favorable gradient should not exceed 12%. However, grades of up to 15% for distances of up to 300 m will be allowed if this substantially reduces road length. These grades should be followed by grades of less than 10% for distances of 100 m or more.

ANNEXURE 3:
TREE MARKING GUIDELINES

Marking Guidelines for Group Selection System

The Group Selection System aims to secure natural regeneration by imitating nature in the creation of small opening in the forest stand; thus allowing light to reach the forest floor and creating favorable microclimatic condition for seed germination and seedling establishment. It is important to avoid damage to the remaining stand by selecting only trees that will fall into the opening and ensuring that accurate felling is carried out.

- Small groups spaced at specified interval will be harvested removing all tress over 10 cm DBH.
- The group will be located along extraction lines.
- The distance between the extraction lines will be no less than 60 m.
- The distance between the groups, along the extraction lines, will be less than 50 m.
- The shape of the harvested groups can be irregular, according to the site and terrain conditions.
- Existing opening in the stand having already established regeneration should be used as a nucleus for marking the groups.
- Signs of existing wind fall in the stand should form the basis of the opening. In such a case, opening boundaries should correspond to changes in soil moisture that is often the cause of the windfall.
- Wind firm trees must surround the selection groups. This could be achieved by leaving intermediate height trees along the edge of the opening.
- The trees will be marked for harvesting along the extraction corridors.
- The extraction corridors must be as narrow as possible; 2-4 m in the Fir stands and no wider than 4 m in the Spruce and Hemlock stands.
- The maximum size of the groups will be on an average less than 0.15 hectares depending on the sites characteristics and stand condition.
- Diseased, dead and malformed tress will be marked on the priority basis and should be used as a nucleus for creating as opening.
- Boundaries of opening should, where possible corresponds to change in slope. An opening should not end in the middle of a steep slope since tree will slide into the remaining stand during logging.
- Care must be taken in choosing the boundary of the opening. Trees, which can be expected to fall into the opening, should be marked while trees leaning out of the proposed opening must be left standing so as to minimize damage to the remaining stand.
- Trees damaged during harvesting will be cut and removed in the subsequent cleaning operations.
- Fruiting trees and some hollow trees which will have less economic value will not be harvested; it will be left for preserving biodiversity.

Marking guidelines for Single Tree Selection System

Felling under the Single Tree Selection System should be done in accordance with the following guidelines:

- Trees marked for harvesting will be evenly distributed throughout the stand.
- Diseased, malformed, dead and decaying trees will be marked on a priority basis; especially these are hampering the better ones (unless objectives of biodiversity conservation dictate otherwise). These trees can be marked even if below the set diameter limit of 50 cm. However, care should be taken that no large openings are created in the stand by marking these trees.
- Trees of exploitable size should be marked, particularly if defective or lacking in vigor; mature and over-mature trees over 50 cm DBH outside bark to be marked.
- No more than one third of the stand volume should be marked for harvesting.
- In mixed stands, an even and suitable distribution of species should be left standing.
- Fruiting trees and some hollow trees which will have less economic value will not be harvested; it will be left for preserving biodiversity.

Marking Guidelines for Blue Pine under Seed Tree System

- The seed tree system is used in pure pine stands or mixed stands consisting of mixture of pine and spruce with pine predominating.
- The Seed Tree System will be used in the above stands only on suitable sites.
- The system will not be used on steep and exposed, South or South-West sites.
- In mixed stands, an equal distribution of pine and spruce will be left standing.
- Slope characteristics, wind firmness and aesthetic value will be considered.
- About 20 to 25 trees per hectare (i.e. approximately 22 to 26 meters apart) will be left standing.
- Diseased, malformed and dying trees will be cut on priority basis.
- Trees left standing will be of good health and form to ensure good seed source.
- The shape of the area chosen for the seed tree can be irregular.
- Maximum size of a contiguous area harvested using this system should not exceed one hectare.
- Fruiting trees and some hollow trees which will have less economic value will not be harvested; it will be left for preserving biodiversity.

Marking Guidelines for Thinning in Blue Pine Stands

Thinning will be carried out in immature stands. The objective of thinning is to increase growth and quality of stands and at the same time provide small dimension. Healthy, vigorous trees will be released by cutting.

Spacing and stand Density Regulation

The spacing of trees should be roughly 2 m and the resulting stand density, approximately 2,500 trees/ha. Preferentially maintain admixed species, unless damaged or malformed. Mean maximum diameters of solitary blue pines provide guidance for optimal size dependent stand density considering a 25% deduction of mean maximum crown dimensions for optimal spacing in closed stands. Trees in closed stands will not develop the crown dimensions of free growing (solitary) trees and at the same time individual tree growth and stand growth have to be optimized. A too severe reduction of stem density (increase of spacing for optimized growth of individual trees) would result in lower standing volume per hectare.

Selection of Plus Trees

Once the stand reaches crown closure at the beginning of pole stage (at top heights of 12-15 m), differentiation between trees in terms of performance and quality will start to become clearly visible in case initial spacing has been carried out. Trees forming part of the stand at time of the final cut (plus trees) have to be selected and marked during this time. A change or supplementary marking of plus trees at a later stage are not possible.

The number of plus trees depends on the target diameter during the final harvest. Considering crown dimensions with a target DBH of 50 cm at rotation period of 100-130 years, selection of 200 plus trees per hectare resulting in a spacing of 7 m between plus trees is recommended. In case the target production for the stand is 40 cm DBH at final harvest, optimal spacing is 6-6.5 m resulting in 260 stems per hectare (Darabant, Rai, Eckmullner, Gratzer, & Gyeltshen, 2012).

In case of doubt, stability should have priority before quality. In locations where suitable trees are lacking, no plus tree should be selected. While carrying out thinning operations, special care should be given to plus trees in order to protect them from damage. In case initial spacing has not been carried out, stands reaching pole stage are densely stocked and differentiation between trees in terms of vitality and quality is not clearly visible. Marking of plus trees at this stage is not meaningful. Therefore, a series of low-intensity thinning entries should be completed before trees are differentiated enough in terms of stability and quality criteria so that selection of plus trees can be carried out (Darabant, Rai, Eckmullner, Gratzer, & Gyeltshen, 2012).

- For each plus tree, mark the one or two (maximum three) strongest competitors for removal in order to provide it enough growing space. Ideally, the total volume removed should be around 25% corresponding to moderate thinning intensity.
- Paint plus trees with yellow band to signalize their importance and for ease of marking in subsequent entries. Trees with such a yellow band should

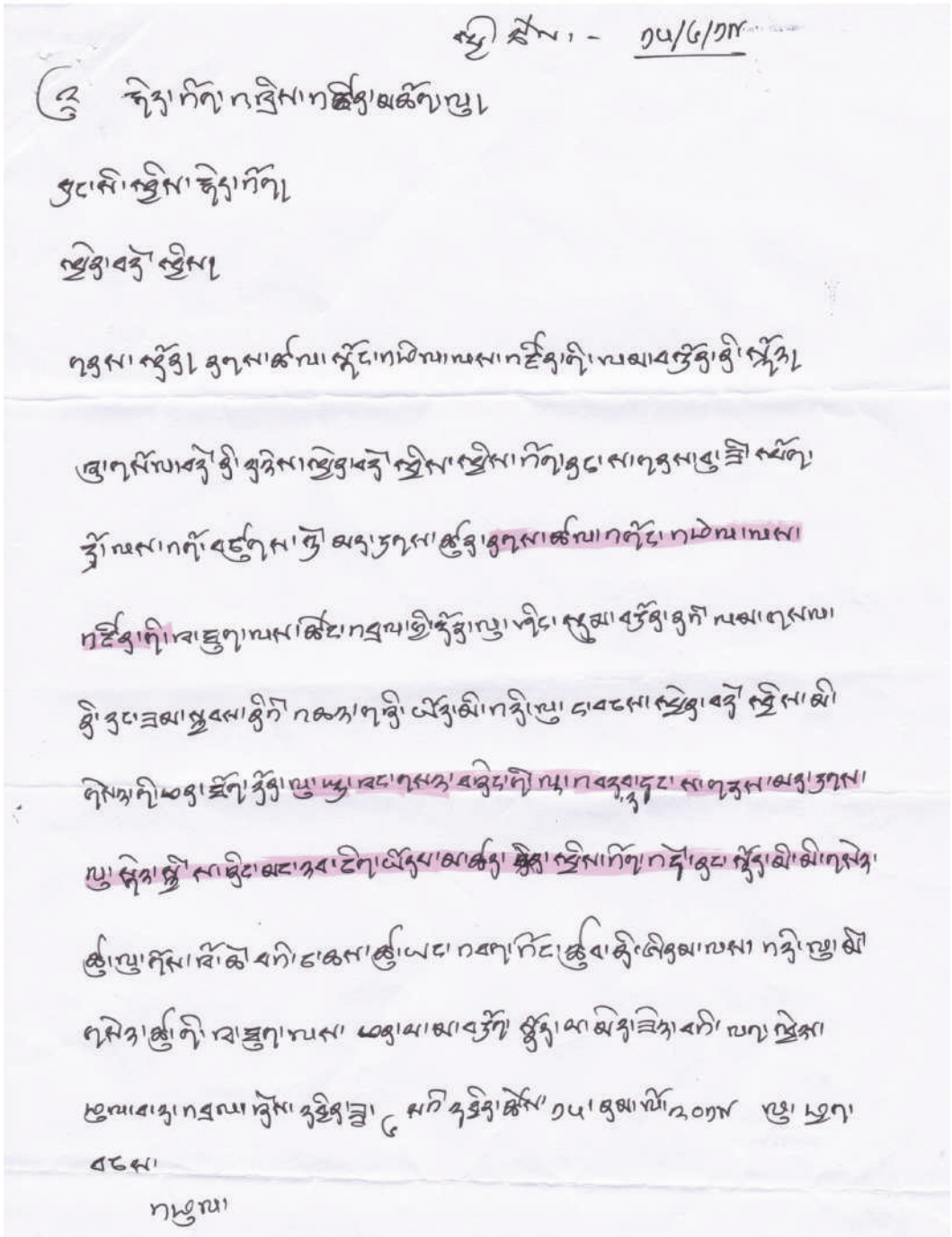
be protected throughout the stand development as they represent the final crop.

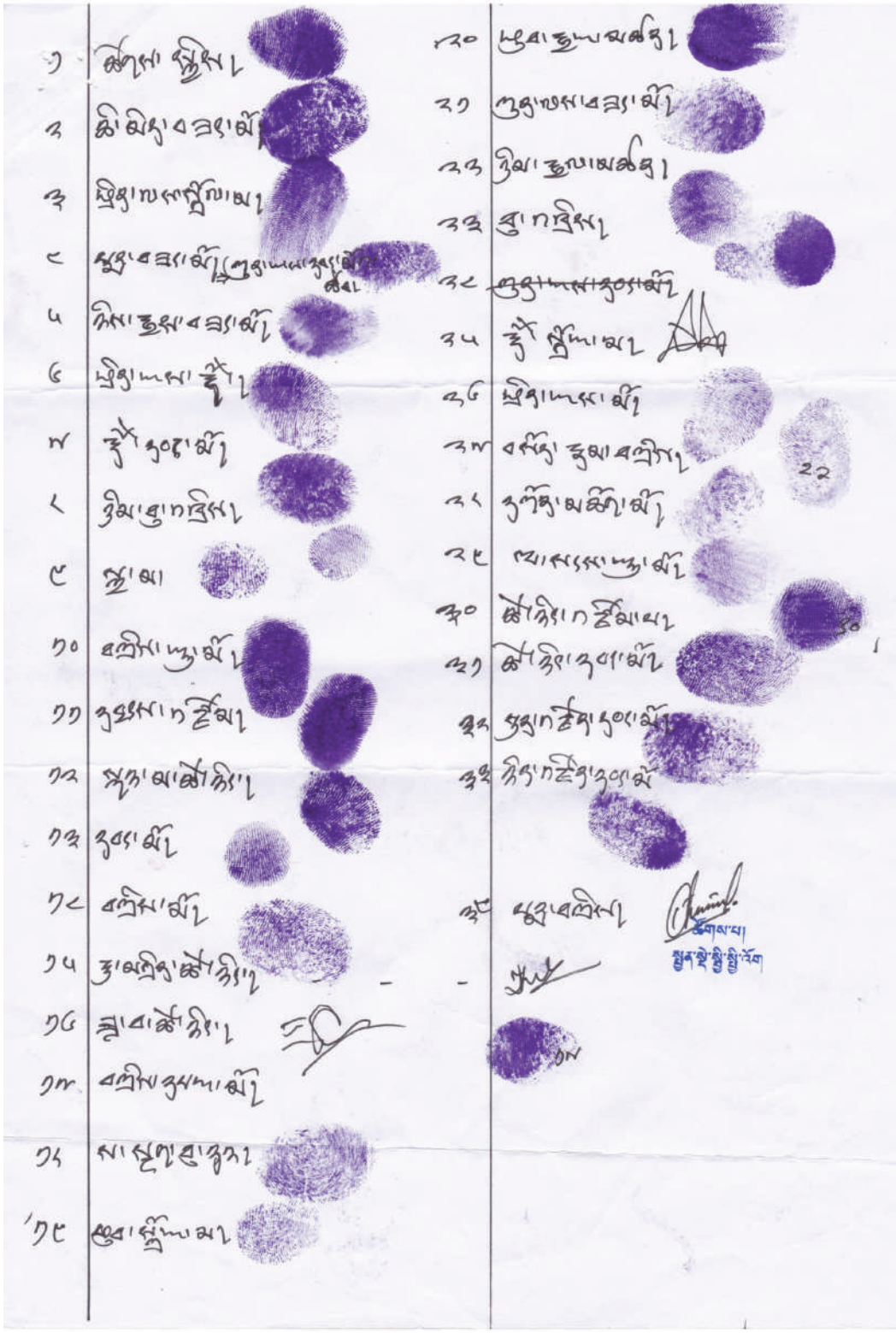
- The remaining stand may optionally be thinned, but this is not an essential requirement. In case of thinning the remaining stand, concentrate on removal of malformed and diseased trees.
- In case the favored tree (plus tree or other) has a crown ratio below half or an asymmetric crown, remove maximum one competitor in order not to jeopardize stability.
- Remove trees affected by dwarf mistletoe on a top priority basis.
- The stems of forked trees belong to the same vegetative individual and have to be treated together- if you remove one, you have to remove both.
- Remove malformed trees and trees with other diseases than dwarf mistletoe.
- Marking should not result in creation of gaps in the canopy.
- Focus on maintaining a well-structured stand.
- Focus on promoting a mixed-species stand.
- Do not blaze trees in the remaining stand. Blazing wounds weaken the trees and provide entry point for pathogens, devaluating the most valuable first log of the tree.
- Remove wolf trees (large emergent trees remaining from an earlier cohort) in a priority basis and do not consider their volume within the target of 25% volume removal.
- Do not worry about having to induce regeneration in the course of thinning.
- Thinning is primarily about stand improvement and is not a regeneration cut (Darabant, Rai, Eckmullner, Gratzer, & Gyeltshen, 2012).

Marking for Rural Uses

- It is necessary that the marking for rural use, whether for timber or fuel wood, should be done under standard Silvicultural system.
- Firewood marking when necessary should be done under Single Tree Selection System from local use area only.
- Flag posts, fence posts and poles demand should be met by marking for thinning in the pole crop high density stands thereby subjecting the stands to Silvicultural thinning.

ANNEXURE 4:
SOCIAL CLEARANCE FOR ROAD AND BRIDGE CONSTRUCTION





ANNEXURE 5:
ENVIRONMENTAL IMPACT ASSESSMENT REPORT OF PROPOSED FOREST ROAD

ENVIRONMENTAL IMPACT ASSESSMENT REPORT FOR CONSTRUCTION OF FOREST ROAD AT CHENDEBJI FMU, MEDTA BLOCK, TRONGSA DZONGKHAG

1 Name of the applicant : Natural Resources Development Corporation Ltd.

2 Name of project : Construction of forest road

3 Present mailing address : Chief Executive Officer, NRDCL Thimphu, P.O. Box no. 192, Tel. no. 326749, EPABX no. 00975-02-323834/323868. Fax no. 00975-02-325585. Email: info@nrdcl.bt

4 Name of environmental focal person : Mr. J.K.Nepal, Sr. Engineer, Production Division, NRDCL HQ, Thimphu. Tel. no. 02-323834/323868. Email: jknepal@nrdcl.bt

5 Project objectives : Timber harvesting & afforestation of harvested areas

6 Relevence to overall planning : Revision of Forest Management Plan

7 Funding and costs : Funded by NRDCL, Thimphu
Nu. 26,886,300.00 (+) Nu. 15,000,000.00 for 1 bailey bridge

8 Project description

8.1 Project location : From 79km point along Wangdue - Trongsa National Highway.

Table 1: Road location details by Dzongkhag and Geog

Road chainage		Dzongkhag	Gewog	Town	Village
From	To				
0 + 000	0 + 12000	Trongsa	Tanbsebji		Chendebji

8.2 Category of road : Access road

8.3 Road specification

Table 2. Road Specification/Quantities

Item	Unit	Specification/Quantities
Right of way clearing	m	10.00
Formation Width	m	5.00
Pavement Width including edging	m	3.50
Pavement material (Edging, soling & agttes)	cum	13,140.87
Volume of excavated material		
a) Excavation in soil all type	cum	42,228.33
b) Excavation in rock all type	cum	22,692.20
Average road gradient	%	±6
Maximum road gradient	%	±11
Cross drain	no	NIL
Box/Hume pipe culvert	no	37
Bridges	no	1.00
Total length of bridges	m	20.84
V-shaped side drain diamensions		
In soil (horizontal x vertical)	cm	40CM X 30 Cm
In rock (horizontal x vertical)	cm	30 CM X 20 CM
Total length of v-shaped drain	m	10,400.00
Box shaped side drain diamensions (lengthxbreadthxheight)	cm	NIL
Total length of box drain	m	NIL

8.4 Excavated Materials : The excavated material will be managed and disposed off safely at designated locations through the use of excavator and tipper trucks or hydraulic tractors.

8.5 Explosives : Approximate quantity of explosive to be used is as under:

Sl. No	Particulars	Quantity
1	Safety fuse	1320 coils (Approx)
2	detonator	2310 Nos. (Approx)
3	D-chord	1870 m (Approx)
4	Jelatine	2970 kgs (Approx)

Control single shot blasting technique will be adopted with the engagement of a trained & certified blaster.

9 Alternatives : NIL

10 Public Consultation : Public consultation meeting conducted

11 Project site Physical Environmental details

11.1 Topography and Geology

Table 3: Topography and observations along the road

Chainage(Km 0+000)		distance (m)	Side slope %	Observation on geology & possible problem	Method of slope & terrain stabilization Above & Below road
From	To				
0 + 000	0 + 12000	12000.00 (Medta block)	10 -120	Thimphu Gneiss complex formation & no problem foreseen	Normal Bio-engineering + Retaining & Breast wall structure works wherever required.
Total		12,000.00			

11.2 Water Course Crossings

Table 4: Details of water courses that will require crossing along the proposed road

Chainage at which road crosses water course	Name of water course	Type of crossing	If bridge, Length of bridge (m)	Down stream water users- details		
				Name of community or individual	House hold (no)	Type of use
0000 + 0381	N A	Hume pipe culvert	NIL	Chendebji	44	Drinking & irrigation
0381 + 1236	N A	Hume pipe culvert	NIL	Chendebji		
1236 + 1326	NA	Hume pipe culvert	NIL	Chendebji		
1326 + 1533	NA	Hume pipe culvert	NIL	Chendebji		
1533 + 2634	NA	Hume pipe culvert	NIL	Chendebji		
2634 + 2805	NA	Hume pipe culvert	NIL	Chendebji		
2805 + 2863	NA	Hume pipe culvert	NIL	Chendebji		
2863 + 3340	NA	Hume pipe culvert	NIL	Chendebji		
3340 + 3612	NA	Hume pipe culvert	NIL	Chendebji		
3612 + 3628	NA	Hume pipe culvert	NIL	Chendebji		
3268 + 3699	NA	Hume pipe culvert	NIL	Chendebji		

3699 + 4134	NA	Hume pipe culvert	NIL	Chendebji		
4134 + 4369	NA	Hume pipe culvert	NIL	Chendebji		
4369 + 4421	NA	Hume pipe culvert	NIL	Chendebji		
4421 + 4705	NA	Hume pipe culvert	NIL	Chendebji		
4705 + 4861	NA	Hume pipe culvert	NIL	Chendebji		
4861 + 5777	NA	Hume pipe culvert	NIL	Chendebji		
5777 + 5827	NA	Hume pipe culvert	NIL	Chendebji		
5827 + 5827	NA	Hume pipe culvert	NIL	Chendebji		
5827 + 5923	NA	Hume pipe culvert	NIL	Chendebji		
5923 + 6356	NA	Hume pipe culvert	NIL	Chendebji		
6356 + 6426	NA	Hume pipe culvert	NIL	Chendebji		
6426 + 6537	NA	Hume pipe culvert	NIL	Chendebji		
6537 + 6632	NA	Hume pipe culvert	NIL	Chendebji		
6632 + 8350	NA	Hume pipe culvert	NIL	Chendebji		
8350 + 9560	NA	Hume pipe culvert	NIL	Chendebji		
9560 + 9870	NA	Hume pipe culvert	NIL	Chendebji		
9870 + 11000	NA	Hume pipe culvert	NIL	Chendebji		
11000 + 11100	NA	Hume pipe culvert	NIL	Chendebji		
11100 + 11559	NA	Hume pipe culvert	NIL	Chendebji		
11559 + 11781	NA	Hume pipe culvert	NIL	Chendebji		
11781 + 12000	NA	Hume pipe culvert	NIL	Chendebji		

12 Project Site Ecological Description

12.1 Land Use/Vegetation

Table 5: Land use and forest clearance required for road construction

Chainage from take off		Land use	Area (M^2)	Tenure	Affected House hold no
From	To				
0 + 000	12 + 000	Mixed conifer forest	130,000.00	10 years	NIL

Table 6: Areas Required for Project Facilities

Facility	Land use	Area (m^2)	Tenure/ownership	Remarks

Labour camp	Mixed conifer forest	2000 per annum	Govt. reserve forest	Till project completes
Others				

12.2. Protected area : The protected areas such as Soil protection, local water supply protection, Reparian protection, Wild life protection etc. shall be indentified where no commercial activities shall be allowed.

13 Project social environment

13.1. Population

Table 7: Project Beneficiaries. Households with possible access <2km either side of the road

Dzongkhag	Gewog	Households (No)
Trongsa	Tangsebji	44

Source of information: as per attached No Objection letter of the Gup, Tangsebji Geog

Loss of Houses, Services, Infrastructure and Cultural Heritage Sites

Type of loss	NOS	Description of disturbance
Service	NIL	NIL
House	NIL	NIL
Infrastructure	NIL	NIL
Cultural sites	NIL	NIL
Heritage	NIL	NIL

13.3 Aesthetics

No aesthetic distrubance is foreseen however, grass seeding & other bio-engineering technique measures shall be applied on the slopes for reclaiming immediately after road construction.

14 Project Impacts and Mitigation Measures

Type of negative impact	Mitigation measures	Estimated metigation costs
Blockage of water canal	Cleaning & maintenance	Nu. 10,000.00 (Lumpsum)
House	NIL	NIL
Infrastructure	NIL	NIL

14.1. Monitoring Program

Monitoring of the construction works will be done by Site supervisor, Chendebji Unit, NRDCL, including time to time monitoring by the Unit Manager, Chendebji Unit under Jakar Regional Office, Bumthang. The Regional Manager, Jakar Regional Office, NRDCL Bumthang, shall also carry out the frequent monitoring. Also the Engineer from Production Division, NRDCL HO, shall carry out the monitoring of the construction works as & when required.

(J.K. Nepal)
Sr. Engineer
Production Division, NRDCL HQ

ENVIRONMENTAL IMPACT ASSESSMENT REPORT FOR CONSTRUCTION OF FOREST ROAD AT CHENDEBJI FMU, NALAJEM BLOCK, TRONGSA DZONGKHAG

1 Name of the applicant : Natural Resources Development Corporation Ltd.

2 Name of project : Construction of forest road

3 Present mailing address : Chief Executive Officer, NRDCL Thimphu, P.O. Box no. 192, Tel. no. 326749, EPABX no. 00975-02-323834/323868. Fax no. 00975-02-325585. Email: info@nrdcl.bt

4 Name of environmental focal person : Mr. J.K.Nepal, Sr. Engineer, Production Division, NRDCL HQ, Thimphu. Tel. no. 02-323834/323868. Email: jknepal@nrdcl.bt

5 Project objectives : Timber harvesting & afforestation of harvested areas

6 Relevence to overall planning : Revision of Forest Management Plan

7 Funding and costs : Funded by NRDCL, Thimphu
Nu. 7,035,900.00

8 Project description

8.1 Project location : From 20km point of existing forest road

Table 1: Road location details by Dzongkhag and Geog

Road chainage		Dzongkhag	Gewog	Town	Village
From	To				
0 + 000	0 + 3000	Trongsa	Tanbsebji		Nalajem

8.2 Category of road : Access road

8.3 Road specification

Table 2. Road Specification/Quantities

Item	Unit	Specification/Quantities
Right of way clearing	m	10.00
Formation Width	m	5.00
Pavement Width including edging	m	3.50
Pavement material (Edging, soling & agttes)	cum	3,555.00
Volume of excavated material		
a) Excavation in soil all type	cum	13,896.14
b) Excavation in rock all type	cum	5,209.81
Average road gradient	%	±4
Maximum road gradient	%	±12
Cross drain	no	NIL
Box/Hume pipe culvert	no	23
Bridges	no	NIL
Total length of bridges	m	
V-shaped side drain diamensions		
In soil (horizontal x vertical)	cm	40CM X 30 Cm
In rock (horizontal x vertical)	cm	30 CM X 20 CM
Total length of v-shaped drain	cm	2,960.00
Box shaped side drain diamensions (lengthxbreadthxheight)	cm	NIL
Total length of box drain	m	NIL

8.4 Excavated Materials : The excavated material will be managed and disposed off safely at designated locations through the use of excavator and tipper trucks or hydraulic tractors.

8.5 Explosives : Approximate quantity of explosive to be used is as under:

Sl. No	Particulars	Quantity		
1	Safety fuse	360 coils	(Approx)	
2	detonator	630 Nos.	(Approx)	
3	D-chord	510 m	(Approx)	
4	Jelatine	810 kgs	(Approx)	

Control single shot blasting technique will be adopted with the engagement of a trained & certified blaster.

9 Alternatives : NIL

10 Public Consultation : Public consultation meeting conducted

11 Project site Physical Environmental details

11.1 Topography and Geology

Table 3: Topography and observations along the road

Chainage(Km 0+000)		distance (m)	Side slope %	Observation on geology & possible problem	Method of slope & terrain stabilization Above & Below road
From	To				
0 + 000	0 + 3000	3000.00 (Nalajem block)	10 -120	Thimphu Gneiss complex formation & no problem foreseen	Normal Bio-engineering + Retaining & Breast wall structure works wherever required.
Total		3,000.00			

11.2 Water Course Crossings

Table 4: Details of water courses that will require crossing along the proposed road

Chainage at which road crosses water course	Name of water course	Type of crossing	If bridge, Length of bridge (m)	Down stream water users- details		
				Name of community or individual	House hold (no)	Type of use
0000 + 0105	N A	Hume pipe culvert	NIL	Nalajem	15	Drinking & irrigation
0105 + 141	N A	Hume pipe culvert	NIL	Nalajem		
141 + 379	NA	Hume pipe culvert	NIL	Nalajem		
379 + 618	NA	Hume pipe culvert	NIL	Nalajem		
618 + 735	NA	Hume pipe culvert	NIL	Nalajem		
735 + 788	NA	Hume pipe culvert	NIL	Nalajem		
788 + 816	NA	Hume pipe culvert	NIL	Nalajem		
816 + 916	NA	Hume pipe culvert	NIL	Nalajem		
916 + 1041	NA	Hume pipe culvert	NIL	Nalajem		
1041 + 1198	NA	Hume pipe culvert	NIL	Nalajem		
1198 + 1249	NA	Hume pipe culvert	NIL	Nalajem		

1249 + 1312	NA	Hume pipe culvert	NIL	Nalajem		
1312 + 1400	NA	Hume pipe culvert	NIL	Nalajem		
1400 + 1464	NA	Hume pipe culvert	NIL	Nalajem		
1464 + 1566	NA	Hume pipe culvert	NIL	Nalajem		
1566 + 1613	NA	Hume pipe culvert	NIL	Nalajem		
1613 + 1713	NA	Hume pipe culvert	NIL	Nalajem		
1713 + 1771	NA	Hume pipe culvert	NIL	Nalajem		
1771 + 1904	NA	Hume pipe culvert	NIL	Nalajem		
1904 + 2138	NA	Hume pipe culvert	NIL	Nalajem		
2138 + 2189	NA	Hume pipe culvert	NIL	Nalajem		
2189 + 2328	NA	Hume pipe culvert	NIL	Nalajem		
2328 + 2348	NA	Hume pipe culvert	NIL	Nalajem		
2348 + 2656	NA	Hume pipe culvert	NIL	Nalajem		

12 Project Site Ecological Description

12.1 Land Use/Vegetation

Table 5: Land use and forest clearance required for road construction

Chainage from take off		Land use	Area (M^2)	Tenure	Affected House hold no
From	To				
0 + 000	3 + 000	Mixed conifer forest	30,000.00	10 years	NIL

Table 6: Areas Required for Project Facilities

Facility	Land use	Area (m^2)	Tenure/ownership	Remarks
Labour camp	Mixed conifer forest	2000 per annum	Govt. reserve forest	Till project completes
Others				

12.2. Protected area : The protected areas such as Soil protection, local water supply protection, Reparian protection, Wild life protection etc. shall be indentified where no commercial activities shall be allowed.

13 Project social environment

13.1. Population

Table 7: Project Beneficiaries. Households with possible access <2km either side of the road

Dzongkhag	Gewog	Households (No)
Trongsa	Tangsebji	15

Source of information: as per attached No Objection letter of the Gup, Tangsebji Geog

Loss of Houses, Services, Infrastructure and Cultural Heritage Sites

Type of loss	NOS	Description of disturbance
Service	NIL	NIL
House	NIL	NIL
Infrastructure	NIL	NIL
Cultural sites	NIL	NIL
Heritage	NIL	NIL

13.3 Aesthetics

No aesthetic distrubance is foreseen however, grass seeding & other bio-engineering technique measures shall be applied on the slopes for reclaiming immediately after road construction.

14 Project Impacts and Mitigation Measures

Type of negative impact	Mitigation measures	Estimated metigation costs
Blockage of water canal	Cleaning & maintenance	Nu. 10,000.00 (Lumpsum)
House	NIL	NIL
Infrastructure	NIL	NIL

14.1. Monitoring Program

Monitoring of the construction works will be done by Site supervisor, Chendebji Unit, NRDCL, including time to time monitoring by the Unit Manager, Chendebji Unit under Jakar Regional Office, Bumthang. The Regional Manager, Jakar Regional Office, NRDCL Bumthang, shall also carry out the frequent monitoring. Also the Engineer from Production Division, NRDCL HO, shall carry out the monitoring of the construction works as & when required.

(J.K. Nepal)
Sr. Engineer
Production Division, NRDCL HQ

ENVIRONMENTAL MANAGEMENT PLAN FOR CONSTRUCTION OF 20.00KMsFOREST ROAD AT METAPCHU FMU UNDER PHUENTSHOLING REGIONAL OFFICE, NRDCL, IN CHUKHA DZONGKHAG.

Sl. No.	Activity	Potential Negative Environment Impact	Mitigation Measures	Public Participation and Coordination	Socio-Economic and cultural considerations	Budgeting	Supervision	Monitoring
1	Work camp location, operation & closure, restriction on workers (sanitation, fuel wood collection, poaching etc.)	• Garbage, oil & grease pollution Damage to vegetation & wildlife	• Provide sanitary facilities and restore • Provide fuel to workers	• DoF&PS • Awareness of labours	• Consider local culture and compensate, if required	• Incorporated	• Unit Manager • Site supervisor	• Regional Manager • Engineer, NRDCL HQ • External team
2	Explosive & toxic waste management	• Fire & explosion hazard • Ground & surface water pollution	• Do not store near surface water • Use plastic sheeting under hazardous material • Collect waste properly & dispose off safely	• Contact Ministry of Home & Cultural Affairs in case of hazard or needing material innihilation	• Consider local drinking water sources	• Incorporated	• Unit Manager • Site supervisor	• Regional Manager • Engineer NRDCL HQ • External team
3	Water Management	• Sedimentation of surface water • Slope failure • Creation of new gullies • Water seepage	• Build check dams • Tap excess water by catch drains and dispose off to natural gullies	• Involve locals when deciding about discharge location • Dzongkhag administration	• Irrigation channel and drinking water supplies need consideration	• Will be incorporated if required.	• Unit Manager • Site supervisor	• Regional Manager • Engineer NRDCL HQ • External team

(J.K. Nepal)
Sr. Engineer
Production Division, NRDCL HQ

ANNEXURE 6:
RECORD KEEPING FORMS

Compartment Record Sheet

Block: ……								
Compartment: …….								
Sub-compartment: ……..								
Year	**Harvesting**		**Tending**		**Planting**		**Others**	**Remarks**
	Area (ha)	**Volume (m^3)**	**Area (ha)**	**Volume (m^3)**	**Area (ha)**	**Species**		
2018								
2019								
2020								
2021								
2022								
2023								
2024								
2025								
2026								
2027								
2028								

Rural Allotment

Block :.....
Compartment: .....
Sub-compartment: .....

MC	WC	Date	Name & Address	Permit No.	TMB No.	Particulars			Volume (m^3)			Comments
						Species	Product Types	Amount	Marked	Recovered	Firewood	

Commercial Allotment

Block :.....
Compartment: .....
Sub-compartment: .....

MC	WC	Year of Activity	Commercial Activiies							Extracted (NRDCL)	Firewood (lops/ tops)	Other Activities	TMB No.	Comments (Icluded details description of cable line locatiom in relation to mappable features)
			Cable Lines			Groups/Patches/Other		Marked						
			Line No.	Length (m)	Azimuth	Total No.	Total Area (ha)	No. of Trees	Vol.					

Stand Tending and Regeneration[8]

Block :.....
Compartment: .....
Sub-compartment: .....

MC	WC	Cable Line No.	Year	Stand Tending		Regeneration						Comments or Other Activities
				Activity	Area (ha)	Natural/ Plantation	Species	Year Surveyed	Area (ha)	Survey Results (stems/ha/ survival percent)	Resurvey?	

[8]*Used for brushing, planting, weeding, and spacing or ground preparation activity*