ROYAL GOVERNMENT OF BHUTAN
DEPARTMENT OF FORESTS AND PARK SERVICES
OFFICE OF THE CHIEF FORESTRY OFFICER
GEDU FOREST DIVISION

"Walking the Extra Mile".

MANAGEMENT PLAN
FOR
METAPCHU FOREST MANAGEMENT UNIT
CHUKHA DZONGKHAG

(1st JANUARY 2018 to 31st DECEMBER, 2027)

Plan Prepared by:
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January 2017

AUTHORITY FOR PREPARATION, REVISION AND APPROVAL

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 Gedu Territorial Forest Division, Department of Forests and Park Services (DoFPS), MoAF.

PROVISION FOR REVISIONS AND CHANGES

This Plan may be revised during the period when it is in effect 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, or during intances of major challenges and need to relook and reemphasize the management plan, the Head of the Department, DoFPS, can authorize the revision of this plan.

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
Thimphu
Date.....

Recommended for approval:

Director
Department of Forests & Park Services
Date.....

Recommended for approval:

Secretary
Ministry of Agriculture& Forests
Date. 26/3/18

APPROVED:

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

རྒྱལ་ཡོངས་མཐའ་འཁོར་གནས་སྐྱོང་ལྷན་ཚོགས།
དཔལ་ལྡན་འབྲུག་གཞུང་།
National Environment Commission
Royal Government of Bhutan

NECS/EACD/Dzo-Chukha//3553/2018/ 664 June 6, 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 Metapchu Forest Management Unit (FMU) measuring an area of 10,676.53 ha (Ten Thousand Six Hundred Seventy Six point Five Three hectares) at Metakha aand Geling Gewog under Chhukha 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 5,030m^3 (Five Thousand Thirty Meter cube);
4. ensure that no extraction of timber is carried out at the critical watershed;
5. avoid any direct or indirect damage/disturbances to the water source for the communities in and around the FMU;
6. 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;
7. restore the damage to any public or private properties caused by the operation and management of FMU;
8. 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
9. 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:

NEC, PO Box 466, Thimphu, Bhutan
Tel: (975-2) 323384/325856/324323/326993 Fax: (975-2) 323385
www.nec.gov.bt

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 2008.

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 June 6, 2018 until June 5, 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, Chhukha for necessary action.
3. The Dzongkhag Environment Officer, Chhukha Dzongkhag for necessary action.
4. Guard File (EACD/Dzo-Chhukha) for record.

Sl No - 985
Dt - 7/6/18
R.B - Pem Choky

ACKNOWLEDGMENTS

The author would like to acknowledge the constant support and assistance received from all during the planning process of this Management Plan. This document is the product of many people who assisted in bringing the Plan in its final form.

In this regard, the author would like to particularly extend gratitude to CFO, FRMD and Mr. Arun Rai (Dy. CFO, GIS section), Mr. Tashi Norbu Waiba (Management Planning Section) and Mr. Dawa Zangpo (Forest Resource Section) FRMD for the support, encouragement and technical assistance provided in the planning process.

The author would also like to thank CFO, Gedu Territorial Forest Division, Regional Manager, Phuntsholing Region, NRDCL and his supporting staffs and Gedu Territorial Forest Division staff for rendering assistance during the field visit, among others.

LIST OF ABBREVIATIONS

%	Percent
AAC	Annual Allowable Cut
CFO	Chief Forest Officer
cm	Centimeter
DBH	Diameter at Breast Height
DFO	Divisional Forest Office
DoFPS	Department of Forests and Park Services
DzFO	Dzongkhag Forest Officer
EIA	Environmental Impact Assessment
FMP	Forest Management Plan
FMU	Forest Management Unit
FMCB	Forest Management Code of Bhutan
FRMD	Forest Resources Management Division
GIS	Geographic Information System
Ha	Hectare
km	Kilometer
m	Meter
m^3	Cubic Meter
masl	Meter Above Sea Level
MC	Mixed Conifer
mm	Millimeter
MoAF	Ministry of Agriculture and Forests
NRDCL	Natural Resources Development Corporation Limited
NWFP	Non-wOOD Forest Products
Nu	Ngultrum
NWFP	Non-Wood Forest Products
PFM	Participatory Forest Management
PRA	Participatory Rural Appraisal
RGoB	Royal Government of Bhutan
RM	Regional Manager
RNR	Renewable Natural Resources
RRA	Rapid Rural Appraisal
sp(p)	Species (plural)
UIC	Unit-In-Charge
UM	Unit Manager
WC	Working Circle
WWMP	Wang Watershed Management Project
GTFD	Gedu Territorial Forest Division

EXECUTIVE SUMMARY

This is the second ten-year Management Plan for Metap Chhu Forest Management Unit. The Plan structure is as per the guidelines reflected in the Forest Management Code of Bhutan. It comprises of three main parts:

PART 1 GENERAL DESCRIPTION AND THE CURRENT SITUATION

PART 2 FUTURE MANAGEMENT

PART 3 IMPLEMENTATION OF THE PLAN

PART 1 GENERAL DESCRIPTION AND THE CURRENT SITUATION

i. Metap Chhu Forest Management Unit (MFMU) is located in Metakha gewog under Chukha Dzongkhag. It is situated within 89˚ 22' 36"E and 89˚29'49.95'' E longitude and between 27˚00' 40.46" N and 27˚7'50.72"N latitude. The altitude ranges from 840m.a.s.l in the south up to 3420m.a.s.l in the North. The first ten-year plan was prepared in the year 2007. However, it was not operated as it was economically not feasible for extraction of timbers owing to high operation costs against the net returns. There are six villages falling under MFMU. Bjozhingkha in north falls under Naja Gewog, Paro Dzongkhag, Tsundrugang village(Gelling Gewog, Chukha Dzongkhag) in south and Meta Goenba, Pango and Gumina Village (Metakha Gewog) are administratively under Chukha Dzongkhag. The Mailum Chhu forms the Western boundary while a high Omchu ridge forms the Eastern Boundary. The total Area of MFMU is 10,676.53ha.

ii. MFMU has not been worked commercially in the past but local demands have been met from the areas. The Forest Management Unit (FMU) area is still in good ecological condition, and all the environmental functions are intact. There is still scope for a range of silvicultural operations, and the commercial production of timber.

iii. The forest types found within the MFMU are conifer & scrub forest (263.67 ha), Shrub Forest (124.77ha) and Broadleaf Forest (9836.29ha).

iv. MFMU also provides grazing ground, Tsamdro for communities both within and outside of the FMU.

v. The most common form of precipitation in MFMU is in the form of rain and the maximum precipitation occurs during the month of June, July and August. The average minimum temperature is 6.9˚C and the Average Maximum temperature is 19.3˚C.

vi. There are 127 households within the FMU with approximately 961 people.

vii. Commercially important tree species found within the FMU are *Michelia spp., Persea fructifera, Alnus nepalensis., Juglans regia, Ficus spp., Castanopsis spp., Toona Ciliata, Acer spp., Schima wallichi, Macaranga postulate, Terminalia chebula, Terminalia bellirica., and Quercus spp.among others.*

viii. The wildlife seen or recorded in the FMU area are *Muntiacus muntjac* (Barking deer), *Cervus unicolor* (Sambar), *Sus scrofa* (Wild Boar), *Selenarctos thibetanus* (Himalayan Black bear), *Cuon aplinus* (Wild dog), etc.

ix. The forest inventory of the whole area was carried out in the year 1998 to1999 by the forest inventory crew of FRMD, the then FRDD.

x. The data were validated and corrected and analyzed with the specially developed (PLOT) system. Special diameter/height correlation and local volume functions were developed for this specific unit.

xi. Average gross volume per ha is **146.151M³.**On an average, the number of trees per ha is 106.

PART 2: FUTURE MANAGEMENT

- **The Management Goal of the FMU**
  To Manage the forest on the multiple-use, sustained yield basis for the production of timber, firewood and other forest products; and for conservation of watershed, wildlife and environment.

- For multiple uses on sustainable basis, Metap Chhu FMU has been organized into three management Circle viz. Protection, Production and Non-Production for the smooth implementation of the Plan. Production management Circle have been further divided into two Working Circles; Mixed Broadleaf Working Circle for Commercial use and Local Use Working circle. This allows different areas to be managed and evaluated separately. Inorder to support this long term goal, the FMU will periodically assess seven thematic elements of Sustainable Forest Management. The elements includes extent of forest resources, biological diversity, forest health and vitality, productive and protective functions of forest resources, socio-economic functions and legal, policy and institutional framework. FMU should also periodically assess forests for its vulnerabilities to climate change

- **Management based on Forest Functions**

Code	Function Group(Bold) and Functions	Code	Function Group (Bold) and Functions
S	**Soil protection and Conservation**	**N**	**Nature Conservation**
SC	Soil conservation	NWP	Wildlife Protection
SP	Soil Protection	NWC	Wildlife Conservation
W	**Water and Watershed Conservation**	**Soc**	**Social Function**
WRR	Riparian Reserve Protection	SocL	Social (Local Use Only)
WSh	Watershed Conservation	SocRS	Religious site Protection
WLS	Local Water Supply Protection	SocLC	Local Cum Commercial Use
		RB	**Road Buffer**

To facilitate better organization of Management activities during the implementation of plan and better field orientation within the FMU, the area has been sub-divided into Blocks and Compartments.

- **AAC for Management Working Circle in Standing Volume**

Production Management Circle has been divided into two Working Circles: Mixed Broadleaf Working Circle for Commercial use and Local Use Working circle for this plan period. As few conifer trees are distributed within the commercial use area and contributing to the overall AAC for local use, stratum has been taken out to facilitate better management of AAC by MFMU during the plan implementation and ensure broadleaf trees are not surpassed from the actual available stock in the field.

Strata	Net Operable area (ha)	RME of mature standing volume (m^3/ha)	AAC (m^3/Year)	Clear cut Equivalent (ha)
Mixed Broadleaf (Commercial)	3577.76	123.5	4400	35.62
Mixed Broadleaf Local Use)	512.46	123.5	630	5.1
Total			**5030**	**40.72**

Based on the inventory data and net operable forest area available, the AAC has been fixed at **5030** ***m^3*** in Standing Volume per year.

- **Allocation of AAC**

Standing Volume (m^3)	Allotted to
4400	Allocated to NRDCL to meet commercial demand.
630	Local User (Local villagers, General Public and adhoc). CFO will be responsible for allocating this volume.

- **Limits of Harvesting area for commercial timbers in this plan period (2nd Plan period)**
  The harvesting of commercial timbers by NRDCL must be limited till Compartment Bjozhingkha I only for the current plan period and in no case the harvesting should be diverted to other compartments unless approved by the Director, DoFPS.

- **Silvicultural Systems**
  The prescribed silvicultural system for the commercial harvesting is the Group Selection system with artificial regeneration. Clear cut openings of 0.15-0.25 ha will be created in the stand allowing optimum quantity of light to reach the forest floor and creating conducive micro climatic conditions for seed germination and establishment of seedlings. Criteria for opening the patch and laying out annual coupes are given in detail in the plan. Rural harvesting shall be carried out by applying single tree selection system.

- **Environmental Assessment**
  Gedu Territorial Forest Division team in consultation with NRDCLcarried out detailed EIA and its findings are incorporated in preparing the Forest Management Plan. Checklist of Environmental Parameters for Forestry projects as per NEC guidelines and Forest Management Code has been followed and the following have been taken into consideration in this Management Plan.

  - FMU Planning & Zoning
  - Road Construction and Maintenance
  - Harvesting and Extraction
  - Regeneration and Post-harvesting treatment
  - Local use forest area

PART 3: IMPLEMENTATION OF THE PLAN

i. CFO, Gedu assisted by UIC and other support staff will be the implementing agency. Determination of cutting cycle, annual coupes, harvesting, reforestation, road construction etc. will be done as per prescriptions in this plan. Annual planting will be facilitated through Operational Planning Record keeping and Monitoring will be done by CFO on annual basis as per format. FRMD will evaluate at the interval of 5 years.

ii. Monitoring and evaluation is crucial component of management planning. It is essential that the activities in the Operational Plan be reviewed annually by CFO and mid-term and final-evaluation completed as per the timeline outlined in the plan.

iii. FMU level management committee chaired by the CFO, Gedu will be established to assist in objective setting and ensuring the smooth implementation of the plan. The committee will be comprised of the stakeholders of the FMU and each member has equal say in the recommended management and implementation of the FMU. Planned activities to achieve the FMU objectives will be discussed in the FMU Level Management committee.

iv. Unforeseen circumstances may warrant deviation from the plan prescriptions and in such an event CFO, Gedu 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 revisions.

Activities required by the FMU Plan	**Responsibility**
Implementation and Review	
The CFO, Gedu will be responsible for the implementation of the Management Plan assisted by the UIC and Staff.	CFO, Gedu
The FMU Management Committee chaired by CFO, Gedu will be maintained to ensure the smooth implementation of the Management Plan.	CFO, Gedu
The CFO, FRMD will ensure that the plan is reviewed five years after implementation and at the end of the Plan Period.	CFO, FRMD
Monitoring and Evaluation	
The CFO Gedu will ensure that monitoring is carried out on an annual basis according to the guidelines issued by FRMD.	CFO, Gedu
The CFO, FRMD will ensure that evaluation is carried out at five-year interval based on the information collected by annual monitoring and other necessary information.	CFO, FRMD
Operational Planning	
A rolling Operational Plan will be prepared by the CFO Gedu to facilitate the timely implementation of this Management Plan. The OP will be completed by October every year so that the FMU Management Committee can review it before NRDCLs financial year begins.	CFO Gedu FMU IC
Objective for each Management Circle will be met with the implementation of specific objectivities.	FMU IC
Silvicultural systems for each Working Circle will be adhered to following cutting cycle guidelines to ensure sustainability.	FMU IC
The Unit In-Charge 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. (following Annual Coupe and Tree Marking guidelines) .	FMU IC

The CFO Gedu and the Regional Manager, NRDCL will co-ordinate to ensure that the logging operation and log outturn are conducted smoothly and in accordance with local and other demands.	CFO Gedu RM NRDCL
The FMU IC will ensure that stocking of recruits establishment is regularly monitored and regeneration surveys are conducted, following completion of the harvesting operation.	FMU IC
Enrichment planting of harvested cable lines and plantations will be carried out by NRDCL.	NRDCL RM
Brushing, weeding, fencing, or other action to assist regeneration will be carried out by NRDCL, in consultation with the FMU IC	NRDCL RM
Road survey, design and construction to ensure that the environmental standards are met.	NRDCL
NRDCL road engineers must follow the standards during designing and estimation and provide supervision during construction to ensure that the environmental standards are met.	NRDCL staff
Regular inspection will be conducted by the FMU staff to detect and report any pest and disease out breaks to enable earliest possible remedial or preventive measures to be initiated.	FMU Staff
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 Gedu.	FMU IC
Participatory Forest Management	
The views of stakeholder groups will be incorporated into the operational plans through the inclusion of stakeholder representatives on the FMU Level Management Committee	CFO, Gedu

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GENERAL DESCRIPTION AND CURRENT SITUATION

PART 1: GENERAL DESCRIPTION AND THE CURRENT SITUATION

1. LOCATION, AREA, BACKGROUND AND STATUS

1.1 Location of Metap Chhu Forest Management Unit.

The whole watershed has been identified as potential FMU and it covers total area of **10,676.52ha**. The FMU is located under Metakha and Gelling gewog within the Chukha Dzongkhag. The altitude ranges from 840m.a.s.l to 3420m.a.s.l. MFMU does not lie in any of the protected Areas. The Mailum chu, the main river in between Metakha and Dungna Gewog forms the Western Boundary and the high Omchu ridge forms the Eastern Boundary. The FMU comprises mainly of Government Reserved Forests.

1.2 Area Statement:

The Area of the MFMU is 10,676.52ha. The details of the area statement of the FMU are as under.

Table 1:Area Statement by Land Use(LCMP 2010).

Land Use category	Area (ha)	Percentage (%) of Total Area
Mixed Broadleaf	9836.29	92.13
Shrubs	124.77	1.16
Meadows	1.42	0.01
Kamzhing	357.36	3.35
Built up	3.88	0.04
Chhuzhing	70.04	0.66
River	18.25	0.17
Mixed Conifer	263.67	2.47
Landslide	0.85	0.01
Total	**10676.52**	**100**

1.3 Forest Condition

MFMU has huge altitudinal gradation ranging from 840m.a.s.l to 3430m.a.s.l resulting in huge ecological diversity. The forest types ranges from low sub-tropical forest to high altitude rhododendron forest. Depending on the floristic characteristics, forest of MFMU can be classified broadly into the following forest types:

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Table 2: Forest Types (MFMU).

SL. No.	Forest Type	Altitude (m)	Characteristic species
1	Rhododendron Forest and Fir Forest	>3100	Rhododrendron, Fir and Pedicularis.
2	Cool broadleaved Forest	2000-2900	Acer, Betula alnoides, Exbucklandia spp., Lindera spp., Symplocos spp.
3	Warm broadleaved Forest	1000-2000	Alnus naplensis, Michelia excels, Castanopsis indica, Engelhardia spicata, Macaranga postulate, Schima wallichi.
4	Sub Tropical Forest	200-1000	Gmelia arborea, Ailanthus grandis, Chukrasia tabularis, Daubanga grandiflora.

Adapted from: Grieson and Long, 1983.

1.4 Legal status

1.4.1 Ownership

The Forest and Nature Conservation Act 1995 (FNCA) defines *"forest" 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 Tsamdro (grazing land) or Sokshing (wood lot for collection of leaf litter").* Consequently, all such forests are declared to be Government Reserved Forests (GRF). On this basis, the extent of GRF within the FMU is about 10245.25 ha (95.95%) and the human settlement and agriculture land is about 431.28ha (4.05%) which is private.

1.4.2 Rights and Privileges

The rights and privileges of the local communities, with regard to the use of forest are as per the Forest and Nature Conservation Act of 1995. The Forest Act permits grazing and collection of firewood, fodder and leaf mould for domestic use, either free or on payment of royalty. Fire wood collection is permitted only from dead and fallen trees. Timber trees are issued for *bonafide* domestic use, after the recommendation from the concerned Dzongkhag and royalty has been paid. Hunting is totally prohibited within the forest.

The entire accessible forest land of MFMU is grazed by cattle from Meta, Gelling and Naja Gewogs, and cattle from neighbouring Dzongkhags. Tsamdros are either owned individually or by community until 2016 which wasleased by the government annually to herdsmen or communities at Nu.100 per tsamdro per year.However, Government paid compensation to individual/communities who owned Tsamdro in the year 2016 and 2017 and it is now declared as GRF land unless it is approved for lease again as per existing Land lease Rules.

The Forest and Nature Conservation Act 1995 give authority to DoFPS, to regulate and restrict grazing anywhere in the country, in order to prevent environmental damage. There is no existing sokshing in MFMU.

1.4.3 Grazing Rights

The local communities of Meta and Gelling gewogs as well as outside FMU like Naja gewog have traditional rights for grazing their cattle in the forest within the FMU. The local cattle from the FMU area graze the area both during summer and winter while cattle from Naja gewog (adjoining area) graze during winter. The FNCA, 1995 has the provision of regulating grazing in GRF.

1.4.4 Water Rights

The local population has the traditional rights to use water from the streams and rivers for their domestic purposes, such as home consumption, watering livestock and irrigation of crops. There are numerous small streams and creeks within the MFMU which forma the main irrigation and drinking water for people residing within the FMU. The Shingchen chhu, Metab chhu and Dongdue chhu are the main rivers flowing in the MFMU.

1.5 Historical Monuments and Monasteries

Within the MFMU, there are hardly any gneys, goembas and lhakhangs. The only lhakhang is Meta Goenpa lhakhang with a Lam instituted from the Central Monastic Body which-serves as the centre for rituals activities to Metakha gewog and there is one chorten right above Lhakhang. There is also a sacred groove of cupressus spp. in Meta Yuekha village which locals call as Lhashing.

2. PERMANENT SITE FACTORS

2.1 Topography and Slope.

The MFMU is in general moderate to steeply sloping and mountainous with deeply incised valleys running mainly north-south. Elevation ranges from 840m in south –west to 3420m in the north of the unit.

2.2 Climate

There is no meteorological station in the MFMU. The nearest weather station is in Gedu. The following data on climate conditions are from Gedu weather station, which may hold good because of similar climatic conditions and proximity. The data has been obtained from the Meteorology Division; Department of Hydro-met Services, Ministry of Economic Affairs, Thimphu.

2.2.1 Precipitation

The precipitation of the MFMU is expressed in the following table. The most common

form of precipitation in the MFMU is in the form of rain. The main issues with the precipitation in the valley are during the monsoon when roads and harvesting activities can be hampered or environmental damage can result. From the table it indicates that the maximum precipitation occur during the month of May, June and July.

Table 3: Monthly Average Rainfall (mm).

Months	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Avg. Rainfall (mm)	4.89	14.7	14.5	23.7	28.7	27.8	29.8	17.7	18.6	18.1	7.37	1.6

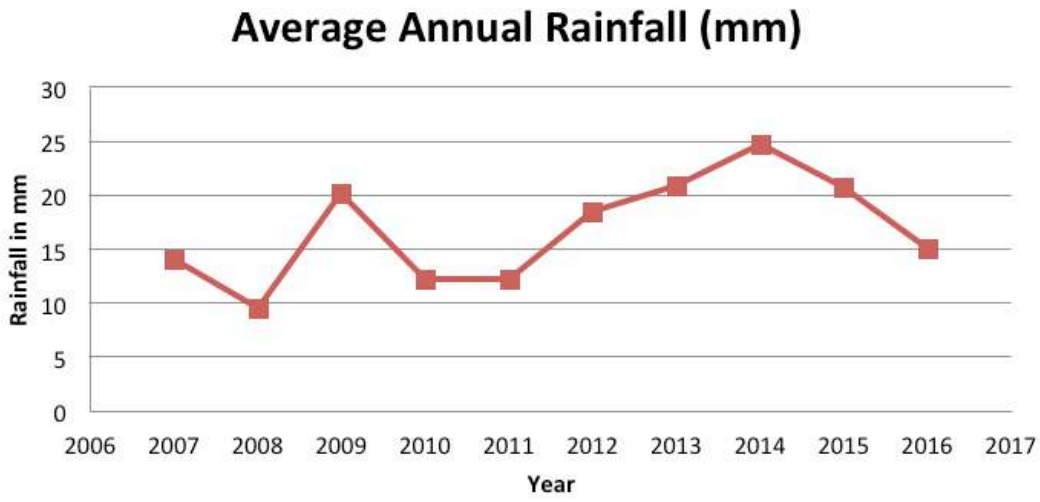


Figure 1: Graph showing Annual Average Rainfall (mm).

2.2.2 Temperature

The average minimum temperature is 6.9˚C and the average maximum temperature is 19.3˚C.

Table 4: Average Temperature.

Months	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Min. Temp	2	3.5	5.5	7.5	10.5	10	9.9	9	8	6.5	6.1	4.4
Max.Temp	14	14.8	18	21	22	22.2	23	22.5	21.5	21.5	16.5	15.5

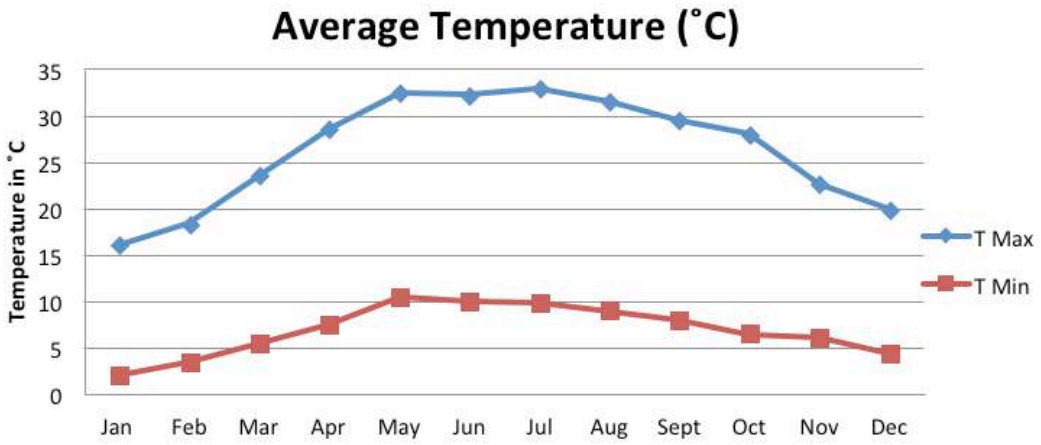


Figure 2: Average Temperature (˚C).

2.3 Geology and soil

Metakha area belongs to the phuntsholing formation, the area was formed during the Paleozoic period and comprises mainly of folded succession of purple phyllites, quartzite, and siliceous limestone.

The detail observation on the area regarding (i) humus content (ii) litter depth (iii) Top soil moisture (iv)Top soil colour and (v) Top soil texture, are presented below:
The soil in the area is predominantly sandy loam (90.6%), 8.1% loamy soil and 1.3% sandy soil. The MFMU is well drained in general with 63.8% of the area with dry topsoil and 36.2% of the area with moist topsoil.

93.3% of the area has dark top soil colour and 6.7% of the area has reddish top soil colour. In the forest area 1.3% of the area has n humus, 43% of the area has humus depth upto 2cm and 55.7% has humus depth from 2-5cm.

2.4 Hydrology

The entire FMU forms the main catchment for Mailum Chhu which flows at the bottom of Metakha gewog. There are no settlements along this river. The MFMU terrain is dissected by many small streams, which flow mainly from north-south. Most of these streams are seasonal, coming into life only in the rainy seasons. All the streams in the FMU drains into three main rivers; Dongdue chhu, Metap chhu and Shingchenlum Chhu and ultimately into Mailum Chhu.

3. VARIABLE SITE FACTORS

3.1 Population and Demography

MFMU consists of 6 hamlets; Meta Goenpa, Meta Yuekha, Pango, Gumina, Bjozhingkha and Tsundrugang. The livestock and their products are one of the main sources of income for the inhabitants of these gewogs. The MFMU has settlers from Paro Dzongkhag and use the resource from the MFMU. There are about 127 households inside the MFMU and the average number of person per household is about 7.5. The total population living within the MFMU is approximately 961 (483 Male and 478 Female) including people in the Government services, business owners etc.

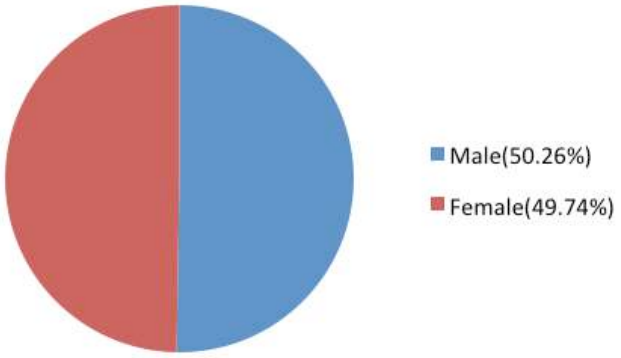


Figure 3: Sex composition.

3.2 Farming and Agriculture

The people living in the valley are subsistence farmer. Their main source of income is from agriculture and livestock and their products. However, cash is becoming more important for the villagers for paying school fees, farm implements, and also to buy food items. People earn their cash income by selling livestock products, on farm labour and by selling cardamom.

Agriculture is the main stay of every household besides rearing of livestock, Rice is the staple diet supplemented with other cereals like buckwheat, wheat, maize and barley. Land is an important resource and land ownership and size of land holdings are still one of the traditional indicators of wealth. Though Metakha is a rice growing area, wet land owned is very less due to steep nature of the area, only about 14.54% of the agricultural land is under wet land category. The extent of kitchen garden is very low as these plots were located around the houses. All the agricultural land of the households are owned and cultivated by the farmers themselves.

The people within the FMU depend heavily on livestock and their products. Livestock pressure is more concentrated in Gumina, Tsundrugang and Bjozhngkha. These three areas

have a large number of cattle populatins as people of Susuna migrate to Bjozhigkha and people of Wanakha migrate to Tsundrugang from October till May. Pigs are reared for meat used during annual household religious ceremonies and Poultry birds primarily raised for eggs.

3.3 Traditional use of Forests

People depend upon the forest for the following supply of resources

- Firewood
- Fencing poles
- Construction Timber
- Bamboo
- Cane shoots
- Edible ferns
- Flag poles

House construction timber is considered the most important forest product by the farmers followed by the fuel wood. The dearth of construction timber is primarily due to the shortage of suitable species which can be used for construction. The other forest produce derived by the community are the fencing posts, flag poles, cans shoots, edible ferns and bamboos.

3.4 Grazing

The information about pattern of grazing, number of cattle and grazing land were mostly acquired from semi structured interviews during the field visit. Grazing is evident in most areas of the FMU and is going to be one of the main pressures in the FMU. The heaviest grazing pressure is more concentrated in Gumina, Tsundrugang and Bjozhingkha village. Local cattle graze during the summer months and the migratory herds during winter months enter the FMU. However, people prefer to raise few productive animals rather than herds of local cattle that will greatly reduce pressure on forests and enhanced income of the people.

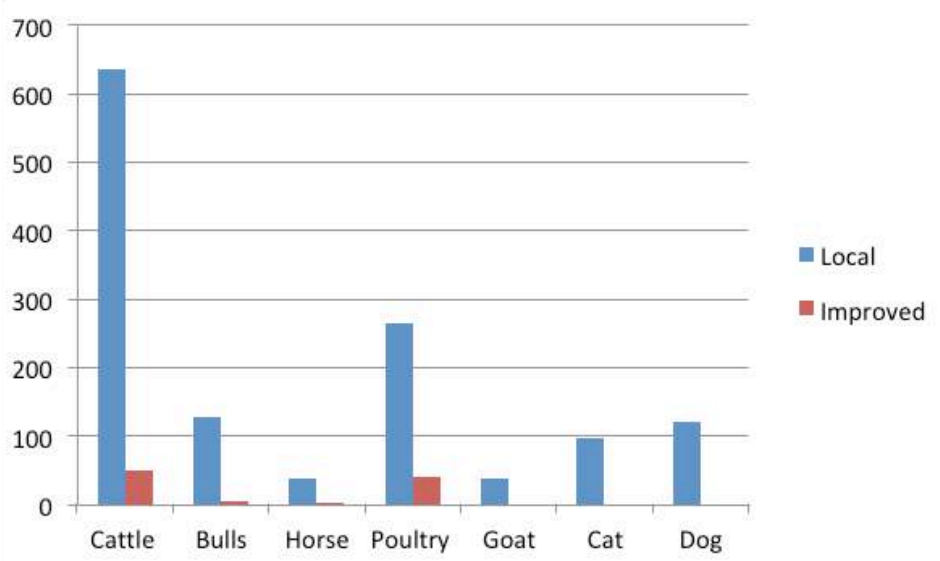


Figure 4: Livestock Recorded in FMU.

3.5 Forest Fires

Fire is not a major problem in the broadleaf forest. The previous Plan stated that, one of the main concern is the *Tseri* practice which was in practice although banned by government. However, there is no such practice at the moment inside FMU during the field visit for plan revision. Strict vigilance should be in place during peak fire season to prevent forest fire and the local people should be educated on fire safety, fire risk mitigation measures based on proper Fire Science. Though fire is not a severe problem for broadleaf, the risk of forest fire near the settlements and also outbreak from the herders are expected due to fuel load.

3.6 Pest and Diseases

There is no history of pest and diseases in the FMU and no signs and symptoms have been observed during the field visit. However, regular inspection needs to be carried out to detect any outbreak of pest or diseases.

3.7 Non-wood Forest Produce

The NWFPs are important mostly to the people for subsistence use. There are few NWFP which people sell to augment their household income. Edible ferns and cane and cane products are few which are sold.

As the forest is their immediate home environment, people have identified a great number of plants both useful and not useful to them. They have names for many species but many are also known by their physical appearances.

3.7.1 NWFP used as Food

Some of the important species used by the people as food are given in the following table.

Table 5: NWFP used as Food.

Sl. No.	Scientific Name	Vernacular Name	Part used	Re marks
1	*Cantharellus cibarius*	Sisi shamu	Entire	Mushroom
2	*Diplazium spp.*	Nakey(2 types)	Tender parts	Fern
3	*Elastotema lineolatum*	Dambroo	Entire	
4	*Girardinia diversifolia*	Zocha	Flower bud and young leaves (Bark use to make fine ropes)	
5	*Laportea terminalis*	Zocha	Flower bud and young leaves(bark use to make fine ropes).	
6	*Musa spp.*	Re-ngala	Flower bud is used as vegetable	
7	*Plectocomia himalayana*	Patsha	Young shoot used as vegetables.	Mature stem used for cane crafts.

Table 6: Wild tubers.

Sl. No.	Scientific Name	Vernacular name	Parts used
1	*Dioscorea belophylla*	Rekay/bantarul	Tuber edible
2	*Dioscorea bulbifera*	Maaka/Geetha	Tuber edible
3	*Dioscorea pentaphylla*	Chakay/Beghur	Tuber edible

3.7.2 Medicinal Plants

A great variety and large number of medicinal plans occur within the forest management unit. They are very well known to the local people and are used for variety of purposes. Some of the plants that are used by the local people are given in Table below.

Table 7: Medicinal plants found in the FMU.

Sl. No	Scientific Name	Vernacular Name	Parts Used
1	*Acorus Calamus*	Chudula/Chudar	Root/tuber can cure sore throat and scabies
2	*Artemesia spp.*	Khempa	Dried immature leaves and flower buds are used for de-worming and it is also used as a cure for fever.

3	*Astilbe rivularis*	Buro-okhati	Root is used for bodyache and toothache.
4	*Cassia spp.*	Tapre	Leaf paste is used for curing ringworm (A.J.C Grierson and D.G Long, 1987)
5	*Ficus semicordata*	Khanew	Figs used in treatment of leprosy.
6	*Morus spp.*	Kimbu(Sanu)	Juice extracted from the root is used as a cure for jaundice
7	*Rhus chinensis*	Bhakimlo	Fruit is used in the treatment of dysentery
8	*Rubia cordifolia*	Tshoe	Used for colouring fabric and us for relieving bodyache
9	*Rubus ellipticus*	Tshema tshelu	Root used in the treatment of diarrhoea.

3.7.3 Cane and Bamboo

The most important use of bamboo is the bamboo mat for making animal sheds and constructing temporary houses. During the field work, the team encountered 7 species of cane and bamboo which is used as vegetable, raw materials for handicrafts, and various purposes such as making small house and fencing etc.

Table 8: List of Cane and Bamboo

Sl. No	**Scientific Name**	**Vernacular Name**	**Parts Used**
1	*Calamus acanthospathus*	Tshim tsha	Young shoot used as vegetable and small, fine splits of mature cane is used for weaving handicrafts.
2	*Cephalostychum spp.*	Lokpa	Young shoots used as vegetable and old stems are used for weaving bamboo mats and making handicrafts.
3	*Chimnobambusa spp.*	Rau	Used for fencing
4	*Bambusa nutans*	Shizang	Used as construction materials for huts and small houses.
5	*Plectocomia himalayana*	Phatsha	Young shoots used as vegetable and old stems are used in making ropes.
6	*Calamus spp.*	Ao	Young shoots used as vegetable and old stems used or weaving mats and making handicrafts.
7	*Bambusa spp.*	Pakshing	

3.7.4 Plants used for fodder

MFMU hold a diversity of fodder species, one of the main concerns in the MFMU is the high cattle population within the Management area as the intensity of browsing is high and the fodder trees are not only lopped but are felled by the cattle owners. Some of the fodder trees are given in Table 12.

Table 9: Fodder species found within FMU.

SI. No.	Scientific Name	Vernacular Name
1	*Acer laviegatum*	Putli
2	*Amoora wallichi*	Lali
3	*Brassiopsis hainla*	Tompam
4	*Castanopsis tribuloides*	Sokay, Katus
5	*Eurya acuminate*	Jhigani
6	*Ficus auriculata*	Dabago
7	*Ficus semicordata*	Khanew
8	*Morus spp.*	Kimbu

3.7.5 General Uses Plant

Besides, the plants mentioned above, there is large number of plants used by the villagers for various purposes; some of the important plants used by the local people for general use are given in Table 13.

Table 10: Other plants

Sl. No	Scientific Name	Vernacular Name	Uses/Parts Used
1	*Cinnamomum spp.*	Shingtsem	Leaves used in tea.
2	*Cuprsssus spp.*	Tshenden	Leaves and twigs used as incense.
3	*Daphne spp.*	Dhey nap	Bark used in making traditional paper
4	*Edgeworthia spp.*	Dhey kap	Bark used in making traditional paper
5	*Piper spp.*	Jungali Pan	Leaves
6	*Thysaenolaena*	Tshakusha	Mature inflorescence used as broom.
7	*Xanthoxylum spp.*	Thingney	Fruit used as spice.

4. FOREST TYPES

MFMU has huge altitudinal gradation ranging from 840masl to 3430masl resulting in huge ecological diversity. The forest types ranges from low sub-tropical forest to high altitude rhododendron forest. Depending on the floristic characteristics, forest of MFMU can be classified broadly into the following forest types.

Table 11: Forest Types(MFMU).

SL. No.	Forest Type	Altitude (m)	Characteristic species
1	Rhododendron Forest and Fir Forest	>3100	Rhododrendron, Fir and Pedicularis.

2	Cool broadleaved Forest	2000-2900	*Acer, Betula alnoides, Exbucklandia spp. , Lindera spp., Symplocos spp.*
3	Warm broadleaved Forest	1000-2000	*Alnus naplensis, Michelia excels, Castanopsis indica, Engelhardia spicata, Macaranga postulate, Schima wallichi.*
4	Sub Tropical Forest	200-1000	*Gmelia arborea, Ailanthus grandis, Chukrasia tabularis, Daubanga grandiflora.*

Adapted from: Grieson and Long, 1983.

5. THE ECOLOGY

The principal high forest in MFMU comprises of *Acer, castanopsis, Alnus, Schima, Quercus* and other broadleaf species which has reached the stage of maturity. This is evident from low density stocks with high diameter class in case of principal species. In the moist and cooler aspects Broadleaf species such as *Alnus*, *Betula utilis, Macaranga, Exbucklandia, Symplocos*and species of Rhododendron with common associates such as Daphne and bamboo takes over. In the open and drier aspects*Rhododendron* with some palatable associates has taken over.

5.1 Floral Association

Diverse broadleaf species are found in the management unit. The tree species found within MFMU are given in **ANNEXURE7.**

5.2 Fauna

The diverse species of plants/trees that are found within the management unit has created a Conducive condition for various species of birds and animals to live. The following species of wildlife were sighted or evidences of their presence were observed. Among the various species of wildlife within the FMU, the following species deserve special attention.

Table 12: List of MFMU fauna.

English Common Name	Local Name	Zoological Name
1. Wild boar	Riphag	*Sus scrofa*
2. Wild dog	Phao	*Cuon alpinus*
3. Himalayan bear	Dhom	*Selenarctos thibetanus*
4. Sambar	Shau	*Cervus unicolor*
5. Barking deer	Kasha	*Muntiacus muntjac*

5.3 Avifauna

There are quite a number of birds in the FMU. The different categories of forest ecosystem in the Metap Chhu forest managementunit are best suited for the avifauna wealth present there. The following birds were recorded in the FMU.

Table 13: Birds of MFMU.

English Common Name	Scientific Name	Remarks
1. Himalayan Treepie	*Dendrocitta formalis*	Spotted
2. Large Hawk Cuckoo	*Cuculus sparveriodes*	Spotted
3. Black Bulbul	*Hypsepetes madagascariensis*	Spotted
4. Red vented Bulbul	*Pycnontus cafer*	Spotted
5. Verdicter Fly Catcher	*Muscicapa thalassina*	Spotted
6. White throated fantail	*Rhiphudura albicollis*	Spotted
7. Rufous turtle dove	*Streptopelia orientalis*	Spotted
8. Himalayan Cuckoo		Spotted
9. Common crow	*Corvus splendens*	Spotted
10. Common myna	*Acridotheres tristis*	Spotted
11. Khallej pheasant		Local sources
12. White throated laughing thrush	*Zoothera citrina cynotus*	Spotted
13. Rufous necked hornbill	*Aceros naplensis*	Spotted
14. Magpie robin	*Copsychus saularis*	Spotted
15. Black drongo	*Dicrurus adrimilis*	Spotted
16. Jungle crow	*Corvus macrorhynchos*	Spotted
17. Eurasian Cuckoo		Spotted
18. White capped redstart	*Chaimarrornis leucocephalus*	Spotted
19. House sparrow	*Passer domesticus*	Spotted
20. Pale blue flycatcher	*Muscicapa unicolor*	Spotted
21. Yellow billed blue magpie	*Urocissa flavirostris*	Spotted
22. Striated laughing thrush	*Garrulus striatus*	Spotted
23. Streaked spider hunter	*Arachnothera magma*	Spotted
24. Rufous necked laughing thrush	*Garrulax ruficollis*	Spotted
25. Green backed tit	*Parus spp.*	Spotted
26. Black browed tree pie	*Dendrocitta frontalis*	Spotted

6. SOCIO-ECONOMICS

6.1 Sources of Income and expenditure

The people living within the FMU are subsistence farmers. The main source of income is from agriculture and livestock and their products. However, cash is becoming more important for the villagers for paying school fees, farm implements, and also to buy food items. People earn their cash income by selling livestock products, on farm labour and by selling cardamom at markets in Phuentsholing and Jaigaon as the villages are connected by farm road very recently. Most of the household income are used in food and clothing. People

within the FMU also recognizes the importance of education, therefore, they perceive that the expenditure for educating their children has increased over the past few years.

7. CURRENT TIMBER DEMAND AND SUPPLY

The only way of assessing the wood demand in the Dzongkhag is by studying the past supply trends. The people living within and in the periphery of FMU have been using these forests for fulfilling their daily needs. The rural allotments were given in the form of *drashing, cham, tsim, dangchhung* and firewood. The trees are marked on Single Tree Selection System.

7.1 Supply of commercial timber from FMU.

The supply of commercial timber in standing form for construction works of developmental activities within Metap Chhu FMU from 2007 to 2016 is given in the table below.

Table 14: Supply of Commercial Timber.

Year	Timber (m3)
2007	00.00
2008	00.00
2009	00.00
2010	108.50
2011	00.00
2012	53.87
2013	17.96
2014	24.18
2015	06.65
2016	35.28
Total	**246.44**

7.2 Supply of Rural Timber and Firewood from FMU.

All the people living within the FMU collect timber and firewood from nearby forests. It is utilized for construction of new houses, repair, renovation and extension of rural houses, shed for livestock, potato storehouse, farm guard shed/watch tower, toilet and machinery sheds. Besides, it is also used for constructing wooden water channel, water tank, agricultural implements including, domestic furniture, flag poles and fencing poles. The supply of rural timber and firewood from MFMU during the period from 2007 to 2016 has been given in the table below.

Table 15: Supply of Rural Timber.

Year	Timber (m3)

2007	NA
2008	NA
2009	279.98
2010	273.68
2011	85.66
2012	NA
2013	131.2
2014	236.64
2015	369.04
2016	728.7
Total	**2104.9**

8. SILVICULTURAL ASSESSMENT

8.1 Past Silvicultural Treatment

Before the first Management Plan there was no commercial harvesting and the trees were marked on Single Tree Selection System for rural allotment. During the first Management Plan period (2007-2017), Patch cut System was prescribed based on forest type and mode of regeneration. ***Patch Cut System is considered as an appropriate silvicultural system for managing Broadleaf Forest as it promotes natural regeneration and requires no treatment to induce natural regeneration.*** Single Tree Selection System was prescribed in local use forests areas for rural marking.

8.2 Forest Types

Broadleaf Forest occupies the largest portion of the FMU. This forest type is dominated by Michelia, Persea, Acer, Castanopsis, Toona, Quercus Macaranga and Juglans regia. As per Flora of Bhutan *(A.J.C. Grieson & D.Glong)* could be considered as Cool Broadleaved Forest Type. At the lower altitude Duabanga and Gmelia species are found and at the higher altitude, Rhododrendron and Fir species are found. Broadleaf forest covers extensive areas (92.13%) of the FMU.

9. ORGANIZATION AND ADMINISTRATION

9.1 Organization

FMU is under the jurisdiction of Gedu TFD, and is directly administered by the Chief Forestry Officer (CFO). The CFO will be supported by the Unit-In-Charge (UIC), who will supervise the FMU operations. Operational Plans (OPs) will be prepared by the FMU management, with assistance and input from the CFO, Gedu TFD. All activities within the FMU will be administered by the CFO,Gedu.

9.2 Health and Safety

The forestry operation involves major risk during harvesting and transportation of timber.

Site specific risk assessment is required for the FMU to ensure health and safety of the field staffs. During the process of felling, the chain saw should be equipped with full functioning chain breaks and feller should ensure to keep two tree lengths apart while felling. The danger of falling timbers and overhead cable lines is inevitable and care should be taken while stacking. The stacking should be done to a standard height in the same direction. First aid box and necessary field gears needs to be provided to the workers during the operation.

9.3 Record Keeping

The FMU Unit office shall maintain the records of all the activities within the FMU as per the record-keeping format of the Forest Management Code of Bhutan (FMCB), 2004. The activities may include area or number of cable lines harvested annually to achieve Annual Allowable Cut (AAC), timber volume accrued from operated cable lines, forest road construction and sanitation or epidemic felling, among others. The records have to be maintained both for standing and log volume.

10. INFRASTRUCTURE, TRANSPORT AND EQUIPMENTS

10.1 Roads

The approach to MFMU is from Ganglakha, which is 59 km away from the FMU boundary (Mailum Chhu). There is GC road to the FMU and Farm Roads within FMU. Some sections of the GewogConnectivity road and Farm Road are in immediate need of maintenance and side drains are blocked in some places. There is need to have bridge over Metap Chhu inside FMU as it would hinder movement of vehicles during Summer Season. The UIC can accordingly calculate the length of the road to be constructed per year within FMU, based on the available stock and mention in the OP. The Access road to MFMU is from via Dungna presently and in future upon completion of Chongaykha-Omchu Farm road, the FMU access road will be shortened by almost 50%. Further, there is also need for NRDCL to construct forest road which connects Metakha block and Bjozhingkha Block via shingchenlum Chhu, in order to serve as alternative road (Within FMU Boundary) in addition to that planned by engineer from Tsundrugang-Boomelum-Bjozhingka Block in 2nd Plan.

11. EVALUATION OF FIRST PLAN.

The first plan of the FMU was prepared in 2007 and had a plan period of ten years till 2017. However, the FMU was not operated as it was found economically not feasible for extraction of timbers owing to high operation costs against the net returns. Though the FMU continued to cater to the needs of timber for rural applicants, no major comercial timber extraction activities were carried out. However, Clear cut area for farm road and Clear cut equivalent for rural and commercial (Standing tree) allotted are as follows:

Clear Cut area (Farm Roads): 9.87ha.

Clear Cut equivalent [Rural timber + Commercial (standing tree)]: 20.45ha

11.1 Review of Road Building Activities

40 km from Kungkha to Metakkha Gewog Centre (Inside FMU)Gewog farm road have been constructed during the last Plan period by Chukha Dzongkhag Administration connecting FMU with the motorable Road. The farm road is maintained by DoR but some sections of the farm road required immediate maintenance and zig cuttings for transportation of heavy vehicles. Further about 6 Km road from Metakha to Tsundrugang have been constructed in year 2015-16 which connects Metakha, Bjozhingkha and Tsundrugang Blocks.

Table 16: Details of Road Construction during 1st Plan period.

Road Constructed (Location)	Road Constructed (Km)	Remarks
Kungkha to Metakha Block	40Km	GC Road maintained by DoR.
Metakha to Tsundrugang Block	6Km	Farm Road

PART 2: THE FUTURE MANAGEMENT

12. Management strategy.

12.1 Introduction.

The Royal Government of Bhutan's policy is to retain at least 60% of the country under forest cover. Productive forests are to be managed under a system of sustained yield using scientific management. Consequently the RGoB has adopted a firm national policy requiring the preparation and implementation of scientific management plans for all areas where forests are harvested for commercial purposes.

12.2 Forest Policy

Over the years, there has been increasing pressure on the environment and the natural resources, the alarming consequences of which are 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. 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.

According to FNCA 1995, 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. FNCA 1995 provides legislative framework for the community participation in the forest Management and streamline the preparation of supporting forest rules and regulations. The regulation layout the best practices that apply nationwide.

1.3 Goals

The goal of the management of Metap Chhu FMU is to:
'manage the forest on a multiple-use sustainable yield basis for the production of timber, fuel wood and other forest products; and for conservation of watershed, wildlife and environmental protection'.

1.4 Objectives.

The broad objectives of management of MFMU are mentioned under different Management Circles viz; Protection, Non-Production and Production Management Circles:

Protection Management Circle

- To check soil erosion and denudation in the catchment areas of water bodies in the interest of soil and water conservation.

- To protect the forest from encroachment, fire, grazing and other illegal activities.
- To conserve and enhance wildlife habitats and biodiversity and to meet needs of people on sustainable basis.
- To raise awareness, conserve the biodiversity and respect the sanctity of religious and historical sites.

Non-Production Management Circle

- To maintain and improve the forest condition to retain its multiple value.
- To conserve and enhance biodiversity and meet the local demand for NWFPs.
- To conserve the catchment areas.

Production Management Circle

- To meet the local requirement, as priority for timber, firewood and other forest products.
- To manage the FMU for commercial timber production on sustainable basis.
- To protect the forest from fire and illegal activities and over grazing.
- To create employment opportunities for the local people and maintain productive forest.

The emphasis of the objectives is on providing a sustainable supply of wood to the local population and industries, and at the same time conserving and improving the environment of the area.

The priorities of the management are to:

1. Ensure prompt regeneration of harvested areas.
2. Enforce sound harvesting practices.
3. Make use of the over mature and decaying stands and ensure regeneration.
4. Protect against pests, fire and erosion.
5. Improve degraded forests.

1.5 Strategies

The management strategies for achieving the above mentioned objectives are:

- Classifying the management area into protection, Non-production production and Limited production forests based on ecological and environmental reasons and pre-

scribe the most appropriate management prescription in consistent with the goal and objectives.

- Deciding the annual allowable cut on sustainable basis from the available growing stock and operable area within the production forests.
- Allocating the annual allowable cut rationally, to the local people, urban and government organizations and for commercial purposes.
- Construction of sound forest road network for accessibility.
- Monitoring and evaluating the implementation of the plan.
- Organizing suitable implementation arrangement through the Territorial Forest Division and the NRDCL.

1.6 Management Based on Forest Functions

12.6.1 Introduction

Forest Function Mapping is the term used for grouping the different potential uses of the forest. The different forest potential area 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 basis of social importance.

Forest function defines all the ecological, environmental and social function within a particular area (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 FMU in charge with first hand information on the location of different forest functions in order to enable him to specify the required management prescriptions and to control their implementation.

12.6.2 The Main Objective 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 areas within the FMU.
- To provide a tool for the management planner for balancing the requirement of nature conservation, environment protection, social forestry and commercial timber production and also to provide spatial information required to compute the sustainable AAC.

- To provide the UIC with information on the location of different forest function in order to specify the required management prescriptions on the ground and to control their implementation.

12.6.3 Function Groups

The Functions used in this management plan are listed in the table below. Some of these groups include functions that differ only in the degree of intensity of their management prescriptions.

Table 17: Different Forest Function used in the Management Plan.

Function Group(Bold) and Functions	**Code**	**Function Group (Bold) and Functions**
Soil protection and Conservation	**N**	**Nature Conservation**
Soil conservation	NWP	Wildlife Protection
Soil Protection	NWC	Wildlife Conservation
Water and Watershed Conservation	**Soc**	**Social Function**
Riparian Reserve Protection	SocL	Social (Local Use Only)
Watershed Conservation	SocRS	Religious site Protection
Local Water Supply Protection	**RB**	**Road Buffer**

12.6.4 Mapping Forest Functions

The criteria used to prepare Forest Function Map for MFMU is given below:

Table 18: Criteria for Forest Function Mapping.

Function Group and Codes	**Criteria for Mapping**
Soil conservation	**SP**:very steep areas(Slopes greater than 100%), areas with indication of slight to moderate eerosion.
	SC: steep or sensitive areas (76%-100%)
Water and Watershed Conservation	**WSh**: catchment areas of watercourses on steep slopes and on poorly drained areas, other sites serving as water retention areas or water sources.
	WRR: Areas within 30m along all perennial streams, water logged areas and swamps.
	WLS:Upper catchment areas of streams serving as drinking water supply for settlement downstream.
Nature Conservation	**NWP**:Alpine areas, ecosystem of high conservation value.
	NWC: areas identified as biological corridor and all areas rich in wildlife, both in species and number.

Social Functions	**SocL**: Areas close to or accessible to settlement or village, the areas traditionally used with definite boundaries.
	SocRS: Lhakhangs/goenpas, gneys and other religious sites
Road Buffer	**RB**: 200m uphill and 100m downhill for motorable public road, 30m uphill and 10m downhill for unstable forest roads.

Table 19: Total area under different Forest Functions

Sl. No.	Forest Functions	Code	Area (ha)
1	Soil protection	SP	4242.15
2	Soil conservation	SC	2538.39
3	Wildlife Protection	NWP	4242.15
4	Wildlife Conservation	NWC	2538.39
5	Riparian Reserve Protection	WRR	171.93
6	Local water supply protection	WLS	84.85
7	Watershed Conservation	WSh	10419.75
8	Social, Local Use Only	SocL	866.04

12.6.5 Restriction on Forest Function

The forest functions identified in the MFMU sets restriction for commercial and local activities as required by each function for management. The following table defines specific restrictions against each function.

Table 20: Restriction on Forest Functions

Code	Function	Restriction on Commercial Use	Restriction on Local Use
SP	Soil Protection	No commercial use	No local use
SC	Soil Conservation	No clear cutting	Low impact cattle grazing
WRR	Riparian Reserve	No commercial use	Only collection of NTFP
WSh	Watershed Conservation	No clear cutting	Reduce cattle grazing
WLS	Local water supply protection	No commercial use	Low impact use only
SocRS	Religious site Protection	No commercial use	Only uses that do not disturb the sanctity of the area
SocL	Social/Local use Only	No commercial use	
NWP	Wildlife Protection	No commercial use	Restrict activities that change habitat quality
NWC	Wildlife Conservation	No clear cutting	Minimize local use in the area to reduce disturbances

8. QUANTITATIVE ASSESSMENT

13.1 Forest Management Inventory

The forest inventory of the whole stocked area was carried out in the year 1998 to 1999 by the forest inventory crew of FRMD(then FRDD). The objective of the inventory was to provide essential background information for writing management plan for the area and more specifically to:

- Establish a forest management unit under Chukha Dzongkhag as there is no FMU in the Dzongkhag so far. This also meets the government policy of having at least one FMU in each Dzongkhag.
- To provide a relatively accurate overview of the growing stock and regeneration potential of the natural forest in the area, according to the major forest types.
- To give an overview of the general site characteristics of the natural forests in terms of soil, other resources and their use by local population.
- To provide an indication of timber quality in the different forest types.
- To furnish essential data on tree height to enable the construction of local volume table for the main species.
- To facilitate the supply of immediate local timber demand.

The inventory was conducted only in the natural forest land. 362 plots were laid out with 26.2983ha as the maximum area representation per plot. An equal square spacing distribution of 600m between the lines and 438m between the plots on a line was used. The inventory design was aimed at a sampling error of ±10% at confidence level of 95%. After completion of field work, the data were entered in to the computer, validated and corrected, and analyzed with the specially developed <PLOT> system. ***However, for the purpose of the second management plan of Metapchu FMU, no inventory was carried out. Instead the inventory results of the inventory carried out in the first plan period was revalidated by adjusting the total volume of timbers extracted from the FMU during the first plan period. The results were further validated using R-statistics for calculation of average standing volume per hectare, basal area per hectare and number of trees per hectare during this plan period.***

13.2 Forest Management Inventory Result

The inventory result provided in the following chapters refers only to the area subject to commercial production.

Summary of Inventory Results

Stratum Name	Average Vol/ha		Average No. of trees/ha		Average Basal Area/ha	
	m3	SE%	No. of trees	SE%	Basal area	SE%
Mixed Broadleaf	146.15	15.56	106	15.38	15.15	14.37

13.2.1 Average Volume per hectare

Average gross volume per ha is 146.15M³. The number of trees in the lower diameter class of 10-19 & 20-29 is very low. Regeneration of important timber species (*Michelia spp., Persea fructifera, Juglans regia, Ficus spp., Castanopsis spp., Toona Ciliata, Acer spp., Schima wallichi, Terminalia spp., and Quercus spp.*) throughout the operable area is very low or absent. Grazing of various intensities and the limited light reaching the floor are the two main factors hampering natural regeneration of the major timber species which needs overhead light for maximum growth. However, with intensive management, the condition of the growing stock can be improved and the productivity of the forest can be enhanced, by creating favourable conditions for regeneration, growth and increasing the stock. The average gross volume per hectare for different species and distribution of volume for different diameter class are given below.

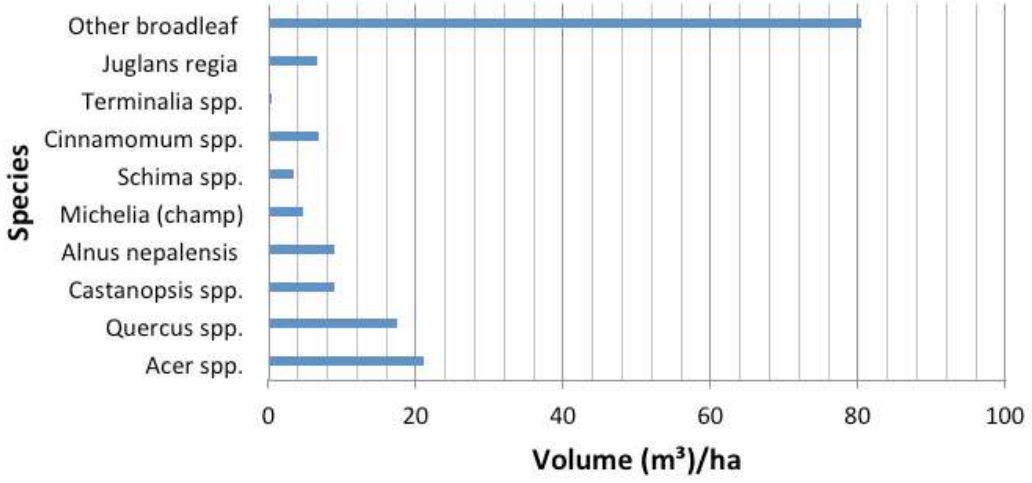


Figure 5: Average Volume (m³/ha).

Figure 6: Distribution of volume for Diameter Class.

13.2.2 Species Distribution.

On an average, the number of trees per ha is 106(refer Table 21). 69.38% of the trees are unknown and has been put under the other broadleaf category.

Table 21: No. of trees per ha by species.

Species	**No. of trees/ha**	**%**
Acer spp.	8.97	8.18
Quercus spp.	4.37	3.98
Castanopsis spp.	5.29	4.82
Alnus nepalensis	3.22	2.94
Michelia (champ)	1.38	1.26
Schima spp.	2.07	1.89
Cinnamomum spp.	5.29	4.82
Terminalia spp.	0.46	0.42
Juglans regia	2.53	2.31
Other broadleaf	76.09	69.38
Total	**106.67**	**100**

14. AREA ORGANIZATION

14.1 Spatial Organization

The main management tools used for implementing silvicultural and management regimes

are the use of management circles. Scientific management of the FMU is achieved through organization of the management circles into blocks, compartments, and where applicable sub-compartments. These blocks will be managed according to the forest type and functions designed to the compartment and apply the appropriate silvicultural regime for the forest type and function. Strict controls on the amount of harvested wood and the ways harvesting is conducted are specified. Blocks have been demarcated according to the natural drainage and terrain features wherever possible. The composition of Blocks and Compartments is given in the following table:

Table 22: Blocks and Compartment with their Corresponding area(ha).

Block	**Compartment**	**Area(ha)**	**Gross Operable area(ha)**	**Net Production Area(ha)**
Metakha	I	1413.75	594	415.8
	II	778.91	499	349.3
Bjozhingkha	1	1276.74	599	419.3
	II	1332.38	730	511
Boomelum	I	931.66	480	336
	II	1153.78	462	323.4
Tsundrugang	1	1300.21	692	484.4
	II	2489.09	1055	738.5
Total		**10,676.52**	**5111.00**	**3577.7**

14.2 Determining Operable area

Forests are managed for multiple purposes. The role of forests 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 forests, all such purposes cannot be equally harmonized. One purpose has to take precedence over 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 (Slope greater than 100%)
- Soil conservation
- Agriculture areas
- Riparian buffer and zones
- Local water supply protection
- Biodiversity areas (wildlife conservation and protection)
- Religious site protection

- Road buffer

14.3 Organization into management circles and working Circles

Working circles are directly linked to the categories of forest function identified above. Working circles are managed for objective specific to that working circle. The organization into different working circle and the specific prescriptions are given below.

Table 23: Area statement of Management Circle and Working Circle.

Management Circle	**Area (ha)**
Protection Management Circle	
• Soil Protection	4242.15
• Riparian Reserve	171.93
• Local water supply protection	84.84
• Wildlife protection	4242.15
• Religious site Protection	0.78
Non-production Management Circle	
• Kamzhing	350.54
• Chhuzhing	69.49
• Meadows	1.42
• shrubs	114.49
• Built up	3.88
Production ManagementCircle	
• Mixed Broadleaf working circle (Commercial)	5111.06
• Mixed Broadleaf working circle (Local use Only)	512.46

14.4 Protection Management Circles

The Protection Management circle is area under protection where no commercial activities can take place. The protection Management circle is the sum of all the protection functions; wildlife protection, soil protection, riparian reserve protection, religious site protection, and local water supply protection and covers an area of **4499.72ha** of the total FMU area. The management objectives and options are briefly outlined below, but the management of individual protection functions will comply prescriptions as detailed under individual functions.

Note: *Here function overlaps. Like water protection overlaps with soil protection and major stream buffer which is known as Riparian reserve protection overlaps with local water supply protection.*

*Table 24**: Management objectives, Options and Responsibility for protection working*

circle

Management Objectives	Management Options	Responsibility
• To conserve and enhance wildlife habitats and biodiversity	• Avoid disturbance • Promote research	• All parties • Territorial
• To conserve the water catchments functions and watershed values of the FMU	• Minimal intervention	• All parties
• To meet local needs for NWFPs sustainably	• Provide licensing for local residents • Resource assessment	• Territorial • Territorial
• To protect the forest from grazing, fire and illegal activities	• Involve local people in mitigation impacts	• Territorial
• To raise awareness of the important biodiversity areas	• Public meetings/field visits • Literature • Research	• Territorial • Territorial • Territorial
• To respect the sanctity of religious places	• Non-intervention	• All parts

Forest Function Map (Annexure I):
The mapping procedure is done as per section 'forest function mapping' of Forest Management code of Bhutan 2004. Function boundaries are digitised/derived from the working map or directly from GPS data. The standardised buffers along/around objects created are as follows:

Riparian Reserve Protection (WRR):
30 m along alluvial and semi-alluvial rivers
100 m along non-alluvial rivers and around lakes

Water Supply Protection (WSP):
10 m each side of water (irrigation) channels
30 m along WRR of water body used for local water supply

Road Buffer (RB)
According to the code on forest function mapping, the following road buffers are required.

- Along motorable public road: 200 m uphill, 100 m downhill
- Along forest road in unstable terrain: 30 m uphill, 10 m downhill (as indicated on sketch map)

Religious Site Protection
50 m radius around object.

14.5 Non-Production Management Circle (overlapping)

The Non-production Management circle includes areas where production is not economic or feasible. It generally comprise of non-forest areas, settlements and agricultural use areas. The total area under non-production management circle is about **539.82ha** of the total area. The management objectives and options are described below, but the most important objectives is to regenerate the poor regenerated or blank areas and improve existing forest condition.

*Table 25**: Management Objectives, Options and Responsibility for Non-Production Working Circle***

Management Objectives	Management Options	*Responsibility
• To manage grazing for livestock	• Plant fodder trees • Rotational grazing • Local involvement	• Territorial/Gup • Territorial/Gup • Territorial/Gup
• To conserve and enhance biodiversity	• Promote research	• Territorial
• To conserve water catchments functions	• Replant deforested area • Maintain vegetation cover • Introduce Soil & water conservation Activities	• NRDCL/Territorial • All parties • NRDCL/Territorial

***Note**: Lead agency is the first agency listed.*

14.6 Production Management Circle

The Production management circle is the area derived from the remaining area after critical functions were identified and mapped out and consequently grouped into protection and non-production and production working circles. The production management circles cover a total area of **5623.52ha**. The Production management circle is divided into two working circles and management options and objectives are described for each in subsequent sections.

Note: *Mixed conifer area (27.20ha) excluded from production area, since the area is covered with stunted juniper and top broken fir specie which are not feasible for commercial operation. Therefore, only broadleaf area of **5623.52ha** considered for AAC calculation.*

14.7 Management of Working Circles

The Production Management circle has been divided into two working circles;

i. Mixed broadleaf (Commercial Production).

ii. Mixed broadleaf (Local Use).

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

Table 26: Mixed broadleaf Commercial Working Circle

WORKING CIRCLE: MIXED BROADLEAF (COMMERCIAL PRODUCTION) AAC=4400m³				
Management Objective	**Management options**	***Responsibility**	****Monitoring**	**Silvicultural Systems**
To manage the commercial timber production on a sustainable basis.	• Operate entire length of cable line	• Territorial /NRDCL	• Territorial	Silviculture system applied will be patch clear cut system with natural regeneration. NRDCL will employ appropriate and cost effective fencing for a period of 7 to 8 years. Commercial harvesting in this Working circle is largely dependent on the construction of the proposed forest road.
	• Ensure cable-line layout allows interline logging	• Territorial /NRDCL	• Territorial	
	• Encourage cleaning of ENTIRE lines by firewood contractors	• NRDCL	• Territorial	
	• Use appropriate logging and silvicultural methods	• NRDCL/Territorial	• Territorial	
	• Harvest all areas regardless of financial return	• NRDCL	• Territorial	
To create local employment opportunities	• Provide proper training	• NRDCL/Territorial	• Territorial	
	• Encourage contractors to hire locally	• NRDCL	• NRDCL	
To protect the forest from fire and illegal activities and from grazing in regeneration areas.	• Control grazing, poaching and illegal felling with local community participation.	• Territorial		
To enhance and improve forest condition and productivity	• Ensure that all barren and past harvested areas are restocked sufficiently with desired species composition	• NRDCL/Territorial	• Regeneration survey	
	• Use the stand tending techniques	• NRDCL/Territorial	• Territorial	
	• Work with local communities for planting /restocking activities	• NRDCL/Territorial	• Territorial	
	• Create favourable conditions for regeneration and growth.	• NRDCL	• Territorial	
To continually improve health and safety standards	• Provide training to contractors	• NRDCL	• Territorial	
	• Promote awareness in the local community	• Territorial	• Territorial	
To conserve the water catchments functions	• Minimal intervention	• Territorial/NRDCL	• Territorial	
	• Abide by stream buffer regulations	• NRDCL/Territorial	• Territorial	
To maintain biodiversity within the production area	• Low impact silvicultural systems	• Territorial/NRDCL	• Territorial	

Note: All objectives will be evaluated annually by the FMU Level Management Committee

***Lead Agency for Responsibility is the agency listed first.**

**** All objectives and activities will be evaluated during the Mid-Term Review**

WORKING CIRCLE: MIXED BROADLEAF (LOCAL USE) AAC= 630m³				
Management Objective	**Management options**	***Responsibility**	****Monitoring**	**Silvicultural Systems**
To meet local requirement, as a priority, for timber, fuelwood and other forest products on a sustainable basis.	• Allow closely monitored and controlled marking of trees	• Territorial	• Territorial	Silviculture system applied will be singe tree selection system.
To protect the forest from fire and illegal activities and from grazing in regeneration areas.	• Control grazing, fire,poaching and illegal felling with local community participation.	• Territorial	• Territorial	
To enhance and improve forest condition and productivity	• Control grazing, poaching and illegal felling with local community participation.	• Territorial		
To enhance and improve forest condition and productivity	• Ensure that all barren and past harvested areas are restocked sufficiently with desired species composition	• NRDCL/Territorial	• Regeneration survey	
	• Use the stand tending techniques	• NRDCL/Territorial	• Territorial	
	• Work with local communities for planting / restocking activities	• NRDCL/Territorial	• Territorial	
	• Create favourable conditions for regeneration and growth.	• NRDCL	• Territorial	
To continually improve health and safety standards	• Promote awareness in the local community	• Territorial	• Territorial	
To conserve the water catchments functions	• Minimal intervention	• Territorial/NRDCL	• Territorial	
	• Abide by stream buffer regulations	• NRDCL/Territorial	• Territorial	
To maintain biodiversity within the production area	• Single tree selection and Low impact silvicultural systems	• Territorial/NRDCL	• Territorial	

Table 27: Mixed Broadleaf Local Use Working CircleNote: All objectives will be evaluated annually by the FMU Level Management Committee

***Lead Agency for Responsibility is the agency listed first.**

**** All objectives and activities will be evaluated during the Mid-Term Review.**

14.8 Implementing managementof Working Circles

The concept of Forest Function Mapping has been used in this Plan to delineate between forest and different land use in the FMU for implementing sustainable management of forest resources and making resources available and affordable to the public. This will be further supplemented with detailed information collected during Operational Planning. But, implementation of correct prescriptions in the field still remains a challenge.

Therefore, the Unit In-charge will have to be fully convinced with the FMU information prior to going in the field. Further, the forest function maps may be updated according to the field observations.

15. YIELD REGULATION AND HARVESTING

15.1 Determination of the Annual Allowable Cut (AAC).

15.1.1 Introduction

Principle of sustainability, the backbone of forest management which focuses on sustainable utilization of forest resources by present generation and preservation for future generation as well. 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 compromising the productivity of the soil. Calculation of Sustained Yield is expressed as AAC.

15.1.2Method for Calculation of AAC.

A combination of area, volume and rotational age of species is used for the calculation of AAC in Metap Chhu FMU. Since methodology is simple and easy to use. The method used for calculating the AAC for Metap Chhu FMU is given below:

$$\text{AAC per Working Circle} = \frac{\text{Net Operable Area} \times \text{Average standing volume per ha.}}{\text{Rotation}}$$

The method is applied for calculating AAC for each working circle and are added together to calculate the Total AAC.

15.1.3Calculation of AAC for Metap Chhu 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, *Patch cut system*almost inevitably lead to some

patches of mature timber being left in later phases due to the presence of new regeneration and the damage that the total removal of the cover storey would cause. With such challenging terrain in MFMU, exact geometric shape patch layout is rarely possible, interlocking of patches is therefore more appropriate and further area is lost. Due to above inevitable fact around 30% of area from the gross operable area has been reduced to calculate the net operable area in commercial Working Circle. In case of local use, the gross operable area has not been reduced since Single Tree Selection System will be applied.

Table 28: Calculation of Net Operable Area.

Working Circle	**Gross Operable Area**	**Calculation**	**Net Production Area**
Mixed broadleaf (Commercial Use)	5111.06	Gross operable Area-30%	3577.76
Mixed Broadleaf (Local Use)	512.46	Gross operable area	512.46
Total	**5623.52**		**4090.22**

Note: *Mixed Conifer area is not considered for AAC calculation due to area being covered by stunted growth juniper and top broken fir which were not feasible for commercial allocation.*

Rotation

For *Patch cut system*, the objective is to have more or less even aged regeneration in areas worked out at each cut. The assumed rotation length in mixed broadleaf forests is 100years (including the 10 years minimum regeneration period). For Local Use, the rotation length is also kept at 100 years and the harvesting will be done by *Single tree selection System*.

Mixed Broadleaf Working Circle: 90+10 years

Average Standing Volume

The mature standing volume is taken from the inventory data that is calculated using <PLOT> Programme.

Table 29: Average Standing Volume for the Working Circles.

Strata	**Average Standing Volume (m^3/ha)**	**Sampling error % (at P=0.95)**	**Reliable Minimum Estimate (m^3/ha)**
Mixed broadleaf (Combined)	146.151	15.5	123.5

AAC for each working Circle

The AAC for each working circle, based on the above table is given in table below:

Table 30: AAC by Working Circle (Standing Volume)

Strata	Net Operable Area (ha)	Rotation	RME of Average Standing Volume (m^3/ha)	AAC (m^3/ year)	Clear cut Equivalent (ha)
Mixed broadleaf (Commercial)	3577.76	100	123.5	4400	35.62
Mixed broadleaf (Local use only)	512.46	100	123.5	630	5.10
Total				**5030**	**40.72**

Therefore, it is proposed to use the standing volume of **5030m^3** as AAC and this shall be reviewed against the production figures at the mid-term review.

15.2 Recording and Accounting for AAC.

AAC will be monitored through the records of trees 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 totalled on annual basis from the Tree Marking Register.

15.3 Allocation of the AAC (Standing Volume)

The allocation of the AAC has to take into account the needs of the local people (within the FMU) while providing NRDCL with timber. However, the working circles have been divided into commercial and local use separately. Whereas, the current demand for timber for timber for rural construction purposes is not high. The allocation of timber as per the working circle AAC will be as follows.

Local Use- 630m^3	Allocated to local users (local villages, general public and adhoc). The volume of cham, tsim, dangchung, etc. from operations will be included in this allocation. The territorial CFO, Gedu will be responsible for allocating this volume.
Commercial-4400m^3	Allocated to NRDCL to meet commercial demand.

The allocation is tentative. The rural demand of the timber within the FMU is not high according to the past demand trend. But during the FMU-Level Committee meeting, the members felt that the local demand may rise in future because of the road going to the area. The UIC and CFO can study the demand trend and make adjustments with the allocated AAC while preparing the Operational Plan.

The CFO can make adjustment with the AAC allocation as per the actual demand but the fact should be borne in mind that **AAC is calculated by working Circle and is not transferable between working Circles**. This means that when we talk of allocating AAC of **630m^3** to the local users, we can extract an annual volume of **630m^3** only from the Local Use Working Circle. When the local demand is less than the allocated AAC, the remaining

volume may be allocated to NRDCL to meet commercial demand.

The allocation can be altered after having a meeting with stakeholder groups and discussion during the FMU Level Management Committee Meeting.

It is predicted that Local AAC allocation can be different for different years, owing to the varying local demand in the past. The UIC shall propose necessary changes in consultation with concerned CFO and reflect the changes in the Annual Operation Plan.

15.4 Distribution of the cut

AAC has been calculated by Working Circles providing the distribution of the cut for each working circle. Therefore, harvesting from each Working Circle has to be strictly followed as in the Management Plan. Number of cable lines to be harvested annually should be mentioned in OP.

15.5 Limits of Harvesting area for commercial timbers in this plan period (2nd Plan period)

Block	Compartment	Area(ha)	Gross Operable area(ha)	Net Production Area(ha)	1/3 of the net pro-du-ction area (ha)	cumulative net production area(ha)	Total clear cut equivalent for 10 years (ha)
Metakha	I	1413.75	594	415.8	137.214	1180.641	
	II	778.91	499	349.3	115.269	1043.427	
Bjozhingkha	1	1276.74	599	419.3	138.369	928.158	
	II	1332.38	730	511	168.63	789.789	
Boomelum	I	931.66	480	336	110.88	621.159	
	II	1153.78	462	323.4	106.722	510.279	
Tsundrugang	1	1300.21	692	484.4	159.852	**403.557**	**356.7**
	II	2489.09	1055	738.5	243.705	243.705	
Total		**10,676.52**	**5111**	**3577.7**	1180.641		

Table : Harvesting limits of Commercial Timbers for the current plan period.

Total AAC for 10 years = 44000 m3

Total clear cut equivalent for 10 years = 44000/ 123.5 =356.7ha

From the above table, total clear cut equivalent of 10 years for the FMU is met fromthe net production area of **Tsundrugang Block, Compartment I and II.**

Therefore the harvesting of commercial timbers by NRDCL must be limited till Tsundrugang Block, Compartment I and II only for the current plan period and in no case the harvesting should be diverted to other compartments or carried out beyond Tsundrugang Block unless approved by the Director, DoFPS.

16. SILVICULTURAL SYSTEMS

16.1 Prescribed Silvicultural System in Broadleaf Forests - Group Selection System with Artificial Regeneration.

On 17th of January 2005, Silvicultural Systems Consultative Workshop was held at the Department's Conference Hall. During the workshop, the participants agreed to prescribe Group Selection System with artificial regeneration as the silvicultural system in broadleaf forests in Bhutan.

The following considerations should be made before the application of the silvicultural system.

1. ***Factors of Locality***
   Factors of locality include micro-climate, slope aspects, soil, humidity, rainfall, and geology of the locality which affect the growth of the plant. The nutrient of the soil is also very important for regeneration of the area. Biotic factors like grazing should be considered before clear felling.

2. ***Potential Productivity of the Site***
   Potential Productivity of the site should be assessed and the silvicultural technique suitably modified to ensure rapid growth of new plants in the clear felled areas. In Bhutan there is a lack of information on potential productivity of sites. It is also imperative that inputs are applied judiciously. In other countries, people have even irrigated as well as applied fertilizers to the site.

3. ***Species and composition***
   Clear felling system is suited to light demanding species. The composition of the species can be changed to ensure the best financial results. But there are trees that can't withstand wind throws. So, clear cutting is going to expose them, causing uprooting and other damages. Some species can't stand the frosts during winter. Clear cutting expose them to such adverse condition. Choice for species and composition should be made taking into consideration these characteristics of different species.

4. ***Regeneration***
   The success of any system depends entirely on the success of the regeneration of

the logged areas. Artificial regeneration is the only option if there is no natural regeneration.

The practice of keeping the area barren for a year allowing firewood contractors to collect lop and tops from the cable line could mean extended exposure of the area to soil erosion. But in sub-tropical conditions of Bhutan, grasses and shrubs cover the soil soon after the clear cutting. Thus, even with the canopy gone, the cover provided by grasses and shrubs are enough safeguards against soil erosion or soil deterioration.

However, the invasion by grasses and shrubs can mean danger of fire for other inter-cable line stands. Once the area is about to be planted, the weeds and shrubs should be weeded out. Weeding should take place thrice a year as per the Norms and Standard of Plantation 2016 issued by SFED.

To ensure the survival of artificial regeneration created by the NRDCL the UIC should carry out plantation survival survey by doing total count in the planted areas annually. If the survival percentage is less than 70% the NRDCL should be apprised to carry out beating up and other necessary maintenance work to improve the status of survival.

Group Selection System has been prescribed in the broadleaf forests. The group selection system has been prescribed in preference to Strip Clear Cutting system that was in operation in previous plan basically because the latter is seen as environmentally riskier. The large tracts of land being clear felled would open the area to hazards of monsoonal rain and soil erosions. Even aesthetically, the large openings would be an eye sore. In group selection system, trees develop in clearly defined even-aged aggregations; this is of substantial advantage in developing good form especially in hardwoods.

Under the group selection system, small openings will be created in the stand allowing light to reach the forest floor and creating microclimatic conditions conducive for seed germination and establishment of seedlings.

There are important unresolved problems with sub-tropical and warm broadleaved silviculture in Bhutan; particularly the poorly understood regeneration dynamics of commercial species. Good regeneration has proved extremely difficult. There are also still considerable doubts regarding the best silvicultural systems for managing broadleaved forest. It is likely to be some time before research results are available and it is quite possible that stand succession towards commercially useful species is naturally a very long process (Whitfield, 2001).

Since one of the main reasons for failing of silvicultural systems is the lack of regeneration,

it has been proposed during the Consultative Workshop that the group selection system should be combined with artificial regeneration.

The Group Selection System with artificial regeneration is synonymous to the Patch Cutting

System as recommended by the RNR-RC Yuispang as per the *Forest Research Findings and Recommendations during the 8th FYP, RNR RC Yusipang (2003)*. The "patch" in patch cutting system would mean smaller groups (as compared to groups Group Selection System in Conifers) in Group Selection System. As per their research findings, the patch cutting system with fencing is proven to be the best option in terms of fostering biodiversity, mitigating grazing impact and safeguarding financial viability for sustainable management of mixed broadleaf forests in Eastern Bhutan.

General guidelines for Patch-cutting system (group selection system) in broadleaf forest. (vide the *Forest Research Findings and Recommendations during the 8th FYP, RNR RC Yusipang, 2003)*

- Patches of mature and over-mature trees under which there is existing regeneration or which are most likely to regenerate successfully should be given first preference. This would include large trees with spreading crowns, which absorb sunlight if permitted to reach the forest floor would enhance seedling development.
- In selecting patches, ridge tops are preferred over depressions, up slope positions over down slope in order to minimize damage to regeneration in subsequent felling operations.
- The size of openings should depend on stand composition and condition. In general, the size of opening should vary from 0.15 to 0.5 ha. It should not be too large, as it will favour the growth of other species, which have less timber value.
- Distance between the patches retained should be such that patches of trees retained will form a wind firm group of trees and appear as a uniform patch.
- In mature broad-leaved forests with many mature and over-mature trees it is expected that 75% of the standing volume would be harvested by felling 40 to 60 % of the area.
- The direction of the tree lean, and the topography should be taken into account to prevent large trees being felled on nearby advanced growth.
- Dead or dying trees or those showing symptoms of decay or damage (snags, scars conk, mistletoe, etc.) should be retained to safeguard flora and fauna niches or habitats.
- Sufficient seed trees in the interline spaces adjacent to the cable lines opened up should

be retained as potential seed sources for seedling regeneration in patch-cuts.

The Group Selection System has following advantages:

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

In areas where openings 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 distributions of the trees are strictly followed and should match with the openings created under group selection system. Care should also be taken to avoid felling trees on environmentally sensitive areas, buffer areas and corridor protection areas.*The figure in the following page gives the schematic diagram for laying out the groups along the cable lines. This figure is to be used as a guide and reference only and is not to scale with actual dimensions in the field.*

The length of the cable line and number of openings along the cable lines must be determined by the availability of stocks along the cable line.

16.1.1 Working Pattern

Clear cut patches of approximately 0.15- 0.25ha will be opened up along the cable lines depending on the stand composition and condition. The distance between the cable lines will not be less than 75metres and a patch of intact forest not less than 60metres should separate each opening along the cable lines. **The corridor should not exceed four metre widths.** The length of the cable line and number of openings along the cable lines must be determined by the availability of stocks, stand composition and condition along the cable line. The individual opening need not be uniform in shape and size or systemically located along the cable lines. In most cases the openings will be irregular in shape and systematic location of patches will be almost impossible. Aspect, slope and Silvicultural requirement will influence the actual size and shape of the patches.

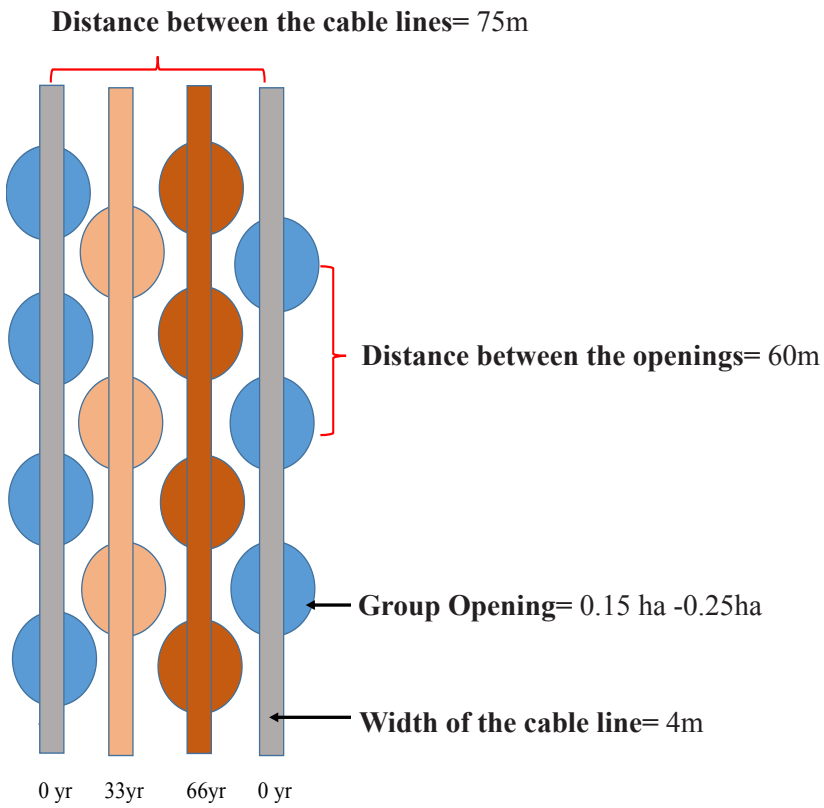


Figure 7: Schematic diagram showing the clear cut patches along the cable lines for **Metap Chhu FMU.**

Only one third of the area of the stand will be subjected to harvesting between intervals of thirty three years for mixed broadleaf forests. The groups will be opened up along cable lines. The distance between two cable lines would be 75 meters, and between groups would be 60 meters.

The approach of working to a minimum cable line spacing of 75 m for the group selection system will only work if matched with appropriate felling group sizes. Execution of this plan will keep a minimum of 75 m distance to prevent subsequent cable lines running through old previously cut groups and damaging regeneration. This is owing to the experiences gained from the implementation of the past two plans for 20 years. As have been planned in the paper it does not work in practical ground situation due to terrain, slope, direction of tree leaning, expertise of loggers, etc. Line spacing and group size then need to be carefully considered on a site-by-site basis and provide for a specific number of subsequent passes. One prescription will not be appropriate everywhere.

It is, therefore, very important for cable lines to be recorded properly. Once the cable lines are calibrated for the group openings, it would be important to have the same group opening spacing for the first phase of cable lines since the interlocking openings of second and third passes should not fall on the previously harvested areas. This requirement of the Square Interlocking groups' layout necessitates the excellent record keeping of the worked cable lines and their openings' locations.

Working for Cable Lines
AAC for commercial harvesting = 4400
Volume= 123.5m³/ha
Clear Cut area equivalent=4400/123.5=35.62ha

The length of the cable lines and number of openings along a cable lines must be determined by the availability of the stocks in a cable line. In the event of good stocks, the AAC or clear cut area equivalent of the FMU (whichever is achieved earlier) could be met even from a single cable line. In such instances, laying of subsequent cable lines must be restricted to next harvesting period only (Next OP).

16.2 Single Tree Selection System
This System will be practiced in Local Use forests areas for rural marking. 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 the forest. This system helps to maintain uneven-aged character of the crop in the forest as in nature.

It is observed that in most cases, the trees of best economic interest are selected and felled. Instead of following this, the UIC should judge and familiarize with the forest condition and silviculture 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.

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

Prescribed Silvicultural Systems for the FMU

- *For the production areas where commercial harvesting will take place,the pre-*

scribed Silvicultural system is the Group Selection system with artificial regeneration.

- *For the local use the prescribed Silvicultural System is the Single Tree Selection system.*

17. FOREST PROTECTION

17.1 Fire

Fireis not a major problem in the broadleaf forest. In Metap Chhu, one of the main concerns is the ongoing tseri practice. Though banned by the government in view of increased soil erosion, people in that area still practice tseri cultivation. This practice is carried out during winter when the humidity in the atmosphere is less and the surrounding vegetation is fairly dry, so far there have been no cases of forest fire in the area but the practice might gradually clear the surrounding government forest land. Therefore, CFO, Gedu will have to take necessary action to discourage such practices within MFMU.

17.2 Pest and Diseases Management

The FMU staff should regularly conduct inspection to detect any outbreak of any pests or diseases. Detailed descriptions on symptoms and damage,, preventive and control measures including information on life cycles and identification photographs can be sought from *Important Forest Pests and Diseases of Bhutan with Control Measures, Tshering & Chhetri (2000)*. Reports should be made to the CFO or relevant research specialist.

17.3 Grazing

The Forest Policy of Bhutan lays emphasis on multiple-use of forests, Grazing will be allowed in the FMU area at minimal scale in Protection Management Circle and focusing more on Non-Production Management Circle.

Grazing must be excluded from regeneration areas, and allow the areas to establish regeneration, if the forest is to continue to be productive for timber in the future.

18. ENVIRONMENTAL IMPACT ASSESSMENT

18.1 Introduction

Environmental Assessment is a prerequisite for any approved management plan. The forest management plan must ensure an environmental assessment for all the forestry operations prescribed in the management plan. The environmental Impact Assessment for Metap Chhu was done by a team from Gedu Territorial Forest Divison and NRDCL.

18.2 Method and Project Summary

A team from GTFD and NRDCL carried out detailed EIA for the FMU. The Team, led by the Forest Management Planner, GTFD comprised of Engineer and RM, Phuntsholing,

NRDCL. One stake holder meeting was carried out with the relevant stakeholders.

The public endorsed the opening of the Metap Chhu Forest Management Unit and they had no objection to the proposal. The major activities involved would be the construction of a minimum 20Km Forest road and one bridge (i.e wooden bridges) within FMU for extraction of timber from different Blocks and Compartments. The Forest of Metap Chhu will be brought under sustainable forest management by determining the annual allowable cut. It means that no cut will take place without carrying out the inventory of the resources. Although the forests of Metap Chhu did not see any commercial harvesting activities but the forest has been fully degraded by the local communities for house construction timber and other rural uses.

Grazing is common within the whole area of MFMU. During winter the cattle from the community of wanakha and susuna graze within the FMU. The forest has come under tremendous pressure from grazing and since most of the broadleaf species are palatable, the cattle may be browsing on the regeneration in winter when the seedlings are more susceptible to damage.

There is already a road network established (GC Road maintained by DoR) from Ganglakha to Metakha (Inside FMU) and Farm road constructed from Metkha to Tsundrugang (Block IV). One alternative for road construction from the end of the existing Chongaykha road to Omchu (East of FMU) is feasible which is currently under construction by Chukha Dzongkhag as Farm Road which could reduce transportation cost by more than 50%. There is need to construct Forest Road inside FMU and it does not fall inside private registered land and hence there is no issue of land acquisition/appropriation. In addition, maintenance of existing Farm road inside the FMU should be maintained by NRDCL.

The Road constructed and maintained would help the people of Metakha to carry out their developmental works due to construction of the forest road. Road is the lifeline and it would play a crucial role in shaping the future of Metakha community.

18.3 Project Description

18.3.1 Introduction

It is the policy of the department to have one forest management unit in each and every Dzongkhag to supply timber on sustainable basis to the people of Bhutan. Metap Chhu forest has been chosen as one of the potential forest management unit that could cater to the needs of people on sustainable basis. The forest management unit will be worked on the principle on sustainable uses and supply timber to market and at the same time improves the forest stand at Metap Chhu Forest. The whole of Metap Chhu watershed area, which amounts to 10676.53ha, has been taken for the project. The project will be used for harvesting and

reforesting the whole area. The over matured trees will be felled to improve the stand and at the same time provide timber to the market.

18.3.2 Objective:

The main objectives of creating the FMU is:

- To improve the forest stand of Metap Chhu
- To ensure sustainable supply of timber, fuelwood and non-wood produces.
- To regulate grazing in orderly manner and on sustainable basis.
- To support people for development purpose by the way of constructing forest roads.

18.3.3 Benefits

It is anticipated that felling those over matured trees and opening of the space to encourage natural regeneration would improve the forest, which is at the moment on degrading state. The natural regeneration is a big problem mainly due to grazing in the forest all round the year and the competition from the unwanted species that dominate over the principle commercial species. The forest road constructed and farm road maintained by NRDCL would help local communities in transportation of goods. Establishment of FMU would create job opportunities as the local communities have very less land holdings for agricultural purposes. The local people will not have any problem in getting the transportation as there would be Truck available due to the transportation of timber from FMU. The overall benefit would be that the forest of Metap Chhu FMU would be able to be managed on the principle of sustainability. The over matured timber which would otherwise rot in the forest would be brought in the market to earn revenue for the government and at the same time improve the forest stand.

18.4 Checklist for Environmental Parameters for Forestry Projects

The initial stage of the EIA involved the completion of the checklist to identify where there will be significant environmental effects. In general, the operation of FMU will have no significant effects on the environment. The potential critical areas of reduction of water quality and, closely linked, erosion control is being taken care of as described in the later sections.

CHECKLIST OF ENVIRONMENTAL PARAMETERS FOR FORESTRY PROJECTS

CHECKLIST OF ENVIRONMENTAL PARAMETERS FOR FORESTRY PROJECTS AT MFMU

	Adverse Environmental impacts	Preliminary Evaluation			
		No significant effect	Small Effect	Moderate Effect	Major Effect
I.	**COMMERCIAL LOGGING**				
A.	**Environmental Consideration 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 downstream beneficial uses*	✓		
2.	Relation to other dedicated land uses				
a) conservation area		*a) impaired ecological and recreational opportunities*	✓		
b) economic ventures		*b) possible economic loss*	✓		
3.	Traditional Forest uses	3) impaired beneficial uses			
4.	Rehabilitation	4) Social problems	✓		
5.	Relation to regional/ national forestry plans	5) Possible conflicts with established management policies	✓		
6.	Critical environment areas	6) Downstream economic lossess	✓		
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	✓		
B.	**Construction Regarding Planning and design**				
1.	Cost/benefit analysis				
2.	Operation and maintenance	Diminished project efficiently and objectives if lack of funds			✓

3.	Data base 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 environment 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	✓		
C.	**Construction 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)	Soil compaction	b) *Increased runoff*	✓		

c) Log floatation	c) *Impede vegetation*	N.A		
d) Allocation	d) *Less than optimum economic benefits*		✓	
4. Logging in riparian zones	4) degradation of waterways/fisheries	N.A		
5. Socio-economics				
a) *Employment opportunities*		✓		
b) *Loss of traditional forest use*	b) *Economic and cultural losses*	✓		
D. Considerations regarding post-project activities				
1. Rehabilitation and conservation		✓		
2. Road shutdown		✓		
II. **Reforestation/Afforestation**				
A. **Consideration Regarding Project Siting**				
1. History of forest abuse	1) Need of project goals if not effectively controlled			✓
2. Relation to other dedicated land uses				
a) Conservation area		✓		
b) Economic areas	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*	a) Social conflict if local people not significantly involved	✓		
b) *Training*		✓		
c) *Non-wood products*		✓		
5. Operations 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. **Consideration Regarding Project Operations**				
1. Commercial logging	1. Same as in commercial logging A and B	✓		
2. Reduced water supplies	2. Socio-economic 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. Socioeconomic benefits				
a) *Employment opportunities*			✓	
b) *Fuelwood*			✓	

c) *Enhanced fisheries*		✓		
d) *Enhanced recreation/tourism*		✓		
7. Water sources benefits		✓		
a) *Minimized overland flows*		✓		
b) *Reduced flood peaks*		✓		
c) *Water quality*		✓		

Source: Forestry Sectoral Guidelines, NEC(1999).

18.4.1 Forest Management Unit: Planning and Zoning

The project would also help in restoring ecological condition of the forest and at the same time those timber that would rot in the forest would be brought to the market and utilized which would not only earn revenue for the government but also provide employment to the local people. No operation should take place in the project area without proper management plan and operational plans. The department and the NRDCL would provide sufficient staff to prepare and implement the management plan and operational plans. Strict monitoring will be done to ensure correct implementation of the plan.

The management plan is based on the forest function map which is already prepared where all the protected areas are clearly demarcated. Harvesting of even the over matured trees will be on the basis of sustainable management. No commercial harvesting is to take place outside FMU except for road clearance. Department of forest will mark the trees for road clearance. Forest function mapping has been done according to the FMCB identifying important functions like Soil protection and conservation, Watershed conservation, Biodiversity and Wildlife conservation, Religious site protection, Riparian water reserves, Local water supply, etc. and only thereby deriving the remaining area for timber production.

18.4.2 Road Construction and Maintenance

The road construction in Metap Chhu FMU is aimed at minimum negative environment impacts.

The NRDCL engineer will supervise the road construction with minimum negative environmental impact. Many of the environmentally sensitive areas have been taken care during the road survey itself. The road has been aligned in such a way that none of the religious sites are affected and the road does not cut across any of the drinking water sources. For stream crossings, culverts, hume pipe and bridges have been designed to minimize the pollution of the stream along with side drains. As general rules, excavators will be

deployed, bulldozers shall not be permitted to be used. Road standards recommended by FRMD and the general principle 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.

Camps of the labourers will be established 100metres away from the streams and the water will be brought to the camp, waste water will be diverted from entering back into the main stream. No washing or bathing will be allowed in the running stream if there is settlement downstream.

During the assessment two options were identified by the Engineer as given below:
Option I, Existing GC Road to Metakha Block: There is about 59Km from existing NRDCL depot(Ganglakha) to Metakha Gewog Office which passes via Dungna Gewog.

Option II, Access Forest road to Tsundrugnag block: Take off point from existing Chongaykha Farm road to Tsundrugang village (Under construction by Chukha Dzongkhag Administration (Approx. 29 Km from existing NRDCL Depot, Ganglakha).

Option I has been taken into consideration during the Public Consultation meeting held in April 2017, until the farm road construction that connects Tsundrugang block is completed (i.e Option II).


Figure 8:Public Consultation Meeting.

18.4.3 Harvesting and Extraction
Mitigation measure will be applied 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. Power chain saws would be used in place of axe to reduce waste. The harvesting prescription and Silvicultural treatment have been taken care of and described in detail in the management plan.

18.4.4. Regeneration and Post-harvesting treatment

The stand replacement in the patches will be by natural regeneration with fencing for a period of 7 to 8 years. This would be beneficial as the future harvest would depend on the quick establishment and status of the regeneration of the seedlings. The series of operations to be followed after harvesting are prescribed in the management plan. Regular maintenance of the regeneration area will be done and the CFO shall evaluate the area at the end of three years. If the survival percentage is lower than 70-80%, immediate beating up will be carried out with local species. Monitoring of plantations and regeneration surveys will be carried out regularly.

Stream and Riparian Zone Protection & Biodiversity Conservation within the working Forest have been identified as major components and described in detail in Forest Function Mapping.

18.5 Existing Environment

18.5.1 Topography, Geology and Soils

The MFMU in general is moderate to steeply sloping and mountainous with deeply incised valleys running mainly north to south-west. Elevation ranges from 840m to 3400 m in the north of the unit. The terrain is dissected by many small streams, which flow mainly from north to South-West. Most of these streams are seasonal, coming into life only in the rainy seasons. All the streams in the FMU drains into three main rivers, Dongdue chhu, Metap Chhu and Boomelum Chhu.

Metakha area belongs to the phuntsholing formation, the area was formed during the Paleozoic period and comprises mainly of folded succession of purple phyllites, quartzite, and siliceous limestone.

The soil in the area is predominantly sandy loam (90.6%), 8.1% loamy sand and 1.3% sandy soil. The MFMU is well drained in general with 63.8% of the area with dry topsoil and 36.2% of the area with moist topsoil. 93.3% of the area has dark topsoil colour and 6.7% of the area has reddish top soil colour. In the forest area 1.3% of the area has no humus, 43% of the area has humus depth up to 2cm and 55.7% has humus depth from 2-5cm (Derived from inventory results).

18.5.2 Surface and Ground water hydrology and quality

The surface water is used only for drinking and for irrigation. Some households have access to rural drinking water scheme while others do not have. The drinking water scheme provides water through PVC pipes but those household which do not get water from such a scheme avail drinking water from open surface running water which may be polluted. The ground water is not at all explored and used.

18.5.3 Plant, animal species and habitat

So far as the Metap Chhu is concerned there are no endemic plant habitat found within the area. Rufous necked hornbill is common within the FMU. Apart from this, no plants or animals of rare or endemic status is found during plan preparation.

18.5.4 Cultural significant sites

Apart from the Meta Goenpa Lhakhang and the Lhashing (Sacred groove), there is no other site of religious importance.

18.6 Assessment of Impacts and mitigation measures.

18.6.1 Impact on water:

Pollution

The drinking water could be easily polluted due to disposal of garbage and the sewage. The settlement of labour camps that would be engaged for road construction and harvesting operation would definitely pollute the drinking water sources. The establishment of the camp and the human defecates would be the main polluting agent. The other pollution could come from the soil spills from the machineries and the vehicles.

Damage to pipes lines for Lhakhang and household

The road passes through the existing water pipe lines for Meta Goenpa Village and Lhakhang. So during the road construction, these pipe lines would be damaged and their drinking water could be disturbed. For other villages like Gumina and Pango, teh water pipe and the source are far away from the road construction. However, for villages like Bjozhingkha and Tsundrugang, the water source for these areas has been buffered and the implementers have to take care that the water source is not disturbed.

Drying up of water sources

Many of the drinking water sources originate from the forested area. Although the road does not cut through the water sources but during the construction phases may damage the surrounding vegetation. The harvesting operation and opening of the forest might result into drying up of the water sources.

Mitigations

The windrow will not be pushed down the slopes where the valleys has water sources and using excavator rather than using Bulldozer will avoid this. The windrow will not be dumped on the running streams that might choke the running streams.

Proper pit latrines and garbage disposal system will be in place and the temporary huts will be at least 100metress away from the camps and the wastewater will not be allowed to drain into the main stream.

The coupes will be laid around in such a way that they are located away from the stream and water sources. Riverbeds and stream buffers will be maintained as per the management plan prescriptions and forest function maps will be referred.

During the construction phase the NRDCL site engineer will monitor the road construction activities. None of the forest roads passes through the spring or stream sources and at least 100metres have been maintained to prevent drying up of water sources or polluting. The water pipes will be replaced that might be damage during the road construction.

18.6.2 Impact on forest resources

The patch openings might result in to grazing grounds with no regeneration of principal tree species. This could result into reducing the total forest cover within FMU area. More opening means more area for under growth, which in turn results into more grazing ground for the cattle round the year.

Due to short-term gains, the implementers might go for choosing the best trees and leaving behind over matured or diseased & unwanted trees species. There are possibilities that contractor would go for only sound trees which would fetch better price in the market and leave behind the unsound trees.

Implementer might go in the easy accessible area only and start logging in that area while the whole idea of opening this FMU is to manage the forest in sustainable basis. For the proper implementation of FMU plans, a qualified Range Officer would be required along with sufficient number of support staff. It would be same in case of NRDCL, as they need to have enough staff placed in the FMU.

It is likely that operation would occur along the stream and river buffer whereby polluting the water sources. Many of the stream or river sources originate from the forest areas and if the buffers are not respected there could be conflict between the implementers and the local communities. Improper harvesting techniques by untrained personnel would result into damaging the surrounding trees that may not require felling. It would also result in more waste of the timber resources.

Mitigations

The management plan for the whole area is for a period of ten years which is prepared before the harvesting operations take place. Harvesting will not exceed the prescribed AAC in the management plan. The size of the opening of 0.25 is recommended but can vary depending on the stand composition and structure. For proper planning, implementation and monitoring of the FMU activities, a full set of staff for the unit would be required both by the DoFPS and NRDCL.

18.6.3 Impacts on the faunal diversity

Impacts on the faunal diversity by road construction & forest harvesting are rather limited as:

- The species composition & forest types are similar throughout the FMU area.
- The protected/non-harvested forest areas provide sufficient space, cover for movement and food sources.

Mitigations

The patch openings will be fenced to protect the regeneration stands from cattle and the wild animals for the success of regeneration. There is no endemic flora and faunal species found in the area. Therefore, it was not necessary to adopt any special mitigation measures in protecting the species. The animals do require good forest for foraging, shelter and cover. Therefore, clear felling of large stretch of forest will not be allowed & the harvested forest areas must be brought under forest cover (within the shortest time gap) by natural regeneration with fencing and supplemented by planting in those areas that remain under stocked. Only few species of forest dwellers with no preference on any special forest types or habitats were identified except the pheasants and rufous necked hornbill. However, their habitats have been well secured, as it all falls under protected Zones.

18.6.4 Impacts related to Ecology (Flora)

Change of present forest composition, from uneven aged to even aged crop and from a crop of multiple species to monoculture.

Existing pockets of bamboo clumps specially *Celephalostychum spp.* after road construction will have impact on local and other user groups.

Epiphytic plants (not identical as of now) are abundant on the trunks of all layers of forest canopy. All these diversity may gradually be affected on opening of the forest stock.

Mitigations

Patch clear cut with appropriate opening size has been designed for the Forest management unit to mimic in the best possible way. This would ensure that the composition of the forest

is not changed within the operated area in the long run. Harvesting will be followed by natural regeneration with cost effective fencing for a period 7 to 8 years.

Ecological loss of Bamboo (*Cephalostychum spp.*) due to unmanaged harvesting has already taken place. Mitigation with proper scientific management prescription of Bamboo will be undertaken. Protection measures will be undertaken for those areas under deterioration.

Forest road has been aligned so that it does not pass through any of the critical area where the disturbance could be more. In many of the critical area that might damage the surrounding. Hume pipes, culverts and bridges have been designed.

18.7 Monitoring and Evaluation

The management plan is for a period for a period of ten years, approved by the Minister, Ministry of Agriculture. The plan will be implemented by NRDCL. Annual operational plan will be prepared based on the management plan by the GTFD in consultation with the stakeholders and approved by the head of the department. The annual monitoring will be carried out by the concerned Division (Unit In-Charge) and submitted to the Department based on the annual monitoring forms. FRMD will also monitor the implementation activities. The plan will be reviewed after five years and at the end of the plan period, evaluation will be done prior to the revision of the plan.

19. Financial and Economic Appraisal

19.1 Economic Analysis

Investigation in forest management are made with the expectation of high financial as well as economic returns. Economic benefits can be in the form of socio-economic development of the community or the people and at the same time improving the quality of the forests. Technically, good forest management by using appropriate Silvicultural treatments can improve the existing stands of Metap Chhu forests, thereby yielding better growth and also promoting better regeneration of principle species.

The road is going to act as the lifeline towards development projects in future.

19.2 Financial Analysis

The present financial forecast is done based on the approximate rates derived from Wangdigang and Gogona FMU. The assumptions on which the calculations are based are listed in Table 32 and the financial forest in Table 33.

There is 50 km approximately to reach operable area via Dungna and need to construct one wooden bridge. Further, 20km of road(estimate) has to be built within the operable

area. However, the financial forecast has been done for one plan period which may not be realistic.

This financial forecast is based on assumptions available and is only a projection of a possible cash flow scenario. **This is not a valid/legal statement and therefore should only be used as a guide.**

With the road network to the FMU area, rural allotment is expected to increase and royalty from rural timber and firewood allotment is also going to fetch good revenue to the CFO office. This has not been worked out due to unpredictability of trend in rural demand in coming years.

Table 31: Assumed figures in financial forecast for MFMU.

Assumptions	**Figures**
M^3 to cft.	35.31
Volume Recovery by NRDCL	40%
Road construction Nu./Km	2359500
Length of proposed road within the FMU (Km)	20km
Road Maintenance (Nu./Km/year)	12000
Distance to Depot (Km)	50
Cable crane (Nu./cft.)	12.82
Regeneration maintenance (For cable line) (Nu./ha)	3500
Artificial Planting	45.72ha
Plantation Cost(As per Plantation norms and standards,SFED)	Nu.50000
Inventory cost (Nu./cft)	0.08
Marking cost (Nu./cft.)	0.08
Felling and cross cutting (Nu./cft.)	2.5
Cost of constructing one wooden bridge	1000000

					2017	2018	2019	
	AAC (m^3)	**Rec. Vol (m^3)**	**Nu./cft**	**Nu./m^3**	**Nu.**	**Nu.**	**Nu.**	
Revenue:NRDCL								
Timber-Commercial	4400	1760	153.85	5432.4	9561024	9561024	9561024	
Timber-Rural	630							
Total RevenueNRDCL					9561024	9561024	9561024	
Costs: NRDCL								
Bridge Construction					1000000			
Road Construction					4719000	4719000	4719000	
Road Maintenance		12000/km				24000	48000	
Marking Cost			0.08	2.82	17084.2086	17084.2086	17084.2086	
Inventory cost			0.08	2.82	17084.2086	17084.2086	17084.2086	
Feling and Crosscutting Cost			2.5	88.28	534820.54	534820.54	534820.54	
Cable craning			12.82	452.67	2742378.974	2742378.974	2742378.974	
Transportation to Depot per Km			8.4	296.6	522016	522016	522016	
Regeneration Maintenance (Nu./ha)		Nu.3500/ha			160020	160020	160020	
Artificial Planting		Nu.50000/ha			2286000	2286000	2286000	
Plantation maintenance		Nu.4500/ha			205740	205740	205740	
Total Cost: NRDCL					11444160.54	10468160.54	10492160.54	
Total Revenue less Total Cost: NRDCL					-1883136.54	-907136.54	-931136.54	
Royalty: Commercial			15	529.65	932184	932184	932184	
Total Revenue: (Revenue less Cost less Royalty): NRDCL					-2815320.54	-1839320.54	-1863320.54	

Table 32: Financial forecast for MFMU for a period of 10 years.

2020	2021	2022	2023	2024	2025	2026	10 Yr.
Nu.	Nu.	Nu.	Nu.	Nu.	Nu.	Nu.	Total(Nu.)
9561024	9561024	9561024	9561024	9561024	9561024	9561024	95610240
9561024	9561024	9561024	9561024	9561024	9561024	9561024	**95610240**
							1000000
4719000	4719000	4719000	4719000	4719000	4719000	4719000	47190000
72000	96000	120000	144000	168000	192000	216000	1080000
17084.2086	17084.2086	17084.2086	17084.2086	17084.2086	17084.2086	17084.2086	170842.086
17084.2086	17084.2086	17084.2086	17084.2086	17084.2086	17084.2086	17084.2086	170842.086
534820.54	534820.54	534820.54	534820.54	534820.54	534820.54	534820.54	5348205.4
2742378.974	2742378.974	2742378.974	2742378.974	2742378.974	2742378.974	2742378.974	27423789.74
522016	522016	522016	522016	522016	522016	522016	5220160
160020	160020	160020	160020	160020	160020	160020	1600200
2286000	2286000	2286000	2286000	2286000	2286000	2286000	22860000
205740	205740	205740	205740	205740	205740	205740	2057400
10516160.54	10540160.54	10564160.54	10588160.54	10612160.54	10636160.54	10660160.54	**106521605.4**
-955136.54	-979136.54	-1003136.54	-1027136.54	-1051136.54	-1075136.54	-1099136.54	**-10911365.4**
932184	932184	932184	932184	932184	932184	932184	**9321840**
-1887320.54	-1911320.54	-1935320.54	-1959320.54	-1983320.54	-2007320.54	-2031320.54	**-20233205.4**

20.Research

- Research programs will be implemented in collaboration with UWICER. The FMU level Management Committee for Metap Chhu FMU will discuss, during the yearly meeting and decide what research is deemed necessary in the FMU for the coming year. Some relevant research topics as given below:
- Impact of commercial harvesting on wildlife.
- Change of forest composition in operated areas.

Human wildlife conflict due to harvesting operations.

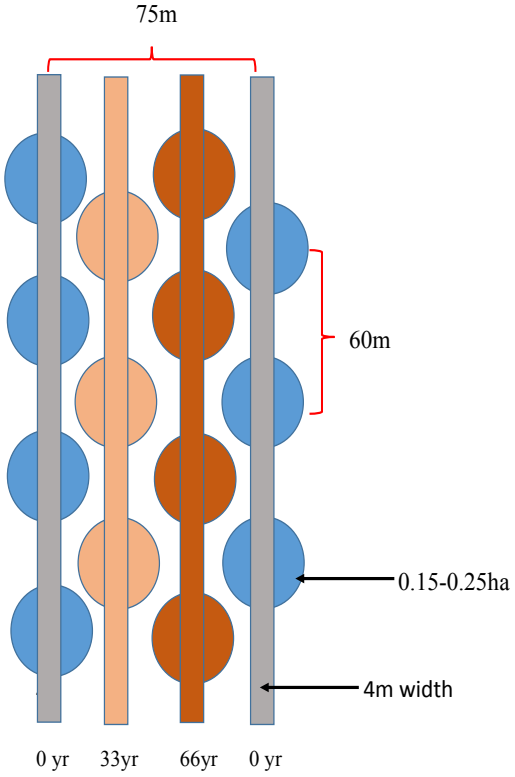
PART 3: IMPLEMENTATION OF THE PLAN

21. IMPLEMENTATION AGENCY

The Chief Forestry Officer (CFO), Gedu Territorial Forest Division, will be responsible for the implementation of this management plan, assisted by the Unit In-Charge and other support Staff.

21.1 Determination of Cutting Cycles

Absolute **minimum** of 75 m cable spacing for 0.25 ha patch clear cut should be adopted, intending two passes and assuming roughly circular patch. The rotation has been fixed at 100years; this means that the three cable lines that will be implemented are occurring at Year 0, Year 33 and Year 66. The original lines (Year 0) will therefore be harvested in Year 100. This gives adjacent areas time to regenerate so as not to cause large, open, blank areas within the forest.



Line spacing and patch clear cut size need to be carefully considered on a site-by-site

basis and provide for a specific number of subsequent passes. One prescription will not be appropriate everywhere. The layout of patch opening is a problem in diverse terrain in Bhutan. The Unit In-Charge, looking ahead and planning accordingly must therefore tailor the field to suit the terrain. Less sensitive sites with degrading and very over mature stands may require a shorter conversation period resulting in closer initial line spacing and higher removal per pass than more sensitive sites.

21.2 Annual Coupe

- The annual coupe for harvesting in the operable area must be selected based on the criteria's that include, accessibility, slope, stand condition, and environmental conditions. Coupes must comply with the following conditions:
- Based on the Silvicultural System, the annual coupe will follow the required spacing designated above, within the limits of the AAC.
- The Unit In-Charge will determine the location and extent of cable lines in the Compartment to be harvested annually, in consultation with NRDCL staff. NRDCL will then plan for harvesting operations and the location of the cable cranes, alignment of cable lines and designated log landing points. Environmentally sensitive areas designated in the forest function map will be identified, their position indicated and care taken to ensure the appropriate prescriptions/restrictions are followed.
- The Unit In-Charge will then mark the trees in the Sub-coupes as prescribed.
- Cable line layout will be based on safety, stand composition, environment and cost considerations. NRDCL will be permitted, in consultation with the Unit In-Charge, to align cable lines diagonally across contour lines in order to avoid environmentally-sensitive sites, identify stable landing points or to secure a sufficient length of cable corridor in order to put the cutting system into effect in a cost effective manner.
- The cable lines may traverse slopes greater than 100% but forest on such slopes is not to be harvested.

Because of constraints imposed by the terrain and other on-site considerations, adjacent cable lines need not be necessarily parallel to one another. The prescribed interval between the sub-coupe cable lines is considered a *minimum* value.

21.3 Health and Safety

Health and Safety of the workers has become one of the most important means to assess the quality of modern workplace. It deals with protection of workers health through control of the work environment to reduce or eliminate hazards.

In Bhutan, health and safety is not accorded its due importance due to lack of any legal labour provisions in the country. But this scenario might change in the future and employer will make the work environment much safer to eliminate huge losses through compensation.

- Harvesting and extraction activities have been identified as the areas that need to be addressed in the earnest. The safety practice has been observed poor throughout Bhutan. Following are the activities that need immediate attention:
- Chainsaw operations
- Felling
- Timber stacking in Depots

Lack of understanding of personal safety by the workers

- Some safety measures can be initiated with very little financial resources and these measures are going to make an improvement of the safety of the workers.
- Always make the workers wear tough head gear
- Ensure that the chainsaw are fully equipped with a functioning chain break
- Do not make the timber pile too high
- Train the workers

Educate the workers on their safety

It is recommended that system approach be used for identification and minimization of the work hazards because accidents arise from the interaction of the workers and their work environments, both must be carefully examined to reduce the risk of injury. Injury can result from poor working conditions, the use of improperly designed equipmentsand tools, fatigue , distraction, lack of skills and risk taking. The system approach examines the following areas: all work conditions to eliminate or control hazards, operating methods and practices, and the training of employees and supervisors. The system approach moreover demands a through investigating of all accidents and near misses. Key facts about accidentsand injuries are recorded, along with the history of the worker involved, to check and eliminate any recurring hazards.

The system approach also pays special attention to the capabilities and limitations of the working population. It recognizes large individual differences among people in their physical and psychological capabilities. The job and the workers, therefore, should be appropri-

ately matched whenever possible.

NRDCL should take the lead role in training contractors in the proper work practices with the possibility of initiating a certification system. The Department should back this and it should aim at penalizing contractors who do not abide by the set policy (Stark, 2003)

21.4 Tree Marking Rules

- In general, the following factors are to be considered when determining the spatial framework and sequential order of the patches selected for harvest;
- Patches of mature and over mature trees under which there is existing regeneration or which are most likely to regenerate successfully should be given first preferences. This would include large trees with spreading crowns, which absorbs sunlight if permitted to reach the forest floor would enhance seedling development.
- In selecting patches, ridge tops should be preferred over depression.
- In general, the size opening of 0.25ha need not be strictly adhered to and the size of the opening can vary from 0.15 to0.5 ha depending on the stand opposition and condition. However, it should be remembered that the patch opening should not be too large, as it will favour the growth of other unwanted species.
- The direction of the tree lean and topography has to be taken into account to prevent large trees being felled on nearby advanced growth.
- Dead, dying, malformed, or damaged (snags, etc.) trees will be retained in between patch clear cut opening, and in the interline spaces, to safeguard flora and fauna niches or habitats, but not in the harvested patches themselves, where there is the risk of wind throw and danger to personnel working underneath. Diseased trees 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.
- Sufficient seed trees in the interline spaces adjacent to the cable lines opened up should be retained as potential seed source for seedling regeneration in the patch cuts.

The trees selected will be marked with the authorized marking hammer close to the ground level by unit staff, and the 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, volumes at the NRDCL Depot will also be recorded.

21.5 Harvesting

In view of the generally steep terrain and the management objectives set for the Unit, the harvesting method to be used will be a skyline cable 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 buffer zones. This system has other advantages:
- Minimizes soil disturbances and initiation of soil erosion.
- Maximizes workers safety (if used correctly according to the manufacture's directions and according to the safety practices in the Code of Logging Practices).
- Avoids damage to residual reserve stands.
- Avoids disruptions to wildlife corridors.
- Minimises noise and dust pollution on any adjacent farmlands and villages.

Eliminates the need for log extraction tracks and feeder road construction.

1. Harvesting in the working circles, commercial broadleaf is to be carried out in accordance with the following prescriptions.
2. 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 landings should be identified and incorporated into the forest road design. Care should be taken to avoid locating lines in and along gullies and other protected areas. Trees to be felled will be enumerated and marked in time so as to delay harvesting operations.
3. The cable shall not exceed the prescribed width of 4m stated in the Silvicultural System for the Working Circle.
4. Trees will be felled, de-limbed, cross cut, extracted on the cable, loaded and hauled to the log depot. Only chainsaws and handsaws 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.
5. The use of axes is discouraged except in fuel wood splitting.
6. 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 logs/timber entered in the Log Yard Register will be submitted to The CFO every month. This information will be used for royalty calculation and issuance of removal

of permits. Logs will be transported by private haulage contractors and all deliveries will be made to designated depots and/or sawmills.

7. 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, Gedu.

8. The CFO and the Divisional Management, 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.

Fuelwood will be collected from harvesting residues. It is important that all lops and tops for fuelwood are collected along *entire* cable lines, not just the easily accessible areas. It is desirable that the trees to become fuelwood are extracted with the cable line and fuelwood conversion occurs at the designated log landing area.

21.6 Reforestation of Harvested Sites.

The proposed harvested area will be reforested through natural regeneration and with appropriate cost effective fencing for a period of 7 to 8 years. The natural regeneration should be supplemented by planting in areas that remain under stocked after a waiting period of 3 years.

It is recommended that regeneration surveys be conducted every three years, until the regeneration has reached a height that will ensure its survival. If the first survey (at the end of 3rd year) indicates poor stocking, remedial action must be taken in the following planting season. The FMU In-charge will ensure that stocking or regeneration is first monitored within three years following completion of the harvesting operation.

The factors that limit the success of regeneration include; grazing pressure, protracted harvesting periods and brush growth. These problems must be addressed if regeneration is to have a fighting chance. It is recommended in this plan period to adopt more tending activities, such as weeding, brushing and fencing, so that regeneration has a chance to establish. This would also reduce the cost of reforestation as clearing and replanting in failed area would cost much more than the initial tending for natural regeneration.

There is a developing understanding by territorial and NRDCL staff of the right size of openings to promote regeneration of various species. It is vital that this silvicultural knowledge is utilised and implemented. Opening that are too large or too small for the target species can again lead to excessive weed and brush growth before regeneration can be successfully established (Whitfield, 2001).

Depending upon the cattle population and site condition cost effective fencing shall be done in the regeneration area. Besides fencing, other action to protect regeneration will be carried out by NRDCL, in consultation with the FMU In-Charge and the FMU level management committee. All regeneration surveys and regeneration activities will be funded by the implementing agency-NRDCL. Budgetary requirements will be written in the operational Plan in consultation with NRDCL.

21.7 Sequence of operations relating to the annual coupe.

The operations relating to the annual coupe should follow the sequence given in Table 33.

Table 33: Sequence of operations related to the annual coupe.

Operation Description	**Timing (Months) (- before felling; + after felling)**
Unit In-charge decides on the location and size of annual coupe in accordance with the Annual Operational Plan.	-12
NRDCL and FMU IC prepares an estimate of human, material, equipment and financial resources required.	-10
Unit In-Charge finalises the annual coupe size, demarcates the coupe and instructs NRDCL to carry our pre-logging planning	16
NRDCL prepares cable line layout and alignment plan, as well as 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 skyline installation and installs the skyline and cable crane.	-1
NRDCL commences systematic harvesting and extraction operations according to the approved sequence in the Annual Operational Plan.	0
NRDCL/Contractor completes harvesting and extraction	When completed
The FMU In-Charge will inspect the coupes when harvesting is completed and will issue a Coupe Clearance Certificate – only if all aspects of the operation are satisfactory and all timber is removed from the annual coupe.	When works completed
DoFPS assess success of natural regeneration	As per guidelines
NRDCL completes post-harvesting operations	As per FMU IC instructions

21.8 Road Construction

Forest roads, despite its negative impacts on forests and local environment, still forms an essential part of managed forest estate, both for timber transportation and to provide access for forest management and monitoring. Road construction in the FMU requires extra precautions to achieve environmental conservation. The basic necessity in forest road con-

struction 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 drainage structures, to have an efficiently drained compact road surface.

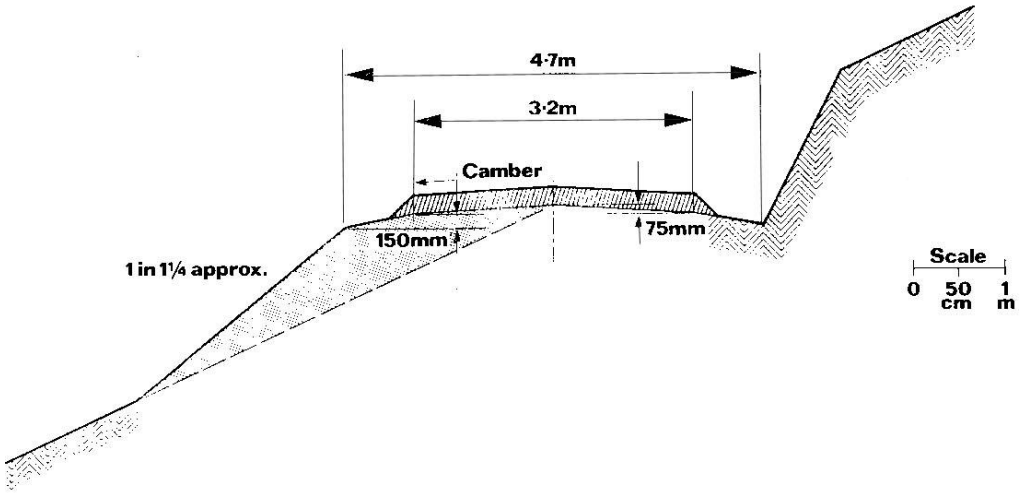
Road survey, design and construction will be carried out by NRDCL. The road is to be located by marking a grade-line on the ground. This grade-line is then used as a basis for the road design, which will vary with the location of the road as necessary to meet the standards mentioned below in terms of bend radius, proportion of cut/fill for various slopes, etc. NRDCL will mark the design centreline in the field so that contractor compliance to it can be monitored effectively. The road design should be part of the contract document.

Road standards

A set of road standards has been developed by the Forest Engineers of Third Forestry Development Project(TFDP). These road standards, although developed in the east, address policies that are required throughout Bhutan. These standards will be adopted for the Metap Chhu FMU and NRDCL road engineers must follow these standards, given as **Annexe 2** during designing and estimation and provide supervision during construction to ensure that the standards are met.

The impact management recommendations from NEC(1999), Forestry; Bhutanese environment assessment sectoral guidelines must be also referred to, wherein general principles and practices to minimize negative economic and environmental impacts of road access are cited.

Road design in MFMU should follow the recommended road profile in the following Figure to avoid excessive water pooling leading to rutted road surfaces that inhibit access during monsoon season. Improper drainage may also lead to landslides. Following recommended road design would decrease maintenance costs for the future.



Recommended road profile

22. PLANNING

22.1 Operational Plan

Operational plans will be prepared by the CFO, Gedu and the Unit In-Charge to facilitate the timely implementation of this management plan. Operational Plan will be prepared annually (for a two-year rolling period). Assistance in preparation of the Operational Plan can be provided by other parties e.g. NRDCL and technical assistance and back-stopping will be provided by FRMD. The primary aim in preparing Operational Plan is to determine and Co-ordinate the timely input of resources to put the overall Plan into effect in a cost-effective manner and according to the objectives.

The Operational Plan is also the tool used to provide for changes that cannot be foreseen or allowed in the Management Plan, such as insect and disease outbreaks, severe fire etc. If and when these occur, the current Operational Plan should be immediately reviewed and methods of operation modified to deal most effectively with possible changes in the sustainable level of harvest.

The rolling Operational Plan will include detail of activities for the coming year (Year 1) and an outline of activities for the following year (Year 2). Guidelines for operational Planning have been prepared by FRMD and are available in all Territorial Divisions and UIC offices. The guidelines is user-friendly and contains detailed process for preparing and implementing the Operational Plan, FRMD will continue to update the changes.

Year 1	2	3	4	5	6	...

Detailed outline	Detailed outline	Detailed outline	Etc.
	Detailed Outline	Detailed outline	Detailed Outline

Concept of Rolling Plan.

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

The process for preparing and implementing the Operational Plan is laid out in Table below:

Table 34: Operational Planning Process.

Activity (Planning Step)	Objective	Output	Responsibility(Lead)	Comments
Approved FMP				
PRAs with Local stakeholders	To prepare participatory plans for fire management; grazing control and rural timber. To involve relevant stakeholders in planning for activities which have a direct impact in their "interest".	Participatory plan for grazing management; fire management or rural timber harvesting (to be incorporated within the OP).	DoFPs and FMU In-charge	First step is to enter into discussions with stakeholders and their representatives. Use PRA techniques to prepare a plan. Plan costs are included in the OP.
Operational inventory	To assess the resource availability for the planned harvesting area.	Site-level inventory data for operational area to be harvested. Précise estimate of volume to be removed during the coming year.	FMU In-charge NRDCL	For the areas proposed for harvesting during the next 2 years. May be combined with harvesting plan and cable line survey.
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 May be combined with Operational inventory.

Preparation of Operational Plan	To prepare a cost plan for implementation during the next 2 years (involving stakeholders participation for some activities). To formalise local institutional responsibility for planned activities (e.g. grazing , fire management, rural timber distribution)	Approved operational plan with budget. Identified responsibilities for each planned activity Calculated costs for each planned activities.	FMU In-charge with local stakeholders as required	Activities linked with objectives identified in the FMP and following options and guidelines in the FMP. Each activity with identified responsibility for implementation, estimated cost, and site-specific locations. OP prepared according to standard format

Activity (Planning Step)	**Objective**	**Output**	**Responsibility(Lead)**	**Comments**
FMU annual report presented to the FMU management committee	To review progress and identify and address any implementation problems To identify any future actions necessary based on issue arising.	FMU Annual report endorsed by FMU management committee.	FMU manager presents to the FMU management Committee	During FMU management committee annual meeting Implementation problems need to be addressed before endorsing the new OP.
OP reviewed by FMU committee and endorsed	For the FMU management committee to endorse the OP (Prior to approval by DoFPs) To endorse expenditure estimates for the coming financial year	OP endorsed by FMU management committee	FMU manager presents to the FMU management committee	During FMU management committee annual meeting
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 management committee	FMU management committee	Meeting needs to take place at earliest to ensure that budget requirement can be included in the NRDCL AOP for the next financial year
OP approved by Director, DoFPs	To approve the OP for implementation	Approved plan and budget	Approval by NRDCL and Director, DoFPs.	OP approval linked with sanctioned budget for all planned activities.

Activity (Planning Step)	Objective	Output	Responsibility(Lead)	Comments
OP implementation by NRDCL	To carry out planned activities	Harvested timber; protected are; roads; fuelwood etc	According to responsibilities identified in the operational plan e.g. FMU In-charge NRDCL etc.	Each activity with a specific responsibility and budget
Monitoring of activities	To assess the level of achievement of planned activities	Information for FMU annual report	FMU In-charge	DoFPs responsibility is to monitor the implementation of activities carried out by NRDCL
DoFPs Unit In-charge prepares FMU annual report	To report progress against planned activities To highlight any problems being encountered in implementation	FMU annual report	FMU In-charge	Prepared annually Progress is reported against each FMP objectives and the associated activities
Prepare the next years operational plan	To prepare the next operational plan taking into account progress over the past year	Operational plan	FMU In-charge	Operational plan may alter in response to FMU management committee suggestions.

22.2 FMU Level Management Committee

For the smooth implementation of the plan, an FMU-Level Management Committee has been established. The committee consists of following members:

- CFO, Gedu, Chairman
- FMU Unit In-Charge, Gedu Territorial Forest Division.
- Regional Manager,NRDCL, Phuntsholing
- Forest Range Officer, Gedu and Tshimasham Range.
- Unit Incharge,NRDCL,Gedu.
- Gup, Metakhaand Gelling Geog, Chhukha Dzongkhag.

FMU-Level management committee; terms of reference

A. During FMP preparation

- To represent the interest of identified stakeholder groups during the planning and process for FMP preparation.
- To discuss and agree on FMU forest management objectives for different parts of the forest (zones and working circles), based on national priorities and combined with specific local conditions and local 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 and ensure that their interests are effectively accommodated in the final version of the management plan.
- To review and endorse the draft forest management plan before it is presented to Director General, DoFPs and Ministry of Agriculture and Forests.

B. During operational planning, implementation and monitoring

- To represent the interests of all the identified stakeholder groups during annual planning and review of activities under Ops.
- To review achievements during the previous year (based on an FMU) annual report submitted by the FMU In-Charge) and advise and act on any issues identified in this report.
- To make recommendations for changes to the proposed OP for the coming year based on the previous year's experience and on the need to achieve the agreed objectives in the FMP.
- To endorse activities, priorities and funding arrangements within the draft OP before submission to the Director General. DoFPS.

- To participate in the 5-year mid-term evaluation of the FMP.
- To hold any additional meetings as required in response to specific issues arising from FMP and OP implementation.
- To participate in the final (10-year) EVALUATION of the FMP.

This will require at least one annual meeting of the FMU-level management committee during each year of FMP implementation with the possibility of further meetings to address any urgent matters. Meetings need to be timed to ensure consistency with the annual planning cycle and financial year.

22.3 Staff

The Chief Forestry Officer, Gedu Division is the overall controlling officer. The FMU Unit In-Charge will have direct responsibility in control and management of the FMU. The UIC office will be under the administrative control of the CFO, Gedu Division. The CFO is the direct representative of the Department and as such he/she is solely responsible for all forestry activities, both technical and administrative, in his jurisdiction.

22.4 Responsibility

Following staffs have to be appointed immediately for the smooth implementation of the Management Plan.

Unit In-Charge	1
Deputy Ranger	1
Foresters	3

22.5 Buildings

A unit office for the Unit In-charge, DoFPS and unit Manager, NRDCL will have to be constructed in future. Until then, Unit In-charge can utilize Gewog Forest Office as his/her office. Further, a check post will have to be constructed either at Mailum Chhu or at Omchu Village(South-East of FMU boundary).

Establishment of NRDCL Depot is recommended either at Dungna or Chongaykha area since these two areas are along the access road of FMU and also the distance to FMU and market is found optimal.

22.6 Vehicle and Equipments

There is a requirement of at least on motorcycle or a 4-wheel vehicle for the unit for day-to-day implementation of the forestry activities and to liaise with the divisional headquarters. The following equipments are necessary for the staff to carry out the work efficiently,

Suunto clinometers	2nos.
Suunto Compass	2nos.

Diameter Tapes	3nos.
Distance measuring tapes	3nos.
Computer	2 set
Bark Gauge	2nos.
Walkie-talkie set	3-4 nos.

23. MONITORING AND EVALUTION

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 FMU, 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, and the second stage checks that the objectives of the plan are being achieved over the longer term. Monitoring (checking on inputs on a year to year basis) is the term used for the first stage and evaluation (Checking achievements against objectives over five year periods) is the second stage.

The third forestry development project (TFDP), working closely with the FRMD developed a new monitoring and evaluation process in 1999, for use on FMUs in Bhutan. Different forms were developed on different time scales; **Monitoring Form A** for the annual monitoring process, **Evaluation Form A** for the five year evaluation, and **Evaluation Form B** for the once only Evaluation. The field data collection forms used, consists of **physical and Financial Forms 1-3**, **Environmental Forms 4-11** and the **Physical, Financial and Environmental Summary Form.**

The necessary Monitoring and Evaluation Forms will be available with CFO Gedu or at FRMD.

23.1 Record Keeping

The records should be kept by blocks and compartments. This would ensure that each activity that occurs is recorded in an easy to find format. Totals of the AAC allotment would then be submitted monthly to the CFO-as is already required.

It is essential that all records of activities and operations within the FMU be maintained so that analysis and investigation of past management can be carried out and AAC allotments can be followed. Although record keeping may not seem as important as some management activities, it is the backbone of future management decisions and the importance must be stressed.

The guidelines to complete and fill the forms; one for Rural Allotment, one for Commercial Allotment and one for Stand Tending and Regeneration activities are available in all Territorial Divisions and UIC offices.

It is also important to record ***all activities*** for future management and monitoring and evaluation.

23.2 Mid-term Review of the FMU Plan.

The head, FRMD, will ensure that the plan is reviewed five years after implementation. The review should be preceded by an Evaluation.

The Mid-term review will be discussed with the FMU Level Management Committee.

23.3 MONITORING

Monitoring is the examination of whether inputs, activities and outputs are successfully supplied according to the planned schedule. The CFO Gedu will ensure that monitoring is carried out on an annual basis as per the guidelines issued by FRMD. In the context of FMU implementation, *inputs* includes machinery availability and staff skills and availability, while *outputs* include operational plan competition, road construction, production of forests produce.

It is essential that monitoring forms are recorded regularly and are handed over for review. The plan must be monitored to obtain the best practice of forest management.

23.4 EVALUATION

Evaluation is the examination of whether objectives are being achieved. In the context of FMU evaluation, sufficient time has to elapse before a realistic assessment can be made of progress towards fulfilling objectives (Incoll 1999). Evaluation must be carried out at five-year intervals, 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 obtained from FRMD.

Corrective action, if it is necessary, may require changes to a range of inputs or to implementation methodology. Staff those are independent of field activities will carry out the evaluation.

The Director, DoFPS, will appoint the Evaluation Team.

24. CONSTRAINTS AND RISKS

The possible risks and constraints in smooth implementation of the management plan are

- Inadequate fund for implementation of the plan.
- Uncertainty of natural regeneration, due to grazing, and undergrowth competition.
- Lack of research information.
- Lack of skilled and trained forest workers.
- Lack of sufficient support staff to the UIC.

25. DEVIATION FROM PLAN PRESCRIPTION.

The AAC shall be allowed to deviate for +/- 10% during any one year and the excess or deficit will have to be adjusted during the subsequent years so that there will not be any excess or deficit from the prescribed cut during the plan period of 10years. **However, the total volume harvested over successive five year periods must be no more than five times the AAC volume.**

Unforeseen circumstances may warrant deviations from plan prescriptions and in such an event the CFO, Gedu, must obtain prior written approval from the Head of 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.

26. REFERENCES

TSHERING, KAKA(2007), Forest Managemtn Plan for Metap Chhu FMU,FRDD, Department of Forest and Park Services,MoAF.

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PRAKASH, RAM and KHANNA, L.S (1991), Theory and Practices of Silvicultural Systems, International Book Distributors, Dehradun.

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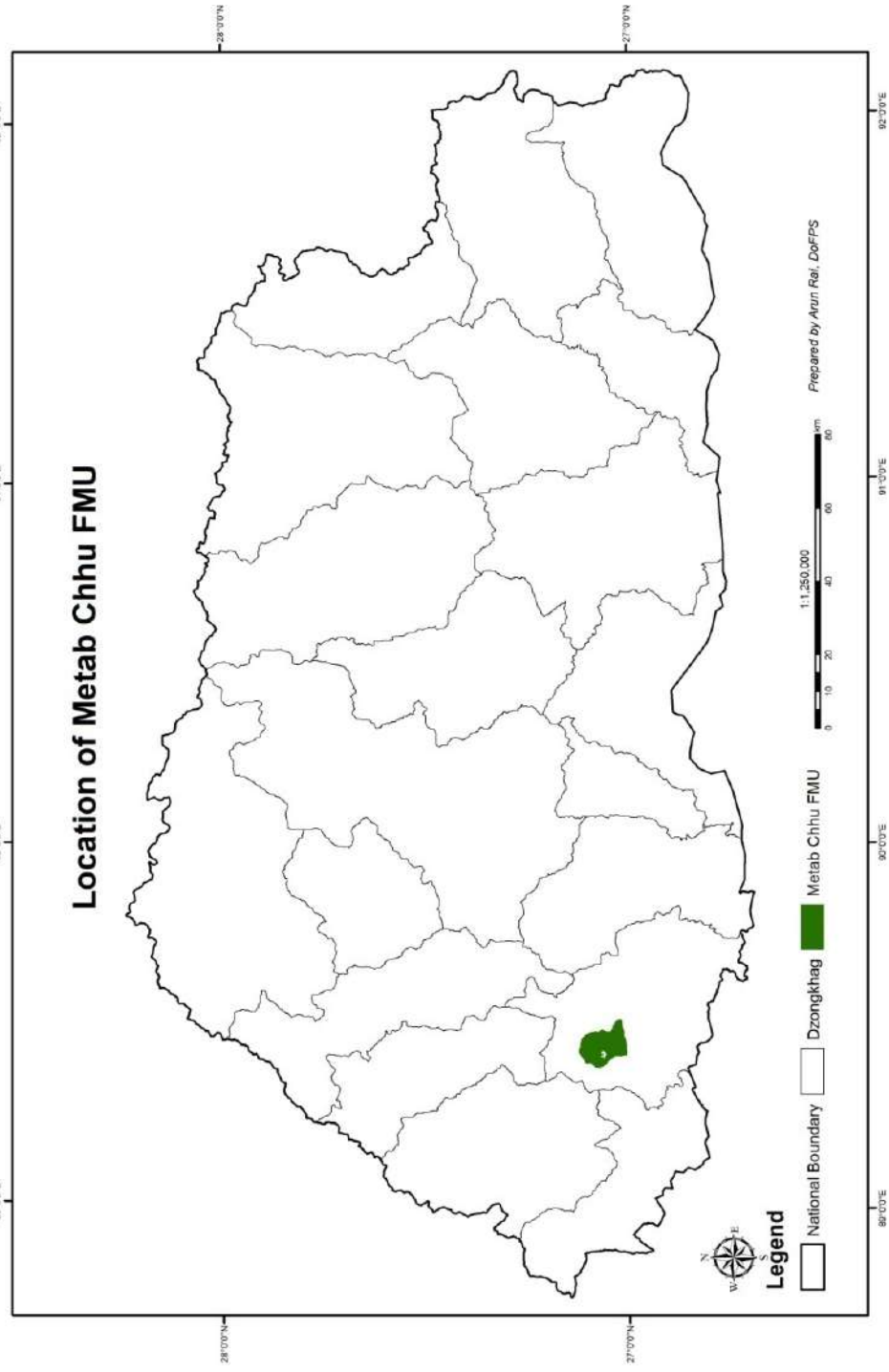
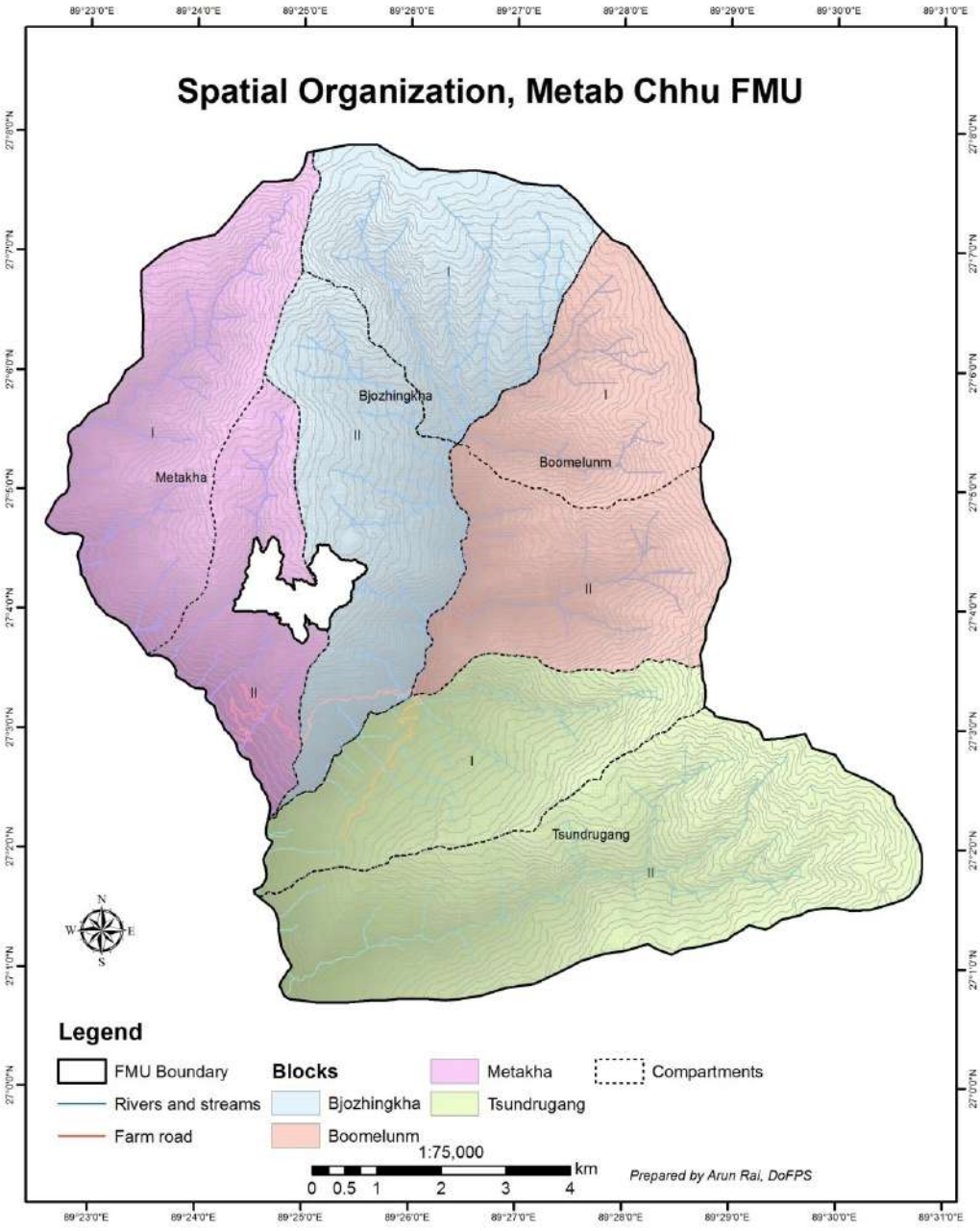
ANNEXURE 1:Maps of Metap Chhu Forest Management Unit

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89°29'0"E
89°30'0"E
89°31'0"E
27°8'0"N
27°7'0"N
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27°4'0"N
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27°2'0"N
27°1'0"N
27°0'0"N
Bjozhingkha
Metakha
Boomelunm
Tsundrugang
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Legend
FMU Boundary
Rivers and streams
Farm road
Blocks
Bjozhingkha
Boomelunm
Metakha
Tsundrugang
Compartments
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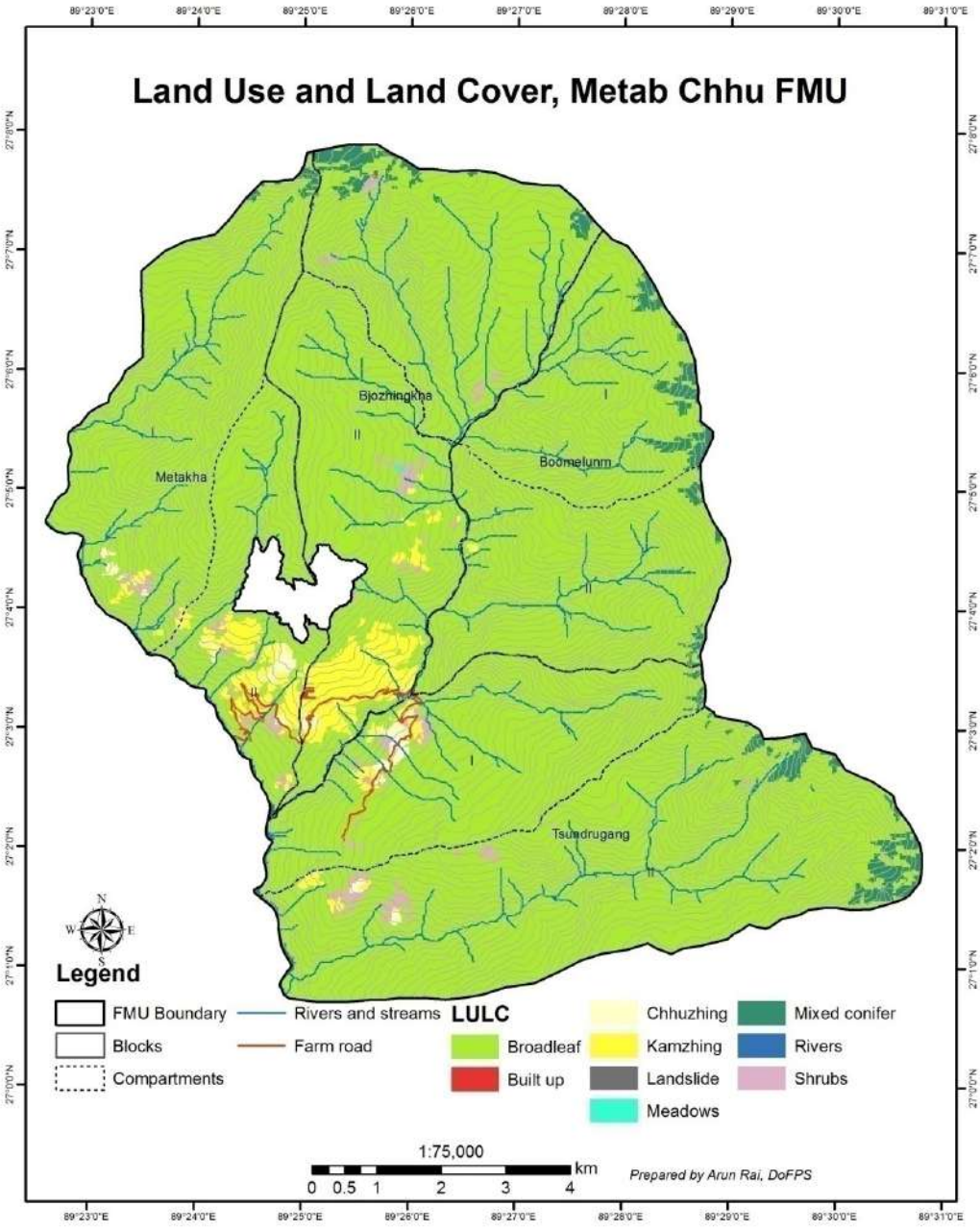
km
Prepared by Arun Rai, DoFPS


Land Use and Land Cover, Metab Chhu FMU
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89°30'0"E
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FMU Boundary
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Compartments
Rivers and streams
Farm road
LULC
Broadleaf
Built up
Chhuzhing
Kamzhing
Landslide
Meadows
Mixed conifer
Rivers
Shrubs
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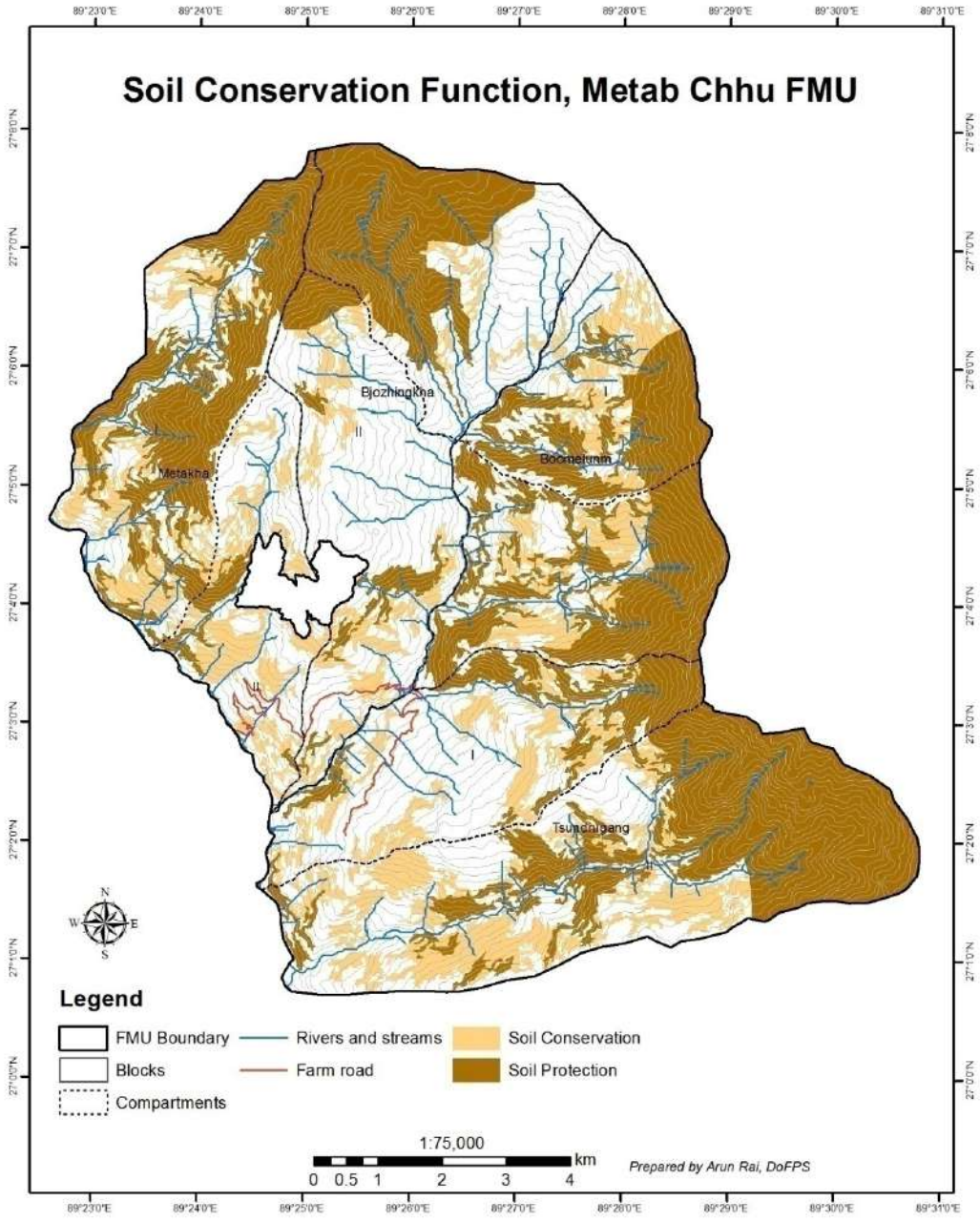
Prepared by Arun Rai, DoFPS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Boomeytnim
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FMU Boundary
Blocks
Compartments
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Farm road
Soil Conservation
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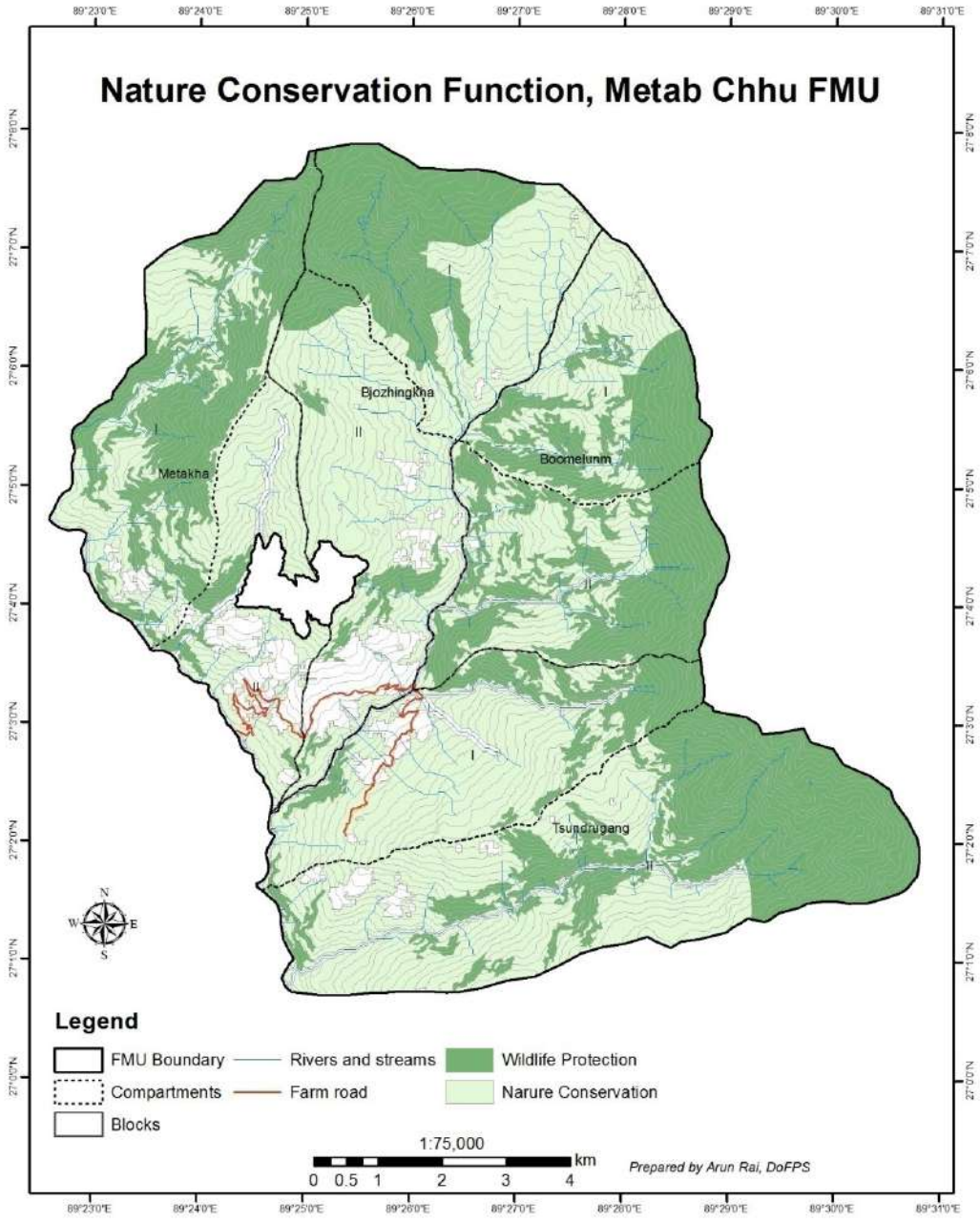
Prepared by Arun Rai, DoFPS


Nature Conservation Function, Metab Chhu FMU
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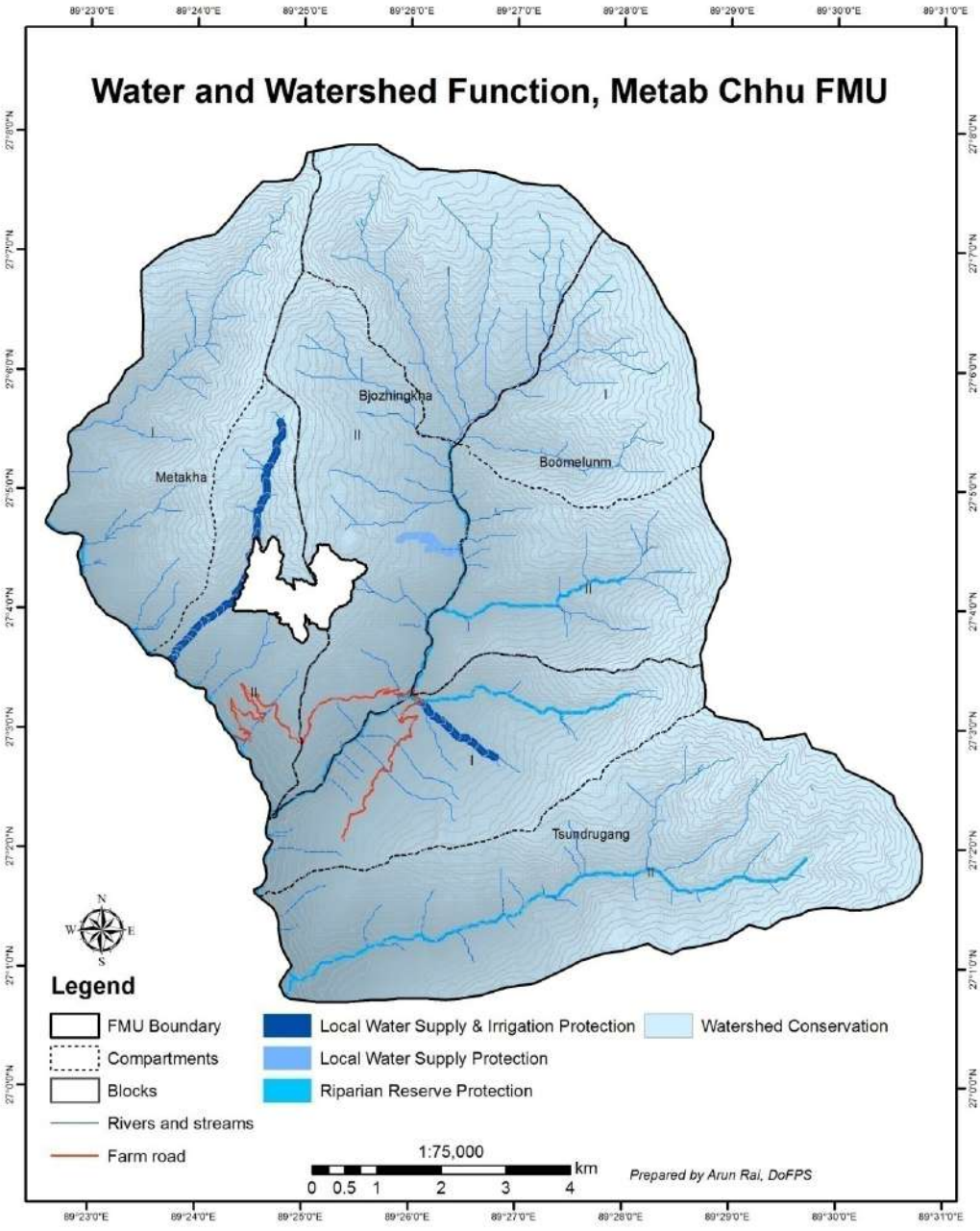
Prepared by Arun Rai, DoFPS


Water and Watershed Function, Metab Chhu FMU
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Rivers and streams
Farm road
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Riparian Reserve Protection
Watershed Conservation
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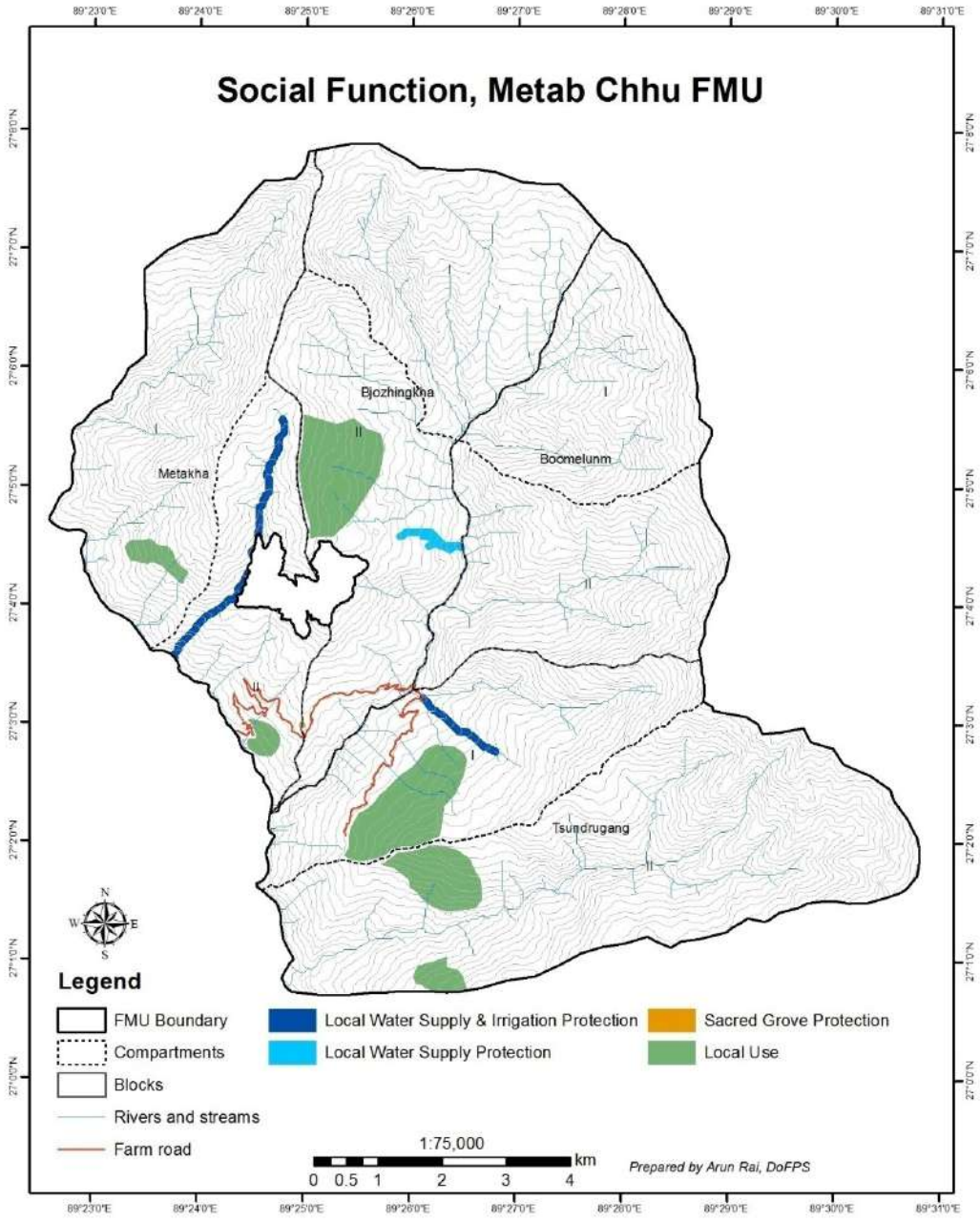
km
Prepared by Arun Rai, DoFPS


Social Function, Metab Chhu FMU
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FMU Boundary
Compartments
Blocks
Rivers and streams
Farm road
Local Water Supply & Irrigation Protection
Local Water Supply Protection
Sacred Grove Protection
Local Use
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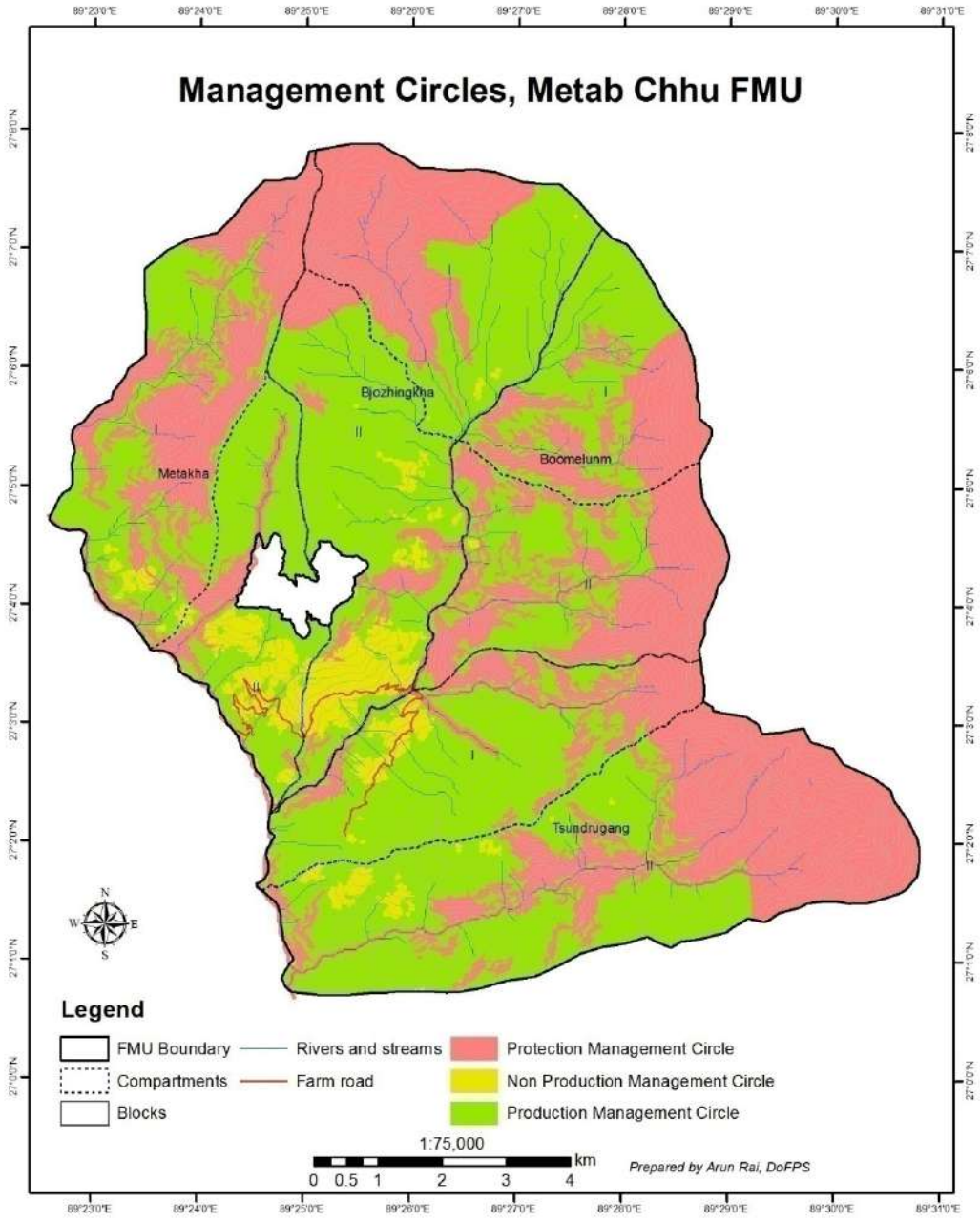
km
Prepared by Arun Rai, DoFPS


Management Circles, Metab Chhu FMU
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27°3'0"N
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27°0'0"N
Bjozhingkha
Boomelunm
Metakha
Tsundrugang
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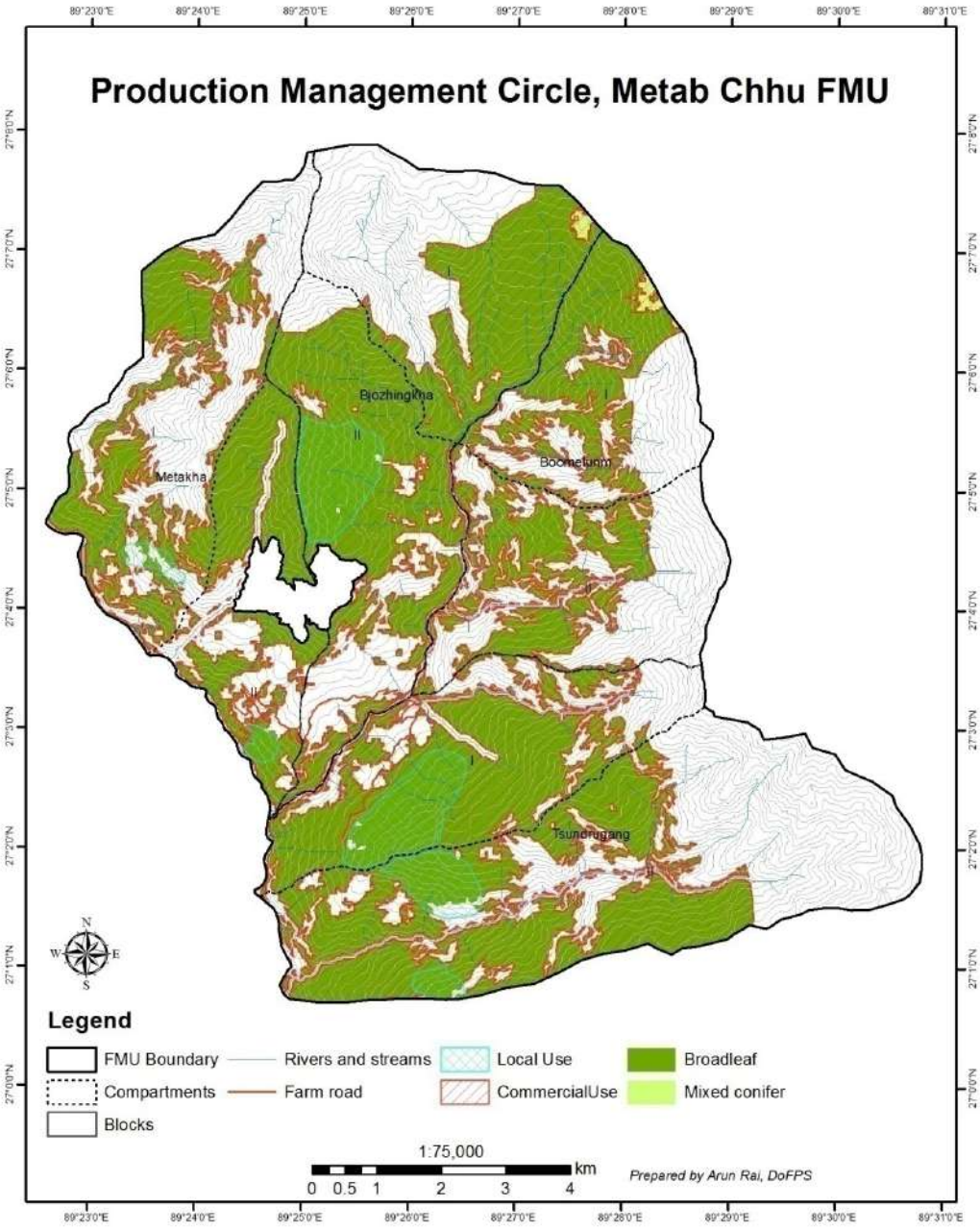
Legend
FMU Boundary
Compartments
Blocks
Rivers and streams
Farm road
Protection Management Circle
Non Production Management Circle
Production Management Circle
1:75,000
0 0.5 1 2 3 4
km
Prepared by Arun Rai, DoFPS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27°7'0"N
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Metakha
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FMU Boundary
Compartments
Blocks
Rivers and streams
Farm road
Local Use
CommercialUse
Broadleaf
Mixed conifer
1:75,000
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km
Prepared by Arun Rai, DoFPS

FMU Roads.

ANNEXURE 2: Forest Inventory Result of Metap Chhu FMU

Main Table 1. Survivor Trees >= 10 cm Dbh: Average Number of Trees per Ha.

Inventory Unit	: Metapchu	Number of Strata	:	1
Stratum	: Mixed B/L limited production	Number of Sampling Units	:	87
Area (ha)	: 3769.8	Estimate of Total	:	109.655
Period	: 03/12/98 to 14/05/06	t (0.975, 86)	:	1.988
		Sampling Error% for Estimate (at P=0.95)	:	17.50
Tree Status	: Survivor			
Timber Quality	: All (Dbh 10+ cm)			

Estimated Parameter : AVERAGE NUMBER OF TREES PER HA (/ha)

Species Group	Dbh class (cm) 10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	-109	-119	120+	total	%
Acer	1.15	0.69	1.38	1.84	0.46	1.84	1.15	0.23	0.00	0.23	0.00	0.00	8.97	8.18
Quercus	0.23	0.46	0.00	0.46	0.69	0.46	1.15	0.92	0.00	0.00	0.00	0.00	4.37	3.98
Castanopsis	0.92	1.38	0.69	0.69	0.69	0.23	0.00	0.46	0.23	0.00	0.00	0.00	5.29	4.82
Alnus nepalensis	0.00	0.23	0.92	0.69	0.46	0.69	0.00	0.00	0.00	0.00	0.00	0.23	3.22	2.94
Champ	0.00	0.00	0.00	0.23	0.46	0.23	0.23	0.23	0.00	0.00	0.00	0.00	1.38	1.26
Schima	0.23	0.00	0.69	0.23	0.23	0.69	0.00	0.00	0.00	0.00	0.00	0.00	2.07	1.89
Cinnamomum	0.46	0.69	0.92	1.61	1.15	0.46	0.00	0.00	0.00	0.00	0.00	0.00	5.29	4.82
Terminalia	0.00	0.00	0.23	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.46	0.42
Walnut	0.00	0.00	0.46	0.69	0.23	0.46	0.46	0.00	0.23	0.00	0.00	0.00	2.53	2.31
Others Brdl	20.46	16.32	14.02	11.95	4.14	4.83	2.53	1.15	0.69	0.00	0.00	0.00	76.09	69.39
total broadl.	23.45	19.77	19.31	18.62	8.51	9.89	5.52	2.99	1.15	0.23	0.00	0.23	109.66	100.00
total	23.45	19.77	19.31	18.62	8.51	9.89	5.52	2.99	1.15	0.23	0.00	0.23	109.66	100.00
%	21.38	18.03	17.61	16.98	7.76	9.01	5.03	2.73	1.05	0.21	0.00	0.21	100.00	

Inventory Unit : Metapchu
Stratum : Mixed B/L Local use production
Area (ha) : 849.4
Period : 04/01/98 to 06/05/06

Tree Status : Survivor
Timber Quality : All (Dbh 10+ cm)

Number of Strata : 1
Number of Sampling Units : 23
Estimate of Total : 93.913
t (0.975, 22) : 2.075
Sampling Error% for Estimate (at P=0.95) : 30.73

Estimated Parameter : AVERAGE NUMBER OF TREES PER HA (/ha)

	Dbh class (cm)													
Species Group	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	-109	-119	120+	total	%
Acer	0.00	0.00	0.00	1.74	0.87	0.00	0.87	0.00	0.00	0.00	0.00	0.00	3.48	3.70
Quercus	0.00	0.00	0.00	0.87	0.00	0.87	0.00	0.00	0.00	0.00	0.00	0.00	1.74	1.85
Castanopsis	7.83	0.00	1.74	0.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.43	11.11
Alnus nepalensis	0.00	2.61	0.00	1.74	1.74	0.00	0.87	0.00	0.00	0.00	0.00	0.00	6.96	7.41
Champ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Schima	0.87	0.00	0.87	0.87	0.87	2.61	0.00	0.00	0.00	0.00	0.00	0.00	6.09	6.48
Cinnamomum	0.00	0.00	1.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.74	1.85
Terminalia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Walnut	0.00	0.00	0.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.87	0.93
Others Brdl	16.52	13.91	13.91	8.70	5.22	2.61	0.87	0.87	0.00	0.00	0.00	0.00	62.61	66.67
total broadl.	25.22	16.52	19.13	14.78	8.70	6.09	2.61	0.87	0.00	0.00	0.00	0.00	93.91	100.0
total	25.22	16.52	19.13	14.78	8.70	6.09	2.61	0.87	0.00	0.00	0.00	0.00	93.91	100.00
%	26.85	17.59	20.37	15.74	9.26	6.48	2.78	0.93	0.00	0.00	0.00	0.00	100.00	

Inventory Unit : Metapchu
Stratum : Mixed B/L Local use production
Area (ha) : 849.4
Period : 04/01/98 to 06/05/06

Tree Status : Survivor
Timber Quality : All (Dbh 10+ cm)

Number of Strata : 1
Number of Sampling Units : 23
Estimate of Total : 93.913
t (0.975, 22) : 2.075
Sampling Error% for Estimate (at P=0.95) : 30.73

Estimated Parameter : AVERAGE NUMBER OF TREES PER HA (/ha)

Species Group	Dbh class (cm) 10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	-109	-119	120+	total	%
Acer	0.00	0.00	0.00	1.74	0.87	0.00	0.87	0.00	0.00	0.00	0.00	0.00	3.48	3.70
Quercus	0.00	0.00	0.00	0.87	0.00	0.87	0.00	0.00	0.00	0.00	0.00	0.00	1.74	1.85
Castanopsis	7.83	0.00	1.74	0.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.43	11.11
Alnus nepalensis	0.00	2.61	0.00	1.74	1.74	0.00	0.87	0.00	0.00	0.00	0.00	0.00	6.96	7.41
Champ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Schima	0.87	0.00	0.87	0.87	0.87	2.61	0.00	0.00	0.00	0.00	0.00	0.00	6.09	6.48
Cinnamomum	0.00	0.00	1.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.74	1.85
Terminalia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Walnut	0.00	0.00	0.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.87	0.93
Others Brdl	16.52	13.91	13.91	8.70	5.22	2.61	0.87	0.87	0.00	0.00	0.00	0.00	62.61	66.67
total broadl.	25.22	16.52	19.13	14.78	8.70	6.09	2.61	0.87	0.00	0.00	0.00	0.00	93.91	100.0
total	25.22	16.52	19.13	14.78	8.70	6.09	2.61	0.87	0.00	0.00	0.00	0.00	93.91	100.00
%	26.85	17.59	20.37	15.74	9.26	6.48	2.78	0.93	0.00	0.00	0.00	0.00	100.00	

Inventory Unit : Metapchu
Stratum : Combined
Area (ha) : 4619.2
Period : 04/01/98 to 14/05/06

Tree Status : Survivor
Timber Quality : All (Dbh 10+ cm)

Number of Strata : 2
Number of Sampling Units : 110
Estimate of Total : 106.760
t (0.975, 108) : 1.983
Sampling Error% for Estimate (at P=0.95) : 15.38

Estimated Parameter : AVERAGE NUMBER OF TREES PER HA (/ha)

Species Group	Dbh class (cm) 10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	-109	-119	120+	total	%
Acer	0.94	0.56	1.13	1.82	0.54	1.50	1.10	0.19	0.00	0.19	0.00	0.00	7.96	7.45
Quercus	0.19	0.38	0.00	0.54	0.56	0.54	0.94	0.75	0.00	0.00	0.00	0.00	3.88	3.64
Castanopsis	2.19	1.13	0.88	0.72	0.56	0.19	0.00	0.38	0.19	0.00	0.00	0.00	6.23	5.84
Alnus nepalensis	0.00	0.67	0.75	0.88	0.70	0.56	0.16	0.00	0.00	0.00	0.00	0.19	3.91	3.66
Champ	0.00	0.00	0.00	0.19	0.38	0.19	0.19	0.19	0.00	0.00	0.00	0.00	1.13	1.05
Schima	0.35	0.00	0.72	0.35	0.35	1.04	0.00	0.00	0.00	0.00	0.00	0.00	2.81	2.63
Cinnamomum	0.38	0.56	1.07	1.31	0.94	0.38	0.00	0.00	0.00	0.00	0.00	0.00	4.63	4.34
Terminalia	0.00	0.00	0.19	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.38	0.35
Walnut	0.00	0.00	0.54	0.56	0.19	0.38	0.38	0.00	0.19	0.00	0.00	0.00	2.22	2.08
Others Brdl	19.74	15.88	14.00	11.35	4.34	4.42	2.22	1.10	0.56	0.00	0.00	0.00	73.61	68.95
total broadl.	23.77	19.17	19.28	17.91	8.54	9.19	4.98	2.60	0.94	0.19	0.00	0.19	106.76	100.00
total	23.77	19.17	19.28	17.91	8.54	9.19	4.98	2.60	0.94	0.19	0.00	0.19	106.76	100.00
%	22.27	17.96	18.06	16.78	8.00	8.60	4.67	2.43	0.88	0.18	0.00	0.18	100.00	

Main Table 2. Mortality Trees, Salvageable, Lying >= 10 cm Dbh: Average Number of Trees per Ha.

Inventory Unit	: Metapchu	Number of Strata	: 1
Stratum	: Mixed B/L limited production	Number of Sampling Units	: 87
Area (ha)	: 3769.8	Estimate of Total	: 0.690
Period	: 03/12/98 to 14/05/06	t (0.975, 86)	: 1.988
		Sampling Error% for Estimate (at P=0.95)	: 113.40
Tree Status	: Salvageable Dead, Lying		
Timber Quality	: All (Dbh 10+ cm)		

Estimated Parameter : AVERAGE NUMBER OF TREES PER HA (/ha)

	Dbh class (cm)													
Species Group	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	-109	-119	120+	total	%
Acer	0.00	0.00	0.00	0.00	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	33.33
Quercus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Castanopsis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Alnus nepalensis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Champ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Schima	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cinnamomum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Terminalia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Walnut	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Others Brdl	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.00	0.00	0.00	0.23	0.46	66.67
total broadl.	0.00	0.00	0.00	0.00	0.23	0.00	0.00	0.23	0.00	0.00	0.00	0.23	0.69	100.00
total	0.00	0.00	0.00	0.00	0.23	0.00	0.00	0.23	0.00	0.00	0.00	0.23	0.69	100.00
%	0.00	0.00	0.00	0.00	33.33	0.00	0.00	33.33	0.00	0.00	0.00	33.33	100.00	

Inventory Unit : Metapchu
Stratum : Mixed B/L Local use production
Area (ha) : 849.4
Period : 04/01/98 to 06/05/06

Tree Status : Salvageable Dead, Lying
Timber Quality : All (Dbh 10+ cm)

Number of Strata : 1
Number of Sampling Units : 23
Estimate of Total : 0.000
t (0.975, 22) : 2.075
Sampling Error% for Estimate (at P=0.95) : 0.00

Estimated Parameter : AVERAGE NUMBER OF TREES PER HA (/ha)

	Dbh class (cm)													
Species Group	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	-109	-119	120+	total	%
Acer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Quercus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Castanopsis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Alnus nepalensis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Champ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Schima	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cinnamomum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Terminalia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Walnut	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Others Brdl	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
total broadl.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	

Inventory Unit : Metapchu
Stratum : Combined
Area (ha) : 4619.2
Period : 04/01/98 to 14/05/06

Tree Status : Salvageable Dead, Lying
Timber Quality : All (Dbh 10+ cm)

Number of Strata : 2
Number of Sampling Units : 110
Estimate of Total : 0.563
t (0.975, 108) : 1.983
Sampling Error% for Estimate (at P=0.95) : 113.12

Estimated Parameter : AVERAGE NUMBER OF TREES PER HA (/ha)

	Dbh class (cm)													
Species Group	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	-109	-119	120+	total	%
Acer	0.00	0.00	0.00	0.00	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	33.33
Quercus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Castanopsis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Alnus nepalensis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Champ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Schima	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cinnamomum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Terminalia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Walnut	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Others Brdl	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.00	0.00	0.00	0.19	0.38	66.67
total broadl.	0.00	0.00	0.00	0.00	0.19	0.00	0.00	0.19	0.00	0.00	0.00	0.19	0.56	100.00
total	0.00	0.00	0.00	0.00	0.19	0.00	0.00	0.19	0.00	0.00	0.00	0.19	0.56	100.00
%	0.00	0.00	0.00	0.00	33.33	0.00	0.00	33.33	0.00	0.00	0.00	33.33	100.00	

Main Table 3. Survivor Trees >= 10 cm Dbh: Average Basal Area per Ha.

Inventory Unit	: Metapchu	Number of Strata	: 1
Stratum	: Mixed B/L limited production	Number of Sampling Units	: 87
Area (ha)	: 3769.8	Estimate of Total	: 16.232
Period	: 03/12/98 to 14/05/06	t (0.975, 86)	: 1.988
		Sampling Error% for Estimate (at P=0.95)	: 15.44
Tree Status	: Survivor		
Timber Quality	: All (Dbh 10+ cm)		

Estimated Parameter : AVERAGE BASAL AREA PER HA (m^2/ha)

	Dbh class (cm)													
Species Group	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	-109	-119	120+	total	%
Acer	0.02	0.03	0.14	0.30	0.11	0.58	0.47	0.13	0.00	0.18	0.00	0.00	1.95	12.03
Quercus	0.01	0.02	0.00	0.08	0.15	0.15	0.49	0.49	0.00	0.00	0.00	0.00	1.39	8.54
Castanopsis	0.02	0.07	0.06	0.10	0.16	0.07	0.00	0.27	0.16	0.00	0.00	0.00	0.90	5.55
Alnus nepalensis	0.00	0.02	0.09	0.11	0.11	0.22	0.00	0.00	0.00	0.00	0.00	0.26	0.80	4.91
Champ	0.00	0.00	0.00	0.04	0.11	0.08	0.11	0.13	0.00	0.00	0.00	0.00	0.46	2.86
Schima	0.00	0.00	0.06	0.04	0.05	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.37	2.27
Cinnamomum	0.01	0.03	0.08	0.26	0.26	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.78	4.80
Terminalia	0.00	0.00	0.02	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.35
Walnut	0.00	0.00	0.04	0.11	0.05	0.14	0.18	0.00	0.18	0.00	0.00	0.00	0.70	4.29
Others Brdl	0.36	0.77	1.25	1.83	0.94	1.54	1.06	0.62	0.47	0.00	0.00	0.00	8.83	54.40
total broadl.	0.41	0.93	1.74	2.90	1.94	3.13	2.32	1.63	0.80	0.18	0.00	0.26	16.23	100.00
total	0.41	0.93	1.74	2.90	1.94	3.13	2.32	1.63	0.80	0.18	0.00	0.26	16.23	100.00
%	2.52	5.71	10.72	17.87	11.92	19.25	14.29	10.07	4.94	1.11	0.00	1.60	100.00	

Inventory Unit : Metapchu
Stratum : Mixed B/L Local use production
Area (ha) : 849.4
Period : 04/01/98 to 06/05/06

Tree Status : Survivor
Timber Quality : All (Dbh 10+ cm)

Number of Strata : 1
Number of Sampling Units : 23
Estimate of Total : 10.360
t (0.975, 22) : 2.075
Sampling Error% for Estimate (at P=0.95) : 41.64

Estimated Parameter : AVERAGE BASAL AREA PER HA (m^2/ha)

Species Group	Dbh class (cm) 10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	-109	-119	120+	total	%
Acer	0.00	0.00	0.00	0.25	0.17	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.75	7.27
Quercus	0.00	0.00	0.00	0.14	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.38	3.71
Castanopsis	0.11	0.00	0.15	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.41	3.95
Alnus nepalensis	0.00	0.11	0.00	0.27	0.41	0.00	0.33	0.00	0.00	0.00	0.00	0.00	1.13	10.94
Champ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Schima	0.01	0.00	0.08	0.11	0.20	0.84	0.00	0.00	0.00	0.00	0.00	0.00	1.24	12.0
Cinnamomum	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	1.40
Terminalia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Walnut	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.63
Others Brdl	0.31	0.61	1.20	1.28	1.15	0.83	0.38	0.46	0.00	0.00	0.00	0.00	6.23	60.10
total broadl.	0.43	0.72	1.64	2.21	1.93	1.92	1.05	0.46	0.00	0.00	0.00	0.00	10.36	100.00
total	0.43	0.72	1.64	2.21	1.93	1.92	1.05	0.46	0.00	0.00	0.00	0.00	10.36	100.00
%	4.12	6.97	15.84	21.30	18.63	18.54	10.17	4.43	0.00	0.00	0.00	0.00	100.00	

Inventory Unit : Metapchu
Stratum : Combined
Area (ha) : 4619.2
Period : 04/01/98 to 14/05/06

Tree Status : Survivor
Timber Quality : All (Dbh 10+ cm)

Number of Strata : 2
Number of Sampling Units : 110
Estimate of Total : 15.152
t (0.975, 108) : 1.983
Sampling Error% for Estimate (at P=0.95) : 14.37

Estimated Parameter : AVERAGE BASAL AREA PER HA (m^2/ha)

	Dbh class (cm)													
Species Group	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	-109	-119	120+	total	%
Acer	0.01	0.03	0.11	0.29	0.12	0.47	0.45	0.10	0.00	0.15	0.00	0.00	1.73	11.43
Quercus	0.00	0.01	0.00	0.09	0.13	0.17	0.40	0.40	0.00	0.00	0.00	0.00	1.20	7.94
Castanopsis	0.03	0.05	0.08	0.11	0.13	0.05	0.00	0.22	0.13	0.00	0.00	0.00	0.81	5.35
Alnus nepalensis	0.00	0.03	0.07	0.14	0.17	0.18	0.06	0.00	0.00	0.00	0.00	0.21	0.86	5.67
Champ	0.00	0.00	0.00	0.03	0.09	0.06	0.09	0.11	0.00	0.00	0.00	0.00	0.38	2.50
Schima	0.00	0.00	0.07	0.05	0.08	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.53	3.50
Cinnamomum	0.00	0.03	0.09	0.21	0.21	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.66	4.37
Terminalia	0.00	0.00	0.02	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.31
Walnut	0.00	0.00	0.04	0.09	0.04	0.12	0.15	0.00	0.14	0.00	0.00	0.00	0.58	3.83
Others Brdl	0.35	0.74	1.24	1.73	0.98	1.41	0.93	0.59	0.38	0.00	0.00	0.00	8.35	55.11
total broadl.	0.41	0.89	1.72	2.77	1.93	2.90	2.09	1.42	0.65	0.15	0.00	0.21	15.15	100.00
total	0.41	0.89	1.72	2.77	1.93	2.90	2.09	1.42	0.65	0.15	0.00	0.21	15.15	100.00
%	2.72	5.87	11.36	18.30	12.77	19.16	13.77	9.36	4.32	0.97	0.00	1.40	100.00	

Main Table 4. Survivor Trees >= 10 cm Dbh: Average Gross Volume per Ha.

Inventory Unit	: Metapchu	Number of Strata	: 1
Stratum	: Mixed B/L limited production	Number of Sampling Units	: 87
Area (ha)	: 3769.8	Estimate of Total	: 158.772
Period	: 03/12/98 to 14/05/06	t (0.975, 86)	: 1.988
		Sampling Error% for Estimate (at P=0.95)	: 16.54
Tree Status	: Survivor		
Timber Quality	: All (Dbh 10+ cm)		

Estimated Parameter : AVERAGE GROSS VOLUME PER HA (m^3/ha)

	Dbh class (cm)												
Species Group	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	-109	-119	120+	total	%
Acer	0.11	0.24	1.18	2.88	1.11	6.43	5.49	1.54	0.00	2.09	0.00	0.00	21.06	13.27
Quercus	0.03	0.10	0.00	0.84	1.43	1.95	6.34	6.74	0.00	0.00	0.00	0.00	17.43	10.98
Castanopsis	0.09	0.37	0.45	0.98	1.41	0.43	0.00	3.26	1.89	0.00	0.00	0.00	8.87	5.59
Alnus nepalensis	0.00	0.11	0.70	0.95	1.13	2.12	0.00	0.00	0.00	0.00	0.00	3.90	8.91	5.61
Champ	0.00	0.00	0.00	0.32	0.86	0.77	1.21	1.43	0.00	0.00	0.00	0.00	4.59	2.89
Schima	0.01	0.00	0.51	0.32	0.49	2.09	0.00	0.00	0.00	0.00	0.00	0.00	3.42	2.16
Cinnamomum	0.02	0.19	0.54	2.22	2.45	1.39	0.00	0.00	0.00	0.00	0.00	0.00	6.80	4.28
Terminalia	0.00	0.00	0.18	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.51	0.32
Walnut	0.00	0.00	0.32	0.99	0.34	1.39	1.85	0.00	1.75	0.00	0.00	0.00	6.65	4.19
Others Brdl	1.77	5.04	10.06	15.93	9.00	15.54	10.78	6.71	5.70	0.00	0.00	0.00	80.52	50.72
total broadl.	2.02	6.04	13.94	25.75	18.22	32.11	25.67	19.67	9.34	2.09	0.00	3.90	158.77	100.00
total	2.02	6.04	13.94	25.75	18.22	32.11	25.67	19.67	9.34	2.09	0.00	3.90	158.77	100.00
%	1.28	3.80	8.78	16.22	11.47	20.22	16.17	12.39	5.88	1.32	0.00	2.46	100.00	

Inventory Unit	: Metapchu	Number of Strata	: 1
Stratum	: Mixed B/L Local use production	Number of Sampling Units	: 23
Area (ha)	: 849.4	Estimate of Total	: 90.138
Period	: 04/01/98 to 06/05/06	t (0.975, 22)	: 2.075
		Sampling Error% for Estimate (at P=0.95)	: 47.27
Tree Status	: Survivor		
Timber Quality	: All (Dbh 10+ cm)		

Estimated Parameter : AVERAGE GROSS VOLUME PER HA (m^3/ha)

	Dbh class (cm)													
Species Group	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	-109	-119	120+	total	%
Acer	0.00	0.00	0.00	2.36	1.73	0.00	3.83	0.00	0.00	0.00	0.00	0.00	7.92	8.79
Quercus	0.00	0.00	0.00	1.42	0.00	2.85	0.00	0.00	0.00	0.00	0.00	0.00	4.28	4.74
Castanopsis	0.36	0.00	1.10	1.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.93	3.25
Alnus nepalensis	0.00	0.73	0.00	2.21	3.65	0.00	3.39	0.00	0.00	0.00	0.00	0.00	9.99	11.08
Champ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Schima	0.04	0.00	0.66	0.90	1.12	7.88	0.00	0.00	0.00	0.00	0.00	0.00	10.61	11.77
Cinnamomum	0.00	0.00	1.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.12	1.24
Terminalia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Walnut	0.00	0.00	0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.49	0.55
Others Brdl	1.42	3.86	8.57	10.42	11.10	8.41	4.19	4.84	0.00	0.00	0.00	0.00	52.80	58.58
total broadl.	1.82	4.59	11.95	18.78	17.61	19.14	11.41	4.84	0.00	0.00	0.00	0.00	90.14	100.00
total	1.82	4.59	11.95	18.78	17.61	19.14	11.41	4.84	0.00	0.00	0.00	0.00	90.14	100.00
%	2.02	5.09	13.25	20.83	19.53	21.23	12.66	5.37	0.00	0.00	0.00	0.00	100.00	

Inventory Unit : Metapchu
Stratum : Combined
Area (ha) : 4619.2
Period : 04/01/98 to 14/05/06

Tree Status : Survivor
Timber Quality : All (Dbh 10+ cm)

Number of Strata : 2
Number of Sampling Units : 110
Estimate of Total : 146.151
t (0.975, 108) : 1.983
Sampling Error% for Estimate (at P=0.95) : 15.50

Estimated Parameter : AVERAGE GROSS VOLUME PER HA (m^3/ha)

Species Group	Dbh class (cm) 10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	-109	-119	120+	total	%
Acer	0.09	0.19	0.96	2.78	1.22	5.25	5.18	1.26	0.00	1.71	0.00	0.00	18.65	12.76
Quercus	0.03	0.08	0.00	0.95	1.16	2.12	5.18	5.50	0.00	0.00	0.00	0.00	15.01	10.2
Castanopsis	0.14	0.30	0.57	1.07	1.15	0.35	0.00	2.66	1.55	0.00	0.00	0.00	7.78	5.32
Alnus nepalensis	0.00	0.22	0.57	1.18	1.59	1.73	0.62	0.00	0.00	0.00	0.00	3.19	9.11	6.23
Champ	0.00	0.00	0.00	0.26	0.71	0.63	0.99	1.17	0.00	0.00	0.00	0.00	3.74	2.56
Schima	0.01	0.00	0.54	0.43	0.61	3.15	0.00	0.00	0.00	0.00	0.00	0.00	4.75	3.25
Cinnamomum	0.02	0.15	0.65	1.81	2.00	1.13	0.00	0.00	0.00	0.00	0.00	0.00	5.76	3.94
Terminalia	0.00	0.00	0.15	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.42	0.28
Walnut	0.00	0.00	0.35	0.81	0.28	1.13	1.51	0.00	1.43	0.00	0.00	0.00	5.52	3.77
Others Brdl	1.70	4.82	9.78	14.91	9.39	14.23	9.57	6.36	4.65	0.00	0.00	0.00	75.42	51.61
total broadl.	1.99	5.77	13.58	24.47	18.11	29.73	23.05	16.94	7.62	1.71	0.00	3.19	146.15	100.00
total	1.99	5.77	13.58	24.47	18.11	29.73	23.05	16.94	7.62	1.71	0.00	3.19	146.15	100.00
%	1.36	3.95	9.29	16.74	12.39	20.34	15.77	11.59	5.22	1.17	0.00	2.18	100.00	

ANNEXURE 3: Compartment Description.

Block: Metakha Compartment:I

Altitude	1224-3361m
Aspect	Eastern
Terrain	Moderate to steep
Total Area	1413.75ha

Forest Description: The compartment consists of matured stand of Broadleaf Species such as *Albizia, Schima, Michelia, Alnus, Castanopsis, Quercus, Morus,Toona ciliata* and other broadleaf species. Rural timber has been allotted. However, no commercial marking was done from this compartment.

Prescription: The area was operated under Single Tree Selection System for rural timber allotment during the first Management Plan. No commercial harvesting is carried out.

Block: Metakha Compartment:II

Altitude	974-2733m
Aspect	Southern
Terrain	Moderate to steep
Total Area	778.91

Forest Description: The compartment consists of matured stand of Broadleaf Species such as *Albizia, Prunus, Rhus, Magnolia, Schima, Michelia, Alnus, Castanopsis, Quercus, Saurauja* and other broadleaf species. Rural timber has been allotted. However, no marking was done at the source of irrigation water. Pangu Community Forest falls in this Compartment.

Prescription: The area was operated under Single Tree Selection System for rural timber and firewood.

Block: Bjozhingkha Compartment:I

Altitude	1730-3420m
Aspect	Southern
Terrain	Moderate to steep
Total Area	1276.75ha

Forest Description: The compartment consists of matured stand of broadleaf species and some Conifer species such as *Juglans regia, Phoebe, Persea, Acer, Magnolia, Quercus* among others. Rural timber has been allotted from this compartment. However, no marking

was given from the areas serving as water source.

Prescription: Rural timber allotment for Metakha and Metkha Yuekha Village was made from this compartment prior to CF establishment. However, grazing in this compartment needs to be controlled.

Block: Bjozhingkha Compartment:II

Altitude	955-2988m
Aspect	South East
Terrain	Gentle to steep
Total Area	1332.38ha

Forest Description: The compartment consists of matured stand of broadleaf species such as *Michelia, Terminalia, Elaeocarpus, Engelhardia, Exbucklandia, schima, Beilschelmiedia*, etc. Meta Goenba CF is located in this Compartment.Rural timber Allotment from CF and outside CF is made. However, no marking was given from the areas serving as water source.

Prescription: Single tree selection system was followed during allotment.

Block: Boomelum Compartment:I

Altitude	1730-3327m
Aspect	Southern
Terrain	Moderate to steep
Total Area	931.66ha

Forest Description: The compartment consists of matured stand of broadleaf species such as *Persea, Quercus lamellosa, Elaeocarpus, Betula, Acer, Phoebe, Juglans regia,Rhodrodendron,* etc.

Prescription: The area will be operated for commercial production only under Patch cut system.

Block: Boomelum Compartment:II

Altitude	1413-3327m
Aspect	Northern
Terrain	Moderate to steep
Total Area	1153.78ha

Forest Description: The compartment consists of matured stand of Broadleaf species such as *Michelia, Rhus, Prunus, Alnus, Morus, Exbucklandia, Erythrina* and others. The compartment have good cover of cane growth and should be managed with NWFP plans in future.

Prescription: Pacth cut system to be followed.

Block: Tsundrugang Compartment:I

Altitude	921-3089m
Aspect	North west
Terrain	Very Gentle to steep
Total Area	1300.21ha

Forest Description: The compartment consists of matured stand of broadleaf species such as *Michelia, Quercus, Phoebe, Persea, Rhus, Alnus, Macaranga, Toona ciliate, Albizia, Ficus, etc.* Rural timber has been allotted to Gumina and Meta Yuekha villagers. However, no marking was given from the areas serving as water source.

Prescription: Single Tree Selection System for rural timber allotment. However, grazing in this compartment needs to be regulated.

Block: Tsundrugang Compartment:II

Altitude	840-3375m
Aspect	South Eastern
Terrain	Moderate to steep
Total Area	2489.09ha

Forest Description: The compartment consists of matured stand of broadleaf species such as *Michelia, Magnolia, Prunus, persea, Quercus, Schima, Symplocus, castanopsis,* etc. And no Rural timber allotment is made since the Tsundrugang villagers are not entitled for rural timber as their census is under Naja Gewog, Paro Dzongkhag.

Prescription: Grazing in this compartment needs to be regulated and controlled.

ANNEXURE 4: Road Standards

ROAD STANDARDS

As stated in the Dongdechu FMU management plan (D.Dorji and W. Incoll, 2001), the following standards will be implemented for design, drainage and construction of all forest roads:

Road Design

1. Road lengths and density should be minimised, consistent with access requirements to reduce environmental impacts and enhance access economics.
2. Where possible locate roads in areas with low slide slopes, the maximum side slope allowed in all areas except rock is 100%.
3. Roads must be constructed in such a way that no earthworks 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.
4. Roads should be planned in such a way as to balance cut and fill to minimise transport of construction material.
5. Roads should not be constructed in steep and unstable areas where there is the possi-bility of landslide. A thorough survey of any area suspected of being unstable should be undertaken prior to work commencing.
6. Roads should be kept as narrow as possible to reduce damage to the environment and to reduce costs.
7. Where possible, box cuts should be avoided, however they are acceptable for short distances (up to 300meters) if they reduce the length of the road, reduce environmental damage and are properly drained.
8. Minimum radius formed by curves or corners should be 15 meters and should where possible fit the topography of the land.
9. Roads should be located on elevated areas where possible to minimise side cutting, width of clearing and drainage problems.
10. Side cutting should be carried out leaving a stepped batter, each step no more than 3 meters in vertical height and no more than 100% gradient with a 1.5 metre horizontal step.
11. Convex road surface should be maintained t all times with the centre line 30cm higher than the edges.
12. Stabilise and re-vegetate cut and fill slopes with shrubs, grasses and legumes as soon as possible after construction.

13. Ensure proper maintenance of roads and enforce road use restrictions during critical weather conditions such as monsoon season.

Drainage

1. Road planning should ensure that roads are located in such a way as to minimise stream river crossings.
2. Roads should not be constructed in areas, which are prone to flooding in the monsoon season.
3. In areas where side slopes of 70% or greater extend for a distance of 100m or more above the proposed road catch drain should be constructed to divert surface water into culverts. Side drains or table drains should be at least 40cm deep and 65cm wide and should drain into culverts of sufficient size and frequency.
4. Al 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.
5. Culverts of appropriate diameter (not less than 30cm) 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 erodible material then the distance between the culverts must be reduced by 50%.

Road gradient %	**Distance between culverts (metres)**
4	110
5-8	90
9-10	80
11-15	60

6. Culverts should be laid at 2 to 5% gradient across the road to enable water flow but should not exceed 6%, as damage from erosion will result.
7. Culvert pipes (Hume pipe) should be buried a minimum of 700mm below the surface of the road.
8. In areas of high seasonal rainfall, catch drains should be constructed above the road to collect surface runoff and prevent it reaching the road.
9. Drains should not be allowed to directly enter a watercourse but should be diverted into surrounding vegetation at least 50meters before watercourse.
10. Sumps or silt traps should be placed in drains every 50 meters in erodible soils and must be cleaned regularly.

Road standards

1. All timber over 30cm 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).
2. 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 ad stabilise the slope.
3. Where side slopes of 70% or more extend more than 100 meters downhill no side casting of spoil should e allowed. In this situation end haul methods must be used.
4. Forest roads should only be constructed on stable soil types where there is no possibility of slippage.
5. All road construction on side slopes of over 50% or difficult terrain, such as boulder fields, must be carried out using excavators.
6. Batter and fill slopes should not exceed 100%.
7. Where road construction is carried out on side slopes of over 90% rock or concrete walls should be built to support both batter and fill (this is not required in solid rock).
8. 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.
9. The adverse gradient should not exceed 10%. However, grades of up to 12% will be allowed for distance of up to 300meters if this substantially reduces road length. Following this incline a minimum distance of 100meters of grades of 10% or less must be maintained.
10. The favourable gradient should not exceed 12%. However, grades of up to 15% for distances of up to 300meters will be allowed if this substantially reduces road length. These grades should be followed by grades less than 10% for distance of 100metres or more.

ANNEXURE 5:Tree Marking Rules

TREE MARKING RULES

Marking Rules for single Tree Selection System.

- Selection System will beused on sensitive exposed sites, and for areas where other Silvicultural System cannot be applied.
- Trees marked for harvesting will be evenly distributed throughout the stands.
- Mature and over mature trees should be given preference for removal.
- Dead, dying, diseased and malformed trees will be marked on a priority basis. However, care should be taken so that no large openings are created in the stands by marking these trees.
- In a mixed stand, even distribution of species should be left standing as future crop.
- Where cable cranes are to be used, the extraction line will be as narrow as possible, not wider than four meters.
- Trees damaged during harvesting will be marked and removed during the subsequent coup cleaning operation.

Marking Rules for Patch Clear Cut System.

- Patches of mature and over mature trees under which there us existing regeneration or which are most likely to regenerate successfully should be given first preference. This would include large trees with spreading crowns, which absorbs sunlight if permitted to reach the forest floor would enhance seedling development.
- In selecting patches, ridge tops should be preferred over depression.
- In general, the size opening of 0.25ha need not be strictly adhered to and the size of the opening can vary from 0.15 to 0.5 ha depending on the stand composition and condition. However, it should be remembered that the patch opening should not be too large, as it will favour the growth of other unwanted species.
- The minimum distance between the extraction lines will be approximately 75 metres.
- The distance between the patch clear cut, along the extraction lines will not be less than 50 metres.
- The extraction corridors must be as narrow as possible, however, no wider than 4 metres.
- The shape and size of the patch clear cut can be adjusted according to the site and terrain conditions and need not be exactly circular.

- The direction of the tree lean and topography has to be taken into account to prevent large trees being felled on nearby advance growth.
- Dead, dying, malformed or damaged (snags etc.) trees will be retained in between patch clear cut, and in the interline spaces, to safeguard flora and fauna niches or habitats, but not in the harvested groups themselves, where there is the risk of wind throw and danger to personnel working underneath. Diseased trees 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.
- Sufficient seed trees in the interline space adjacent to the cable lines opened up should be retained as potential seed source for seedling regeneration in the patch cuts.
- The trees selected will be marked with the authorized marking hammer close to ground level 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 volumes at the NRDCL depot will also be recorded.

ANNEXURE 6:Bamboo Management Guidelines

1. Bamboos

Introduction

Bamboo is one of the most important components of the livelihood of the people of Metap Chhu FMU. The most important use of bamboo is the bamboo mat for fencing animal shed and houses. During the field work, the team encountered 7 species of cane and bamboo which is variably used as vegetable, raw materials for handicrafts, and various purposes such as making small house, erecting fences. The most important bamboo found in the areas is calamus acanthospathus (tsim tsha), Cephalostychum spp., Chimnobambusa spp. (Rau), Bambusa nutans, Plectocomia himalayana, calamus spp. and Bambusa spp.

Harvesting guidelines will differ with species. Following general guidelines may be applied for large Bamboos:

1. Immature culms less than 1 yea t old should not be cut (should be applicable to bamboos which young shoot not used as vegetable).
2. Immature culms of 1 to 2 years have very high water content and shrivel up when cut, this makes them useless for construction. Speed of development depends on the condition of the clump and the position of the culm: if the clump is vigorous and the culm is in an exposed position it matures much sooner; cumls at the centre of a poor clump mature more slowly (Haun et al.-1961 & Storey-1988, written in Bradshaw paper 2001).
3. In a clump containing 12 culms or more, at least 6 mature culms over 1 year old should be retained and in a clump containing less than 4 mature culms over 1 year old, all should be retained during felling. Mature culms should be left evenly distributed throughout the clump to provide mechanical support as well as nourishment (Gautam-1988, Bahadur et al.-1980 written in Bradshaw paper 2001 and Luna, I.F.S India).
4. All culms older than 4 years should be removed.
5. 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 written in Bradshaw paper 2001).
6. 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 30cm. Thinning the clumps reduces rhizome overcrowding and encourages the production of new culms in the centre of the clump (Gautam-1988 and Sharma-1988 written by Bradshaw paper 2001).
7. Large bamboos should (ideally) be thinned annually during winter, as this is the time when the plants growth is slowest. However, it is possible to harvest at any time except when new shoots are developing (Storey -1988a written in Bradshaw paper 2001).

8. Damaged culms, debris and cut branches which may have become infested with shoot boring moths (family : Pareuplexia), should be removed and burnt as well as all dead and dry culms (Bahadur et al, 1980, Stapleton-1985a, Storey-1988a & Gautam-19888 written in Bradshaw paper 2001).

Harvesting Technique

The mature culms are selected and harvested. Fully mature culms are stronger, denser, more durable and less prone to insect attacks. Mature culms should be cut during the dry season (especially in winter) when starch content is low and no young shoot is sprouting. Culms should be cut close to the ground to maximise utilization of quality portions of the culms (Palijon 2000).

The culms should be cut off by cutting round once with the sharp tools (any prunnin tools like hadn-saw, axe, sickle, khukuri and patang) 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.

Cultivation of Bamboos.

In Metap Chhu people have realized the importance and disappearance of bamboos. Now the bamboos are grown at many places around each household. The cultivation of bamboos should be encouraged in the FMU, and the UIC shall seek literature and consultation from FRMD and other relevant agencies and provide necessary technical assistance to bamboo cultivation in the FMU.

Cephalostychum

Cephalostychum spp. bamboo is widely found and used by the people of Metap Chhu FMU, since there is a lack of enough research on this species, a general guideline has to be adapted for the time being from GENERAL GUIDELINE FOR MANAGEMENT OF BAMBOO IN BHUTAN by Prabhat Kumar Mukhia,FRMD. The guideline has been based on the local practices which has work quite well in the area in terms of harvesting and planting of the Bamboo Species.

Description

This genus of bamboo forms dense impenetrable clumps and found extensively within the Metap Chhu FMU which has humid sub-tropical climate. The genus has pendulous culm tip and thelength goes up to 6 to 15 meters with internodes of 70cm and sometimes upto 1m. The average diameter of culm ranges from 4 to 5 cm. Within the FMU, the collected culms from the wild are used as raw materials for weaving bamboo mats for making cow-shed, temporary huts and fencing.

Harvesting

As per the local practices, the culm of 9 to 12 months or older than this are cut in a slating fashion by patangs. Cutting is done at 0.46m to 0.61m above ground. The collection of the culms starts from October till mid May.

Planting

People within the FMU do not plant this genus as it is widely available from the nearby forest but this may not be the case in the future with increased demand and use, fuelled by the economic development as a consequence of forest construction as soon as the FMU is operationalized. Currently there is no research on the planting method of the bamboo. However, the farmers usually practice the traditional method of planting in which the entire rhizome is dug up with culm keeping atleast 1 to 1.5m of height. The rhizome is dug up and planted immediately during the onset of monsoon.

ANNEXURE 7:List of Timber Species Found Within Metap Chhu FMU

List of timber species found in Metap Chhu Forest Management Unit.

Sl. No.	Species	Botanical Name	Timber grade
	ACE	*Acer spp.*	A
	ACEC	*Acer campbellii*	A
	ACEL	*Acer laviegatum*	A
	ALB?	*Albizia spp.*	E
	ALBE	*Albizia lebbeck*	A
	ALBP	*Albizia prcera*	E
	ALBU	*Albizia lucidior*	E
	ALCC	*Alcimandra cathcartii*	E
	ALNN	*Alnus nepalensis*	C
	AMOW	*Amoora wallichii*	B
	ANOL	*Anogeissus latifolius*	E
	BEID	*Beilschmiedia dalzellii*	E
	BET?	*Betula spp.*	B
	BETA	*Betula alnoides*	B
	BRAA	*Brassiopsis hainla*	E
	BRAI	*Brassiopsis hispida*	E
	BRAM	*Brassiopsis mtis*	E
	CAOP	*Calophyllum polyyanthum*	E
	CAT?	*Castanopsis spp.*	C
	CATI	*Castanopsis indica*	C
	CATL	*Castanopsis lanceifolia*	C
	CATT	*Castanopsis tribuloides*	C
	CIN?	*Cinnamomum spp.*	E
	CINB	*Cinnamomum bejolghota*	E
	CINI	*Cinnamomum impressinervium*	E
	CODG	*Cordia grandis*	E
	CODO	*Cordial oblique*	E
	DAPC	*Daphnephyllum chartaecum*	D
	DILI	*Dillenia spp.*	E
	ELA?	*Elaeocarpus spp.*	B

	ELAI	*Elaeocarpus sikkimensis*	B
	ELAP	*Elaeocarpus sphaericus*	E
	ELAV	*Elaeocarpus varuna*	B
	ENGS	*Engelhardia spicata*	E
	ERY?	*Erythrina spp.*	E
	ERYA	*Erythrina arborescens*	E
	ERYT	*Erythrina stricta*	E
	EURC	*Erythrina cavinervis*	E
	EXBP	*Exbucklandia populnea*	B
	FIC?	*Ficus spp.*	E
	FICH	*Ficus hispida*	E
	FICN	*Ficus neriifolia*	E
	GAUP	*Garuja pinnata*	C
	GLOT	*Glochidion thomsonii*	E
	HELN	*Helicia nilagirica*	E
	HOVA	*Hovenia acerba*	E
	JUGR	*Juglans regia*	S
	LIH?	*Lithocarpus spp.*	E
	LINP	*Lindera pulcherrima*	E
	LIS?	*Litsea spp.*	E
	LYOO	*Lyonia spp.*	E
	MAA?	*Macaranga spp.*	E
	MAAD	*Macaranga denticulate*	E
	MAGC	*Magnolia campbellii*	E
	MARU	*Macropanax undulatus*	E
	MELA	*Melia azadarach*	E
	MIC?	*Michelia spp.*	E
	MICC	*Michelia excelsa*	A
	MICV	*Michelia velutina*	E
	MORM	*Morus macroura*	S
	OSTP	*Ostodess paniculata*	E
	PENR	*Pentapanax racemosus*	E
	PER?	*Persea spp.*	C

	PERF	*Persea fructifera*	C
	PHBA	*Phoebe attenuata*	B
	PHBL	*Phoebe lanceolata*	E
	PRU?	*Prunnus spp.*	D
	QUEL	*Quercus spp.*	D
	QUEM	*Quercus glauca*	D
	QUER	*Quercus lamellosa*	D
	QUES	*Quercus griffithii*	D
	RHO?	*Quercus semecarpifolia*	D
	RHUC	*Rhododrendron spp.*	E
	RHUH	*Rhus chinensis*	E
	RHUP	*Rhus paniculata*	E
	RHUS	*Rhus succedanea*	E
	SARA	*Sarcosperma arboretum*	E
	SAUN	*Saurauja napaulensis*	E
	SCHW	*Schima wallichii*	B
	SYM?	*Symplocos spp.*	E
	SYMG	*Symplocos glomerata*	E
	SYML	*Symplocos lucida*	E
	TALH	*Talauma hodgsonii*	E
	TEDF	*Tetradium fraxinifolius*	E
	TERM	*Terminalia myriocarpa*	A
	TOOC	*Toona ciliata*	B

ANNEXURE 8:Record Keeping Forms.

Compartment Record Sheet

Block:…….Compartment:……..…Sub-Compartment:…….……

Year	Harvesting		Tending		Planting		Other	Remarks
	Area (ha)	**Vol. (m3)**	**Area (ha)**	**Vol. (m3)**	**Area (ha)**	**Species**		
2017								
2018								
2019								
2020								
2021								
2022								
2023								
2024								
2025								
2026								

Rural Allotment

Block:…… Compartment:……. Sub-Compartment:……..

MC	WC	Date	Name and Address	Permit #	TMB #	Particulars			Volume (m3)			Comments
						Species	Product Type	Amount	Marked	Recovered	Firewood	

Commercial Allotment

MC	WC	Year of Activity	Commercial Activities					Volume(m^3)				Other Activities	TMB #	Comments (Include detailed description of cable line location in relation to mappable features)
			Cable Lines			Groups/Patches/ Other		Marked		Extracted (FDC)	Firewood (lops/ tops)			
			Line #	Length (m)	Azimuth	Total #	Total Area (ha)	# of trees	Vol.					

STand Tending and Regeneration

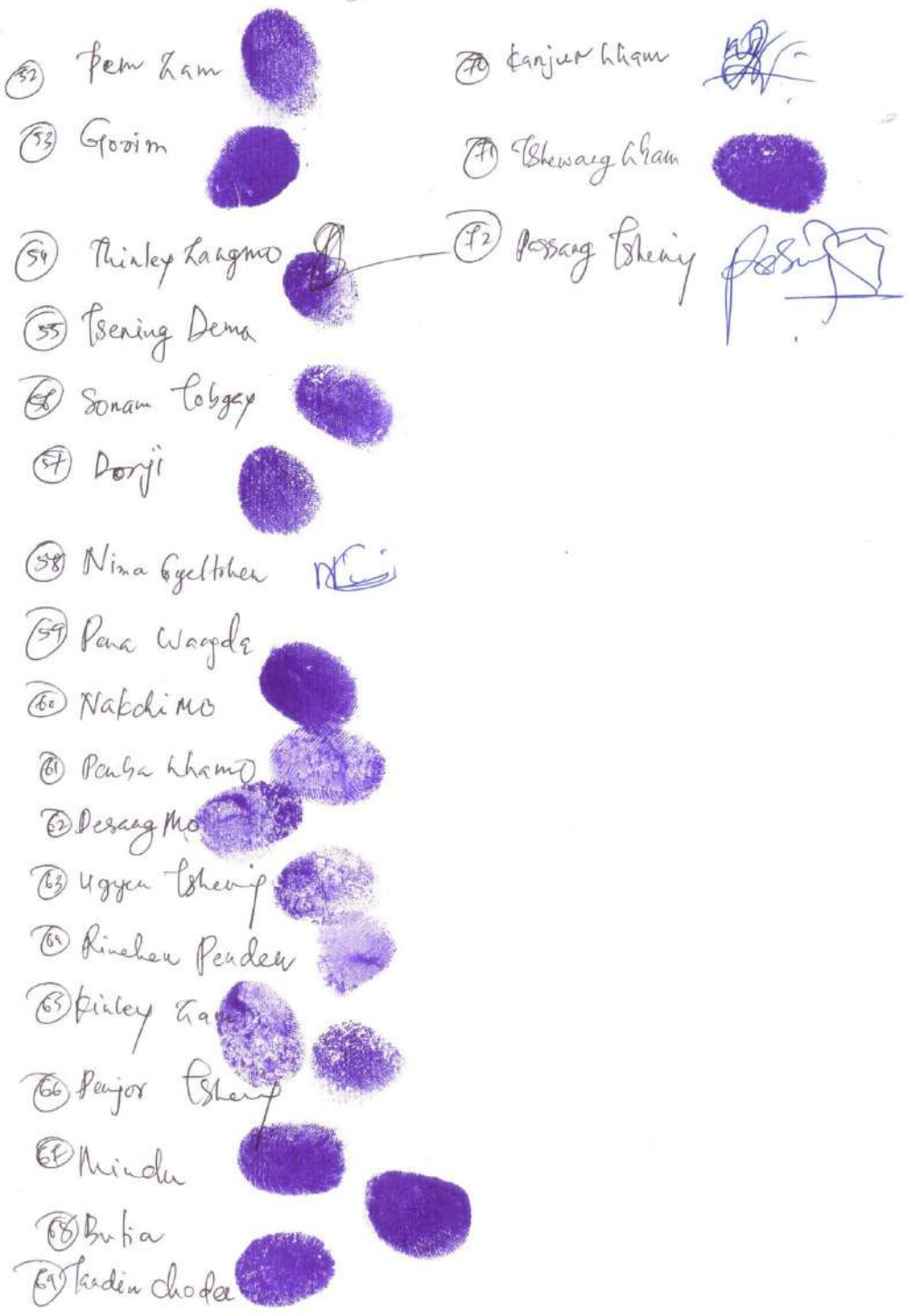
Block:…….Compartment:……Sub Compartment:……

MC	WC	Cable line #	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?	

□ Use for brushing, planting, weeding, and spacing or ground preparation activity.

ANNEXURE 9: Public Consultation Meeting


20 Chimmi
21 Chundum
22 Tandin Wangmo
23 Nanga Pem
24 Tsendu Wangmo
25 Pema Wangchuk
26 Sonam Khan
27 Passang Wangmo
28 Jambay Wangmo
29 Rinchen Gyelbhen
30 Dema
31 Sherab Lhamo
32 Yeshi Wangmo
33 Himpathi
34 Lhengo
35 Karma Dem
36 Sangay Wangmo
37 Lhakpa Dorji
38 Dema Yanglei
39 Sangay Penjor
40 Tashi Mo
41 Choden
42 Sangay Dem
43 Nanga
44 Sangay Wangdi
45 Ugyen Dorji
46 Rinzin Dem
47 Lhakpa
48 Ugyen
49 Jangchub
50 Chencho Pem
51 Changa Wangmo


52 Pem Zam
53 Goorim
54 Thinley Zangmo
55 Tsering Dema
56 Sonam Tobgay
57 Dorji
58 Nima Gyeltshen
59 Pema Wangda
60 Nakchi MO
61 Pasha Khamo
62 Dasang MO
63 Ugyen Tshering
64 Rinchen Penden
65 Pinley Za
66 Penjor Tsh
67 Nindu
68 Bu ti a
69 Tandin Choda
70 Kanjur Khan
71 Tshewang Kham
72 Passang Tshering

Public consultation Meeting. 04/04/2017

1) Tashi Tobgyel, chief Forestry officer.
2) Wangchuk, Regional Manager, NRDCL.
3) Penjor Wangdi, Forestry officer.
4) Rinzin Dorji, Forestry officer.
5) Singye Wangchuk, CFEO, Metakha.
6) J.K Nepal, Engineer, NRDCL.
7) Karma Dorji, UM, NRDCL.

ANNEXURE 10: Environment Impact Assessment Report of Proposed Forest Road.

ENVIRONMENTAL IMPACT ASSESSMENT REPORT FOR CONSTRUCTION OF FOREST ROAD AT METAPCHU FMU, CHUKHA 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, 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. 61,036,000.00 (Estimated cost)

8 Project description

8.1 Project location : From N27° 01' 7.01", E89° 26' 13.24" to N27° 05' 22.28", E89° 27' 35.15"

Table 1: Road location details by Dzongkhag and Geog

Road chainage		Dzongkhag	Gewog	Town	Village
From	To				
0 + 00000	0 + 20,000	Chukha	Metakha & Gelling		Meta Goenpa, Meta Yuekha, Pangu, Tshundrugang, Gumina & Bjozhingkha

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)	m^3	21,900.00
Volume of excavated material		
a) Excavation in soil all type	m^3	70,366.71
b) Excavation in rock all type	m^3	57,865.38
Average road gradient	%	±6
Maximum road gradient	%	±12
Cross drain	no	NIL
Box/Hume pipe culvert	no	110
Bridges	no	NIL
Total length of bridges	m	NIL
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	19,835.00
Box shaped side drain diamensions (lengthxbreadthxheight)	cm	NIL
Total length of box drain	m	NIL

Page 1

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	2400 coil (Approx)
2	detonator	4200 Nos (Approx)
3	D-chord	3400mtrs (Approx)
4	Jelatine	5400 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 + 20000	20,000.00	30 -120	Phuentsholing formation & possiblity of land slip at few locality, no major problem foreseen	Normal Bio-engineering, Retaining & Breast wall structure works wherever required will be constructed.
Total		**20,000.00**			

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
0+000 - 0+127	N A	Hume pipe culvert	NIL	Meta Goenpa, Meta Yuekha & Gumina villages	100	Irrigation only
0+127 - 0+849	N A	Hume pipe culvert	NIL			
0+849 - 1+278	NA	Hume pipe culvert	NIL			
1+278 - 2+096	NA	Hume pipe culvert	NIL			
2+096 - 2+128	NA	Hume pipe culvert	NIL			
2+128 - 2+173	NA	Hume pipe culvert	NIL			
2+173 - 2+258	NA	Hume pipe culvert	NIL			
2+258 - 2+336	NA	Hume pipe culvert	NIL			
2+336 - 2+509	NA	Hume pipe culvert	NIL			

2+509 - 3+148	NA	Hume pipe culvert	NIL	Meta Goenpa, Meta Yuekha & Gumina villages	100	Irrigation only
3+148 - 3+372	NA	Hume pipe culvert	NIL			
3+372 - 3+692	NA	Hume pipe culvert	NIL			
3+692 - 4+051	NA	Hume pipe culvert	NIL			
4+051 - 6+740	NA	Hume pipe culvert	NIL			
6+740 - 7+210	NA	Hume pipe culvert	NIL			
7+210 - 8+170	NA	Hume pipe culvert	NIL			
8+170 - 9+290	NA	Hume pipe culvert	NIL			
9+290 - 9+450	NA	Hume pipe culvert	NIL			
9+450 - 9+880	NA	Hume pipe culvert	NIL			
9+880 - 11+000	NA	Hume pipe culvert	NIL			
11+000 - 13+000	NA	Hume pipe culvert	NIL			
13+000 - 14+890	NA	Hume pipe culvert	NIL			
14+890 - 16+140	NA	Hume pipe culvert	NIL			
16+140 -16+180	NA	Hume pipe culvert	NIL			
16+180 -16+680	NA	Hume pipe culvert	NIL			
16+680 - 18+710	NA	Hume pipe culvert	NIL			
18+710 - 19+090	NA	Hume pipe culvert	NIL			
19+090 - 19+240	NA	Hume pipe culvert	NIL			
19+240 -19+370	NA	Hume pipe culvert	NIL			
19+370 - 19+970	NA	Hume pipe culvert	NIL			

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	20 + 000	Mixed hard wood	200,000.00	10 years	NIL

Table 6: Areas Required for Project Facilities

Facility	Land use	Area (m^2)	Tenure/ownership	Remarks
Labour camp	Mixed hard wood	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. have been 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)
Chukha	Metakha & Gelling	NIL

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

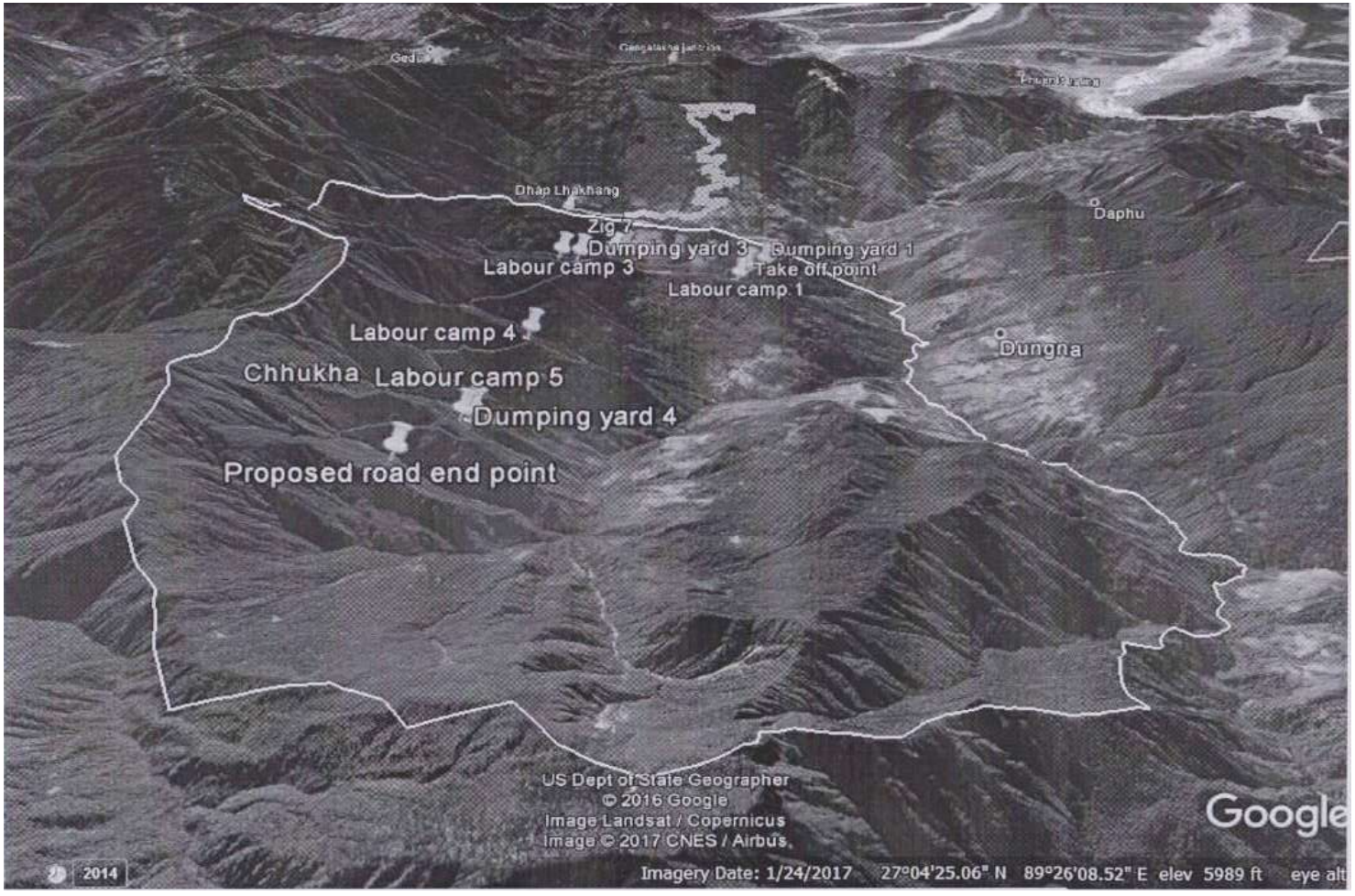
Monitoring of the construction works will be done by Site supervisor, Gedu Unit, NRDCL, including time to time monitoring by the Production Incharge, Gedu Unit under Pling Regional Office, Phuentsholing. The Regional Manager, Pling Regional Office, NRDCL Pling, shall also carry out frequent monitoring work. Also the Engineer from Engineering Service Section, NRDCL HO shall carry out the monitoring works as & when required.

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

ENVIRONMENTAL MANAGEMENT PLAN FOR CONSTRUCTION OF 20.00KMs FOREST 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)
Engineer
Production Division, NRDCL HQ


Dhap Lhakhang
Zig 7
Dumping yard 3
Dumping yard 1
Take off point
Labour camp 3
Labour camp 1
Daphu
Labour camp 4
Dungna
Chhukha
Labour camp 5
Dumping yard 4
Proposed road end point
US Dept of State Geographer
© 2016 Google
Image Landsat / Copernicus
Image © 2017 CNES / Airbus
Google
2014
Imagery Date: 1/24/2017 27°04'25.06" N 89°26'08.52" E elev 5989 ft eye alt