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ROYAL GOVERNMENT OF BHUTAN
DEPARTMENT OF FORESTS AND PARK SERVICES
OFFICE OF THE CHIEF FORESTRY OFFICER
PARO FOREST DIVISION
"Walking the Extra Mile".

MANAGEMENT PLAN
FOR
BITEKHA FOREST MANAGEMENT UNIT

PARO DZONGKHAG

(1st August, 2016 to 31st July, 2026)

Plan Prepared by:

Ugyen Tshering (Forestry Officer)
Territorial Division, Paro
May, 2016

PARO BHUTAN: Tel.No.0975-271221/272163 Fax No. 272162

Designed and Printed at Bhutan Printing Solutions

AUTHORITY FOR PREPARATION, REVISION AND APPROVAL

PERIOD OF THE PLAN

This Plan is valid for the period of 10 years from 1st August, 2016 to 31st July, 2026.

AUTHORITY FOR PREPARATION, REVIEW AND APPROVAL

The authority for preparation of this plan was delegated to the Territorial Forest Division, by Department of Forests and Park Services, Ministry of Agriculture and Forests, Royal Government of Bhutan vide office order no. FRMD/MPS/1(e)/2014-2015/701 dated December 1, 2014.

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 if there arise huge challenge and need to relook and reemphasize the management plan, the Head of Department, DoFPS, can authorise a revision of this plan.

APPROVAL

This Plan has been examined by a wide section of user groups, clients and organizations. The final version of this Plan was presented to the Department on 13th May, 2016 for comments. Plan was reviewed and technically cleared by the Head, FRMD, and an environmental clearance was obtained from National Environment Commission Secretariat. It is then submitted to Head, DoFPS, who, after further review and amendments, forward 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.....

APPROVED/NOT APPROVED

Hon'ble Minister
Ministry of Agriculture & Forests
Date:.....

ACKNOWLEGEMENT

I would like extend sincere thanks to the Department of Forests and Park Services, particularly FRMD, MoAF, for delegating preparation of Forest Management Plans of FMUs to the Territorial Divisions. Delegation has not only helped in building technical capacity of Division, but would also facilitate better implementation of the plan prescriptions by bridging the gap between planning and implementation.

I would like to express special gratefulness to Mrs. Dimple Thapa, Dy.Chief Forestry Officer, FRMD, DoFPS, for her relentless technical support and constant guidance during entire planning process.

Special thanks also goes to Mr. Arun Rai, Dy. Chief Forestry Officer, FRMD, DoFPS,and Mr. Tshering, Sr.Forestry Officer, Territorial Division, Paro, for their technical support.

Very much indebted to Mr. Kaka Tshering, Chief Forestry Officer, Paro Territorial Forest Division, for his constant guidance and administrative support.

I also extend my heartfelt thanks to the staff of Bitekha FMU and NRDCL of Rinpung Region for field assistance and support during entire planning period.

Heartfelt thanks also goes to the Gup and the community people of Nago, Bjilikha, Bitekha, Sagu, Rashigang, Susunang, Bjazhina, Tsuendugompa and Wanakha villages for their active participation in the public consultative meeting and providing feedbacks and comments.

This Bitekha Forest Management Plan is the contribution of many people through field assistance and support, technical backstopping, valuable feedbacks and comments and thanks are extended to all those who contributed to the development of this Forest Management Plan for Bitekha FMU.

Ugyen Tshering,

Forestry Officer, Territorial Forest Division, Paro

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

NEC/ESD/Dzo-Paro/3393/2016/ 1370

October 5, 2016

ENVIRONMENTAL CLEARANCE

The National Environment Commission (NEC) is pleased to issue environmental clearance in respect of Forest Resources Management Division (FRMD) as per the meeting held on September 30, 2016 for the operation and management of Bitekha Forest Management Unit (FMU) measuring an area of 7260.10 (Seven thousand two hundred sixty point one) hectares under Paro Dzongkhag with following terms and conditions:

1. As per Section 28.3 of the Regulation for the Environmental Clearance of Projects 2002, any modification of proposal/application shall take place only with prior approval from NEC;
2. **The holder shall ensure that this environmental clearance is valid only for the operation and management of Bitekha Forest Management Unit (FMU) measuring an area of 7260.10 (Seven thousand two hundred sixty point one) hectares under Paro Dzongkhag;**
3. The holder shall ensure that operation and management of Bitekha Forest management Unit is in line with the National Environment Protection Act 2007, Environment assessment Act 2000 and its Regulation 2002, Waste Prevention & Management Act of Bhutan 2009 and its Regulation 2012 and The Water Act of Bhutan 2011 and its Regulation;
4. The holder shall ensure that the activity complies with the Environmental Standards 2010;
5. The holder shall ensure that the activity is carried out as per the management plan submitted for environmental clearance;
6. The holder shall ensure compliance to all the terms and conditions of stakeholder clearances at all times;
7. The holder shall ensure that the activity is within the demarcated lease hold boundary;
8. The holder shall ensure to strictly implement the Report on Compliance Monitoring of Forest Management Unit 2010;
9. The holder shall ensure that the annual timber extraction from the FMU does not exceed its Annual Allowable Cut (ACC) of 4200 cubic meters;
10. The holder shall ensure that extraction of timer is done strictly as per the silvicultural system stated in the management plan;
11. The holder shall ensure that prescriptions of the management plan is strictly implemented;
12. The holder shall ensure that local residents, households, communities, public, private parties and any religious, cultural, historic and ecologically important sites are not adversely affected by the activity;
13. The holder shall ensure that NEC and any other relevant authorities are informed of any unanticipated or unforeseen chance-find of any precious metals or minerals or articles, that have economic, cultural, religious or ecological importance;
14. The holder shall ensure to maintain a buffer of 100feet (30m) between the activity site

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

and the edge of the river bank;

15. The holder shall ensure that watershed and catchment areas are protected strictly as proposed in the management plan;
16. The holder shall ensure that protection management circle of the FMU is never encroached;
17. The holder shall ensure adequate regeneration and re-vegetation in the harvested area;
18. The holder shall be solely responsible for any dispute arising due to the activity;
19. The holder shall ensure that reforestation program is implemented as proposed in the management plan upon completion of each corridor in consultation with the Divisional Forest Office, Paro Division;
20. The holder shall ensure that reforested areas are protected from animals;
21. The holder shall ensure that no exotic plant species are introduced during the reforestation;
22. The holder shall ensure that lops and tops are managed properly to ensure maximum survival of regeneration;
23. The holder shall ensure to construct side drains, cross drains, causeways, and other supporting structures (retaining/breast walls) along the approach road to prevent soil erosion, improve its stability and sustainability;
24. The holder shall ensure that adequate safety gadgets and outfits such as safety helmets, eye goggles, breathing masks, ear muffs, safety boots, etc. are provided to all workers and any other person entering the work-site;
25. The holder shall ensure that visual impact on the environment due to the activity is minimized and appropriate measures are put in place to improve the visual impact of the environment;
26. The holder shall ensure that underage workers are not employed;
27. The holder shall ensure that first aid-kit is available at the work-site at all times;
28. The holder shall ensure that proper health check up facilities are provided to all employees and health records are maintained accordingly;
29. The holder shall ensure that the safety signs are posted at strategic locations within the work-site, including signboards indicating the where specific safety gadgets are required to be used;
30. The holder shall ensure that signboard is erected at take-off point of the approach road showing the name of the FMU and contact address of the implementing agency;
31. The holder shall ensure that a copy of this environmental clearance is available at the work-site at all times;
32. The holder shall develop contingency plan to deal with unforeseen environmental risks, hazards & accidents and submit to NEC within **3 (three) months** from the date of issue of this environmental clearance;
33. **The holder shall ensure that renewal of this environmental clearance is processed at least 3 (three) month prior to its expiry along with a copy of environmental clearance and a report on the implementation of its terms and conditions;**
34. **The holder shall ensure that monitoring on the implementation of the management plan is conducted at least annually and annual monitoring report is submitted to**

NECS accordingly;

35. The holder shall ensure that Detailed Implementation Plan (DIP) is developed focusing on the implementation of the terms and conditions of this environmental clearance and submit to NECS within **3 (three) months** from its date of issue; and
36. The holder shall ensure strict implementation of the terms and conditions of this environmental clearance at site at all times.

Failure to comply with any of the above terms and conditions shall constitute an offence under the Environmental Assessment Act 2000, its Regulations 2002, the National Environment Protection Act 2007 and any other relevant laws. Penalties for such offences shall include but not limited to suspension and/or revocation of environmental clearance in part or whole without any liability on the part of the Royal Government.

This environmental clearance is valid till **October 4, 2021** and is subject to periodic review.

Secretary

To,
Director,
~~Forest Resources Management Division,~~
Department of Forest and Park Services,
Thimphu.

Copy to:

1. The Dasho Dzongdag, Chairman, Dzongkhag Environment Committee, Paro for kind information
2. The Chief Forest Officer, Paro Division for information
3. The Chief Environment Officer, Compliance Monitoring Division, NEC for kind information
4. The Dzongkhag Environment Officer, Dzongkhag Administration, Paro for necessary action
5. File ESD/ Dzo- Paro for record

Letter No. 244
Received on 10/10/16
File No. ....

NEC, PO Box 466, Thimphu, Bhutan
Fax: (975-2) 323385

Compliance Monitoring Report

1. General Information

1.1. Name of the activity (including nature/type of the project)
.....
.....

1.2. Location (including survey No./Plot No and project area, if applicable).....
.....
.....

1.3. Environmental Focal Person & Contact details.....
.....
.....

1.4. Number of employees (regular/casual, national and non-national):.....
.....
.....

1.5. Year of Commencement.....

1.6. EC reference No. and its validity.....
.....

1.7. Date of reporting.....

2. Description of the compliance to EC terms and conditions

Sl No	Terms and Condition of the EC	Action/activities undertaken/implemented to achieve compliance including evidence, wherever applicable	*Remarks*

3. **Any other initiatives undertaken other than stipulated in the EC**

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4. **Emission/discharge test, if applicable**

Sl No	Parameters as in Environmental Standards, 2010					Emission test result carried out by the project proponent (Attach the test report)					Date and time of monitoring. Specify methodology of test	Remarks
	Industrial effluent discharge	*Ambient air quality*	*Industrial emissions*	*Work place emission*	*Noise level*	*Industrial effluent discharge*	*Ambient air quality*	*Industrial emissions*	*Work place emission*	*Noise level*		
1												
2												
3												
4												
5												

5. **Details of attachment (Documents that needs to be attached while providing information as required under point number 2, 3 and 4)**.....

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Reported by:

(Signature)
Name:
Designation:
Company:

LIST OF ABBREVIATIONS

AAC	Annual Allowable Cut
cm	Centimetres
DBH	Diameter at Breast Height
DoFPS	Department of Forests and Park Services
FMCB	Forest Management Code of Bhutan
FMP	Forest Management Plan
FMU	Forest Management Unit
GIS	Geographic Information System
Ha	Hectare
HHs	Households
km	Kilometre
LCMP	Land Cover Mapping Project
masl	Metre above sea level
M	Metre
M^3	Cubic metre
NECS	National Environmental Commission Secretariat
NRDCL	Natural Resources Development Corporation Limited
RNR-RDC	Renewable Natural Resources-Research Development Centre
UIC	Unit In-Charge
WCD	Wildlife Conservation Division
^{0}	Degree
%	Percentage
^{0}c	Degree Celsius
SFED	Social Forestry and Extension Division
UWICE	Ugyen Wangchuck Institute for Conservation and Environment

EXECUTIVE SUMMARY

This is the second ten-year plan to be written for Bitekha FMU. The plan consist three main parts as per the FMCB, 2004.

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

- Bitekha Forest Management Unit (BFMU) is located under Naja *Gewog* in Paro *Dzongkhag*; situated between 27º 12'00" to 27º19'00" North latitudes and 89º 22'30" to 89º 31'00" East longitudes. The altitude ranges approximately from 2600 min the south to 4049 m in the north-west. Both *Nangoron Chhu* and *Lumnamo Chhu* flow towards South and Southeast respectively; meeting Haa *Chhu* outside the FMU.Paro-Zonglela FMU forms its northern boundary while Haa-East FMU and Selela FMU form the northwestern boundary and southwestern boundary respectively. The National Highway borders Bitekha FMU in the south and the east. The total area of FMU is 7260.10ha.

- BFMU caters forestry services to Nago, Bjilikha, Bitekha, Sagu, Rashigang, Susunang, Bjazhina, Tsuendugompa and Wanakha villages. The local mature canopy species (indicator species) for the BFMU includes *Picea* spinulosa, *Tsuga dumosa, Abies densa,Pinus wallichiana , Juniperus recurva, Rhododendron sp., Acer campbellii, Betula alnoides, Populus ciliata, Rhus chinensis, Quercus semecarpifolia,Larix* sp. and *Taxus* sp. The principal commercial species of FMU comprises *Picea* spinulosa (Spruce), *Tsuga dumosa* (Hemlock), *Abies densa* (Fir) and *Pinus wallichiana* (Blue pine).

- The final evaluation of FMU was carried out in May 2015 by Department of Forests and Park Services (DoFPS). The AAC set for the last plan is **4200m^3**in standing volume for commercial use and **1800m^3**standing volume for local users. The standing volume removed to meet commercial demand and local uses over ten years is 29511.72m^3 and 16555m^3 respectively. The timber removal for commercial and local use has not surpassed against the prescribed AAC. Silviculture System applied for commercial harvesting was Group Selection System and Single Tree Selection for rural use.

- Commercial operational has been carried out from Susunang and Nago block. Forest logging road of 5 km has been constructed at Nago block by Natural Resources Development Corporation Limited (NRDCL)during the last plan period while 0.720 meters of existing forest road constructed by erstwhile Bhutan Logging Corporation was maintained by NRDCL for timber transportation.

PART 2: FUTURE MANAGEMENT

- **The Management Goal of the FMU**

  To manage the forest on a multiple use, sustained yield basis for the production of timber, fuelwood,non-wood forest products, conservation of watershed, wildlife and environment.

  For multiple uses on sustainable basis, three Management Circles have been identified: **Protection**, **Production** and **Non-Production** including **Non Wood Forest produce (overlapping)** with all other Management Circles. 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**

  Management based on different forest functions will also be adopted as per the prescriptions in the Plan. Following forest functions and the management options with restrictions have been described in detail.

Code	Function Group	Code	Function Group
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**
		SoCL	*Social (Local use only)*
WRR	*Riparian Reserve Protection*	***SoCRs***	*Social (Religious Site Protection)*
WSH	*Watershed Conservation*		
WLS	*Local Water Supply Protection*		

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

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

  Production Management Circle has been divided into threeWorking Circles: Mixed conifer working circle, Fir working circle and Broadleaf working circle for this plan period. As few broadleaf trees are distributed within the local use area and contributing to the overall AAC for local use, stratum has been taken out to facilitate better

management of AAC by BFMU during the plan implementation and ensure conifer trees are not surpassed from the actual available stock in the field.

Strata	Net Operable Area (ha)	Rotation	RME of mature standing volume (m^3/ha)	AAC (m^3/year)	Clear cut Equivalent (ha)
A. Commercial Use					
Mixed Conifer	1477.5	180	344.25	2826	8.21
Fir	475.3	180	293.56	775	2.64
Total				**3601**	10.85
B. Local Use					
Mixed Conifer	962.5	180	162.45	869	
Broadleaf		110	5.73	50	
Total				**919**	

Based on the inventory data and net operable forest area available, the Annual Allowable Cut (AAC) has been fixed at 4500 m^3 in Standing Volume per year.

- **Allocation of AAC**

Standing Volume (m^3)	Allotted to
900 m^3	Local users (local residents of BFMU)
3600 m^3	NRDCL to meet commercial timber demand in the market

- **Silvicultural Systems**

  The prescribed Silvicultural System for the commercial harvesting is the Group Selection System. Group openings will be created in the stand allowing optimum quantity of light to reach the forest floor and creating conductive micro climatic conditions for seed germination and establishment of seedlings. Criteria for opening the groups and laying out annual coupes are given in detail in the Plan.

  For Local Use Only for rural marking, Single Tree Selection System will be applied.

- **Environmental Assessment**

  FRMD and Paro 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

- CFO,Paro, will be responsiblefor the implementation of this Management Plan, assisted by the Unit In-charge and other supporting staff under Division.Determination of cutting cycles, annual coupes, harvesting, reforestation, road construction etc. will be done as per prescriptions of the plan. Annual planning will be facilitated through Operational Planning.
- 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.
- FMU Level Management Committee chaired by the CFO, Paro,shall be established to assist in objective setting and ensuring the smooth implementation of the plan. The committee willcomprisestakeholders of the FMU and each member will have 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 Meetings.
- Unforeseen circumstances may deviate from plan prescriptions and in such an event the CFO,Paro, must obtain prior written approval from the Head of Department. The reasons for the deviations must be fully justified by the CFO in writing in this respect and such approveddeviations entered into the Management Plan during the next scheduled planning period and plan revision.

Actions required by the FMU Plan	Responsibility
1.Implementation and Review	
The CFO Paro will be responsible for the implementation of this Management Plan, assisted by the UICand staff.	CFO, Paro
The FMU Management Committee chaired by the CFO Paro will be maintained to ensure the smooth implementation of the Management Plan.	CFO, Paro
2. Monitoring and Evaluation	
The CFO Paro will ensure that monitoring is carried out on an annual basis according to the guidelines issued by FRMD	CFO, Paro
The CFO, Paro will ensure that evaluation is carried out at five-year intervals, based on the information collected by annual monitoring and other necessary information.	CFO, Paro
3. Operational Planning	

Actions required by the FMU Plan	Responsibility
A rolling operational plan will be prepared by the CFO Paro, assisted by FMU IC and NRDCL, 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 NRDCL financial year begins.	CFO, Paro, 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 Paro 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, Paro, RM, NRDCL
The FMU IC will ensure that stocking of natural regeneration is regularly monitored and regeneration surveys are conducted as per the plan prescription and guidelines, following completion of the harvesting operation.	FMUIC
Enrichment planting of harvested cable lines and plantations will be carried out by NRDCL.	RM, NRDCL
Fencing, or other action to protect regeneration will be carried out by NRDCL, in consultation with the FMU IC	RM, NRDCL
Brushing, weeding, fencing, or other action to assist regeneration will be carried out by NRDCL, in consultation with the FMU IC	RM, NRDCL
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
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, Paro	FMU IC
4. 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, Paro

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PART 1
INTRODUCING FMU

1. LOCATION, AREA, BACKGROUND AND STATUS

1.1 Location

Bitekha Forest Management Unit (BFMU) is located within Naja *Gewog* in Paro *Dzongkhag*; stretching between 27º-12'- 00" to 27º-19'-00" North latitudes and 89º-22'-30" to 89º-31'-00" East longitudes. Paro-Zonglela FMU forms its northern boundary while Haa-East FMU and Selela FMU form the northwestern boundary and southwestern boundary respectively. The metalled Highway borders Bitekha FMU in the south and the east.

The altitude ranges from approximately 2600min the south up to 4049m in north-west. Both *Nangoron Chhu* and *Lumnamo Chhu* flow towards South and Southeast respectively; meeting Haa *Chhu* outside the FMU. BFMU consists of 365 households spread over 9 villages. The villages namely, Nago, Bjilikha, Bitekha, Sagu, Rashigang, Susunang, Bjazhina, Tsuendugompa and Wanakha fall under Bitekha FMU. There are numerous streams which feed to Ha *Chhu*.

1.2 Historical Background

The first sustainable forest management plan for Bitekha was implemented from 1st August, 2006 to 31st July, 2016. Final review of FMU was carried out in May 2015 by Department of Forests and Park Services (DoFPS). The total volume of timber removed by Natural Resources Development Corporation Limited (NRDCL) from cable lines to meet commercial use in the plan period was 29512m^3in standing volume against 42000m^3, which is about 2951m^3per year against prescribed AAC of 4200 m^3per year. For rural timber supply in the plan period, the total timber removed from FMUover ten years was 16555m^3 against 18000m^3 with annual removal of 1656m^3against 1800m^3.

There was no systematic and continuity of regeneration survey carried out in the harvested areas in the first management plan and as a result most of the harvested areas are poorly regenerated. Tending operation in harvested areas was absent in the first plan period.

1.3 Area statement

Table 1: **Land cover classifications (LCMP, 2010)**

Class	Sub-Class	Category	Area(ha)	Area (%)
Forests	Conifer Forests	Fir Forest	1247.37	17.2
		Mixed Conifer Forest	4445.27	61.2
		Blue Pine Forest	470.05	6.5
	Broadleaf Forest	Broadleaf	36.63	0.5
Shrubs			402.94	5.6
Meadows			110.22	1.5
Cultivated Agricukture Land	Kamzhing		525.92	7.2
	Horticulture	Apple Orchard	5.42	0.1
Built Up Areas			0.79	0.0
Snow Cover			6.95	0.1
Rock Outcrops			8.54	0.1
Total			**7260.10**	**100.0**

1.4 Forest Condition

The major forest types of BFMU are mixed conifer and blue pine forests. The mixed conifer forest comprises *Picea* spinulosa (Spruce), *Tsuga dumosa* (Hemlock), *Abies densa* (Fir) and *Pinus wallichiana* (Blue pine),*Juniperus recurva*, *Larix griffithii* and some broadleaf species like *Rhododendron*, *Quercus semecarpifolia*, *Populus ciliata* and *Acer campbellii*. Within gross operable area of 4137.5 ha for this plan period, about 82.3 % is covered by mixed conifer forests and 17.7% by fir forests.

As per the forest inventory result, the highest average numbers of trees and average standing volume for commercial production area are high in mixed conifer stratum with highest average volume in 70-95 cm dbh classes. For local use area, the highest average standing volume and number of trees are high in conifer stratum. For overall local conifer AAC, different sizes of trees contribute to the AAC. 9% iscontributed by *Dangchung*/pole size, 58% by *Tsim*, 24% by *Cham* and 10% by *Drashing*.

1.5 Legal Status

1.5.1 Ownership

Clear ownership and management rights are vital for good governance and sustainable management of forests. The Forest and Nature Conservation Act 1995, defines forest as "*any land and water body, whether or not under vegetative cover, in which no person has acquired a permanent and transferable rights of uses and occupancy, whether such land is located inside or outside the forest boundary pillars, and includes land registered in a person's name as tsamdo (Grazing land) or sokshing (woodlot for collection of leaf litter)*"**.** All such areas are considered as Government Reserve Forest (GRF)and constitutes about 6199.32 ha(85.4%).

1.5.2 Rights and privileges

The rights and privileges of the local inhabitants, with regard to the use of forest, comply with Forest and Nature Conservation Act (FNCA) of 1995 and National Forest Policy (NFP) of 2011. The FNCA permits grazing and collection of firewood, fodder and leaf mould for domestic use, either free or on payment of Royalty. Collections of dry firewood from dead and fallen trees are permitted. The timber trees are issued for bonafideuse in rural area, after paying royalty. Hunting is prohibited in the forest.

1.5.3 Grazing rights

The local communities have traditional rights for grazing their cattle in the forest within the unit. The local cattle graze during the summer and winter months while the migratory cattle graze the same area during summer months. There exist grazing rights for some of the villages outside of the FMU. However, the FNCA, 1995, has the provision of regulating grazing in GRF Landin order to prevent environmental damages.

1.5.4 Water rights

The local population has traditional rights to use water from rivers and streams for their domestic purposes, such as home consumption, irrigation and other uses. The Water Act of Bhutan 2007 also provides provision for abstraction and use for domestic use and small scale schemes as determined in regulation under this act. The main streams are Nangoron Chu and Lumnamo Chu.Besides these two streams, there are many streams and creeks found in the FMU that serve as water source for the communities.

1.5.5 Historical Monuments and Monasteries

Numerous religious sites are located in different areas within the BFMU. A buffer of 50m has been sited around all the sacred sites. The most important ones

include*Nago gompa* located at Nago.*Jaba goenpa, Tseri goenpa,Yangchen goenpa*and *Tsuendu goenpa* located in Rashigang block.*Wangdi gney* (rock outcrop) is located in Susunang block and is acknowledged by the local people.

2. PERMANENT SITE FACTORS

2.1 Topography and Slope

The general terrain of BFMU is moderate in most part of the compartment. However, few compartments are steep and mountainous. The altitude ranges from 2,600 to 4,049m at the ridge top. There are many small streams which flow into the main rivers, viz, Nangoron Chu and Lumnamo Chu during the monsoon season which ultimately drains into Haa Chu and then to Wangchhu River.

Slopes are usually steep at higher elevations above 4000m and gentler at the bottom of the valley. Slope classification was done through measurement of distance between 40m contours on the 1:25 000 topographical map. Areas with >100% slope were delineated on the Function Map as *SP - Soil Protection* where no activities are allowed to take place. Slopes that ranged from 76 – 100% are classified as *SC - SoilConservation* where limited forestry activities can take place.

2.2 Climate

2.2.1 Meteorological Stations

There is no meteorological station at Bitekha. All the meteorological data have been derived from Meteorology Section, Hydromet Services Division, Department of Energy, Ministry of Trade and Industry, Thimphu, Bhutan.

2.2.2 Temperature

Table 2: Average monthly maximum temperature (°C)

Year	Jan	Feb	Mar	April	May	June	Jul	Aug	Sep	Oct	Nov	Dec
2010	11.5	9.3	15.7	18.0	17.0	16.6	17.6	19.4	18.6	19.1	19.5	17.3
2011	17.8	17.5	19.1	21.4	20.7	21.4	21.9	21.7	21.4	22.1	13.6	11.1
2012	10.0	14.6	14.2	15.6	19.3	20.8	21.9	21.3	20.2	18.2	15.1	7.1
2013	6.1	12.9	14.6	14.1	17.0	20.9	22.1	20.4	19.9	18.3	16.2	12.3
2014	11.7	12.1	14.8	17.7	18.2	20.5	23.5	19.9	19.2	18.1	14.2	13.0

Source: Department of Hydro-Met Services, Ministry of Economic Affairs, Thimphu, Bhutan, 2015

Table 3: Average monthly minimum temperature (°C)

Year	Jan	Feb	Mar	April	May	June	Jul	Aug	Sep	Oct	Nov	Dec
2010	-1.5	-3	5.2	8	9.6	10.3	9.6	9.9	8.4	6.3	7.4	7.1
2011	6.2	5.7	7	10.5	10.7	13	16.1	14.3	11.3	14	4.1	1.5
2012	2	4.1	3.2	5.8	7.6	11.9	12.9	13.8	12.3	7.3	1.3	0.8
2013	0.6	1.2	3.5	6.1	10.3	13.9	14.8	14	12.4	8.4	1.9	-0.7
2014	-2.3	-2.5	1.1	5.6	9.3	13.3	15.2	13.9	12.3	6.7	3.4	0.1

Source: Department of Hydro-Met Services, Ministry of Economic Affairs, Thimphu, Bhutan, 2015

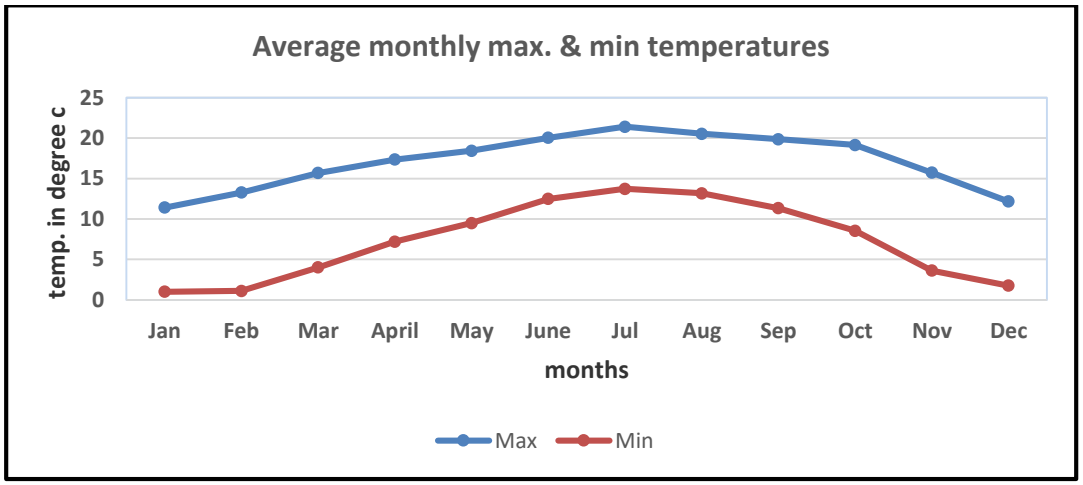


Figure 1: Average monthly maximum and minimum temperatures

2.2.3 Precipitation

Table 4: Average monthly rainfall (mm)

Year	Jan	Feb	Mar	April	May	June	Jul	Aug	Sep	Oct	Nov	Dec
2010	27	0	289	601	-1038.4	116.9	472.2	509	343	345	25	7.5
2011	0	63	106	403	277	621	371	397	0	0	75	13.5
2012	20.9	35.8	178	488	222	513	481.8	339	67.4	28.9	0	0
2013	0	17	374	335	357	251	246	513	199	222.5	8	0
2014	0	0	0	209	529.5	569	605	906	518	0	0	41

Source: Department of Hydro-Met Services, Ministry of Economic Affairs, Thimphu, Bhutan, 2015

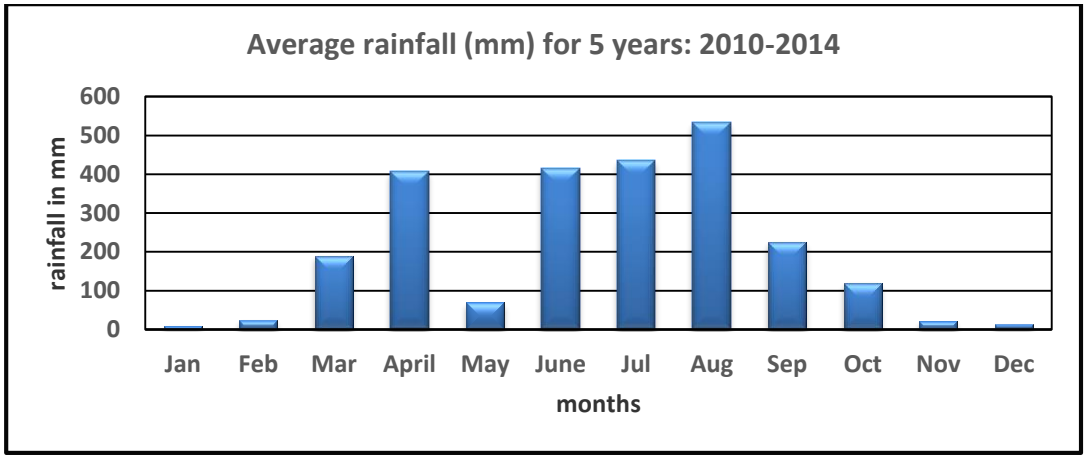


Figure 2: Average monthly rainfall

2.2.4 Relative Humidity

Table 5: Average monthly relative humidity (%)

Year	Jan	Feb	Mar	April	May	June	Jul	Aug	Sep	Oct	Nov	Dec
2010	67.9	70.1	73.2	72.2	72.9	69.6	55.6	47.8	44	54.4	43	38.3
2011	67.5	47.5	69.1	49.4	38.5	54.4	70	68.3	66.4	66.4	84.3	70.4
2012	45.8	74.2	79.8	81.8	70.1	77.3	81.5	86.8	86.5	82.5	75.3	79
2013	77.6	78.2	69.6	86.5	88	84.3	83.6	87.5	84.8	89.3	79.6	84.9
2014	74	87.1	89.5	79.3	81.8	95.6	90	93.8	88	86.2	83.1	85.7

Source: Department of Hydro-Met Services, Ministry of Economic Affairs, Thimphu, Bhutan, 2015

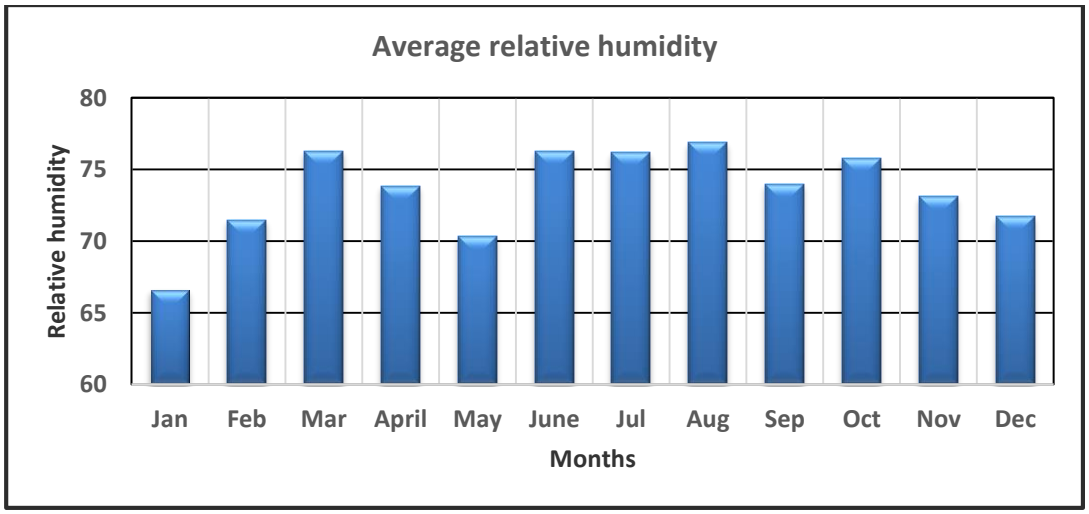


Figure 3: Average monthly relative humidity

2.3 Geology and Soil

The geological formation is dominated by the Precambrian series which is characterised by the presence of assorted combinations of rocks such as graphite schist, granite-mica schist, flaggy quartzite, calc-silicates, Gneiss and marble.The area is characterised by brown or grey podzolic (ash-like) forest soil that are sandy loam to clayey loam in nature. In general the soils are moderately fertile and owing to the clay content the water retention is fairly well. It has been observed that the soils are fairly stable and are not prone to frequent or large scale surface erosion or landslides. However, there is a moderate risk of surface erosion and gullying. These soil types are suitable for forestry activities, as long as the silviculture and management are appropriate. Therefore, care must be taken not to expose large areas ensuing in the loss of fertile soils.

2.4 Hydrology

The whole BFMU is watershed for *Nangoron Chu*, *Lumnamo Chu* and several small rivers and streams which flows north to south and finally congregatewith Haa Chu outside the FMU. Some tributaries of *Nangoron Chu* and *Lumnamo Chu*and small rivers and streams are used by the communities for drinking, irrigating vegetable crops etc. These are imperative water sources and serve as water holes for livestock too. Majority of villages are in Rashigang block and therefore it's of utmost importance to maintain water quality and quantity in the plan period.

3. VARIABLE SITE FACTORS

3.1 Population and Demography

The total population residing both within and nearby the FMU region is about 4097 as of 2015 (Table 6)with population density of 27 person/km^2. Out of the total population, 2085 are males and 2012 are females. The average household members come to about 9 persons per household.

Table 6: Population/demographic profile by *Chewog* under *Naga Gewog*

Sl.No	Chewog	Villages	Male	Female	Total	Total HHs
1	Bitekha	Bitekha, Bjilikha, Sagu	406	330	736	96
2	Rasgigang	Rashigang, Bjazhina	427	451	878	86
3	Tsendugoenpa	Tsendugoenpa	427	380	807	77
4	Nagu-linzhi	Nago	299	319	618	83
5	Wanakha	Wanakha, Susuna	526	532	1058	106
Total			**2085**	**2012**	**4097**	**448**

Source: Gewog Administration, Naja *Gewog, 2015*

3.2 Farming and Agriculture

People residing in BFMU are engaged in subsistence farming. The average dry land holding per household is about 3.276 acres while apple orchard and vegetable garden is about 0.1 acres per household as per the record maintained by Naja *gewog* administration. There are no wetlands due to water shortage. Commonly grown cereals include wheat (both *Ka* and *Nga*) and buckwheat.Potato and cabbage are their main cash crops. Cabbage is also grown twice.Other vegetables grown are chili, peas, beans, turnips and carrots. Due to land terrain and small land holding, complete mechanized farming is not practiced. Gewog statistics shows that there are two number of power tiller, 2 rice mill set and 52 spraying machine. Rural people also raise livestock for the dairy products. The livestock population was recorded with 2645 local and 1111 numbers of improved cattle, 29 pig, 1 sheep and 8 goats as of August, 2015. TheRNR-EC at Pokona-Bitekha providestechnical backstopping on agriculture farming, livestock sector development and management and extension of forestry activities to the rural communities of BFMU.

3.3 Traditional Use of the Forest

The rural people living in and around BFMU has been using forests for collection of timbers for house construction, non-wood forest products for consumption, as grazing field for their cattle, as water source for drinking, etc. Such practice of forest use has been carried out since time immemorial. Even with the establishment of forest and BFMU since 2006, the use of forest has not hampered such traditional use and their needs are still met even after establishment of BFMU as per the annual monitoring records of FMU.

3.4 Grazing

The total population of cattle owned by the villages is about 3756 heads of cattle and 8 heads of goats. Rural people let their animals to graze in the BFMU and grazing is evident in most areas of the FMU, with heaviest grazing pressure in the forest areas close to the settlements, forest roads, and open grounds without vegetation. The seasonal grazing by cattle of migratory herders starts from mid-March to till end of August in the FMU areas and this grazing trend falls in the month of growing seasons and adds up to increased pressure on the grasslands and forests around the settlements, harvested areas, which could adversely affect thenatural regeneration and plantation and would affect the carrying capacity on long run. During winter months, people move to warmer places along with their

animals in the month of September/October and return back in the month of March/April.

Animals are allowed to graze freely in the FMU. Grazing at current rate would have little impact on soil and water quality, but uncontrolled grazing could lead to poor regeneration and soil compaction in times to come. With deletion of tsamdro and sokshing from thram and reverted to GRF land as per Land Act 2007, grazing field for animals will be challenging for rural people and BFMU to maintain natural regeneration in harvested areas and plantation from its establishment.

There was decline of local cattle population by almost 10% from 2940 in 2012-2013 to 2645 in 2015 and there was increased of improved cattle by 5 % from 2012-2013 with 1062 to 1111 by mid of 2015. If similar trend of cattle population persist in the Naja *gewog*, pressure on natural regeneration and biodiversity within BFMU would gradually decline. It has observed in the first plan period that grazing didn't have much effect on the regeneration of bluepine as abundant regeneration can be seen in most of the locations. However in higher elevations where mixed conifer, spruce and fir dominate, it appears that regeneration was affected slightly.

3.5 Forest Fires

Fire isnot a regular phenomenon in the FMU.In the first plan period, there was no incidence of forest fire.However, it can be common in the lower parts of the FMU particularly in the dry blue pine zones. The limited availability of fire fighting equipment and transportation would create inconvenience in fighting forest fire. The steep terrain would make more difficult to control and supress forest fires.

3.6 Forest Pests and Diseases

In the first plan period, there was outbreak of spruce bark beetles (*Ips schumtzenhoferi*) at Nago block, compartment 3, sub-compartment b in 2015. About 0.79 ha have been affected with 143 trees which is equivalent to 536 m^3 standing volume. However, affected trees were removed immediately by NRDCL to prevent further spread of beetles to the unaffected stands. There are still few trees affected by pests and diseases in almost all areas of FMU, which needs to be monitored periodically to detect any freshly attach for prompt action. Die back in Fir is also commonly seen in all the three blocks especially at higher altitudes.

Bark beetle infestation from Haa-East FMU has spread to BFMU in Nago block as well since these two FMUs share the same boundary and seems population of beetles in Haa-East FMU have reached beyond epidemic proportion. This is a sign of caution that BFMU and NRDCL should not overlook.Since the epidemic level of

beetle extended mainly at altitudes between 2,800 - 3,300 *masl* (Tshering & Chhetri, 2000) and BFMU falling approximately within these ranges, beetles might affect the FMU and create perennial problem for the forest management in this plan period. Therefore, NRDCL should try to extract lops and tops as soon as possible to avoid creating conducive conditions for breeding of bark beetle giving way to widespread infestation. FMU staff should also carry out strict monitoring so that early detection of bark beetle infestation could be achieved and avoid spreading to the surrounding trees.

3.7 Non-Wood Forest Products

In last plan period, 326truck load of stone/boulder, 11.truckload of pine needles, 64 truck load of stone chips, 25 kilogram of *Shilaje*t and 1 truck load of leaf mould were supplied from the BFMU for commercial and local use purposes. Local people usually collect NWFPs for their *bonafide* use. However, there are poor records in BFMU office, which needs to strengthen in the second plan period for sustainability of NWFPs for future generations. FRMD in collaboration with SFED should look into the possibility of developing methodology for calculating AAC for major NWFPs, which are not yet developed. However, it would not be possible to estimate NWFPs and come up with the harvesting limit due to its distribution pattern and its abundances.

4. ECOLOGY

4.1 Floral Associations

On the basis of forest production zone, the forest type for BFMU has been classified into two major groups: mixed conifer and fir groups. Blue pine group has been merged with the mixed conifer group in this plan period. Although blue pine growth is prominent at lower altitudesand thrives well in drier areas, there is exceptions that many blue pine stands falls inside the privateregistered land as there is evident in the field that many blue pine stands are declared as registered land, after registered land with trees are given provision for conversion into agriculture farm use. There is also provision of commercialization of timber from the private registered. Blue pine on the moister slopes, it occurs in combination with Spruce, Hemlock and Fir, and often has greater stature than the ones at lower altitudes.

Mixed conifer forest comprises mostly of spruce and hemlock with very small patches of Larch, *Taxus* and *Cupressus*. However, these small patches are not of common sight and therefore their occurrence is confined to a limited suitable areas.

Fir forest is the hallmark of the highest forested ridges of BFMU and favor dense under storey growth of rhododendrons and other shrubs are usually seen. Often, the ground layer is mossy that supports a number of small herbs such as *Primula sikkimensis, Gentiana ornate, Potentilla atrosanguinea, Potentillapeduncularis, Aconitum* sp, *Bergenia ciliata,Viola* sp., *Plantago ovata*, etc. Fir becomes more stunted at the tree line and is mixed with smaller rhododendron species (i.e. *Rhododendron nivale*).

Top canopy:*Picea* spinulosa (Spruce), *Tsuga dumosa* (Hemlock), *Abies densa* (Fir) and *Pinus wallichiana* (Blue pine)

Middle canopy:*Juniperus recurva, Pieris formosa, Rhododendron nivale, Rhododendron arboretum, Rhododendron barbatum, Rhododendron cinnabarinum, Acer campbellii, Lyonia villosa, Lyonia ovalifolia, Betula alnoides, Populus ciliata, Rhus chinensis, Quercus semecarpifolia,Larix* sp., *Persea* sp., *Taxus* sp., *Ilex dipyrena, Salix* sp.

Shrubs:*Daphne papyracea, Piptanthus nepalensis, Principia utilis, Zanthoxylum alatum, Berberis* sp, *Rosa laevigata, Pyrus pashia, Viburnum erubescens, Benthamidia capitata, Cotoneaster* sp, *Gaultheria fragrantissima, Sarcococca saligna, Coriaria nepalensis*

Ground cover:*Aconitum* sp, *Thalictrum foliolosum, Bergenia ciliata, Potentilla* sp, *Inula* sp, *Elshotzia fruticosa, Elshotzia flava, Elaeagnus parviflora, Heracleum* sp, *Aresaema griffithi, Viola* sp., *Iris* sp., *Rumex* sp, *Rubus* sp, *Rumex hastatus, Rheum* sp, *Jasminum humile, Primula densiflora, Primula sikkimensis, Sambucus adnata, Aster* sp, *Senecio diversifolius, Euphorbia* sp, *Vaccinium nummularia, Gentiana ornate, Euphorbia cognate, Cardiocrinum giganteum, Paris polyphylla.*

4.2 Fauna

Table 7: Birds of Bitekha

Sl.No.	Common Name	Scientific Name	IUCN Conservation Status	Remarks
1	Blue-fronted Redstart	*Phoenicurus frontalis*	LC	Spotted
2	White-throated Redstart	*Phoenicurus schigticeps*	LC	-do-
3	Large billed Crow	*Corvus macrorhynchos*	NT	-do-
4	Green backed Tits	*Parus monticolus*	LC	-do-
5	House Sparrow	*Passer domesticus*	LC	-do-

Sl.No.	Common Name	Scientific Name	IUCN Conservation Status	Remarks
6	Oriental-turtle Dove	*Streptopelia orientalis*	LC	-do-
7	Blood Pheasant	*Ithaginis cruentus*	LC	-do-
8	Monal Pheasant	*Lophophorus impejanus*	LC	-do-
9	Spotted Nutcracker	*Nucifraga caryocatactes*	LC	-do-
10	Yellow-billed Blue Magpie	*Urocissa flavirostris*	NT	-do-
11	Blue-whistling Thrush	*Myophonus caeruleus*	LC	-do-
12	Stripped-throated Yuhina	*Yuhina gularis*	LC	-do-
13	Rofous-venetd Yuhina	*Yuhina occipitalis*	LC	-do-
14	Grey-sided Bush Warbler	*Cettia brunnifrons*	LC	-do-
15	Grey-backed Shrike	*Lanius tephronotus*	LC	-do-
16	White-throated laughing thrush	*Garrulax albogularis*	LC	-do-
17	White spotted laughing thrush	*Garrulax ocellatus*	LC	-do-
18	Red tailed Minla	*Minla ignotincta*	LC	-do-
19	Chestnut tailed Minla	*Minla strigula*	LC	-do-
20	Plain backed thrush	*Zoothera spiloptera*	LC	-do-
21	White tailed nuthatch	*Sitta himalayensis*	LC	-do-
22	Eurasian Tree creeper	*Certhia familiaris*	LC	-do-
23	Rusty flanked Tree creeper	*Certhia nipalensis*	LC	-do-
24	Green tailed Sun bird	*Aethopyga nipalensis*	LC	-do-
25	White-browed rosefinch	*Carpodacus thura*	LC	-do-
26	Kalij pheasant	*Lophura leucomelan*	LC	-do-
27	Darjeeling Wood pecker	*Dendrocopos darjellensis*	LC	-do-
28	Ashy drongo	*Dicrurus leucophaeus*	LC	-do-
29	Long-tailed Minivet	*Pericrocotus ethologus*	LC	-do-
30	Common Buzzard	*Buteo buteo*	LC	-do-
31	Black Eagle	*Ictinaetus malayensis*	LC	-do-

LC: Least Concern, NT: Near threatened

Table 8: Wild animals of Bitekha

Sl. No.	Common Name	Scientific Name	IUCN ConservationStatus	Remarks
1	Himalayan black Bear	*Selenarctos thibetanus*	VU	Direct sight and Local sources
2	Wild boar	*Sus scrofa*	LC	Digging signs and droppings
3	Sambar deer	*Cervus unicolor*	VU	Foot prints and droppings
4	Barking deer	*Muntiacus muntjak*	LC	Direst sight, call and droppings
5	Red Panda	*Ailurus fulgens*	VU	Scats /footprints & Local sources
6	Short-tailed Mole	*Talpa mrrcura*	LC	-do-
7	Jungle Cat	*Felis chaus*	LC	-do-
8	Musk Deer	*Moschsus chrysogaster*	EN	Direct sight & hair in scats
9	Himalayan Tahr	*Hemitragus jemlahicus*	NT	Droppings
10	Himalayan Flying squirrel	*Petaurista petaurista*	LC	Direct sight and Local sources
11	Wolf	*Canis lupus*	LC	Local sources
12	Leopard	*Panthera pardus*	NT	Pugmarks
13	Leopard cat	*Felis bengalensis*	LC	Local sources
14	Wild dog	*Cuon alpinus*	EN	Direct sight and Local sources

VU: Vulnerable,LC: Least concern, EN: Endangered, NT: Near Threatened

5. SOCIO-ECONOMICS

5.1 Common sources of Income

Most of the household within BFMU depend on subsistence farming and rearing of livestock. The major crops grown are wheat, chili, potato and cabbage. Local people also market milk for processing unit for production of butter and cheese. They also market poultry products for revenue generation. They also practice horticulture and few of them possess apple orchard.

6. CURRENT TIMBER SUPPLY AND DEMAND

6.1 Supply of commercial timber, firewood and wood chips from FMU

The Annual Allowable Cut (AAC)of the first management plan has been set at 4200m^3 for commercial use. Against this prescribed allowable cut, the timber harvested to meet commercial demand is29511.72m^3(Table 9).

Table 9: Timber harvested for commercial use against prescribed AAC

Plan Year	Standing Volume (m^3)				Total Standing Volume harvested (m^3)
	Normal Cable Lines	Sanitation Operation	Transmission Line	Forest Road	
August 2006	0.00	0.00	0.00	0.00	0.00
2007	0.00	0.00	1022.16	0.00	1022.16
2008	2062.62	0.00	0.00	Na	2062.62
2009	3599.70	0.00	0.00	0.00	3599.70
2010	2113.71	0.00	0.00	Na	2113.71
2011	3627.72	0.00	0.00	0.00	3627.72
2012	4200.00	0.00	0.00	0.00	4200.00
2013	4201.85	0.00	0.00	0.00	4201.85
2014	3580.42	0.00	0.00	0.00	3580.42
2015	619.58	1006.21	0.00	0.00	1625.79
July 2016	2960.77	57.18	0.00	459.80	3477.75
Total	**26966.37**	**1063.387**	**1022.16**	**459.8**	**29511.72**

Based on the AAC allocated in the Forest Management Plan(FMP) for commercial use, the volume of timber to be harvested and supply in a year is planned in the operational plan. For commercial timber harvesting, NRDCL extract allotted timber from cable lines based on prescribed AAC. In case there are ad hoc removals of timber required like sanitation operation from bark beetles affected stands, NRDCL poetized the sanitation operation and then only extracted timber from normal cable lines. So, timber extraction was within the prescribed AAC and FMP allowed to vary the AAC by plus or minus 10 % in individual year, but the volume cut in each five year period was not allowed to be no more than five times the AAC. As removal of timber was regulated by AAC, there was no room for modification of felling to suit demand, and this is one of the economic objections of sustained yield.

Even if there are lots of upcoming developmental activities where the demand for timber is expected to increase by manifolds in second plan period, AAC would prevent increase of felling and sales and helps to sustain timber stock for continue supply. In the last plan period, AACallotted for commercial use is 70% against the allotted AAC.

6.2 Supply of Rural Timber from FMU

The rural allotment in the form of shingles, *drashing, cham, tsim, dangchung*, poles and posts have been allotted and the trees were marked on SingleTree Selection System. More demand was found for Blue pine, Spruce and Hemlock that are used for construction timber. Blue pine is preferred for the purpose in comparison to others because of its technical properties to work with and easily reachable by the people. Firewood was supplied to rural people in the form of lops and tops from FMU and no green standing tree feeling was allowed for firewood in the plan period.

Table 10: Rural timber supply from FMU

Plan Year	Total Standing Volume (m^3)
August, 2006	0.00
2007	1423.42
2008	1011.06
2009	2062.55
2010	1553.22
2011	2007.42
2012	1656.43
2013	1993.45
2014	1834.84
2015	1212.61
July, 2016	1800.00
Total	**16,555.00**

In the last plan period, rural AAC allotted was 16555m^3 for ten years and timber harvested was less by 8% against this AAC in the plan period.

7. SILVICULTURAL ASSESSMENT

7.1 Past Silviculture Treatment

There was commercial harvesting at Susunang block by erstwhile Bhutan Logging Corporation (BLC) before the first Management Plan. For rural timber marking, Single Tree Selection System was applied for rural allotment. During the first management plan period, Group Selection System was prescribed based on forest

type and mode of regeneration. Group Selection System is considered as an appropriate silvicultural system for managing temperate Mixed Conifer forests as it promotes natural regeneration and requires no treatment to induce natural regeneration (Moktan, 2003). Seed Tree System was prescribed for blue pine forest. For local use areas for rural marking,Single Tree Selection System was prescribed in the plan period.

7.2 Forest Types

Thepresent forest types of BFMU areBlue pine, Mixed Conifer and Fir. Their distribution range, indicator and associated species of each forest types are shown in table 11.

Table 11: Forest types and its distribution range

Forest Types	Distribution	Principle Tree Species	Associated Tree Species
Blue Pine Forest	Distribution of blue pine stand, mixed with few Oak and Poplur is mostly found in the lower altitudes and are mostly of immature stand. As it goes upper, it is mixed with Mixed Conifer species like Spruce and even with Hemlock to certain extent. It is of matured stand	*Pinux wallachiana*	*Quercuss sp, Populus sp, Picea spinulosa, Tsuga domusa*
Mixed Conifer Forest	This forest is dominated by Spruce and Hemlock and are found in the upper valley of FMU. There are few Larix, Taxus, Cupressus, Juniper, Acer, Oaks, Pieris and Betula distributed in confined places. At lower altitude, Spruce and Hemlock is mixed with Oak species. This forest has both matured as well as over matured trees	*Picea spinlosa, Tsuga dumosa*	*Larix griffithii, Taxux baccata, Cupressus sp, Juniperous recurva, Acer cambelli, Quercuss sp, Pieris, Betula utilis*
Fir Forest	Fir occupies the highest elevations and starts from 3400m and are mostly matured and over matured. Fir dieback has affected the trees on the ridges reducing its production potential. The trees are matured enough for harvesting and some over matured trees have decayed due to the attack by bark beetle and no logging activity resulting in waste of resources.	*Abies densa*	*Rhododendron sp., Lyonia ovalifolia,*

Note: In this plan period, blue pine stratum has been merged with mixed conifer because of few inventory plots; giving high margin of error. The other reason is there are many private registered

lands inside blue pine stratum and much of the stand would be removed by private individuals for commercialization in future.

Table 12: Production area (commercial &local)covered by different forest types

Forest Type	Area (ha)	Percent of Forests Types	Percent of FMU Area
Mixed Conifer & broadleaf	3405.4	82.3	46.9
Fir	732.1	17.7	9.6
Total	**4137.5**	**100**	**56.5**

8. ORGANISATION AND ADMINISTRATION

8.1 Organisation

The FMU will be under the jurisdiction of CFO, Paro Territorial Forest Division. Division will appoint Unit In-charge at the rank of Range officer along with other support staff as prescribed in the plan.The Division's Management Planner will assist CFO in planning, guiding, monitoring and evaluating BFMU governance and plan implementation through understanding, organizing, engaging and ensuring, to improve decision making about forest goods and services.

8.2 Record Keeping

The unit office will maintain complete records of all the FMU activities within the Unit as per the record-keeping format of FMCB and guidelines developed by Forest Resources Management Division (FRMD) and Paro Territorial Forest Division.

8.3. Health and Safety

In line with the recommendation of Richard W Bradshaw, the suggested route to follow would be: -

- All the workers will be equipped with safety gears and equipment;
- Carry out risk assessment for all active harvesting sites;
- Implement pollution control measures;
- Implement emergency evacuation plans;
- Implement supervisory checks for contractors and subcontractors, for conformity to 'best practice' while working on harvesting sites;
- Implement accident/incident reporting procedures.

9. INFRASTRUCTURE, TRANSPORT AND EQUIPMENT

9.1 Forest Logging Roads

In this plan period, about 6 km approach logging road to Nago Block of BFMU will be constructed in addition to the existing 5 km road constructed in the first plan period from the exiting Haa-East FMU. However, major maintenance of Haa-East FMU road needs to be done before further construction of road takes place. The approach logging road to Susunang Block will be from near Susunang Nursery and it needs to be newly constructed. 13.60 km road is planned in this plan period.

For the entire FMU, the total logging road network would be about 19.60 km with an average of 1.96 km/year. However, NRDCL and FMU can plan the length of road construction in a year based on the available stock by proposing in the Operational Plan for implementation.

10. EVALUATION OF PREVIOUS (1ST AUGUST, 2006 TO 31STJULY, 2016)

It is important for FMU to under-go evaluation at intervals of five years to examine whether objectives set in the plan are achieved or not and to provide corrective measures for Territorial Division for intervention, if any. The final evaluation was carried out by DoFPS from4th to 9th May, 2015 by a team constituted by the Director General, DoFPS.

10.1 Review of Goals and Objectives

The broad goal of BFMU in the first plan period was to manage BFMU on a multiple and sustained yield basis for the production of timber, fuel wood and other forest products and for watershed and environmental protection. However, based on annual operational plan, more focus was given to timber production. To manage forest for the long term for the benefits of present and future generations, the present plan includesother elements of sustainable forest management. It includes the use of social, environmental and economic value that help to maintain the flow of forest goods and services without substantial degradation over time.

Table 13: Details of area clear cutequivalentfrom production working circle

Plan Year	Area Cut in ha			
	Normal cable lines	Road construction	Sanitation operation	Total
August, 2006	0.00	0.00	0.00	0.00
2007	0.00	0.00	0.00	0.00
2008	6.27	0.94	0.00	7.21
2009	5.54	0.00	0.00	5.54
2010	5.31	0.94	0.00	6.25
2011	5.25	0.00	0.00	5.25
2012	5.86	0.00	0.00	5.86
2013	5.70	0.00	0.00	5.70
2014	5.53	0.00	0.00	5.53
2015	0.40	0.00	0.79	1.19
July, 2016	2.53	0.47	0.00	3.00
Total	**42.39**	**2.35**	**0.79**	**45.53**

The AAC of the last management plan was 4200 m^3 for NRDCL to meet commercial demand and 1800m^3 for local uses. The timber removal by NRDCL in the last plan period was 29511.72.m^3 (Table 9) against42000m^3 standing volume, while for rural use the total removal in ten years was 16555m^3 (Table 10) against 18000 m^3. Therefore, the average timber harvested per year by NRDCL was 2951.172.m^3 and for local supply was 1655.5m^3. The area equivalent for clear cut in a year to harvest AAC in the plan period was 22 ha, which is 220 ha for ten year and the area clear cut in the plan period was 45.53 ha (Table 13), which is about 4.553ha/year against available equivalent clear cut area of 22ha/year. This indicates that neither standing timber volume nor area clear cut was surpassed against the prescribed volume and area in the plan period. Local people were allotted lops and tops as firewood and other forest products based on their demand.

Although timber harvesting by NRDCL was in line with the principle of sustainability wherein, annual removal of wood products compared to the volume determined was less, some of the group openings and cable corridors were larger than the prescriptions and some of the harvestedareas were over taken by weeds and shrubs (fig.4) and supressed principle species. Besides absence of tending operation in the plan period, periodic regeneration survey as recommended in the plan was not carried out by FMU. This has attributed to failure of regeneration and growth of weeds in the cut over areas. NRDCL has also not carried out artificial planting in the plan period.

Figure 4: Growth of weeds in harvested cable corridors

In the plan period, there was no major issue on wildlife habitats degradation and exploitation of biodiversity. However, there werefew cases of poaching of musk deer and other animals in the FMU. Large openings were avoided while laying group openings and areas identified as protection zone for habitats and corridors of some of the faunal species like Monal pheasant was protected in the plan period.

Local people were given preference than outsiders to work in the FMU for timber harvesting, road maintenance and otherlabour opportunities etc. There was no forest fire incidence recorded in the FMU during the plan period. FMU staff hascarried out periodic patrolling to avoid setting of fire in the forest by local people.

FMU also serves as grazing ground for local cattleof six villages and complete stoppage of grazing in the forest was not possible since people were grazing their animals in the FMU area since time immemorial. However, there is sign of reducing local cattle population from 2012 to 2014 as per RNR-EC livestock statistical record.

Loggers and workers at the site used basic safety gears and measures while harvesting, logging and transporting timbers. The catchment areas within the area were also maintained in the plan period by not marking trees and felling. Even for

cable lines, stream buffer of 30 m was maintained and labour camps were not allowed at the upper area of water source.

10.2 Review of Harvesting Activities

The timber harvesting is done with a fixed skyline and gravity cable system. Dragging and rolling of logs has been found to be very minimum and have helped to reduce impact on soil erosion. However, in some cases the cable corridors were wider than prescribed width of 4 m and large opening created. In some lines, openings were created evenif there are natural openings, which have created larger opening of the canopy. In most of the cases, the slope aspect was not given due consideration, wherein the area harvested was poor with natural regeneration.

Most of the cable lines are laid in systematic manner or are parallel to each other except in few cases where it forms V-shaped due to existence of steep terrain and where cable line was laid to tap available resources with minimum environmental damage. In many cases, the cable corridors of minimum 4m was created with minimum distance of 60 m between two cable lines and 50 m between each group openings. However, in few cable lines the distance varied from 65 m to 70 m due to steep terrain and some openings or barren land without timber stock was not included even if it falls in the group opening. Small openings of 0.15 ha average opening was maintained in many cases, but at Susunang block, group opening size was more than the prescribed size and as a result weeds have overtaken over principle tree species. As per FMP prescription, 30m river buffer along perennial streams/rivers have been also maintained. Workers have been provided with safety gadgets such as helmets, boot and gloves, but no first-aid kit has been provided to them. The loggers or chain saw operators deployed by NRDCL were licenced with formal training. The waste generated by workers at the site were collected and burnt or disposed in pits and water sources were not polluted by workers.

The stump height of trees were maintained as prescribed by FMP and stumps of spruce and blue pine were also debarked. Coupe clearance certificate was issued to NRDCL from 2008. However, lops and tops are not removed from all the cable lines and is not found to be economical due to huge cost of transportation which is attributed to bad road condition. NRDCL and FMU office are not adequately equipped with computer and other facilities which are hampering record keeping works. Sooth implementation of management plan is also hampered by shortage of staff, both in FMU and NRDCL.There was not much harvesting of NWFPs from the FMU in the plan period and there seems to be fewer disturbances on NWFPs

distribution. However, removal of valuable NWFPs might take place in future from the FMU area.

However, there were some issues observed while evaluating the progress of the first plan.

- The orientation of some cable lines and group openings are not correctly laid out exposing the harvested areas to southern and south-western aspect, leading to poor regeneration;
- Lops and tops are not removed properly from the cable lines due to poor road condition and distance;
- There is no mobility facility for FMU staff to visit the site/FMU for monitoring and other activities;
- NRDCL is not adequately equipped with computer and other facilities hampering record keeping works;
- Group openings in some cable lines were larger than the prescribed size and it has favoured the growth of undesirable species such as oak, Berberies, among others and not the desired species;
- No proper tree marking register and compartment record keeping is maintained as prescribed in FMCB 2004.
- Inadequate FMU staff as prescribed in the FMP, hampering smooth implementation of the management activities;
- FMU staff were not familiarize with the FMU boundary, blocks, compartments and sub-compartments.

Some of the other issues observed in the plan period were lack of proper natural regeneration survey till 2014 and tending operation in the entire plan period.

10.3 Review of Road Construction Activities

The management plan has projected about 34.1 km road in the last plan period with 3.41 km/ year. Against this projected road length, 5 km road (table 14) was constructed in the plan period. For Nago block, two alternatives were recommended: alternative I with 11 km from the existing Haa-East FMU road and alternative II with 6km from Nago village. However, 5 km road was constructed from alternative I in the plan period.

Table 14: Road constructions

Year of construction	Block	Compartment & sub-compartment	Road length (km)
2008	Nago	IIIb	2
2010	Nago	IIIb	2
2016	Nago	IIb	1
Total			**5**

10.4 Review of Reforestation

Natural regeneration was preferred in the FMU during the plan period. However, if natural regeneration fails, either enrichment or complete socking by planting was prescribed. The plan recommended to plant the harvested area with commercially viable local species with not more than 3 species on each site and regular maintenance of plantation at the end of three years to be carried out and if the survival percentage is less than 80%, to carry out immediate beating up with same species was the plan prescription.

There was no artificial plantation carried out even if the natural regeneration had not come up. Natural regeneration survey after three years, as prescribed by FMP, had also been not carried out by FMU staff and there was no corrective measure taken as per natural regeneration guidelines. Natural regeneration survey was initiated only from 2015 and planned for 6.49 ha area plantation for area harvested in 2012 based on regeneration result.

Further, the plan recommended to adopting more tending activities, such as weeding, brushing and fencing to facilitate chance of natural regeneration, there was lack of tending activities and as a result the natural regeneration was very poor in all the harvested areas. The final evaluation of the plan implementation also revealed very poor regeneration with an average of 1-2 seedlings in 2m x 2m quadrant.

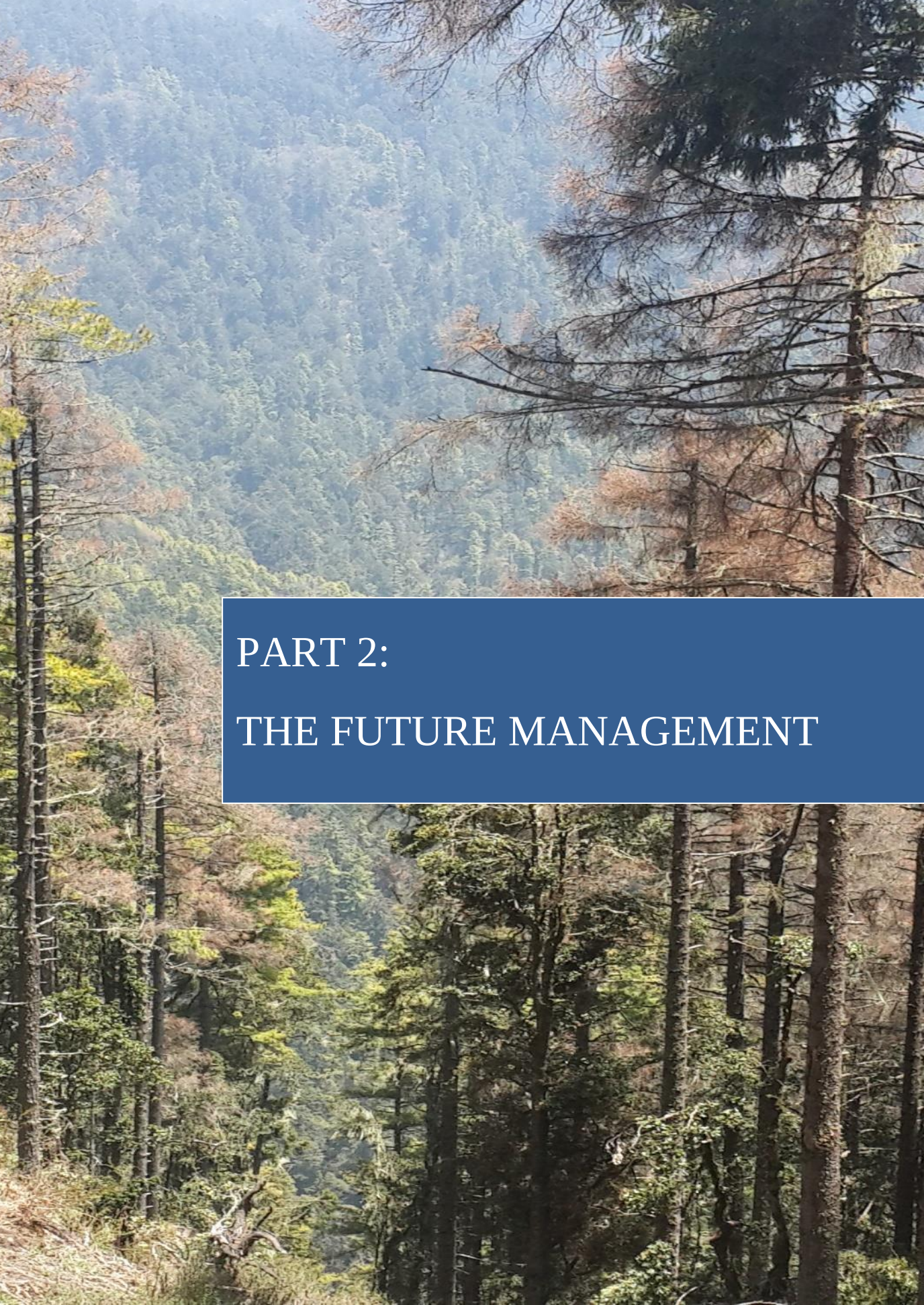
10.5 Review of other Developmental activities

Two community forest namely Jaba Lingzhi and Nagu were established inside the FMU in 2008 and 2010 respectively with an total area of 382.76 ha. Further, forestry clearance of about 4 ha of production working circle has been issued for leasing of GRF land for development of water plant at Bitekha in 2010 by Division.

As per recommendation of the final evaluation by Department in May 2015, area has been deducted from the production forest during the plan revision. Area from water plant at Bitekha has also been deducted from the production-working circle.

About 24 km farm road has been constructed inside the BFMU in the last plan period. Construction is confined inside the non-production working circle and are mostly near the settlement wherein, area has been prescribed for local use. For improvement of accessibility and livelihoods of the rural communities, farm roads are expected to increase over the next few years. As one of the pillars for sustainability of forest management is social besides economic and environment, the construction of farm road inside the FMU of non-production can't be predicted and include under logging road network in this plan period. Construction will solely depend on the requirement of community or individual households. However, CFO, Paro, and BFMU should ensure farm roads are not passed through the production working circle. Even inside the non-production area, roads should be aligned with minimal disturbance to the environment and landscape.

ForestManagement Code of Bhutan, 2004, recommends that the FMUs be retained as the principle unit for sustained yield. However, if production working circle from FMU is allotted or leased out to individual vested benefits and interests or for any developmental activities, sustainability of natural forest for timber production for current and future needs would be compromised. To achieve the principle of timber sustainability, this plan recommends BFMU and CFO to retain the production working circle.



PART 2:

THE FUTURE MANAGEMENT

THE FUTURE MANAGEMENT

11. INTRODUCTION

The Royal Government of Bhutan (RGoB) is committed to the principles and practice of sustainable forest management and to achieve such management, sound policies along with comprehensive approach, appropriate legislative and governance framework is important. The national forest policy, 2011, envisaged sustainable management of Bhutan's forest resources and biodiversity and the RGoB has adapted a firm national policy requiring the preparation and implementation of scientific management plans to produce a wide range of social, economic and environmental goods and services and fulfil social, economic, ecological and cultural needs of the present and future generations. It is important to understand our forest resource dynamics from what has already occurred and useful to take a look at what is likely to occur in near future. The constitution of the kingdom of Bhutan mandated to retain at least 60% of the country under forest cover for all times to come.

11.1 Forest Policy

1. One of the policy measures of the National Forest Policy of 2011 is to have forest management plans for all GRF land focusing on sustainable supply of forest products or ecosystem services. Several principles have been considered while framing the National Forest Policy of 2011 and some of these are equity and justice in terms of access, optimal utilization, conservation of forest resources and its ecosystem services.
2. Contribution of forest products and services for poverty reduction through integrated approach.
3. Deregulation and devolution through people centred forest management practices and decision making.
4. Application of good science and indigenous knowledge through integrated research and development in all aspects of forest planning and management.
5. Allowing imports of logs and sawn timber to enhance availability of timber materials within the country while export of round logs and sawn timber shall not be allowed to encourage value-addition.

11.2 Goals

The overall Goal of the Bitekha Forest Management Plan is to manage the forest on a multiple use, sustained yield basis for the production of timber, fuelwood, non-wood forest products, and conservation of watersheds, wildlife and environment.

Inorder to support this long term goal, the FMU will have to periodically assess every thematic elements of Sustainable Forest Management (SFM). 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. The Territorial Forest Division, Paro, will have to facilitate FMU to assess these thematic elements of SFM, including vulnerabilities to climate change. CFO will seek technical support from the Department if there is limited capacity at the Division to assess these thematic elements.

11.3 Objectives

The objectives of the BFMU have been divided under the Management Circles and Working Circles set up for the ease of implementation. Three Management Circles have been identified; **Protection**, **Production** and **Non-Production** including **Non Wood Forest produce (overlapping)** with all other Management Circles. The objectives are listed below. This allows different areas to be managed and evaluated separately. Some of the same objectives may occur under different Management Circles.

Protection Management Circle

- To conserve the water catchment functions by keeping buffer zones and not harvesting timber;
- To protect the forest from fire and illegal activities through involvement of local people;
- To allow low-impact collection of Non-Wood Forest Products through some regulations;
- To conserve and protect wildlife habitats and biodiversityby not interfering any human interventions while managing FMU;
- To raise awareness on biodiversity and the natural forest to local communities and stakeholders;
- To respect the sanctity of religious places and to protect historical sites through FMU management.

Non-Production Management Circle

- To manage and regulate grazing for livestock through involvement of local communities;
- To conserve and protect biological diversity by regulating function maps of FMU;
- To conserve the water catchment areas by keeping buffer zone and not harvesting timber;
- To maintain the forest condition by following the plan prescriptions of management plan;
- To meet the local demand for NWFPs on sustainable basis.

Production Management Circle

- To meet local requirement, as a priority, for timber, fuelwood and other forest products on a sustainable basis;
- To manage the FMU for commercial timber production on a sustainable basis;
- To enhance and improve forest condition and productivity to meet national needs;
- To create local employment opportunities through forestry activities;
- To protect the forest from pest and diseases, fire, illegal activities and from grazing in regenerating areas.

11.4 Management Based on Forest Function

11.4.1 Introduction

Forest function mapping is an essential tool for forest management planning by the planner and implementation of the management plan by FMU In-charges. Function mapping is used for groping different potential uses of the forest. The different potential includes soil conservation, watershed conservation, habitat for flora and fauna and resource based for many kinds of human needs. The forest functions are objectively limited by site condition by its dominant site of forest type with its accessibility and slops, habitat for wildlife, water catchment, social and religious sites, ecological/biodiversity area, barren area, etc. They are not subjective to human demands.

FMCB (2004) describes forest function as, the forest area within the FMU and can be categorized as ecological, environmental and social functions. It serves to balance the often diverging interests of commercial logging, local forest use and nature conservation.

11.4.2 Objectives of forest function mapping

The main objectives of forest function mappingin this plan are:

- To define different environmental and social functions of the forest and depict them on the maps;
- To identify production, non-production and protection area within the FMU;
- To provide a tool for the management planner for balancing the nature conservation, environment protection, social forestry and commercial timber production and also to provide the spatial information required to compute the sustainable AAC;
- To provide the FMU In-charge with information on the location of different forest functions in order to enable him/her to specify the required management prescriptions on the ground and to control their implementation.

11.4.3 Function groups

The functions used in this management plan are listed in Table 15. Some of these groups include functions that differ only in the degree of intensity of their management prescriptions.

Table 15: List of different forest function groups and functions

Code	Function Group	Code	Function Group
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***	*Social (Religious Site Protection)*
WLS	*Local Water Supply Protection*		

11.4.4 Mapping forest functions

The criteria used to prepare forest function maps for the FMU is given in table 16 below.

Table 16: Criteria for mapping forest functions

Function group and codes	Criteria for mapping
Soil Protection and Conservation	**SP:** very steep areas (slopes of greater than 100%), areas with indication of slight to moderate erosion, **SC:** steep or sensitive areas (slopes of 76 - 100%).
Water and Watershed Conservation	**WSh:** catchment areas of watercourses on steep slopes and on poorly drained areas; other sites serving as water retention areas or water sources **WRR:** areas within 30 metre along all perennial streams, water logged area and swamps
Nature Conservation	**NWP:** Endangered species territory, alpine areas, ecosystems of high conservation value
Social Function	**SocL:** area close to or accessible to settlement or village, the areas traditionally used with definite boundaries **SocRS:** *lhakhangs/goembas* and *gneys* and other religious site

11.4.5 Restrictions of Forest Functions

The specific restrictions to be applied to forest in the various function categories are summarized in Table 17. These restrictions should be applied in conjunction with the objectives set for each Management Circle.

Table 17: Impact of forest function classification on commercial and local use

Code	Function	Restriction on Commercial Use	Restriction on Local Use
NB	Biodiversity Protection	No commercial use	No local use
SP	Soil Protection	No commercial use	No tree felling, minimise human interference
SC	Soil Conservation	No clear cutting; no conversion into plantation; extension of regeneration periods; no ground skidding	Low impact local use
NWP	Wildlife Protection	No commercial use	Restriction to activities that do not change habitat quality and disturb wildlife
NWC	Wildlife Conservation	No clear cutting; no conversion into plantation; leave some undistributed patches; minimize disturbing to understorey vegetation	Low impact local use
WLS	Local Water Supply Protection	No commercial use	No tree felling, minimise human interference
WSh	Watershed Conservation	No clear cutting; no conversion into plantation; minimise disturbance to understorey vegetation	Low impact local use, single tree selection
WRR	Riparian Reserve Protection	No commercial use	Only collection of NWFPs, no boulder collection, no *tsamdo*, no *sokshing*
NWP	Wildlife Protection (Alpine Area)	No commercial use	Restriction to activities that do not change habitat quality and disturb wildlife; minimise grazing activities where possible
SocL	Social (Local Use Only)	No commercial use	No restriction

12. QUANTITATIVE RESOURCE ASSESSMENT

12.1 Forest Management Inventory

The inventory of Bitekha Forest Management Unit was carried out by FRMD Inventory Crew in 2013. A total of 208 plots were laid throughout the BFMU at the spacing of 600m x 430m out of which 133 plots were used of analysis of data to calculate AAC for the plan period.Trees >10 cm DBH(over bark) had been collected from accessed plots. Each plots represent an area of26 ha. The inventory was designed with target sampling error of+/- 10 % and the coefficient variation of 67%. About 19 % of the sample plots were measured as special plots. The general objective of the inventory was to provide essential background information for drawing up a management plan. More specifically the objectives of the inventory were:

- To provide a relatively accurate overview of the growing stock and regeneration potential of the natural forest in the area, according to major forest types;
- To give an overview of the general site characteristics of the natural forest, in terms of soil, non-green vegetation and use by the local population;
- To provide an indication of timber quality in different forest types;
- To furnish essential data on tree height to enable the construction of local volume tables for main species;
- Toallocate supply of timber for commercial and local use from the FMU area;
- To compare and observe the change in analysed inventory data of first and second plan period.

12.2 Forest Management Inventory Result

For analysis of inventory data, 133 number of plots, which falls inside the production working circle, were used to estimate average standing trees volume and other parameters. Out of 133 inventory plots, 94 plots falls inside the commercial use area and 39 plots in local use area. The R-statistics was used to analyse the inventory data for calculation of average standing volume per hectare, basal area per hectare and number of trees per hectare in this plan period.

The summary of inventory results is shown in the table below.

Table 18: Summary of inventory results

Stratum Name	Gross area (ha)	No.of plots	Average Volume/ha		Average No.of trees/ha		Average Basal Area/ha	
			M^3	SE %	No.of trees	SE %	Basal area	SE %
Commercial Use								
Mixed Conifer	2273.1	67	407.88	15.6	195.9	10.5	29.6	14.4
Fir	732.1	27	374.44	21.6	162.1	16.3	27.1	20.5
Total	3005.2	94						
Local Use								
Mixed Conifer	1132.3	39	228.74	28.98	55.1	40.0	19.5	25.4
Broad leaf			12.21	53.05	154.4	21.1	2.2	45.4
Total	1132.3	39						

SE: Sampling Error (at 95% level of probability)

13. AREA ORGANISATION

13.1 Spatial Organisation

The area of FMU has been divided into blocks, compartments and sub-compartments for better management of FMU areas. The blocks have been demarcated according to the natural drainage and land terrain and there are three blocks: Nago, Rashigang & Susunang.

The compartments within the blocks were demarcated based on identifiable topographic or plainmetric features such as prominent ridges, rivers and streams, etc.

Table 19: Areas by blocks, compartments and sub-compartments in the FMU

Sl.No.	Block	Compartment	Sub-compartment	Sub-compartment Area (ha)	Total Compartment Area (ha)
1	Nago	I	a	196.34	1065.56
			b	711.18	
			c	158.04	
		II	a	185.47	580.94
			b	395.47	
		III	a	269.14	749.34
			b	440.69	
			c	39.51	
Sub Total					**2395.84**
2	Rashigang	I	a	67.83	1117.43
			b	544.27	
			c	505.33	
		II	a	679.7	679.75
Sub Total					**1797.18**
3	Susuna	I	a	287.95	1080.43
			b	123.81	
			c	511.88	
			d	156.79	
		II	a	652.14	957.80
			b	305.67	
		III	a	378.29	1028.86
			b	404.39	
			c	246.18	
Sub Total					**3067.09**

13.2 Determining Operable Area

Bitekha forests will be managed for multiple purposes. The multiple uses of forests are generally protective, climatic, productive, scientific, recreational, aesthetic, social, etc. However, while managing a unit area of forest, all such purposes cannot be synchronized. The areas 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 forest inventory

information. The functions that take precedence over commercial and rural forestry activities are:

- Soil protection areas (slope greater than 100 %);
- Soil conservation;
- Riparian buffers and zones;
- High altitude zones (above 4000m);
- Local water supply protection;
- Biodiversity areas (wildlife conservation and protection);
- Religious site protection;
- Agricultural uses;
- Road buffers.

13.3 Organization into Management Circles and Working Circles

The function mapping was used to delineate three broad management circles for BFMU: Protection, Production and Non-Production Management Circles.

Table 20: Area statement for management circles and working circles

Functions/Zones	Area covered(ha)
Protection Management Circles	
Soil Protection	1408.32
Wildlife Protection	1288.51
Riparian Reserve Protection	198.33
Local Water Supply Protection	85.60
Religious site protection	6.28
Non-Production Management Circles	
Private/Cultivated Land	531.33
Meadows	110.22
Built Up Areas	0.79
Shrubs	402.94
Snow Cover	6.95
Production Management Circle	
Mixed Conifer and Broad leaf Working Circle	3405.4
Fir Working Circle	874.06

13.3.1 Protection Management Circle

The Protection Management Circle is an area under protection where no commercial activities can take place. The Protection Working Circle is the sum of all protection functions; wildlife protection, soil protection, riparian reserve protection, religious site protection and local water supply protection and covers a total area of 2061.93ha; making 28% of the total area.The management objectives and options for this circle are briefly given below.

Table 21: Protection management circle

Management Objectives	Management Options	Responsibility
To conserve and enhance wildlife habitats and biodiversity.	Avoid disturbance Promote research.	All parties Territorial Division
To conserve the water catchment functions and watershed values of the FMU	Minimal intervention.	All parties
To meet local needs for NWFPs on sustainable basis.	Resource assessment Regulate harvesting on sustainable basis.	Territorial Division
To protect the forest from grazing, fire and illegal activities.	Involve local people in participatory planning process.	Territorial Division
To raise awareness of the important biodiversity areas.	Public meetings/field visits Research.	Territorial Division
To respect the sanctity of religious places.	Non-intervention	All parties

NB: Sanitation operations may be carried out with appropriate silviculture operations to remove diseased stands and prevent further spread of pests and diseases with prior approval from the Head of the Department.

13.3.2 Non-Production Working Circle

The Non-Production ManagementCircle includes areas where production is not economical or feasible. The management circle generally comprises non-forest areas, settlements and agricultural use areas. The total area under Non-Production Management circle is about 1060.77ha and it is 15% of the total BFMU area.

As principle of equity and justice has been considered as one of the principle for formulation of national forest policy and managing forests responsibly and sustainably requires a balanced approach encompassing economic, social and environment, limited

developmental activities may be allowed inside the non-production working circle with less significant impact on the FMU to support local livelihoods. The activity has to pass through the relevant environmental Acts and Rules, and other necessary applicable laws.

Table 22: Non-production management circle

Management Objectives	Management Options	*Responsibility
To meet NWFPs for local needs	Apply management guidelines and involve community for monitoring	Territorial Division
Environmental conservation	Consider environmental values in the planning process	NRDCL/Territorial Division
To maintain and improve the non-forested area	Follow plan prescriptions	NRDCL/ Territorial Division
To regulate grazing by livestock	People's participation through workshops and sensitization	NRDCL/Territorial Division

*Note: Lead agency is the first agency listed

13.3.3 Production Management Circle

The Production ManagementCircle comprise the area left after identifying the critical functions and mapping out by using GIS software. This management circle constitute areas which are more stable and stocked with commercially important species. The area would be harvested for commercial and rural timber supply.The area for production circle is 4137.3 ha and it makes 57% of the total FMU area.

Sustainability of this working circle should be science-based measures that provide a consistent approach to define, assess, monitor and report progress on sustainable forest management to a wide range of stakeholders and institutions. As the management circle also contain rich biodiversity because of stable and good stands, the production forests, therefore, need to be managed for more than just timber production, but also for objectives such as biodiversity conservation, environmental services, including carbon capture and storage. Management perspectives need to embrace the larger landscape, not be focused simply at the stand level. In this working circle. To retain management circle as a unit of sustainability for timber production, developmental activity should not be encouraged for individual vested interest or benefits. This is to sustain working circle for not only perpetual production of timber and conservation of biodiversity, but also for carbon capture and storage by avoiding reduction of production area and safeguard from unwanted disturbances, which may impact social and economic as well as environmental dimensions of forestry. This is also to include the important function of forests and trees outside forests to store carbon and thereby contribute towards the achievement of commitment on climate

change.Forest Management Code of Bhutan, 2004, also recommend that FMUs be retained as the principle unit for sustained yield.

CFO, Paro, should create an appropriate section with competent forestry officer under Division to look after all the matters related to FMUs and facilitate CFO in reviewing and ground truthing of any proposals of land lease and allotment or for any developmental activities within FMU. This is to ensure dealing officer thoroughly verify in absence and on behalf of CFO to avoid any procedural lapses like in the last plan period. As per evaluation recommendation, establishment of new CF in already existing/operating FMU should not be allow. In case there is need for establishment for the benefit of local communities, establishment should be allow during time of plan revision only after through discussion in the FMU-Level Forest Management Committee Meeting between CFO and local communities for smooth functioning of FMU operations. In case the proposed area for any developmental activities falls inside the production-working circle and it is of national interest and benefits, CFO will apprise the Department for perusal for further action.Any activity within production management circle has to pass through the relevant environmental Acts and Rules, and other necessary applicable laws.

Blue pine production working circle has been merged with the mixed conifer forests in this plan period because only limited number of inventory plots falls inside the stratum and margin of error was high to project the AAC for this stratum. Further, there are existence of many private registered land inside the blue pine forest, which are near the settlement. Including blue pine forest as separate working circle in this plan period would compromise sustainability of actual blue pine forests, which would be known after private individual land owners convert registered land with blue pine stands to agriculture use. Therefore, blue pine stratum has not been projected as separate working circle in order to facilitate BFMU and Division to regulate allocation of conifer trees for local use.

Table 23: Production management circle

Management Objectives	Management Options	*Responsibility
To meet local need timber and other forest produce on sustainable basis	Priority must be given to local people	Territorial
Manage commercial timber production on a sustainable basis	Scientific and systematic harvesting	NRDCL/Territorial
Enhance and improve forest condition and productivity	Suitable silviculture operation, adapt research findings and re-forest harvested areas	NRDCL/Territorial
Create employment	Preference to local people and involve them	NRDCL/Territorial

Maintain biodiversity within production area	Document, research and field visit	Territorial

*Note: Lead agency is the first agency listed

13.3.4 Non Wood Forest Products Management Circle (overlapping)

Non-Wood Forest Products (NWFPs) are important source of income for improvement of rural people's livelihoods. However, unregulated collection of NWFPs may not only surpass the production potential of NWFPs in the forest, but would also cause genetic erosion in the wild in near future. Certain NWFPs would be also serving as food materials for wildanimals and unsustainable collection would reduce food materials in the wild and cause wildanimals crossing into agriculture field in search of food, thereby causing human-wildlife conflict. NWFPs should be assessed with available guidelines for resource availability and accordingly prescribe for sustainable harvesting. FRMD in collaboration with SFED should look into the possibility of developing methodology for calculating AAC for important NWFPs of the FMU. FMU in-charge should make use of available references developed by SFED for assessing NWFPs and then regulate supply during this plan period for sustainability. Removal of NWFPs from BFMU with intend of research and commercialization utilization by any individual or parties should, in this plan period, be guided by Biodiversity Act of Bhutan to conserve value of genetic materials/resources and ensure there is access and benefit sharing to the resources provider.

The Management Circle shall overlap with all other Management Circles, including Protection and Non-Production Management circles which constitutes the entire FMU area. The overall objective of this Working Circle is to manage the NWFPs in Bitekha on sustainable basis, and monitor low impact collection.

13.4 Management of Working Circles

The Production Management Circle has been divided into three regular working circlesfor easy management of the forests. The Production Working Circle includes all areas where harvesting can occur, both commercial and rural. The Working Circles have been created on the consideration of stands requiring similar silvicultural treatment and rotation age. The three working circles are:

i. **Mixed Conifer Working Circle**
ii. **Fir Working Circle**
iii. **Broad leafWorking Circle**

Table 24: Mixed conifer working circle

WORKING CIRCLE: MIXED CONIFER AAC = 43695 m^3				
Management Objectives	**Management Options**	***Responsibility**	****Monitoring**	**Silvicultural Systems**
To meet local requirements as a priority, for timber, fuel wood and other forest products on a sustainable basis	• Allow closely monitored and controlled marking of trees	• Territorial	• Territorial	**Single Tree Selection System** Applied for Local Use Only for rural tree marking
To manage the commercial timber production on a sustainable basis.	• Use appropriate logging and silviculture methods • Operate entire length of cable line • Ensure cable line layout allows interline logging • Encourage cleaning of entire harvested areas • Maintain prescribed group and cable corridor sizes • Reforest harvested areas if natural regeneration fails	• Territorial/NRDCL • Territorial/NRDCL • Territorial/NRDCL • NRDCL/Territorial • Territorial/NRDCL • NRDCL/Territorial	• Territorial • Territorial • Territorial • Territorial • Territorial • Territorial	**Group Selection System** Cable lines will be laid to their full capacity. Group openings will not exceed 0.15ha and the space between the cable lines will not be less than 60m. The layout of lines must allow at least two interline logging operations.The distance between groups along cable lines will not be less than 50m. The corridor should not exceed 4m width. All merchantable trees >10cm DBH will be felled. Dead, dying, malformed and diseased trees will be felled by priority.
To create local employment opportunities.	• Provide proper training • Encourage contractors to hire worker locally	• NRDCL/Territorial • NRDCL	• Territorial • NRDCL	
To protect the forest from fire and illegal activities and from grazing in regenerating areas.	• Control grazing, fire, poaching and illegal felling with local community participation	• Territorial	• Territorial	

To enhance and improve forest condition and productivity.	• Ensure that all bare and past harvested areas are restock sufficiently with desired species composition • Use stand tending techniques • Work with local communities for planting/restocking activities • Use FULL CABLE LINE LENGTH in Beetle Attacked areas • Create favourable conditions for regeneration and growth	• NRDCL/Territorial • NRDCL/Territorial • NRDCL/Territorial • NRDCL/Territorial • NRDCL	• Territorial • Territorial • Territorial • Territorial • Territorial	Openings can have irregular shapes and should be based on terrain features and stand conditions. Areas of windfall, natural openings and regeneration should be considered when locating group openings. Damage to residual stand must be avoided.
To continually improve health and safety standards.	• Provide training to contractors • Promote awareness in the local community	• NRDCL • Territorial	• Territorial • Territorial	
To conserve the water catchment functions.	• Minimal intervention • Abide by stream buffer regulations	• Territorial/NRDCL • NRDCL/Territorial	• Territorial • Territorial	
To maintain biodiversity within the production area.	• Low impact silviculture systems	• Territorial/NRDCL	• Territorial	

NB:

- *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 and final evaluation.*

Table 25: Fir working circle

WORKING CIRCLE: FIR AAC = 775 m^3				
Management Objectives	**Management Options**	***Responsibility**	****Monitoring**	**Silvicultural Systems**
To meet local requirements as a priority, for timber, fuel wood and other forest products on a sustainable basis	• Allow closely monitored and controlled marking of trees • Promote use of discarded timber	• Territorial • Territorial	• Territorial • Territorial	**Single Trees Selection: For Rural Tree Marking**
To manage the commercial timber production on a sustainable basis.	• Operate entire length of cable line • Ensure cable-line layout allows interline logging • Encourage cleaning of entire lines by firewood contractors • Use appropriate logging and silvicultural methods • Harvest all areas regardless of financial return	• Territorial/NRDCL • Territorial/NRDCL • NRDCL • NRDCL/Territorial • NRDCL	• Territorial • Territorial • Territorial • Territorial • Territorial	**Group Selection: Commercial use** Cable lines will be laid to their full capacity. Group openings will not exceed 0.1ha and the space between the cable lines will not be less than 60m. The layout of lines must allow at least two interline logging operations. The distance between groups along cable lines will not be less than 50m. The corridor should create to pass cable tension or log and should not be considered for timber production. Trees
To create local employment opportunities.	• Provide proper training • Encourage contractors to hire locally	• NRDCL/Territorial • NRDCL	• Territorial • NRDCL	
To protect the forest from fire and illegal activities and from grazing in regenerating areas.	• Control grazing, fire, poaching and illegal felling with local community participation	• Territorial	• Territorial	

To enhance and improve forest condition and productivity.	• Ensure that all bare and past harvested areas are restock sufficiently with desired species composition • Use stand tending techniques • Work with local communities for planting/restocking activities • Harvest ALL Fir(Dieback also)areas to ensure the next rotation has less rot using FULL CABLE LINE LENGTH • Create favourable conditions for regeneration and growth	• NRDCL/Territorial • NRDCL/Territorial • NRDCL/Territorial • NRDCL/Territorial • NRDCL	• Territorial • Territorial • Territorial • Territorial • Territorial	falling the cable line will be felled if trees obstruct cable tension and in any case corridor width should not be more than 4m wide. All merchantable trees >10cm DBH will be felled. Dead, dying, malformed and diseased trees will be felled by priority. Openings can have irregular shapes and should be based on terrain features and stand conditions. Areas of windfall, natural openings and regeneration should be considered when locating coupes. Damage to residual stand must be minimised.
To continually improve health and safety standards.	• Provide training to contractors • Promote awareness in the local community	• NRDCL • Territorial	• Territorial • Territorial	
To conserve the water catchment functions.	• Minimal intervention • Abide by stream buffer regulations	• Territorial/NRDCL • NRDCL/Territorial	• Territorial • Territorial	
To maintain biodiversity within the production area.	• Low impact silviculture 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 and Final Review.*

Table 26: Broadleaf working circle

WORKING CIRCLE: Broadleaf AAC = 50 m^3				
Management Objectives	**Management Options**	***Responsibility**	****Monitoring**	**Silvicultural Systems**
To meet local requirements as a priority, for timber, fuel wood and other forest products on a sustainable basis	• Allow closely monitored and controlled marking of trees • Promote use of discarded timber	• Territorial • territorial	• Territorial • territorial	**Single Trees Selection: For Rural Tree Marking.** Broad leaf species are distributed singly inside the local use area and contributes about 5 % to the overall local AAC. Moreover, as per recent trend of commercializing blue pine trees from private registered land, most of the blue pine stands seems to be inside the local use area. There is less demand on broadleaf species for timber by local people and merging broad leaf with conifer stratum would not only compromise sustainability of blue pine and other conifer species inside Government Reserved Forest Land of FMU, but would also surpass from the actual availability of blue pine and other conifer timber in the plan period.
To protect the forest from fire and illegal activities and from grazing in regenerating areas.	• Control grazing, fire, poaching and illegal felling with local community participation	• Territorial	• Territorial	
To enhance and improve forest condition and productivity.	• Use stand tending techniques • Work with local communities for planting/restocking activities • Harvest dead, dying, dried and diseased trees to ensure creation of space for natural regeneration, by creating favourable conditions for regeneration and growth	• Territorial • Territorial • Territorial	• Territorial • Territorial	
To conserve the water catchment functions.	• Minimal intervention • Abide by stream buffer regulations	• Territorial • Territorial	• Territorial • Territorial	
To maintain biodiversity within the production area.	• Low impact silviculture systems	• Territorial	• Territorial	

Note:

- *All objectives will be evaluated annually by the FMU Level Management Committee during the Mid-termand final Evaluation.*

13.5 Implementing Management of Working Circle

The concept of Forest Function planning has been used in this plan to allocate land use among the forest in the FMU to facilitate strategic planning for sustainable yield.However, the problem would remain to implement these prescriptions on the groundas locating individual forest functions with boundaries would be complex. Nonetheless, this will be done through an operational planning process whereby information that is more detailed is collected through inventory and discussions with all the stakeholders and this is indicated in later sections.

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

14. YIELD REGULATION AND HARVESTING

14.1 Determination of the Annual Allowable Cut (AAC)

14.1.1 Introduction

Principle of Sustained Yield is an accepted norm in Forest Management; forming the core principle of organized forestrywithout impairment of the productivity of the soil. It ensures stability and continuous supply of raw material to meet the social and domestic needs of the people. The principle envisages that a forest should be so exploited that the annual or periodic felling do not exceed the annual or periodic growth.The concept has been evolved from the basic consideration that the later generations may derive from the forests at least as much of the benefits as the present generations. Calculation of Sustained Yield is expressed as Annual Allowable Cut (AAC).

14.1.2 Increment Based AAC

In many of the FMUs in Conifer zone, increment based method could be used for sustainable cut based on the yearly increment. Unfortunately, this method relies heavily on the growth data for which in Bhutan we do not have permanent sample plots to ascertain the data. At present, the increment data available has, therefore, not been used in determining the AAC.

14.1.3 Area based AAC

Area based AAC requires less inventory data and works well with an even distribution of volume over the forest, which is not the case in the natural forests of Bhutan. An area based

AAC would indicate difficulties for NRDCL in practical planning and operational viability as actual volume brought to market would vary dramatically year to year.

14.1.4 The Most Appropriate AAC Method

Given the options of many formulae with their own advantages and disadvantages, many studies were done and it was found that a fairly simple and robust methodology could be used and accordingly the following calculation is used for calculating the AAC in standing volume equivalent. The formula is based on a combination of area, volume and rotation.

$$AAC\ per\ Working\ Circle = \frac{Net\ Operable\ Area}{Rotation} * Average\ Standing\ Volume\ per\ Ha$$

14.1.5 The Calculation of AAC for Bitekha FMU

Net Operable Area

The total operable area is identified through mapping using Geographic InformationSystem (GIS). However, it has been observed that all the operable area identified is not accessible for timber harvesting due to presence of steep and rocky terrain, water bodies, and other conservation areas. Also Group Selection System almost inevitably leads to some patches of mature timber being left in later phases due to the presence of new regeneration and the damage that the total removal of the over-storey would cause. In such challenging terrain as in Bhutan, exact geometric-shape group layout is rarely possible. Further, timber removal would also take place through other biotic and abiotic factors during plan period and operable area would reduce, but would not be possible to account in some cases. Some of the inventory plots fall inside the production area of previously operated area and estimated standing volume from this area also contributes to the estimated AAC of the future plan. There are private registered land within local use area and many blue pine stands would felled for conversion of agriculture use wherein, trees would be completely removed from the land. As it is difficult to get clear picture of blue pine forest falling within the private registered land, certain percent has been deducted for the calculation of net operable area. Therefore, due to above inevitable areas and circumstances,certain percent of the area has been reduced from the gross operable area to calculate net operable area for commercial and local use working circles.

Because of singly distributed broadleaf trees inside the local use, it is not possible to reflect in the production function map. However, broadleaf contributes 5% to the local AAC and BFMU will have to accordingly regulate allocation of AAC by considering the standing volume contributed by broad leaf. This allows different areas to be managed and evaluated separately.

Table 27: Net operable area

Working Circle	Gross Operable Area (ha)	Calculation	Net Operable area (ha)
A. Commercial Use (NRDCL)			
Mixed Conifer	2273.1	**Gross Operable Area – 35%**	1477.5
Fir	732.1	**Gross Operable Area – 35%**	475.3
Total	**3005.2**		**1952.8**
B. Local Use (Rural)			
Mixed Conifer	1132.3	**Gross Operable Area – 15%**	962.5
Broad leaf			
Total	**1132.3**		**962.5**

Rotation

Species *Rotation* or *Production Period* is an imprecise concept in silvicultural system other than *Clear-felling System* and *Plantations.* Since reliable increment data is still very limited for Bhutan, assumed rotation lengths need to be cautious. For Group Selection System, the objective is to have more or less even aged regeneration in areas worked out aneach cut. The assumed rotation length for mixed conifer like Hemlock and Spruce is 140 years and for Fir is 160 years. The assumed rotation length for broad leaf is 110years. Consideration of regeneration period while calculating rotation lengths is a crucial factor. Therefore, while calculating AAC in BFMU, for this plan period a 20 years of regeneration period has been added to the rotation age of Mixed Conifer and for Fir, while for broadleaf, 10 years of regeneration period has been added. The assumed rotation lengths for the calculation of AAC in BFMU are:

Fir working circle : 160+20 years

Mixed Conifer working circle : 160+20 years

Broadleaf working circle : 100+10 years

Average Standing Volume

The Mature Standing Volume is taken from the inventory data that is calculated using R-statistics and Microsoft SQL programme. Owing to the high sampling error, the range of possible standing volumes at 95% probability level is large, meaning that there is a high level of uncertainty with these figures.The sampling error and reliable minimum estimate for each stratum is given below.

Table 28: Average standing volume

Strata	Average Standing Volume (m^3/ha)	Sampling error % (at P=0.95)	Reliable Minimum Estimate (m^3/ha)
Commercial use			
Mixed Conifer	407.88	15.6	344.25
Fir	374.44	21.6	293.56
Local use			
Mixed Conifer	228.74	28.98	162.45
Broad leaf	12.21	53.05	5.73

AAC for each WorkingCircle

Table 29: AAC for each working circles in standing volume

Strata	Net operable area (ha)	Rotation	RME of Average Standing Volume (m^3/ha)	AAC (m^3/year)	Clear Cut Equivalent Area (ha)
Commercial use					
Mixed Conifer	1477.5	180	344.25	2826	8.21
Fir	475.3	180	293.56	775	2.64
Total	**1952.8**			**3601**	10.85
Local use					
Mixed Conifer	962.5	180	162.45	869	
Broad leaf		110	5.73	50	
Total	**962.5**			**919**	

The total AAC for BFMU for this plan period is fixed at 4500m^3 in standing volume.

The AAC for each working circle is not permitted to transfer AAC allocation from one working circle to another and the AAC for each working circlemust be adhered to. However, it is permissible to vary the AAC by plus or minus 10%in individual years, but the volume cut in each five year period must be no more than five times the AAC.

14.2 Recording and Accounting for AAC

Every trees marked in all working circles for commercial and rural use from commercial and local production area identified will be entered intoTree Marking Book (TMB) by UIC. Separate TMB and register for commercial and local/rural timber marking will be maintained in the BFMU office. Besides TMB and registers, the UIC will maintain compartment record keeping format of FMCBon annual basis and safely store for record of annual AAC (both standing volume in cubic meter and clear cut equivalent area in hectare) achievements. The AAC has been calculated as gross bole volume, and this is the measure that should be totalled on an annual basis from the TMB, formats and registers. AAC will be accounted and adjusted in annual operational plan to regulate and ensure the timber harvesting donot exceed prescribed AAC.

Every tree removal through other means like natural calamities such as windstorm, landslide, and biotic interferences like illegal harvest, pests and diseases, forest fire, developmental activities, etc., should be recorded as per block and compartment wise and account in AAC for the year.Considering only the timber removal from normal cable lines and rural tree marking through valid permit would undermine the sustainability since huge quantity of timber would have been removed through above process by end of the plan period. This would not only provide record of actual removal of trees, but would also remind NRDCL and rural people for their active participation on forest management in some ways or the other to sustain timber production.

14.3 Allocation of the AAC

The allocation of the AAC must take into account the needs of the local people (living within and near to BFMU) while providing NRDCL with timber and accounting for the needs of other organisations and national needs. The AAC for commercial and rural has been allotted as follows:

Standing Volume (m^3)	Allotted to
900	Local use: allotted tolocal user (Local residents and the general public)
3600	NRDCL: Allotted to NRDCL for meeting the timber demand in the market.

14.4 Distribution of the cut

To provide basic distribution of cut, the AAC has been calculated by Mixed Conifer, Fir and BroadleafWorking Circle. The AAC between Working Circles is **non-transferable** if layout of cable lines working is confined to one particular working circle. However, if cable lines passes through all the working circle e.g. from mixed conifer to fir, the overall AAC would be considered. The operation is,therefore, to provide a properly organised and

regulated management, economical harvesting and regeneration, an orderly and sequential system of harvesting.

Although the AAC is volume based, it is essential to monitor the amount of area that is being harvested. Assuming the reliability of the inventory (average standing volume) is reasonably high, the volume per hectare should be calculated during operational inventory to represent the number of lines that can be feasibly operated and mentioned in Operational Plan. Therefore, if the UIC notices that more cable lines (or less) are being harvested annually then the AAC **must be** adjusted.

For overall local conifer AAC, different sizes of conifer timber trees contributes to the AAC. 9% was contributed by pole sized, 58% by *Tsim*, 24% by *Cham* and 10% by *Drashing*. Therefore, it is imperative that the BFMU workout the allotment of conifer timber based on the availability of timber available in different sizes. Local use of conifer timber would be high on *Drashing* size and removal of trees of *Drashing* size should be regulated to ensure there is no over harvesting of one timber sizes.

15. SILVICULTURAL SYSTEM

15.1 Group Selection System

Group Selection System with natural regeneration based on forest type and mode of regeneration is the prescribed Silvicultural System for the Mixed Conifer. The particular Silvicultural System has been selected based on ecosystem and natural regeneration system. The Group Selection System has also been introduced in preference to Single Tree Selection System as an effective way of regenerating the major coniferous species. Small openings 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. The openings should be no larger than one and half tree length in the Hemlock, Spruce and Fir stands.

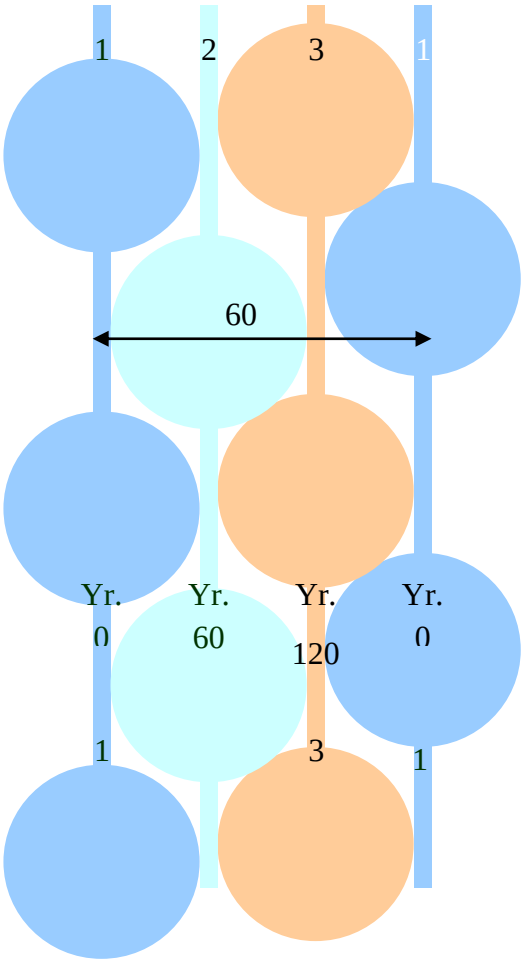


Figure 5:Layout for group selection

15.1.1 Working Pattern

The groups of prescribed size will be opened up along the cable lines on either side of the cable corridor alternatively. The distance between

the cable lines will not be less than 60 m and not less than 50 m between the groups along the cable lines. The distance between cable lines can be more than 60 m by few meters if the group openings are not accessible within 60 m distance. The group openings will be considered even if there is no stock of timber or few standing trees and considered the area as clear cut area as the AAC is determined by area also and for sustainability of FMU. The corridor width should not exceed 4 mand only trees that would obstruct cable crane tension and safe passage of logs should be marked and felled. If the branches are overlapping the cable corridor and would increase the width of cable corridors, it is recommended to lop the branches instead of felling the tree. The cable corridor is passage of skyline and logs and should not be considered as timber production area. The effective area within the limitof standard cable length is 6 ha (1000 m X 60 m), (-) the area of the corridor of 0.40 ha (1000 m X 4 m), thus the one-third removal would be equivalent to (1.87 ha) which is the area available for opening groups. Thus, it would be possible to open up around 9 to 10 groups along the standard cable lines. If the average height is taken to be around 35 metres and further, the diameter of any openings will not exceed 50 metres.

Due to land terrain of the FMU, the individual openings need not be uniform in shape and size or systematically located along cable lines. In most cases the openings will be irregular in shape and systematic location of groups will be almost impossible. Aspect, slope and Silvicultural requirement will influence the actual size and shape of the groups. However, an average of 0.15 ha opening is recommended for group openings under mixed conifer working circle and not more than 0.1 ha in case of fire working circle. The details on group openings are given in the table 31.

Table 30: Size of group opening based on forest type and conditions.

Sl.No.	Forest Type	Site Conditions	Understory Conditions	Size of Group Opening
1	**Spruce**	Moist sites (mostly Northern aspects, valleys)	Bamboos and understory competitors	0.1-0.25ha
			Herbaceous understory, no major competitors	0.25-0.35ha
		Dry sites (mostly Southern aspects, ridges)	Bamboos and understory competitors	0.1ha
			Herbaceous understory, no major competitors	0.1-0.15ha
2	**Hemlock**	Moist sites (mostly Northern aspects, valleys)	Bamboos and understory competitors	0.1-0.25ha
			Herbaceous understory, no major competitors	0.25-0.3ha
		Dry sites (mostly Southern aspects, ridges)	Bamboos and understory competitors	0.1-0.15ha
			Herbaceous understory, no major competitors	0.1-0.2ha
3	**Fir**		Bamboo/large rhododendron understory	0.1ha centered around saplings/poles
			Herbaceous/moss understory, no major competitors	0.25ha

Source: RNR-RDC, Yusipang

Existing openings in the stands which can be expanded, signs of existing windfall in the stands, stands which are matured or diseased, and stands infested with mistletoes should be chosen as groups for opening on priority basis.

In order not to lose the site protection effect of the surrounding trees, it is necessary that the specified size for openings should be strictly adhered to. The felling direction should be considered and trees should be felled towards the centre of the group opening wherever possible to avoid damage to the unmarked trees.

Terrain with steep slope and exposed to south and south-western aspects should be avoided, or the openings should be smaller to match with the terrain and site conditions or the selection system should be applied in areas where opening cannot be created under Group Selection System (in between two cable lines). However, spatial distribution of the trees should be strictly followed and should match with openings created under Group Selection System.

It is also recommended to retain rotten logs and coarse woody debris on the forest floor particularly in Spruce and Hemlock forests as seed beds for regeneration as given below.

Table 31: Coarse woody debris (CWD) based on size of group opening.

Sl.No.	Forest Type	Opening Size (ha)	Coarse Woody Debris (m^3)
1	Spruce	0.15	0.6-1.3
		0.20	0.8-1.8
		0.25	1.0-2.3
		0.30	1.2-2.7
		0.35	1.4-3.2
2	Hemlock	0.15	1.3-1.8
		0.20	1.8-2.4
		0.25	2.3-3.0
		0.30	2.7-3.6
		0.35	3.2-4.2

Source: RNR-RDC, Yusipang

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 and lesser damage to residual stands;

- Aesthetically and environmentally more acceptable than clear cutting system.

15.3 Single Tree Selection System

This System will be adopted in Local Use Only forests areas for rural tree 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. Felling should involve removing of trees or small groups of trees. 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 first especially in young and immature stands.

- Dead, dying, diseased, misshapen 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.

15.4 Silviculture Research Findings for general reference (by RNR-RDC, Yusipang)

RNR-RDC, Yusipang, has compiled several research findings on silviculture system of conifer forests of the country in 2014, and has been recommended for Forest Management Code of Bhutan. Although recommendations have to be site specific and appropriate, some of the recommendations mightbe very useful for the general reference to the Division and BFMU to certain conditions of forests and site specific in FMU.

15.4.1 Fire forests(*Abies densa*)

Table 32: Silviculture recommendations for the fir forests.

Understory conditions	Management type	
	FMUs, WS, leased GRF	CF, PF, GRF outside FMU, PA
Bamboo / large rhododendron Understory	Group selection (0.1 ha) centred around saplings / polesSingle tree selection	Single-tree selection Group selection (0.1 ha) centred around saplings / poles

Herbaceous / moss understory, no major competitors	Group selection (0.25 ha) Single tree selection	Single-tree selection Group selection (0.25 ha)

Recommendations Group Selection

- On sun-exposed sites, select oval-shaped openings with long axis in E-W direction

General recommendations

- Selectively thin out middle layer to stabilize stands
- Do not harvest in wet spots and on slopes >70%
- Conserve snags
- On sites with bamboo / rhododendron destroy these through directional felling
- On sites with bamboo retain coarse woody debris as nurse logs for regeneration
- If openings become dominated by bamboo, apply moderate cattle grazing to promote regeneration, phase out grazing once seedlings reach bamboo height

15.4.2 Hemlock forests (*Tsuga dumosa*)

Table 33: Silviculture recommendations for the hemlock forests.

Site conditions	Understory Conditions	Management type	
		FMUs, WS, leased GRF	CF, PF, GRF outside FMU, PA
Moist sites (mostly northern aspects, valleys)	Bamboos and Understory Competitors	Group selection (0.1 - 0.25 ha) Single tree selection	Single-tree selection Group selection (0.1 ha)
	Herbaceous understory, no major competitors	Group selection (0.25 - 0.3 ha) Single tree selection	Single-tree selection Group selection (0.1 ha)
Dry sites (mostly southern aspects, ridges)	Bamboos and Understory Competitors	Slit cut (0.1 ha: 20m*50m) Group selection (0.1 - 0.15 ha)	Single-tree selection Group selection (0.1 ha)
	Herbaceous understory, no major competitors	Slit cut (0.125 ha: 25*50m) Group selection (0.1 - 0.2 ha)	Single-tree selection Group selection (0.1 ha)

General recommendations

- In the harvested area maintain large size coarse woody debris (rotten logs), or intact timber, in case rotten logs are not available (10 m^3*ha^{-1})
- On sites dominated by dense bamboo understory, prescribe cattle grazing to reduce bamboo height enabling successful regeneration

15.4.3 Spruce forests (*Picia spinulosa*)

Table 34: Silviculture recommendations for the spruce forests.

Site conditions	Understory Conditions	Management type	
		FMUs, WS, leased GRF	CF, PF, GRF outside FMU, PA
Moist sites (mostly northern aspects, valleys)	Bamboos and understory competitors	Group selection (0.1 - 0.25 ha) Single tree selection	Group selection (0.1 ha) Single-tree selection
	Herbaceous understory, no major competitors	Group selection (0.25 - 0.35 ha) Single tree selection	Group selection (0.1 ha) Single-tree selection
Dry sites (mostly southern aspects, ridges)	Bamboos and Understory Competitors	Slit cut (0.1 ha: 20m*50m) Group selection (0.1 ha)	Group selection (0.1 ha) Single-tree selection
	Herbaceous understory, no major competitors	Slit cut (0.125 ha: 25*50m) Group selection (0.1 - 0.15 ha)	Group selection (0.1 ha) Single-tree selection

General recommendations

- Thinning & tending to avoid slim trees and unstable stands
- Logging sanitation to avoid bark beetle attack
- Create small openings on dry sites to avoid heavy competition and bark-beetle attacks

15.4.4 Blue pine forests (*Pinux wallichiana*)

Table 35: Silviculture recommendations for the spruce forests.

Site conditions	All management types
No pests	Single tree selection Small group selection

General recommendations

- In stands in western Bhutan heavily infested by dwarf mistletoe, applying clearcutting, leaving uninfected trees as seed trees
- Blue pine stands tend to be extremely densely stocked, leading to high mortality and instability. Conduct periodic thinning in Blue pine stands

16. FOREST PROTECTION

16.1 Fire

Noincidences of fire have been recorded in the first management plan period. However, the dead and dying species are prone to fire resulting from the carelessness of the local people. The risks of fire are expected with the opening of forests due to harvesting in future. Strict vigilance should be in place to prevent fire and also the local people should be made aware on fire prevention and control measures. The Unit-in charge and the Unit Manager should review forest fire protection programs at regular intervals in close consultation with the local people and other stakeholders.

16.2 Pest and Diseases Management

The Eastern Himalayan spruce bark beetle, *IPs Schmutzenhoferi*, is a serious pest of *Picea spinulosa* and *Pinus wallachiana* in Bhutan. In the first management plan period, 160 numbers of trees (equivalent to 611.20 m^3 standing volume) were affected by spruce bark beetle and was salvaged in 2015. The cause of bark beetle outbreak would have been contributed by various factors, but some of the preventable causes of beetles would be unhygienic logging operation by contractors and removal of timber by miscreants wherein,Spruce and Blue pine tree barks are not debark, dragging and rolling of logs, felling direction not followed, etc. In this management plan period, the following strategies were recommended for prevention of bark beetle epidemics.

- Reducing other bark beetles breeding possibilities (if any);

- Always debarking fresh logs, stumps, rejected logs, butt and the branches up to 10 cm diameter of Spruce and Blue pine immediately after the felling by NRDCL and local people.;
- Arranging to fell the drying, weak, mistletoe attacked, diseased and damaged trees and debark;
- Not neglecting to organise debarking of stumps and unused tree tops;
- Looking for wind fallen, hanging and broken trees, and arranging immediate sanitation operation;
- Improving forest management conditions;
- Ensuring living conditions for all beneficial organisms (parasites, predators, birds, insect feeding animal);
- Ensuring that during road construction and logging operation utmost care is taken to minimise damage to the stands;
- Taking extra caution to prevent forest fire;
- Creating general awareness on bark beetle problem by holding public meetings;
- Periodic survey of the forest stands by FMU & NRDCL staff;
- Avoid rolling and dragging of logs and prevent root rot and strictly follow tree felling techniques;
- Capacity building of NRDCL and FMU staff on early detection of bark beetle presence by proposing in operational plan with adequate budget allocation;
- Understand and consider the life cycle and metamorphosis of bark beetles to adopt control measures by FMU staff.

For immediate removal of affected trees to prevent further spread of beetles and control its epidemic, FMU will enumerate the affected trees and records all the required information advised by CFO, Paro, or the DoFPS. Detection report should be submitted to the CFO, Paro,and also to Specialist(s) for preventive measures.

For detailed descriptions on symptoms and damages, preventive and control measures including information on life cycles and identification photographs can be referred to *Important Forest Pests and Diseases of Bhutan with Control Measures*, Tshering & Chhetri (2000).

16.3 Grazing

In line with the multiple-use of forests as outlined in the Forest Policy of Bhutan, grazing will be allowed in some parts of the FMU. However, grazing will not be allowed in areas

identified as protection areas and only light grazing should be permitted in areas identified as conservation areas. The strategies those are aimed at reducing and regulating grazing in the forest and at improving breeds of cattle and their productivity per unit should be promoted under the annual operational plan. These strategies would include the development of improved pastures near villages, planting of fodder trees, introduction of high yielding breeds of cattle, etc. More importantly, a participatory approach to secure the cooperation of local villagers in keeping their cattle out of environmentally sensitive areas and away from regeneration coupes will be adopted with high priority. These strategies will be implemented through the combined efforts of CFO, Paro, and Dzongkhag Livestock Sector, Paro. Fencing, which is expensive, will be adopted as a last resort to protect regeneration seedlings and saplings in harvested coupes.

Grazing issues will be put up in the FMU Level Management Committee Meeting to address the issues and participatory approach should be used to secure cooperation of local people in keeping their cattle out of regenerated areas and environmentally sensitive areas. NRDCL and BFMU should raise fodder tree species and distribute to the local people for plantation in their private land.

17. ENVIRONMENTAL IMPACT ASSESSMENT

For any developmental proposals in Bhutan, the Environmental Assessment Act (2000) requires the proposals to meet a series of environmental criteria. The National Environmental Commission Secretariat has developed various Sectorial Environmental Guidelines to be adopted by the applicants. The Environmental Clearance for Forestry Activities specifies the detail criteria to be met by an applicant to carry out the forestry activities. If the Sectoral Guidelines are met in this chapter, it is assumed that the requirement of the Act will also be met.

This section of the plan provides information on how the forestry activities will be carried out and controlled so that the proposed activity meets the requirement of the Act.

17.1 Project Description

17.1.1 Introduction

Bitekha forest has been supplying timber and other ecological goods and services for last 10 years with Sustainable Forest Management Plan and it will be worked on the same principle of sustainability in the second plan period thereby making timber available in the market as well as meeting the *bonafide*requirement of the local people and providing other ecological goods and services from BFMU forest. The demand for timber is continuously increasing in the market,but the supply of the timber is more or less remaining the same. Besides removal of timber through regulated annual allowable cut, timbers are also removed through *ad hoc* locality factors interference.

17.1.2 Objectives

- To maintain and improve the present vegetation cover and also to protect the environmental, soil, watershed and biodiversity of Bitekha;
- To ensure sustainable supply of timber, poles and posts, fuel wood and non-wood forest productsthrough regulated harvesting and collection;
- To enhanced the awareness of the local communities within the FMU to participate in forest protection and conservation;
- To generate employment opportunities for the local people in forest based activities;
- To regulate grazing to maintain the ecology and natural regeneration potential of forests;
- To promote local research, demonstration, aesthetic and educational values of the natural forest ecosystem.

17.1.3 Project Location and Area

Bitekha Forest management Unit is situated within Naga Gewog under Paro Dzongkhag. It is located between 27°-12'-00" to 27°- 19 '- 00 "North latitudes and 89° - 22 '- 30" to 89°-31' - 00" East longitudes. The total area of the FMU is7259.7 ha. Paro-Zonglela FMU forms its northern boundary while Haa-East FMU and Selela FMU form the northwestern boundary and southwestern boundary respectively. The National Highway borders BFMU in the south and the east.

17.1.4 Benefits

In some areas, there are overmatured Mixed Conifer and Fir stand. Their increment would be very less or no increment at the moment. It is expected that by removing those matured and overcrowded trees, space would be created for regeneration and would improve forest condition. Removal of wood from forest would also meant considerable removal of stored carbon from the forest and replace with new vegetation to absorb increasing greenhouse gases.However, openings would be created considering the silviculture characteristics of the species to avoid colonizing of harvested areas by colonizer species, which would alter the structure and composition of the natural stand. The forest road of about 19.60 km would be constructed within this plan period of ten years.Local people would be benefited for transportation of forest products and would minimize damage to soil and environmental by avoiding manual dragging and rolling of timbers and other forest products.

The operation of the FMU would create job opportunities for the local people and the priority will be given to the local residents. The existing forest road would be improved to have proper access to FMU and NRDCL staff for regular and periodic monitoring and strengthened management of FMU on the principle of sustainability. The over matured timber, which otherwise would rot and occupy space in the forest, would be brought to the market to meet timber demand and generate revenue for the government and improve the forest stands at the same time.

17.2 Forest Management Unit: Planning and Zoning

Forest Management Code of Bhutan (2004) is exhaustively used to write Forest Management Plans for FMUs in Bhutan. The detailed and participatory consultative land use planning has to be carried out while preparing the management plan. The process is briefly outlined below:

For this plan period, a forest resource inventory was carried by FRMD inventory team in 2013 to provide the information about tree stocking, regeneration, standing timber volumes, site characteristics, wildlife presence and under storey species.

For the forest management, forest zoning is based on the above data collected, using the forest function mapping prescribed in the Forest Management Code of Bhutan. The whole area is divided into blocks and prescribed for Management and Working Circle. The blocks are further divided into compartment and sub-compartment. The Protection management circle which includes soil protection, wildlife protection, rivers and streams buffer protection and non-production such as settlement, agriculture land, barren/open area, etc. were excluded from the net operable area.

The potential area with well stocked forests was identified using GISand was followed by reconnaissance survey for ground truthing. Consultation with the local communities of Naja *Gewog* was carried out in 30th October, 2013 to ascertain potential conflicts between forestry use and existing local use and they have expressed strong support and cooperation for this plan period.

The project would also help in restoring the ecological condition of the forest and at the same time those timber that would rot in the forests 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 would take place in the project area without proper management plan and operational plans. The DoFPS and NRDCL would provide sufficient staff to prepare and implement the management plan and operational plans. Strict monitoring will be done to assure there is correct implementation of the plan prescriptions.

17.3 Harvesting & Extraction

In this management plan period, annual timber removal on standing volume in cubic meter, expressed as Annual Allowable Cut (AAC) is prescribed at 4500m^3. On the other hand, the annual removal of timber from the BFMU can harvest 4500m^3 and AACmay vary by plus or minus 10% in individual years, but the volume cut in each five year period must be not more than five times the AAC. Out of 4500m3 of AAC, 3600m3 will be allotted to NRDCL to meet commercial demand and 900 m3 will be allotted for local use to meet rural timber demand in the plan period.

For harvesting and extraction of timber by NRDCL, cable cranes will be allowed and manual logging will not be permitted. Dragging of logs will also be avoided to minimize

damage to the surrounding environment. Only power chain saws will be used in place of axe or conventional timber harvesting tools to avoid timber waste and only trained and licensed chain saw operators will be deployed for timber harvesting. Only harvesting prescription and silviculture treatment prescribed in this management plan will be adopted.

17.4 Road Construction and Maintenance

Rad construction at BFMU in this plan period will be aimed at minimum negative environmental impacts. The road will be aligned in such a way that none of the religious sites are affected. Hume pipes, culverts and bridges would be designed for stream crossing to minimize the negative impacts on streams.

As forest road from Nago block will be continued in this plan period, annual major maintenance of Haa-East forest road should be carried out by NRDCL. This would not only facilitate transportation of timber from the production area, but would also reduce the transportation cost with better pliable road. Major maintenance of existing 5 km road of Nago block should also be carried out by NRDCL annually.

Road standards recommended by FRMD and NECS Forestry Sectorial Guidelines will be followed. Complete Road Standard is given in annexure4.

17.5 Regeneration and Post-Harvesting Treatment

In this management plan period, natural regeneration is prescribed for reforestation of harvested areas. FMU and NRDCL will carry out natural regeneration survey every after three years and take corrective measures as per the guidelines developed by FRMD and continue till the end of plan period.This will be the most crucial as the future harvest would depend on the status of the regeneration and their establishment of the seedlings. However, for the success and chance of natural regeneration, NRDCL should do tending operations by proposing in annual operational plan with adequate budget and it is recommended to carry out tending operations for THREE years in Blue pine forest and for SIX years in Mixed Conifer and Fir forests to ensure adequate population of established regeneration of desired species in the FMU and for establishing good future crop.Tending operation would include weeding, clearing of bushes and undesirable shrubs, lops and tops; obstructing natural regeneration from its growth, safeguarding regenerated seedlings with help of fencing to protect from cattle browsing and trampling, soil scarification, etc. However, if the natural regeneration does not occur within three years, it will be supplemented by artificial planting of the principal and local species. 1600 seedlings per hectare should be planted. FMU and NRDCL should consider making right choice of species and plan according to the forest type. For instance, blue pine seedlings should not be planted in mixed conifer zone to avoid disturbance to stand structure and composition in long run.

Regular maintenance of the plantation will be done by NRDCL and the CFO shall evaluate the plantation at the end of three years. If the survival percentage is lower than 80 %,

immediate beating up will be carried out with same species by NRDCL. Plantation would be taken over by the Department only after proper assessment and is successful with 80 % of 1600 planted seedlings with required saplings height. Till plantation is successfully established, harvesting agency would take good care and carry out regular maintenance.

17.6 Existing Environment

17.6.1 Topography and Geology

The general terrain of the project area is moderate in most parts of the area with occasional steep areas in some parts. The National Highway leading to Haa forms the lower boundary in the south and the east and towards this boundary, settlements, schools, RNR-EC, gewog administration and agriculture lands can be seen.

The project areas over 100 % were considered as very steep areas and it is delineated as SP-Soil Protection in this management plan where no activities can take place. Slopes within 76-100 % are classified as SC-Social Conservation and limited activities can take place in such areas.

The geological formation is dominated by the Precambrian series which is characterised by the presence of assorted combinations of rocks such as graphite schist, granite-mica schist, flaggy quartzite, calc-silicates, gneiss and marble. The area is characterized by brown or grey podzolic (ash-like) forest soil that are sandy loam to clayey loam in nature.

17.6.2 Hydrology

Nangoron Chhu and Lumnamo Chhu flow towards south and south-east respectively, feeding Haa Chhu outside the study area. There are numerous small streams and the project area is generally well-drained. The entire area is of special importance as a water supply source for settlements of Naja gewog and as a catchment for Haa Chhu, which ultimately feeds to Wangchhu River System; the largest in the western part of Bhutan.The water sources are clean and water pollution by people and the animals is very negligible.

17.6.3 Air quality and noise

There are no industries or any activities inside FMU which cause pollution and there seems to be negligible air pollutants in the atmosphere. Nonetheless, sources of air pollutants may exist either from natural or man-madein the FMU. The natural sources may be from biological decay, pollen grains of flowers, spores, etc. Man-made causes of air pollution may come from vehicular emissions, agriculture activities etc. There might be noise due to logging and harvesting activities. The noise is very negligible and the only noise is from the cattle within the area and the sound of cymbals from the lhakhangs during the performance of religious rituals.

17.6.4 Plant and animal species and habitat

The plant and animal species found in the FMU are diverse and rich compared to its geographical size. Diversity and richness of plants and animal species is due to its altitudinal variation and aspects.There is no endemic plant habitats recorded for the FMU. However, FMU is endowed with quite a number of plants for medicinal purposes and few endangered wild animals are sighted in the project area. Some of the common recorded species include, sambar deer, barking deer, monal pheasants, wild boar, Himalayan black bear, Red panda and snow-capped langur. Endangered animal like Musk deer is also sighted in the FMU.

17.6.5 Scenic qualities

The BFMU has no unique scenic scenario in particular and hence the area has not been in use by tourists so far. The area has not been either competent to be considered either as a national park or wildlife sanctuary.

17.6.6 Cultural significant sites

Mountain ridges of Bitekha with rock out crops are considered as sacred *gneys* by the local community. One of the most outstanding one is *wangdi gney* located in susunang.The area has six prominent goenpas, namely, Nago goenpa, Bitekha goenpa, Jaba goenpa, Tsheri goenpa, Yangchen goenpa and Tsuendu goenpa known for their respective deities.

17.7 Assessment of Impacts and Mitigating Measures

17.7.1 Impact on water

Pollution and dying up of water sources

Disposal of garbage and sewage by workers engaged for road maintenance and harvesting operations might pollute the rivers and streams. Improper forestry operations may also have severe flows of debris, timber logs etc. along some streams and might pollute streams. Streams might get contaminated due to spillage/leak from logging machineries.

Water sources inside the FMU would dry up if forestry operations are carried out without considering any environmental risk assessment. One anticipated activity would be from forest road construction besides farm road or approach road if not planned properly and considered standard of road design and specification,whereinsurrounding vegetation would be damaged during the course of road construction, resulting into drying up of water sources. Other activity would be felling of trees without keeping prescribed or adequate buffer from streams/rivers supplying water for drinking or other purposes to downstream settlements. Opening of forest areas without proper management would also dry up water source and lack of proper management of their drinking water source by local communities would also lead to drying up of water sources in the FMU.

Mitigations

Pollution is man-made and has to be controlled by the people themselves to reduce water pollution. No labour camps will be allowed near the water bodies and above any water

source. All the waste generated from the camps will be collected, stored and disposed in environmentally suitable manner. A garbage pit has to be dug near the labor camp to dispose the wastes.Pit latrines have to be dug and use of streamsides should be avoided. The sewage water will not be allowed to drain into the stream supplying water to the households. No bathing and washing willbe allowed in the stream above if the people below use the water for drinking. Care should be taken by the NRDCL and FMU that no vehicles and machinery used in the forest are allowed to change their oils in and around the stream, not to spill the oil or dispose the oil in the field area. Pollution of water to be dealt as per the relevant waste prevention and management act and rules.

Logging related operations will be avoided from the water bodies such as rivers, streams, etc. by BFMU & NRDCL.A buffer of 30m on either side of streams, rivers or water source will be maintained and in case any types of road crosses streams/rivers hume pipes willbe used instead and water will be made to run through it. In order to maintain the continuous flow of stream water without drying, care will be taken not to cut the trees near any water bodies/sources within 30m or deprive the area nearby or surrounding water sources from vegetation.

The forest road will not pass through any river or stream source and a minimum of 100m road buffer have to be maintained to prevent the drying or polluting of the water source. The water pipes damaged during road construction will be replaced by NRDCL or any parties involved. NRDCL site engineer will monitor the road construction activities during the construction phase. The use of bulldozer will be replaced by excavator in order to avoid the blocking of rivers and streams by wind-throw resulting from the road construction. Excavated materials from road construction will be dumped at identified dumping site and should not be rolled down the filled in side of road to avoid damage to the top soil, vegetation, animals and even to settlements and lives of people leaving or falling below the proposed road. Natural drainage should not be affected by FMU/forestry activities and check dams should be constructed in areas prone to high run-off.

Except as otherwise provided in the prevailing Water Act of Bhutan, a person may not discharge any effluent directly or indirectly to any water resource unless the discharge is in compliance with the Effluent Discharge Standard. Notwithstanding any other provisions, it shall be unlawful to discharge any chemical, radiological, radioactive, medical or any other hazardous waste into water bodies. Any person discharging effluent shall be liable to pay a charge as prescribed in the regulations under Water Act and any person who acts in breach of the provisions of the relevant section shall be guilty of an offence under the Water Act.

Cattle grazing in the watersheds will be regulated to minimize the surface run off. To protect water sources in the area, forestry operation will be done through an appropriate silviculture systems and management plan prescriptions.

As springs might be a primary source of water security for the local residents, local communities should understand and protect their springs. The inherent nature of the

resource, lack of scientific understanding, climate variability and land-use changes all would make springs vulnerable to extension. The conventional water conservation approaches may not suffice to protect and conserve springs. Therefore, BFMU should assist communities to protect and conserve springs by coordinating with relevant Stakeholders and local expertise by understanding the hydrologic characterization of the spring type, drainage and recharge area, and recharge and discharge parameters, such as water quality and quantity.

17.7.2 Impact on forest resources

Impact on forest resources might be from forest pests and diseases, forestry operation and developmental activities. Creating of larger group openings and cable corridors would invite unwanted weeds and woody species over principle species. As seen in Susunang block where Blue pine regeneration could be seen in mixed conifer forest, larger openings would invite colonizer species like blue pine and would change the composition and structure of mixed conifer forest in long run. This in turn might impact on the forest resources associated with mixed conifer. Accessibility of forest resources by constructing forest road might also lead to illegal harvesting and collection of forest resources.Unregulated and over grazing inside FMU would also impact on forest regeneration, ground vegetation and vulnerable areas. Unsustainable harvesting of economically valuable forestry resources by local people would also impact on some of the valuable medicinal plants and might have genetic erosion.

Spruce bark beetles might also be a concern in this plan period as bark beetle infestation from Haa-East FMU has spread to BFMU in Nago block as well since these two FMUs share the boundary and seems population of beetles in Haa-East FMU has reached beyond its epidemic proportion. Since the epidemic level of beetle extended mainly at altitudes between 2,800 - 3,300 m (Tshering & Chhetri, 2000) and BFMU falling approximately within these elevation ranges, beetles might affect the FMU and create perennial problem for the forest management. Haa-East FMU,BFMU and NRDCL should not overlook evenif there are few trees affected by bark beetles.

The field staff are of the opinion that the current system of tendering sanitation operation compromise the sanitation work quality as the procedures facilitate trickling down of financial and there is no direct and complete financial benefit to actual workers at the site through contractor. NRDCL and FMU also finds challenging with this system as it don’t provide any provision to remove bark beetle affected trees, which is confined in pocket and no accessibility for timber extraction through skyline system. But removal of these affected tress are vital to control beetle population and further spreading. It is imperative that we relook the system if it serve less purpose on the ground and an appropriate and applicable system or mechanism is invited and adapted to ensure there is less impact on forest resources by pest and diseases.

FMU activities may also disturb the sanctity and sacredness of the *gneys* as well which otherwise takes hours to walk. Any developmental activities inside FMU area by individuals

or groups would also influence forest resources by clearing forested area and thereby degrading forests and wildlife habitats.

In first plan period, NRDCL and FMU have planted blue pine seedlings in the mixed conifer forest zone besides blue pine overtaking most of the harvested areas of FMU. As there is already upward shift of blue pine forest into spruce/hemlock forest, reforestation of harvested areas by wrong species would influence species composition and structure. It would altered the mixed conifer forest zone into mono stand and impact forest resources and biodiversity.

Mitigations

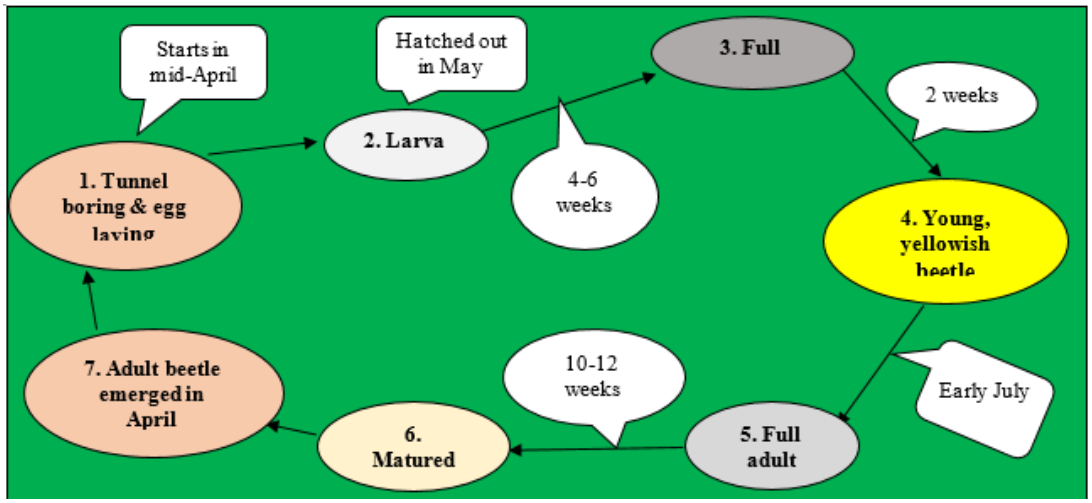
Harvesting of timber from the production area will be carried out as per the plan prescription and any deviation of the plan will be approved by Head of the Department. Forest functions and their restrictions prescribed in this management plan will be followed till end of this plan period.

NRDCL will follow the road standard developed by the FRMD and always follow environmentally friendly machineries and specifications. Any developmental activity(s) or project(s) in the FMU area will have to be inline with the management circle and proponent will have to have written consent from the local people residing nearby and downstream having either direct or indirect impact. CFO, Territorial Division, Paro, will then issue any forestry clearance for any developmental activities within the provision of plan prescriptions and relevant rule of law. Any projects or activities inside production working circle for individual vested interest or benefits will not be encouraged so as not to undermine principle of sustainability.

Periodic monitoring of the FMU activities will be carried out by CFO, Paro,and any technical assistance required for intervention will be sought from FRMD. Mid-term and final evaluation of FMU will be initiated by CFO and apprise the Department through FRMD for timely evaluation and the evaluation team provides valuable suggestions and recommendations for interventions to mitigate impact on forest resources and for better management of FMU.

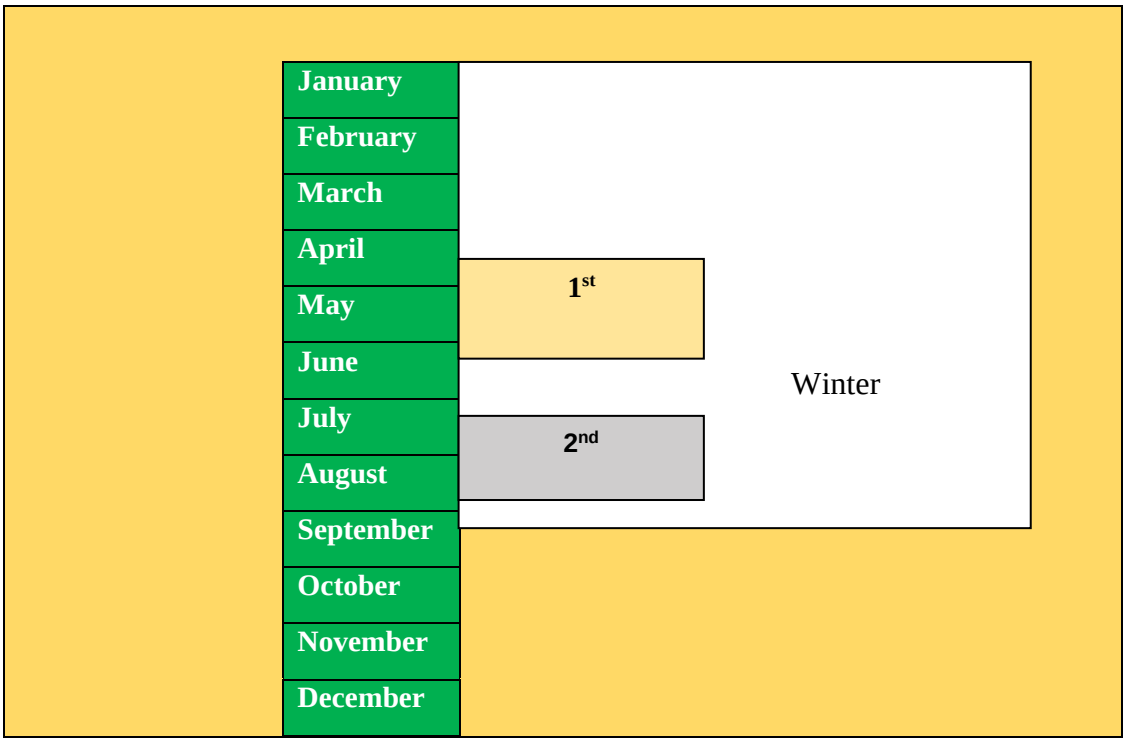
For attempt of sanitation operation of bark beetle affected stands, life cycle of bark beetles should be carefully studied and understand to undertake sanitation operation at right time. For instance, sanitation in the month of July to September may not help us to effectively minimize beetle population as the beetle emerge as adult by early July and become matured adult by August and September. An attempt should be made during critical period of beetle life stages like egg and larvae stage and during winter months. Field offices should not only understand the finding of '***Important Forest Pests and Diseases of Bhutan with Control Measures***' by Gem Tshering and D.B.Chhetri, 2000, as shown below, but also the site-specific life cycle and behaviors of beetles in your jurisdiction. NRDCL and FMU will carry

out periodic monitoring of forest to detect pests and disease outbreak for prompt control and mitigation measures.



Source: Sketched from Tshering & Chhetri, 2000

Figure 6: Developmental stages of spruce bark beetles



Source: Outlined from Tshering & Chhetri, 2000

Figure 7: Two generations of bark beetles per year

NRDCL will extract lops and tops as soon as possible to avoid creating conducive environment for breeding of bark beetle giving way to widespread infestation. Stumps and logs of spruce and blue pine will be debarked immediately by NRDCL and rural applicant. Periodic monitoring of forest will be carried out by FMU and NRDCL to detect any freshly attacksof bark beetles for prompt action.

It is of utmost importance to consider the staff strength engaged in the FMU functioning and CFO, Paro, should depute adequate staff with complete package of equipment for the defined jobs and management of FMU will be taken into landscape approach by considering all the elements of sustainable forest management.

BFMU and NRDCL will consider right choice of species for reforestation of harvested areas. CFO, Paro, will periodically monitor FMU and see FMU and NRDCL have made correct choice of species based on the forest types.

17.7.3 Impacts on the faunal diversity

There are few endangered wild animals inhabiting inside FMU area and forestry operation would, somehow, disturb their habitat and diversity. Harvesting operation might result in the loss of wildlife habitats thereby reducing their number in the area. With road access into the forest, poaching of wildlife is also anticipated in future and impact on the numbers and species richness of available fauna inside the FMU area. Forest road construction would also disturb the area used as corridor by wild animals.

Mitigations

A good forest cover would be required that would provide wild animals with adequate food and shelter. Therefore, large coupe openings will be avoided and the harvested forest areas to be brought under forest cover within the shortest period of time, either by natural or artificial planting. Some species such as monal pheasants require a special habitat and FMU will take care of it. However, in the planning process of the plan implementation, their habitats and biological corridors will be identified and secluded under Protection Zone.

Evaluations of FMU will have to say about the status of faunal diversity and numbers in comparison to the baseline data. CFO, Paro, and BFMU with FMU Level Management Committee will have to plan and propose budget in the planning cycle of the Government and apprise Department and RNR-RDC, Yusipang/UWICE to provide training on survey design and data analysis of fauna to the FMU and Division staff.

NRDCL will promote the implementation of sustainable management of forests by restoring degraded forests and substantially increase afforestation and reforestation programs annually. As recommended, NRDCL will annually reforest at least half of the clear cut area of which would be about 5 ha per annum. FMU shall ensure that there is less disturbance

from timber harvest to natural habitats and for this, NRDCL shall adopt more efficient production techniques. Regular wildlife patrolling will be done by FMU and even CFO, and to facilitate this activity, CFO and UIC will explore financial support and secure fund for the activity. Poaching of protected species of flora and fauna from FMU will be prevented by FMU.

17.7.4 Impact on scenic beauty

Although there is no unique scenic beauty, unmanaged forestry activities would impact on scenic beauty of Bitekha. Ecosystem of the area is undisturbed even though there are logging operations in some parts of the FMU. Harmony between nature and people is still not impacted and behavior and values of people seems to be proactive towards their surrounding environment. However, forestry activities beyond the plan prescriptions would impact natural scenic beauty of the area. Developmental activities related to natural resources of FMU might impact too on the scenic beauty.

Mitigation

Forestry operation will follow all the plan prescriptions and avoid any impact on scenic qualities of the area. Through assessment on impact of scenic beauty has to be done by experts before any developmental activities are initiated by any parties. To avoid any disharmony between local people and landscape; affecting physiological well-being of people, which is one of the domain of Gross National Happiness, any parties willing to propose any developmental activities will consult local people of the area and obtain written consent from them and the local government for further processing.

17.7.5 Impacts related to Ecology (Flora)

The most anticipated impact on the flora of the FMU would be change in the present forest composition particularly in operated areas in long run from forestry operations. Larger group openings and cable crane corridors would invite colonizing plant and tree species and change the composition and structure from original floral composition. Establishment of non-native plant species would also be a problem in long run due to larger opening of groups and corridors. Impact on floral would also be from grazing by local cattle.

Mitigations

Small group openings and cable corridors will be created to avoid over growth of weeds and colonizing species over principle species. NRDCL will carry out tending operations as prescribed in this management plant to give more chance for natural regeneration and establishment. BFMU will periodically carry out plant indicator species monitoring as per the prescribed format of FMCB and facilitate FMU evaluation. Flora experts will be consulted based on findings and know the status of forest dwelling species from the evaluation.CFO and UIC will seek technical support from WCD and RNR-RDC Yusipang/UWICE to provide training on flora survey methods to FMU and Territorial

Division. However, CFO will secure fund or budget by proposing to the Government or to any relevant funding agencies.

Although there are no accurate data on carrying capacity of the various types of forest and grassland in the Himalayan region, Territorial Division will make general visual assessment of grazing pressure in the forest and apprise Department and FMU Level Management Committee, and regulate to check overgrazing.

17.8 Monitoring and Evaluation

The next Management Plan will be prepared by Paro Territorial Forest Division. It will be technically reviewed by FRMD, DoFPS, and approved by the Minister, MoAF. The plan will be implemented by NRDCL under the supervision of CFO, Paro Territorial Division. For smooth implementation of the plan, annual operational plan will be prepared by Paro Territorial Division in consultation with the stakeholders identified in the management plan. Other relevant stakeholders will also be apprised by FMU IC for participation and engagement. The Operational Plan (OP) will be approved by the Head of the Department.

Periodic monitoring will be carried out by Paro Territorial Division (CFO and UIC) as per the monitoring framework outlined in FMCB and FRMD guidelines. Annual monitoring report will be submitted to the FRMD, DoFPS, as per timeframe, forms and proper channel of the FMCB and management plan prescription. Based on the monitoring report, FRMD will also monitor the implementation of the activities and provide technical backstopping with advices and recommendations.

There will be two evaluations of FMU: mid-term evaluation at last quarter of the fifth year and final evaluation at the last quarter of the ninth year by the independent of staff implementation. An evaluation team will be constituted by the head of the Department. CFO will apprise the Department for evaluation and evaluate the FMU as per terms of reference.

Table 36: Checklist of environmental parameters for forestry projects**.**

	Adverse Environmental Impacts	Preliminary Evaluation			
		No Significant Effect	Small Effect	Moderate Effect	Major Effect
I. COMMERCIAL LOGGING					
A. Environmental Considerations Regarding Project Siting					
1. Watershed Areas					
a) erosion	*a) downstream economic losses*	✓			
b) siltation	*b) downstream economic losses*	✓			
c) hydrology	*c) increased peak and flood*	✓			

	Adverse Environmental Impacts	Preliminary Evaluation			
		No Significant Effect	Small Effect	Moderate Effect	Major Effect
	flows				
d) water quality	*d) loss of downstream beneficial uses*	✓			
2. Relation to other dedicated land uses					
a) conservation areas	*a) impaired ecological and recreational opportunities*	✓			
b) economic ventures	*b) possible economic loss*	✓			
3. Traditional forest uses	3. Impaired beneficial uses	✓			
4. Rehabitation	4. Social problems	✓			
5. Relation to regional/ national forestry plans	5. Possible conflicts with established management policies	✓			
6. Critical environmental areas	6. Downstream economic losses	✓			
a) erosion	*a) downstream economic losses*	✓			
b) siltation	*b) downstream economic losses*	✓			
c) hydrology	*c) increased peak and flood flows*	✓			
d) water quality	*d) loss of downstream beneficial uses*	✓			
7. Precious ecology	7. Loss of ecological values	✓			
B. Considerations Regarding Planning and Design					
1. Cost/benefit analysis		✓			
2. Operations and maintenance	2. Diminished project efficiency and objectives if lack of funds	✓			
3. Data base for decision making		✓			
4. Road network design					

	Adverse Environmental Impacts	Preliminary Evaluation			
		No Significant Effect	Small Effect	Moderate Effect	Major Effect
a) erosion	*a) downstream economic losses*	✓			
b) siltation	*b) downstream economic losses*	✓			
c) hydrology	*c) increased peak and flood flows*	✓			
d) water quality	*d) loss of downstream beneficial uses*	✓			
5. Design of logging activities	5. Unnecessary damage to residual stand		✓		
6. Critical environmental areas					
a) erosion	*a) downstream economic losses*	✓			
b) siltation	*b) downstream economic losses*	✓			
c) hydrology	*c) increased peak and flood flows*	✓			
d) water quality	*d) loss of downstream beneficial uses*	✓			
7. Precious ecology	7. Loss of ecological values	NA			
C. Considerations Regarding Project Operations					
1. Road construction					
a) erosion	*a) downstream economic losses*		✓		
b) siltation	*b) downstream economic losses*	✓			
c) hydrology	*c) increased peak and flood flows*	✓			
d) water quality	*d) loss of downstream beneficial uses*		✓		
2. Felling					
a) erosion	*a) downstream economic losses*		✓		
b) siltation	*b) downstream economic losses*	✓			
c) hydrology	*c) increased peak and flood flows*	✓			
d) water quality	*d) loss of downstream beneficial uses*		✓		
3. Log					

	Adverse Environmental Impacts	Preliminary Evaluation			
		No Significant Effect	Small Effect	Moderate Effect	Major Effect
conveyance and allocation					
a) erosion	*a) downstream economic losses*	✓			
b) soil compaction	*b) increased runoff*	✓			
c) log floatation	*c) impede navigation*	N.A.			
d) allocation	*d) less than optimum economic benefits*	N.A.			
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		NA			
2. Road shutdown		NA			
II. REFORESTATION/AFFORESTATION					
A. Considerations Regarding Project Siting					
1. History of forest abuse	1. Negation of project goals if not effectively controlled	✓			
2. Relation to other dedicated land uses					
a) conservation areas		✓			
b) economic ventures	*b) Interference with more profitable ventures*	✓			
c) regional/national forestry plans		✓			

	Adverse Environmental Impacts	Preliminary Evaluation			
		No Significant Effect	Small Effect	Moderate Effect	Major Effect
3. Rehabitation	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		NA			
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		✓			

	Adverse Environmental Impacts	Preliminary Evaluation			
		No Significant Effect	Small Effect	Moderate Effect	Major Effect
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. Socioeconomic losses	✓			
3. Chemicals and fertilizers	3. Impaired fisheries and aquatic systems	NA			
4. First-year operations	4. Increased erosion due to soil disturbance	NA			
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) fuel-wood			✓		
c) enhanced fisheries		✓			
d) enhanced recreation/ tourism		✓			
7. Water resources benefits		✓			
a) minimized overland flows		✓			
b) reduced flood		✓			

	Adverse Environmental Impacts	Preliminary Evaluation			
		No Significant Effect	Small Effect	Moderate Effect	Major Effect
peaks					
c) water quality		✓			

Source: ADB (1987) and Forestry Sectoral Guidelines, NEC (1999)

18. FINANCIAL AND ECONOMIC APPRAISAL

Financial forecast and economic appraisal has been drawn for BFMU for ten years. This forecast is projected to assume the revenue to NRDCL, treasury (via royalty), the cost and royalty paid by NRDCL. Overhead costs to NRDCL are not included. Some of the figures are estimates based on the assumption listed and the information made available to the planner. The assumptions for the forecast are listed in table 37. A summary of the forecast is presented in table 38 and forecast itself in table 39.

Table 37: Assumptions used for financial forecast

Assumptions	Figures
m^3 to cft	35.31
Recovery Volume (%)	60
Road construction (Nu/km)	2359500
Length of proposed new road (km)	19.60
Road maintenance (Nu/km/yr)	12000
Distance to Depot (km)	40
Cable crane (Nu/cft)	20.02
Rural Allotment (m3)	1100
Regeneration maintenance (for cable lines) (Nu/ha)	3500
Creation of plantation (ha/year) , half of the clear cut area equivalent	5
Plantation cost (as per plantation norms and standard, SFD for 5 ha model plantation)	50000

Table 38: Financial forecast summary (for this plan period)

Category	Amount (Nu in millions)
Total Revenue NRDCL	202.88
Total Costs NRDCL	90.52

Total Royalty NRDCL	15.57
Total Revenue Less Royalty	96.79

Table 39: Financial forecast for Bitekha FMU (2016-2026)

Financial Forecast for Bitekha FMU (20016-2026)															
					2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	10 Years
	AAC (m3)	Rec. vol m^3	Nu/c ft	Nu/m3	Nu	Nu	Nu	Nu	Nu	Nu	Nu	Nu	Nu	Nu	Nu
Revenue: NRDCL															
Timber – Commercial	4500	2700	133	4696.23	12679821	21133035	21133035	21133035	21133035	21133035	21133035	21133035	21133035	21133035	202877136
Timber – Rural	1100														
Total Revenue NRDCL					12679821	21133035	21133035	21133035	21133035	21133035	21133035	21133035	21133035	21133035	**202877136**
Costs: NRDCL															
Bridge Construction/															
Road Construction					4624620	4624620	4624620	4624620	4624620	4624620	4624620	4624620	4624620	4624620	**46246200**
Road Maintenance					264000	287520	311040	334560	358080	381600	405120	428640	452160	475680	**3698400**
Marking Costs			0.1	3.5	9450	9450	9450	9450	9450	9450	9450	9450	9450	9450	**94500**
Inventory Costs			0.08	2.83	7641	7641	7641	7641	7641	7641	7641	7641	7641	7641	**76410**
Felling and Crosscutting			4.5	158.9	429030	429030	429030	429030	429030	429030	429030	429030	429030	429030	**4290300**
Debarking*			2	70.62	190674	190674	190674	190674	190674	190674	190674	190674	190674	190674	**1906740**
Cable craning			12.83	453.0273	1223173.71	1223173.71	1223173.71	1223173.71	1223173.71	1223173.71	1223173.71	1223173.71	1223173.71	1223173.71	**12231737.1**
Transportation to Depot			19.9	702.669	1897206.3	1897206.3	1897206.3	1897206.3	1897206.3	1897206.3	1897206.3	1897206.3	1897206.3	1897206.3	**18972063**
Stand Tending (spacing etc.)*															
Regeneration maintenance				Nu.3500/ha	32550	32550	32550	32550	32550	32550	32550	32550	32550	32550	**325500**
Creation of plantation*				Nu.50000/ha	250000	250000	250000	250000	250000	250000	250000	250000	250000	250000	**2500000**
Plantation maintenance*				Nu.3500/ha	17500	17500	17500	17500	17500	17500	17500	17500	17500	17500	**175000**
Total Costs NRDCL					8945845.01	8969365.01	8992885.01	9016405.01	9039925.01	9063445.01	9086965.01	9110485.01	9134005.01	9157525.01	**90516850.1**
Total Revenue less Total Cost:NRDCL					3733975.99	12163669.9	12140149.9	12116629.9	12093109.9	12069589.9	12046069.9	12022549.9	11999029.9	11975509.9	**112360285.9**
Royalty: Commercial			9.8	346.038	1557171	1557171	1557171	1557171	1557171	1557171	1557171	1557171	1557171	1557171	**15571710**
Total Revenue(Revenue less cost less Royalty) : NRDCL					2176804.9	0606498.9	-13697320.9	-13673800.9	10535938.9	0512418.99	10488898.9	10465378.9	10441858.9	10418338.99	**96788575.9**

19. RESEARCH

Research programs will be implemented in collaboration with RNR-RDC, Yusipang/UWICE. The FMU-Level Management Committee for BFMU will discuss, during the yearly meeting, and decide what research is deemed necessary in the FMU for the coming year. Evaluation of FMU should also advise Territorial Forest Division, Paro, and BFMU to initiate research on relevant subject based on field observations and its importance. Research should be doable within the plan period and some of the possible research areas in the plan period would be as follows:

- Presence of small mammals and potential impact from forestry operations;
- Succession in Mixed Conifer zone;
- Socio-economic benefits from establishment of FMU;
- FMU forest contribution to Carbon Cycle or climate change;
- Disturbance of forest health and vitality from forestry operation;
- Change in forest cover over the plan period and its likely impact on biodiversity and sustainability;
- Fire die back and its changes in structural and composition;
- The extent of influence on management of forest through legal, policy and institutional framework;
- Valuation and accounting of economics, social and environmental benefits and services in multiple use forest landscape.

PART 3:

PLAN IMPLEMENTATION

20. IMPLEMENTATION AGENCY

The CFO,ParoTerritorial Division, will be responsible for the implementation of this Management Plan. He will be assisted by the Unit in-charge and other support Staff. FRMD will provide technical support in sustainable forest management during the plan period. CFO, Paro, will identify relevant field of training required by FMU staff and propose adequate budget for training in the fiscal year.

20.1 Cutting Cycle

Cable line spacing must be properly laid to enable future cable passes. To enable two cable lines passes between interlines of two cable lines in future, aminimum of 60 m cable line spacing should be adopted for Mixed Conifer and Fir Working Circles.The rotation for Mixed Conifer and Fir Working Circle is 180 years. This means that the two cable lines that will be implemented in future are occurring at year 60 and year 120. The original lines will therefore be harvested in Year 180. This gives adjacent areas time to regenerate so as not to cause large, open, blank areas within the forest. The size of the group opening will vary between 0.1ha to 0.35ha for Mixed Conifer Working Circle with an average opening of 0.15ha.

20.2 Annual Coupe

Laying of cable lines in the field should start from proper desktop planning with help of geo-spatial technology tools like GPS and GIS, followed by field truthing. The criteria for selecting annual coupe for harvesting in the operable area must be based on production circle, accessibility, slope, stand condition, and other environmental conditions. Coupes must comply with the following conditions.

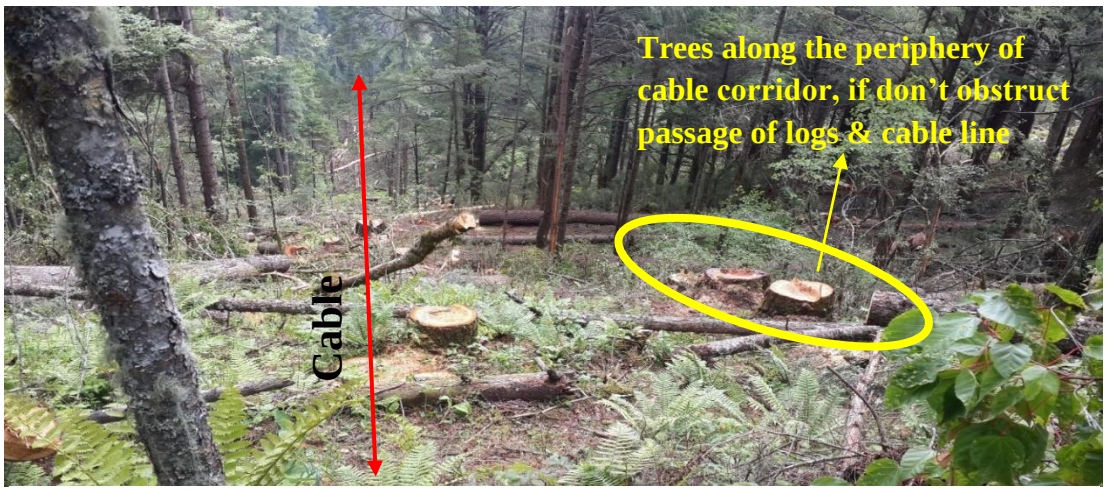


Figure 8: Cable corridor and felling of trees along the periphery

- Unit in-charge will decides on the location and size of annual coupe in accordance with the Annual Operational Plan before 12 months of felling in consultation with NRDCL;
- Trees enumerated along the cable corridors and group openings should be either painted or tie with ribbon for marking later on. Trees should not be blazed to avoid oozing of cambium sap for disease infestation;
- Based on the Silvicultural System, the annual coupe will follow the required spacing designated above, within the limits of the AAC;
- All management prescriptions and restrictions outlined in the plan must be considered and strictly 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, terrain, environment and cost considerations;
- The cable lines may traverse slopes greater than 100 % but extraction is not allowed.

20.3 Tree Marking Rules

- Patches of mature and over-mature trees are selected systematically according to the patch size given in plan;
- Enumerated trees during cable line survey should be marked as per sequence of operation after OP is formally approved;
- Trees within stream buffer strips and on slopes greater than 100% must not be marked;
- The direction of the tree lean and topography has to be taken into account to prevent large trees being felled on nearby advanced growth;
- Dead, dying, malformed, or damaged (snags, scars, conk, etc.) trees will be retained in between patches, 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 (bark beetle, mistletoe) will be removed to protect the quality of the remaining stand;
- All species listed for protection under the Forest and Nature Conservation Act (1995) must be protected if encountered;
- The trees selected will be marked with the authorized marking hammer close to ground level by Unit staff, and diameter measurements, along with estimated total tree height and tree species, will be entered in the Tree Marking Book or marking

register. The volume of each tree will be estimated using an appropriate Volume Table or equation;

- The minimum distance between cable lines will be 60m and between group openings with minimum of 50m. Trees along the periphery of group openings and cable corridors will be retained if trees do not obstruct cable crane tension and passage of logs. NRDCL has to cut branch instead of felling to avoid wider openings;
- Some phenotypically superior trees along the periphery of cable corridors and group openings should be retained to serve as seed trees for natural regeneration. FMU will ensure not to mark those trees.

20.4 Harvesting

To minimize environmental damage and in view of the generally steep terrain of FMU, skyline cable system will be used to extract harvested logs from coupes to the road head. This system will allow logs to be kept above the forest floor during extraction and will enable logs to be taken across sensitive ecological sites, gullies and riparian filter buffer zones. Trees will be cut above 10 cm from the ground level to avoid wood waste. Stumps of Spruce and Blue pine must be immediately debarked to avoid bark beetle infestation and burnt it if possible. Removal of lops and tops will be mandatory for NRDCL and maintain forest ecosystem health and vitality. This system has other advantages:

- Minimises soil disturbance and initiation of soil erosion;
- Maximises worker safety (if used correctly according to the manufacturer's directions and according to the safety practices in the Code of Practice);
- Avoids damage to residual reserve stands;
- Avoids disruption to wildlife corridors in valley bottoms;
- Minimises noise and dust pollution on any adjacent farmlands and villages; and,
- Eliminates the need for log extraction tracks and feeder road construction.

Figure 9: Example of good stump height maintained and less waste of timber in stump.

Harvesting in the Working Circles is to be carried out in accordance with the following prescriptions.

1. The layout of the cable lines should be planned and undertaken well in advance of the harvesting operations after the logging coupe has been demarcated. Suitable log landing site should be identified and incorporated into the forest road design;
2. Trees to be felled will be enumerated and marked in time so as not to delay harvesting operations. Cable corridor shall not exceed the prescribed width for each Working Circle;
3. Trees will be felled, de-limbed, crosscut, extracted on the cable, loaded and hauled to the log depot. Felling direction should be considered and it was one of the observations reflected in Royal Audit Report for FMUs of the country. Damage to soil should be minimized at all times. NRDCL should explore budget and provide training to the chain saw operators on tree felling directional techniques;
4. Use of axes is discouraged and should use only power chain saws. Chain saw operators should be licensed and have formal training. Operators and workers should be provided with safety equipment and first aid-kit at all times;
5. All infected Blue pine and Spruce, if any will be debarked as soon as they are felled to avoid the spread of bark beetle;
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 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 concern CFO;
8. The CFO and the Regional Manager, NRDCL will co-operate and co-ordinate to ensure that the logging operation and log outturn are conducted smoothly and in accordance with local and other demands;
9. Fuelwood will be collected from harvesting residues. It has been observed in the first plan period that lops and tops form all the cable lines were not removed. NRDCL should explore possibilities of extracting lops and tops in this plan period for forest health and vitality. Lops and tops should be 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 areas;

10. Gravity cable systems are the only form of cable harvesting systems used in Bhutan. Although no other harvesting system is being introduced, it would be beneficial to investigate other possibilities that would increase production. This would allow more 'less desirable' timber to make it to the landing, promoting utilisation of poorer quality timber and fuelwood residues.

20.5 Reforestation of Harvested Sites

To maintain productive capacity of forest functions, the amount of harvested areas should have been successfully regenerated or restocked either naturally or through reforestation programs. In the first plan period, the total clear cut areas for timber harvesting was 45.53ha, excluding areas harvested through other locality factors. However, there was no plantation program carried out in the harvested areas even if the natural regeneration was not successful. The final evaluation revealed a very poor regeneration with 1-2 seedlings in 2m X 2m quadrant. With such management practices, other elements of sustainable forest management would be missing from the management regime. As there is clear indication from the past management practices, this plan tries to re-examine and emphasize the criteria and thematic elements of sustainable forest management.

In this plan period, natural regeneration is preferred in the FMU. It is recommended that based on the natural regeneration guidelines developed by FRMD, regeneration survey be conducted in harvested area every three years, including harvested year as year one, for its natural regeneration until the regeneration has reached a height that will ensure its survival. Based on the regeneration analysis, remedial action must betaken in the planting season by reflecting in the annual plan of operation called Operational Plan. It has to be systematically continued till the end of the plan period to ensure natural regeneration is periodically monitored and checked for its establishment. As recommended in the final FMU evaluation by the Department, NRDCL should carry out tending operations for THREE years in Blue pine forest and for SIX years in Mixed Conifer and Fir forests so that regeneration has a chance to establish.This would also reduce the cost of reforestation as clearing and replanting as failed area would cost much more than the initial tending for natural regeneration.

For artificial regeneration, nursery shall raiselocal species by NRDCL and species raising should be done as per the operation of working circle. Barren/ degraded/open area shall be planted by NRDCL with commercially viable local species based on forest strata. Regular maintenance of plantation shall be done to ensure the survival is 1600 seedlings per hectare with 80 % successful survival. The CFO shall evaluate the plantation at the end of three

years, including plantation year as year one, and if the survival percentage is lower than 80%, immediate beating up should be carried out with the same species.

The factors that would limit the success of regeneration include; grazing pressure, protracted harvesting periods and weeds and brush growth. These problems must be addressed if regeneration is to have a fighting chance.

There is a developing understanding by Territorial and NRDCL staff of the right size of openings to promote regeneration of various species and this knowledge is being supplemented by recent research. Hemlock can apparently cope with larger openings than Spruce and being light demanding, Blue pine regenerates well in even larger openings. In transition areas between one species zone and another, opening size may help target the desired species. It is vital that this silvicultural knowledge is utilised and implemented. Openings that are too large or too small for the target species can again lead to excessive weed and brush growth before regeneration can become established (Whitfield, 2001).

Enrichment planting, if necessary, will be carried out by NRDCL. Depending upon the cattle population and site condition, an appropriate fencing shall be done in the plantation area and plantation watchmen shall be deployed, if necessary. Fencing or other action to protect regeneration will be carried out by NRDCL, in consultation with the FMU In-charge and the FMU Level Management Committee. Budgetary requirements for every activitywill be proposed in the Operational Plan by NRDCL and FMU as per the arrangement made for funding.

20.6 Sequence of Operations Related to the Annual Coupe

Table 40: Sequence of operations relating 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 out pre-logging planning	-10
FMU and 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	-9
FMU IC marks the carriage corridor trees and the trees to be felled in the first sub-coupe	-2
NRDCL manually fells trees that are in the way of the skyline installation and installs the skyline and cable crane	-1
NRDCL commences systematic harvesting and extraction operations according to the approved sequence in the Annual Operational Plan	0
NRDCL/Contractor completes harvesting and extraction	When completed
The FMU IC will inspect the coupes when harvesting is completed and	When works completed

will issue a Coupe Clearance Certificate - only if all aspects of the operation are satisfactory and all timber is removed from the annual coupe.	
FMU IC assess success of natural regeneration.	As per guidelines
NRDCL completes post-harvesting operations.	As per Operational Plan &FMU IC instructions

20.7 Road Construction

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

One approach with 6 km new road to Nago Block of FMU will be in addition to the existing 5km road constructed in first plan period from the existing Haa East FMU forest road. For Susunang Block, the take-off point will be from near Susunang Forest Nursery that needs to be newly constructed and is about 13.60 km in this plan period. For this plan period, the total road construction would be 19.60 km and for entire FMU, which is about 1.96 km/year. The total forest road network inside production working circle would then cometo about 24.60 km by end of this plan period.

NRDCL will have to comply all the mitigation measures identified against each potential negative environmental impact as per Environmental Impact Assessment report for Bitekha FMU and consider all the socio-economic and cultural aspects. Methods of slope and terrain stabilization of above and below road should be carried out wherever required. Protected areas such as soil, local water supply, riparian, wildlife should be identified and no commercial activities be carried out. Necessary budget should be incorporated where ever required to address negative impact on environmental management through construction of 19.60 km forest road. Supervision and frequent monitoring of forest road construction works should be carry out by Rinpung Regional Office, NRDCL, Paro.

Road survey, design and construction will be carried out by NRDCL and 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 TFDP. These road standards, although developed in the east, address policies that are required throughout Bhutan. These standards are adopted in all FMUs and NRDCL road engineers must follow these standards, given in Annex 4 during designing and estimation for BFMU and provide supervision during construction to ensure that the standards are met.

Road design in BFMU should follow the recommended road profile in Figure 7 to avoid excessive water pooling leading to rutted road surfaces that inhibit access during monsoon season. Improper drainage may also lead to landslides.

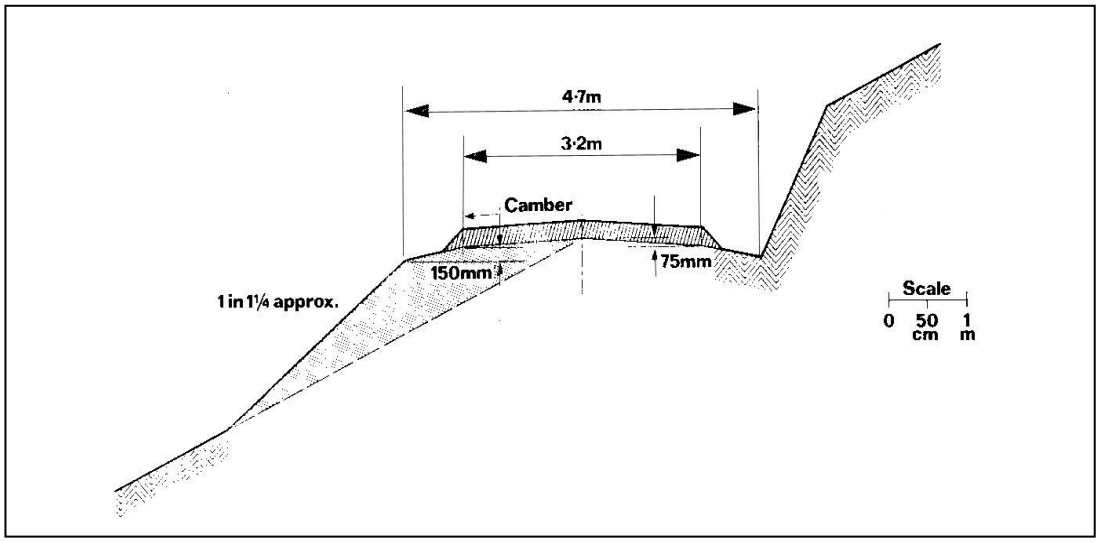


Figure 10: Recommended road profile

21. PLANNING

21.1 Operational Plan

For smooth implementation of this management plan, Operational Plans will be prepared by the CFO,Paro Territorial Division and the Unit-in-charge. The main purpose of preparing operational plans are:

- To identify and describe forest management activities which will be carried out during the coming year and (in the case of rolling two-year plans) during the following year;
- To estimate the cost of carrying out the activities and identify funding sources.

An approved operational plan is the legally binding basis by which implementation is guided and responsibility and accountability is determined for the one year operational period.

Operational Plans (OPs) should follow some general principles so that they are effective and practical forest management tools. OPs should be as simple and concise as possible. Standard format should be followed and contain all the information for planning purpose. It has to be participatory and site specific and quantitative. In short, CFO, UICand RM should make OP document very useful to meet the planning needs of the DoFPS and NRDCL.

The OPs are prepared annually for a two-year rolling period. Therefore the activities for the second year of the plan are carried forward into the first year of the next plan. This has

important implications for budgeting (since it will then be possible to estimate budgets well in advance of the start of the financial planning year) and for participatory processes since these can be carried out a year before the start of the activity.

The OP 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 fires, staff training, compliance of monitoring and evaluation recommendations, etc. Some *ad hoc* activities like sanitation operation is approved by the head of the Department and is updated in next operational plan. In this way, operational plan facilitate to update any activities implemented outside planned activities.

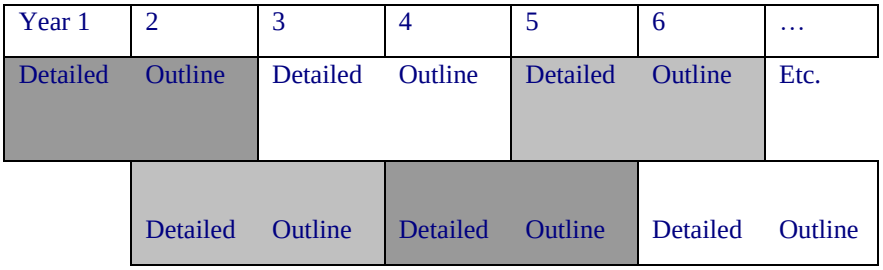


Figure 11: Concept of rolling plan

The OP will be presented to the FMU-Level Management Committee during annual meeting with FMU annual progress report. Any arising issues with regard to FMU implementation will be discussed and incorporated in the proposed operational Plan. NRDCL will agree and commit for funding of the activities. Inclusion of a consultation process with local communities in preparation of the OP is particularly important so that potential issues concerning communities in the forthcoming operational areas are worked through before the plan is implemented.

The process for preparing and implementing the Operational Plan is laid out in Table 41.

Table 41: Preparation and implementation of operational plans

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)	BFMU IC	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 Calculation of the harvestable volume	Site-level inventory data for operational area to be harvested Precise estimate of volume to be removed during the coming year.	BFMU IC and 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	BFMU IC and 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 stakeholder 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	BFMU IC and NRDCL	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 location. FMU level management committee members to be involved. OP prepared according to standard formats of FMCB
FMU annual report	To review progress and identify and	FMU Annual report	BFMU IC	During FMU management committee annual

Activity (Planning Step)	Objective	Output	Responsibility (lead)	Comments
presented to the FMU management committee	address any implementation problems To identify any future actions necessary based on issues arising	endorsed by FMU management committee		meeting as per FMCB format 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	BFMU IC 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 by September to ensure that budget requirements can be included in the NRDCL APO for the next financial year
OP approved by Director, DoFPS	To approve the OP for implementation	Approved plan and budget	Review and recommend for approval by FRMD and approved by Director, DoFPS	OP approval linked with sanctioned budget for all planned activities
OP implementation by NRDCL	To carry out planned activities	Harvested timber; protected area; roads; fuelwood etc.	According to responsibilities identified in the operational plan e.g. CFO, FMU In-charge, NRDCL, DzFO etc.	Each activity with a specificresponsibility and budget. Any ad hoc activities arises during the plan period, approval for deviation of plan has to be obtained by Division and FMU from DoFPS.
Monitoring of activities	To assess the level of achievement of planned activities	Information for FMU annual report	BFMU IC and CFO	DoFPSresponsibility is to monitor the implementation of activities carried out by NRDCL

Activity (Planning Step)	Objective	Output	Responsibility (lead)	Comments
				Monitoring also has a cost which needs to appear in the OP
Unit In-charge prepares FMU annual report	To report progress against planned activities To highlight any problems being encountered in implementation	FMU Annual report	BFMU IC	Prepared annually Progress is reported against each FMP objective and the associated activities
Prepare the next year's operational plan (steps 2-5)	To prepare the next operational plan taking into account progress over the past year	Operational plan	BFMU IC	Operational plans may alter in response to FMU Management Committee suggestions and recommendations

For details, CFO and UIC must refer FMCB for planning purposes and followed the recommended format and structure and timeline for preparation of Operational Plans.

21.2 FMU Level Management Committee

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

- CFO, Paro Territorial Division, Chairman
- FRMD Representative
- FMU In-charge, Bitekha FMU
- Regional Manager, Rinpung Region, NRDCL, Paro
- Gup, Naja Gewog, Paro
- Dzongkhag Livestock Officer, Paro Dzongkhag
- Unit Manager, Bitekha FMU, NRDCL, Paro
- Key Village Elders

Terms of Reference for the FMU Level Management Committee:

A. During FMP preparation;

- To represent the interests of identified stakeholder groups during the planning 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 Minister for Agriculture and Forests for final approval.

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

This will require minimum 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 arising. Meetings need to be timed to ensure consistency with the annual planning cycle and financial year.

21.3 Staff

The CFO, ParoTerritorial 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, ParoTerritorial Division. The CFO is the direct representative of the Department in the field and as such he/she is solely responsible for all forestry activities, both technical and administrative in his/her jurisdiction.

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

Unit In-charge	1
Ranger	2
Foresters	4

21.3.1 Responsibility

The Unit in-charge (UIC) should be committed, dedicated and sincere to the FMU with basic knowledge on Sustainable Forest Management (SFM) and GIS. The UIC will be responsible to look after overall administration and implementation of the FMU activities. He will guide and direct his field colleagues in smooth implementation of the assigned works.

One ranger will be assigned to look after commercial timber logging and other will assist UIC in administrative and technical aspects. Each forester will be assigned for each block to look after rural forestry activities and one forester for other activities as required. Each assigned staff will be solely responsible to exactly locate their block boundary, compartment and sub-compartments. They will have to know every activities happening in their block or

working site and keep every detail records and apprise UIC for update in the office data base or record keeping system. UIC will guide and monitor their record keeping registers and books time to time to ensure records of the activities are recorded and maintained with proper update.

21.4 Buildings

A unit office for the BFMU will have to be constructed and at the same time a check post at exit point to prevent illegal activities within FMU. The current FMU office is quite small and don't have adequate meeting/gathering hall for FMU Level Management Committee to come together to discuss, raise issues and address it. A new unit office is required in this plan period with staff' quarter to solve housing problem for FMU staff. The CFO, Paro, will have to propose adequate budget in the fiscal year to construct unit office and staff' quarters.

21.5 Vehicles and Equipment

There is a requirement of at least one 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 equipment are necessary for the FMU to enable FMU staff carry out activities efficiently.

Table 42: Office and field equipment in FMU

Equipment	Minimum Requirement	Equipment	Minimum Requirement
Suunto clinometers	2 no.	Walkie-talkie set	4 nos.
Suunto compass	2 no.	GPS	3 nos.
Diameter tapes	4 nos.	White board with stand	1 no.
Distance measuring tapes	3 nos.	Binocular	2 nos.
Computer	4 sets	High pixel digital camera	1 no.
Projector	1 no.	Camera traps	4 nos.

In addition to these equipment, other equipment might come into demand in changing time and UIC will have to accordingly propose budget and procure for the FMU office. FMU should not be using conventional techniques and methodologies for management of FMU. As working system changes over time, FMU should be able to adapt to latest techniques and knowledge of managing BFMU in a more scientific and sustainable approach.

22. MONITORING AND EVALUATION

The primary focus of the Royal Government of Bhutan's Forest Policy is to ensure conservation of the environment and, only thereafter, to allow the derivation of economic

benefits (such as commercial timber production) from the forest. To ensure that this policy is being carried out in the management of 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 Forms1-3,Environmental Forms 4-11** and the **Physical, Financial and Environmental Summary Form.**

The necessary Monitoring and Evaluation Forms is available in the FMCB.

22.1 Monitoring

Monitoring is the examination of whether inputs, activities and outputs are successfully supplied according to the planned schedule. The CFO, Paro, 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 OP completion, road construction, production of forest produce, and the like.

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

Table 43: A Summary of data collection, monitoring & evaluation forms & their use**.**

Form Nos.	Form Name	Purpose of the Form	Who Fills In the Form?	How Often?
Form 1 Form 2 Form 3	**Physical & Financial Data – Commercial Activities** **Coupes harvested** **Territorial Activities**	Field data collection & recording of FMU activities	FMU IC	Every July, for the previous year (1 July to 30 June).
Form 4	**Code of Forest Practice Forms: Road Drainage by Culverts**	Field data collection	FMU IC	Every March

Form Nos.	Form Name	Purpose of the Form	Who Fills In the Form?	How Often?
Form 5	**Code of Forest Practice Forms: Road Drainage by Side Drains, Batter & Fill Slopes**	Field data collection	FMU IC	Every March
Form 6	**Code of Forest Practice Forms: Stream Crossings**	Field data collection	FMU IC	Every March
Form 7	**Code of Forest Practice Forms: Cable Lines**	Field data collection	FMU IC	Every March
Form 8	**Code of Forest Practice Forms: Interlines**	Field data collection	FMU IC	Every March
	Physical, Financial and Environmental Summary	Summarise Forms 1 to 8	FMU IC	Every July for the previous year
Form 9	**Monitoring of Animal Indicator Species**	Field data collection	FMU IC	Every April & October
Form 10	**Monitoring of Plant Indicator Species and Regeneration**	Field data collection	FMU IC	Every April & October
Form 11	**Community Participation RRA Checklist**	Field data collection for 5 year Evaluation	FMU IC	Every 5 Years
Monitoring Form A	**Annual Monitoring**	Monitoring (*data from Summary form*)	DFO for FMU concerned	Every Year
Evaluation Form A	**Five-Year Evaluation**	Evaluation (*data from Form A and Forms 9-11*)	Evaluation Team	Every 5 Years
Evaluation Form B	**1st Five-Year Evaluation**	Evaluation (*data from a range of sources directly into the Form*)	Evaluation Team	When 1st 5-year evaluation is done & only rarely thereafter.

22.1.1 Record Keeping

Record keeping and reporting is one of the important tool in this management plan of BFMU for sustainability and it has to be maintained throughout the plan period. 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. Record keeping is the

backbone of future management decisions and the importance must be stressed by CFO and FMU in-charge.

BFMU should keep detail records of the FMU activities by blocks and compartments/sub-compartments, commercial and rural, planned and *ad hoc* separately in the data base of FMU by not only following all the recording forms recommended in the FMCB, but also by maintaining additional data and information.Records related to forestry activities should be updated till end of the plan period and produce copy for office record. Data collection must also focus on people-not on trees alone since we need to improve our understanding of the people who live in and around forests to measure the importance of forests on social aspects. This would ensure recording and maintaining correct and consistent annual records of FMUs and facilitate mid-term and final evaluation of BFMU.

The guidelines to complete and fill in the forms; one for Rural Allotment, one for Commercial Allotment and one for Stand Tending and Regeneration activities are available in FMCB, 2004 or in Territorial Divisions, Paro, and FMU office.

22.1.2 Reporting

BFMU in-charge should keep FMU records in the standard format recommended in the FMCB and any format circulated by the Territorial Division and the Department and follow the timeframe for the submission of required information. Any amendments of record through validation should be apprised to Division for similar correction and update.

BFMU should be able to furnish any kind of data or record to Division and to the Department at any time and data maintained in any form should be consistent to eachother. Required records for mid-term and final evaluation should be made readily available to the evaluation team.

22.2 Evaluation& Compliance

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 and CFO, Paro Territorial Division, 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 the Territorial Division, Paro, or from FRMD. However, the detailed forms are there in the FMCB for evaluation.

Staff that are independent of field activities will carry out the evaluation. The evaluation team will be constituted by the Head, DoFPS, and will comprise of eight team members (minimum five) to include representatives.The team composition for evaluation of BFMU would comprise of the following members from:

FRMD (leading agency)

Policy and Planning Division, MoAF

CFO, Territorial Division (not from same Division)

NRDCL Regional Manager (not from same Division)

Dzongkhag RNR Sector (Forestry, Agriculture and Livestock)

RNR-RDC Forestry

Local Government

22.2.1 Mid-Term Evaluation

The Mid-Term Evaluation of BFMU will take place during the last quarter (April-June) of the fifth year (2021) of the FMP period. Team will evaluate implementation of FMU activities based on the required forms and field observation. Observations with suggested recommendations will be provided to BFMU and Territorial Division, Paro, for implementation.

CFO and UIC will implement the recommendations and advices of the evaluation team and submit compliance report. Recommendations would be in achievable in shortterm and longterm. However, the Department will provide sufficient time to implementers to implement the recommendations based on their nature of issues and time required.

The findings of mid-term evaluation should be communicated to the FMU Level Management Committee during their annual meeting by the CFO, Paro.Develop action plan based on the recommendations and address by proposing in the cycle of fiscal year of the Government and then into the operational plan. CFO should submit compliance report to the Department for perusal and record.

22.2.2 Final Evaluation

Final evaluation is to take place during the last quarter (April-June) of the ninth year (2025) of the FMP period. The evaluation team will evaluate FMU activities and specify corrective actions, if necessary, and who should carry out.

FMU and NRDCL will implement recommendations and submit compliance report to the Department through Division. The Territorial Division, Paro, and NRDCL will be given sufficient time for implementation based on the nature of issues and recommendations. The final evaluation should directly inform the preparation of the FMP for the subsequent 10year period.

CFO should communicate findings and recommendations of the evaluation to the FMU Level Management Committee during their annual meeting. Develop action plan and address by proposing in the operational plan. The CFO should submit compliance report to

the Department of Forests and Park Services for perusal and record. The recommendations of the evaluation should be incorporated in the next planning period.

23. CONSTRAINTS AND RISKS

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

- Inadequate fund for implementation of the management plan;
- Uncertainty of natural regeneration due to gazing and undergrowth competition;
- Lack of research information;
- Lack of skilled and trained forest workers;
- Shortage of FMU staff;
- Poor communication between field and office staff and between involved parties;
- Frequent re-deployment and transfer of FMU staff by Division and the Department;
- Lack of cooperation and support from the local people;
- Lack of commitment and responsibility from field staff of FMU and NRDCL and Territorial Division;
- Lack of sound knowledge on sustainable forest management and GIS within FMU and Territorial Division.

24. DEVIATIONS FROM PLAN PRESCRIPTIONS

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 10 years. However, the total volume harvested over successive five year periods must be no more than five times the AAC volume.

Unforeseen circumstances may direct deviations from plan prescriptions and in such an event the CFO,Paro, must obtain prior written approval from Head of the Department. The reasons for the deviations must be fully justified by the CFO in writing and such approved deviations entered into the Management Plan during the next scheduled operation plan or revision of Forest Management Plan.

25. REFERENCES

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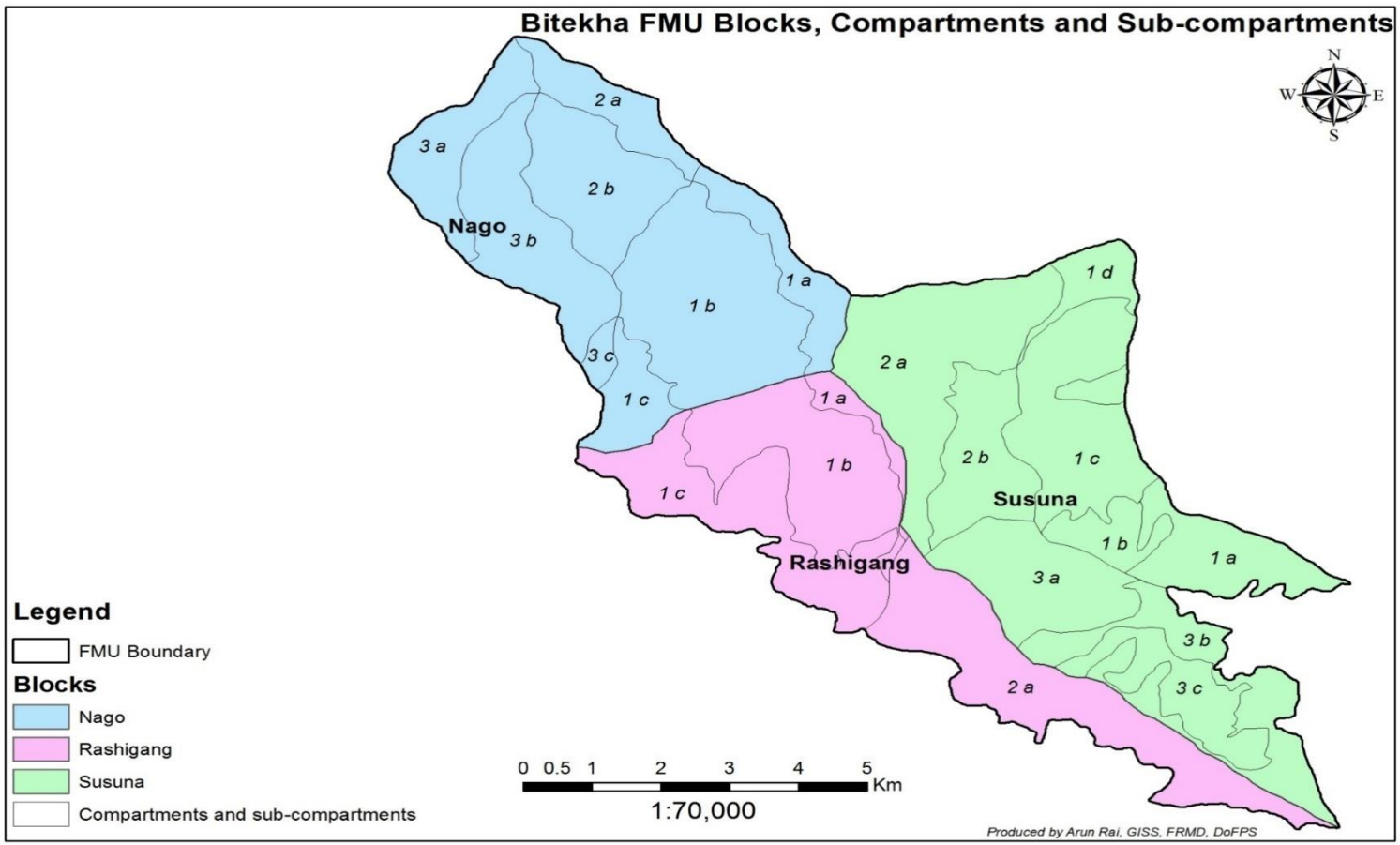
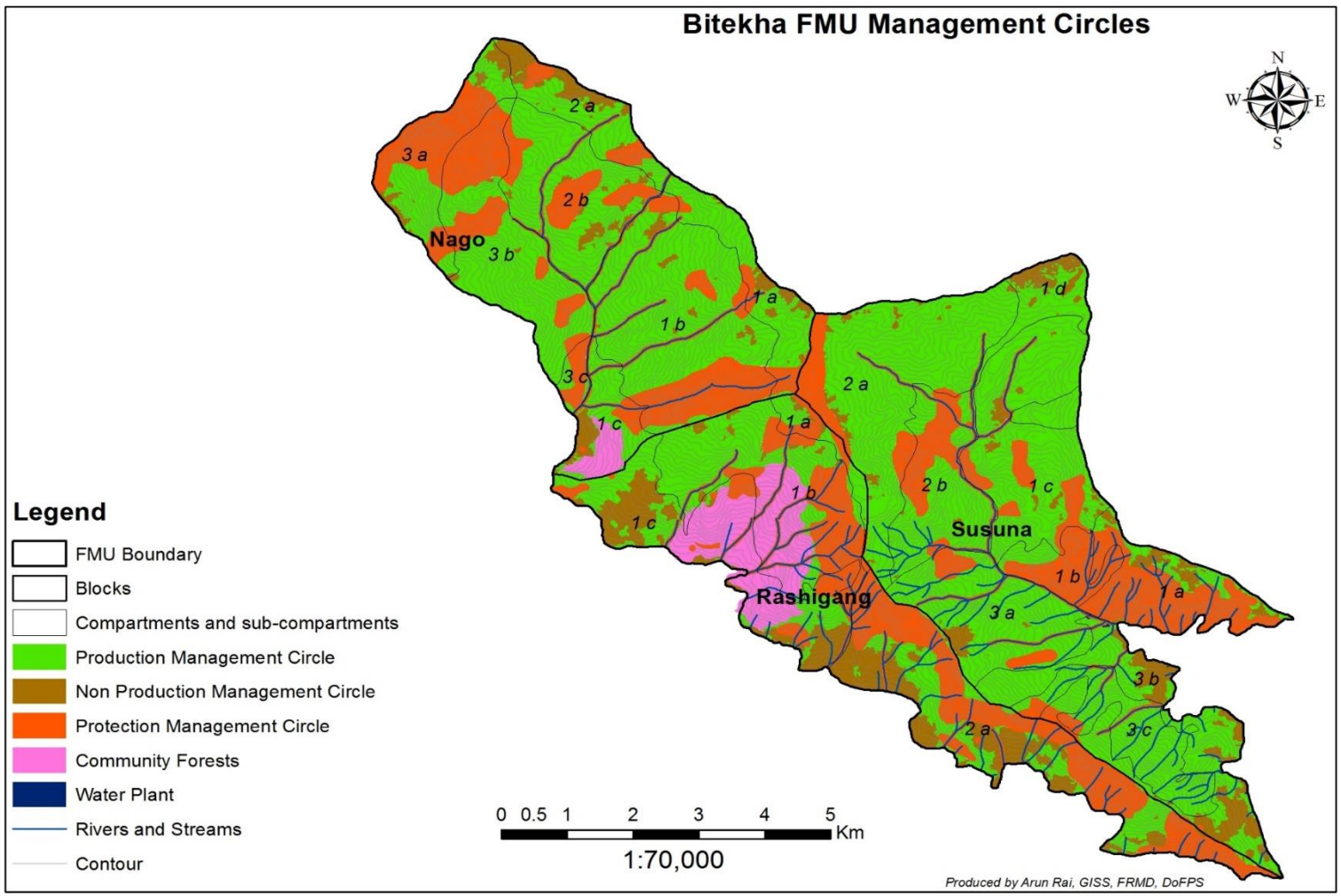
Annexure 1: Maps of Bitekha FMU




Bitekha FMU Management Circles
N
W
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Nago
Susuna
Rashigang
2 a
3 a
2 b
3 b
1 a
1 b
3 c
1 c
1 d
Legend
FMU Boundary
Blocks
Compartments and sub-compartments
Production Management Circle
Non Production Management Circle
Protection Management Circle
Community Forests
Water Plant
Rivers and Streams
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Km
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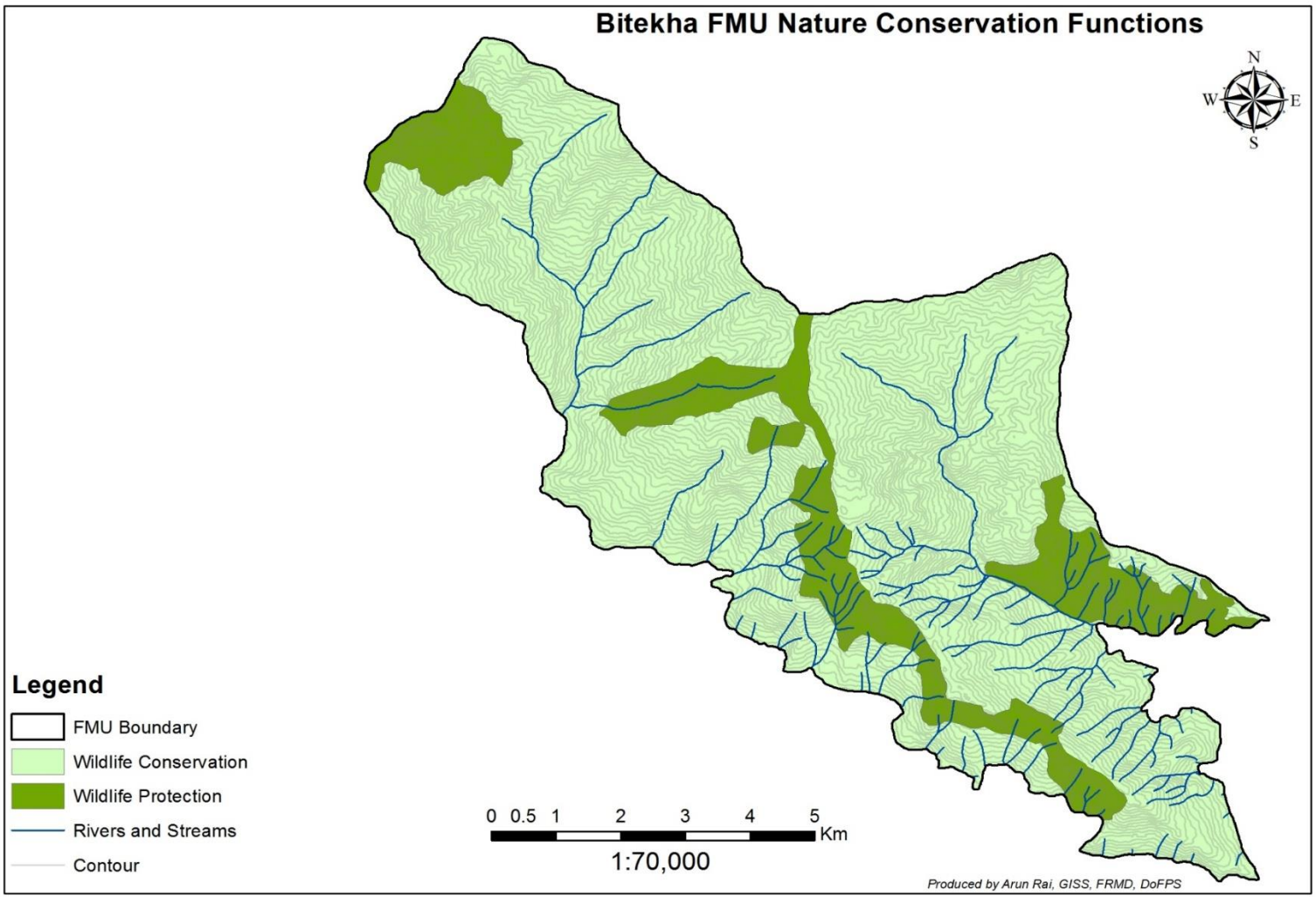
Bitekha FMU Nature Conservation Functions
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Legend
FMU Boundary
Wildlife Conservation
Wildlife Protection
Rivers and Streams
Contour
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Km
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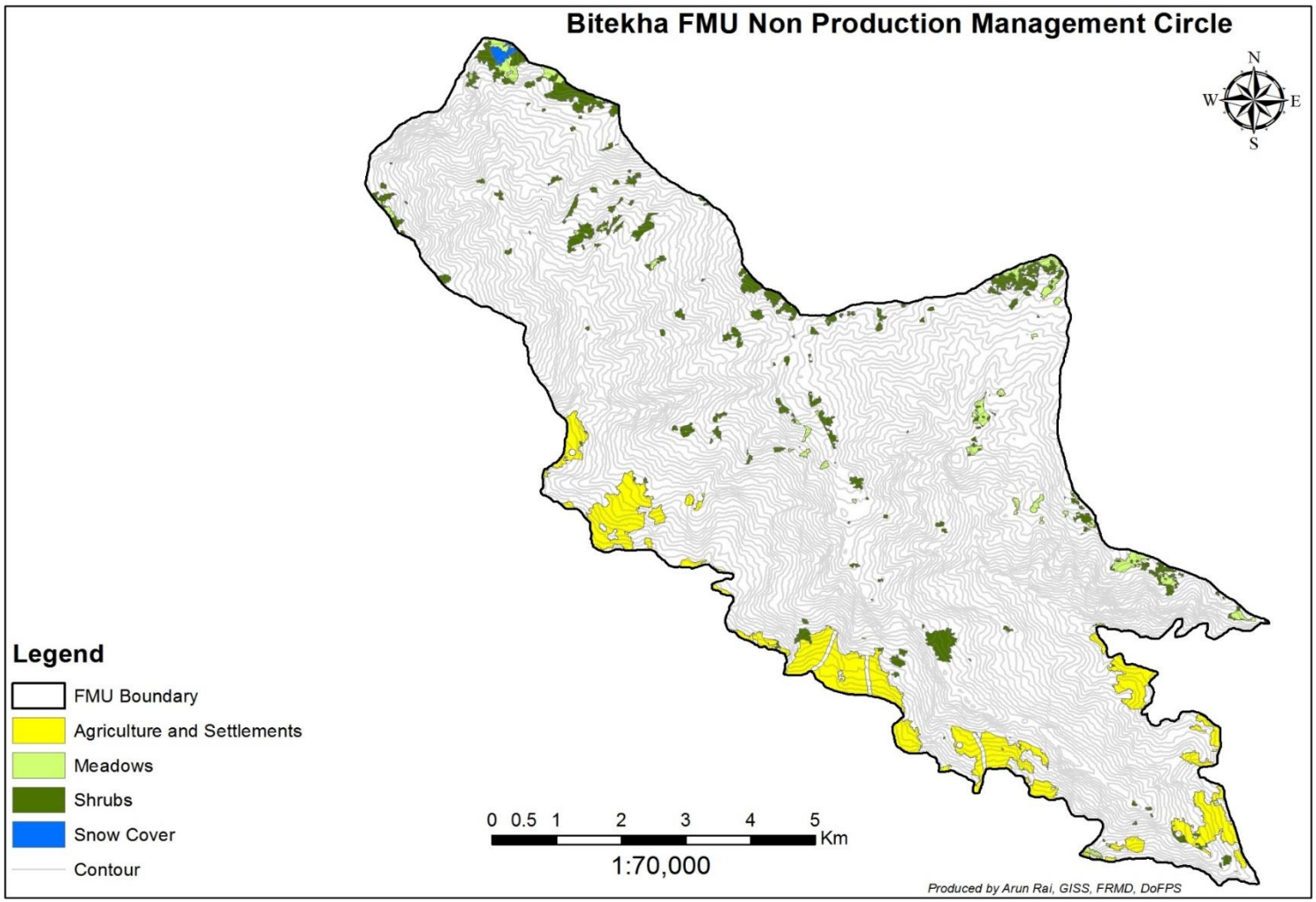
Bitekha FMU Non Production Management Circle
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E
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Legend
FMU Boundary
Agriculture and Settlements
Meadows
Shrubs
Snow Cover
Contour
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Km
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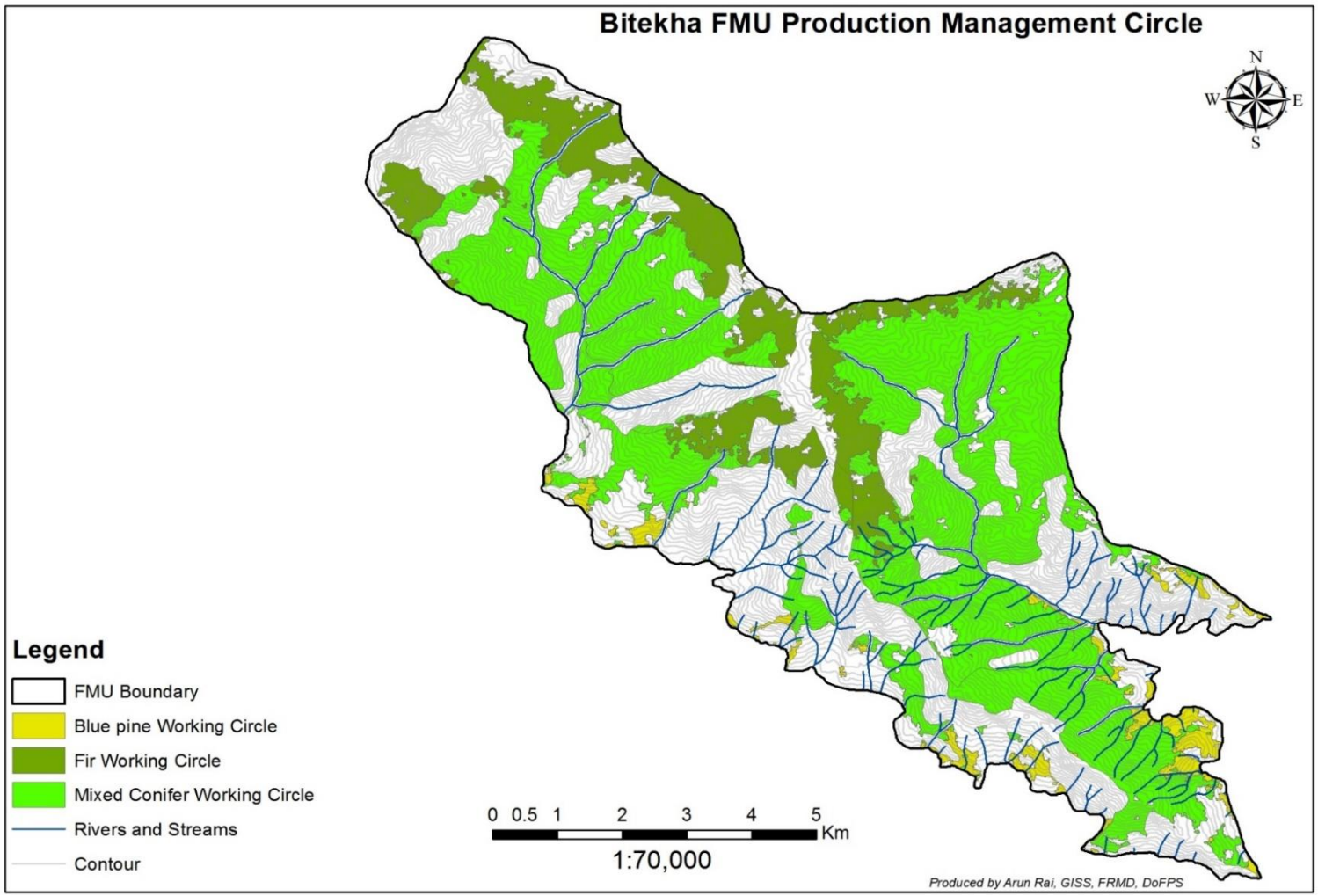
Produced by Arun Rai, GISS, FRMD, DoFPS


Bitekha FMU Production Management Circle
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Legend
FMU Boundary
Blue pine Working Circle
Fir Working Circle
Mixed Conifer Working Circle
Rivers and Streams
Contour
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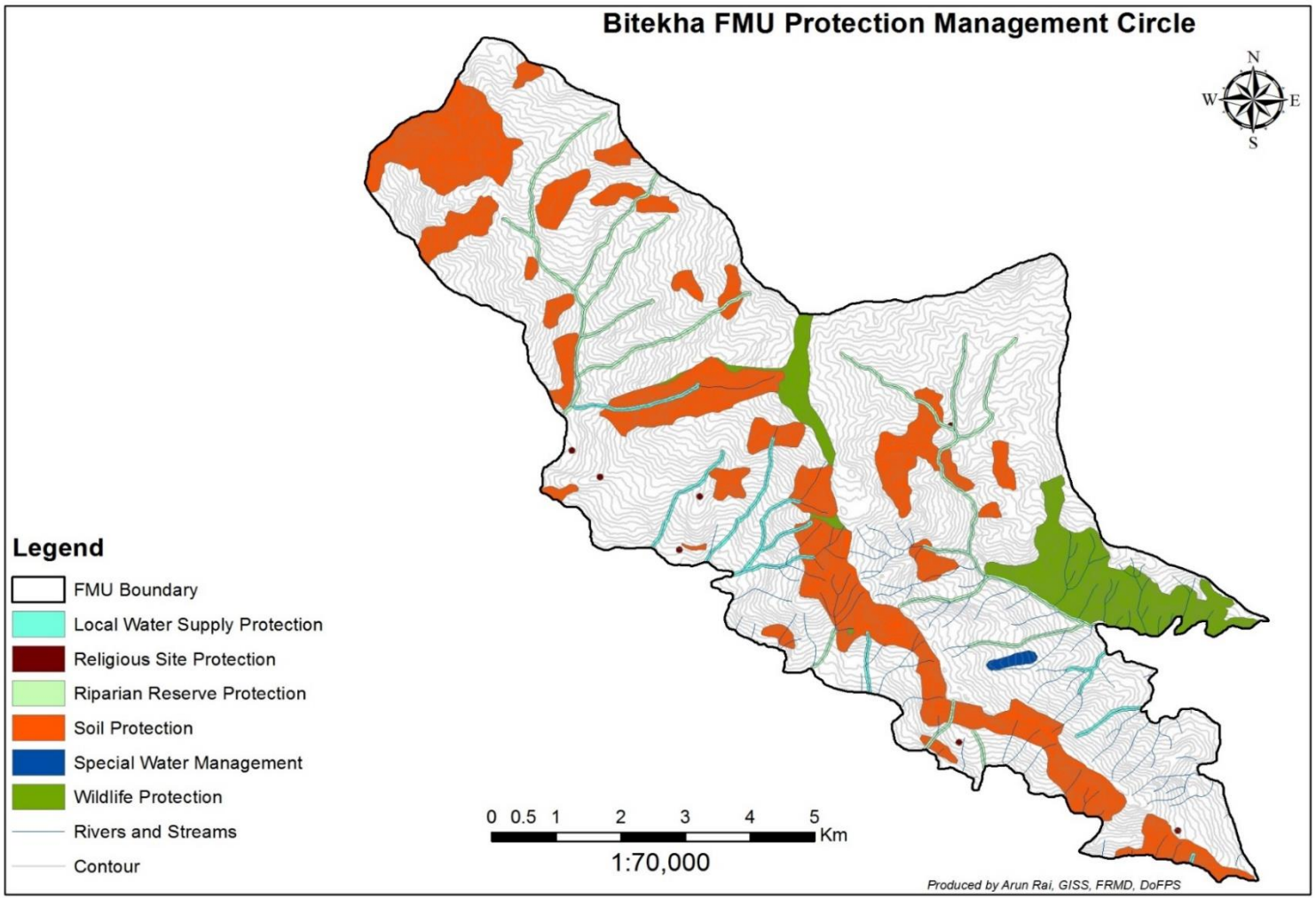
Produced by Arun Rai, GISS, FRMD, DoFPS


Bitekha FMU Protection Management Circle
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Legend
FMU Boundary
Local Water Supply Protection
Religious Site Protection
Riparian Reserve Protection
Soil Protection
Special Water Management
Wildlife Protection
Rivers and Streams
Contour
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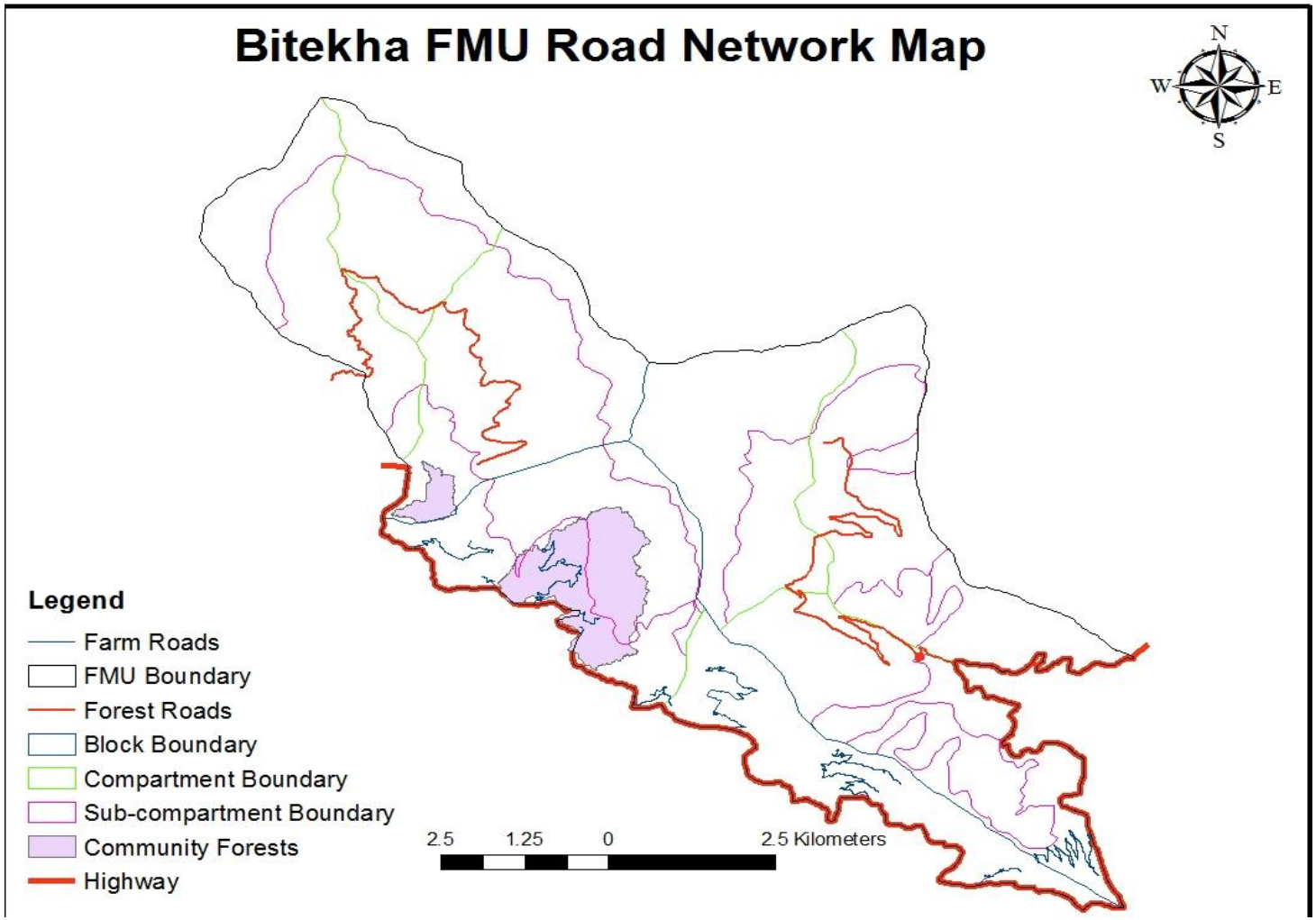
Bitekha FMU Road Network Map
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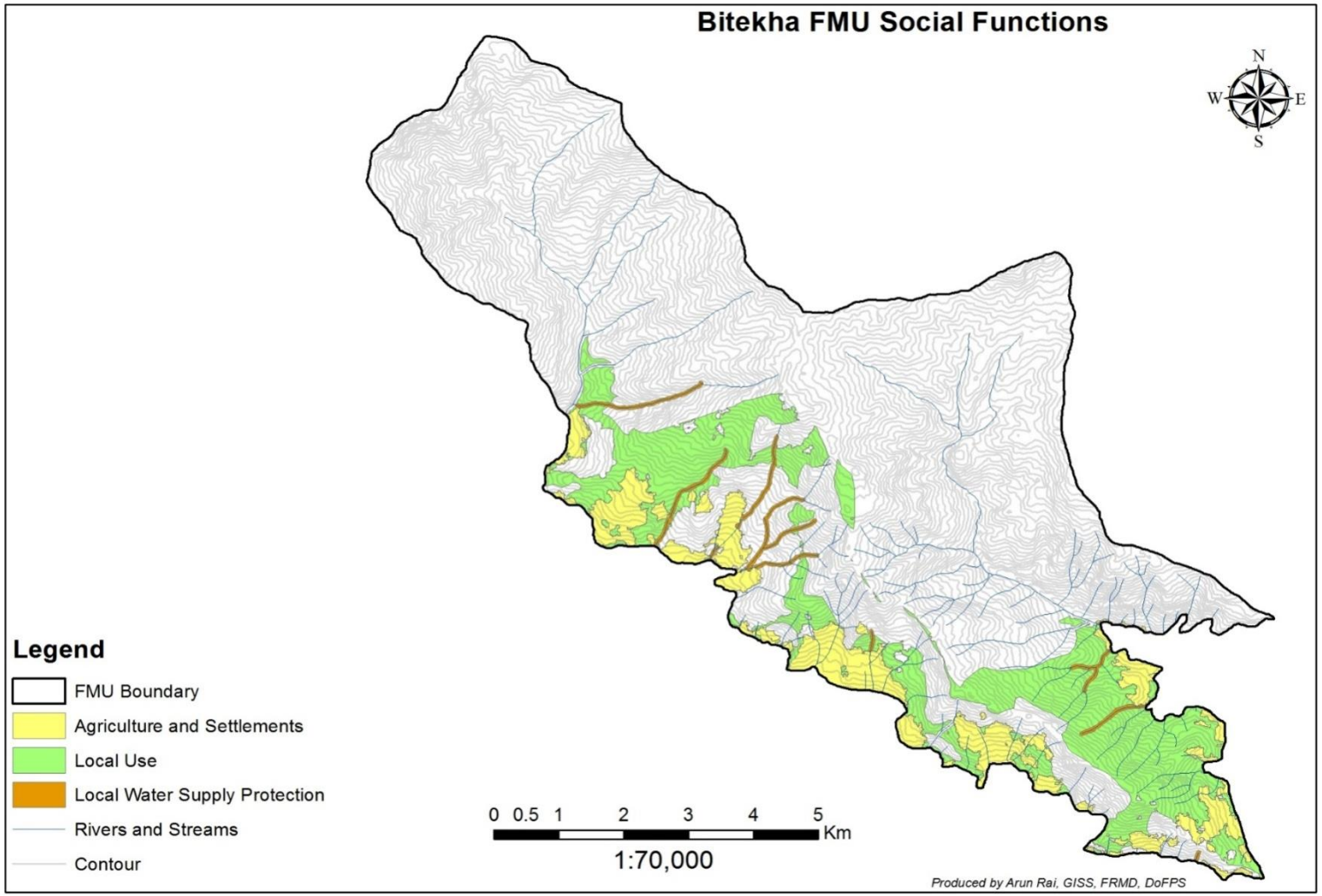
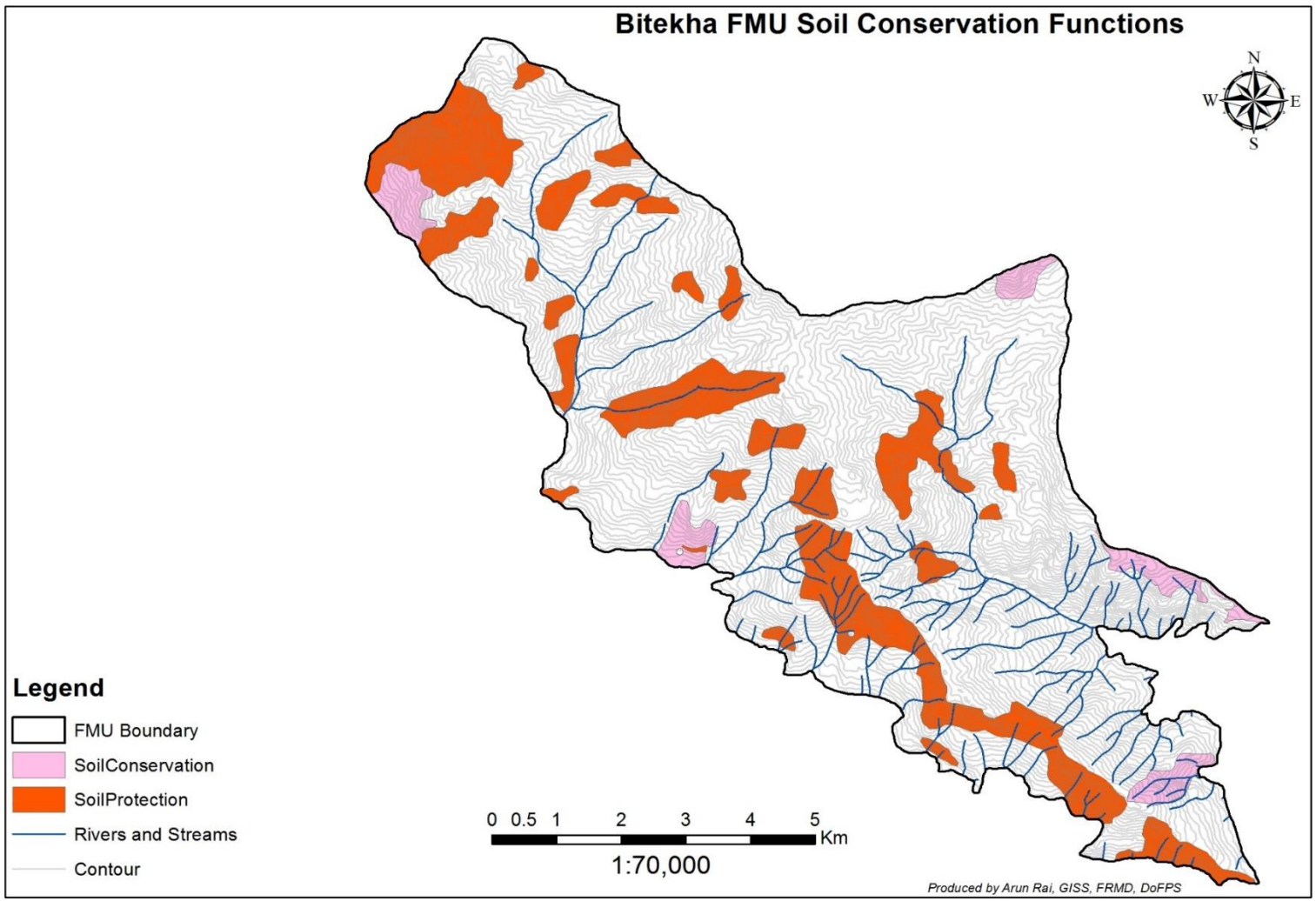
Legend
Farm Roads
FMU Boundary
Forest Roads
Block Boundary
Compartment Boundary
Sub-compartment Boundary
Community Forests
Highway
2.5
1.25
0
2.5 Kilometers


Bitekha FMU Social Functions
N
W
E
S
Legend
FMU Boundary
Agriculture and Settlements
Local Use
Local Water Supply Protection
Rivers and Streams
Contour
0 0.5 1 2 3 4 5
Km
1:70,000
Produced by Arun Rai, GISS, FRMD, DoFPS


Bitekha FMU Soil Conservation Functions
N
W
E
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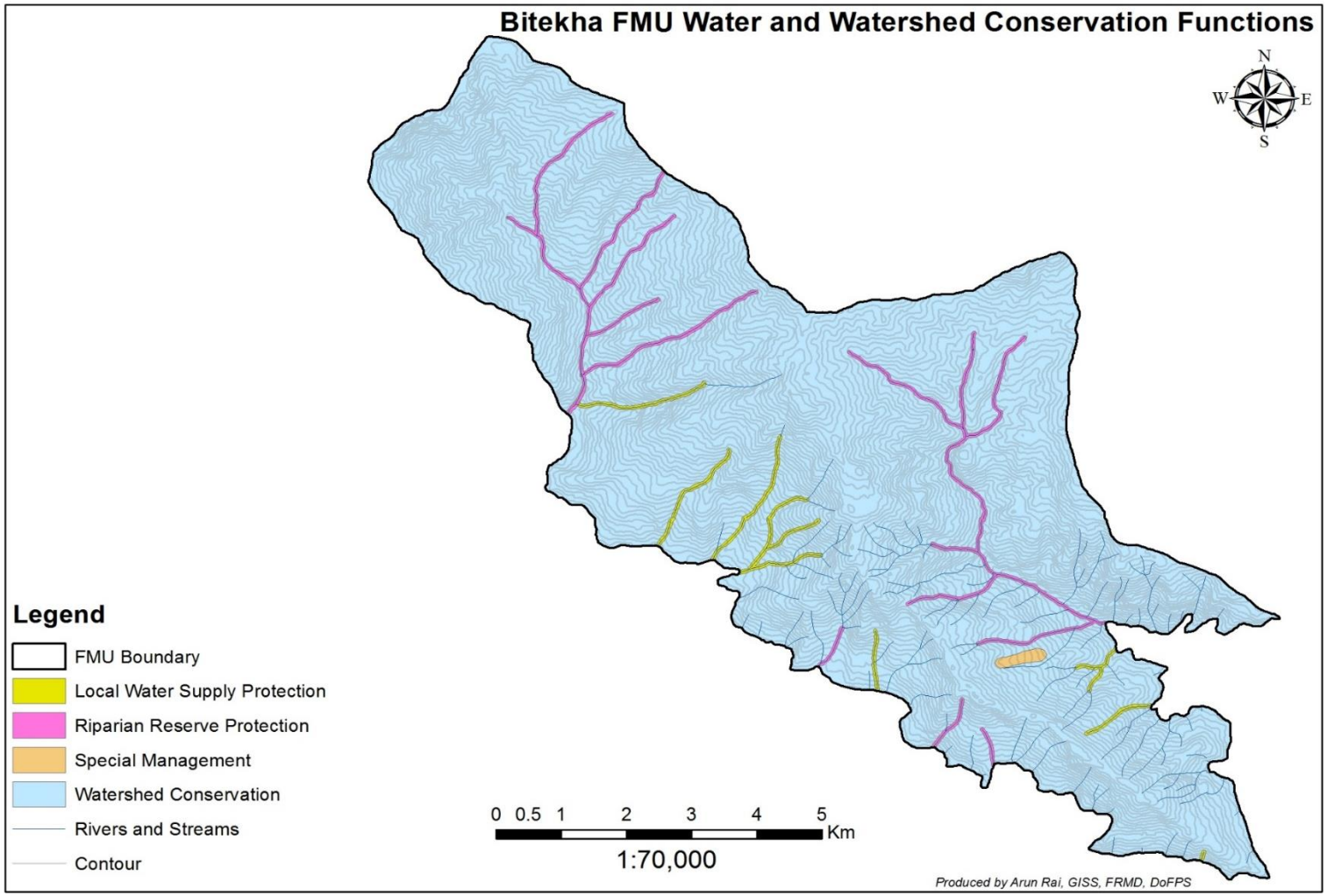
Legend
FMU Boundary
SoilConservation
SoilProtection
Rivers and Streams
Contour
0 0.5 1 2 3 4 5
Km
1:70,000
Produced by Arun Rai, GISS, FRMD, DoFPS


Bitekha FMU Water and Watershed Conservation Functions
N
W
E
S
Legend
FMU Boundary
Local Water Supply Protection
Riparian Reserve Protection
Special Management
Watershed Conservation
Rivers and Streams
Contour
0 0.5 1 2 3 4 5
Km
1:70,000
Produced by Arun Rai, GISS, FRMD, DoFPS

Annexure 2: Inventory Results

Main Table 1. Trees >= 10 cm DBH: Average Gross Volume per Ha.

Inventory Unit : Bitekha Period: 2013 Timber Quality : All (DBH 10+cm)

Stratum : Mixed conifer, fir and broadleafSampling Error % for Estimates : (at P=0.95)

Area : 4137.5 ha Number of sampling Units : 133

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

Stratum Name	Production	Definition & Estimates_volume_per_hec								
		Estimated total volume per hectare	Sample variance of total volume per hectare	Estimated variance of total volume per hectare	Margin of error (%) of total volume per hectare	lower limit of volume per hectare	upper limit of volume per hectare	Percent coefficient of variation	Standard error percent	Nos. of Plots
Mixed conifer	Commercial	407.8834571	97595.88341	1456.654976	15.61020947	344.2119951	471.5549192	76.5913383	9.3571212	67
Fir	Use	374.4354151	58339.55773	2243.829143	21.60934633	293.5223695	455.3484607	64.50667363	12.6508	27
Mixed conifer	Local use	228.7430114	60297.10734	1546.079675	28.9810383	162.4509116	295.0351111	107.3495936	17.189692	28
Broadleaf		12.20784406	575.3859814	14.7534867	53.0461906	5.732047831	18.68364028	196.4900962	31.463596	11

Main Table 2. Trees >= 10 cm DBH: Average Number of Trees per Ha.

Inventory Unit : Bitekha Period: 2013 Timber Quality : All (DBH 10+cm)

Stratum : Mixed conifer, fir and broadleaf Sampling Error % for Estimates : (at P=0.95)

Area : 4137.5 ha Number of sampling Units : 133

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

Definition & Estimates_numtree_per_hec

Stratum Name	Production	Estimated number of trees per hectare	Sample variance of total number of trees per hectare	Estimated variance of total number of trees per hectare	Margin of error (%) of total number of trees per hectare	lower limit of number of trees per hectare	upper limit of number of trees per hectare	Percent coefficient of variation	Standard error percent	Nos. of Plots
Mixed conifer	Commercial	219.1044776	12962.82225	193.474959	10.59077161	195.8996228	242.3093324	51.96351613	6.3483539	67
Fir	Use	193.8461538	8984.615385	345.5621302	16.38058996	162.0930102	225.5992975	48.89816445	9.589719	27
Mixed conifer	Local Use	154.3589744	14581.38138	373.8815739	21.11937134	121.7593294	186.9586194	78.22894086	12.526656	28
Broadleaf		55.17241379	7338.235294	253.0425963	49.04701426	28.11199213	82.23283546	155.2650944	28.832004	11

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

Inventory Unit : Bitekha Period: 2013 Timber Quality : All (DBH 10+cm)

Stratum : Mixed conifer, fir and boradleaf Sampling Error % for Estimates : (at P=0.95)

Area : 4137.5 ha Number of sampling Units : 133

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

Stratum Name	Production	Definition & Estimates_ba_per_hec								
		Estimated basel area of trees per hectare	Sample variance of total basel area of trees per hectare	Estimated variance of total basel area of trees per hectare	Margin of error (%) of total basel area of trees per hectare	lower limit of basel area of trees per hectare	upper limit of basel area of trees per hectare	Percent coefficient of variation	Standard error percent	Nos. of Plots
Mixed conifer	Commercial	34.58954468	599.9894609	8.95506658	14.43298095	29.59724229	39.58184707	70.81527822	8.6514632	67
Fir	Use	35.19574582	465.687555	17.91105981	20.5397014	27.96664472	42.42484692	61.31364618	12.024595	27
Mixed conifer	Local Use	19.50953204	337.106933	8.643767513	25.40683258	14.5527779	24.46628618	94.11026358	15.069703	28
Broadleaf		2.213197859	10.13874978	0.349612061	45.44757388	1.207353127	3.219042591	143.870569	26.716094	11

Main Table 4. Trees >= 10 cm DBH: Combined.

Inventory Unit : Bitekha Period: 2013 Timber Quality : All (DBH 10+cm)

Stratum : Mixed conifer, fir and boradleaf Sampling Error % for Estimates : (at P=0.95)

Area : 4137.5 ha Number of sampling Units : 133

Definition & Estimates_ba_per_hec

Estimated Parameters	Estimated basel area of trees per hectare	Sample variance of total basel area of trees per hectare	Estimated variance of total basel area of trees per hectare	Margin of error (%) of total basel area of trees per hectare	lower limit of basel area of trees per hectare	upper limit of basel area of trees per hectare	Percent coefficient of variation	Standard error percent	Nos. of Plots
Average Volume per Ha	485.8587072	79738.91112	658.9992655	8.758415587	443.3051825	528.4122319	58.11994039	5.283630944	133
Average Trees Per Ha	297.3553719	14623.66533	120.8567383	6.128479243	279.1320097	315.5787341	40.6679547	3.697086791	133
Average Basal Area per Ha	42.8305789	532.9219251	4.40431343	8.122285259	39.3517571	46.30940069	53.8986453	4.899876845	33

Main Table 5. Trees >= 10 cm DBH: DBH class wise.

Inventory Unit : Bitekha Period: 2013 Timber Quality : All (DBH 10+cm)

Stratum : Mixed conifer Sampling Error % for Estimates : (at P=0.95)

Area : 4137.5 ha Number of sampling Units : 94

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

Use : COMMERCIAL USE

CONIFER_VOL_10-29cm _Pole		CONIFER_VOL_30-69 cm_Tsim	
Definition_volume_per_hec	Estimates_volume_per_hec	Definition_volume_per_hec	Estimates_volume_per_hec
Estimated total volume per hectare	7.375537496	Estimated total volume per hectare	15-May
Sample variance of total volume per hectare	74.40810819	Sample variance of total volume per hectare	11191.74127
Estimated variance of total volume per hectare	0.800087185	Estimated variance of total volume per hectare	120.341304
Margin of error (%) of total volume per hectare	20.15104851	Margin of error (%) of total volume per hectare	13.34304304
lower limit of volume per hectare	5.889289357	lower limit of volume per hectare	118.3800641
upper limit of volume per hectare	8.861785635	upper limit of volume per hectare	154.8353089
Percent coefficient of variation	116.9543706	Percent coefficient of variation	77.44148894
Standard error percent	12.12760328	Standard error percent	8.03030832
Conifer_VOL_70-95 cm_Cham		Conifer_ 95cm +_Drashing	

Definition_volume_per_hec	Estimates_volume_per_hec	Definition_volume_per_hec	Estimates_volume_per_hec
Estimated total volume per hectare	139.1138375	Estimated total volume per hectare	84.79649
Sample variance of total volume per hectare	33926.56517	Sample variance of total volume per hectare	58877.35548
Estimated variance of total volume per hectare	364.801776	Estimated variance of total volume per hectare	633.0898439
Margin of error (%) of total volume per hectare	22.81291633	Margin of error (%) of total volume per hectare	49.3034675
lower limit of volume per hectare	107.3779142	lower limit of volume per hectare	42.98888011
upper limit of volume per hectare	170.8497609	upper limit of volume per hectare	126.6040999
Percent coefficient of variation	132.4035456	Percent coefficient of variation	286.1516614
Standard error percent	13.7296081	Standard error percent	29.67254502

Main Table 6. Trees >= 10 cm DBH: DBH class wise.

Inventory Unit : Bitekha Period: 2013 Timber Quality : All (DBH 10+cm)

Stratum : Boradleaf Sampling Error % for Estimates : (at P=0.95)

Area : 4137.5 ha Number of sampling Units : 94

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

Production Area : COMMERCIAL USE

10-29cm DBH		30-50cm	
Definition_volume_per_hec	Estimates_volume_per_hec	Definition_volume_per_hec	Estimates_volume_per_hec
Estimated total volume per hectare	10.35559948	Estimated total volume per hectare	10.27238458
Sample variance of total volume per hectare	225.5664089	Sample variance of total volume per hectare	624.6969478
Estimated variance of total volume per hectare	2.425445257	Estimated variance of total volume per hectare	6.717171482
Margin of error (%) of total volume per hectare	24.98867104	Margin of error (%) of total volume per hectare	41.92225297
lower limit of volume per hectare	7.767872795	lower limit of volume per hectare	5.96596953
upper limit of volume per hectare	12.94332617	upper limit of volume per hectare	14.57879963
Percent coefficient of variation	145.031376	Percent coefficient of variation	243.3119402
Standard error percent	15.03905312	Standard error percent	25.23027287

Main Table 7. Trees >= 10 cm DBH: DBH class wise. (Combined)

Inventory Unit : Bitekha Period: 2013 Timber Quality : All (DBH 10+cm)

Stratum : Boradleaf and Oak Sampling Error % for Estimates : (at P=0.95)

Area : 4137.5 ha Number of sampling Units : 94

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

Production Area : COMMERCIAL USE

BL+OAK_COMBINED VOL

Definition_volume_per_hec	Estimates_volume_per_hec
Estimated total volume per hectare	45.62294227
Sample variance of total volume per hectare	13736.57195
Estimated variance of total volume per hectare	147.7050748
Margin of error (%) of total volume per hectare	44.26261673
lower limit of volume per hectare	25.42903419
upper limit of volume per hectare	65.81685035
Percent coefficient of variation	256.8951426
Standard error percent	26.63878535

Main Table 8. Trees >= 10 cm DBH: DBH class wise. (Combined)

Inventory Unit : Bitekha
Period: 2013 Timber Quality : All (DBH 10+cm)
Stratum : Conifer
Sampling Error % for Estimates : (at P=0.95)
Area : 4137.5 ha
Number of sampling Units : 39
Estimated Parameter : AVERAGE GROSS VOLUME PER HA (M^3/HA)
Production Area : LOCAL USE

RURAL_CONIFER_10_29cm_Pole

Definition_volume_per_hec	Estimates_volume_per_hec
Estimated total volume per hectare	18.12590947
Sample variance of total volume per hectare	469.9753482
Estimated variance of total volume per hectare	16.78483387
Margin of error (%) of total volume per hectare	38.49877558
lower limit of volume per hectare	11.14765626
upper limit of volume per hectare	25.10416268
Percent coefficient of variation	119.6018046
Standard error percent	22.60261653

RURAL_CONIFER_30_69cm_Tsim

Definition_volume_per_hec	Estimates_volume_per_hec
Estimated total volume per hectare	94.3768687
Sample variance of total volume per hectare	4946.477974
Estimated variance of total volume per hectare	176.6599276
Margin of error (%) of total volume per hectare	23.98786857
lower limit of volume per hectare	71.73786948
upper limit of volume per hectare	117.0158679
Percent coefficient of variation	74.52165235
Standard error percent	14.08326853

RURAL_CONIFER_70-95 CM_Cham

Definition_volume_per_hec	Estimates_volume_per_hec
Estimated total volume per hectare	68.4950058
Sample variance of total volume per hectare	20639.99139
Estimated variance of total volume per hectare	529.2305484
Margin of error (%) of total volume per hectare	56.62515257
lower limit of volume per hectare	29.70960426
upper limit of volume per hectare	107.2804073
Percent coefficient of variation	209.7470441
Standard error percent	33.58640693

RURAL_CONIFER_96cm +_Drashing

Definition_volume_per_hec	Estimates_volume_per_hec
Estimated total volume per hectare	23.67735275
Sample variance of total volume per hectare	1846.449972
Estimated variance of total volume per hectare	47.34487107
Margin of error (%) of total volume per hectare	48.99470695
lower limit of volume per hectare	12.07670316
upper limit of volume per hectare	35.27800234
Percent coefficient of variation	181.4828657
Standard error percent	29.06051623

Annexure 3: Compartment Descriptions & Prescriptions

BLOCK: ***NAGO*** **COMPARTMENT: I**

Site Characteristics	Forest Description	Plan Prescriptions
Altitude : 2720-3880m **Aspect :** South West **Terrain :** Gentle to steep **Total Area: 1065.4 ha** **Protection: 451.46 ha** **Non-production: 57.26 ha** **Production:68.86 ha**	Matured Mixed Conifer stands, comprises mainly of Spruce and Hemlock with few Larch, Betula, Cupressus and Junipers occupying higher altitudes and Rhus, Populus, Pieris and Acer occupying the lower altitudes. Good regeneration of spruce and hemlock under the matured stands. The Fir stands are matured and over matured on the ridges; however some fir regeneration can be sighted at places. At this altitude couple of good Juniper trees is also found with young regeneration beneath. Fir die back can be seen in Fir zone especially at very high altitudes. This zone has very good undergrowth especially of Rhododendrons and Juniper. No growth of bamboo and Daphne can be seen. Pure patches of Spruce, Hemlock and Fir are found on South Western aspects of the compartment. A patch of Blue pine stand is found below, poles and young stands at lower altitudes and matured stands at higher altitudes. The growth of bamboo has been seen in this zone in moister areas and along the rivers and streams.	**Commercial use** As per the map and function mapping prescriptions in the plan. No ground based skidding. Planting can be done in blank areas.

BLOCK: *NAGO* **COMPARTMENT: II**

Site Characteristics	Forest Description	Plan Prescriptions
Altitude : 3000- 4040m **Aspect :** South West **Terrain:** Gentle to steep **Total Area: 580.9 ha** **Protection: 167.15 ha** **Non-Production:76.61 ha** **Production: 359.85 ha**	Matured stand of Spruce and Hemlock with matured to over matured stand of Fir. Few stands of Juniper and Rhododendrons are also encountered. In some places there is good regeneration of Juniper and Rhododendrons. At higher elevations, pure stands of Fir are found with open canopy due to die back of Fir.	**Commercial use** Wherever natural regeneration is not successful, these areas are to be supplemented with artificial regeneration. No ground based skidding

BLOCK: *NAGO* **COMPARTMENT: III**

Site Characteristics	Forest Description	Plan Prescriptions
Altitude : 2720- 4000m **Aspect :** North East **Terrain:** Moderate to steep **Total Area: 749.3 ha** **Protection: 552.26 ha** **Non-Production:25.77 ha** **Production: 388.10 ha**	Forest generally comprising of Hemlock and Spruce and Fir stands at higher elevations. Stand matured to over-mature. A small patch of Blue pine occurs at lower altitudes. Good regeneration of principal species is seen within the matured stands of Spruce and Hemlock but regeneration is poor in Fir stand due to less humus depth and poor soil quality.	**Commercial use** As per the prescription in the plan. Blue pine thinning; minimize grazing in the regeneration areas.

BLOCK: *RASHIGANG* **COMPARTMENT: I**

Site Characteristics	Forest Description	Plan Prescriptions
Altitude: 2680- 3840m **Aspect :** Eastern-Western	Mainly matured stand of Hemlock and Spruce with mixtures of Larch, *Taxus*,	**Local use**

in general **Terrain:** gentle to steep **Total Area: 1117.4 ha** **Protection:462.63 ha** **Non-Production: 145.45 ha** **Protection: 402.85 ha**	*Populus ciliata, Rhus chinensis*, Acer sp. and *Pieris formosa*, and matured and over-mature Fir above and mostly immature Blue pine below mixed with popular, willow and hemlock.Rivers and streams depressions have good growth of spruce and hemlock with good regeneration of the same underneath. It is accompanied by good growth of bamboo. Plenty of oak trees can be seen growing in the area. However, there is no sign of Fir regeneration. Good regeneration of blue pine is seen.	As per the prescription in the plan. Grazing must be controlled. Protection from forest fire is required. Harvesting of bamboos should be done on a sustainable basis.

BLOCK: *RASHIGANG* **COMPARTMENT: II**

Site Characteristics	Forest Description	Plan Prescriptions

Altitude: 2560- 3400m **Aspect :** Southern **Terrain:** Gentle to steep **Total Area: 679.7 ha** **Protection: 616.70 ha** **Non-Production: 168.54 ha** **Production: 160.61 ha**	Immature Blue pine stand. Some spruce, hemlock, oaks, popular and willow are also seen growing in between the blue pine stands. Blue pine regeneration is found in abundance	**Local use** As per the prescription in the plan. Blue pine thinning needs to be done.

BLOCK: *SUSUNANG* **COMPARTMENT: I**

Site Characteristics	Forest Description	Plan Prescriptions
Altitude : 2440- 3840m **Aspect :** South-West in general **Terrain:** Moderate to steep **Total Area: 1080.4 ha** **Protection: 400.73 ha** **Non-Production:86.08 ha** **Protection: 598.69 ha**	Mainly Hemlock mixed with Spruce, Fir on higher elevations and immature and matured Blue pine at lower elevations with common associates such as *Populus ciliata*, *Aesculus indica*, *Acer campbellii*, Spruce, Hemlock and Daphne. Dense growth of bamboo occurs in Fir zone, Junipers and Rhododendrons are found in middle canopy intermixed with some larch, hemlock and acer at places.	**Commercial use** As per the prescription in the plan. The Fir on the ridges is affected by bark beetle and needs to be felled. Natural regeneration in many places needs to be supplemented by artificial planting. Grazing must be regulated and prohibited in regeneration areas.

BLOCK: *SUSUNANG* **COMPARTMENT: II**

Site Characteristics	Forest Description	Plan Prescriptions

Altitude: 2840- 3840m **Aspect:** Eastern in general **Terrain:** Moderate to steep **Total Area: 957.7 ha** **Protection: 210.75 ha** **Non-Production:20.98 ha** **Production: 735.48 ha**	Mostly Matured Mixed Conifer andFir with some over-matured Fir on the ridges.	**Commercial use** As per the prescription in the plan. The regeneration is quite poor, needs to be supplemented by artificial planting.

BLOCK: *SUSUNANG* **COMPARTMENT: III**

Site Characteristics	Forest Description	Plan Prescriptions
Altitude: 2440- 3400 m **Aspect:** Eastern in general **Terrain:** Moderate to steep **Total Area: 1028.9 ha** **Protection: 138.94 ha** **Non-Production: 116.03 ha** **Production: 803.05 ha**	Mainly over-matured Hemlock mixed with Spruce and immature Blue pine. The area has been logged in the past, so the existing forest type includes mostly of over-matured hemlock and young blue pine.	**Commercial use** As per function mapping in the plan. Regulation and control of grazing.

Annexure 4: 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 side 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 watercourses or watercourse buffer areas. Care should also be taken to ensure that no earthworks 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 possibility 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 300 metres) 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 metres 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 metre's in vertical height and no more than 100% gradient with a 1.5 metre horizontal step.
11. Convex road surface should be maintained at all times with the centre line 30 cm higher than the edges.
12. Stabilise and revegetate 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 100 metres or more above the proposed road catch drains should be constructed to divert surface water into culverts. Side drains or table drains should be at least 40cm deep and 65cm wide and should drain into culverts of sufficient size and frequency.

4. All culverts must have stone or concrete aprons at their exit points to prevent erosion by water. These aprons should be of suitable width and design to prevent any erosion-taking place and should extend down the slope for at least the length of the spill. They should divert the water back into the stream if the water came from a stream.

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 to 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 50 metres before a watercourse.

10. Sumps or silt traps should be placed in drains every 50 metres in erodible soils and must be cleaned regularly.

Road Construction

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 and stabilise the slope.

3. Where side slopes of 70% or more extend more than 100 metres downhill no side casting of spoil should be 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 distances of up to 300 metres if this substantially reduces road length. Following this incline a minimum distance of 100 metres 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 300 metres will be allowed if this substantially reduces road length. These grades should be followed by grades of less than 10% for distances of 100 metres or more.

Annexure 5: Tree Marking Guidelines

1. Marking Rules for Single Tree Selection System

- Selection System will be used on sensitive and exposed sites 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.
- Trees damaged during harvesting will be marked and removed during the subsequent coup cleaning operation.

2. Marking Rules for Group Selection System

- The Group Selection System has been introduced as an effective way of regenerating the major coniferous forest type in Bhutan. Small openings will be created in the stand allowing light to reach the forest floor and creating conductive micro-climatic conditions for seed germination and for establishment of seedlings.
- Group Selection System will be applied on suitable sites in the mixed conifer, Spruce, Blue Pine, Hemlock and Blue Pine-Hemlock stands.
- The openings will be located along and to the sides of the cable lines as per the Silvicultural requirement of the species.
- The distance between the extraction lines will be approximately 60 metres.
- The distance between the groups, along the extraction lines will be approximately 50 metres.
- The shape and size of the groups can be adjusted according to the site and terrain conditions.
- Existing openings in the stand having already established regeneration should be utilized as a nucleus for making the groups.
- Sign of existing windfall in the stand should form the basis of the opening. In such cases opening boundaries should correspond to changes in soil moisture, which is often the cause of windfall.
- The selected groups must be surrounded by wind firm trees. This could be achieved by leaving intermediate height trees along the edge of the openings.
- The trees will be marked for harvesting along the extraction corridors.
- The extraction corridors must be as narrow as possible, however, no wider than 3-4 metres.
- No protected species (*Rhododendrons etc.*) will be marked either in the groups or along the corridors.

- The maximum size of the openings will be, on average, less than 0.15 ha for mixed conifer and 0.10 for fir forest (i.e. the diameter being one and half tree length, but maximum 50 metres.)
- Diseased, dead, and malformed trees will be marked on priority basis and should be used as nucleus for creating an opening.
- Boundaries of opening should, wherever possible, correspond to changes in slope. An opening should not end in the middle of a steep slope since trees will slide into remaining stand during logging.
- Care must be taken in choosing the boundary of the opening. Trees which can be expected to fall into the opening should be marked while trees leaning out of the proposed opening must be left standing so as to minimize damage to the remaining stand.
- Trees damaged during harvesting will be cut and removed in the subsequent cleaning operations.

3. Marking for Rural Uses

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

Annexure 6Environmental Impact Assessment of Forest Road

ENVIRONMENTAL IMPACT ASSESSMENT REPORT FOR CONSTRUCTION OF FOREST ROAD AT BITEKHA FMU, NAGU BLOCK, PARO 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. 25,647,000.00 (Estimated cost)

8 Project description

8.1 Project location : From 22.00km point at Haa East & Bitekha FMU (17.00 + 5.00kms) respectively.

Table 1: Road location details by Dzongkhag and Geog

Road chainage		Dzongkhag	Gewog	Town	Village
From	To				
0 + 000	0 + 6000	Paro	Naja		Nagu

1:50,000 Topo map attached.

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	6,570.00
Volume of excavated material		
a) Excavation in soil all type	m^3	56,100.00
b) Excavation in rock all type	m^3	45,900.00
Average road gradient	%	±6
Maximum road gradient	%	±12
Cross drain	no	NIL
Box/Hume pipe culvert	no	NIL
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	5,970.00
Box shaped side drain diamensions (lengthxbreadthxheight)	cm	NIL
Total length of box drain	m	NIL

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

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

Sl. No	Particulars	Quantity
1	Safety fuse	720 coils (Approx)
2	detonator	1260 Nos. (Approx)
3	D-chord	1020mtrs. (Approx)
4	Jelatine	1620 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 + 6000	6000.00 (Nagu block)	30 -120	Precambrian formation & no problem foreseen	Normal Bio-engineering + Retaining & Breast wall structure works wherever required.
Total		6,000.00			

11.2 Water Course Crossings

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

Chainage at which road crosses water course	Name of water course	Type of crossing	If bridge, Length of bridge (m)	Down stream water users- details		
				Name of community or individual	House hold (no)	Type of use
0000 + 0015	N A	H/pipe culvt	NIL	Nagu	19	Drinking & irrigation
0015 + 0277	N A	H/pipe culvt	NIL	Nagu		
0277 + 0618	NA	H/pipe culvt	NIL	Nagu		
0618 + 0718	NA	H/pipe culvt	NIL	Nagu		
0718 + 0886	NA	H/pipe culvt	NIL	Nagu		
0886 + 1019	NA	H/pipe culvt	NIL	Nagu		
1019 + 1204	NA	H/pipe culvt	NIL	Nagu		
1204 + 1285	NA	H/pipe culvt	NIL	Nagu		
1285 + 2085	NA	H/pipe culvt	NIL	Nagu		
2085 + 2171	NA	H/pipe culvt	NIL	Nagu		
2171 + 2240	NA	H/pipe culvt	NIL	Nagu		

2240 + 2335	NA	H/pipe culvt	NIL	Nagu	19	Drinking & irrigation
2335 + 2487	NA	H/pipe culvt	NIL	Nagu		
2487 + 2612	NA	H/pipe culvt	NIL	Nagu		
2612 + 2763	NA	H/pipe culvt	NIL	Nagu		
2763 + 2794	NA	H/pipe culvt	NIL	Nagu		
2794 + 3040	NA	H/pipe culvt	NIL	Nagu		
3040 + 3190	NA	H/pipe culvt	NIL	Nagu		
3190 + 3340	NA	H/pipe culvt	NIL	Nagu		
3340 + 4090	NA	H/pipe culvt	NIL	Nagu		

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	6 + 000	Mixed conifer forest	60,000.00	10 years	NIL

Table 6: Areas Required for Project Facilities

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

12.2. Protected area : The protected areas such as Soil protection, local water supply protection Reparian protection, Wild life protection etc. shall be indentified where nc 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)
Paro	Naja	

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 technique measures shall be applied on the slopes for reclaiming immediately after road construction.

14 Project Impacts and Mitigation Measures

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

14.1. Monitoring Program

Monitoring of the construction works will be done by Site supervisor, Bitekha Unit, NRDCL, including time to time monitoring by the Unit Manager, Bitekha Unit under Rinpung Regional Office, Paro. The Regional Manager, Rinpung Regional Office, NRDCL Paro, shall also carry out the frequent monitoring works. Also the Engineering Section shall carry out the monitoring works as & when required.

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

PRELIMINARY COST ESTIMATE 6.00 KMS

Sl. No.	Particulars of work	Quantity	Unit	Rate	Amount (Nu)	Remarks
1	**EARTH WORK**					BSR 2013, CG0002,
1.1	Right of way clearing	60,000.00	sqm	6.99	419,400.00	P. 4
1.2	Formation cutting					BSR 2013, RW0013,
	a) Excavation of all types of soil	56,100.00	cum	59.71	3,349,731.00	P.62
	b) Excavation of all types of rock with or without blasting	45,900.00	cum	211.21	9,694,539.00	BSR 2013, RW0014, P. 62
2	**MASONRY WORKS**					
2.1	Excavation in foundation trenches for construction of hume pipe culvert					BSR 2013, EW0105,
	a) Excavation of all types of soil	346.40	cum	95.67	33,140.09	P. 6
	b) Excavation of all types of rock with or without blasting	99.80	cum	398.49	39,769.30	BSR 2013, EW0107, P. 6
2.2	Providing & laying NP2 class RC pipes including collars					BSR 2013, DR0093,
	a) 600mm dia with 45mm wall thick	100.00	m	2,946.13	294,613.00	P. 9
	b) 900mm dia with 55mm wall thick	25.00	m	5,296.31	132,407.75	BSR 2013, DR0095, P. 9
2.3	Providing & laying dry rubble masonry with hard stone in catch pit, retaining wall, appron etc.	191.20	cum	1,660.08	317,407.30	BSR 2013, SM0050, P. 21
2.4	Filling of trenches	81.20	cum	61.62	5,003.54	BRS 2013, EW0195, P. 7
3	**ROAD WORKS**					BSR 2013, EW0002,
3.1	Preparation of sub grade	21,900.00	sqm	9.93	217,467.00	P. 5
3.2	Providing & laying hammer dressed stone edging 150mm x 300mm	12,000.00	m	81.36	976,320.00	BSR 2013, SM0073, P. 22
3.3	Providing & laying stone soling	4,020.00	cum	1,270.67	5,108,093.40	BSR 2013, SM0072, P. 22
3.4	Providing & laying base course	2,010.00	cum	1,754.64	3,526,826.40	BSR 2013, RW0147, P. 65 (+) MT0069, P. 3
3.5	Providing & laying shoulder filling	900.00	cum	67.72	60,948.00	BSR 2013, EW0096, P.6
3.6	Digging & providing V shaped earthen side drain	5,970.00	m	18.39	109,788.30	BSR 2013, RW0107, P. 64
3.7	Consolidation of road surface	20,100.00	sqm	6.98	140,298.00	BSR 2013, RW0125, P. 64
TOTAL					24,425,752.08	
Add 5% contingency					1221287.60	
GRAND TOTAL					25,647,039.68	
Or SAY					**25,647,000.00**	

Prepared & submitted by:

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

NVIRONMENTAL IMPACT ASSESSMENT REPORT FOR CONSTRUCTION OF FOREST ROAD AT BITEKHA FMU, SUSUNA BLOCK, PARO 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. 02-326749, EPABX no. 00975-2-323834/3238868, Fax no. 00975-2-325585, Email: info@nrdcl.bt

4 Name of environmental focal person : Mr. J.K. Nepal, Engineer, Production Division, NRDCL HQ, Tel. 02-323868, 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. 60,275,600.00 (Estimated cost)

8 Project description

8.1 Project location : From 26.00km point along Chuzom-Haa National Highway

Table 1: Road location details by Dzongkhag and Geog

Road chainage		Dzongkhag	Gewog	Town	Village
From	To				
0 + 000	13 + 600	Paro	Naja		Susuna

1:50,000 Topo map attached.

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	6,570.00
Volume of excavated material		
a) Excavation in soil all type	m^3	56,100.00
b) Excavation in rock all type	m^3	45,900.00
Average road gradient	%	±6
Maximum road gradient	%	±12
Cross drain	no	NIL
Box/Hume pipe culvert	no	NIL
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	5,970.00
Box shaped side drain diamensions (lengthxbreadthxheight)	cm	NIL
Total length of box drain	m	NIL

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

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

Sl. No	Particulars	Quantity	Unit	Remarks
1	Safety fuse	1633.00	coils	(Approx)
2	detonator	2858.00	Nos.	(Approx)
3	D-chord	2313.00	mtrs.	(Approx)
4	Jelatine	3672.00	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 stabilizatior Above & Below road
From	To				
0 + 000	13 + 600	13,600.00	30 -120	Precambrian formation & no problem foreseen	Normal Bio-engineering + Retaining & Breast wall structure works wherever required.
Total		13,600.00			

11.2 Water Course Crossings

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

Chainage at which road crosses water course	Name of water course	Type of crossing	If bridge, Length of bridge (m)	Down stream water users- details		
				Name of community or individual	House hold (no)	Type of use
0000 + 0092	N A	H/pipe culvt	NIL	Susuna		
0092 + 0150	Lumnam ochhu	H/pipe culvt	NIL	Susuna		
0150 + 0196	NA	H/pipe culvt	NIL	Susuna		
0196 + 0244	NA	H/pipe culvt	NIL	Susuna		
0244 + 0490	NA	H/pipe culvt	NIL	Susuna		
0490 + 0593	NA	H/pipe culvt	NIL			
0593 + 0787	NA	H/pipe culvt	NIL			
0787 + 1755	NA	H/pipe culvt	NIL	Susuna		
1755 + 1845	NA	H/pipe culvt	NIL	Susuna		
1845 + 2126	NA	H/pipe culvt	NIL	Susuna		
2126 + 2151	NA	H/pipe culvt	NIL	Susuna		
2151 + 2298	NA	H/pipe culvt	NIL	Susuna	22	Drinking & irrigation
2298 + 2452	NA	H/pipe culvt	NIL	Susuna		
2452 + 2490	NA	H/pipe culvt	NIL	Susuna		
2490 + 2540	NA	H/pipe culvt	NIL	Susuna		
2540 + 2627	NA	H/pipe culvt	NIL	Susuna		
2627 + 2775	NA	H/pipe culvt	NIL	Susuna		
2775 + 2883	NA	H/pipe culvt	NIL	Susuna		
2883 + 3111	NA	H/pipe culvt	NIL	Susuna		
3111 + 3126	NA	H/pipe culvt	NIL	Susuna		
3126 + 3466	NA	H/pipe culvt	NIL	Susuna		
3466 + 3475	NA	H/pipe culvt	NIL	Susuna		
3475 + 3545	NA	H/pipe culvt	NIL	Susuna		
3545 + 3616	NA	H/pipe culvt	NIL	Susuna		

3616 + 3772	NA	H/pipe culvt	NIL	Susuna	22	Drinking & irrigation
3772 + 3937	NA	H/pipe culvt	NIL	Susuna		
3937 + 4555	NA	H/pipe culvt	NIL	Susuna		
4555 + 4593	NA	H/pipe culvt	NIL	Susuna		
4593 + 4637	NA	H/pipe culvt	NIL	Susuna		
4637 + 4715	NA	H/pipe culvt	NIL	Susuna		
4715 + 5110	NA	H/pipe culvt	NIL	Susuna		
5110 + 6009	NA	H/pipe culvt	NIL	Susuna		
6009 + 6600	NA	H/pipe culvt	NIL	Susuna		
6600 + 6850	NA	H/pipe culvt	NIL	Susuna		
6850 + 7700	Lumnam ochhu	H/pipe culvt	NIL	Susuna		
7700 + 8200	NA	H/pipe culvt	NIL	Susuna		
8200 + 9200	NA	H/pipe culvt	NIL	Susuna		
9200 + 9950	NA	H/pipe culvt	NIL	Susuna		
9950 + 11500	NA	H/pipe culvt	NIL	Susuna		
11500 + 12500	NA	H/pipe culvt	NIL	Susuna		
12500 + 13500	NA	H/pipe culvt	NIL	Susuna		

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	13 + 600	Mixed conifer forest	136,000.00	10 years	NIL

Table 6: Areas Required for Project Facilities

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

12.2. Protected area : The protected areas such as Soil protection, local water supply protection Reparian protection, Wild life protection etc. shall be indentified where n 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)
Paro	Naja	22

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 technique measures shall be applied on the slopes for reclaiming immediately after road construction.

14 Project Impacts and Mitigation Measures

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

14.1. Monitoring Program

Monitoring of the construction works will be done by Site supervisor, Bitekha Unit, NRDCL, including time to time monitoring by the Unit Manager, Bitekha Unit under Rinpung Regional Office, Paro. The Regional Manager, Rinpung Regional Office, NRDCL Paro, shall also carry out the frequent monitoring works. Also the Engineering Section shall carry out the monitoring works as & when required.

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

ANNEXURES

PRELIMINARY COST ESTIMATE 13.600 KMS

Sl. No.	Particulars of work	Quantity	Unit	Rate	Amount (Nu)	Remarks
1	**EARTH WORK**					BSR 2013,
1.1	Right of way clearing	136,000.00	sqm	6.99	950,640.00	CG0002, P. 4
1.2	Formation cutting					BSR 2013,
	a) Excavation of all types of soil	273,078.03	cum	59.71	16,305,489.17	RW0013, P.62
	b) Excavation of all types of rock with or without blasting	37,855.26	cum	211.21	7,995,409.46	BSR 2013, RW0014, P. 62
2	**MASONRY WORKS**					
2.1	Excavation in foundation trenches for construction of hume pipe culvert					
	a) Excavation of all types of soil	778.50	cum	95.67	74,479.10	BSR 2013, EW0105, P. 6
	b) Excavation of all types of rock with or without blasting	224.60	cum	398.49	89,500.85	BSR 2013, EW0107, P. 6
2.2	Providing & laying NP2 class RC pipes including collars					
	a) 600mm dia	1,243.75	m	2,946.13	3,664,249.19	BSR 2013, DR0093, P. 9
	b) 900mm dia	150.00	m	5,296.31	794,446.50	BSR 2013, DR0095, P. 9
	c) 1200mm dia	12.50	m	7,368.17	92,102.13	BSR 2013, DR0097, P. 9
2.3	Providing & laying dry rubble masonry with hard stone in catch pit, retaining wall, appron etc.	1,467.30	cum	1,660.08	2,435,835.38	BSR 2013, SM0050, P. 21
2.4	Filling of trenches	733.66	cum	61.62	45,208.13	BRS 2013, EW0195, P. 7
3	**CONSTRUCTION OF BRIDGE**					
3.1	Construction of log stringer bridge	2.00	Nos.	L/S	2,000,000.00	Lump sum
4	**ROAD WORKS**					BSR 2013,
3.1	Preparation of sub grade	47,600.00	sqm	9.93	472,668.00	EW0002, P. 5
3.2	Providing & laying hammer dressed stone edging 150mm x 300mm	27,200.00	m	81.36	2,212,992.00	BSR 2013, SM0073, P. 22
3.3	Providing & laying stone soling	9,112.00	cum	1,270.67	11,578,345.04	BSR 2013, SM0072, P. 22
3.4	Providing & laying base course	4,556.00	cum	1,754.64	7,994,139.84	BSR 2013, RW0147, P. 65 (+) MT0069, P. 3
3.5	Providing & laying shoulder filling	2,040.00	cum	67.72	138,148.80	BSR 2013, EW0096, P.6
3.6	Digging & providing V shaped earthen side drain	13,248.00	m	18.39	243,630.72	BSR 2013, RW0107, P. 64
3.7	Consolidation of road surface	45,560.00	sqm	6.98	318,008.80	BSR 2013, RW0123, P. 64
TOTAL					57,405,293.11	
Add 5% contingency					2,870,264.66	
GRAND TOTAL					60,275,557.77	
Or SAY					**60,275,600.00**	

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

ENVIRONMENTAL MANAGEMENT PLAN FOR CONSTRUCTION OF 6.00 + 13.60KMs FOREST ROAD AT BITEKHA FMU UNDER RINPUNG REGIONAL OFFICE, NRDCL, IN PARO 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

Annexure 7: AAC Control Forms

1. Year Wise AAC and Clear Cut Equivalent Area Control for Commercial Production Area

Name of FMU: …….Year:…….....

Species	No. of trees marked	Standing Volume (m^3)*	Area clear cut (ha)				Total clear cut (ha)***	Remarks
			Cable corridors & groups	Forest Road	Damaging agents	Other developmental activities**		
A. Normal Cable Lines (Working circle)								
Total								
B. Pests and Diseases (salvage)								
Total								
C. Forest Road Construction								
Total								

Species	No. of trees marked	Standing Volume (m^3)*	Area clear cut (ha)				Total clear cut (ha)***	Remarks
			Cable corridors & groups	Forest Road	Damaging agents	Other developmental activities**		
D. Natural Calamities (wind fallen, landslide, erosion, lightning, etc.)								
Total								
E. Illegal felling								
Total								
F. Unplanned or Ad hoc Activities (farm road, infrastructure developments, land leasing/allotment, etc)								
Total								
Grand Total								

* From the production working circle, ** To be checked and revise area & AAC for the remaining years , *** To check for achievement of AAC for each year.

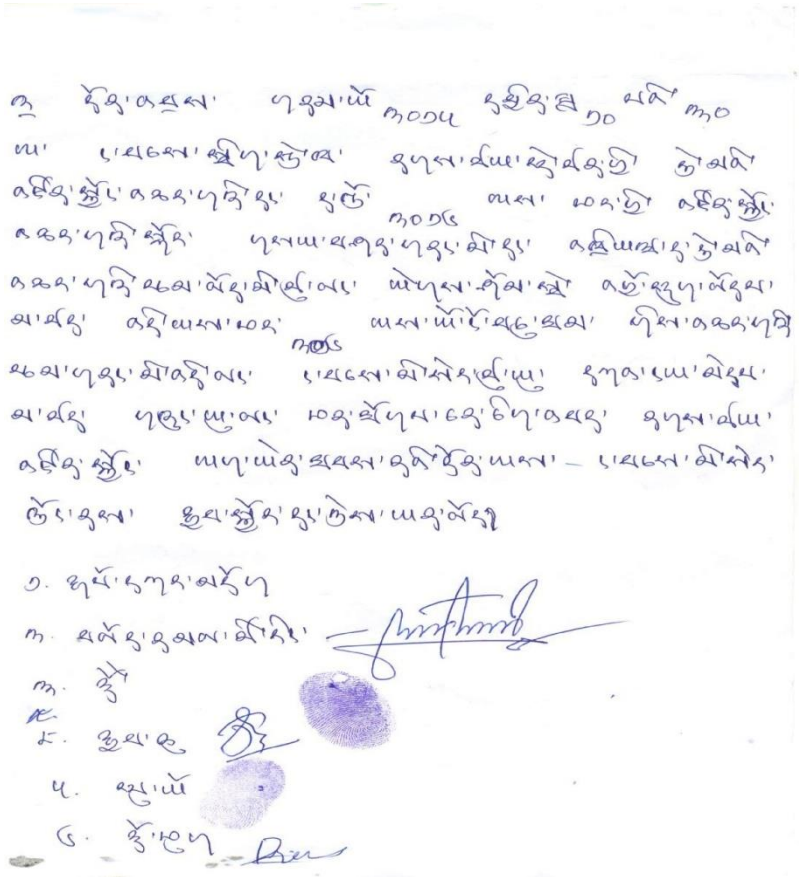
2. Year Wise AAC Control for Local/Rural Production Working Circle

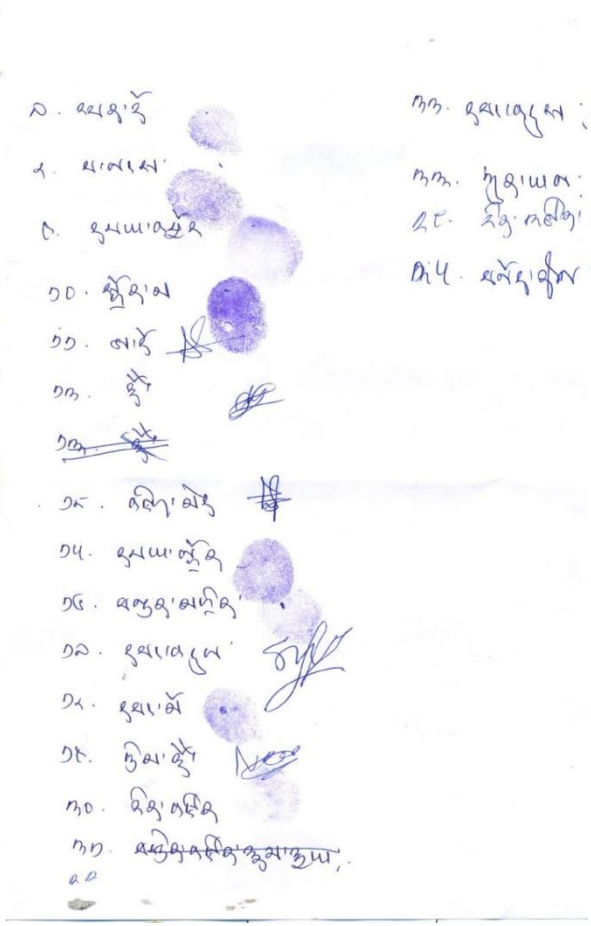
Name of FMU:……Year:…….

Species	Number of stem marked& removed	Standing volume (m^3) * (TMB or marking list)	Remarks
A.Valid timber permit			
Total			
B. Pest and diseases (salvage)			
Total			
C. Illegal felling			
Total			
D. Natural calamities			
Total			
E. Unplanned and Ad hoc Activities (farm road, infrastructure development, land leasing/allotment, etc.)			
Total			
Grand Total			

*To be checked and control every year.

Annexure 8: Socio-economic Report





Public Consultation Meeting on Bitekha FMU Plan Revision
Paro Territorial Forestry Division

Venue: G2C Centre, Naja Gewog, Paro
30th October 2015

Sl #	Participant's Name	Occupation/Designation	Place	Signature
1.	Kaka Tshering	DFO	Paro	
2.	Kado	Gup	Naja	
3	Tashi Norbu Wangdi	FO	Paro.	
4	Sonam Tobgay	GAEO	Naja	
5	Sherub Namgay	UM	MEIAU	
6.	Sonam Tshering	Farmer.	Bitekha	
7.	Dorji	Farmer	Khasha	
8.	Rinzin Tshering Norbu	NFE	Nanakha	
9.	Wangdi Gyeltshen	Tshogpa	"	
10.	Jabchu	~~Naga~~ Farmer	Nagu.	
11.	Ugyen Tshering	FO	Paro	
12	Pulo	Farmer	Lingshi	
13	Dophu	"	"	
14	Tashi Peljor	RM-Paro	[illegible]	
15	Pendho	Farmer	Bitekha	
16	Passang	"	"	
17	Penjor	"	Lingshi	

Sl #	Participant's Name	Occupation/Designation	Place	Signature
18	Dema	Farmer	Lingshi	
19	Ado	"	Nago	
20	Dorji	"	Lingshi	
21	Dorji	"	Nagu	
22	Jigme	Student	Nagu	
23	Pelden	Farmer	"	
24	Tandin.	"	"	
25	Wangdi	Tshogpa	Lingshi	
26	Wangmo	Farmer	Nagu	
27	Nima Dorji	"	Wanakha	
28	Rinzin	"	Nagu	
29	Tenzin Norgay	do.	BFMU	
30	Sonam	Gyeldrung	Naja	
31	Karma Wangdi	Forester	BFMU	
32	Pemba	UIC	BFMU	
34	Tshering Norbu	FR II	BFMU	
35	Wangdi	Farmer	Bitekha	
36.	Kinley	"	Nago.	
37	Budhi Raj Rai		NRDCL.	

38	Dorji Wangdi		Paro Dzongkhag	
39	Kinley Tshelji	Farmer	Tshelji	
40	Sonam Tshgay	GFEO, NAJA	NAJA	
41	Tsheoring Zangmo	Jashina (Farmer)	Jashina	
42	Nasem	Jashina (Farmer)	Jashina	