དཔལ་ལྡན་འབྲུག་གཞུང་། སོ་ནམ་དང་ནགས་ཚལ་ལྟན་ལག་ཤགས་ཚལ་དང་གླིང་ཁ་ཞབས་ཏོག་ལས་ཁུངས།

Royal Government of Bhutan
Ministry of Agriculture and Forests
Department of Forests and Park Services
Divisional Forest Office
Bumthang

Forest Management Plan
for
Dawathang Forest Management Unit

[1st January, 2021- 31st December, 2030]

Prepared by:
Sonam Tashi
Forestry Officer
Bumthang Forest Division
Department of Forests and Park Services
October, 2020

AUTHORITY FOR PREPARATION, REVISION AND APPROVAL

PERIOD OF THE PLAN

This Plan is valid for the period of 10 years from 1st January, 2021 – 31stDecember,2030.

AUTHORITY FOR PREPARATION, REVIEW AND APPROVAL

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

PROVISION FOR REVISIONS AND CHANGES

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

APPROVAL

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

Submitted for Approval:

Chief Forestry Officer
Forest Resources Management Division

Recommended for Approval:

Director
Department of Forests and Park Services

Recommended for Approval:

Secretary
Ministry of Agriculture and Forests

APPROVED

Minister
Ministry of Agriculture and Forests
Date: 08.12.21

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

NECS/EACD/Dzo-Bumthang/4000/2021/1814 **October 11, 2021**

ENVIRONMENTAL CLEARANCE

In accordance with Section 34.1 of the Environmental Assessment Act 2000, this Environmental Clearance (EC) is hereby issued to the Forest Resources Management Division (FRMD), Department of Forests and Park Services for the operation and management of the third phase of the Dawathang Forest Management Unit (FMU) along with the construction of 11.50 kilometers forest road and ropeways in the state reserve forest measuring 15172.20 hectares (37491.26 acres) under Chokhor Gewog, Bumthang Dzongkhag with following terms and conditions:

I. General

The holder shall:

1. comply with provisions of the National Environment Protection Act 2007, Environmental Assessment Act 2000 and its Regulation 2016, Waste Prevention & Management Act of Bhutan 2009 and its Regulation 2012 (Amendment 2016), The Water Act of Bhutan 2011 and its Regulation 2014 and Revised Regulation on the Substances that Deplete the Ozone layer and HFCs 2021;
2. ensure that operation and management of the FMU and construction of the forest road is in line with the Initial Environmental Examination (IEE) form and project documents submitted for EC;
3. ensure that Annual Allowable Cut does not exceed 10,900 m3 (Ten Thousand Nine Hundred cubic meter);
4. ensure that no timber is extracted from the Protection Working Circles and Non-Production Working Circles;
5. ensure that local communities, properties and any religious, cultural, historic and ecologically important sites are not adversely affected by the operation and the management of the FMU and construction of the forest road;
6. restore the damage of any public or private properties caused by the operation and management of the FMU and construction of the forest road;
7. inform NECS and any other relevant authorities of any unanticipated or unforeseen chance-find of any precious metals or minerals or articles, that have economic, cultural, religious, archeological, and/or ecological importance;
8. erect a signboard at the take-off point of the main entry of the FMU stating the name of the FMU and contact address of the Unit In-charge; and
9. ensure that a copy of the environmental clearance is framed and displayed at the site office of the FMU.

Head, FRPIS
for record

II. Environmental standards

The holder shall comply with the Environmental Standards 2020.

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

III. Import and use of Ozone Depleting Substances (ODS)

The holder shall import and use ODS and the Hydrofluorocarbons (HFCs) as per the Revised Regulation on the Substances that Deplete the Ozone layer and HFCs 2021.

IV. Protection and management of water resources

The holder shall:

1. ensure that establishment and operation of the FMU does not disrupt the water flow and pollute the water bodies;
2. ensure that a 100 meter buffer is maintained from the major rivers and local drinking water sources and a 30 meter buffer is maintained from all the streams and springs present within the FMU; and
3. except for water/river crossing infrastructures, ensure that a minimum 30 meters or 100 feet buffer is maintained at all times from the water bodies.

V. Waste prevention and management

The holder shall manage wastes generated from the establishment and operation of FMU and the construction of forest road (site office, labour camps, offices, etc.) with the application of 4R (Reduce, Reuse, Recycle, Responsibility) principle and other environmentally friendly methods of waste management.

VI. Management of excavated materials and run-off

The holder shall:

1. ensure that excavated materials generated during construction of forest road and operation and management of FMU are managed in line with the project document submitted for EC;
2. ensure that fugitive emission from the construction of forest road is managed in line with the project document submitted for EC; and
3. put appropriate measures for management of surface run-off to avoid erosion and landslides.

VII. Monitoring and reporting

The holder shall:

1. ensure that the effective day-to-day monitoring of the EC terms and conditions are carried out by the environmental unit or designated environment focal person; and
2. maintain monthly records on wastes generated and its management, stating types (General wastes & Others), quantities and characteristics and submit to NECS annually.

VIII. Implementation plan

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

IX. Renewal and modification

The holder shall:

1. ensure that renewal of this EC is processed at least three months prior to its expiry along with a copy of EC and a report on the implementation of its terms and conditions as per the

format attached, failing to which the applicant shall be liable for penalty as per the RECOP 2016; and

2. obtain prior approval from NECS for any modification to the existing proposal/application including but not limited to increase in production capacity, change in location of a project, change in ownership, etc.

Reservation

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

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

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

Validity:

The EC issued with validity from **October 11, 2021** until **October 10, 2026** for the operation and management of the Dawathang Forest Management Unit along with the construction of the 11.50 km forest road.

This Environmental Clearance is issued solely pursuant to the Environmental Assessment Act, 2000 and its Regulations and in no way intends to overrule or alter the provisions of any law or rules in force. The Holder of this EC shall be responsible to adhere to the requirements under other laws and the issuing authority assumes no liability resulting from non-compliance or omission of any laws or rules.

(Phento Tshering)
DIRECTOR

The Chief Forestry Officer
Forest Resources Management Division,
DoFPS, Thimphu

Copy to:

1. Chairman, DEC, Dzongkhag Administration, Bumthang Dzongkhag for kind information.
2. The Director, Department of Forests and Park Services, Ministry of Agriculture and Forests, Thimphu for kind information.
2. The Regional Manager, Natural Resource Development Corporation Limited, Jakar Region for kind information.
3. Guard File (NECS/EACD/Dzo-Bumthang/4000) EACD, NECS for record.

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

ACKNOWLEDGEMENT

I would like to express my sincere gratitude and appreciation to all the individuals involved in the formulation of revised Dawathang management plan. Special mention to Unit staffs both Territorial and NRDCL counterpartof Dawathang Forest Management Unit for their assistance and support during data collection and information gathering. In particular, I as a planner would like to thank Mr. Gyalwang Phuntsho, Unit In-charge of Dawathang FMU, Kelzang Choden, Forestry Officer and the inventory crew for their active participation and contribution during the course of preparation of this management plan.

I would like to acknowledge Mr. Pankey Drukpa, Chief Forestry Officer, Bumthang for providing immense support and guidance in the process of writing this plan. The technical advices received from the Chief Forestry Officer have helped me make this plan credible and practically applicable in the field.

Furthermore, I would like to thank the officials of Forest Resources Management Division, particularly Mr. Arun Rai, Principal Chief Forestry Officer, Mr. Dawa Zangpo, Dy. Chief Forestry Officer, Mr. Tashi Norbu Waiba, Dy. Chief Forestry Officer and Mr. Yonten Phuntsho, Dy. Chief Forestry Officer for their technical guidance during various stages of plan writing.

Lastly, my immense gratitude to the Local Government Officials of Chhokhor Gewog and local people of Chokhor Gewogfor their contribution and participation in various consultation meetings while writing this plan.

Sincerely,

Sonam Tashi

LIST OF ABBREVIATIONS

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

EXECUTIVE SUMMARY

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

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

PART 1: GENERAL DESCRIPTION AND THE CURRENT SITUATION

- The Dawathang Forest Management Unit is located in Chokhor Gewog of Bumthang Dzongkhag. The Forest Management Unit falls within 27º 4'03.13'' to 27º28'38.33''N and 90º33'39.75'' to 90º48'35.14''E. The FMU became formally operational under DoFPS in 2000.
- The total area of the FMU has been decreased to 17541.66 ha from 15173.8ha after excluding the municipal boundary for the third plan period.
- The altitude of Dawathang FMU ranges from 2520 meters to 4418 meters amsl and the major forest type found here are mixed conifer and fir forests. The mixed conifer forest comprises of Spruce, Hemlock, Blue pine, Juniper, Larch and some broadleaf species like Poplar, Maple, Rhododendrons, Oak, etc.
- Dawathang FMU is located in Chokhor Gewog of Bumthang Dzongkhag. In total there are 15 villages which administratively falling in two category of Gewog administration and other is Dzongkhag Thromde. There are 428 households with a total population of 2,956 residing within Dawathang FMU (As per Census record). Although the Gewog office accounts more household numbers as some of them choose not to separate their census record.
- As per the Management Plan of Dawathang FMU, AAC of the last Management Plan have been set at 12186 m^3, of which 9756 $m^3$was allocated for commercial extraction and 2424m^3 for rural use. The total volume of rural and commercial timber that could be extracted is 113740 $m^3$of 119376 m^3 prescribed. The84522.38m^3 or 86.63% of timber was actually extracted for commercial purposes which is under cut by 13.36% from its actual target over the 10 years. Over all, the FMU has an undercut volume of 5636.03m^3 or 4.72%. However, in gross prospective the management of FMU is not over harvested during the last plan period.
- Prior to the first plan, 15.82Km of forest road was constructed in Zangtherpo and Crongmenpa Block. Subsequently, a total length of 12.5 kms of forest road was constructed during the first plan period 2000-2010. The road passes through Zangtherpo, Crongmepa and Jakar Block. During the second plan period, a total additional road length of 8.91 kms which passes through Crongmanpa Block (Compartment VI) till Tangzam Block

(Compartment II and III), of which 1.62Km in Jakar Block of Compartment III. In total till date 37.23kms of road was constructed.

PART 2: FUTURE MANAGEMENT

- The overall Goal of the Management Plan is *"To* ***manage the forest on a multiple use, sustained yield basis for the production of timber, fuel wood and other forest products and for watershed, wildlife and environmental protection."***.
- To facilitate the planning, implementation and recording of activities, the Karshong FMU is divided into blocks and compartments. The FMU is broadly divided into seven Blocks, namely Garpang, Jakar, Lamigonpa, Zangtherpo, Crongmenpa, Tangzam and Nakchela. In the previous, there is Dhur Block which its two compartments were merged with WCNP, so the remaining Compartment I was renamed as Tangzam IV. Lamigonpa Block is a derivative of Jakar Block specifically protecting UWICER area as Compartment I. Nakchela Block which was not compartmentalized in previous plan is now divided into 8 Compartments for easier operationalization of the area.
- DawathangFMU has been divided into three Management Circles using forest function mapping and they are Protection, Production and Non-production Management Circle. The Production Management Circle has been divided further into Working Circles so that the objectives are tailored to the type of stand being harvested. The objectives for each management circles have been listed in a logical framework along with the management options and responsibility for easy reference by implementers and monitoring agency.
- The prescribed Silvicultural System for the commercial harvesting is the Group Selection System with natural regeneration in Mixed Conifer Working Circle and Fir Working Circle and Seed Tree System in Blue Pine Working Circle. Group openings will be created in the stand allowing optimum quantity of light to reach the forest floor and creating conductive micro climatic conditions for seed germination and establishment of seedlings. Criteria for opening the groups and laying out annual coupes are given in detail in the Plan. For local use area, single tree selection system will be used.
- In this plan, the AAC has been revised to 10,900 m^3. The decrease in the AAC compared to the previous plan can be attributed to reduction of area to Wangchuck Centennial National Park (WCNP) and Bumthang Thromde. Out of the total AAC of 10,900 m^3, 6900 m^3 has been allocated to commercial use and 4000 m^3 has been allocated to local use.
- In the Production Management Circles, three regular Working Circles and one Overlapping Working Circle has been formed in this plan. The three Working Circles in this management plan are Mixed Conifer, Fir and Blue Pine Working Circle and one overlapping Working Circle is Non-wood Working Circle.
- In collaboration with the NRDCL, the Divisional Forest Office, Bumthang carried out detailed EIA and its findings are incorporated in preparing the Forest Management Plan. Using a series of environmental criteria outlined in the Environment Assessment Act, 2000 and adopted by the National Environment Commission, the guidelines recommended have been examined to ensure that the practice within DFMU meets the requirement. The

Environment Statement includes the effects of previous activities within the FMU along with recommended mitigation measures for future management actions.

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

PART 3: IMPLEMENTATION OF THE PLAN

- The CFO, Bumthang will be responsible for the implementation of this management plan and he will be assisted by the Forest Management Planner, Unit In-charge and other Unit staffs.
- A rolling biennial Operational Plan will be prepared by the Unit In-charge in consultation with the CFO, Bumthang and NRDCL counterpart to facilitate the timely implementation of this management plan.
- FMU-level Management Committee chaired by CFO, Bumthang has been established to assist in objective setting and to ensure the smooth implementation of the Management Plan. The FMU-level Management Committee is comprised of the stakeholders of the FMU and each member has an equal right to say in the recommended management and implementation of the FMP. Planned activities to achieve the FMU management objectives will be discussed in the FMU-level Management Committee meetings.
- The Operational Plan activities will be reviewed annually whereas the mid-term review will take place after five year of plan implementation. The final evaluation shall be carried out during the final year of plan implementation. FRMD will be responsible to initiate evaluation of activities in the FMU.
- Unforeseen circumstances may warrant deviations from Plan prescriptions and in such an event the CFO, Bumthang must obtain prior written approval from the Head of the Department. The reasons for the deviations must be fully justified by the CFO in this respect and such approved deviations entered into the Management Plan during the next scheduled revision.

Actions Required by the FMU Plan	Responsibility
Implementation and Review	
The CFO Bumthang, as the senior territorial officer will be responsible for the implementation of this Management Plan, assisted by Forest Management Planner, Unit-In-charge and other Unit staffs.	CFO
A FMU-level Management Committee chaired by the CFO, will be established to ensure the smooth implementation of the Management Plan.	CFO
The CFO and UIC will ensure that only the silvicultural systems described for each working circle are used for that working circle, and they are implemented thoroughly and correctly.	CFO & FMU UIC
The Head, FRMD, will ensure that the Plan is reviewed five years after implementation (mid-term review), and at the end of the plan period (end-of term review)	Head, FRMD
Monitoring and Evaluation	
The CFO will ensure that monitoring is carried out on an annual basis according to the guidelines issued by FRMD	CFO
The Head FRMD will ensure that evaluation is carried out at five-year intervals, based on the information collected by annual monitoring and other necessary information.	Head, FRMD
Operational Planning	
A bi-annual Operational Plan will be prepared by the CFO to facilitate the timely implementation of this Management Plan, and should be submitted to FRMD by 1st November every year, before the start of operating year.	CFO RM, NRDCL
The budget in the operational plan should be jointly developed by the CFO and RM, NRDCL and agreed by both.	CFO RM, NRDCL
The UIC will determine the location and extent of cable lines in the Compartment to be harvested annually, in consultation with NRDCL staff, as prescribed in the Operational Plan.	FMU UIC
The CFO and the RM, NRDCL will cooperate and coordinate to ensure that the logging operation and log out turn are conducted smoothly and in accordance with local and other demands.	CFO RM, NRDCL
The FMU UIC will ensure that stocking regeneration surveys are conducted as and when required.	FMU UIC
Enrichment planting, if necessary, will be carried out by NRDCL.	NRDCL RM
Fencing or other action to protect regeneration will be carried out by NRDCL, in consultation with the FMU UIC.	NRDCL RM
The FMU UIC will inspect the coupes when harvesting is completed and will issue a Coupe Clearance Certificate only if all aspects of the operation are satisfactory.	FMU UIC
Road survey, design and construction will be carried out by NRDCL.	NRDCL
NRDCL road engineers must follow acceptable standards, designs, estimates and provide supervision during construction to ensure that the standards are met.	NRDCL staff
Regular inspection will be conducted by the FMU staff to detect and report any pest and disease outbreaks to enable earliest possible remedial or preventive measures to be initiated.	FMU staff
Participatory Forest Management	
Records of all trees marked and issued for local use or for conversion within the forest, by Blocks and Compartments will be maintained by the Unit staff and furnished monthly to the CFO Bumthang.	FMU UIC
Timber and non-wood products, including fuelwood, Daphne bark, and bamboo, can be allotted to *bona-fide* local villagers.	FMU UIC, via Operational Plan
The views of stakeholder groups will be incorporated into the operational plans through the inclusion of stakeholder representatives in the FMU-level Management Committee.	CFO

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Figure 1 Cable Line Operation in Tangzam Block

1. LOCATION, AREA, BACKGROUND AND STATUS

1.1 Location and Extend

Dawathang Forest Management Unit is located in Chokhor Gewog under the administrative Dzongkhag of Bumthang between 27º 4'03.13'' N to 27º28'38.33''N and 90º33'39.75''E to 90º48'35.14''E. The FMU includes iconic Jakar Dzong and East-West lateral highway passing below the Forest Management Unit.

1.2 Area Statement

As per the Land Use and Land Cover map (LULC) classification, majority of the FMU area is covered by forest (Map 2). Over 47.52% of the land is covered by mixed conifer forest followed by approximately 17.43% by mixed conifer Blue Pine forest. The build-up area only forms over 0.02% of the total land cover (Figure 2) which is very less comparatively with last plan as Bumthang

municipal boundary was excluded on request from Dzongkhag Administration during consultation (Annexure).

Table 1 Area Statements by Land Use

Land Use	Area (ha)	Percentage Cover (%)
Blue Pine Forest	2,643.86	17.43
Broadleaf Forest	22.11	0.15
Mixed Conifer Forest	7,210.08	47.52
Fir Forest	3432.56	22.62
Shrubs	514.2	3.39
Meadows	158.32	1.04
Build-up	2.42	0.02
Cultivation Land	12.23	0.08
Alpine Scrubs	1070.1	7.05
Snow and Glacier	78.98	0.52
Lake	21.33	0.14
Rivers	5.68	0.04
Rocky Outcrops	0.36	0.00
Total	**15,172.23**	**100.00**

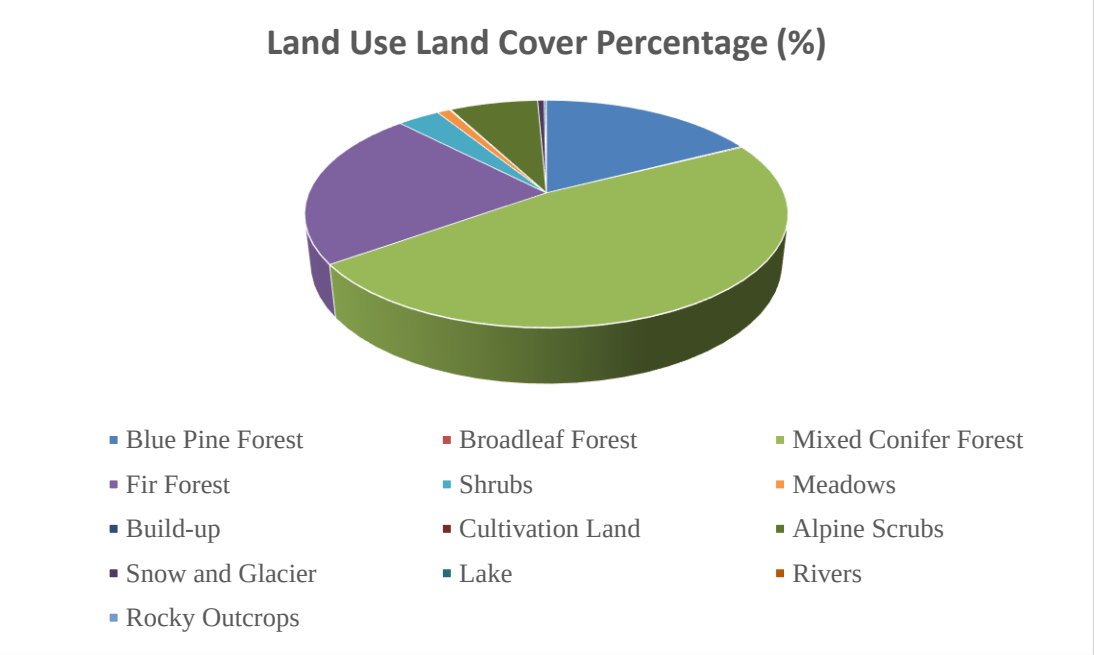
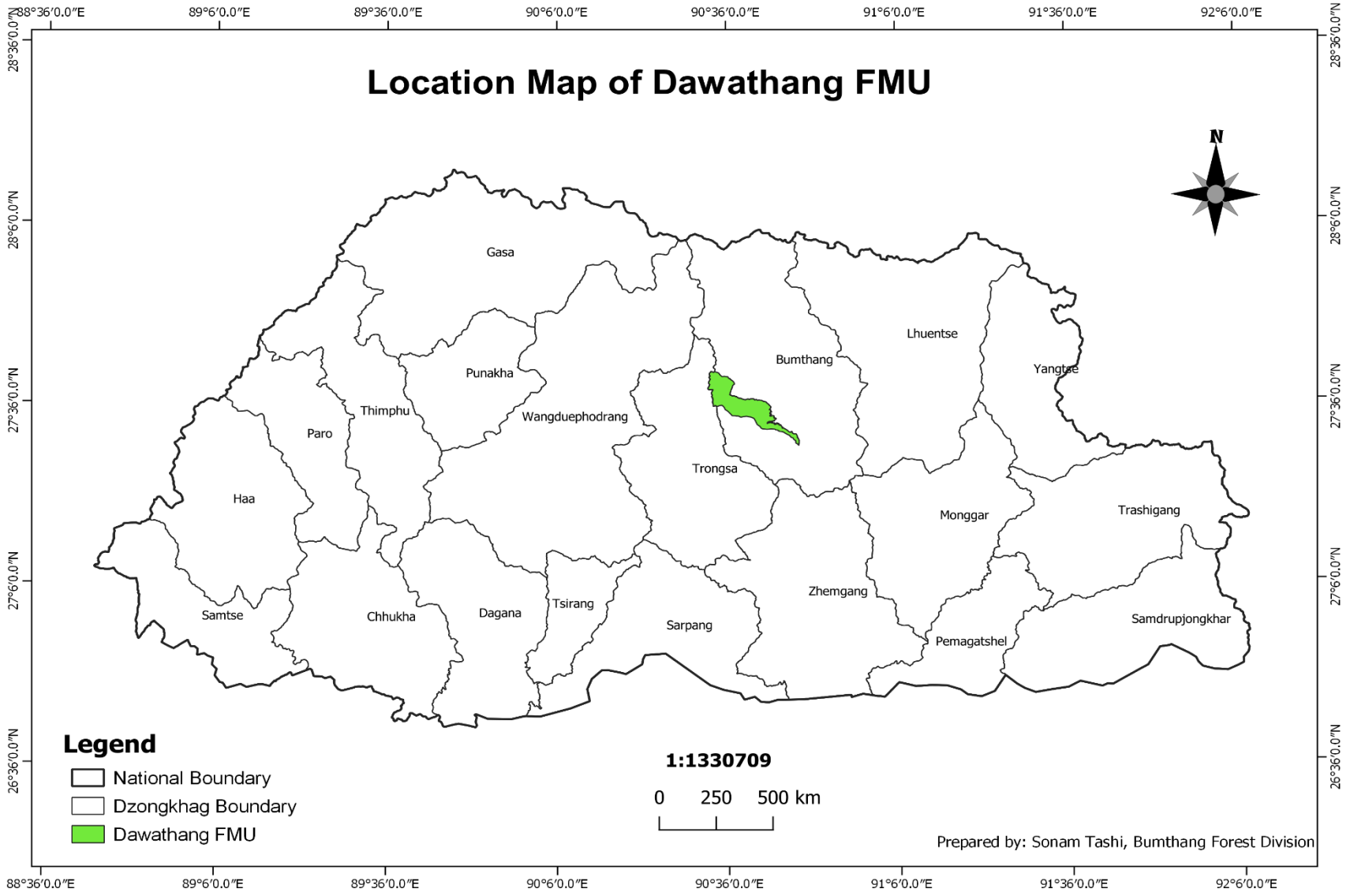
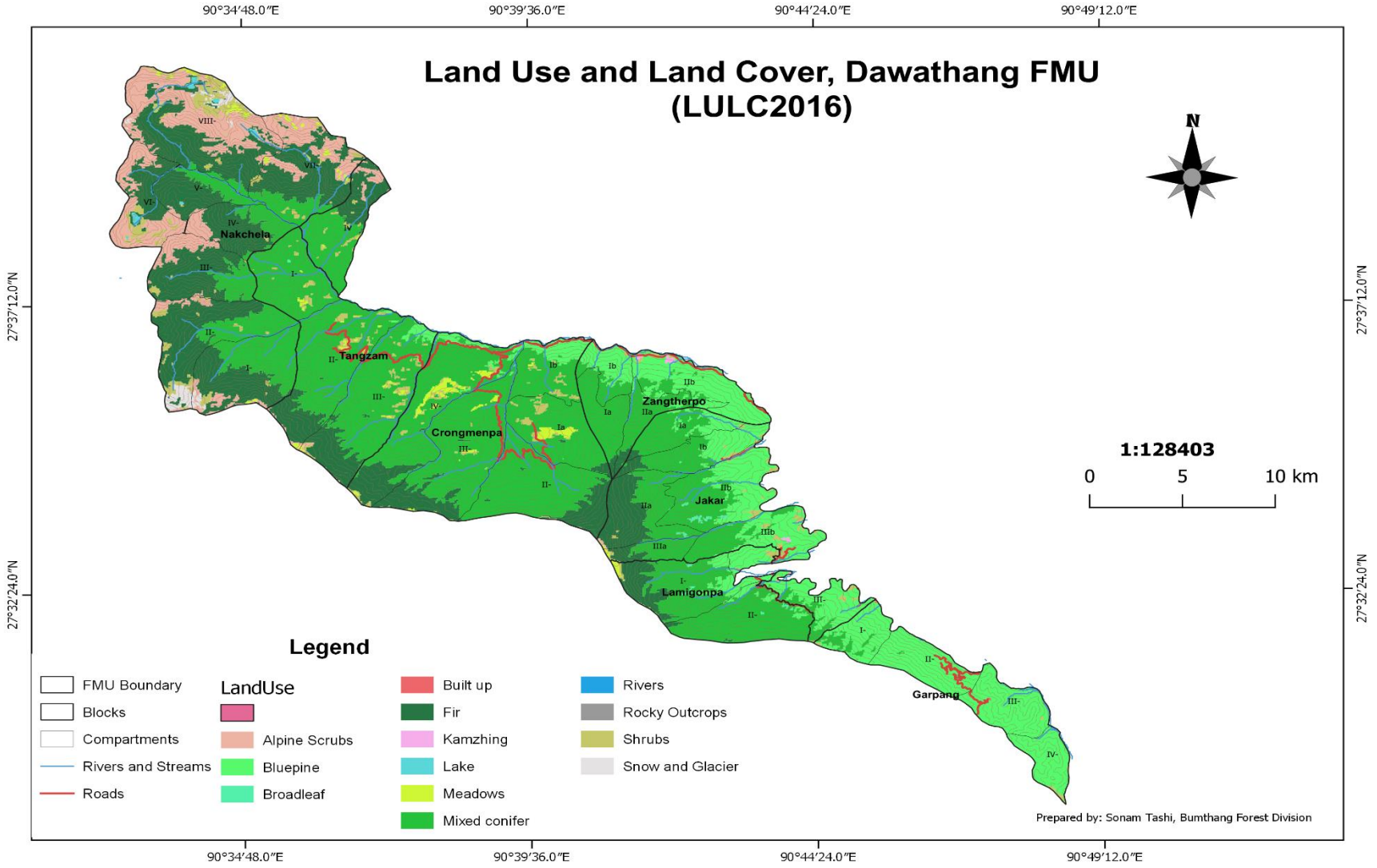


Figure 2: Figure Showing Land use by Percentage

Map 1: Location of Dawathang FMU



Map 2: Land-use and Land Cover



1.3 Historical Background

Historical background was obtained from review of past management plans, semi-structured interview, consultation meetings, informal conservations with the elderly and forest records.

Prior to the designation of current Dawathang FMU, Dhur Forestry Unit was established by IFDP, lamaigompa. The plan titled, Management Plan for the Dhur Forestry Unit (1986/87 to 1995/96 was prepared by Anton Burgi, Integrated Forestry Development Programme.

Later, the Lamaigompa Research Forest was established and has its management plan (1st January, 1993 – 31st December, 2002) written by Anton Burgi, IFDP which is also located within the current DFMU. The Research Forest (1052.5 ha) was established to serve as an open air laboratory for forestry research and also as a training ground for Lamaigompa Logging Training Centre (LGLTC). Long term observation plots were established in different stand types in the utilized as well as non-utilized part of the forest.

The first management Plan for Dawathang Forest Management Unit was prepared and completed in year 2000 by Mr. Lobzang Dorji, currently serving as Director, DoFPS, Ministry of Agriculture and Forests. The FMU was under operation and the plan expired in June, 2010.

Then the second management Plan for DFMU was prepared by Mr. Phub Dhendup, currently serving as CFO of Sarpang Forest Division. The plan was implemented from 1st January, 2011 to 31st December, 2020.

In the second plan the total commercial timber harvested for the last 10 years is 66349.2m^3 and rural volume is 3,292m^3 in Standing Volume. This shows that commercial extraction is undercut by 31.99% of total AAC for ten years and rural extraction exceeded by 25.33% as per the plan. In the second plan almost 8.91 Km of forest road was constructed. All the harvesting operation was to be carried out by using cable crane logging system.

1.4 Forest Condition

The altitude of Dawathang FMU ranges from 2520 meters to 4418 meters amsl and the major forest type found here are mixed conifer and fir forests. The mixed conifer forest comprises of Spruce, Hemlock, Blue pine, Juniper, Larch and some broadleaf species like Poplar, Maple, Rhododendrons, Oak, etc. Around 47.52% is predominantly covered by mixed conifer, followed by Fir forest with 22.62%, and around 17.43% is covered by Blue pine forest in lower elevation of the FMU. (LULC2016).

Dawathang FMU was under commercial harvesting since 1986 and with formal implementation by DoFPS was started from year 2000 as mentioned above. As the area is also the hub of the Dzongkhag, there is a pressure exerted from the rural demand. The area at lower elevation which area kept for local use are mostly in young Blue pine as majority of older trees has been extracted. As Blue Pine is a strong colonizer it is evident that it is also getting higher up the elevation. The whole forest strata in DFMU is having good regeneration and is in good

condition. Although natural regeneration is profuse, few artificial regeneration in the form of plantation was carried out in the past operated areas to complement the national regeneration mostly in mixed conifer and fir strata.

1.5 Legal Status

1.5.1 Ownership

The Forest and Nature Conservation Act, 1995, defines forests as ***"any land and water body, whether or not under vegetative cover, in which no person has acquired a permanent and transferable right of use and occupancy, whether such land is located inside or outside the forest boundary pillars, and includes land registered in a person's name as Tsamdo (grazing land) or Sokshing (woodlot for collection of leaf litter)".***All such areas are considered as Government Reserved Forest and the entire DFMU falls within this category of reserved forest, except for a some part of land classified as cultivations and some build-up areas which are privately owned which comes to 405.64ha comparatively lesser than previous plan having 627.78ha. This is due to the exclusion of Municipal area in the plan.

1.5.2 Rights and Privileges

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

1.5.3 Grazing Rights

As per the new regulation regarding *Tsamdo* and *Sokshing*, (Land Act of Bhutan, 2007) it has been taken over as government reserve forest land and should be subsequently leased for use. However, there is still some traditional users at Tangzam Block and lower area of Nachela Block, who migrates during summer for pasture.

1.5.4 Water Rights

The local population has traditional rights to use water from rivers and streams for their domestic purpose, such as home consumption, irrigation and other uses. There are several streams and creeks in DFMU which is used for drinking water source for the communities. There are currently 19 drinking water tapping point which the water originates from DFMU. Notably, the drinking water to the municipal area is also tapped from Lamigonpa Block.

1.5.5 Historical Monuments and Monasteries

In the previous there are many important monasteries and Dzongs located within DFMU. Kurjey, Jambey Lhakhang are some of the most sacred and iconic Lhakhangs located in the FMU. However, in this plan after exclusion of municipal boundary there is only one Lhakhang located

inside the FMU which is Ugyen Zhabjey above Norbugang village. A buffer of 100 meters has been delineated.

1.5.6 Proximity to Protected Areas

Dawathang FMU shares boundary with Wangchuck Centennial National Park towards the north. During the review and refinement of the PA vide letter no. DoFPS/NCD/PAS-1/2020-21/0808 dated 3/08/2020 (Annexure 7), there is net reduction of 1511.34ha from DFMU area. Previous Compartment of Dhur II and III were completely merged in WCNP and few hectares from Dhur I, Tangzam I and III, Crongmanpa I and IV, Zangtherpo I and II and Nakchela Block were merged. Towards south of DFMU, there is Phrumsengla National Park but do not share any boundary.

2. PERMANENT SITE FACTORS

2.1 Topography and Slope

As in most parts of Bhutan, the terrain in Dawathang FMU is mountainous – from moderate to steep. However, the slopes are gentle compared to other parts of Bhutan. The lower part of FMU are not very steep. But Rocky outcrop is present in Nakchela Block. The elevation ranges from 2,520meters at the valley bottom to 4418 meters at the ridge top. The terrain is also dissected by many small rivulets, making sub-watershed of Lamaigonpa Chuu, Nasphel Chuu, Norgang Chhu and Dhur chuu which eventually drains to become Chamkhar Chuu. The lower slopes are moderately gentle. Flatter areas have been converted to agricultural land.

Major part of FMU falls below 25˚ slope. Slope classification was done with the help of Quantum GIS by using terrain analysis. Areas that were considered over 100% were delineated on the Function Map as SP-Soil Protection where no activities can take place. Slopes that ranged from 76-100% are classified as SC-Soil Conservation where limited activities can take place. Some area which on ground validation is more than 45^0 slope were drawn besides using DEM (Raster file).

2.2 Climate

2.2.1 Meteorological Station

Meteorology Unit of HydroMet Services Division of Ministry of Trade and Industry has a climatological station at Chamkhar. The compiled data for temperature and rainfall was provided by Weather and climate Division, National Center for Hydrology and Meteorology, MoEA, Thimphu.

2.2.2 Temperature

The monthly average temperature for last five years is given in the following tables and graph.

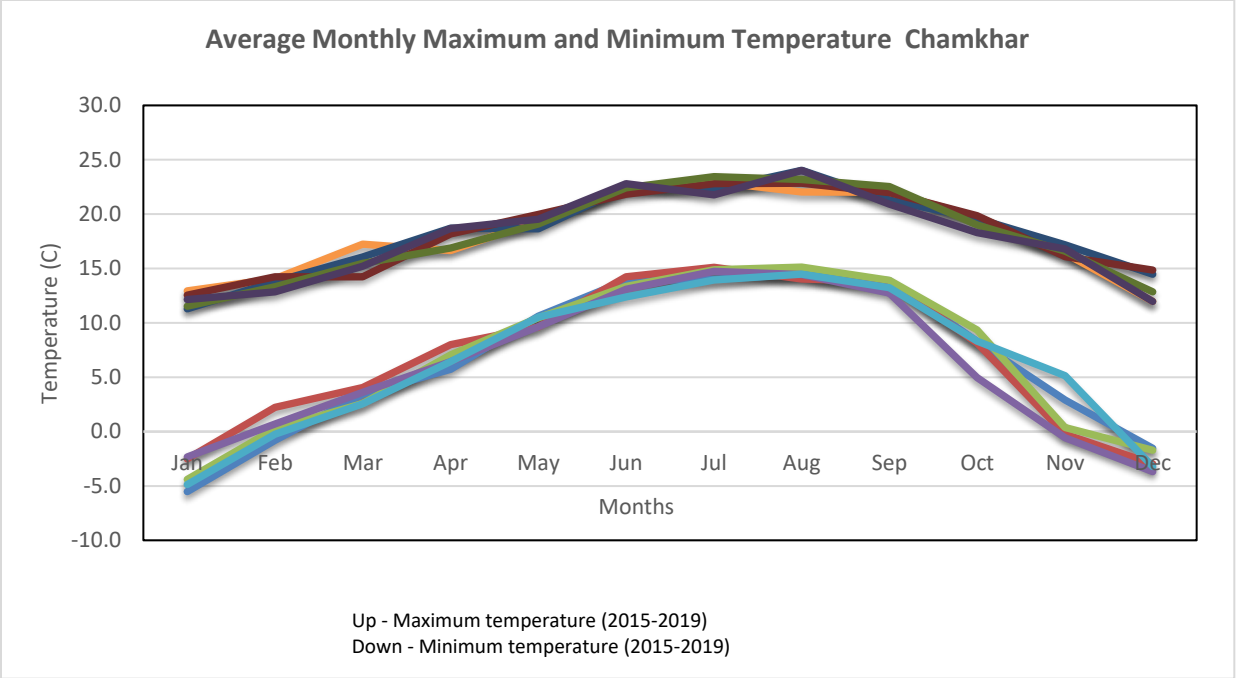


Figure 3: Graph showing Average Temperature for 2015-2019

Average Monthly Maximum Temperature

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2015	12.9	14.1	17.2	16.7	19.4	22.4	23.0	22.0	22.0	19.8	16.4	12.0
2016	11.3	13.8	16.1	18.7	18.7	22.5	22.3	24.0	21.3	19.6	17.2	14.5
2017	12.6	14.2	14.2	18.2	20.0	21.8	22.8	22.8	22.0	19.9	16.1	14.9
2018	11.5	13.3	15.5	16.9	19.1	22.4	23.5	23.2	22.6	19.0	16.6	12.9
2019	12.2	12.9	15.2	18.7	19.5	22.8	21.8	24.0	20.9	18.3	16.8	12.0

Average Monthly Minimum Temperature

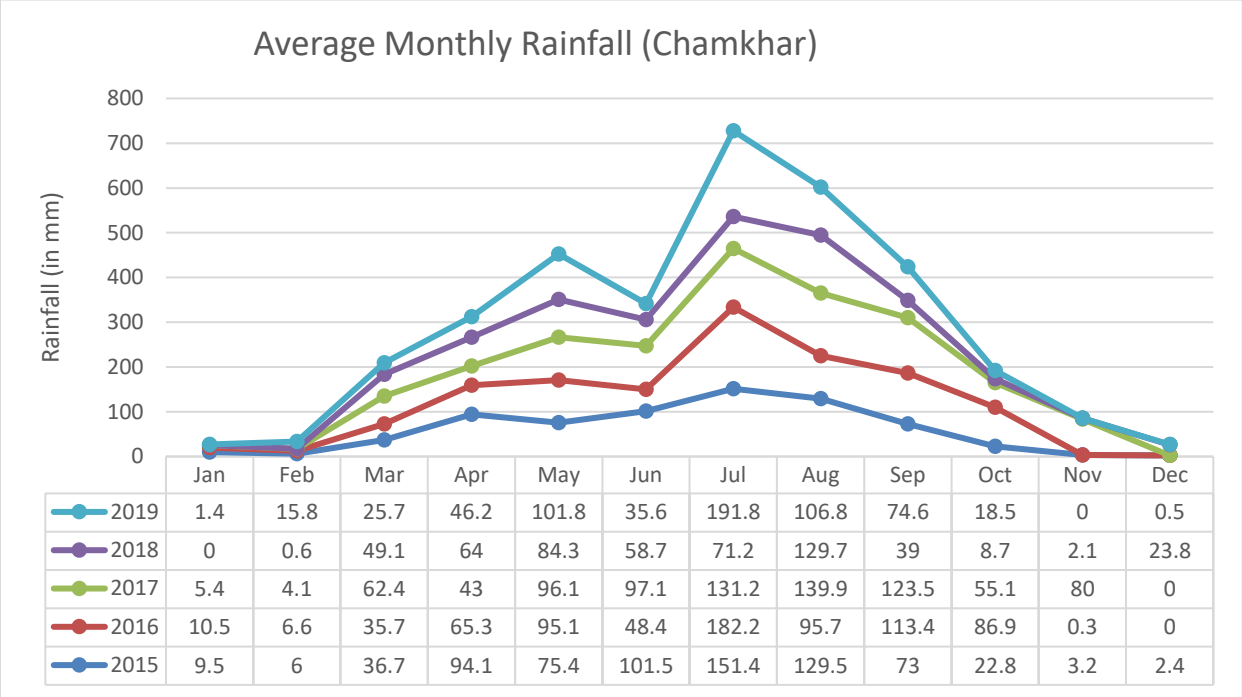
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2015	-5.5	-0.8	3.5	5.7	10.6	13.9	14.0	14.5	13.9	8.3	2.9	-1.6
2016	-2.5	2.2	4.1	8.0	9.6	14.2	15.1	14.0	13.8	8.2	-0.3	-3.0
2017	-4.4	0.3	2.6	7.1	10.5	13.4	14.9	15.1	13.9	9.3	0.4	-1.7
2018	-2.3	0.7	3.6	6.4	9.7	13.1	14.7	14.4	12.7	5.0	-0.6	-3.7
2019	-4.9	-0.2	2.6	6.5	10.5	12.4	13.9	14.5	13.2	8.3	5.2	-3.2

Table 2: Up- Average monthly maximum temperature and Down- Average Monthly Minimum Temperature

The highest average temperature was recorded during the month of August in past years. November, December, January and February are very cold months with temperature dropping below freezing point. The lowest average temperature was recorded during the month of January. Working condition during these cold months is extremely difficult. The months of July and August are generally the warmest months. The temperature starts dropping from the month of September. However, the temperature during the summer does not pose any working difficulty.

2.2.3 Precipitation

During the monsoon, the rainfall can impact the commercial harvesting and transportation of timber to depot if the road is not maintained properly. Briefly during the months of winter, the area receives precipitation in the form of snow. Although affecting mainly high elevation sites, the snow can suspend logging operation and make travel through DFMU difficult. The precipitation of FMU is expressed in the following graph for three years 2015-2019.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2019	1.4	15.8	25.7	46.2	101.8	35.6	191.8	106.8	74.6	18.5	0	0.5
2018	0	0.6	49.1	64	84.3	58.7	71.2	129.7	39	8.7	2.1	23.8
2017	5.4	4.1	62.4	43	96.1	97.1	131.2	139.9	123.5	55.1	80	0
2016	10.5	6.6	35.7	65.3	95.1	48.4	182.2	95.7	113.4	86.9	0.3	0
2015	9.5	6	36.7	94.1	75.4	101.5	151.4	129.5	73	22.8	3.2	2.4

Figure 4: Graph Showing Average Monthly Rainfall of 2015-2019

2.3 Geology and Soil

The rock of Dawathang FMU is categorized in Paro Formation. This formation is characterized by garnetiferous mica-schist, quartzite-schist, calc-silicate, graphite schist and slivers of orthogenesis.

2.4 Hydrology

The entire DFMU is the watershed for Dhur Chuu and Chamkhar Chuu. There are several streams and creeks in DFMU which is used for drinking water source for the communities. There are currently 19 drinking water tapping point which the water originates from DFMU. A total of 5471 people depend on municipal water supply connected mainly from three streams. The two sources are located within the UWICER preserve area, which accounts to dependency of 68% of town community while 9% of the town population depends on Nasiphel (Rongrongchhu) stream. However, 1583 people outside the municipal area depends on 27 other water sources (24 springs, 3 streams). The questionnaire survey 2016 accounted for a total of 7103 population residing within the watershed inclusive of both resident and floating population (Watershed Managment Division, 2017). Residents inside FMU and in municipal area dependent heavily on these water

sources, for drinking, running water mills and cultivation. Besides these rivers and streams serve as the source of water for livestock. The catchment area for the holy Kurje Drupchu also falls within the FMU.Perhaps, in future as the population increases, protection of the Blocks which generates streams supplying drinking water seems very imperative. For now, only buffer is provided to major streams and rivers. The Chamkhar Chuu and Dhur Chuu flows right from the middle, separating the FMU.

3. VARIABLE SITE FACTORS

3.1 Population and Demography

Dawathang FMU is located in Chokhor Gewog of Bumthang Dzongkhag. In total there are 15 villages which administratively falling in two category of Gewog administration and other is Dzongkhag Thromde. As allotment is done through G2C with approved HOH, Thus, demography data from census record is mentioned here. There are 428 households with a total population of 2,956 residing within Dawathang FMU (As per Census record). Although the Gewog office accounts more household numbers as some of them choose not to separate their census record.

Table 3: Village wise population and number of households

Sl. No.	Name of Village	Total Number of Household	Total Population
1	Dawathang	33	200
4	Norbugang	29	190
5	Changwa	26	128
6	Potala	8	41
7	Chakhar	5	34
8	Jampel Lhakhang	15	126
9	Nashiphel	42	288
10	Wangdicholing	74	519
11	Jakar	43	314
12	Lamaigompa	6	103
13	Poengana	24	130
14	Jakar Lhakhang	8	54
15	Chamkhar	81	561
	Total	394	2688

Source: Census Office, Dzongkhang Administration, Bumthang, July, 2020

3.2 Agriculture and Farming System

Bumthaps are mostly engaged in subsistence farming. Almost all the household own dry land where they grow agricultural products. The agricultural products from their field are used for self-consumption and whatever surplus is left, they sell it. The main cash crop is Potato and some villages like Chamkhar and Wangdicholing they grow rice in large scale. Other agricultural crops grown are peas, cabbages, spinach, carrot, chilies etc. Cereals like wheat, sweet and bitter buckwheat is also grown. Besides agriculture farming most of the native Bumthaps are also engaged in livestock rearing. Cattle are usually reared for dairy products.

3.3 Traditional Use of Forest

Ever since the settlement has taken place in and around the DFMU, the people have been using the forest for their livelihood. Main traditional uses of forests consist of collection of fuel wood, harvesting of construction timber and grazing of domestic animals in the forests. The non-wood forest products collection is a minor traditional forest use in a conifer forest. The usual non-wood forest products are bamboo, Betula and Acer burr for making wooden cups and plates, and collection of some medicinal plants. Rural house building timber, firewood and fencing were allotted to all the people in Chokhor gewog until 2014 and after 2014 the division restricted to provide only fencing and firewood to people falling in Thromde area irrespective of whether they are native or nonnative.

3.3.1 Fuel wood: All the people living in and around the Dawathang FMU depend on the nearby forest for their fuel wood requirement. In the last plan period, a total of 17,290 m^3 of firewood have been extracted from the FMU (Table 9). The fuel wood collected by the villagers is used locally for their domestic purposes. About two trees' permit per household are being obtained by the villagers. In the absence of any other trees in the vicinity of the villages the Blue Pine, other trees are also marked for firewood.

3.3.2 Rural Timber: After 2015 Rural timbers were provided to villages of Upper Jakar, Lamigonpa, Poengana, Nesiphel, Changwa, Norbugang and Dawathang which are administratively under the Gewog administration (Table 9).

3.4 Grazing

As mentioned in the grazing right section, the tradional rights from Tsamdro no longer exist. But there are still some traditional users at Tangzam Block and lower area of Nachela Block, who migrates during summer for pasture from Chumey and Nubi Gewog of Trongsa. There are very few families now who do migratory grazing and its declining. In the lower part of DFMU of what we gathered from socio-economic survey and information from the Gewog RNR Office, it was found that the locals residing within and around the FMU rear various types of livestock. As per the survey, the number of high yielding livestock like Jersey and Mithun are around 74% which is significantly high compared to the local breed. The shift of local breed of cattle to the high yielding breed is an indication that the open grazing in the forest has substantially reduced.

In order to reduce the grazing pressure on forest, introduction of improved varieties of livestock and awareness to the people should be continued by relevant agencies.

Table 4: Livestock Information

Dzongkhag / Geog / Cattle type	Calf < 1 Year								
	Male	Female	Heifer	Milch	Dry	Brd. Bull	Bull	Bullock	Total
Bumthang									
Chhoekhor									
Brown Swiss Cross	29	33	70	109	81	4	16	15	357
Brown Swiss Pure									0
Buffalo									0
Doeb-Doebum		1		2			4		7
Doethra-Doethrum					2				2
Holsten Friesian			2	1					3
Jaba									0
Jatsha-Jatsham		1		18	16			2	37
Jersey Cross	226	288	408	746	384	43	153	66	2314
Jersey Pure	4	6	7	13		2	2		34
Mithun						1			1
Nublang-Thrabum	14	23	25	45	59	1	10	39	216
Yak	332	359	316	801	350	45	254	868	3325
Yangku-Yangkum	4	4	7	7	15		7	4	48
Zo-Zom				9	5			2	16
Gewog Total	**609**	**715**	**835**	**1751**	**912**	**96**	**446**	**996**	**6360**

(Department of Livestock, 2019)

3.5 Wildlife

Along with the forest resources inventory carried out in 2020, wildlife survey (direct and indirect sighting) was also recorded by the inventory crews. In the indirect sighting method, the scats, pugmarks, shredded antlers and territory markings were observed and recorded. Droppings of Barking Deer, Red Panda, Musk Deer, Sambar was also sighted during the transect walk in the forest. People residing within the FMU mentioned that the Himalayan Black Bears is abundant and there are incidences of its attack on humans as well as domestic animals. Moreover, there are frequent incidences of wild boar damaging the crops. Details list is mentioned in 4.2 following this section.

3.6 Forest Fire

During the previous plan period, there was one major forest fire that burnt 21.89 ha at Norbugang in winter of 2018. Following year in 2019 the inventory was carried out and total standing volume was deduced to 8348.846m^3. As the volume was almost equivalent to the AAC,

the stand volume of fire burnt area was kept as Operational plan target for the year 2020. The operation was prescribed to clear fell of the fire burnt forest stand. Other than the Norbugang fire, no major fire incident was recorded in past plan period.

3.7 Pest and Diseases

In the last plan period Dawathang FMU have not carried out any sanitation felling in the area. However, during the forest inventory carried out in early 2020, it was observed that there is patch of mixed conifer forest extending to fir forest being infected with Bark beetle. It has infected in patches of approximately 50ha in Dhur Block extending towards WCNP area (previously Dhur II and III). Sanitation felling should be done as soon as possible, but due to accessibility of road it's quite difficult to extract the timber immediately. However, this plan should implement sanitation felling as earliest as possible so that spread of the pest is controlled.

3.8 Non-wood Forest Product

Similar to other Alpine forest, the DFMU forest also provides NWFP varying from bamboo, medicinal plants, fodder, leaf litter, mushrooms, incense plants, burrs besides boulders and sand. In earlier years of plan period, bamboo was in demand due to its numerous uses such as fencing materials, thatching for house walls, cords for tying animals, etc. Bamboo growth is mostly found in the moist sites within mixed conifer forest. It is predominantly found along the perennial streams and damp sites. Due to gregarious flowering of the bamboo, the entire bamboo within the FMU died in mid of plan period. However, new growth can be seen and the regenerations are abundant. The bamboo will be available for harvest in few years' time. Bamboo is one of the NWFP in the FMU which can be explored commercially in order to uplift the livelihood of the local people.

Table 5: NWFPs found in this area

Name of the NWFP	Uses
Bamboo (*Borinda grossa*)	For making bamboo mats, fencing, construction of houses and livestock shed
Mushroom	Mushroom commonly known as *Jili namcho* in local terms is collected by the locals and is consumed as food. It is collected mostly for self-consumption.
Rubia cordyfloria	The plant is collected for preparation of dye and is traditionally used to dye threads for weaving It is also used as dye for coloring floor of traditional houses.
Sand and Boulders	Besides other NWFPs, sand and boulders are also collected for both domestic and commercial purposes from the FMU.

3.9 Mineral Extraction

In DFMU there is one stone quarry which is located in Crongmanpa Block. The quarry is mainly for the extraction of quartzite stone for constructional purpose. The stone quarry is privately operated on name Bremungjuk Stone quarry of 5.23 acres for the lease period of 10 years from April 16, 2015 to April 15, 2025. The quarry is currently supplying boulders for house construction and wall construction mostly to the municipality settlements. It is one and only quarry under Department of Geology and Mines in the Chokhor Gewog.

4. ECOLOGY

4.1 Floral Association

Dawathang FMU basically falls in the Temperate zone of the country and the predominant forest type in the FMU is Mixed Conifer Forest and Fir forest. The upper region of the FMU also constitute of Alpine scrubs of around 7%. The Blue Pine Forest is found in the lower valley whereas the mixed conifer forest confined in between Fir and Blue Pine forest. The Blue Pine forest near to settlements and roads are mostly young and immature. The undergrowth are mostly Daphne and Rhododendron in Mixed Conifer and Fir Forest. Above the Pure Blue Pine forest, Hemlock and Spruce can be found in association with Blue Pine trees. The Hemlock occupies moist slopes whereas spruce can be found in the drier slopes. Bamboo abundantly occupies the moist sites and on either side of perennial streams in the mixed conifer forest and Fir Forest. Scattered growth of *Taxusbaccata* can also be observed in the mixed conifer forest. Along with Hemlock and Spruce, broadleaved species like Betula and Acer is also found scattered in the mixed conifer forest. *Juniper spp., Cupressus sps, and Rhododendron sps,* are can be found in Fir Forest and towards the Alpine scrubs.

Upper Canopy: Spruce (*Picea spinulosa*), Hemlock (*Tsuga dumosa*), Fir (*Abies densa*), Blue pine (*Pinus wallichiana*)

Middle Canopy: Juniper (*Juniperus recurva*), *Rhododendron spp*, Oak (*Quercus semecarpifolia*), *Acer cambellii, Betula alnoides, Populus ciliate*, and other species

Shrubs: *Rosa laevigata, berberis spp, Rubus ellipticus, Eleagnus parviflora,*

Ground Cover: *Aconitum spp., Thalictrum foliolosum, Potentilla spp., viola spp., Senecio spp., Aster albescense, Rumex hastatus, Causinia thomsonii, Gerenium wallichianum.*

4.2 Fauna

Dawthang FMU is very rich in Wild fauna, which evidently, there is short communication paper on “Mammal diversity in a mountane forest in central Bhutan”. The research was conducted from 2016-2017 with camera trap in Lamigonpa Block in DFMU. Moreover, Wildlife evidences were also recorded during the inventory survey conducted in April-May, 2020. The wildlife found in DFMU are listed below:

Table 6: List of Wildlife

Order	Common Name	Scientific Name
Carnivora	Tiger	*Panthera tigris*
	Asiatic Golden Cat	*temminckii*
	Marbled Cat	*Pardofelis*
	Leopard Cat	*Prionailurus bengalensis*
	Asiatic Wild Dog	*Cuon alpinus*
	Red Fox	*Vulpes vulpes*
	Yellow-throated Marten	*Martes flavigula*
	Asiatic Black Bear	*Ursus thibetanus*
	Weasel	*Mustela* sp.
Cetartiodactyla	Himalayan	Serow *Capricornis*
	Barking Deer	*Muntiacus muntjac*
	Sambar Deer	*Rusa unicolor*
	Wild Boar	*Sus scrofa*
	Musk Deer	*Moschhus chrysogaster*
Rodentia	Himalayan Crestless Porcupine	*Hysterix brachyura*
	Orange-bellied Squirrel	*Dremomys lokriah*

(Dhendup, Thinley, & Tenzin , 2019) and Inventory result of 2020

Table 7: List of Birds

Common Name	**Scientific Name**
Monal Pheasant	*Lophophorus impejanus*
Blood Pheasant	*Ithaginis cruentus*
Spotted Nutcracker	*Nucifraga caryocatactes*
Yellow-billed Blue Magpie	*Urocissa flavirostris*
Kalij pheasant	*Lophura leucophaeus*
Large billed crow	*Corvus macrorhynchos*
Yellow-billed chough	*Phyrrocorax graculus*
Green backed Tits	*Parus monticolus*
Blue-fronted Redstart	*Phoenicurus frontalis*
Blue-whistling Thrush	*Myophonus caeruleus*
Grey-sided Bush Warbler	*Cettia brunnifrons*
White throated laughing Thrush	*Garrulax albogularis*
White tailed nuthatch	*Sitta himalayensis*
White capped redstart	*Chairmarrornis leucocephalus*
Plumbeous redstart	*Rhyacornis fuliginosa*
Alpine swift	*Apus mulba*
Hoopoe	*Upapa epops*

(Dhendup P. , 2011)

5. SILVICULTURAL ASSESSMENT

5.1 Present Forest Types

The main forest types of Dawathang FMU are;

Blue Pine Forest:

Blue Pine is mostly found in the lower valley and cover 17.43%. The Blue Pine forests in the vicinity of the settlements are mostly young and are in pole stage. In the higher elevation, the blue pine is usually found mixed with spruce on the drier slopes and hemlock in the relatively moist slopes. Except Nakchela Block, Blue Pine trees are found in lower elevation of the all the remaining Block of the FMU.

Mixed Conifer Forest:

Mixed conifer forest occupies the higher elevations of Dawathang FMU. This forest type is dominated by Hemlock with some areas mixed with Spruce, Blue Pine and Oak. *Taxus baccata* is often found scattered in the Mixed Conifer Forest. In the higher areas, they are mixed with Juniper, Larch, Maple and Birch. Conifer were found in mixed after the pure Blue Pine stand of all the Blocks of DFMU.

Fir Forest:

Fir forest in Dawathang FMU is confined to the uppermost ridges and occurs mostly as pure stand covering 22.62%. In few places this forest is mixed with Birch and the dense canopy provide environment for luxuriant under storey for *Rhododendron spp*. and other shrubs. Most of the Fir at the higher elevation is over matured and are in the state of die back.

5.2 Past Silvicultural Treatment

In the previous management plan, the planner has used an approach which is quite different from the current practice where the AAC is calculated for different forest types in commercial and local use separately. Thus, working circle is kept as Blue Pine, Mixed Conifer and Fir working circle for commercial and mixed conifer and Blue Pine working circle for rural use.

Table 8: AAC for each Working Circles

Strata	Net Operable Area (ha)	Rotation	RME of mature standing volume (m3/ha)	AAC (m3/ year)	Clear cut Equivalent (ha)
Mixed Conifer (Commercial)	3403.85	160	339.38	7220	21.27
Blue Pine (Commercial)	1103.89	120	247.07	2273	9.20
Fir (Commercial)	383.11	180	123.48	263	2.13
Mixed Conifer (Local Use)	861.31	160	328.67	1769	5.38

Blue Pine (Local Use)	521.69	120	150.59	655	4.35
Mixed Conifer (Rural cum Commercial Use)	255.44	160	4.00	6.00	1.60
Total	**6529.28**	**12186**			**43.93**

(Dhendup P. , 2011)

The AAC prescribed for the last management plan was 12,186 m^3 of which 9756 m^3 was allocated to commercial harvesting by NRDCL, 2424 m^3 rural harvesting and 6 m^3 was allocated to Rural cum commercial.

Three silviculture system were prescribed for the operation for the previous plan which are:

1. ***Group Selection system:*** The system is prescribed for Mixed Conifer Working Circle and Fir Working Circle in the FMU. In this system small opening will be created in the stand allowing light to reach the forest floor and creating conducive micro climate for seed germination and establishment of seedlings. The opening will be no longer than one and half tree length in the Hemlock, Spruce and Fire Stand. (System is Detailed in Future management part). As all the operation in the past 10 years were in the Mixed Conifer Forest and touching part of Fir Forest in higher elevation, thus Group Selection system is the only method used in extraction of commercial timber.
2. ***Seed Tree system:*** Blue Pine Working Circle were prescribed with seed tree system were only number of trees were retained to supply seed for regeneration after rest of the trees being harvested. However, seed tree system was not used in the commercial extraction as in the previous plan there were no pure sand of Blue Pine in Tangzam Block.
3. ***Single tree Selection system:*** This system was prescribed in the rural use area where tree is singled out for harvest avoiding to create opening while retaining the adjacent plus trees for regeneration. This system was extensively used in rural use area in previous management plan.

5.3 Plantations

Although the natural regeneration was present, plantation was also carried out in few past operated areas to supplement. The plantation done in the operated area were found adequate and rightly supplementing the regeneration and fulfilling the objective. The regeneration report in Operational Plans of previous management plan also states the same of success in regeneration. Thick growth of Hemlock, Spruce, and Fire saplings could be seen in the past operated cable lines. In total 7.07ha of plantation was carried out in the last plan period which is detailed in Table 13.

6. SOCIO-ECONOMICS

6.1 Common Source of Income

In the previous management plan the area encompasses Chamkhar town settlement which the boundary was kept as Chamkhar Chuu. But during the implementation of the previous plan there was some issues conflicting with municipal area, specifically on Forestry Clearances. Now, in this plan the municipal planning boundary is excluded so that municipal plan does not come in conflict with the FMU management plan in future. However, majority of native communities falling in the municipal authority are still an agrarian practitioner: some into rearing livestock and most into agriculture. Thus, as per the existing regulation they shall still continue to get the privileges of the resources. The settlement falling geographically inside the current DFMU area depend mostly on subsistence farming and rearing of livestock. The majority of the local communities are farmers. They also practice horticulture to a lesser extent and most of them possess some apple orchard. Potato is one of the main cash crops grown by the communities. Besides, cereal like bitter and sweet buckwheat, wheat and barley are also cultivated by the farmers. Other vegetables like cabbage, peas, beans, radish, mustard, etc. are also grown by the communities. The pattern of important crop and cereal grown are given below.

7. CURRENT TIMBER DEMAND AND SUPPLY

The rural house building timber were supplied to all the native communities residing within the FMU, however, after 2014 Rural House Building Timber were not allocated to communities residing within Municipal authority, but were provided with fencing and firewood. Beyond municipal area allotment were made mainly for rural house construction, renovation of rural house, cattle shed construction, fencing of farm lands, rural firewood and flag poles. The average rural consumption is around 3246.40 m^3 but few of the past years have seen more than 4000m^3 quantity. The rural use of timber have hugely exceed the prescribed quantity of 2424m^3.

Table 9: Rural Supply

Year	Quantity supplied in standing form											Total standing volume supplied m^3
	Drashing		Cham		Tsim		Dangchung /poles		Fencing post		Firewood	
	No.	Vol. (m^3)	No.	Vol. (m^3)	No.	Vol. (m^3)	No.	Vol. (m^3)	No.	Vol. (m^3)	m^3	
2011	205	408.94	807	322.383	2261	206.68	945	43.8	1975	301.45	3196	4479.25
2012	309	616.02	1820	726.678	974	89.61	3283	127.23	1709	51.27	2240	3850.81
2013	193	385.02	115	45.915	60	5.4	792	40.67	2008	62.22	1656	2195.23
2014	411	820.21	1806	721.444	805	78.41	2254	109.07	1467	48.57	1164	2941.70
2015	734	1460.83	663	264.662	367	34.74	845	50.25	1157	39.66	2568	4418.14
2016	143	284.91	745	259.075	330	175.55	1372	54.41	2519	76.91	450	1300.86
2017	88	175.8	596	238.244	471	46.77	151	6.04	3168	337.24	3369	4173.09
2018	172	1611.47	468	320.234	311	16.92	1642	66.85	1456	90.258	875	2980.73
2019	52	849.48			130	22.1	2086	88.15	391	174.045	1744	2877.78
2020		5.338					236	9.44	10	9.8	28	52.58

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

Table 10: Commercial Timber Supply

Year	Quantity harvested from Planned OP activities (m3)					Quantity supplied from Unplanned activities (m3)					
	Standing Vol. (m^3) (a)	Log vol. (m^3)	Firewood (m^3)	Wood -chips (m^3)	Others (m^3)	Standing Vol. (m^3) (b)	Log vol. (m^3)	Firewood (m^3)	Wood - chips (m^3)	Others (m^3)	Total standing vol. (m^3) (a)+(b)
2011	5,935.22	3,934.25	1,184	0	-	-	-	-	-	-	5,935.22
2012	9,551.18	6,090.30	2,020	0	-	-	-	-	-	-	9,551.18
2013	9,746.37	5,921.75	3,040	0	-	-	-	-	-	-	9,746.37
2014	9,448.00	5,657.70	1,832	0	-	-	-	-	-	-	9,448.00
2015	9,015.74	5,755.28	2,206	0	-	-	-	-	-	-	9,015.74
2016	9,183.16	5,509.89	2,192	0	-	-	-	-	-	-	3,264.96
2017	2,446.57	1,467.94	512	0	-	-	-	-	-	-	2,446.57
2018	9,146.54	5487.92	3658.62	0	-	257.6	154.56	103.04	-	-	9,404.14
2019	7043.02	3980.55	1192	0	-	494	178.12	118.75	-	-	7537.015
2020	1956.31										1956.307
Total	**73,472.10**	**43,805.58**	**17,836.62**	**0.00**	**0.00**	**751.60**	**332.68**	**221.79**	**0.00**	**0.00**	**68,305.50**

**The data for 2020 is as of October, 2020.*

8. ORGANIZATION AND ADMINISTRATION

8.1 Organization

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

8.2 Health and Safety

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

a. Harvesting and
b. Transportation

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

- Ensure chain saws equipped with full functioning chain breaks
- Always ensure feller to keep two tree lengths apart while felling.
- Deploy only trained power chain saw operators for felling operations.

- Explain the dangers of falling timbers and overhead cable lines.
- Stack timbers in the same direction and not to stack the logs too high.
- Never approach or climb the log pile from the bottom of the slope.
- Always dismantle a stack from the top rather than from the bottom.

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

8.3 Record Keeping

As the lower part of DFMU below Kurjey is currently managed by Chamkhar Range, thus there seems to be discrepancies regarding record keeping. However, overall maintenance of record in the FMU office has substantially improved over the years. Hereon the Unit should continue to maintain the records of all the activities within the FMU as per the record-keeping format reflected in the Forest Management Code of Bhutan, 2004 and other guidelines/format developed by the Department from time to time.

9. INFRASTRUCTURE, TRANSPORT AND EQUIPMENT

9.1 Road

The Thimphu-Bumthang National Highway passes right at the boundary towards the lower part of DFMU and the upper side have Dzongkhang internal road that goes till Kurjey. A total length of 25 kms of forest road was constructed during the first plan period which the road passes through Zangtherpo Block (Compartment Ib and IIb) and Crongmenpa Block (Compartment I, II and III). During the second plan period, a total additional road length of 8.91 Kms was constructed which passes through Crongmanpa Block (Compartment VI) till Tangzam Block (Compartment II and III). As planned in the previous plan the road in the second plan period was constructed from the end 3Km from the Chhuteygang Depot. The construction of forest road has facilitated in extraction and transportation of commercial timber as well as rural timber.

9.2 Buildings

Currently, the Unit office is a temporary shade (log house) which was built during Integrated Forest Development Project (IFDP) in Toktozam and it is not in good shape. Besides FMU office, the temporary shade is also used as forest check post.

9.3 Transport

Due to the lack of budget, Division has not provided any kind of locomotives for the Unit staffs. Unit In-charge and the staffs owned their personal vehicles which they use to travel to the production site and other areas for monitoring the activities.

9.4 Equipment

The office is well equipped with all the necessary equipment that is required to carry out their duty. Through the funding support from RGoB, the office equipment and electronics were procured and distributed.

The equipment and instruments of the Dawathang FMU Office includes;

- Computer (Desktop) set- 2
- Printer- 2
- Xerox Machine- 1
- Laptop- 2
- Clinometer- 3
- Diameter tape- 2
- Measuring tape- 2
- Compass- 3
- GPS Garmin- 2
- Walkie Talkie Sets- 3
- Wedge Prims- 1
- Vernier Calliper - 1
- Bark guage - 1

10. EVALUATION OF PREVIOUS PLAN (20011-2020)

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

This review process will look at the Goals and Objectives, Harvesting operations and AAC prescription, road building and reforestation activities. These reviews should be referred by the implementers so that such short comings are not repeated in the future operations. This review is based on the management plan from 2011 to 2020.

10.1 Review of Goals and Objectives

The Dawathang Forest Management Plan was written considering its importance to various stakeholders and most importantly to maintain healthy forest through extraction of resources on sustainable basis. Although, the operations within the FMU were carried out as per the provisions of the Forest Management Code of Bhutan, 2004, many areas of improvements were seen in the field.

A brief review of the Goals and Objectives from the last management plan is given below. The review will highlight on areas which were neglected during the implementation of last plan period.

Goal

To manage the forest on the multiple use, sustained yield basis for the production of timber, fuel wood and other forest products; and for conservation of watershed, wildlife and environment.

As the goal is usually considered as a long-term objective of the management, it is unlikely to consider that it should be achieved in the short period of time. The overall goal to manage on a multiple use and sustained yield basis was not achieved completely. Although the plan has tried

to successfully implement the goal but as the DFMU area encompasses the core developmental area of the Dzongkhag has exerted increasing pressure on forest resources. The over harvest of rural AAC is evident of the challenge on achieving the goal. However, prescription mentioned in the scientific forest management plan need to be strictly implemented in order to derive benefits for all times to come.

Objectives[1]

The objectives of managing Dawathang FMU are stated under various management circles for the ease of implementation. The management circles identified are Protection, Production, Non-Production and Non-Wood Forest Products (NWFP) (Overlapping). The objectives are listed below.

Protection Management Circle
To check soil erosion and denudation in the catchment areas of rivers, lakes and reservoirs in the interest of soil and water conservation
To protect the forest from encroachment, fire, grazing and other illegal activities
To conserve and enhance wildlife habitats and biodiversity
To meet local needs of NWFP on sustainable basis
To raise awareness on biodiverse area and conserve the biodiversity
To respect the sanctity of religious places and to protect the historical sites

Although soil protection is major constitution of the protection management circle, till date there is no record or observation of major soil erosion and denudation of an area in DFMU. The assessment during Watershed management plan for lower Chhoekhor Bumthang (2018-2023) also testifies the absence of major soil erosion. With regard to fire, DFMU have not recorded forest fire in protection management areas. Illegal activities were rampant in the area due to the demand from municipal area which is expanding explosively in past few years. Whilst, sanctity of the religious places was maintained and protection buffer were not affected. The wildlife aspect was also taken care through awareness programs and continued effort in patrolling. The area which was designated for wildlife protection specifically for Musk Deer of 3374.05 ha were not disturbed during the plan implementation period. Overall, the plan has partially achieved its protection management circle objectives.

Non-Production Management Circle
To maintain and improve the forest condition
To manage and regulate grazing for livestock
To meet the local demand for NWFP
To conserve and enhance biodiversity
To conserve the catchment area

[1] The objectives within the management circle are overlapping with each other in last plan. Thus, it's reviewed as per management circle.

After Forest and Nature Conservation Rules and Regulation 2017, many of the private land owners came forward to remove trees from their private registered land. The removal from private land is still going on. There are 405.64ha of private land within the FMU excluding the municipal area. The removal of trees from private land is one of the contributing factors in declining forest condition as they leave behind operational waste.

Free grazing has decreased due to increase in stall feeding, but free grazing system still exists in the FMU whereby the people leave the cattle to graze openly in the forest area. However, there is no major impact has resulted due to grazing during the past plan period. Some local people, also attributes in shrinking of grazing land due to colonization by Blue Pine. Even though the area of tree cover has increased due to this phenomenon, it has led to decrease in grazing grounds for cattle and hence they are freely left in the forest areas to graze. The improved varieties of livestock were also being reared by the local people and these varieties of livestock are being stall-fed, resulting in lower grazing pressure in the forest.

Although there were no glaring problems in non-Production management circle, however the objectives have not been able to achieve patently.

Production Management Circle

To meet the timber production targets set under ABSD initiatives
To meet the local requirement, as priority, for timber, fuel wood and other forest products on a sustainable basis
To manage the FMU for commercial timber production on sustainable basis
To protect the forest from fire and illegal activities and over grazing in regeneration areas
To create employment opportunities for the local people
To enhance and improve forest condition and productivity to meet national needs

As per the Management Plan of Dawathang FMU, the total volume of rural and commercial timber that could be extracted is 113740m^3 from 2011 to 2020. Of which about 84522.38m^3 or 86.63% of timber was actually extracted for commercial purposes which is under cut by 13.36% from its actual target over the 10 years. Over all, the FMU has an undercut volume of 5636.03m^3 or 4.72%. To specify further, about 84522.38m^3 commercial timbers has been extracted in standing form against the FMU total AAC of 97560 m^3 [9756 X 10]. Similarly, 29217.59 m^3 rural timbers have been extracted against the total nine years [2]volume target of 21816 m^3 (9 X 2424). Over the period there was access extraction from rural allotment of around 7401.588 m^3. The total AAC prescribed as per management plan for ten years is 119376 m^3 which 113740 m^3 has been harvested. However, in gross prospective the management of FMU is not over harvested during the last plan period. So, we can conclude that local requirement has met which is priority and commercial timber production has been achieved conservatively.

[2] As most of the rural allotment is done from October, thus the rural allotment for 2020 is excluded for calculation.

Within the plan period, the division and unit office has initiated several awareness programs annually to sensitize the local people on importance of preventing forest fire and other illegal forestry activities. However, there was one major fire incident in 2018 engulfing 21.89ha of forested land in Production management circle at Jakar Block of Compartment III. In mitigation, AAC for 2020 was met from that fire burnt area.

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

Hence, we can safely deduce that the DFMU area is not over harvested and has achieved its targeted objectives of the plan.

Non-Wood Forest Products Management Circle
To meet the local demand for NWFPs on sustainable basis
To create employment opportunities for the local people and to help local people in generating income from NWFPs
To conserve and enhance biodiversity

The NWFP management circle overlap with all other management circle. People in DFMU only collected bamboo, sand and boulders in considerable quantity. Other NWFP were not very popular in collection due to its limited abundance. There is no annual collection limit prescribed in the management plan due to the difficulty in total assessment. In addition, the other factors which didn't allow for over harvest is its scattered distribution and its proximity to road. Thus, varieties of NWFP that were collected over the last plan period were in sustainable quantity is detailed below.

Table 11: NWFP extracted from FMU from 2011 to 2019

Year	Product Types						
	Bamboo (Unit)	Sand (Unit)	Top Soil (Unit)	Stone/ Boulders (Unit)	Gravel (Unit)	Leaf Mould/ Litters (Unit)	Mushroom (Unit)
2011	38,170	3	0	166	3	0	0

2012	28,110	0	0	190	9	0	0
2013	20,000	0	0	150	3	0	0
2014	1000	0	0	24	0	0	50
2015	10,985	2	0	39	0	0	0
2016	1,720	0	5	18	0	0	0
2017	1,525	3	0	52	0	0	0
2018	3300	27	40.5	131	1.5	0	0
2019	2570	0	6	44	0	0.5	0
Total	**107,380**	**35**	**51.5**	**814**	**16.5**	0.5	**50**

**Somewhere from 2013 the bamboo has started dying and they regenerated from 2017.*

10.2 Review of Harvesting Activities

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

However, some issue has been recorded within the production areas which need to be addressed in the future so that the operation is as per the standard set in the Forest Management Code of Bhutan, 2004. Firstly, the residue in the form of lops and tops which are left after extraction of logs are not being disposed properly. These residue needs to be disposed immediately so that outbreak of pest and diseases is prevented.

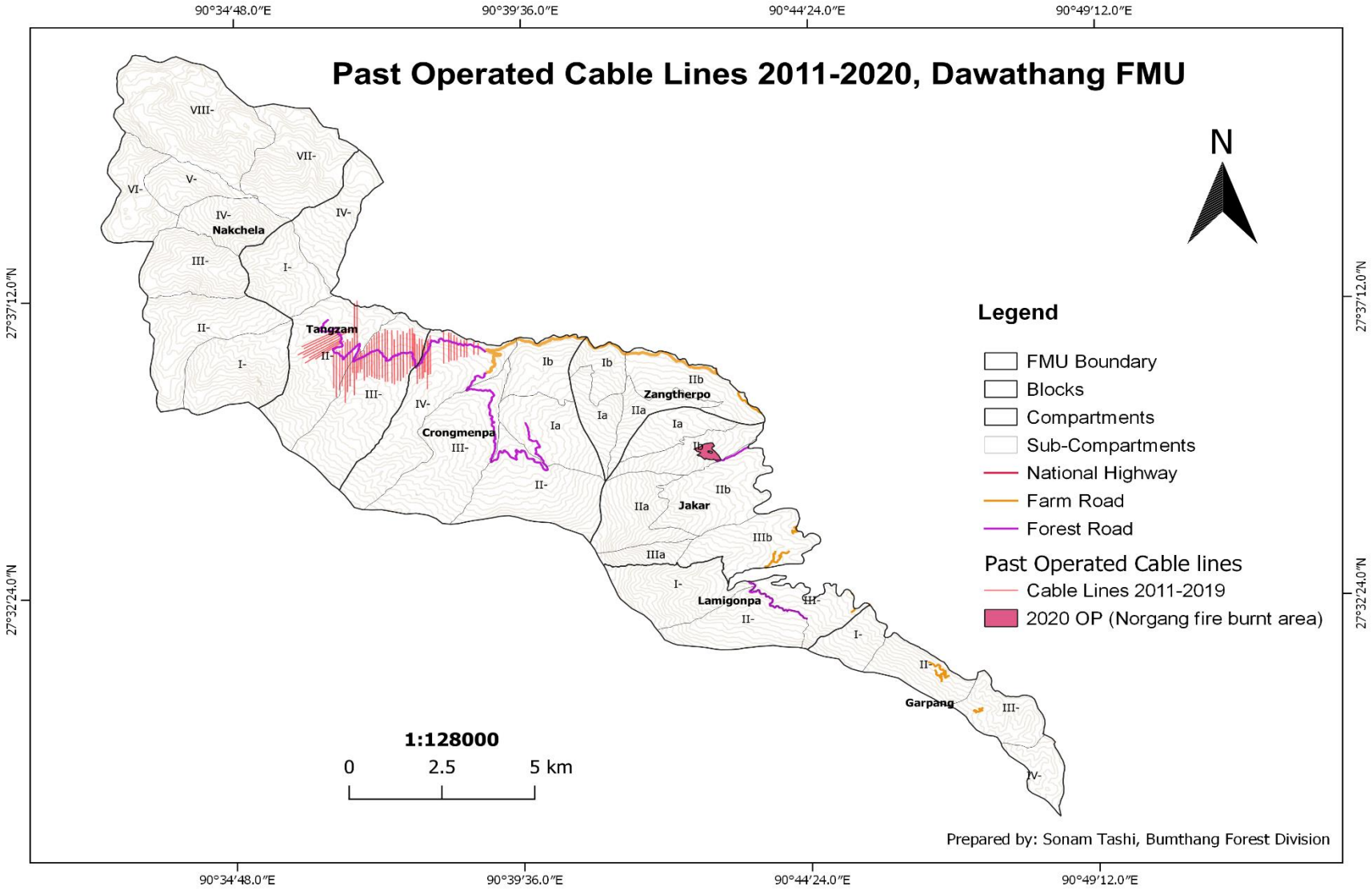
10.3 Review of Road Construction Activities

The construction of forest road has facilitated in extraction and transportation of commercial timber as well as rural timber. A total length of 12.5 Kms of forest road was constructed during the first plan period which the road passes through Crongmenpa Block of Compartment I, II, III and IV. As planned in the previous management plan the road was constructed from the end 3Km from the Chhuteygang Depot. A total of 8.91 Kms was constructed in the previous plan period which passes through Crongmanpa Block (Compartment VI) till Tangzam Block (Compartment II and III), of which 1.62Km in Jakar Block of Compartment III was constructed for the extraction of fire burnt trees above Norgang village. Due to the aspect, DFMU in the mixed conifer forest and Fir Forest is generally damp. In certain sections of the roads in Tangzam Block, side drains and culverts are missing. The dampness and missing of proper road infrastructure causes vulnerability to the road. Thus, requiring frequent maintenance. Moreover, after the establishment of stone quarry just before the depot is also worsening the road. Both NRDCL and the owner of quarry have agreed to maintain the road as it is causing inconveniences to the public commuting from Dhur village.

Table 12: Road Construction Information

Block/Compartment	Year of Construction	Road constructed (km)
Crongmanpa	2011	0.5
Crongmenpa	2012	1
Tangzam III	2013	2
Tangzam III	2014	1
Tangzam III	2015	1.5
Tangzam II	2016	-
Zangtherpo –Tangzam II	2017	-
Tangzam II	2018	0.88
Tangzam II	2019	0.41
Jakar III	2020	1.62
	Total	**8.91**

Map 3: Past Operated Cable Lines from 2011-2020



10.4 Review of Reforestation

Natural regeneration in the DFMU was found to be poor and suppressed by profuse growth of bamboos. The natural regeneration in the cable lines were found to be inadequate. Thus, during the past plan implementation, natural regeneration was supplemented with plantations. Total of 7.07ha of mixed conifer species were planted in cable lines and degraded areas by NRDCL.

The overall survival of the plantation created during the plan period as reported in Annual Operational Plan (2011-2020) was found to be satisfactory and is under continued monitoring. It was also reported that there is need of fencing of plantation area as some of the saplings were damaged by cattle and few others were uprooted by wild boars (Annexure 11).

Table 13: Description of road construction 2011-2020

Year of Plantation	Block/Compartment	Cable Line No	Plantation area planned(ha)	Plantation area implemented (ha)	Plantation Survival Percentage	Remarks
2011	-	-	-	-	-	No plantation was carried out
2012	Crongmenpa IV	1 and 4	2.07	2.07	80%	
2013	Tangzam III	0	0	0	0	
2014	Tangzam III	9 and 10	1	1	75%	
2015	Tangzam III	26 and 27	1	1	65%	
2016	Tangzam IV	30 and 31	1	1	70%	
2017	Tangzam IV	32	1	1	65%	
2018	Tangzam I	-	1	1	68.13%	Degraded area outside cable lines
2019	Tangzam I	-	1	1	62.81%	
	Total		**7.07**	**7.07**		

10.5 Annual Allowable Cut

The total Annual Allowable Cut (AAC) of commercial and rural use of the last management plan is more or less similar to the current management plan, although there is gross area reduction of 2369.3 ha. However, there is increase in rural AAC in current plan which is in accordance with the consumption trend in past 10 years and slight decrease in commercial AAC.

PART 2: FUTURE MANAGEMENT

Figure 5 View from proposed road alignment

11. INTRODUCTION

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

11.1 Forest Policy

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

According to the FNCA (1995) and FNCRR (2017), Management Plan needs to be prepared for all Protected Areas and for all forests where commercial logging is to be undertaken and needs to be approved before implementation(Department of Forests and Park Services, 2017). FNCA

(1995) provides the legislative framework for the community participation in the forest management and streamline the preparation of supporting forest rules and regulations. The regulation lay out the best practices that apply nationwide. This plan has been prepared in line with the Act and the Forest and Nature Conservation Rules and Regulations of Bhutan.

11.2 Goals

To manage the forest on a multiple use, sustained yield basis for the production of timber, fuel wood and other forest products and for watershed, wildlife and environmental protection.[3]

11.3 Objectives

The objectives of managing Dawathang FMU are stated under different management circles identified to ease the implementation of the plan. The three management circles identified are Protection, Production and Non-production Management Circles. As different management circles are managed for different purposes, framing separate objectives can help manage, monitor and evaluate the areas with ease. However, there are instances where different management circles share similar objectives. The NWFP resources is overlapping with other management circles, thus it is not included as separate objective as done in previous plan. The objectives for management of the three management circles are listed below:

Protection Management Circle

- To check soil erosion and denudation in the catchment areas of rivers, lakes and reservoirs in the interest of soil and water conservation.
- To protect the forest from encroachment, fire, grazing and other illegal activities.
- To conserve and enhance wildlife habitats and biodiversity.
- To conserve and improve the health of the watershed.
- To meet the local demand for NWFP on sustainable basis in order to improve socio-economic status of the people.
- To prevent negative impacts due to forest resource use on religious sites and water quality.

Non-Production Management Circle

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

Production Management Circle

[3] Goal and objectives are kept similar to previous plan for proper continuity of achievement.

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

11.4 Management Based on Forest Function

11.4.1 Introduction

Forest function mapping is the term used for grouping the different potential uses of the forest. The different forest potential includes soil conservation, watershed conservation, habitat for flora and fauna and resource based for many kinds of human needs. Forest function, in general, are not based only on subjective human demands, they are significantly and objectively limited by site condition of forest stand. For this reason, categorization of every forest stand into different forest function is mainly based on the dominant site, forest type, accessibility, slope, flora and fauna present. However, some forest function represents certain exception to this rule and these functions are designated on the basis of social importance(Forest Resources Development Division, 2004).

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

11.4.2 The main objectives of Forest Function Mapping are:

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

11.4.2 Function Groups

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

Table 14: Different Forest Function used in the Plan

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

11.4.3 Mapping Forest Functions

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

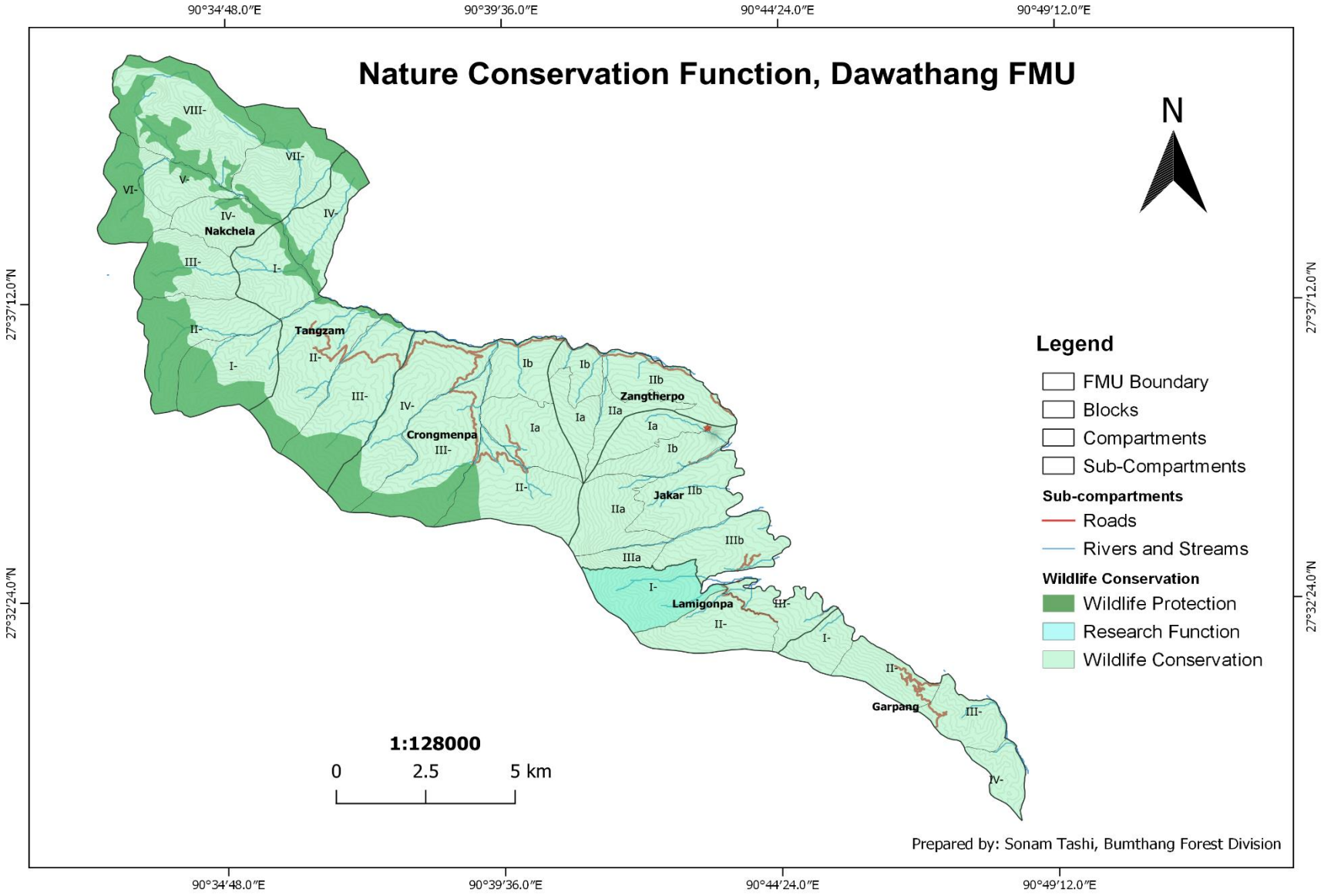
Table 15: Criteria for Mapping Forest Functions

Function Group and Codes	Criteria forMapping
Soil Conservation	**SP:** Very steep areas (slopes of greater than 100%), *areas with indication of slight to moderate erosion*.**SC:** Steep or sensitive areas (slopes of 25^{o}-35^{o})
Water and Watershed Conservation	**WSh:** Catchment areas of water courses, water retention areas. **WRR:** Areas within 30m along all perennial streams, water logged areas, swamp etc. **WLS:** Upper catchment areas of streams serving as drinking water supply for settlement downstream.
Nature Conservation	**NWP:** Alpine areas, Red Panda territory, *ecosystems of high conservation value.* **NWC:** Areas identified as biological corridors and all areas rich in wildlife, both in species and in number.
Social Function	**SocL:** Area close to or accessible to settlement or village, the areas traditionally used already, with definite boundaries. **SocRS:** Lhakhangs/ Goenpas, Gney and other religious sites.
Road Buffer	**RB:** 200m uphill and 100m downhill for motorable public road, 30m uphill and 10m downhill for unstable forest road.

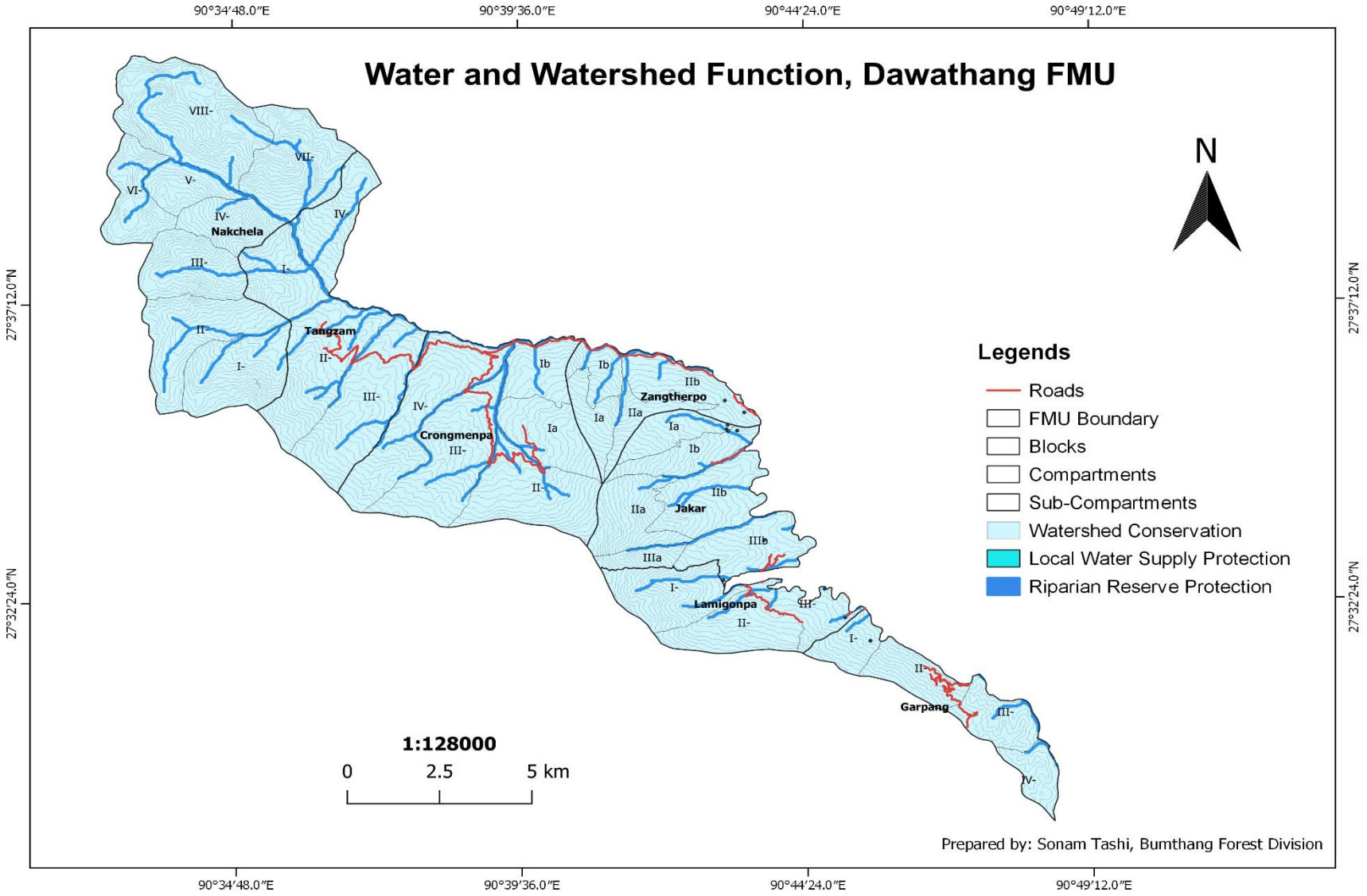
(Forest Resources Development Division, 2004)

Whilst in carrying out function mapping for DFMU, not only the FMCB 2004, but for better specificity during GIS analysis draft FMCB 2020 was followed. Moreover, one additional function was also categorized as Research and Development function assigned for UWICER preserve area (502.54ha) as per the directive received from FRMD.

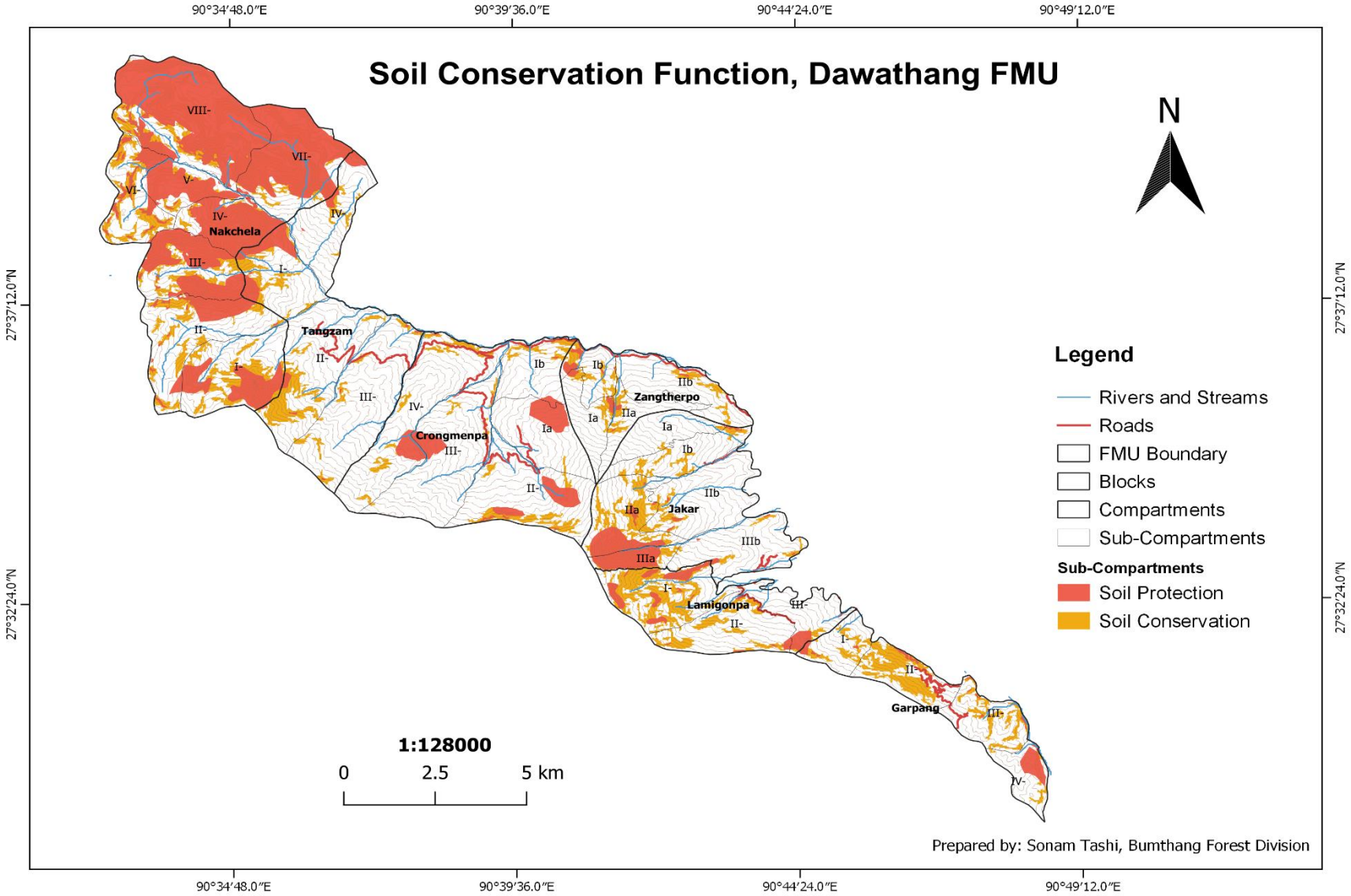
Map 4: Nature Conservation Function



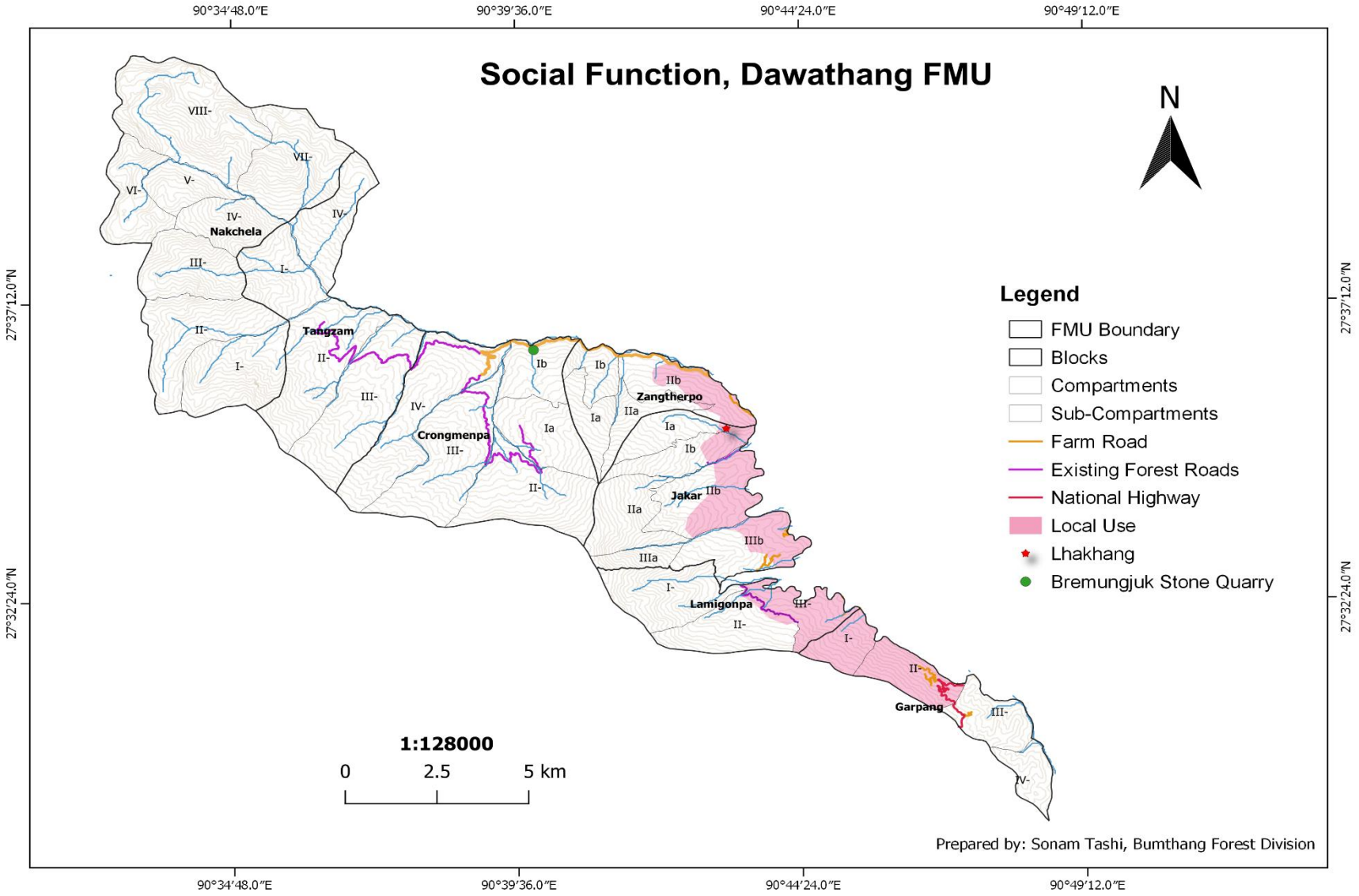
Map 5: Water and Watershed Conservation Function



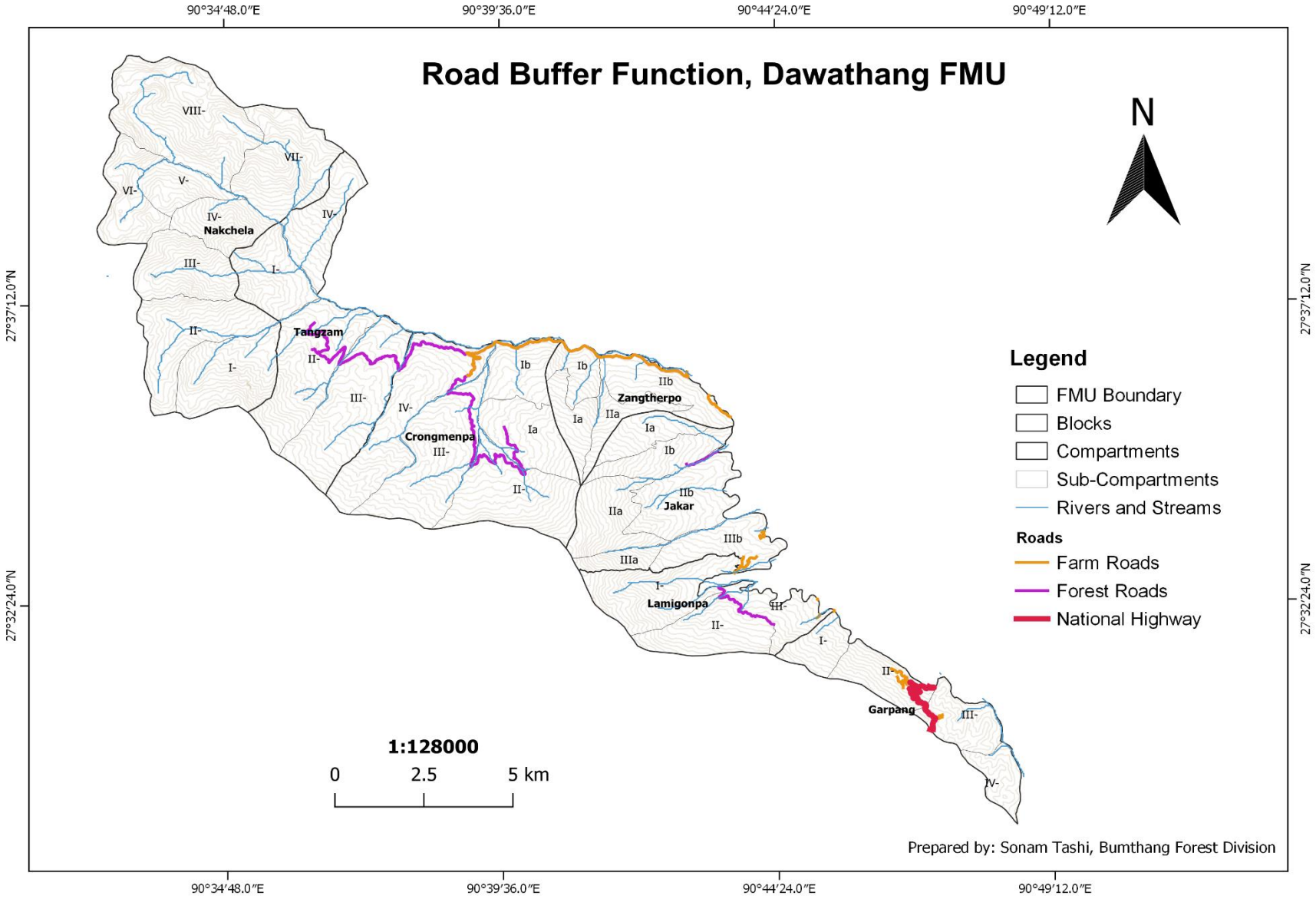
Map 6: Soil Conservation Function



Map 7: Social Function



Map 8: Road Buffer Function



11.4.4 Restrictions of Forest Functions

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

Table 16: Forest Function Restrictions

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

(Forest Resources Development Division, 2004)

12. QUANTITATIVE RESOURCE ASSESSMENT

12.1 Forest Management Inventory

Inventory Design of Dawathang Forest Management Unit

The forest management inventory of Dawathang FMU was conducted in April-May 2020for the preparation of the third management plan. The standard FMU inventory technique was used, with data being collected for trees >10 cm DBH (OB). A total of 253 plots were laid within the FMU at a more practical spacing of 800 m × 800 m, thus a plot representing an area of 67.84 ha. The inventory was designed with target sampling error of +/- 10% at 90% confidence level using the coefficient variation of 72.28%. All inventory plots are designated as special plots in which both height and diameter of the trees were measured.

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

12.2 Forest Management Inventory Result

The data obtained from the forest management inventory was analyzed using statistical software called 'R'. As per the forest management inventory of the FMU carried out in the year 2020, the average standing volume per hectare was found to be 362.53 m^3/ha with a sampling error of 13.36%. The average number of trees per hectare in the FMU was estimated at202 with a standard error of 10.46%. The basal area per hectare was estimated to be around 33.26m^2 with a standard error of 11.98%. The summary of the inventory results is shown in the table below:

Table 17: Summary of Inventory Results for overall FMU area

Parameters	Estimates	Sampling Error (%)	Lower value	Upper value
Total Volume in FMU (m^3)	5811605.39	13.36	5034954	6588257
Total Volume per Hectare (m^3)	362.53	13.36	314.08	410.98
Total Tree Count in FMU (Nos.)	3,247,190.43	10.46	2907490.3	3586890.5
Total Trees per Hectare (Nos.)	202.56	10.46	181.37	223.75
Total Basal Area of FMU (m^2)	533,167.79	11.98	469257.74	597077.86
Total Basal Area per Hectare (m^2)	33.26	11.98	29.27	37.24

**Sampling error is at 95% level of probability*

13. AREA ORGANIZATION

13.1 Spatial Organization

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

Table 18: Block, Compartments and Sub-compartment Information

Block	Block Area (ha)	Compartment	Sub-compartment	Area (ha)
Garpang	1025.25	I		216.73
		II		300.79
		III		312.98
		IV		194.75
Jakar	2063.75	I	a	245.17
		I	b	294.07
		II	a	419.75
		II	b	522.22
		III	a	131
		III	b	451.54
Lamigonpa	1225.37	I		502.54
		II		450.65
		III		272.18
Zangtherpo	1007.55	I	a	221.28
		I	b	186.21
		II	a	199.34
		II	b	400.72
Crongmenpa	3037.12	I	a	430.19
		I	b	314.2
		II		691.48
		III		801.42
		IV		799.83
Tangzam	2408.93	I		416.19
		II		747.6
		III		829.24
		Iv		415.9
Nakchela	4405.82	I		586.27
		II		631.3
		III		478.95

		IV		326.97
		V		255.6
		VI		393.83
		VII		684.15
		VIII		1048.75
	15173.8		Total	15173.8

Although the original FMU spatial organization is maintained, due to net reduction of 1511.34ha from DFMU area by WCNP (Annexure 9) and 858.3ha by the municipal plan (Annexure 5) there is slight change in nomenclature of affected compartments and the outer FMU boundary. Previous Compartment of Dhur II and III were completely merged in WCNP and few hectares from Dhur I, Tangzam I and III, Crongmanpa I and IV, Zangtherpo I and II and Nakchela Block were merged. Lower part of Jakar Block and Garpang Block area has been reduced by the municipal plan.

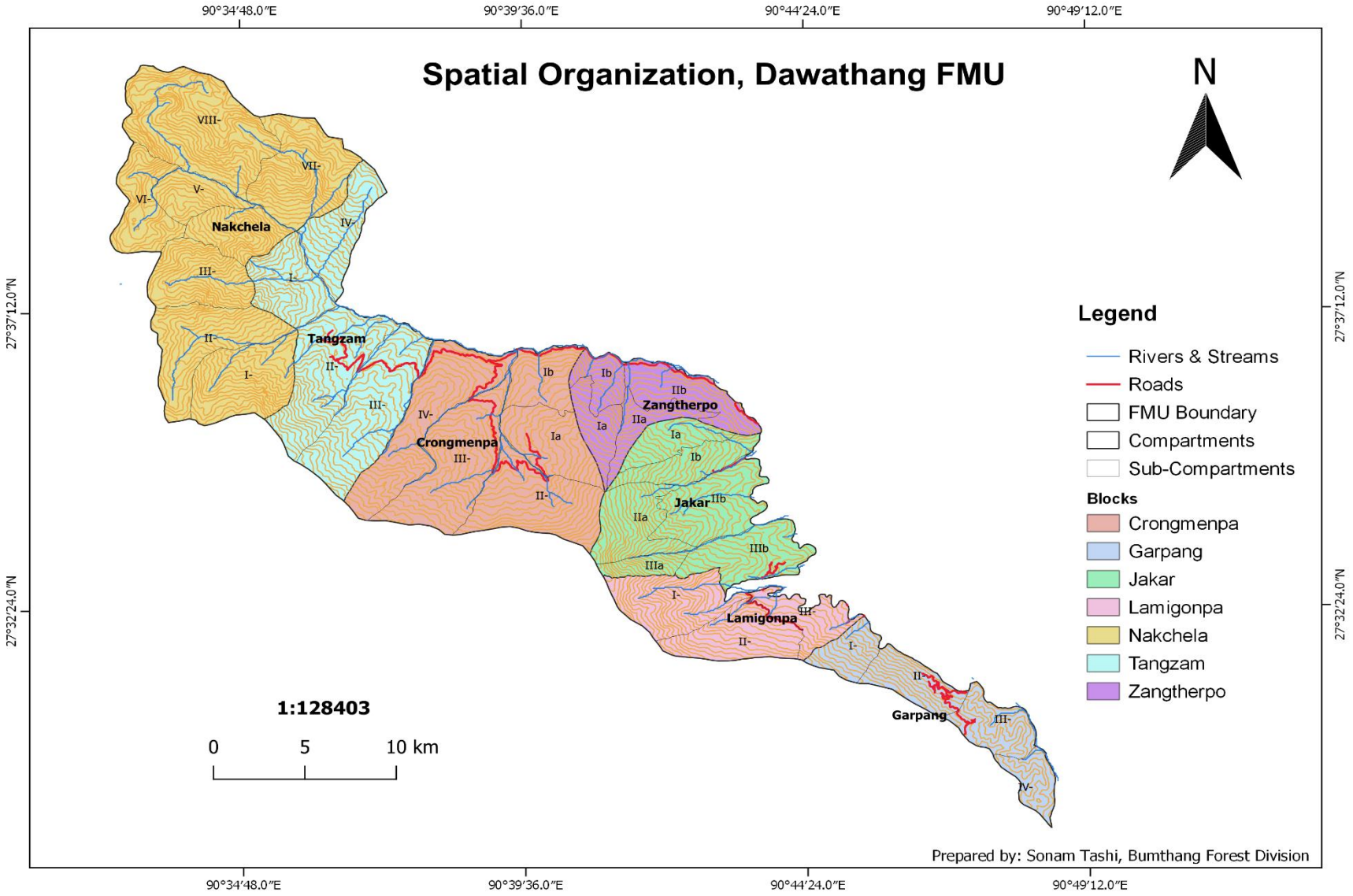
During the Forest Function Mapping, the production areas have been separated for local use and commercial use. However, preference will always be given to native inhabitants for rural timber and NWFPs.

13.2 Determining Operable Area

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

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

Map 9: Spatial Organization of Dawathang FMU



13.3 Organization into Management Circles and Working Circles

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

Table 19: Area Statement for Management Circles and Working Circles

Management and working circle	Area (ha)
Protection Management circle	7547.27
Soil protection	3286.76
Wildlife Protection	3044.13
Riparian Reserve	419.48
Road buffer	291.33
Religious site protection	3.09
Research and Development	502.48
Non-production management circle	2352.08
non forest area	
Private lands	405.64
Production Management circle	7784.61
Blue Pine Working Circle	1939.19
Mixed Conifer Working Circle	5243.54
Fir Working Circle	601.88

**In many cases forest function is overlapping, especially those which depend on the same parameters like slope, wildlife and non-forest.*

13.4 Management Circles

13.4.1 Protection Management Circle

The Protection Working Circle is the sum of all protection functions; wildlife protection, soil protection, riparian reserve protection, religious site protection, road buffer protection and local water supply protection. Commercial harvesting activities are strictly prohibited in this management circle. The total area under protection management circle is 7547.27 ha. The removal of trees may be permitted in the Protection Management Circle to deal with outbreaks of pest and diseases. The outline of management objectives and options of the protection management circle are given below.

Table 20: Protection Management Circle

Management Objectives	Management Options	Responsibility
To conserve and enhance wildlife habitats and biodiversity.	• Avoid disturbance • Promote research and habitat improvement activities	All Parties Territorial Division
To conserve and improve the	• Minimal intervention	All Parties

health of the watershed.		
To meet the local demand for NWFPs on sustainable basis in order to improve socio-economic status of the people.	• Regulate extraction of NWFP on sustainable basis • Carry out resource assessment	Territorial Division
To prevent negative impacts due to forest resource use on religious sites and water quality.	• No interventions	All Parties

13.4.2 Non-production Management Circle

The Non-production Management Circle includes area where production is not economically feasible. It comprises of non-forest areas, build-up areas, agricultural land and rocky outcrops. The total area under non-production management circle is about 2352.08 ha.

Table 21: Non-production Management Circle

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

13.4.3 Production Management Circle

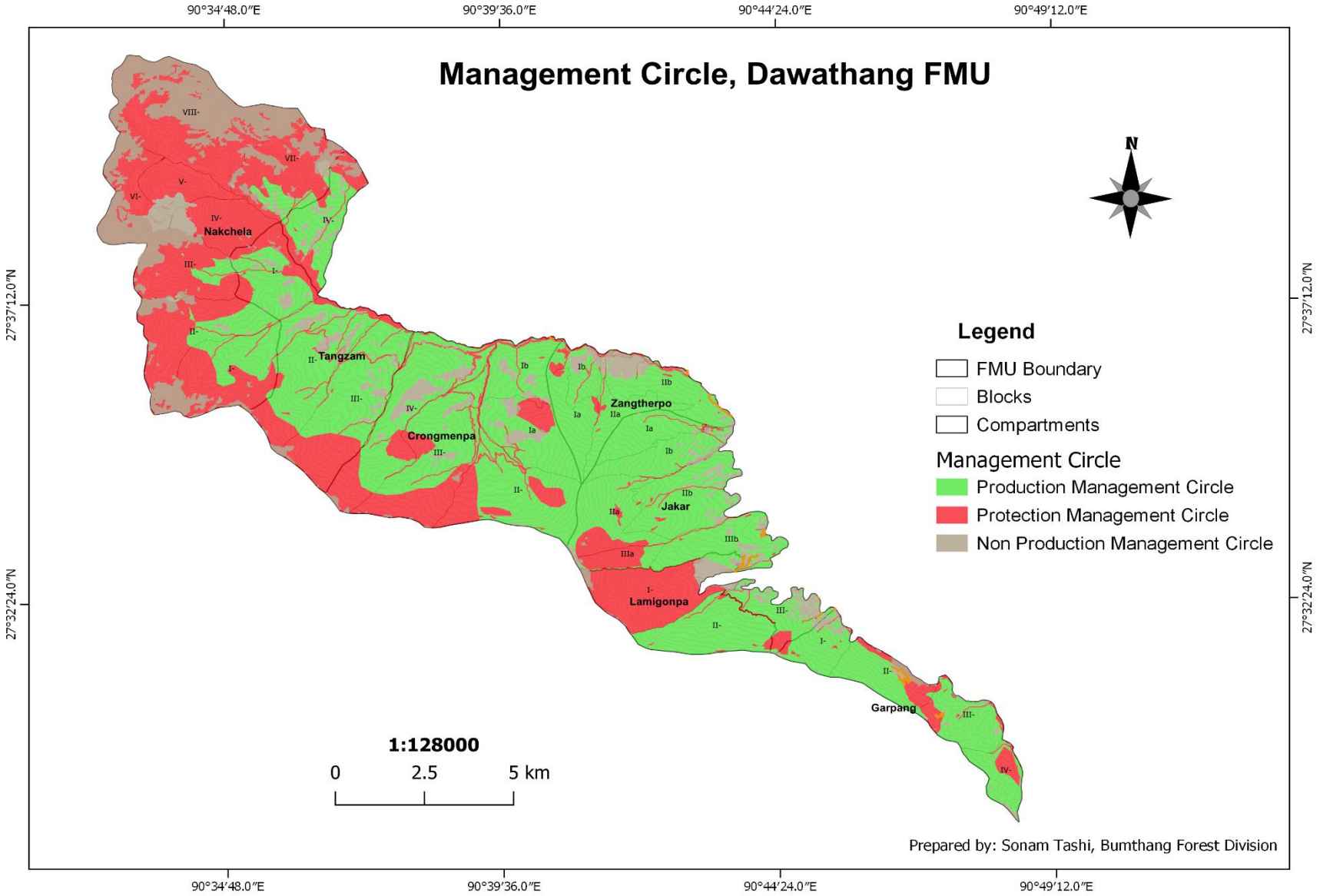
The Production Management Circle comprises of the area that has the potential for harvesting operations. It is the area left after delineation of protection and non-production management circles. This management circle comprises of areas which are well stocked with species which can be harvested on sustainable basis for both local and commercial uses. The total area under production management circle is 7784.61ha.

Table 22: Production Management Circle

Management Objectives	Management Options	Responsibility
To meet local requirements, as priority, for timber, fuel wood and other forest produce on a sustainable basis.	On the basis of single tree selection system from the identified local use area	Territorial Division
To manage and harvest	Group selection system in mixed conifer,	Territorial Division

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

Map 10: Management Circle under Dawathang FMU



13.4.4 Non-wood Management Circle (Overlapping)

The final evaluation of the second plan also recommends having prescription for NWFP management, as in the past the allotment has been done based on availability rather than with a sustainable AAC fixed by the plan. Due to limited resources and expertise to measure the stock of NWFP and to provide an AAC in this plan as well, perhaps it's recommended to estimate the quantity during the OP plan within the OP area which can then at least be regulated of its sustainability by its proportion. The NWFP is designed as an overlapping management circle and the harvesting can be carried out as per the sustainable principles from all other management circles. The Territorial Division should monitor the collection and processing of the NWFPs from the FMU on regular basis to ensure its sustainability. As per the provisions of FNCRR, 2017, the communities should form NWFP Management Groups and by-laws should be developed accordingly for sustainable management and harvest of NWFPs. The groups should take full responsibility for managing the resources in close consultation with the Divisional Office. Bamboo deserves an exclusive mention here as the growth of Bamboo is immense at once, which might be imperative to regulate its growth for allotment as well as to minimize its hindrance for regeneration.

Bamboo

One of the most important bamboo species found in the DFMU is *Borinda grossa*(Figure 8). The presence of *Borinda grossa* is mostly concentrated in Mixed conifer strata of Whole DFMU.

Figure 6 Clump of (Borinda grossa)

Plant Profile

Scientific Name: *Borinda grossa*
Common Name: Baa (Dzongkha)
Family: Gramineae
Habitat: Wetter temperate mixed coniferous forests often associated with hemlock, at altitude of 1,800m to 3,200m.

Physical Characteristics

Borinda grossa is the largest temperate clump-forming bamboo and grows at altitudes from 1,800m to 3,200m. The culms can attain a height up to 10m, and a diameter of 4.5 cm. The internodes can reach 50 cm in length. It has dense clumps and the culms are straight below and drooping above. *Borinda grossa* is found in wet, temperate, mixed forest, often in association with *Tsuga dumosa* (hemlock). It grows well in fertile soil and under humid conditions (Forest Resources Development Division , 2008).

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

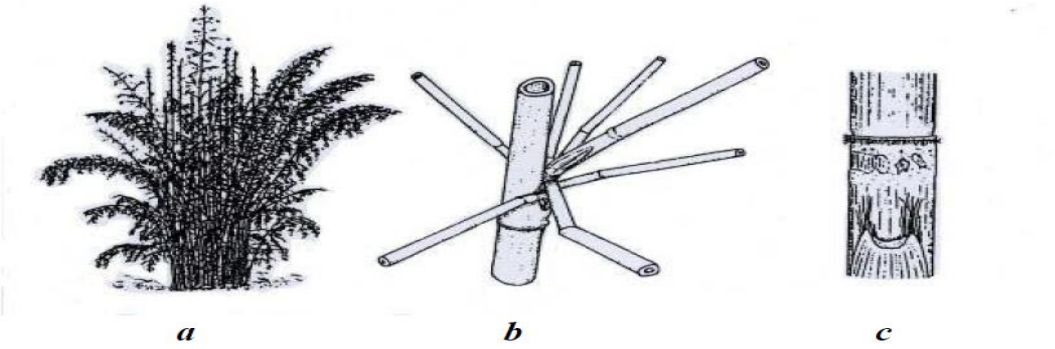


Figure 7: Borinda grossa a) clump habit, b) mid-clum branching and c) clum with sheath

Management

The Guideline for resource assessment and management of *Borinda grossa* by Forest Resources Development Division published in 2008 can be followed for resource assessment and management.

Planting

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

Harvesting Guidelines

The following guidelines are recommended for harvesting:

- Culms should be cut at the base or at the first long internodes above the node.
- Bamboo shoots or culms of less than one-year old should be left intact
- Maximum 33 % of the 1+ year and 2+ year old culms per clump should be harvested each year and 67% should be kept for regeneration. This AHL (Annual Harvesting Limit) can be applied to each available clump.
- 70% of the 3+ years old culms can be harvested. It is important to leave some old culms to provide physical support to the 1+ year and 2+ years old culms.
- Culms should not be harvested when new shoots are sprouting as this practice will harm the new developing shoots. The preferred timing for harvesting bamboo culms is four to five months after the bamboo-shooting season and at least one to two months before the bamboo-shooting season (this season differs according to location and altitude).
- Respect the traditional beliefs (ladam/ridam) related to the allowed timing for entering the forest which overlaps with the bamboo-shooting season.
- Harvesting of condensed/congested clumps should be done in a U-form or horseshoe form in order to maximize the productivity. Young shoots only grow on the edge of the clump. Therefore, harvesting culms in a U-form will allow more shoots to grow.

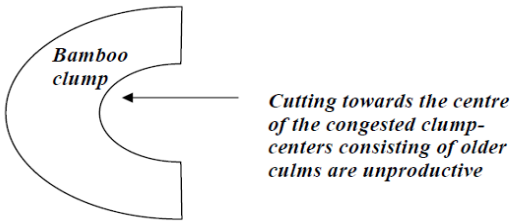


Figure 8: U-form harvesting of Bamboo

(Forest Resources Development Division , 2008)

13.5 Management of Working Circles

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

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

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

Map 11: Production Management Circle

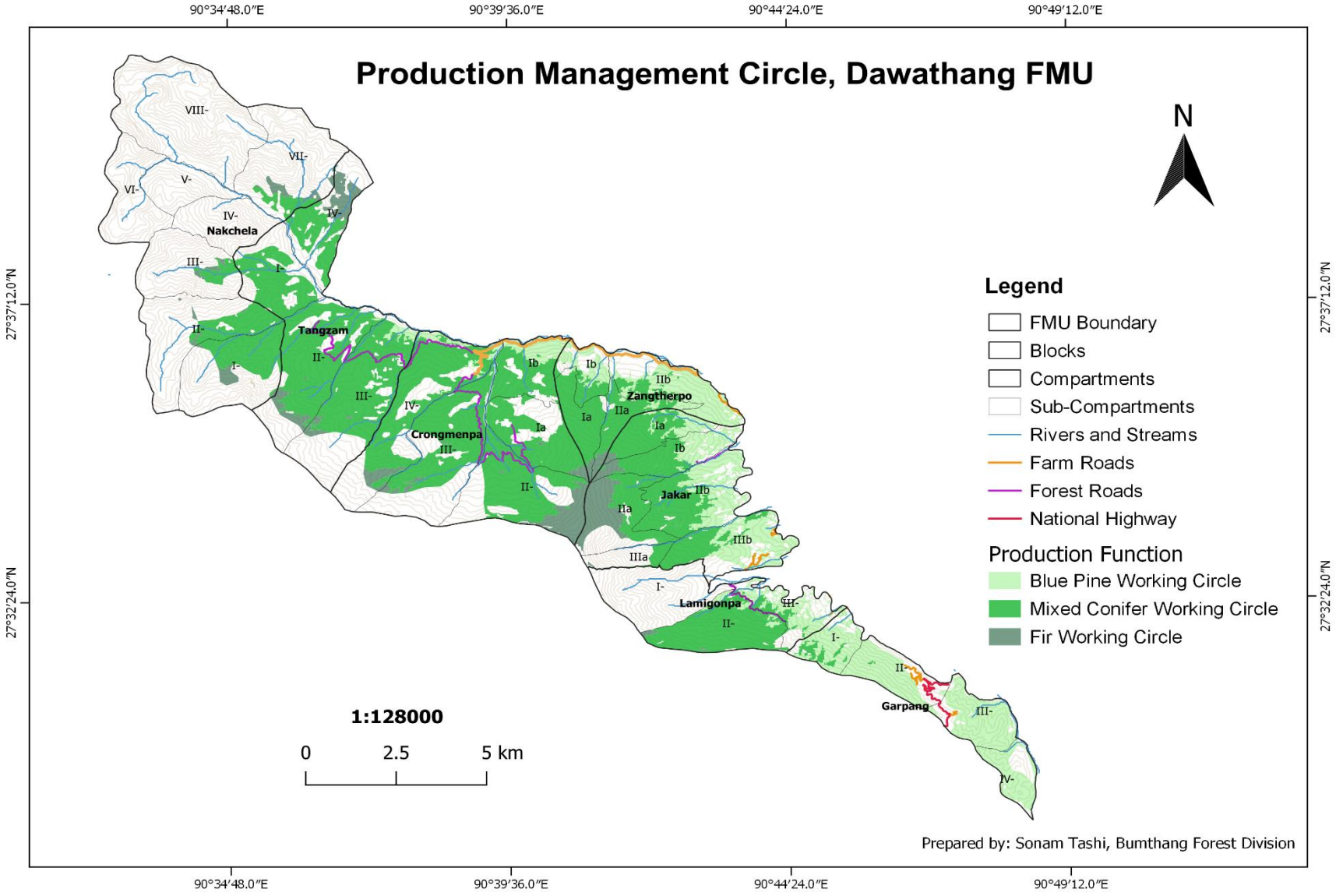


Table 23: Blue Pine Working Circle

WORKING CIRCLE: BLUE PINE				
Management Objectives	**Management Options**	**Responsibility**	**Monitoring**	**Silvicultural Systems**
To meet local requirements, as priority, for timber, fuel wood and other forest produce on a sustainable basis.	1. Controlled marking of trees 2. Systematic thinning	1. Territorial 2. Territorial/ NRDCL	1. Territorial 2. Territorial	***Thinning*** The young Blue Pine stands will be worked under thinning. Marking trees will depend on the number of stems per hectare, age or size class and spatial distribution. The detailed marking guideline for thinning in Blue Pine stand is given in Annexure 3. Dead, dying, malformed and diseased trees will be thinned on priority basis. ***Seed Tree System*** For cable harvesting, felling areas of 1000m × 30m can be logged, leaving 20-25 trees/ha as a seed source. The cable line should be laid to the full length and not to be limited to 1000 m. Harvesting line must not run directly downhill. Lines must be 90m apart to allow two interlines operation. On exposed or sensitive sites harvesting must leave 40-50 trees/ha and all under-story vegetation. Seed tree must be of good form, not over matured and representative of existing stand. In mixed stand, equal distribution of seed tree must be left (Forest Resources Development Division, 2004).
To manage and harvest commercial timber on sustainable basis.	1. Encourage use of small diameter wood 2. Promote commercial harvesting	1. NRDCL 2. NRDCL/ Territorial	1. NRDCL 2. Territorial	
To enhance and improve forest productivity	1. Mark trees for rural use as planned thinning exercise. 2. NRDCL to commercially thin stand. 3. Use appropriate logging and silvicultural methods. 4. Restock logged areas (if natural regeneration fails) or barren areas. 5. Create favorable conditions for regeneration and growth. 6. Involve local communities for planting and restocking activities. 7. Use stand tending techniques, such as bush clearing and spacing. 8. Harvest all areas regardless of financial returns	1.Territorial 2. NRDCL/ Territorial 3. NRDCL 4. NRDCL 5. NRDCL/ Territorial 6. NRDCL/ Territorial 7. NRDCL/ Territorial 8. NRDCL	1. Territorial 2. Territorial 3. Territorial 4. Territorial 5. Territorial 6. Territorial 7. Territorial 8. Territorial	
To maintain biodiversity within the production area	1. Low impact silvicultural system	1. Territorial/ NRDCL	1. Territorial	
To create local employment opportunities	1. Employ local contractors and people. 2. Provide proper training.	1. NRDCL 2. NRDCL/ Territorial	1. NRDCL 2. Territorial	
To protect the forest from overgrazing, fire and illegal activities	1. Control overgrazing, poaching, prevent fire and illegal activities with local participation	1. Territorial	1. Territorial	
To conserve the water catchment functions.	1. Minimal intervention. 2. Abide by stream buffer regulations	1. Territorial 2. NRDCL/ Territorial	1. Territorial 2. Territorial	

Table 24: Blue Pine Working Circle

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

To continually improve health and safety standards.	1.Provide training to contractors and machine operators. 2.Provide awareness to local community.	1.NRDCL 2.Territorial	1. Territorial 2. Territorial	Opening can be irregular shapes and should be based on terrain features and stand condition. Damage to residual tree must be minimized.

Table 25: Fir Working Circle

WORKING CIRCLE: Fir				
Management Objectives	**Management Options**	**Responsibility**	**Monitoring**	**Silvicultural Systems**
To manage the commercial timber production on sustainable basis.	1. Use appropriate logging and silviculture method. 2. Ensure cable line layout allows interline logging. 3. Operate entire cable line. 4.Encourage cleaning of entire cable lines.	1. Territorial/ NRDCL 2. Territorial/ NRDCL 3. Territorial/ NRDCL 4. NRDCL	1. Territorial 2. Territorial 3. Territorial 4. Territorial	***Group Selection System*** The coupe sizes recommended by RNR-RDC Yusipang serves as a guideline to follow for each silvicultural system prescribed for each forest type. Cable lines will be laid to their full capacity. Cable corridors will be not more than 4m wide. Group opening will not exceed 0.15 ha. The distance between the cable lines will be 60m and between groups along cable line will not be less than 50m (Forest Resources Development Division, 2004). All merchantable trees >10cm DBH will be felled. Dead, dying, malformed and diseased tree be felled by priority. Opening can be irregular shapes and should be based on terrain features and stand condition. Damage to residual tree must be minimized.
To enhance and improve forest condition and productivity.	1.Ensure that all barren areas are restocked with suitable native species if natural regeneration fails. 2.Use appropriate logging and silvicultural method. 3.Monitor on the attack of pest and disease. 4.Involve local communities. 5. Harvest all Fir (Dieback) areas to ensure the next rotation has less rot using full cable line lengths 6. create favorable conditions for regeneration and growth	1.NRDCL/ Territorial 2.NRDCL/ Territorial 3.Territorial 4.NRDCL/ Territorial 5. NRDCL/Territorial 6. NRDCL/Territorial	1. Territorial 2.Territorial 3.Territorial 4.NRDCL/ Territorial 5.Territorial 6. Territorial	
To protect the forest from overgrazing, fire, illegal activities and from grazing in regeneration areas.	1.Control over grazing, fire, poaching and other illegal activities through community participation and proper fencing.	1. Territorial/ NRDCL	1. Territorial	
To create local employment.	1.Employ local people. 2.Employ local contractor.	1.NRDCL 2.NRDCL	1.NRDCL 2.NRDCL	
To maintain biodiversity within the production area.	1.Low impact silviculture system.	1. Territorial/ NRDCL	1.Territorial	
To conserve the water catchment functions.	1.Minimal intervention. 2.Abide by stream buffer regulation.	1.Territorial/ NRDCL 2.NRDCL/ Territorial	1.Territorial 2.Territorial	

To continually improve health and safety standards.	1.Provide training to contractors and machine operators. 2.Provide awareness to local community.	1.NRDCL 2.Territorial	1. Territorial 2. Territorial	

13.6 Implementing Working Circle Management

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

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

14. YIELD REGULATIONS AND HARVESTING

14.1 Determination of Annual Allowable Cut (AAC)

14.1.1 Introduction

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

14.1.2 Increment Based AAC

In a perfectly structured normal forest, it should be possible to sustainably cut the annual increment each year. Some calculation methods rely heavily on increment. Unfortunately, data on increment is still limited for Dawathang FMU and Bhutan in general, and it will be some time before valuable data from permanent plots are available. The forests are not perfectly structured, but have very varied natural growing stock (of different cohorts). In the long term, increment should increase as over matured stands are replaced by younger stocks, but it will be many decades before this second growth is available for harvest. There is an over-matured growing

stock and too little and unreliable increment data to be used in determining AAC. Therefore, increment based AAC is currently unsuitable for Bhutan.

14.1.3 The Most Appropriate AAC Method

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

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

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

14.1.4 Calculation of AAC for Dawathang FMU

Net Operable Area

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

In such challenging terrains in Bhutan, exact geometric-shape group layout is rarely possible. Due to the above inevitable fact, the past management plans practiced the method whereby around 20% of area from the gross operable area has been reduced to calculate the net operable area in commercial Working Circles. However, this practice has led to inefficient use of production areas and has affected the sustainability of FMUs in the country. Therefore, this management plan does not prescribe the reduction in areas to calculate net production area as all areas which are inaccessible and inoperable are already mapped out as designated under protection working circle (Table 25). This prescription mandates the Unit In-charge and NRDCL to properly utilize the available production areas so that the area can be sustained for future harvesting operations. Any deviations from the prescribed cable line layout should be approved by the Department prior to implementation.

Table 26: Calculation of Net Production Area

Forest Types	Gross Operable Area (ha)	Calculation	Net Production Area (ha)
Blue Pine	1939.19	In order to calculate the net production area, 20% from the gross operable area has been reduced.	1,551.35
Mixed conifer	5243.54		4,194.83
Fir	601.88		481.50
TOTAL	**7,784.61**		**6,227.69**

Rotation and Regeneration Period

The assumed rotation age for Mixed Conifer is 140 years, fir is 160 years and 110 years for Blue Pine growing in relatively lower altitude. Consideration of regeneration period while calculating rotation age is very crucial. Therefore, in this plan period a 20 years of regeneration period has been added to the rotation gaga of mixed conifer and for fir, while no years is added for Blue Pine rotation years due to its fast and colonizing tendency. The assumed rotation lengths for the calculation of AAC in Dawathang FMU are:

*Fir Working Circle= **160 +20 Years***
*Mixed Conifer Working Circle= **140 +20 Years***
*Blue Pine Working Circle= **110 Years***

Average Standing Volume

The mature average standing volume is derived from management forest inventory data statistically analyzed using "R". The sampling error and RME for each stratum is given below (Table 23). The forest management inventory of Dawathang FMU is designed based on the entire forest type and not based on individual stratum. Therefore, the average standing volume obtained from the analyzed data is kept the same irrespective of the stratum. Hence, the average standing volume for mixed conifer and fir strata is considered as 362.53m^3/ha with a standard error of 13.36%. The reliable minimum estimate of standing volume thus obtained was 314m^3/ha for mixed conifer and Fir strata. Average standing volume for Blue Pine Forest is 176.64m^3/ha with standard error of 24.14%. However, the reliable minimum estimate of standing volume for Blue Pine is thus kept at 133.99m^3/ha.

AAC for Each Working Circle

The AAC for each working circle is given in the following table (Table 27). Due to different rotation and standing volume for each stratum, it is necessary to calculate the AAC for each stratum. However, while implementing practically in the field, it is essential to consider that one cable line may pass through more than one stratum. This makes it difficult to totally base the

harvest as per individual stratum. Therefore, during implementation, the total AAC (sum total of AAC for each stratum) should be considered instead of AAC for each stratum.

Table 27: AAC for the Working Circles (Standing volume)

Stratum	Net Operable Area (ha)	Rotation (Years)	RME standing volume (m^3/ha)	AAC (m^3/yr)	Clear-cut Equivalent
Blue Pine	1551.35	110	133.999	1,889.81	14.10
Mixed Conifer	4194.83	160	314	8,232.36	26.22
Fir	481.50	180	314	839.96	2.68
TOTAL	**6227.69**			**10,962.12**	**43.00**

Therefore, the total workable AAC for Dawathang FMU is fixed at 10,900 m^3 in standing volume. It is permissible to vary the AAC area by plus or minus 10% in individual years, but the volume cut in each five-year period must be no more than five times the AAC. The AAC prescribed is not solely to be met from the cable lines. The volume obtained from ad-hoc logging and thinning within the FMU should be accounted for. Compared to the AAC allocation of the second management plan, the third management plan showed a slight decrease in the AAC from 12,186 m^3 to 10,900 m^3. Due to the reduction of FMU are by WCNP and Bumthang Thromde.

14.2 Recording and Accounting for AAC

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

14.3 Allocation of AAC

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

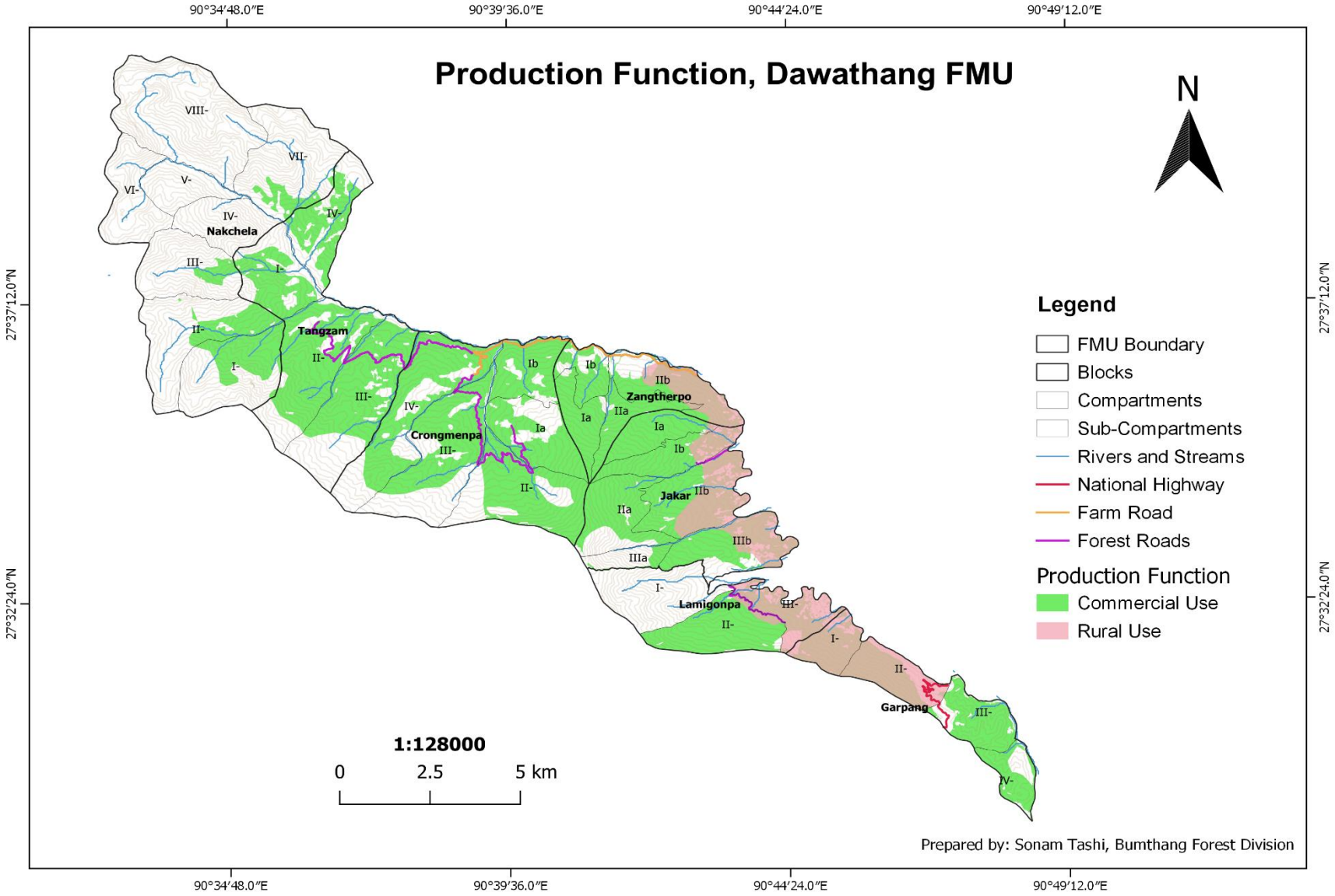
Table 28: AAC for the Working Circles (Standing volume)

Standing Volume (m^3)	Allotted to
4000 m^3	Local Use- Allocated to local villages and general public.
6900 m^3	NRDCL- Allocated for meeting the timber demand in the market.

14.4 Distribution of the Cut

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

Map 12: Production Zone



15. SILVICULTURAL SYSTEMS

15.1 Group Selection System

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

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

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

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

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

The Group Selection System has the following advantages:

- Regeneration in the small groups under even-aged condition gives better stem form.

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

Calculating Number of Cable Lines Annually

Assuming the standard cable line length to be 1,000 meters and number of groups that can be opened in the line to be 10 groups with each group measuring an area of 0.15 ha in Fir and 0.25ha in Mixed conifer and Blue Pine, the approximate number of cable lines that can be installed to achieve the annual allowable cut is worked out below:

Table 29: Workout for Cable Lines

	A	B	C	D	E
Stratum	**RME standing volume (m^3/ha)**	**AAC (m^3/yr)**	**Clear-cut Equivalent =B/A**	**Clear cut Equivalent of one Cable Line (ha)**	**No. of Cable lines per year =C/D**
Blue Pine	133.999	1,889.81	14.10	2.9	4
Mixed Conifer	314	8,232.36	26.22	2.9	9
Fir	314	839.96	2.68	1.9	1
TOTAL		**10,962.12**	**43.00**		14 lines

Although, the above projection is done considering the length of the cable line to be 1,000 meters, the length of the cable line while practically planning in the field may vary based on the topography and site conditions. Moreover, the AAC is for whole FMU rather than for commercial and rural use separately. Therefore, this projection should only be used to initially plan the field work during operational plan preparation. The actual number of cable lines to be installed annually will be guided by the operational inventory and cable line survey carried out during preparation of operational plan.

15.2 Single Tree Selection System

The Single Tree Selection System will be applied to Local Use areas in case of rural marking for extraction of rural house building timber and firewood. Single tree selection system follows principles of nature that matured trees are selected and removed to enable regeneration to replace

them. The felling should be scattered all over the operational area instead of confining to certain parts of forest. Felling should involve removing of trees or small groups of trees. This system helps to maintain uneven-aged character of the forest crop.

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

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

15.3 Seed Tree System

Blue Pine Working Circle will be worked under Seed Tree System as Blue Pine regenerate very easily under Seed Tree System. About 20 to 25 seed trees (plus tree or mother tree) per hectare should be retained as seed source. These trees must be of good health and vigorous in growth which would truly serve as good seed source. Slope characteristics, wind firmness and aesthetic value have to be taken into consideration while utilizing this system. Again, in applying this system, site condition like aspect must be considered. For cable harvesting, felling areas of 1000m x 30m can be logged, leaving 20-25 trees/ha as seed source. Harvesting lines must not run directly downhill. Lines must be 90m apart, allowing 2 interline operations. Dead, dying, malformed and diseased tree will be cut on priority basis. On exposed or sensitive site, harvesting must leave 40 to 50 trees/ha.

15.4 Thinning

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

16. FOREST PROTECTION

16.1 Fire

During the previous plan period, there was one major forest fire that burnt 21.89 ha at Norbugang in winter of 2018. Due to huge area burnt, the Operational Plan for 2020 was fully targeted to extract the timber. Thus, as the FMU area is mostly covered with mixed conifer and Blue Pine Forest, it is essential to take preventive measures to reduce the risk of major forest fire in the future. The Unit In-charge and the Production In-charge of NRDCL will need to review forest fire protection programs at regular interval in consultation with the local communities and the various stakeholders involved with activities of FMU.

16.2 Pest and Disease Management

The unit has reported of growing Bark beetle infestation in Tangzam Block of Compartment IV. The forest inventory results show of 86.65ha of mixed conifer area being infected. To mitigate and control the pest, in this management plan the road to the current infestation has been planned which is detailed in the next implementation part. The sanitation operation has to be carried out as soon as possible so that further spread is controlled.

Such cased do not arise in other part, periodic monitoring of the forests to check any outbreak of pest and diseases will be done. In order to detect and report any outbreak of pest diseases, the FMU staffs will conduct regular inspection to enable the initiation of earliest possible remedial and preventive measures. Report should be submitted to the CFO, Bumthang and also to the Specialist(s) with the Department.

The following are the control measures suggested:

- Regular periodic survey of the forest and removal of deformed trees.
- Regular survey of regenerated areas and burning of infected plants after slashing and debarking.
- Education extension program for the people and the workers in the forest to report symptoms of the disease will be part of the pest and disease management program within the FMU.

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

16.3 Grazing

Grazing has not been much issue in the FMU area, perhaps it can be attributed to the change in rearing method where livestock is mostly kept in vicinity of the settlement for easy milking and feeding purpose rather than grazed freely in forest unlike in past. More so, in line with the multiple-use of the forests and as provided in the National Forest Policy of Bhutan, 2011, grazing will be allowed in some parts of the FMU. Grazing will not be permitted in areas

identified as protection areas and light grazing will be permitted in areas identified as conservation areas. Thus, a participatory approach to secure the co-operation of the local communities to manage the grazing land for their cattle will be adopted with high priority. Regeneration areas will be fenced but timely monitored and supervision of the fences will be carried out by the Unit In-charge.

17. ENVIRONMENTAL STATEMENT

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

17.1 Project Description

17.1.1 Introduction

Dawathang Forest Management Unit was formally established in the year 2000with its first management plan, although IFDP have implemented its plan from 1986-1996. AAC of the first management plan was set at 14,000m^3including rural use which have not exceeded its prescribed extraction limit. The entire extraction of first management plan 2000-2010 was carried out in Crongmenpa Block. In the second plan the total AAC is kept at 12,186m^3 of which commercial harvest is 9756m^3 and 2424m^3 for rural use which is bit lower than the first one.

In this plan the Dawathang FMU will continue working with the principle of sustainability to meet the timber for commercial as well as *bona fide* rural requirements. The FMU will be managed on the basis of sustainability principles which will ultimately improve the forest stands. A total area of the FMU which sums up to 15,172ha will be managed based on this principle out of which only 6,227.69 ha of forest will be subjected to commercial harvesting operations. The broad objective of this project is to harvest the over matured and matured trees to improve the forest stands and also to make timber available in the market along with generation of revenue for the government. To enable transportation of logs from the forest, a total of approximately 11.5 Kms of road need to be constructed during this plan period of 10 years.

17.1.2 Objectives

- To improve the forest, stand of Dawathang FMU.
- To ensure sustainable supply of timber, fuel wood and non-wood forest produces.

- To regulate grazing in an organized manner and on sustainable basis.
- To support developmental activities through the construction of forest road.

17.1.3 Project Location and Area

Dawathang Forest Management Unit is located in Chokhor Gewog under the administrative Dzongkhag of Bumthang between 27º 4'03.13'' N to 27º28'38.33''N and 90º33'39.75''E to 90º48'35.14''E. The FMU includes iconic Jakar Dzong and East-West lateral highway passing below the Forest Management Unit.

As per the Land Use and Land Cover map (LULC) classification, majority of the FMU area is covered by forest (Map 2). Over 47.52% of the land is covered by mixed conifer forest followed by approximately 17.43% by mixed conifer Blue Pine Forest. The build-up area only forms over 0.02% of the total land cover (Figure 1) which is very less comparatively with last plan as Bumthang municipal boundary was excluded on request from Dzongkhag Administration during consultation.

17.1.4 Benefits

1) *Ecological benefit*: Some mixed conifer and fir stand of Dawathang FMU are over matured and at the moment are not putting any increment. Which subsequently have lesser ability in carbon sequestration. It is thus anticipated that by felling the over matured trees and creating space for regeneration would improve the forest condition.

2*) Monetary benefit:* The plan will benefit in revenue generation for government as well as for NRDCL from logging.

3) *Community benefit*: The FMU activities can contribute towards providing employment opportunities to the local communities. Local people can be involved as unskilled labor during the maintenance of road, construction of forest road, extraction of timber and transportation. This will help uplift the livelihood of the people residing in and near by the Forest Management Unit. The existing FMU road have been benefiting Dhur village and tourist, and the proposed new roads will benefit the settlements will immensely benefit the communities of Norbugang village who have land but couldn't farm due to accessibility.

17.2 Forest Management Unit: Planning and Zoning

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

The FMU resource inventory was carried out in April-May 2020 by Division and FRMD Inventory Crew to provide the information about tree stocking, regeneration, timber volumes, site characteristics, wildlife presence and understory species. Consultation with the community was carried out to map out local use areas, drinking water sources, places of religious importance, among others.

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

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

17.3 Harvesting and Extraction

Fixed volume of timber expressed as Annual Allowable Cut (AAC) is prescribed in this Management Plan. The AAC prescribed is 10,900 m^3 in Standing Volume per year. This means that the maximum volume that can be harvested from Dawathang FMU will not exceed 10,900 m^3 per year. Out of 10,900 m^3, 6,900 m^3 will be allotted to NRDCL for commercial harvesting and 4000 m^3 will be allotted for rural use.

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

17.4 Road Construction and Maintenance

For the extraction of timber from the production site, it is necessary to construct all season road to transport the logs and firewood to the timber depot. The physical assessment for the road construction in Dawathang FMU was carried out by the team comprising of Planner, Engineer from NRDCL, Unit staffs both from NRDCL and Bumthang Territorial Division. During the assessment, two options were identified (Map 13). These two access road options are mentioned below:

Proposed Road Alignment 1: *Road extension of 2Km towards Nakchela I and Tangzam III from existing 8.91 kms forest road constructed in last plan.*
Proposed Road Alignment 2: *2Km bifurcating from the existing road towards Bark Beetle infected area at Tangzam IV.*
Proposed Road Alignment3: *Construction of new forest road from existing road constructed for fire burnt area at Norbugang (approximately 7 Kms).*

The forest road construction in Dawathang FMU is aimed at minimum negative environmental impacts. The proposed road has been aligned in such a way that none of the drinking water sources and settlement is affected. For stream crossings, culverts, side drains and hume pipe have been designed to minimize the pollution of the stream.
The takeoff point of the road and the alignment has been agreed by the Norbugang village and the Local Government Leaders of Chokhor Gewog during the consultation meeting (Annexure7)

During road construction, the NRDCL engineers will supervise and no deviation from the proposed road alignment should take place. As general rules, excavators will be deployed. Bulldozers shall not be permitted for use. Road Standards recommended by FRMD and the general principles and practices to be followed during forest road construction as identified by NEC Forestry Sectoral Guidelines will be followed. These will ensure that the road construction within the FMU will meet the recommendations and also ensure that any erosion or other negative impacts will be minimized or eliminated. Complete Road Standard is given in Annexure 2.

17.5 Regeneration and Post Harvesting Treatments

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

17.6 Existing Environment

17.6.1 Topography and Geology

As in most parts of Bhutan, the terrain in Dawathang FMU is mountainous – from moderate to steep. However, the slopes are gentle compared to other parts of Bhutan. The lower part of FMU are not very steep. But Rocky outcrop is present in Nakchela Block. The elevation ranges from 2,520 meters at the valley bottom to 4418 meters at the ridge top. The terrain is also dissected by many small rivulets, making sub-watershed of Lamaigonpa Chuu, Nasphel Chuu, Norgang Chhu and Dhur chuu which eventually drains to become Chamkhar Chuu. The lower slopes are moderately gentle. Flatter areas have been converted to agricultural land.

Major part of FMU falls below 25˚ slope. Slope classification was done with the help of Quantum GIS by using terrain analysis. Areas that were considered over 100% were delineated on the Function Map as SP-Soil Protection where no activities can take place. Slopes that ranged from 76-100% are classified as SC-Soil Conservation where limited activities can take place. Some area which on ground validation is more than 45^0 slope were drawn besides using DEM (Raster file).

The rock of Dawathang FMU is categorized in Paro Formation. This formation is characterized by garnetiferous mica-schist, quartzite-schist, calc-silicate, graphite schist and slivers of orthogenesis.

17.6.2 Hydrology

The entire DFMU is the watershed for Dhur Chuu and Chamkhar Chuu. There are several streams and creeks in DFMU which is used for drinking water source for the communities. There are currently 19 drinking water tapping point which the water originates from DFMU. A total of 5471 people depend on municipal water supply connected mainly from three streams. The two sources are located within the UWICER preserve area, which accounts to dependency of 68% of town community while 9% of the town population depends on Nasiphel (Rongrongchhu) stream. However, 1583 people outside the municipal area depends on 27 other water sources (24 springs, 3 streams). The questionnaire survey 2016 accounted for a total of 7103 population residing within the watershed inclusive of both resident and floating population (Watershed Managment Division, 2017). Residents inside FMU and in municipal area dependent heavily on these water sources, for drinking, running water mills and cultivation. Besides these rivers and streams serve as the source of water for livestock. The catchment area for the holy Kurje Drupchu also falls within the FMU. Perhaps, in future as the population increases, protection of the Blocks which generates streams supplying drinking water seems very imperative. For now, only buffer is provided to major streams and rivers. The Chamkhar Chuu and Dhur Chuu flows right from the middle, separating the FMU.

17.6.3 Air Quality and Noise

The quality of air within the FMU is very good as the pollution is negligible. Due to higher percentage of forest cover within the FMU, the quality of air is comparatively better. Currently the present Bremungjuk quarry located inside the FMU might be negatively contributing to noise and air quality. Moreover, as the FMU is adjacent to Bumthang Thromde thus, certain level of noise and deteriorating air quality is given over the time.

17.6.4 Plant, Animal Species and Habitat

Multi-resource inventory was carried out by FRMD inventory crew in2020 in the entire FMU for the preparation of the third Management Plan. Dawathang FMU is dominated by Fir Forest, Mixed Conifer Forest and Blue Pine Forest. However, few broadleaved species could be found mixed with the conifer forest. The FMU has good floral diversity, due to its altitudinal variation, aspects and different forest composition. Notably, Tiger, Red Panda, Himalayan Musk Deer,

Himalayan Black Bear and other small cat species have been recorded within the FMU which are enlisted in endangered and threatened category. (Table 6)

17.6.5 Scenic Qualities

Due to the temperate forest type in the FMU, the forest behind the majestic Jakar Dzong gives added advantage when it comes to scenic beauty. However, the area has no particular popular sites with scenic beauty.

17.6.6 Cultural Significant Sites

In the previous there are many important monasteries and Dzongs located inside DFMU. Kurjey, Jambey Lhakhang are some of the most sacred and iconic Lhakhangs located in the FMU. However, in this plan after exclusion of municipal boundary there is only one Lhakhang located inside the FMU which is Ugyen Zhabjey above Norbugang village. A buffer of 100 meters has been delineated.

17.7 Assessment of Impacts and Mitigating Measures

17.7.1 Impact on Water

Pollution

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

Drying up of water source

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

Mitigations

A buffer of 30 meters on the either of the main river, and other perennial streams has to be maintained. Additionally, 60m buffer was given to drinking water source points. More so, the current drinking water source of municipality falls in UWICER research area which the whole area is given protection as research area restricting commercial and rural extraction. The forested area where the other drinking water source is located will not be subjected to commercial harvesting. The coupe will be laid in such a way that they are located away from the streams and

rivers. Proper pit latrines and garbage disposal should be in place and the camp sites are at least 100m away from the main streams.

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

17.7.2 Impact on Forest Resources

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

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

Mitigations

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

17.7.3 Impacts on the Faunal Diversity

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

Mitigations

An area of 3044.13ha spanning an area mostly in mixed Conifer Forest and Fir Forest has been designated as wildlife protection areas while the remaining areas are designated as nature conservation areas. The wildlife protection is mainly given for Musk Deer and Red panda based on the inventory carried out in 2020 and also on the previous plan. UWICER research area also recorded with numerous faunal diversities as mentioned in Table 6. Thus, being the research area, it was designated as research protection, which indirectly protecting the wildlife of UWICER research area.

No harvesting operations will be allowed in area designated as wildlife protection function. As all forest areas are not subjected to harvesting operations, enough areas have been kept for free movement of wild animals. Sufficient number of snag trees and fruit bearing trees will be retained to provide enough food for survival and reproduction of wild animals.

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

17.7.4 Impacts on Ecology (Flora)

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

Mitigations

While harvesting timbers from the forest, plus trees will be retained for seed and also some over matured trees will be retained as snag trees which might harbor critical floral and faunal diversity. In order to retain the original forest composition in the harvested areas, the operation should follow the prescriptions strictly. Opening along the cable lines should be maintained as per the prescribed silvicultural systems so that it creates conducive environment for desired

species to regenerate. Larger openings will be avoided in the mixed conifer stand in order to avoid its colonization by blue pine species. To ensure adequate regeneration of desired species, mother trees will be retained in sufficient numbers as a source of seed. Forest roads have been aligned in such a way that it does not pass through sensitive and critical areas. Proper monitoring should be ensured while constructing new forest roads to ascertain minimal damage to nearby vegetation.

17.8 Monitoring and Evaluation

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

Table 30: Checklist of Environmental Parameters for Forestry Projects

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

	Adverse Environmental Impact	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	*			
7. Precious ecology	7. Loss of ecological values	*			
B. Considerations Regarding Planning and Design					
1. Cost/benefit analysis					
2. Operations and maintenance	2. Diminished project efficiency and objectives if lack of funds			*	
3. Data based for decision making		*			
4. Road network design					
a) erosion	a) downstream economic losses		*		
b) siltation	b) downstream economic losses	*			
c) hydrology	c) increased peak and flood flows	*			
d) water quality	d) loss of downstream beneficial uses	*			
5. Design of logging activities	5. Unnecessary damage to residual stand			*	
6. Critical environmental areas					
a) erosion	a) downstream economic losses	*			
b) siltation	b) downstream economic losses	*			
c) hydrology	c) increased peak and flood flows	*			
d) water quality	d) loss of downstream beneficial uses	*			
7. Precious ecology	7. Loss of ecological values	*			
C. Considerations Regarding Project Operations					
1. Road Construction					
a) erosion	a) downstream economic losses		*		
b) siltation	b) downstream economic losses	*			
c) hydrology	c) increased peak and flood flows	*			
d) water quality	d) loss of downstream beneficial uses	*			
2. Felling					
a) erosion	a) downstream economic losses	*			
b) siltation	b) downstream economic losses	*			
c) hydrology	c) increased peak and flood flows	*			
d) water quality	d) loss of downstream beneficial uses	*			
3. Log conveyance and allocation					

	Adverse Environmental Impact	Preliminary Evaluation			
		No Significant Effect	Small Effect	Moderate Effect	Major Effect
a) erosion	a) downstream economic losses	*			
b) siltation	b) increased runoff	*			
c) hydrology	c) impede navigation	*			
d) water quality	d) less than optimum economic benefits		*		
4. Logging in riparian zones	4. Degradation of waterways/fisheries	**N.A**			
5. Socio-economic		*			
a) employment opportunities		*			
b) loss of traditional forest use	b) economic and cultural losses	*			
D. Considerations Regarding Post-Project Activities					
1. Rehabilitation and conservation		*			
2. Road shutdown		*			
II. REFORESTATION/AFFORESTATION					
A. Considerations Regarding Project Siting					
1. History of forest abuse	1. Negation of project goals if not effectively controlled			*	
2. Relation to other dedicated land uses					
a) conservation areas		*			
b) economic ventures	b) Interference with more profitable ventures	*			
c) regional/national forestry plans		*			
3. Rehabilitation	3. Social Problems	*			
4. Siting in degraded forest	4. Possible unnecessary loss of ecological values	*			
B. Considerations Regarding Planning and Design					
1. Cost/benefit analysis					
2. Selection of tree species	2. Diminished project objectives	*			
3. Precious ecology					
a) wildlife		*			
b) fisheries		*			
c) plants		*			
d) soil and water		*			
4. Allocation of benefits to locals		*			
a) employment opportunities		*			
b) training		*			
c) non-wood products		*			
5. Operation and maintenance	5. Diminished project efficiency and objectives if lack of funds			*	

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

18. FINANCIAL AND ECONOMIC APPRAISAL

Ten-year financial forecast and economic appraisal has been drawn for Dawathang FMU. This is intended to identify the revenue to NRDCL and government treasury via royalty. Overhead costs to NRDCL are not included. Some of the figures are estimates based on the assumptions listed

and information made available to the planner. The assumptions for the forest and summery of the forecast is detailed below:

Table 31: Assumption used for financial Forecast

Assumptions	Figures
m^3 to cft	35.31
Recovery Volume (%)	60% (Conifers) and 40% (Broadleaf)
Road Construction (Nu/Km)	3000000
Length of proposed new road	10
Road maintenance (Nu/km/yr)	14000
Distance to Depot (km)	10
Cable craning (Nu/cft)	20
Rural allotment (m^3)	4000
Regeneration maintenance (for cable line) (Nu/ha)	3,500
Artificial Plantation (ha)	10
Plantation cost (as per plantation norms and standard, SFED)	50,000

Table 32: Financial Forecast

Financial Forecast- Dawathang Forest Management Unit															
	AAC (m^3)	Rec. Volume (m^3)	Nu/cft	Nu/m^3	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	10 Years
					Nu	Nu	Nu	Nu	Nu	Nu	Nu	Nu	Nu	Nu	Total (Nu)
Revenue: NRDCL															
Timber- Commercial	6,900	4,140	169.02	5,968.10	41,179,863.78	41,179,863.78	41,179,863.78	41,179,863.78	41,179,863.78	41,179,863.78	41,179,863.78	41,179,863.78	41,179,863.78	41,179,863.78	411,798,637.80
Timber- Rural	4,000														
Total Revenue NRDCL					**41,179,863.78**	**41,179,863.78**	**41,179,863.78**	**41,179,863.78**	**41,179,863.78**	**41,179,863.78**	**41,179,863.78**	**41,179,863.78**	**41,179,863.78**	**41,179,863.78**	**411,798,637.80**
Costs: NRDCL															
Road Construction		3,000,000			6,000,000.00		6,000,000.00		6,000,000.00		6,000,000.00		3,000,000.00		27,000,000.00
Road Maintenance			14,000		301,000.00	329,000.00		28,000.00	28,000.00	56,000.00	56,000.00	84,000.00	644,000.00	98,000.00	1,624,000.00
Marking Cost			0.8	28.25	194,911.20	194,911.20	194,911.20	194,911.20	194,911.20	194,911.20	194,911.20	194,911.20	194,911.20	194,911.20	1,949,112.00
Inventory Costs					30,000.00	30,000.00	30,000.00	30,000.00	30,000.00	30,000.00	30,000.00	30,000.00	30,000.00	30,000.00	300,000.00
Felling and Cross-cutting			3.5	123.585	852,736.50	852,736.50	852,736.50	852,736.50	852,736.50	852,736.50	852,736.50	852,736.50	852,736.50	852,736.50	852,736.50
Debarking			2.5	88.275	365,458.50	365,458.50	365,458.50	365,458.50	365,458.50	365,458.50	365,458.50	365,458.50	365,458.50	365,458.50	365,458.50
Cable Craning			20	706.2	4,872,780.00	4,872,780.00	4,872,780.00	4,872,780.00	4,872,780.00	4,872,780.00	4,872,780.00	4,872,780.00	4,872,780.00	4,872,780.00	4,872,780.00
Transportation to Depot					6,432,069.60	6,432,069.60	6,432,069.60	6,432,069.60	6,432,069.60	6,432,069.60	6,432,069.60	6,432,069.60	6,432,069.60	6,432,069.60	6,432,069.60
Stand Tending (Spacing etc.)															-
Coupe Regeneration															-
Regeneration Maintenance		3,500/cable line				24,500.00	49,000.00	73,500.00	73,500.00	73,500.00	73,500.00	73,500.00	73,500.00	73,500.00	588,000.00
Creation of Plantation		50,000/ha				50,000.00	50,000.00	50,000.00	50,000.00	50,000.00	50,000.00	50,000.00	50,000.00	50,000.00	450,000.00
Plantation Maintenance		8,000/ha					8,000.00	16,000.00	24,000.00	32,000.00	40,000.00	40,000.00	40,000.00	40,000.00	240,000.00
Total Costs NRDCL					**19,048,955.80**	**13,151,455.80**	**18,854,955.80**	**12,915,455.80**	**18,923,455.80**	**12,959,455.80**	**18,967,455.80**	**12,995,455.80**	**16,555,455.80**	**13,009,455.80**	**44,674,156.60**
Total Revenue less Total Costs NRDCL					**22,130,907.98**	**28,028,407.98**	**22,324,907.98**	**28,264,407.98**	**22,256,407.98**	**28,220,407.98**	**22,212,407.98**	**28,184,407.98**	**24,624,407.98**	**28,170,407.98**	**367,124,481.20**
Royalty															
Royalty- Commercial			18	635.58	2,658,901.20	2,658,901.20	2,658,901.20	2,658,901.20	2,658,901.20	2,658,901.20	2,658,901.20	2,658,901.20	2,658,901.20	2,658,901.20	26,589,012.00
Royalty- Rural															
Total Royalty NRDCL					**2,658,901.20**	**2,658,901.20**	**2,658,901.20**	**2,658,901.20**	**2,658,901.20**	**2,658,901.20**	**2,658,901.20**	**2,658,901.20**	**2,658,901.20**	**2,658,901.20**	**24,739,341.60**
Revenue less Royalties NRDCL															
Timber- Commercial					38,520,962.58	38,520,962.58	38,520,962.58	38,520,962.58	38,520,962.58	38,520,962.58	38,520,962.58	38,520,962.58	38,520,962.58	38,520,962.58	387,059,296.20
Timber-Rural															
Total Revenue less Royalty NRDCL					**38,520,962.58**	**38,520,962.58**	**38,520,962.58**	**38,520,962.58**	**38,520,962.58**	**38,520,962.58**	**38,520,962.58**	**38,520,962.58**	**38,520,962.58**	**38,520,962.58**	**387,059,296.20**
Total Revenue less Royalty Less Costs NRDCL					**19,472,006.78**	**25,369,506.78**	**19,666,006.78**	**25,605,506.78**	**19,597,506.78**	**25,561,506.78**	**19,553,506.78**	**25,525,506.78**	**21,965,506.78**	**25,511,506.78**	**342,385,139.60**

Table 33: Financial Forecast Summary (For this plan period)

Particulars	Amount (Nu.)
Total Revenue NRDCL	411,798,637.80
Total Cost NRDCL	44,674,156.60
Total Royalty NRDCL	24,739,341.60
Total Revenue less Royalty less Costs NRDCL	342,385,139.60

19. RESEARCH

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

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

PART 3: IMPLEMENTATION OF THE PLAN

Figure 9: Representative of DoFPS and NRDCL for Implementation of Plan

20. IMPLEMENTING AGENCY

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

20.1 Cutting Cycle

For sustainability of the forest resources in the FMU, the cable line spacing must be properly laid to enable subsequent passes in the future. A minimum of 60 meters needs to be kept in between the cable lines so that two passes can be enabled in the future. Mixed Conifer Working Circle has a rotation period of 160 years, which means that the two cable lines that will be implemented in the future are occurring at year 53 and year 106. The original line will therefore, be harvested in year 160 (Figure 9). This gives sufficient time to the adjacent area to regenerate and also prevents the area from large opening.

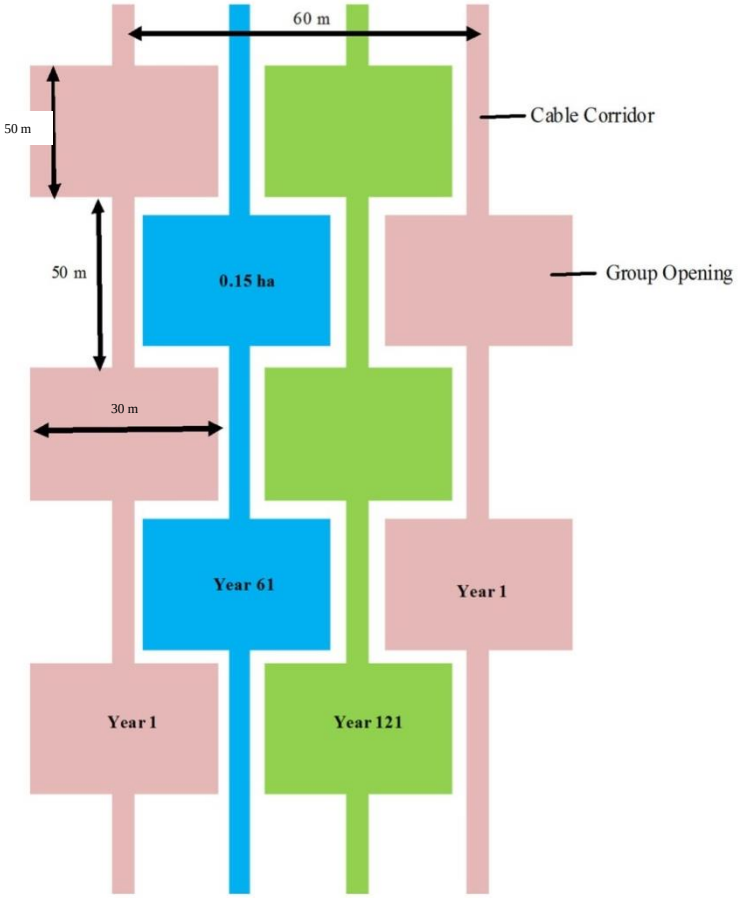


Figure 10: Layouts for Group Selection System

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

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

20.2 Annual Coupe

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

Coupes must comply with the following conditions:

- The Unit In-charge, in consultation with the NRDCL counterpart, will determine the location and extend of the cable lines in the compartment to be harvested annually. All

prescription and restriction laid down in the plan must be considered and adhered to completely.

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

20.3 Tree Marking Guidelines

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

20.4 Harvesting

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

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

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

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

- Fuel wood will be collected from harvesting residues. It is important that all lops and tops for fuel wood are collected along entire cable lines, not just the easily accessible areas. It is desirable that the trees to be used as fuel wood are extracted with the cable line and fuel wood conversion occurs at the designated log landing areas.

20.5 Reforestation of Harvested Sites

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

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

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

20.6 Sequence of Operations Relating to the Annual Coupe

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

Table 34: Sequence of Operations Relating to the Annual Coupe

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

20.7 Road Construction

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

Prior to the first plan, 15.82Km was constructed in Zangtherpo and Crongmenpa Block. Subsequently, a total length of 12.5 kms of forest road was constructed during the first plan period 2000-2010. The road passes through Zangtherpo, Crongmepa and Jakar Block. During the second plan period, a total additional road length of 8.91 kms which passes through Crongmanpa Block (Compartment VI) till Tangzam Block (Compartment II and III), of which 1.62Km in Jakar Block of Compartment III was constructed for the extraction of fire burnt trees above

Norgang village. In total till date 37.23kms of road was constructed. The construction of forest road has facilitated in extraction and transportation of commercial timber as well as rural timber. This has facilitated the smooth transportation of logs from the cable lines to Depot.

Through detailed field survey and consultation with the concerned stakeholders, it was decided that a total of 11.5 kms of forest road will be constructed during this plan period from 2021-2030. Around 2 kms of new road will be constructed Nakchela I and Tangzam III and 2.5Kms will be constructed towards Tangzam IV for the extraction of Bark Beetle affected area. Remaining 7Km is proposed to be constructed from existing road constructed of 1.6Km to Norgang fire burnt area. The existing road should also be maintained on annual basis by NRDCL in order to facilitate safe transportation of logs to depot.

Road Standard

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

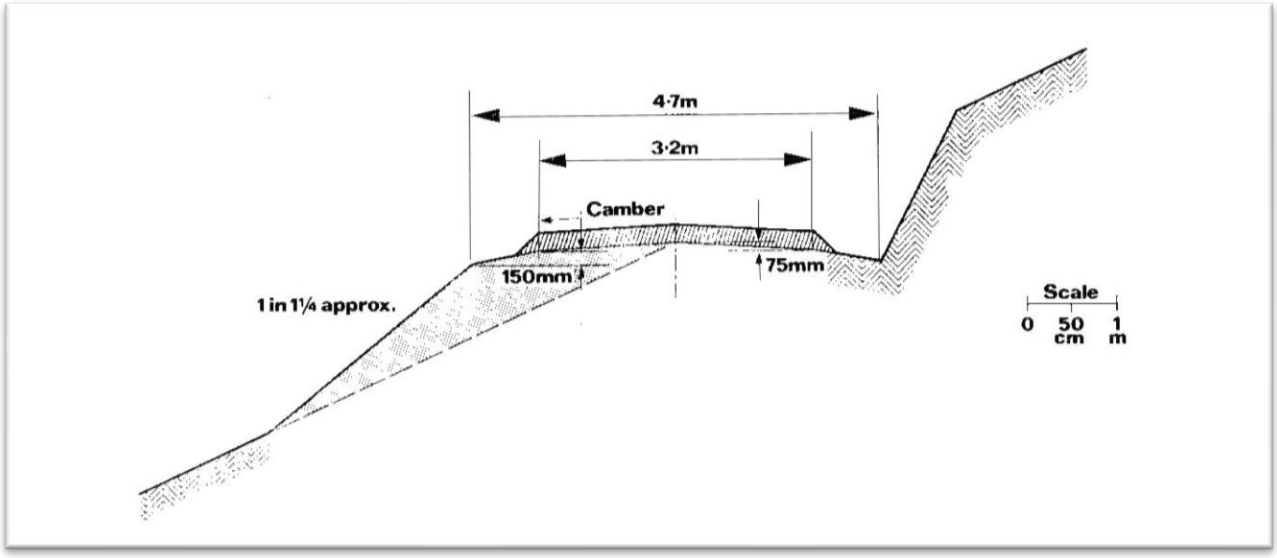
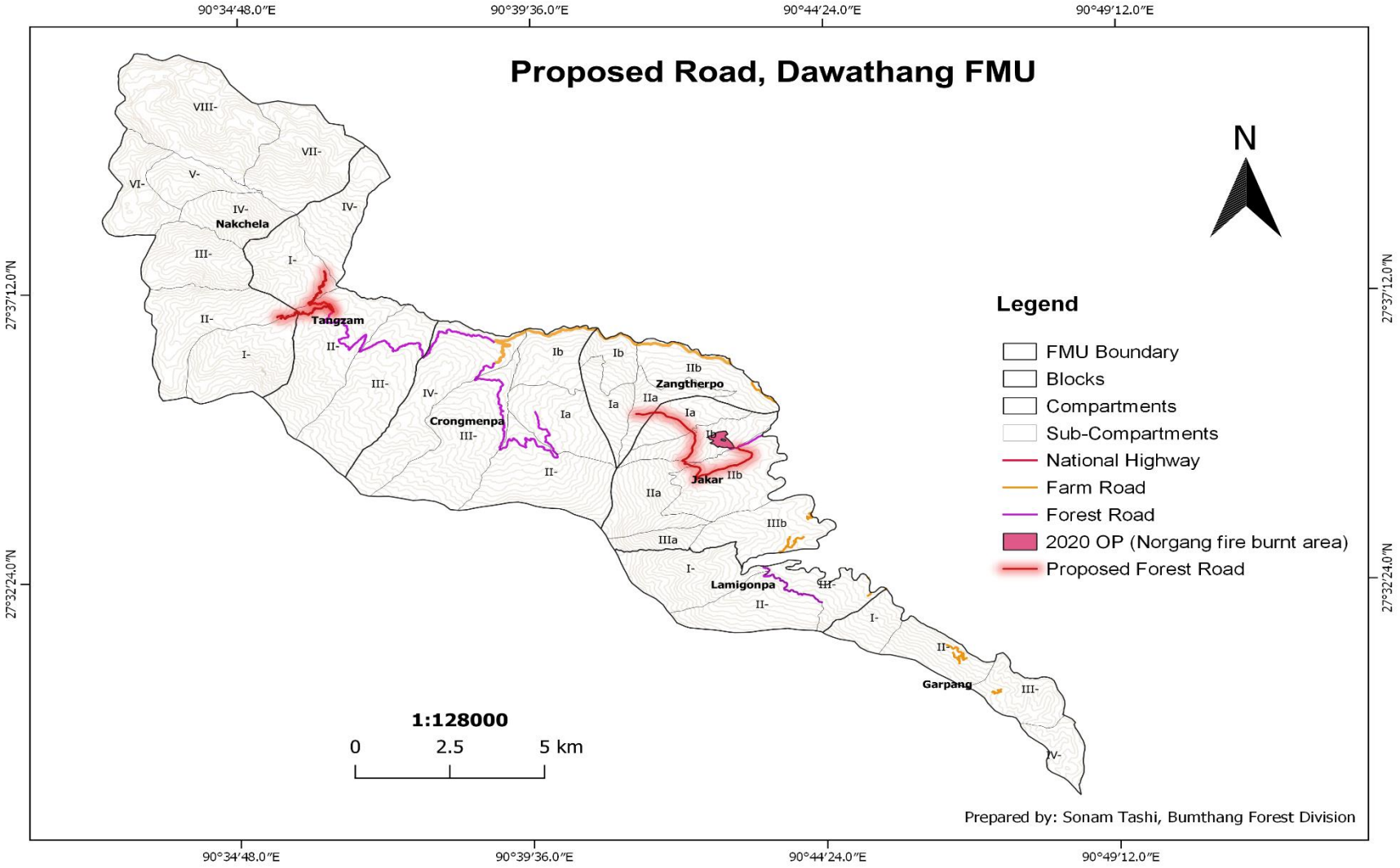


Figure 11: Recommended Road Profile

Map 13: Proposed FMU Road



21. PLANNING

21.1 Operational Plan

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

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

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

Table 35: Concept of Rolling Plan

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

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

Table 36: Preparation and Implementation of Operational Plan

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

Activity (Planning Step)	Objective	Output	Responsibility (Lead)	Comments
6. FMU annual report presented to the FMU-level Management Committee	To review process and identify and address any implementation problems	FMU Annual report endorsed by FMU-level Management Committee	FMU Manager presents to the FMU-level Management Committee	During FMU-level Management Committee meeting
	To identify any future actions necessary based on issues arising			Implementation problems need to be addressed before endorsing the new OP
7. OP review by FMU-level Management Committee and endorsed	For the FMU-level Management Committee to endorse the OP (prior to approval by DoFPS)	OP endorsed by FMU-level Management Committee	FMU Manager presents to the FMU Level Management Committee	During FMU Level Management Committee meeting
	To endorse expenditure estimates for the coming financial year			
8. NRDCL financial commitment within OP agreed	To ensure that NRDCL is committed to funding the agreed activities in the OP	Budget estimates for the OP endorsed by NRDCL and FMU-level Management Committee	FMU-level Management Committee	Meeting needs to take place by November to ensure that budget requirements can be included in the NRDCL APO for the next financial year
9. OP approved by Director, DoFPS	To approve OP for implementation	Approved plan and budget	Approved by FRMD and Director, DoFPS	OP approved linked with sanctioned budget for all planned activities
10. OP implementation by NRDCL	To carry out planned activities	Harvested timber; protected area; roads; fuel wood, etc.	According to responsibilities identified in the OP e.g. FMU In-charge, NRDCL, etc.	Each activity with specific responsibility and budget
11. Monitoring of activities	To access the level of achievement for planned activities	Information for FMU annual report	FMU In-charge	DoFPS responsibility is to monitor the implementation of activities carried out by NRDCL
				Monitoring cost

Activity (Planning Step)	Objective	Output	Responsibility (Lead)	Comments
				need to appear in the OP
12. DoFPS, Unit In-charge prepares FMU annual report	To report progress against planned activities	FMU annual report	FMU In-charge	Prepared annually
	To highlight any problems being encountered in implementation			Progress is reported against each FMP objective and the associated activities
13. Prepare the next years' OP (step 2-5)	To prepare the next OP taking into account progress over the past year	Operational Plan	FMU In-charge	OP may alter in response to FMU management committee suggestions and recommendations

21.2 Mid-term Evaluation of FMP

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

21.3 FMU-level Management Committee

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

The committee shall consist of the following members:

- Chief Forestry Officer, Bumthang (Chairman)
- Regional Manager, Jakar Region, NRDCL
- Unit In-charge, Karshong FMU
- Production In-Charge, NRDCL, Karshong FMU
- Gup/Mangmi, Chumey Gewog
- Tshogpa, Phurgoen, Nangar, Zungnyer and Bithang Chiwog
- FRMD Representative (if possible)

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

During FMU Management Plan Preparation:

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

During the Operational Planning, Implementation and Monitoring:

- To represent the interests of identified stakeholders' group during planning and review of activities under Operational Plans.
- To review achievements during the past year (based on annual report submitted by the FMU Unit In-charge) and advice and act on any issue identified.
- To make recommendation for changes in the proposed Operational Plan for the coming year based on previous years' experience and on the need to achieve the agreed objectives in the forest management plan.
- To review and endorse the draft Operational Plan before submission to the Director, DoFPS for approval.
- To participate in the 5-year mid-term review of forest management plan.
- To hold any additional meeting as required in response to specific issue arising from Forest Management Plan and Operational Plan.

21.4 Staff

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

21.4.1 Responsibility

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

Table 37: Staff requirement in the FMU

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

The Unit In-charge under the guidance of Chief Forestry Officer will be directly responsible for the day-to-day implementation of the plan. The Unit In-charge will keep records of all the works,

supervise and initiate other silvicultural activities as envisaged in this plan. Unit In-charge will be responsible to report to the Chief Forestry Officer, Bumthang.

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

21.5 Buildings

Dawathang Forest Management Unit has been operational since 1986, i.e., for more than 20 years. Although the operation started many years ago, the unit is still using the one storied building which was built during Integrated Forest Development Project (IFDP) in Toktozam. Besides FMU office, the temporary shade is also used as forest check post. A proper FMU office is also essential for a proper function of the FMU and also for effective coordination with NRDCL. If the funds are available, it would be appropriate to construct a new office building along with additional staff quarter to accommodate the unit staffs.

21.6 Vehicles and Equipment

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

- Computer (Desktop) set- 2
- Printer- 2
- Xerox Machine- 1
- Laptop- 2
- Clinometer- 3
- Diameter tape- 2
- Measuring tape- 2
- Compass- 3
- GPS Garmin- 2
- Bark guage -1
- Walkie Talkie Sets- 3

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

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

22. MONITORING AND EVALUATION

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

To ensure that this policy is being carried out in the management of FMUs, a two-stage verification process is necessary. The first stage checks that on-ground activities are being

carried out as planned in the short term, the second checks that the objectives of the plan are being achieved over the longer term. Monitoring (checking on inputs on year-to-year basis) is the term used for first stage and evaluation (checking achievements against objectives over five-year periods) is the second stage.

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

22.1 Monitoring

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

22.2 Evaluation

Evaluation is the examination of whether objectives are being achieved. In the context to FMU evaluation, sufficient time has to elapse before a realistic assessment can be made of progress towards fulfilling objectives (Incoll 1999). Evaluation should be carried out at the intervals of five year, based on the information collected by annual monitoring. The Head, FRMD will ensure that evaluation is carried out at five-year intervals, based on the information collected by annual monitoring and other necessary information. Copies of necessary forms can be collected from FRMD. Corrective actions, if necessary, may require changes to a range of inputs or to implementation methodology. The evaluation will be carried out by staffs that are independent of the field implementation activities. The evaluation team will be appointed by the Director, DoFPS.

23. CONSTRAINTS AND RISKS

Constraint of forest conservation and management planning are:

- Lack of locomotives for field staffs, leading to an inability of the staff to supervise any management activities in the FMU.
- No regular training for field staffs on preparation of operational plans and other related surveys.
- Inadequately trained Unit staffs to carry out cable line profiling.
- Insufficient technical staff in the FMU.
- Increased illegal activities within the FMU due to the close proximity to Bumthang Thromde settlement.
- Financial feasibility for commercial extraction by NRDCL.
- Lack of research.

24. DEVIATION FROM PLAN PRESCRIPTIONS

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

Unforeseen circumstances may warrant deviation from the Plan prescription. In such an event, the CFO, Bumthang must obtain prior written approval from the Director, DoFPS. Any such request for plan deviation(s) must be fully justified and such approved deviation(s) entered into the Management Plan during its next scheduled revision. The NEC Secretariat must be informed of the plan deviations approved by the Head of the Department if any. (Tshering , Managment Plan for Chendebji FMU, 2018)

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ANNEXURES

ANNEXURE 1: COMPARTMENT DESCRIPTION AND PRESCRIPTIONS

Functions like Riparian reserve, soil protection, wildlife protection and non-forest area overlaps.

Block: Garpang **Compartment: I**

Altitude: 2600 m – 3250 m
Aspect: North East
Slope: 5-25 %
Terrain: Gentle slope throughout the compartment
Total area: 216.73 ha
Protection: 15.37 ha
Non-production area: 24.1 ha
Production area: 180.09 ha

Forest Description

The compartment comprises mostly of middle-aged blue pine stands. Towards the ride, few mixed conifer species can be found. The area has private land which the forest has been removed.

Prescription for Future Management

The whole compartment is prioritized for rural use. Thinning operation in the compartment is prescribed.

Block: Garpang **Compartment: II**

Altitude: 2550 m – 3100 m
Aspect: North East
Slope: 5-25 %
Terrain: Gentle Slope
Total area: 300.79 ha
Protection: 87.96 ha
Non-production area: 31.58 ha
Production area: 206.53 ha

Forest Description

The compartment comprises of young blue pine stands throughout. The highway runs through this area (Kekela). Profuse natural regeneration of Blue Pine is seen. The area has private land which is forested and are being removed.

Prescription for Future Management

The compartment is prioritized for rural use. Thinning operation is prescribed for improvement of the forest stand.

Block: Garpang Compartment: III

Altitude: 2550 m – 2900 m
Aspect: North East
Slope: 60-100 %
Terrain: Mostly Steep Slope
Total area: 312.98 ha
Protection: 52.13 ha
Non-production area: 9.62 ha
Production area: 252.71 ha

Forest Description

The compartment has pure Blue Pine stand throughout with profuse natural regeneration. The upper part of the area is traversed by National Highway.

Prescription for Future Management

Thinning operation to be carried out.

Block: Garpang Compartment: IV

Altitude: 2500 m – 2750 m
Aspect: North East
Slope: 60-100 %
Terrain: Steep Slope throughout the compartment
Total area: 194.75 ha
Protection: 48.03 ha
Non-production area: 8.03 ha
Production area: 139.61

Forest Description

The entire compartment has young and pure blue pine stands with profuse natural regeneration.

Prescription for Future Management

As the forest is pure Blue Pine stand, so thinning operation is prescribed for improvement of forest. Can be explored for rural use if the allocated rural area is exhausted.

Block: Lamigonpa Compartment: I

Altitude: 3100 m – 3900 m
Aspect: North East
Slope: 30-80 %
Terrain: Gentle Slope to steep towards the upper boundary.
Total area: 502.48 ha
Protection: 502.54 ha
Non-production area: 14.02 ha
Production area: 0 ha

Forest Description:

The area has fir towards the upper region and mixed conifer towards the lower part of the sub-compartment. The area is allocated to RNRRC as a Research Plot in previous plan and in this current plan the whole compartment is protected under research and development function.

Prescription for Future Management

Only research is prescribed in this compartment. Commercial and rural felling of trees in this compartment is prohibited unless for scientific purpose.

Block: Lamigonpa Compartment: II

Altitude: 3150- 3800m
Aspect: North East
Slope: 10- 80%
Terrain: Gentle to steep slope towards the upper boundary.
Total area: 450.65 ha
Protection: 20.25 ha
Non-production area: 0.18 ha
Production area: 430.22 ha

Forest Description

The area has fir towards the upper region and mixed conifer in mid region and Blue Pie towards the lower part of the sub-compartment.

Prescription for Future Management

Lower part of the compartment is prioritized for rural use. As the compartment is near the Thromde boundary, thus some area of the compartment is anticipated to be developed by Dzongkhang, so no commercial logging is prescribed. Thinning is however prescribed in Blue Pine stand for improvement.

Block: Lamaigonpa Compartment: III

Altitude: 2550m-3250m
Aspect: North East
Slope: 10%- 40%
Terrain: Gentle slope throughout
Total area: 272.18ha
Protection: 37.34 ha
Non-production area: 78.98 ha
Production area: 159.19 ha

Forest Description:

The compartment comprises of young blue pine stands with dense stocking. Towards the lower region there is a settlement of Thromde.

Prescription for Future Management

The entire compartment is prioritized for rural use thus single tree selection system is to be applied. Thinning operation is also prescribed for improvement of stand.

Block: Jakar Compartment: I a

Altitude: 2800 m – 3700 m
Aspect: North West
Slope: 25-30 %
Terrain: Gentle slope throughout
Total area: 245.17 ha
Protection: 8.53 ha
Non-production area: 2.45 ha
Production area: 235.75 ha

Forest Description

The area comprises of matured mixed conifer forests towards the upper region and young blue pine stands towards lower region. The historic Kurje Lhakhang falls within this sub-compartment.

Prescription for Future Management

The lower most part of the sub-compartment is kept for rural use. The upper area falls in the proposed commercial forest road. The Group selection system is prescribed with cable line and single tree selection system for rural use.

Block Jakar Compartment: I b

Altitude: 2600 m – 3550 m
Aspect: East
Slope: 0 - 30 %
Terrain: Flat to gentle slope
Total area: 294.04 ha
Protection: 9.88 ha
Non-production area: 25.98 ha
Production area: 260.52 ha

Forest Description

The area comprises of matured mixed conifer forests towards the upper region and young blue pine stands towards lower region.

Prescription for Future Management

The lower part of this sub-compartment set aside for fulfilling rural timber demand. The upper part of sub-compartment is to be extracted for commercial timber. Group Selection system is prescribed for commercial extraction and single tree selection for rural use.

Block: **Jakar** **Compartment: II a**

Altitude: 3000 m – 4050 m
Aspect: North
Slope: 20-100 %
Terrain: very steep towards the upper boundary and gentle in the lower part
Total area: 419.75 ha
Protection: 100.34 ha
Non-production area: 5.57 ha
Production area: 315.61 ha

Forest Description

The area has matured fir mixed with hardwood in the upper region and matures mixed conifer in the lower part of the sub-compartment.

Prescription for Future Management

The sub-compartment has mature stand and is potential for future harvest. The sub-compartment however is not planned for this plan period.

Block: Jakar **Compartment: II b**

Altitude: 2600 m – 3450 m
Aspect: North
Slope: 10-30 %
Terrain: Gentle Slope throughout
Total area: 522.22 ha
Protection: 21.03 ha
Non-production area: 57.88 ha
Production area: 447.54 ha

Forest Description:

The upper part of the sub-compartment has middle-aged blue pine stands and the lower part has the settlement and cultivation. The historic Jampel Lhakhang is in proximity to the sub-compartment.

Prescription for future management

Lower part of this sub-compartment is set aside for fulfilling rural timber demand. The upper portion has been operated for sanitation felling due to fire in 2018. This plan proposed to take road from the current road constructed for sanitation felling. The take off point for proposed 7Km starts in this sub-compartment.

Block: Jakar **Compartment: III a**

Altitude: 3100 m – 3900 m
Aspect: North East
Slope: 30-80 %
Terrain: Steep
Total area: 131 ha
Protection: 94.47 ha
Non-production area: 5.82 ha

Production area: 32.35 ha

Forest Description:

The sub-compartment was bigger than the current area but due to creation of Lamigonpa I the area has been reduced. The area have mixed conifer in the lower part and fir as you move in the higher elevation of the sub-compartment.

Prescription for Future Management

Majority of the area is quite steep thus, not feasible for commercial logging. Most of the area is in protection zone.

Block: Jakar Compartment: III b

Altitude: 2600 m – 3400 m
Aspect: North East
Slope: 0- 30 %
Terrain: Flat at in the lower part and gentle slope throughout.
Total area: 451.54 ha
Protection: 30.44 ha
Non-production area: 97.81 ha
Production area: 335.58 ha

Forest Description

About 40% of this sub-compartment is covered by middle-aged blue pine stands and towards the higher elevation it is covered with mixed conifer forest.

Prescription for Future Management

The lower portion of the area is prioritized for rural use. Since the area is in close proximity with Bumthang Thromde, thus the development activities may expand towards upper side of the sub-compartment.

Block: Zangtherpo Compartment: I a

Altitude: 2900m – 3780m
Aspect: South
Slope: 10-30%
Terrain: Gentle slope
Total area: 221.28 ha
Protection: 11.75 ha

Non-production area: 0.02 ha
Production area: 209.51 ha

Forest Description

The area was mostly covered with middle-aged blue pine stands and mixed conifer in the higher elevation.

Prescription for Future Management

The sub-compartment is not planned for extraction in this plan. Thinning can be done for improvement of Blue Pine stand.

Block: Zangtherpo Compartment: I b

Altitude: 2780m – 3250m
Aspect: South East
Slope: 10-30%
Terrain: Gentle slope throughout the compartment
Total area: 186.21 ha
Protection: 30.2 ha
Non-production area: 31.08 ha
Production area: 128.25 ha

Forest Description

The area was mostly covered with middle-aged blue pine stands. Mixed conifer is found towards higher elevation of the sub-compartment. The area was once clear felled prior to the first previous plan.

Prescription for Future Management

The sub-compartment is not planned for extraction in this plan. Thinning can be done for improvement of Blue Pine stand.

Block: Zangtherpo Compartment: II a

Altitude: 2800m – 3750m
Aspect: South East
Slope: 10-35%
Terrain: Gentle slope throughout
Total area: 199.34 ha
Protection: 8.09 ha
Non-production area: 0.46 ha

Production area: 190.8 ha

Forest Description

Lower area is mostly covered with middle-aged blue pine stand and higher side is covered with matured mixed conifer stand.

Prescription for Future Management

This plan proposed to take road from higher side of this sub-compartment for commercial extraction. Group selection system is prescribed for commercial harvesting.

Block: Zangtherpo Compartment: II b

Altitude: 2630m – 3000m
Aspect: South East
Slope: 5-35%
Terrain: Gentle slope throughout
Total area: 400.72 ha
Protection: 36.07 ha
Non-production area: 92.43 ha
Production area: 285.35 ha

Forest Description

The sub-compartment comprises of young blue pine stands with dense stocking. Mixed conifer is also found in the higher side of the sub-compartment.

Prescription for Future Management

Lower part of sub-compartment is kept aside for rural use. Single tree selection system is prescribed for rural use.

Block: Crongmenpa Compartment: I a

Altitude: 2700 m – 3800 m
Aspect: North East
Slope: 10-40 %
Terrain: Moderate to steep
Total area: 430.19 ha
Protection: 80.58 ha
Non-production area: 59.21 ha
Production area: 294.87 ha

Forest Description

The upper part of the compartment consists of hemlock and spruce, grassland in the middle and blue pine stands at the lower part.

Prescription for Future Management

The area has been operated for commercial harvesting in the first plan period. No commercial or rural harvesting will be allowed.

Block: Crongmenpa Compartment: I b

Altitude: 2700 m – 3800 m
Aspect: North East
Slope: 10-40%
Terrain: Moderate
Total area: 314.2 ha
Protection: 33.9 ha
Non-production area: 32.88 ha
Production area: 249.58 ha

Forest Description

The compartment consists of middle-aged blue pine stands and mixed conifer forest. There are few blank areas in the sub-compartment. Bremungjuk Quarry is located at the edge of the sub-compartment boundary near the road.

Prescription for Future Management

It's recorded that the sub-compartment has been harvested prior to year 2000 during IFDP implementation. No commercial harvesting is prescribed in this sub-compartment.

Block: Crongmenpa Compartment: II

Altitude: 2700 m – 4000 m
Aspect: North East
Slope: 10-30 %
Terrain: Gentle Slope
Total area: 691.48 ha
Protection: 213.63 ha
Non-production area: 3.06 ha
Production area: 474.85 ha

Forest Description

The compartment is forested with mixed conifer in majority and fir covering the upper side of the compartment. The area was operated in first plan period of 2000-2010.

Prescription for Future Management

No extraction is allowed in this area since it has already been operated. Regeneration needs to be monitored.

Block: Crongmenpa Compartment: III

Altitude: 2900 m – 3900 m
Aspect: South East
Slope: 15-25 %
Terrain: Gentle Slope
Total area: 801.42 ha
Protection: 323.2 ha
Non-production area: 37.46 ha
Production area: 449.28 ha

Forest Description

The area has been previously operated for commercial harvesting. The compartment is mostly dominated with mixed conifer forest and on the higher zone it's covered with fir stand. Certain part of the compartment is covered by grassland. The lower end of the compartment reaches near Chuteygang Depot. The lower part is dominated by spruce.

Prescription for Future Management

No commercial harvesting is allowed in this compartment. Regeneration needs to be monitored.

Block: Crongmenpa Compartment: IV

Altitude: 2700 m – 3900 m
Aspect: North
Slope: 15-25 %
Terrain: Gentle slope at the base and steep towards upper boundary
Total area: 799.75 ha
Protection: 217.24 ha
Non-production area: 105.84 ha
Production area: 488.57 ha

Forest Description

The area has fir along with the hardwood like *Betula spp*. towards the upper part of the boundary. The middle part has matured mixed conifer and the lower part has young blue pine stands. Almost 20% of the area is grassland in this compartment. The area was operated in initial years of second plan period.

Prescription for Future Management

No harvesting in this compartment is allowed. Regeneration should be monitored.

Block: Tangzam Compartment: I

Altitude: 3000m – 3580m
Aspect: South East
Slope: 5-35%
Terrain: Gentle slope throughout the compartment
Total area: 416.19 ha
Protection: 146.63 ha
Non-production area: 40.29 ha
Production area: 235.47 ha

Forest Description

The compartment comprises of matured fir at higher ridges and mature mixed conifer at the lower region. Few grasslands in this compartment are still in use by nomadic herders from Chumey.

Prescription for Future Management

In this plan period, harvesting will be carried out in this compartment. The harvesting shall follow group selection system.

Block: Tangzam Compartment: II

Altitude: 2900m – 4000m
Aspect: South East
Slope: 5 – 35%
Terrain: Gentle slope throughout
Total area: 747.6 ha
Protection: 167.45 ha
Non-production area: 75.38 ha
Production area: 519.55 ha

Forest Description

The compartment is mostly under matured fir and mixed conifer forest. There is two patches of grassland in the compartment which is still being used in summer by the herders.

Prescription for Future Management

Half of the compartment was harvested in the previous plan period and in this plan the initial years of harvesting will be carried out in this compartment. Group selection system will be applied.

Block: Tangzam Compartment: III

Altitude: 2800m – 3960m
Aspect: South East
Slope: 5-35%
Terrain: Gentle slope
Total area: 829.17 ha
Protection: 275.28 ha
Non-production area: 49.61 ha
Production area: 515.85 ha

Forest Description

The area comprises matured fir and mixed conifer forests. Towards the lower region there are young spruce stands.

Prescription for Future Management

The area has been operated in the previous plan period 2011-2020. Thus, no harvesting will be carried out. Regeneration monitoring in the area to be carried out.

Block: Tangzam Compartment: IV

Altitude: 2900m – 4300m
Aspect: South
Slope: 15-60%
Terrain: Lower and middle part has gentle slope and the upper part has steep slope.
Total area: 415.9 ha
Protection: 139.95 ha
Non-production area: 326.55 ha
Production area: 231.19 ha

Forest Description:

The upper part of this compartment is dominated by fir forest and the lower part with a few patches of grassland. The compartment in the lower part is predominantly covered with mixed conifer.

Prescription for Future Management:

The lower mixed conifer stand has been affected with Bark Beetle and its spreading. The first two years of this plan should focus on controlling the pest by clear felling the infected trees. The road is also planned bifurcating from the end of existing road.

Block: Nakchela Compartment: I

Altitude: 3200m-4000m
Aspect: North East
Slope: 10-100%
Terrain: Gentle in lower part and steep in upper region
Total area: 586.27 ha
Protection: 350.27 ha
Non-production area: 61.29 ha
Production area: 236 ha

Forest Description

Maximum compartment is covered by matured fir, rhododendron and mixed conifer stands. Almost upper half of the compartment is protected under wildlife protection function for Musk Deer and Red Panda.

Prescription for Future Management

Upper side is protected for wildlife conservation. While the lower part of the compartment has been planned for harvest in this plan. Group selection system to be applied during harvest.

Block: Nakchela Compartment: II

Altitude: 3300m-4000m
Aspect: South East
Slope: 10-60%
Terrain: Gentle slope in lower part and steep towards up
Total area: 631.38 ha
Protection: 468.65 ha
Non-production area: 77.34 ha
Production area: 150.76 ha

Forest Description

Maximum compartment is covered by matured fir, rhododendron and mixed conifer stands. The area is also covered with rocky outcrops and alpine scrub in the higher ridges of the compartment.

Prescription for Future Management

Lower part of the compartment covered with mixed conifer forest is potential for extraction. Thus, in this plan if possible, operation by group selection system is prescribed.

Block: Nakchela Compartment: III-VIII

The compartment from III-VIII of Nakchela Block is not detailed with description and prescription as it's mostly under glacier, protection functions and rocky outcrops. The area was compartmentalized only if incase its feasible for extraction in future management plans.

Block	Compartment	Area description
Nakchela	III	Total area: 478.95 ha Protection: 424.65 ha Non-production area: 107.44 ha Production area: 51.77 ha
	IV	Total area: 326.97 ha Protection: 286.7 ha Non-production area: 47.14 ha Production area: 0 ha
	V	Total area: 255.6 ha Protection: 219.87 ha Non-production area: 37.81 ha Production area: 0 ha
	VI	Total area: 393.83 ha Protection: 361.15 ha Non-production area: 0 ha Production area: 0 ha
	VII	Total area: 684.15 ha Protection: 577.81 ha Non-production area: 271.83 ha Production area: 78.14 ha
	VIII	Total area: 1048.75 ha Protection: 1048.35 ha

		Non-production area: 591.76 ha Production area: 0 ha

ANNEXURE 2: ROAD STANDARDS

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

Road Design

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

- Stabilize and re-vegetate cut and fill slopes with shrubs, grasses and legumes as soon as possible after construction.
- Ensure proper maintenance of roads and enforce road use restrictions during critical weather conditions such as monsoon seasons.

Drainage

- Road planning should ensure that roads are located in such a way as to minimize stream river crossings and avoid areas which are prone to floods during monsoon.
- In areas where side slopes of 70% or greater extend for a distance of 100m 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.
- All culverts must have stone or concrete aprons at their exit points to prevent erosion by water. These aprons should be of suitable width and design to prevent any erosion, taking place and should extend down the slope for at least the length of the spill. They should divert the water back into the stream if the water came from a stream.
- Culverts of appropriate diameter (not less than 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 (m)
4	110
5-8	90
9-10	80
11-15	60

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

Road Construction

- All timbers above 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).

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

ANNEXURE 3: TREE MARKING GUIDELINES

Marking Guidelines for Group Selection System

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

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

Marking guidelines for Single Tree Selection System

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

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

Marking Guidelines for Blue Pine under Seed Tree System

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

Marking Guidelines for Thinning in Blue Pine Stands

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

Spacing and stand Density Regulation

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

Selection of Plus Trees

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

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

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

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

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

Marking for Rural Uses

- It is necessary that the marking for rural use, whether for timber or fuel wood, should be done under standard Silvicultural system.
- Firewood marking, when necessary, should be done under Single Tree Selection System from local use area only.
- Flag posts, fence posts and poles demand should be met by marking for thinning in the pole crop high density stands thereby subjecting the stands to Silvicultural thinning (Weather and Climate Serice Division, 2018) (Wangchuk, 2009).

ANNEXURE 4: Dzongkhag Administrative Approval

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Royal Government of Bhutan
Dzongkhag Administration, Bumthang

"Towards Beautiful Bumthang"

JKD/ENV-06/2020/ 1031

27/10/2020

Dzongkhag Administrative Approval

In exercise of the powers delegated under the National Environment Protection Act, 2007 of the National Environment Comission Secretariat, Section 47, which mandates the Dzongkhag Environment Committee (DEC) as the Competent Authorities in making recommendations to the concerned Ministries, Local Governments and /or the Secretatieat concerning any measures that need to be taken to protect the quality of the Environment. Also, Dzongkhag Administration is mandated to issue the Dzongkhag Administrative approval as per the Section , 3.10 of Application of the Environmental Clearances Guideline, the Dzongkhag Administrative Approval is hereby accorded to **Mr. Pankey Drukpa in favour of Bumthang Forest Division** for the operation of the **Dawathang Forest Management Unit** with the following terms and conditions:

1. The holder shall ensure that this Administrative Approval is valid only for the proposed activity, i.e operation of the Dawathang Forest Management Unit under Chokor Gewog.
2. The holder shall ensure that the proposed activity is in line with the National Environment Protection Act 2007, National Environment Protection Act 2007, Environmental Assessment Act 2000 and its Regulation 2016, Waste Prevention and Management Act of Bhutan 2009 and its Regulation 2016 and The Water Act of Bhutan 2011 and its Regulation 2014;
3. The holder shall ensure that the activity complies with the Environmental Standards 2010;
4. The holder shall ensure that dusts generated during the operation are adequately suppressed;
5. The holder shall ensure that adequate visual impact mitigation works (rehabilitation and landscaping) are carried out at all times;
6. The holder shall ensure that local residents, communities and any religious, cultural, historic and ecologically important sites are not adversely affected by the activity;
7. The holder shall be solely responsible for any disputes arising due to the activity; and
8. This administrative approval is issued based on non-technical assessments . The applicant may process and obtain other approvals/clearances/ aggrements for the proposed activity form concerned authority as per rules in force

Non-compliance of any of the above mentioned conditions shall result in revocation of the Administrative Approval.

(Pasang Dorji)
Chairman
Dzongkhag Environment Committee

CC:

1. Gup, Chokor Gewog, Bumthang for kind information
2. Office Copy

PABX-03631200DZONGDAG-Ext 132 (O) Fax # 03-631806 DZONGRAB-Ext 119 (O) Fax # 03-631461
Website: http://www.bumthang.gov.bt

ANNEXURE 5: Minutes of meeting with Dzongkhang Administration and Thromde

Minutes of Meeting for Dawathang FMU management Plan revision consultation meeting

11th Feb, 2020

Venue: Divisional Conference Hall

CFO warmly welcomes all the stakeholders who are inside the forest management of Dawathang FMU. Further, he humbly thanked Dasho Dzongda for his presence in the consultative meeting amidst his busy schedule.
Prior to the discussion, the stakeholders were made aware of the FMU management plan also the functioning of the FMU through brief presentation by Sonam Tashi, planner. As the management plan will be third after the IFDP operation from 1986-1996.

- 1st Dawathang Forest Management Plan 2000-2010
- 2nd Dawathang Forest Management Plan 2011-2020
- 3rd Proposed Forest Management Plan 2021- 2030

As evolving regulations and developmental activities, it is imperative to consult the stakeholders on the proposed management plan, because the plan will give management prescription which shall restrict and manage it for sustainable forest resources, watershed and biodiversity all together. Furthermore, the consultation is as per the requirement of Forest Management code of Bhutan 2004.

Sl. No.	Discussion	Resolution
1	Dasho Dzongda acknowledged and welcomed the consultation workshop for the FMU management plan revision. He stressed on water source to be protected and given due protection with rules when planning the management plan. Dasho was also aware of the wildlife from the Lamigonpa to kikila and to be well studied and then give appropriate prescription. Dasho fondly requested to mention eco-tourism aspects should there be any. More than the municipal, the developmental activities are observed more in the extended area, thus the exclusion of the area should also include the extended area.	To focus and address on the drinking water source and the watershed area. Municipal Extended area to be excluded in the plan if possible. Wildlife protection need to be given importance in the plan.

	Urban forestry should also need some focus and if possible, can be reflected in the plan. Protection for the drinking water supply should be one of the priorities for the management plan. The division requests for the extended area boundary shapefile to be shared to the planner. There is need to include restriction to fell trees in area where there is water source irrespective of the private land. CFO The division will also study the habitat and movement of wildlife in consultation with the UWICER and then we will try to map the area into wildlife conservation area. Chokhor Gup The plan to address the road maintenance from Dur to the Kurjey area. CFO For road maintenance the NRDCL is also of the opinion that the Bremungjuk quarry need to jointly maintain the road as it is being used by Bremungjuk quarry also. So, we need to discuss together the way forward of who will maintain the road. Dasho Dzongda There is need to discuss the maintenance of the road collectively in a forum to discuss the way forward and responsibility to maintain and use the road.	

ANNEXURE 6: Gewog administrative clearance

Dawathang FMU plan revision: Road Planning Consultation Meeting with Gewog Administration and NRDCL

Minutes of the Meeting 14/10/2020

Discussion

CFO cordially Welcomed the all the participants present for the Dawathang FMU plan revision: road planning consultation meeting.

The divisional Planner presented on the current scenario and how the new road for the coming plan will be. The road engineer from NRDCL has also detailed out how EIA for the road will be carried out.

The Gewog Administration shared his concern regarding the road maintenance. And there will be not much issues regarding the extraction of the timber however, the NRDCL need to maintain the road. Currently there is also complains from the public regarding the road that is damaged by the transportation of the timber from Dhur site. Moreover, he budget amount that was allocated for the Dhur area is not enough and there is need of additional amount.

The NRDCL engineer assured that that the road maintained will be estimated and incorporated in the annual plan.

The Gup emphasized on the road maintenance than any other pressing issues as it cause major inconvenience to the public, however, it will also benefit the Norgang community as road will improve if NRDCL assures to maintain.

The NRDCL counterpart reassured that the road will be maintained as it is exclusively used for the extraction of the timber which is different than the Dhur which the road is used both by the public as well as the quarry transportation.

The NRDCL engineer also agrees that there is issues in the road till Dhur as it was evident of the current visit. There is no timber operation right now so it's obviously the damaged is by the quarry. The Production In-charge, said that the NRDCL region will discuss with the quarry proprietor to jointly maintain the road.

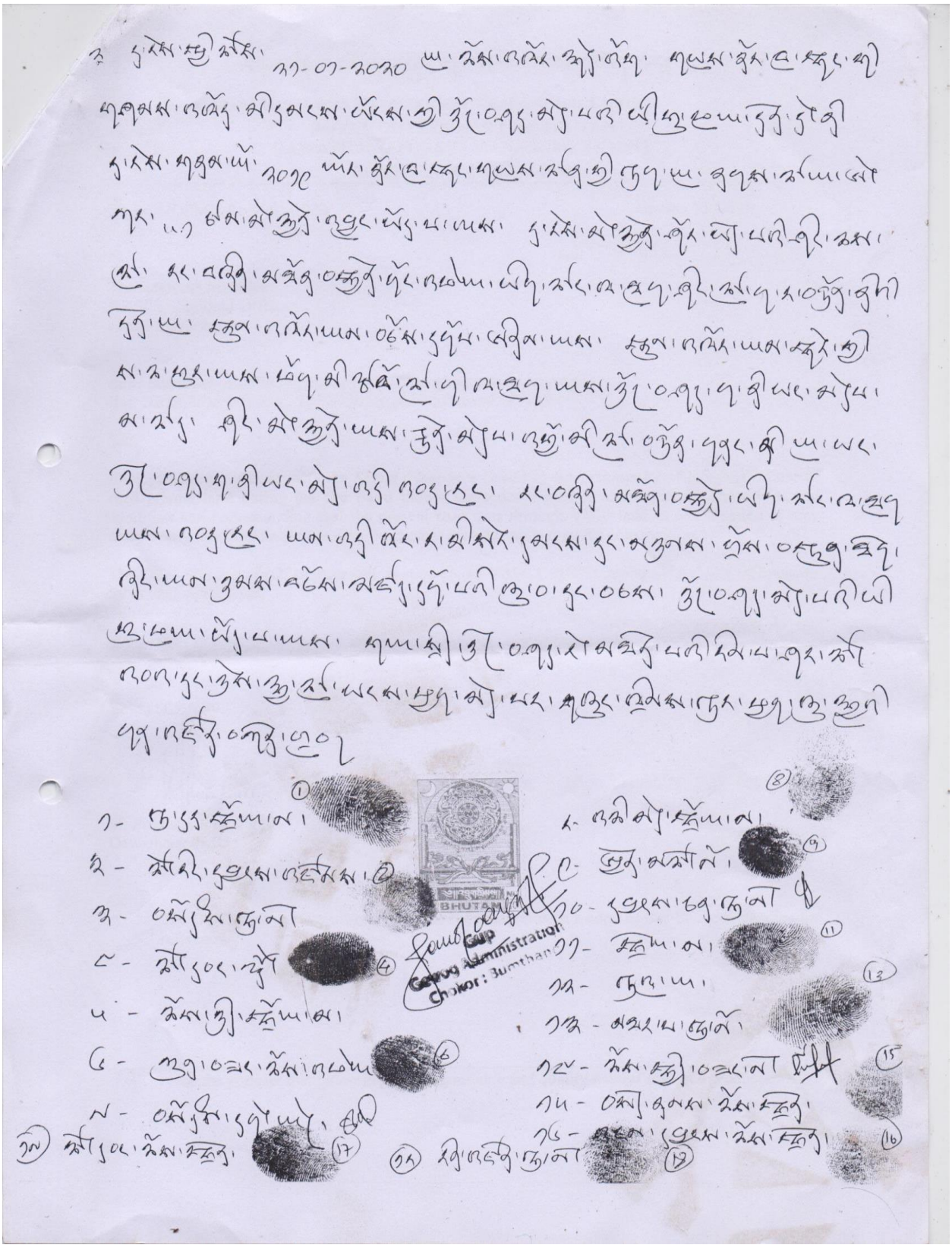
The Gewog Administration also states that it will be imperative to maintain the road at least till the Menchugang. Similarly, the road till Norgang village will need more maintenance and concern form NRDCL side.The PI assured that the road will be maintained from the Gewog office till the Menchugang before the NRDCL financial closing jointly with the Quarry owner.

Resolution

1. There is not much issue from the Gewog Administration and will not be from public unless the road is maintained and it's pliable for the public when the extraction will take place from Norgang.
2. The NRDCL assured that road maintenance from Jambay Lhakhang till the Norgang village which is around 1.2 Km will be diligently maintained with base course and proper drainage.
3. The Gewog assures to issue Gewog clearance for the forest road construction from Norgang to Rabtentse.

Nidup Dorji (JE)
Namgay Dorji
14/10/20
Mangmi (Chokhor Gewog)
Sr. PI
Chief Forest Officer
Bumthang Forest Division
Bumthang
NIC, SPMU
Fo
Sonam Tashi

ANNEXURE 7: Minutes of the Gewog public consultation meeting



ANNEXURE 8: Consultation with Ugyen Wangchuck Institute for Conservation and Research

Minutes of the consultative meeting UWICER for Dawathang FMU Plan revision

Venue: UWICER hall
Date: 5th August, 2020

Background

The purpose of the consultation meeting was based on the proposal from UWICER to exclude UWICER research area from Dawathang Forest Management plan. The Bumthang Forest Division has forwarded the proposal to FRMD which the department responded with the reasons not to have multiple management regimes under one area and also not to set precedence over proposal received from others which have reached to the department. The consultation was done in consideration of department's directive as well as to find way to accommodate both objectives of research purpose and rural use. The consultation meeting was done between UWICER management and Bumthang Forest Division's Chief and FMU planner.

Discussions

The consultation meeting began with the opening remark from Director, UWICER on importance of the consultation. Subsequently, the historical background on the UWICER proposal was presented to the forum by Rinchen Namgay, Sr. Forestry Officer.

In the presentation, historically there was a map with compartmentalization done with utilization being kept at North and South of the institute. The historical map comprises of 1071ha, which in the same area UWICER has been carrying out research till date. The presentation also highlighted on the importance of water sources which the institute have carried out detailed mapping.

During the discussion, some the officials from UWICERS has an opinion that it could have been better if the area is designated as different management regime as research preserve. In that way, they can manage and protect the area based on the need of research.

One important aspect was discussed, which was regarding protection of water source originating in the area which is supplied as drinking water to almost all the down town settlements by the municipality. The UWICER management stresses the need of protection not only particular stream but whole catchment area.

Researchers of the institute also emphasized to how important the area is as wildlife habitat. As they did camera trapping which showed numerous wildlife sightings including the elusive Royal Bengal Tiger. The institute testified with scientific paper on Mammal diversity in montane forest of central Bhutan and other research which are currently undergoing.

Resolution

1. The Bumthang Forest Division assured to consult with FRMD to designate the UWICER research area into different function.
2. The Lamigonpa area to be designated as different Block and Compartments. Which the compartment adjacent to UWICER research area can be assigned different function as per the FMCB 2004.
3. There will be no commercial harvesting from the UWICER proposed area of 502 ha which will be kept for research and protection of drinking water source of Bumthang Thromde.

Participant list:

1. Shacha Dorji, Director, UWICER.
2. Pankey Drukpa, CFO, Bumthang Forest Division.
3. Sherub, Specialist, UWICER.
4. Kado Tshering, Specialist, UWICER.
5. Sangay, PCFO, UWICER.
6. Dhendup Tshering, Dy CFO, UWICER.
7. Rinchen Wangchuck, Sr. FO, UWICER
8. Rinchen Namgay, Sr. FO, UWICER
9. Tashi Dhendup, Sr. FO, UWICER
10. Karma Tenzin, Sr. FO, UWICER.
11. Kinley Choden, Sr. EO, UWICER.
12. Kuenga Thinley, Ranger, UWICER.
13. Sangay Pelzang, IT Officer, UWICER.

Minute Keeper:

Sonam Tashi
FO(Planner) Bumthang Forest Division

ANNEXURE 9: Area Revision of Protected Area

དཔལ་ལྡན་འབྲུག་གཞུང་། ས་ནམ་དང་ནགས་ཚལ་ལྷན་ཐབས། ནགས་ཚལ་དང་གླང་ཀ་ཞབས་ཏོག་ལས་ཁུངས།

Royal Government of Bhutan
Ministry of Agriculture and Forests
Department of Forests and Park Services

DIRECTOR

DoFPS/NCD/PAS-01/2020-21/ 0808 3rd August 2020

The Director,
Department of Survey and Mapping,
National Land Commission Secretariat,
Thimphu

Subject: Deposting of data of the revised protected areas system

Dear Sir,

The Department of Forests and Park Services would like to kindly inform the NLCS that we undertook an inhouse review and refinement of our Protected Areas boundaries for the last one year. This exercise was felt needed since the current protected areas were designed in the early 1990s and with the limited technology available during that time there seems to be lots of variations on the boundaries on the ground.

Using the latest GIS technology, we have refined the boundaries of the protected areas (5 National Parks, 4 Wildlife Sanctuaries, 1 Strict Nature Reserve and 8 biological corridors) to physically follow identifiable natural features like rivers, streams, gullies and ridges.

We would like to state here that the overall coverage of the PA system after this refinement exercise remains the same at 51.44% of the country's geographical area.

Sincerely,

(Lobzang Dorji)

Copy:

1. Hon'ble Lyonpo, MoAF for kind information
2. Hon'ble Secretary, MoAF for kind information
3. Chief Forestry Officers of DoFPS for information and necessary action

Post Box. No. 1345 Phone: 975 (02) 323055/321185/322487, EPABX: 334458/334487 Fax: 322395/322836 Hot line: 211 website: www.dofps.gov.bt

ANNEXURE 10: Environmental Impact Assessment Report of Proposed Forest Road

ENVIRONMENTAL IMPACT ASSESSMENT REPORT FOR CONSTRUCTION OF FOREST ROAD AT DAWATHANG FMU UNDER JAKAR REGION

1 Name of the applicant : Natural Resources Development Corporation Limited

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. Nidup Dorji, Jr. Engineer, Forest Resource Division, NRDCL HQ, Thimphu. Tel. no. 02-323834/323868. Email: nidup.dorji@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. 38,500,000.00

8 Project description

8.1 Project location 1 : Continuation from existing forest road.

Project location 2 : Continuation from norgang farm road

Table 1: Road location details by Dzongkhag and Geog

Road chainage		Dzongkhag	Gewog	Town	Village
From	To				
0+0000	2000+0000	Bumthang	Choekhor		Nil
0+0000	2500+0000	Bumthang	Choekhor		Nil
0+0000	7000+0000	Bumthang	Choekhor		Norgang

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)	cum	14,454.96
Volume of excavated material		
a) Excavation in soil all type	cum	77,235.56
b) Excavation in rock all type	cum	35,218.43
Average road gradient	%	±9
Maximum road gradient	%	±12
Cross drain	no	NIL
Box/Hume pipe culvert	no	39
V-shaped side drain diamensions		
In soil (horizontal x vertical)	cm	40CM X 30 Cm
In rock (horizontal x vertical)	cm	30 CM X 20 CM
Total length of v-shaped drain	m	10,883.00
Box shaped side drain diamensions (lengthxbreadthxheight)	cm	NIL
Total length of box drain	m	NIL

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

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

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

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

9 Alternatives : NIL

10 Public Consultation : Public consultation meeting conducted

11 Project site Physical Environmental details

11.1 Topography and Geology

Table 3: Topography and observations along the road

Chainage(Km 0+000)		Distance (m)	Side slope (%)	Observation on geology & possible problem	Method of slope & terrain stabilization Above & Below road
From	To				
0 + 000	0 + 2000	2,000.00	10 -120	Paro formation & no problem foreseen	Normal Bio-engineering + Retaining & Breast wall structure works wherever required.
1 + 000	0 + 2500	2,500.00	11 -120	Paro formation & no problem foreseen	Normal Bio-engineering + Retaining & Breast wall structure works wherever required.
0 + 000	0 + 7000	7,000.00	10 -120	Paro formation & no problem foreseen	Normal Bio-engineering + Retaining & Breast wall structure works wherever required.
Total		**11,500.00**			

11.2 Water Course Crossings

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

Hume pipe required for the road to Nakchela

Chainage at which road crosses water course	Name of water course	Type of crossing	If bridge, Length of bridge (m)	Down stream water users- details		
				Name of community or individual	House hold (no)	Type of use
0+000 + 0+023	NA	Hume pipe culvert	NIL	None	None	None
0+023 + 0+048	NA	Hume pipe culvert	NIL			
0+048 + 0+ 568	NA	Hume pipe culvert	NIL			
0+568 + 0+729	NA	Hume pipe culvert	NIL			
0+729 + 1+235	NA	Hume pipe culvert	NIL			
1+235 + 1+679	NA	Hume pipe culvert	NIL			
1+679 + 2+000	NA	Hume pipe culvert	NIL			

Hume pipe required for the road to bark beetle area

Chainage at which road crosses water course	Name of water course	Type of crossing	If bridge, Length of bridge (m)	Down stream water users- details		
				Name of community or individual	House hold (no)	Type of use
0+000 + 0+048	N A	Hume pipe culvert	NIL	None	None	None
0+048 + 0+0350	N A	Hume pipe culvert	NIL			
0+0350 + 1+067	NA	Hume pipe culvert	NIL			
1+067 + 1+435	NA	Hume pipe culvert	NIL			
1+435 + 1+451	NA	Hume pipe culvert	NIL			
1+451 + 1+ 698	NA	Hume pipe culvert	NIL			
1+698 + 2+356	NA	Hume pipe culvert	NIL			
2+698 + 2+500	NA	Hume pipe culvert	NIL			

Hume pipe required for road at norgang

Chainage at which road crosses water course	Name of water course	Type of crossing	If bridge, Length of bridge (m)	Down stream water users- details		
				Name of community or individual	House hold (no)	Type of use
0+000 + 0+006	N A	Hume pipe culvert	NIL	None	None	None
0+006 + 0+015	N A	Hume pipe culvert	NIL			
0+015 + 0+068	NA	Hume pipe culvert	NIL			
0+068 + 0+317	NA	Hume pipe culvert	NIL			
0+317 + 0+335	NA	Hume pipe culvert	NIL			
0+335 + 0+412	NA	Hume pipe culvert	NIL			
0+412 + 0+523	NA	Hume pipe culvert	NIL			
0+523 + 0+796	NA	Hume pipe culvert	NIL			
0+796 + 1+223	NA	Hume pipe culvert	NIL			
1+223 + 1+453	NA	Hume pipe culvert	NIL			
1+453 + 1+621	NA	Hume pipe culvert	NIL			
1+621 + 1+969	NA	Hume pipe culvert	NIL			

1+969 + 2+019	NA	Hume pipe culvert	NIL	None	None	None
2+019 + 2+087	NA	Hume pipe culvert	NIL			
2+087 + 2+225	NA	Hume pipe culvert	NIL			
2+225 + 2+598	NA	Hume pipe culvert	NIL			
2+598 + 3+732	NA	Hume pipe culvert	NIL			
3+732 + 4+812	NA	Hume pipe culvert	NIL			
4+812 + 4+517	NA	Hume pipe culvert	NIL			
4+517 + 5+912	NA	Hume pipe culvert	NIL			
5+912 + 6+324	NA	Hume pipe culvert	NIL			
6+324 + 6+858	NA	Hume pipe culvert	NIL			
6+585 + 6+836	NA	Hume pipe culvert	NIL			
6+836 + 7+000	NA	Hume pipe culvert	NIL			

2 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	11 + 000	Mixed conifer forest	110,000.00	10 years	NIL

Table 6: Areas Required for Project Facilities

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

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

3 Project social environment

13.1. Population

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

Dzongkhag	Gewog	Households (No)
Bumthang	Choekhor	29

Source of information: As per the villager of Norgang

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

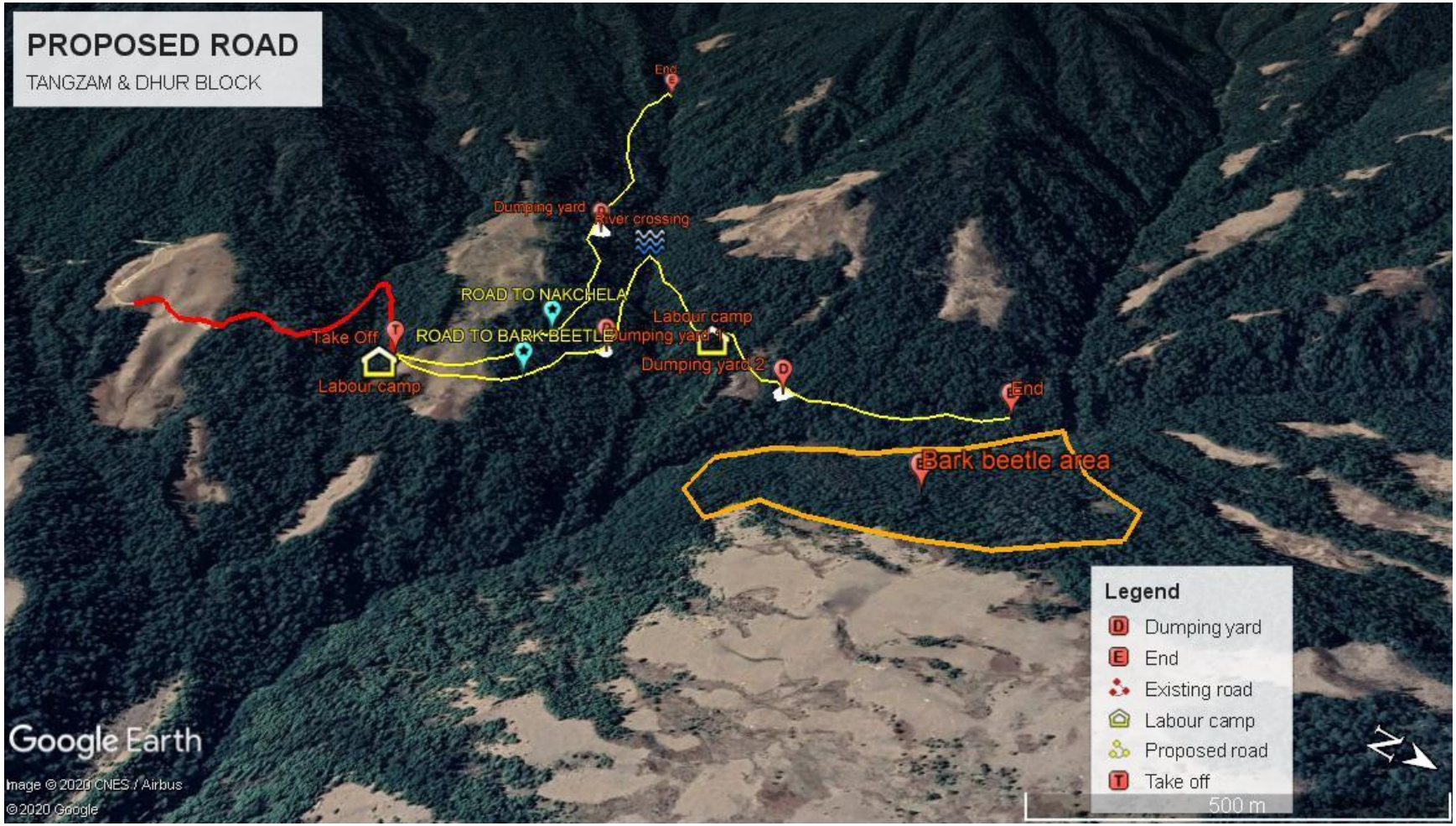
Monitoring of the construction works will be done by Site supervisor, Dawathang unit, NRDCL, including time to time monitoring by the Unit Manager, Dawathang Unit under Jakar Regional Office, Bumthang. The Regional Manager, Jakar Regional Office, NRDCL Bumthang, shall also carry out the frequent monitoring.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

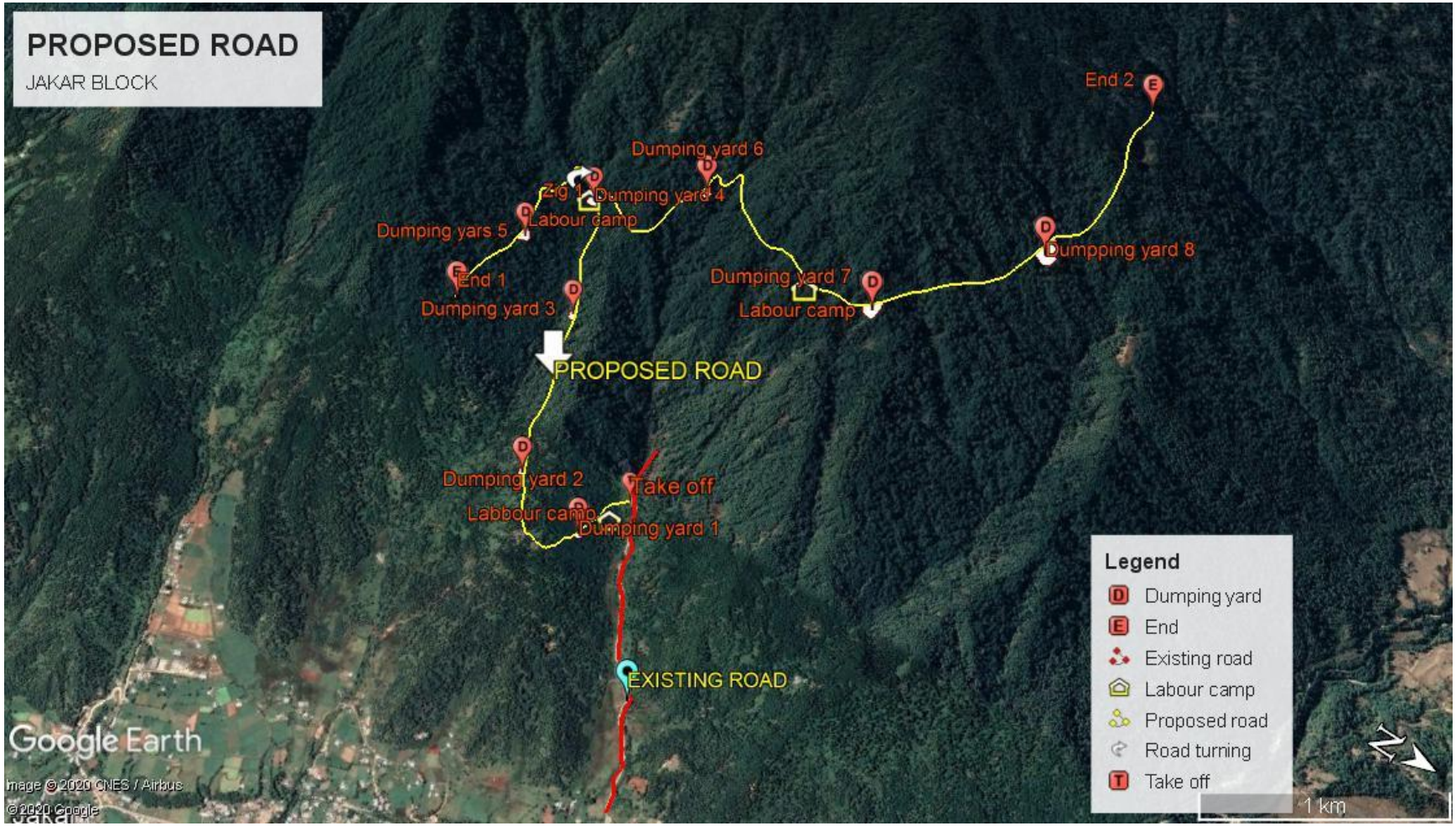
(Nidup Dorji)
Junior Civil Engineer
Forest Resource Division, NRDCL,HO

ENVIRONMENTAL MANAGEMENT PLAN FOR THE CONSTRUCTION OF ROAD AT DAWATHANG FMU

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 tea
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 tea
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 tea

(Nidup Dorji)
Jr. Civil Engineer
Forest Resource Division, NRDCL HO


PROPOSED ROAD
TANGZAM & DHUR BLOCK
End
Dumping yard
River crossing
ROAD TO NAKCHELA
Labour camp
Take Off
ROAD TO BARK BEETLE
Dumping yard 1
Dumping yard 2
Labour camp
End
Bark beetle area
Legend
Dumping yard
End
Existing road
Labour camp
Proposed road
Take off
500 m
Google Earth
Image © 2020 CNES / Airbus
©2020 Google


PROPOSED ROAD
JAKAR BLOCK
End 2
Dumping yard 6
Dumping yard 4
Labour camp
Dumping yars 5
End 1
Dumping yard 3
Dumpping yard 8
Dumping yard 7
Labour camp
PROPOSED ROAD
Dumping yard 2
Take off
Labbour camp
Dumping yard 1
EXISTING ROAD
Legend
Dumping yard
End
Existing road
Labour camp
Proposed road
Road turning
Take off
1 km
Google Earth
Image © 2020 CNES / Airbus
© 2020 Google

ANNEXURE 11: SURVIVAL PERCENT OF PAST PLANTATION ASSESSMENT

Plantation Monitoring and Evaluation (Survival Assessment) form

Sl. #	Division	Location Name	Gewog	Type of plantation	Area (ha)	Year of creation	No. of live seedlings counted			Overall survival %	Date of assessment	Remarks
							Plot-1	Plot-2	Plot-3			
1	Bumthang	Crongmanma block, Dawathang	Chokhor	Mixed	1	2014	615	625	-	77.50	8.9.2020	
2	-Do-	Crongmanma block, Dawathang	Chokhor	Mixed	1	2015	595	495	-	68.13	8.9.2020	
3	-Do-	Tangzam block, Dawathang	Chokhor	Mixed	1	2016	575	585	-	72.50	8.9.2020	
4	-Do-	Tangzam block, Dawathang	Chokhor	Mixed	1	2017	595	605	-	75.00	8.9.2020	
r	-Do-	Tangzam block, Dawathang	Chokhor	Mixed	1	2018	1090	-	-	68.13	8.9.2020	Threwa
5	-Do-	Crongmanma block, Dawathang	Chokhor	Mixed	1	2019	1005	-	-	62.81	8.9.2020	Threwa

General Remarks

The overall survival rate is found satisfacttory & some areas the plantation is damaged by cattles due to absence of barbed wire fencing.
Browse d & uprooted by Wild boars in some areas.
Monitoring & Evaluation Member

Gyelwang Phuntsho
Unit Incharge

Chador Zangmo
Sr. Forester

Karma Dhendup
Sr. Production Incharge

Kinzang Dorji
Dy. PI

Ugyen
Sr. EA

ANNEXURE 12: RECORD KEEPING FORMS

Compartment Record Sheet

Block: ……

Compartment: …….

Sub-compartment: ……..

Year	Harvesting		Tending		Planting		Others	Remarks
	Area (ha)	Volume (m^3)	Area (ha)	Volume (m^3)	Area (ha)	Species		
2018								
2019								
2020								
2021								
2022								
2023								
2024								
2025								
2026								
2027								
2028								

Rural Allotment

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

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

Commercial Allotment

Block: ……
Compartment: ……
Sub-compartment: ……

MC	WC	Year of Activity	Commercial Activities					Volume (m^3)				Other Activities	TMB No.	Comments (Include detailed description of cable line location in relation to mappable features)
			Cable Lines			Groups/ Patches/ Other		Marked		Extracted (NRDCL)	Firewood (lops/ tops)			
			Line No.	Length (m)	Azimuth	Total No.	Total Area (ha)	No. of Trees	Vol.					

Stand Tending and Regeneration[8]

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

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

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

Dawathang FMU Inventory Crew (2020)

5th March 2020