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

MANAGEMENT PLAN
FOR
KHOTOKHA FOREST MANAGEMENT UNIT

WANGDUE DZONGKHAG

(1st January 2020 to 31st December, 2029)

Plan Prepared by:

Tshering Choden (Forestry Officer, Wangdue Division)
Tashi Norbu Waiba (Sr. Forestry Officer, FRMD)
Lhab Tshering (Forestry Officer, FRMD)
October 2019

AUTHORITY FOR PREPARATION, REVISION AND APPROVAL

PERIOD OF THE PLAN

This Plan is valid for the period of 10 years from **1 January 2020 to 31 December 2029**

AUTHORITY FOR PREPARATION, REVIEW AND APPROVAL

The authority for preparation of Forest Management Plan for Forest Management Unit has been delegated to Territorial Divisions by the Department of Forests and Park Services, Ministry of Agriculture and Forests, Royal Government of Bhutan, vide No. FRMD/MPS/1(e)/2014-2015/701 dated December 1, 2014.

PROVISION FOR REVISIONS AND CHANGES

This Forest Management Plan may be revised during the plan period when it is in effect. If major changes occur in the Forest Management Unit or if new information becomes available that may have significant implication on the effective implementation of the plan sustainably, the Director , DoFPS has the authority to revise and approve the plan. The CFO, Territorial Division , Wangdue, may be advised 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 proposed plan has been reviewed by FRMD and was furthered reviewed and technically cleared by the Technical Advisory Committee of the DoFPS. An environmental clearance was obtained from the Secretariat of the National Environment Commission. It was then submitted to the Director, Department of Forest and Park Services (DoFPS), who, after further review and amendments, forwarded with his recommendation for approval to the Secretary, Ministry of Agriculture and Forests. The Secretary, MoAF, further reviewed and submitted the plan to the Minister, Ministry of Agriculture and Forests 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
Date:.....

Recommended for Approval:

Secretary
Ministry of Agriculture and Forests
Date:.....

APPROVED

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

ACKNOWLEDGEMENT

This Management Plan would not have been materialized without the kind support and assistance of so many individuals and organizations. I would like to extend my sincere gratitude to the CFO, Territorial Forest Office, Wangdue for extending every possible support for successful completion of the Plan writing.

The planner is greatly indebted to the officials of FRMD for providing their invaluable guidance, comments and suggestions throughout the plan writing process. Thanks to the team from FRMD who trained our field staffs for carrying out forest inventory and who assisted and guided us during the field inventory. I would like to specially thank Mr. Arun Rai, Dy. CFO and Mr. Dawa Zangpo, Sr. FO, FRMD for their valuable comments and technical assistance during the preparations of forest functions maps.

Also would like to thank GEF_LDCF for the financial support rendered for preparation of this Management Plan without which it would have been very difficult to carry out field works.

My deepest gratitude and appreciation to the entire field staff of Territorial Division who actively participated in a month long strenuous and effortful forest inventory. With the help of inventory team the collection of reliable information and data that are crucial for proper and accurate planning was made possible. I would also express a heartfelt gratitude to the Unit staffs (both Territorial and NRDCL counterpart) of Khotokha Forest Management Unit for their endless support, kind and understanding spirit during socio-economic surveys and data collection process.

My thanks also goes to the Local Government Officials of Bjena and Rubeisa Gewog, and also the local communities residing within the FMU for their contribution and participation in socio-economic surveys and consultation meeting while writing this plan.

Finally, my thanks go to all the people who have supported me to complete the plan writing successfully directly or indirectly.

LIST OF ABBREVIATIONS

%	Percentage
AAC	Annual Allowable Cut
CFO	Chief Forest Officer
Cm	Centimetre
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
FMCB	Forest Management Code of Bhutan
FNCA 1995	Forest and Nature Conservation Act 1995
FNCRR 2017	Forest and Nature Conservation Rules and Regulations 2017
FRMD	Forest Resources Management Division
GIS	Geographic Information System
Ha	Hectare
Km	Kilometer
KFMU	Khotokha Forest Management Unit
M	Meter
m^3	Cubic meter
masl	Meter Above Sea Level
MC	Mixed Conifer
MoAF	Ministry of Agriculture and Forests
NRDCL	Natural Resources Development Corporation Limited
Nu	Ngultrum
NWFP	Non-wood Forest Products
OPs	Operational Plans
RGoB	Royal Government of Bhutan
RM	Regional Manager
RME	Reliable Minimum Estimate
RNR	Renewable Natural Resources
SFED	Social Forestry & Extension Division
sp(p)	Species (pl)
SRF	State Reserve Forests
TD	Territorial Division
TFDP	Third Forestry Development Project
TMB	Tree Marking Book
UIC	Unit In-charge

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

NECS/EACD/DZO-W/PHODRANG/3818/2020/५१४१ **March 26, 2020**

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 fourth phase of the Khotokha Forest Management Unit (FMU) along with the construction of 8.6 km forest road and operation of ropeways in the state reserve forest measuring 9,281.027 hectares at Ruebisa and Bjena Gewog under Wangdue Phodrang Dzongkhag with the following terms and conditions:

I. General

The holder shall:

1. comply with provisions of the National Environment Protection Act 2007, Environmental Assessment Act 2000 and its Regulation 2016, Waste Prevention & Management Act of Bhutan 2009 and its Regulation 2012 (Amendment 2016), The Water Act of Bhutan 2011 and its Regulation;
2. ensure that the operation and management of FMU is in line with Initial Environment Examination document and Forest Management Plan submitted for EC;
3. ensure that Annual Allowable Cut (AAC) is fixed to 9800 m^3 (Nine Thousand and Eight Hundred Cubic Meter);
4. ensure that no extraction of timber is carried out in 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 management of FMU;
6. restore the damage to any public or private properties caused by the operation and management of FMU;
7. inform NECS and any other relevant authorities of any unanticipated or unforeseen chance-find of any precious metals or minerals or articles, that have economic, cultural, religious, archeological, and/or ecological importance;
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; and
9. ensure that a copy of the EC is maintained at the project site at all times.

II. Environmental standards

The holder shall comply with the Environmental Standards 2010.

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

III. Import and use of ODS

The holder shall not use Ozone Depleting Substances as per the Revised Regulation on the Control of ODS 2008.

IV. Protection and management of water resources

The holder shall:

1. ensure that operation and management of FMU does not disrupt the water flow and pollute the water bodies; and
2. ensure that a buffer zone of 100 meters is maintained from the major rivers and local drinking water sources and a buffer zone of 30 meters is maintained from the all the streams and springs present within the FMU.

V. Waste prevention and management

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

VI. Management of excavated materials and run-off

The holder shall:

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

VII. 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.

VIII. 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 information on the generation of wastes on a monthly basis and submit report to NECS annually.

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 herewith; and

2. obtain prior approval from NECS for any modification to the existing proposal/application.

Reservation

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

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

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

Validity:

This EC is issued with validity from **March 26, 2020** till **March 11, 2025** only for the operation of the Khotokha FMU with AAC of 9800 m^3 along with the construction of 8.6 kms forest road and operations of ropeways.

(Thinley Dorji)
Offtg. DIRECTOR

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

Copy to;

1. The Dzongkhag Environment Officer, Wangdue Phodrang, for kind information and necessary compliance monitoring; and
2. Guard File (3818/2020) EACD, NECS for record.

NATIONAL ENVIRONMENT COMMISSION : THIMPHU : BHUTAN

EXECUTIVE SUMMARY

Khotokha Forest Management Unit was established in 1984. This is the Fourth Management Plan for Khotokha Forest Management Unit. The Plan is prepared according to the standard format and structure 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

- Khotokha FMU falls under two Gewogs, namely Bjena and Rubeisa Gewog under Wangduephodrang Dzongkhag. It lies between 90°15'5" to 90°32'20" East longitude and 27° 26'5" to 27°32'20" North latitude. The total area of the FMU has been reduced to 9,281.027 ha after removing Khotokha Ramsar (126.586 ha) from within the FMU.

- Khotokha FMU has a broad valley in the middle with the bounding hills rising in moderate slopes with occasional steep areas in some parts. The elevation of the KFMU ranges from 2,300 meters at the valley bottom to 3,800 meters at the ridge top. The rainfall is typical monsoon type. The month of June, July and August receive the highest amount of rainfall. It receives snowfall in the months of January and February. KFMU covers the water catchment of Paza chu.

- Khotokha is the traditional grazing ground for the people of Bjena and Ruebisa Gewogs. The people living in these valleys are drawn from different households and different villages in the lowland. Most of the people migrate seasonally and maintain two homes; a summer home in uplands (fallng within KFMU) and a winter home in the low lands (outskirts of KFMU boundary). There are 19 hamlets and 111 households falling within the FMU boundary. The total population of FMU is 671 (as per the socio-economic survey).

- Forest in Khotokha FMU are broadly divided into three types; Mixed Conifer, Blue pine and Mixed Broadleaf. Mixed Conifer occurs throughout the FMU comprising of Hemlock, Fir and Spruce. While Blue pine (mature and immature

stands) occupies the mid-elevation zone and occurs in the drier inner valleys on the south-eastern slope. Broadleaf are found to occur in southern part of the management unit along Paza Chhu. Luxuriant growth of rhododendrons, other shrubs and herbs e.g. Primula species are commonly found in the understorey promoted by the humid environment.

The AAC of the last Management Plan have been set at 9,400 m^3, including 1,900 m^3 standing volume for local use. The total commercial timber harvested for the last 10 years is 72,824.558m^3 and rural volume is 16,748.27m^3 (record as of August 2019) in Standing Volume. This shows that commercial extraction is undercut by 2,175.442$m^3$and rural extraction is undercut by 2,251.73$m^3$of total AAC for ten years.

- A total of 50.5 km of forest road have been constructed in FMU during the last three Plan periods. The road network has immensely benefitted the local people residing within the FMU.

PART 2: FUTURE MANAGEMENT

- The overall goal of Khotokha FMU is to ***"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".***

- Khotokha FMU has been organized into Management Circles and Working Circles. Three Management Circles have been identified viz.*Protection, Production* and *Non-Production* including *Non Wood Forest produce (overlapping)* with all other Management Circles. Production Management Circle have been further divided into three Working Circles; Blue Pine Working Circle, Mixed Conifer and Mixed Broadleaf Working Circle.

- FMU is divided into Blocks to facilitate better management of the forestry activities that will be implemented once the Plan is adopted. The need for compartment was not felt and therefore, the area is maintained till division of Blocks. There are five blocks in KFMU namely Dolangdo, Subesa, Kekephu, Sele and Chibegang.

- Production Management Circle has been divided into three working circles: Blue Pine, Mixed Conifer and Mixed Broadleaf working circle for this plan period.

- Based on the inventory data and net operable forest area available, the Annual Allowable Cut (AAC) for this plan period has been fixed at 9800 m^3 in standing volume per year.

- Out of 9800 m^3, a total of 7,900 m^3 standing volume is allocated for commercial harvesting by NRDCL and remaining 1,900 m^3 is kept aside for rural allotment.

- The prescribed Silvicultural System for the commercial harvesting is the Group Selection System with natural regeneration in Mixed Conifer Working Circle and Seed Tree System in Blue Pine Working Circle. Mixed broadleaf Working Circle will be worked under Patch-cut System. For local use area, single tree selection system will be used.

- The Environmental Impact Assessment was carried out in collaboration with the NRDCL, the Divisional Forest Office, Wangdue based on the Sectorial guidelines prepared by NEC for Forestry activities and for Roads. A road of 8.6 kms will be constructed in the FMU to support transportation. 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, Wangdue, Unit In-charge of KFMU and other support staff will form the implementing agency. All activities such as determination of cutting cycles, annual coupes, harvesting, reforestation, and road construction etc. will be executed as per the plan prescriptions only.
- A rolling biennial Operational Plan will be prepared by the Unit In-charge in consultation with the CFO, Wangdue and NRDCL counterpart to facilitate the timely implementation of this management plan. Record keeping and Monitoring will be done by the CFO on annual basis as per the format.
- FMU-level Management Committee chaired by CFO, Wangdue 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, Wangdue Division 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.

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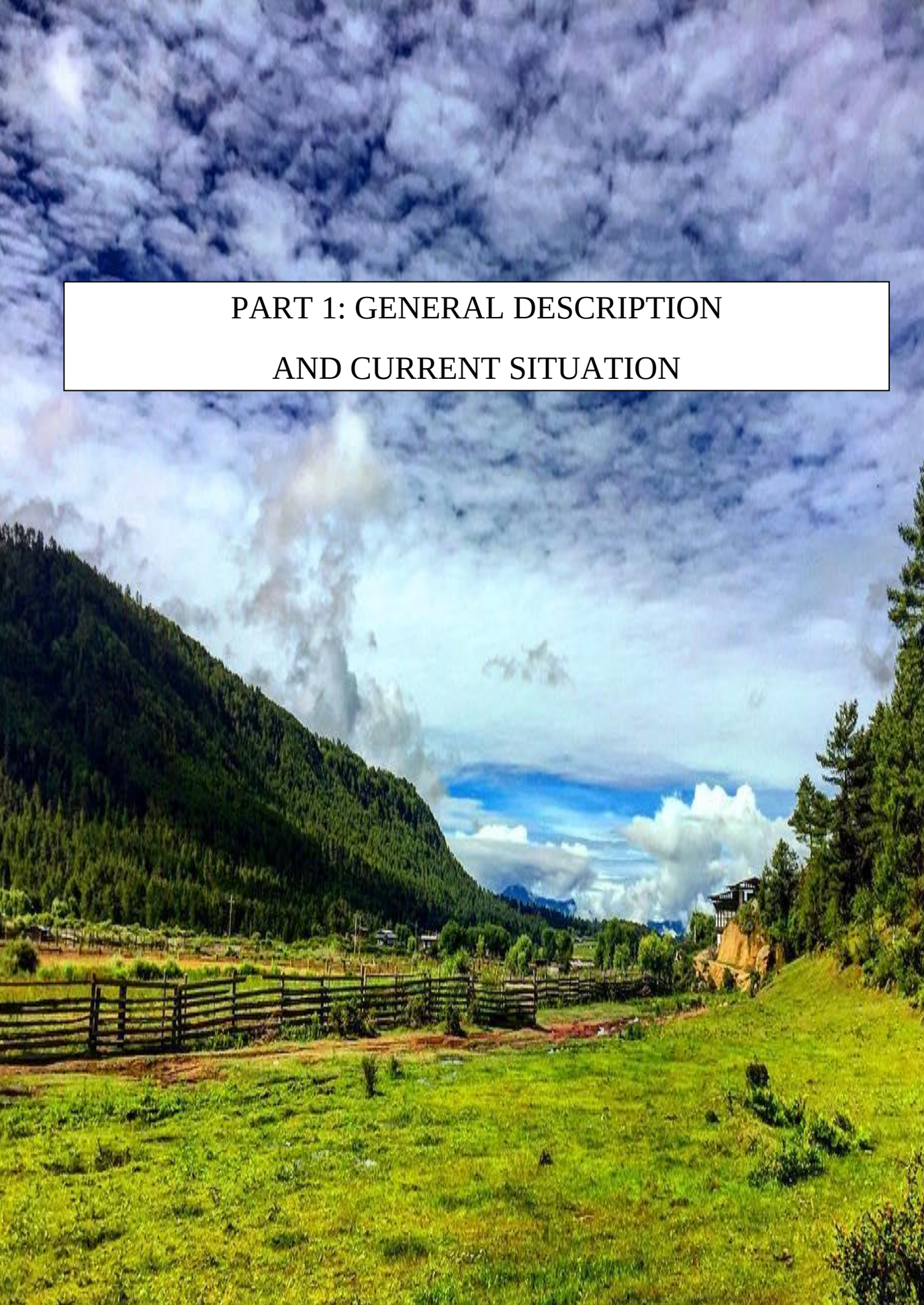
PART 1: GENERAL DESCRIPTION AND CURRENT SITUATION



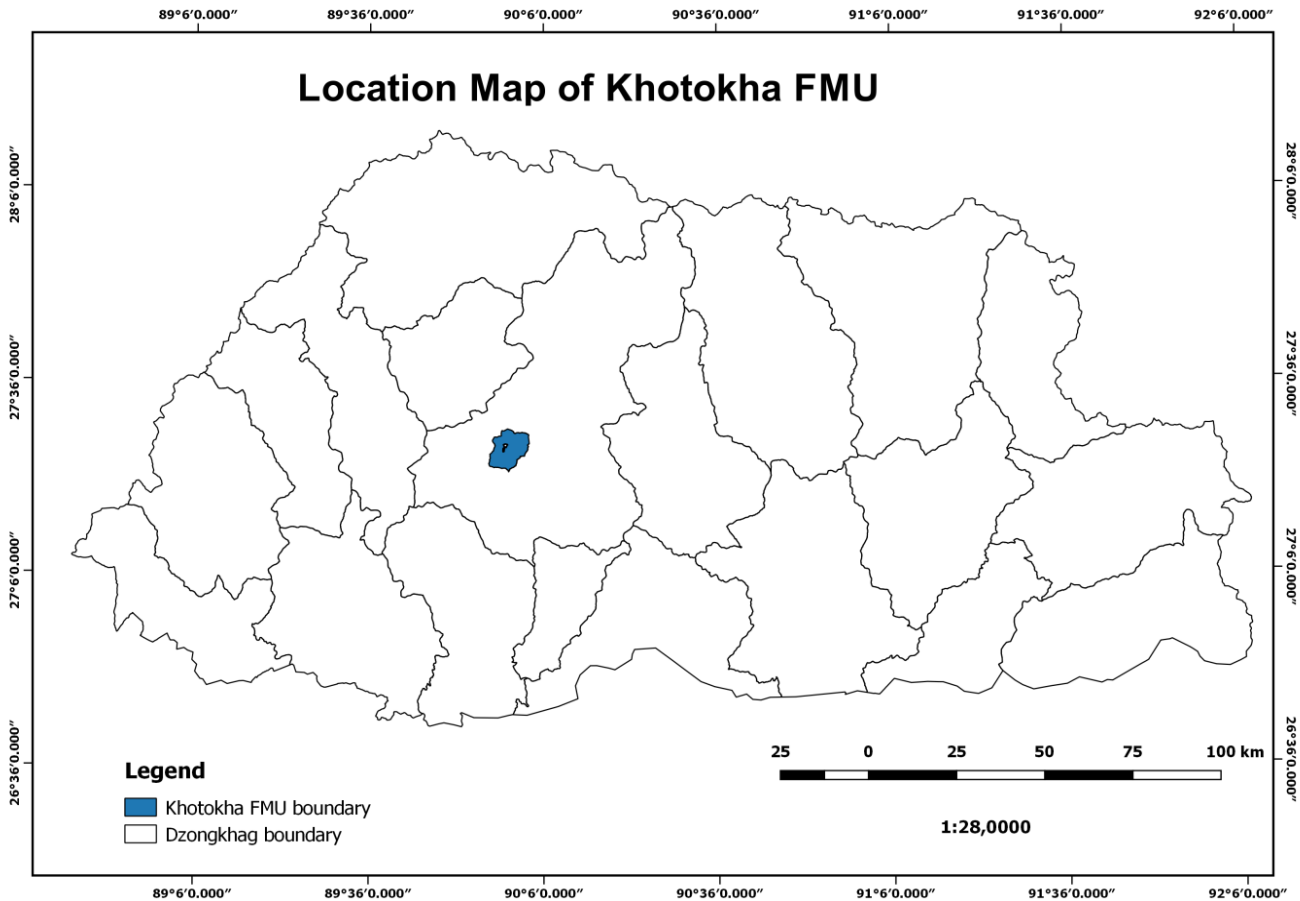
PART 1: GENERAL DESCRIPTION AND CURRENT SITUATION

1. LOCATION, BACKGROUND, AREA AND STATUS

1.1. Location and Status

Khotokha Forest Management Unit is located in two Gewogs under Wangdue Phodrang Dzongkhag namely Ruebisa and Bjena Gewog. It lies between 90°15'5" to 90°32'20" East longitude and 27° 26'5" to 27°32'20" North latitude (Toposheet no. 78 E/15 and 78 I/13) and covers an area of 9,281.027 ha. It has an altitudinal range of 2,300m in the valleys to 3,800at the ridge tops.

Khotokha FMU is connected by a 19 km farm road from Tekizampa. With proper maintenance of farm road (which was initially constructed by NRDCL as forest road and later handed over to the Gewog administration) by the Gewog administration, the road is now pliable in dry seasons as well as during monsoons unlike in the past years when the road were only pliable during dry seasons. The cable ropeway commonly known as Tashila ropeway which connected Chuzomsa to Tashila or the footpath which is about three hours of uphill climb is no more under operation due to poor maintenance of the ropeway and a more pliable farm road. The farm road of 6 kms that was constructed by NRDCL connects Khotokha with Gogona but is not used much by the people due to poor road condition and maintenance.



Map 1.1: Location of Khotokha FMU

1.2. Historical Background

The first Forest Management Plan for KFMU was prepared in the year 1984 by the then Department of Forest in order to manage the forest resource in a more scientific manner with an area of 4,908 ha and a plan period of 10 years (1984-1994). Even back then, timber was transported using the cable cranes and tractor skidder. Tashila ropeway was set up with the main objective of transporting timber, it catered to the social obligation of providing a means of conveyance for the people. The FMU area was later extended from 4,908 ha to 9,407ha during the second revision which commenced from 1998 to 2008.The area was further extended to 9,407.48 ha during the third revision (2009-2019). For this management plan, the Khotokha Ramsar wetland area of 126.586ha, which have a different management regime, has been extracted from the Khotokha FMU area using QGIS tools, thereby reducing the total area of Khotokha FMU to 9,281.027 ha.

People in and around the FMU met their domestic requirement of firewood and small timber from the forest even prior to the preparation of the management plan, although the demand at that time was very insignificant, it was observed that some areas near the habitation had been degraded as the local people have been meeting their requirement from these areas.

1.3. Area Statement

The following table and figure gives the areas of various land use types dominant in the Khotokha FMU. The information has been mostly derived from LULC, 2016 land use maps, topographic maps and wherever necessary field truthing was done.

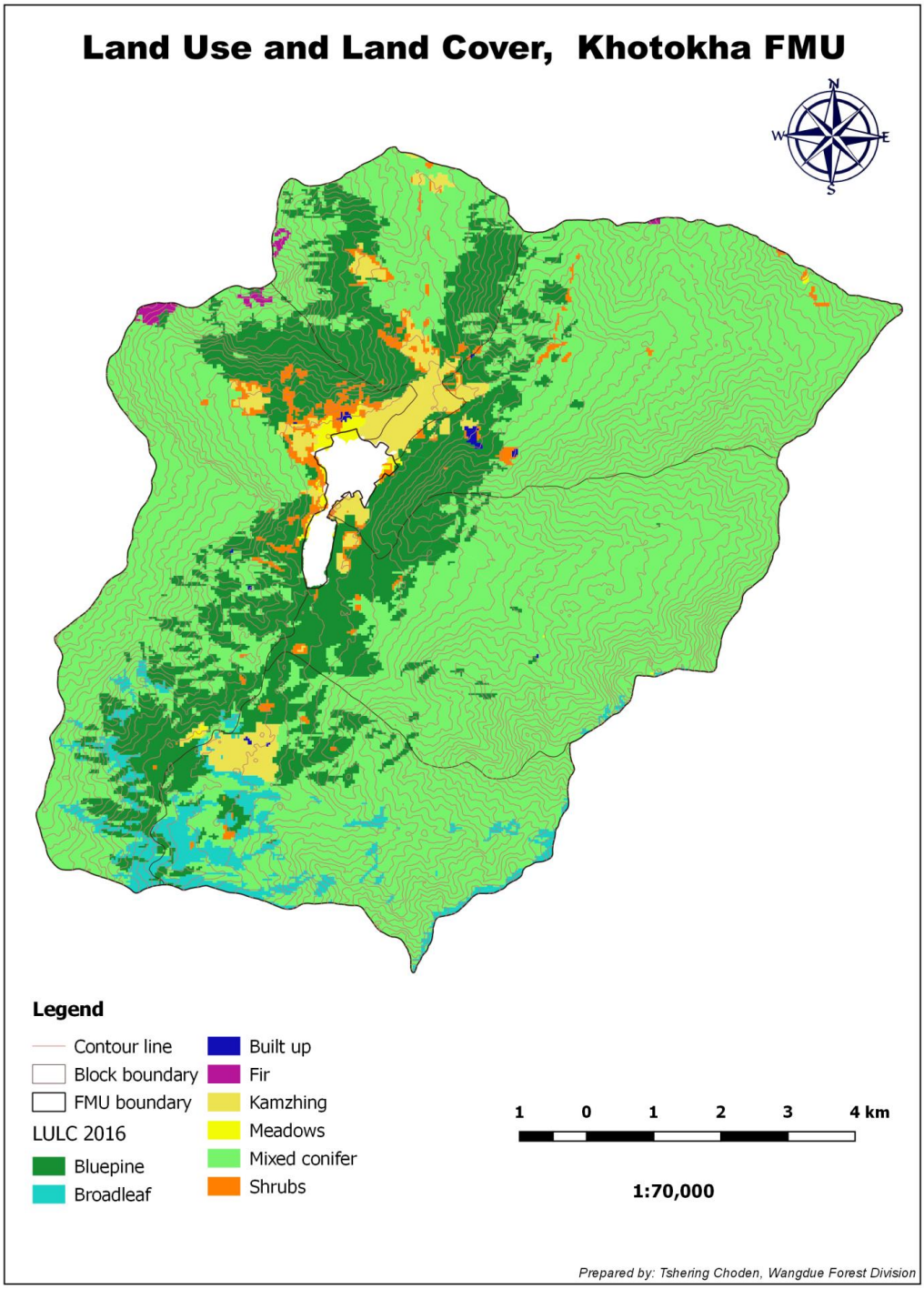
Table 1.1: Area statement by Land use

Land Use Type	Area(Ha)	Area Percentage (%)
Built-up	10.113	0.11
Kamzhing	289.775	3.12
Shrubs	166.218	1.79
Meadows	29.001	0.31
Broadleaf	313.937	3.38
Fir	25.130	0.27
Bluepine	1,966.258	21.19
Mixed-conifer	6,480.596	69.83
TOTAL	**9,281.027**	**100**

1.4. Forest condition

The major forest types found within the FMU are Blue pine forest, mixed conifer forest and mixed broadleaf forest. The mixed conifer forest is composed of species like Hemlock (*Tsuga dumosa*), Blue pine (*Pinux wallichaina*), Spruce (*Picea spinulosa*), Juniper (*Juniperus recurva*), and some broadleaf species like Maple (*Acer campbellii*), *Rhododendron sp.,* Oak (*Quercus sp.*), etc. The young blue pine forests of Khotokha are either secondary crops or have been established through natural regeneration in pasture and agricultural lands. Most of the blue pine stands occur close to the settlements and on the relatively flat valley bottom. They are quite dense and have not been thinned. There is a vast stretch of young stand of blue pine in Kekephu and Sele Block towards the valley which could serve as future stands. Thinning needs to be carried out to ensure superior quality of future stocks. As per land use land cover, 2016, the forest within FMU is dominated by mixed conifer forest with 69.83% followed by Blue pine forest with 21.19% and Mixed Broadleaf forest with 3.38% cover.

Map 1.2: Land Use Land Cover of Khotokha FMU



1.5. Legal Status

1.5.1. Ownership

The entire KFMU falls within the category of Government Reserved Forest in accordance with the forest and nature conservation act, 1995 which defines forest as ***"any land and water body whether or not under vegetative cover in which no person has acquired a permanent and transferable rights of uses and occupancy whether such land is located inside or outside the forest boundary pillars and includes land registered in a person's name as Tsamdro (grazing land) or Sokshing (woodlot for collection of litter)''***.

If deemed necessary, all such lands can be acquired by the Royal Government of Bhutan for national benefit. However, this does not apply to the private land existing within KFMU, which has been classified as non-forest/cultivation area (299.88 Ha).

1.5.2. Rights and Privileges

The rights and privileges of the local inhabitants with regard to the use of forest and forest products are as per the Forest and Nature Conservation Act (FNCA) of 1995 and the National Forest Policy of 2011. The FNCA, 1995 permits grazing and collection of firewood, fodder and leaf mould for domestic use, either free or on payment of royalty. Firewood collection is permitted from only dead and fallen trees. Timber trees are issued for *bona-fide* domestic use after they have been marked by a forest officer and royalty has been paid. Hunting wild animals is totally prohibited in the forest.

1.5.3. Grazing Right

The local communities have the traditional rights for grazing their cattle in the forest within the forest management unit. As per the revised act (The Land Act of Bhutan, 2007), it is stated that in section 235 of chapter 10, "All Tsamdro rights maintained in the *Thram* prior to enactment of this Act shall be deleted from the *Thram*. Upon deletion, the *Tsamdro* land shall be reverted and maintained as the Government land in Thromde or the Government Reserved Forest land in reserved areas."

Therefore, all the *Tsamdros* which has been registered in the name of an individual or community was given back to the Government and deemed as Government Reserved Forest. However, the Tsamdros can be leased for use as per the regulations of the government. The Forest and Nature Conservation Act, 1995, give authority to

the Department of Forests, to regulate and restrict grazing anywhere in the country, in order to prevent environmental damages.

1.5.4. Water Rights

The local population has the traditional rights to use water from the rivers and streams for their domestic purposes, such as home consumption, irrigation and other uses. There are many other small streams and creeks within KFMU.

As per the socio-economic survey conducted, there were nine water sources identified for hamlets falling under Bjena Gewog and five water sources for the hamlets falling under in Rubeisa Gewog.
The following table gives the details of these water sources for Bjena and Rubeisa along with the hamlets that it provides for.

Table 1.2: List of water sources for Bjena and Rubeisa Gewog

Sl. No.	Name of Source	Type of source	Hamlets Benefitted by the Water Source	Gewog
1	Agayphajonye	Spring	Wacheythangkha	Bjena
2	Dimichong	Spring	Rampangna	Bjena
3	Lubjena	Spring	Gazhi menchu, Shubesa	Bjena
4	Sangchu Chong	Spring	Shubesa	Bjena
5	Chamichu	Spring	Balue Goenpa	Bjena
6	Dolaykha	Spring	Jichuna, Eusa	Bjena
7	Baza chhu	Spring	Gangrichen, Soebesa, Eusa, Rinchenling Shedra	Bjena
8	Sa karbu drupchu	Spring	Rinchenling shedra	Bjena
9	Gogomo	Spring	Shubesa	Bjena
10	Chhadri chhu	Spring	Shelley	Rubeisa
11	Dem lemi chong	Spring	Penjorling, Goensa	Rubeisa
12	Wolaylo	Spring	Changmilo, Penjorling	Rubeisa
13	Ngamichhu	Perennial stream	Jongphel	Rubeisa
14	Jishey chu	Spring	Chuba	Rubeisa

1.5.5. Historical Monuments and Monasteries

The lush Blue Pine highland of Khotokha valley, historically known as khothang Delay Sum, now popularly called as Sha Khotokha has numerous Lhakhangs,

Goenpa, Gney (sacred sites), Chortens and other religious sites found scattered over the Khotokha valley. Most of the Lhakhangs and Goenpas are more than 300 years old.

Amongst the religious sites *Rinchenling Shedra* (Buddist College) is the most recently built. It was established in the year 1997 over an area of 5 acres. Rinchenling Shedra is a Government Monastic School with around 300 monks. The place was blessed by great Buddhist master and a scholar who spread the teaching of Buddha in Bhutan in a great scale known as *Kuenkhen Longchen Rabjam*. The place Rinchenling is one of the 8 'Lings' in Bhutan.

Dechen Draphu is considered as one of the most sacred site which is rarely visited owing to the distance and the difficult road conditions. The most sacred site of Guru Rinpoche lies in a Draphu (Cave). History narrates of Guru Rinpoche having mediated in the miraculously formed cave and later flew to Goen Tshephu in Punakha.

Dolung Goenpa is one of the most sacred Lhakhangs in Wangduephodrang District and was established by *Yongzin Nga Gi Wangchuk* (Son of *Ngawang Chogyel*) in the 16th century. The name Dolung comprises two words which are "Do" which means stone and "Lung" which means handle. It is associated with famous Dolung Raksha (Mask dance). The name of the Lhakhang came into existence afterthe *2nd Je Khenpo Kuenkhen Sonam Yoeser* found a stone with handle during the foundation laying ceremony. Kuenkhen Sonam Yoeser served as Chila during those days. In the past, Dolung Goenpa was considered as one of the four most important temples in Bhutan which was headed by prominent abbots. Of the many relics, the popular ones are statues of the past present and future Buddha, Deshed Choeten Gyed (the Eight types of stupas that marks the eight deeds of the Buddha), statues of the Eight manifestation of Guru Rinpochhe, statues of the thousand arms and thousands eyes (Chag Tong Chen Tong), Buddha of compassion (Chenrizig), the Ox head mask (Raksha), the Stone with Handle (Dolung), Kanjur and Tenjur (commentaries on the teachings of the Buddha). The Goenpa was later extended as a meditation hub for monastic body and also the seat of Great Spiritual Masters *His Holiness Khenchen Ngawang Thinley the 7th Je Khenpo* and *His Holiness Khenchen Gewa Shacha Rinchen* the 9th Je Khenpo. As prophesied the newly reconstructed Lhakhang which was consecrated by His Eminence *Gyaltshay Truelku Jigme Tenzin Wangpothe 8th reincarnation of Desi TenzinRabgay* in 2013 has been elevated as *DolungSherub Yoedsel Chhoeling Goinzing Dratshang* with 50 monks, 3 Lopens and a Lam.

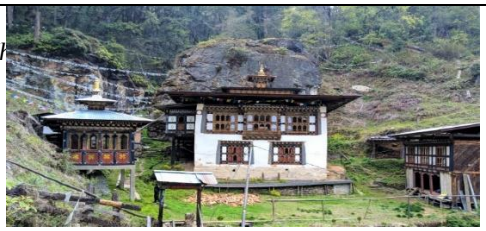
Balue Goenpa is yet another holy site in the midst of sacred Khotokha. It is the seat of *Sey Gartoen*, son of *Phajo Drugom*, and a key figure in spreading Drukpa Kajued in Wangdiphodrang. The Lhakhang is associated with the "Statues from Tibet". Legend has it that long time before, in the 1200s or so, the *ruebs* (some sort of bones from cremation of a learned or extraordinary person) of *Wachey Zhelngo* (The descendants of Sey Gartoen from Wachey village in Bjena Gewog, Wangdiphodrang) were sent to Tibet. Upon receiving the ruebs, they've send down a golden statue in return. The end of receiving the golden statues came to an end when an unholy rueb was sent on one occasion. The certain Tibetans believed that the Wachey Zhelgno has become extinct then.

Drubchhu of Yen Lag Geden, Drubchhu of Sa Karpo established by kuenkhen Sonam Yoedzer and *Drubchhu of Dakini (Khandromai Drupchu)* are other power places of Pilgrimage. All these monuments are provided a buffer of 100 m around within the FMU.

Other old and historically important monasteries situated within the KFMU are:

- Gyeney Lhakhang
- Dolay Goensa
- Drajangchu
- Kasharawa Lhakhang
- Tshokolo Lhakhang
- Goentangmo Lhakhang
- Goenphakha Lhakang
- Chebigang Lhakhang
  - kibijuney Lhakhang
  - Gangkalo Goenpa

Rinchenling Shedra

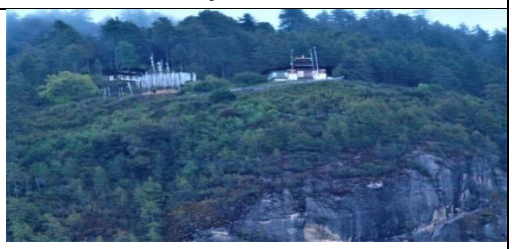


Dechen Draphu

Dolung Goenpa

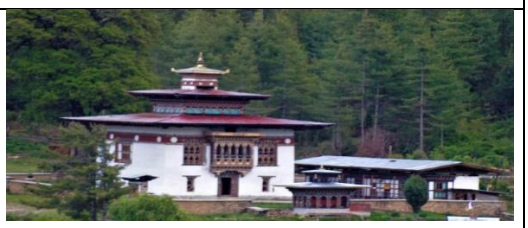
Dolay Goensa

Balue Goenpa



Dra Jangchu

Khandromai Drubchhu



Jangsa Dzong

Phajo Nye

Figure 1.1: Historical Monuments and Monasteries

1.5.6. Proximity to Protected Areas

A small portion of the northern biological corridor (BC-8) connecting Jigme Dorji National Park and Jigme Singye Wangchuck National Park cuts through a small fragment of the North eastern boundary of the FMU (Shobela top connecting with Gogona).This small area of 195.59 ha has been put under Production WC for the current management plan, but harvesting from this area shall be restricted owing to its ecological importance unless there are any special orders from the Department.

Khotokha ramsar site (Ramsar Site no. 2033) was designated as Wetlands of International Importance by the Ramsar Secretariat on 7th May 2012 with an area of 126.586 ha. The plains of ramsar site are locally known as kateythang. The plain is grazing ground for the cattle of Bjena and Rubeisa gewog. It was once proposed for an international airport but the project was shelved. Located west of the Black Mountain range, Khotokha wetland is one of the sources for the tributaries of the Puna Tsang Chhu river.

The water seeping out of the marshes form small gully streams that accumulate and flow south, providing drinking water and irrigation water for potato farms, the main cash crop of the area. The subalpine shrub marsh, consisting of peat bogs and fens, is one of the last remaining places in Bhutan where summer-winter migrations of farmers are practiced.

The site provides one of the main wintering sites in the bio-geographic region for the vulnerable Black-necked Crane (*Grus nigricollis*) and is also home to other endangered species such as the Asiatic Wild Dog (*Cuon alpines primaevus*). The cranes winter at the site due to the good roosting ground in the marshes and feeding ground in the farmlands. The local inhabitants live in harmony with the migratory birds, considering them sacred and a sign of good harvest. Owing to its importance in conservation and its management regime, Khotokha Ramsar area was extracted from the total Khotokha FMU area using QGIS tools to avoid any negative impacts (noise pollution and sedimentation of rivers) from the surrounding logging activities.

Figure 1.2: Black-necked cranes at Khotokha Ramsar Site

Picture courtesy:Sonam Norbu, Bhutan and beyond:a personal journey

2. PERMANENT SITE FACTORS

2.1. Topography and Slope

Khotokha FMU has a broad valley in the middle with the bounding hills rising in moderate slopes with occasional steep areas in some parts. The elevation of the KFMU ranges from 2300 meters at the valley bottom to 3800 meters at the ridge top.

The area of Khotokha FMU is found to be reasonably workable with about 71.27% of the FMU falls within slope classes of $>10^0$ to 25^0 and remaining 28.73% of the FMU has slope greater than 25^0. The following figure gives the detail of area distribution by slope classes of the KFMU. Slope classification was done with the help of Quantum GIS by using slope analysed from Alos PALSAR DEM (20m resolution). 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.

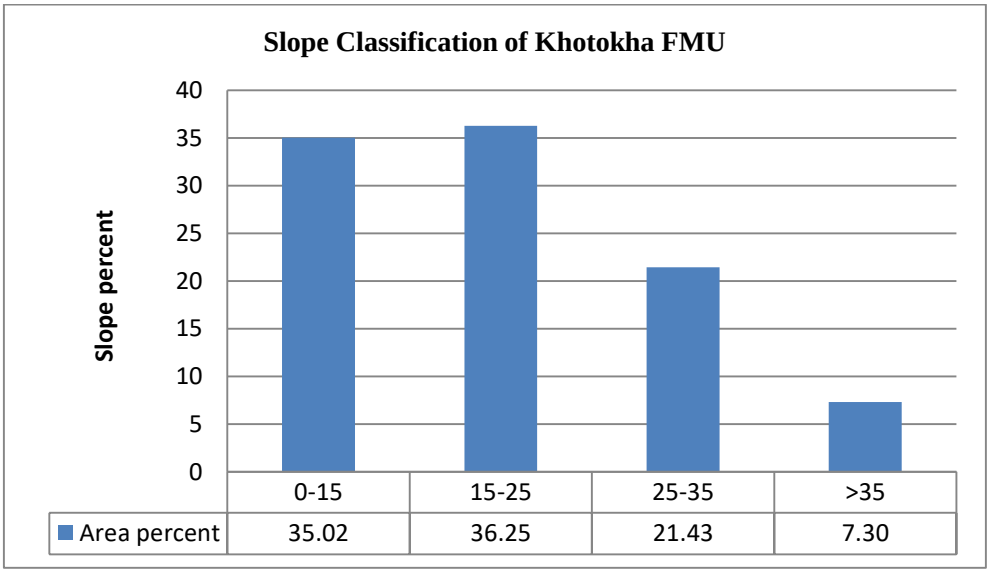


Figure 1.3: Distribution of areas by slope classes for the whole FMU area

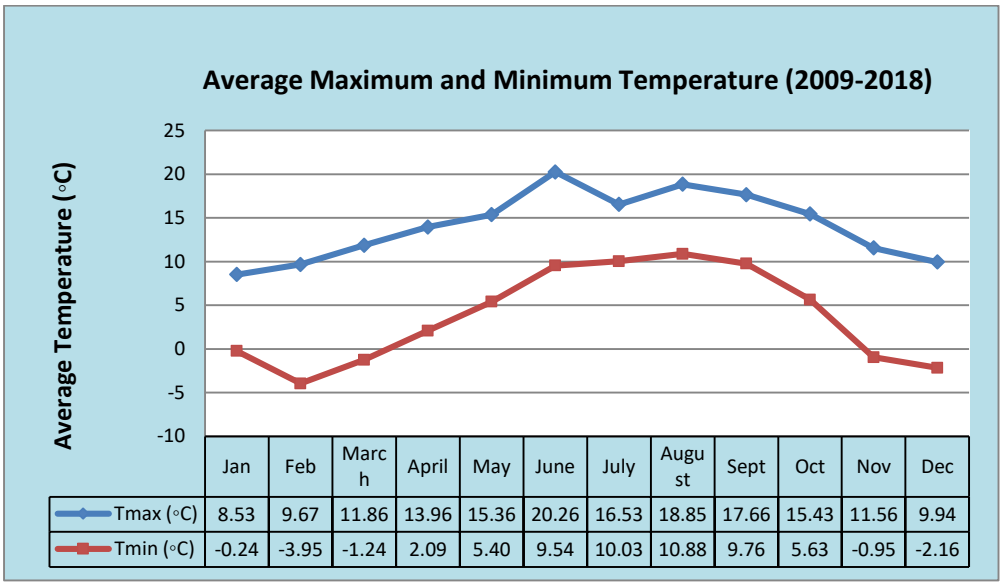
2.2. Climate

2.2.1. Meteorological stations

There is no meteorological station in Khotokha FMU. To determine the climatic attributes of the place, closest weather station situated in Phobjikha located at 2860maslwas used for obtaining the necessary data. Meteorological data has been derived from the data provided by Meteorology Section; Department of Hydromet Services, Ministry of Economic Affairs, Thimphu. Phobjikha being close to Khotokha FMU, not only has similar topography as Khotokha FMU but is also subjected to similar climatic conditions.

2.2.2. Temperature

The average of the ten years (2008 to 2018) was taken to determine the average maximum and minimum temperature which can be observed in the following graph:



	Jan	Feb	March	April	May	June	July	August	Sept	Oct	Nov	Dec
Tmax (◦C)	8.53	9.67	11.86	13.96	15.36	20.26	16.53	18.85	17.66	15.43	11.56	9.94
Tmin (◦C)	-0.24	-3.95	-1.24	2.09	5.40	9.54	10.03	10.88	9.76	5.63	-0.95	-2.16

Figure 1.4: Average maximum and minimum temperature of KFMU
Source: Department of Hydro-Met Services, MEA Thimphu, Bhutan

2.2.3. Precipitation

The graph indicates the heaviest average rainfall to be in the month of July measuring about 31mm and least being in January and December month.

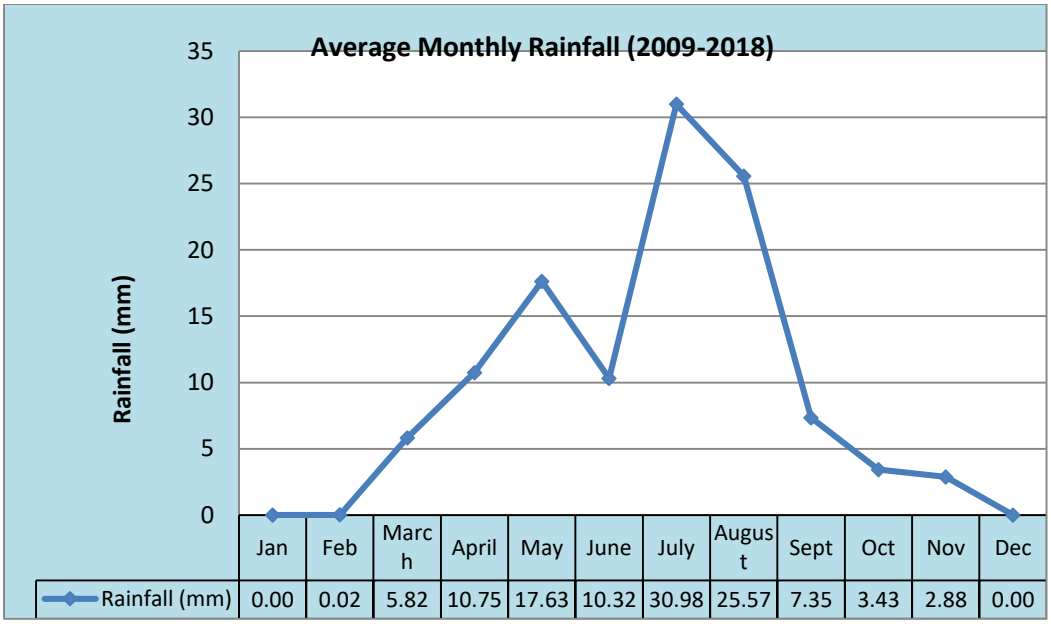


Figure 1.5: Average monthly rainfall in mm

Source: Department of Hydro-Met Services, MEA Thimphu, Bhutan

2.2.4. Relative Humidity

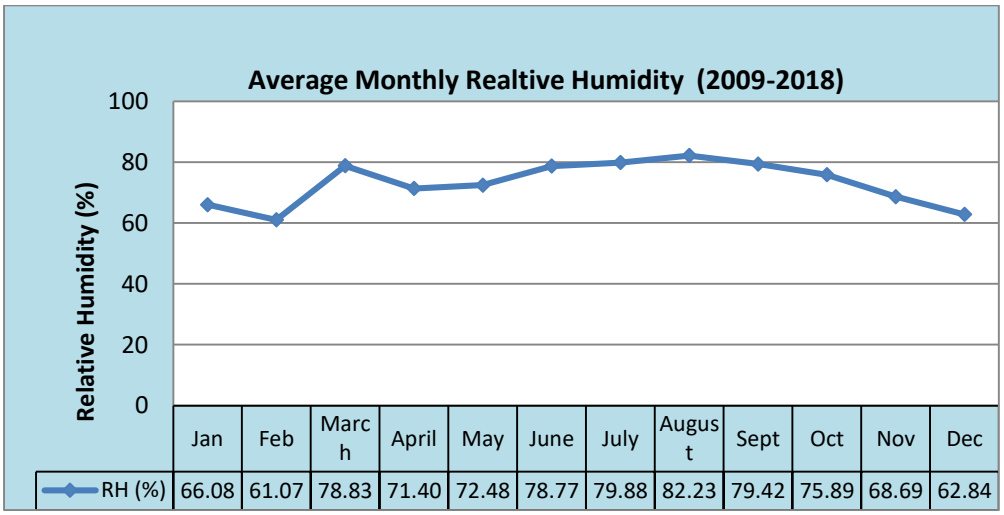


Figure 1.6: Monthly average maximum and minimum relative humidity for last 10 years

Source: Department of Hydro-Met Services, MEA Thimphu, Bhutan

2.3. Geology

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

2.4. Hydrology

The management unit is the watershed area of Paza chhu which flows from north to the south dividing KFMU more or less into two halves. There are several other watersheds; the most important ones are those of Lae chhu and Keke chhu. There are also numerous swampy or waterlogged areas in the flat and gentle slope which act as a source of water for the people living downstream. The cattle grazing in these watersheds should be regulated to minimize the surface run off. In addition, appropriate silvicultural systems, prescriptions and harvesting methods are implemented in order to ensure that the quality and quantity of water is not affected by forestry operations.

3. VARIABLE SITE FACTORS

3.1.Population and Demography

Khotokha is the traditional grazing ground for the people of Bjena and Ruebisa Gewogs and most of the people migrate seasonally. There are 19 hamlets falling within the FMU boundary. All 111 households falling within the FMU boundary were surveyed by the survey team from Wangdue Forest Division as per the socio-economic survey questionnaire given in the Forest management Code of Bhutan, 2004. From the analysed data, the average number of individual per household was computed to be six. The total population of FMU has is 671 individuals with 311 male and 360 females. As per the Population and housing census of Bhutan, 2017 there are a total household of 319 in Bjena and 305 in Ruebisa Gewog, with a total population of 3393 and 3800 respectively. People of Bjena gewog occupy upper half of the valley while the people of Rubeisa Gewog occupy the lower half. The people living in these valleys are drawn from different households and different villages in the lowland.

Table 1.3: Villages in lowland valley from which households come from

Gewogs	Hamlets within Khotokha FMU	Villages in lowland valley from which households come from
Bjena	Shelley	Permanent settlement in Khotokha valley
	Chuba	Samdrupgang
	Penjorling	Samdrupgang, Zamday
	Goensa	Zamday, Kiplung
	Changmilo	Permanent settlement in Khotokha valley
	Jongphey	Samdrupgang
	Gazhikha	Permanent settlement in Khotokha valley
	Gazhi menchu	Permanent settlement in Khotokha valley
Rubeisa	Tashitokha	Phintshogang
	Sewgang	Permanent settlement in Khotokha valley
	Gangrichen	Ngawang, Umtegang, Bakakha and Jagarlingchu
	Eusa	Wache Toe, Lumpa, Takakha, Gumena, Tikekha
	Soeberam	Permanent settlement in Khotokha valley
	Soebesa	Balakha, Phintshogang
	Shubesa	Themakha, Balakha and Phintshogang
	Jichuna	Tashitokha
	Baley Goenpa	Permanent settlement in Khotokha valley
	Rampana	Tahistokha
	Wocheythangka	Permanent settlement in Khotokha valley

Table 1.4: Demographic data of Hamlets within Khotokha FMU

Hamlet	Households (No.)	Sex		Age Group (years)			
		Male	Female	<6	7 to 14	15-64	>64
Shelley		71	88	13	18	111	17
Chuba	1	4	5	0	0	8	1

Penjorling	13	31	39	5	14	48	3
Goensa	11	35	35	1	13	53	3
Changmilo	2	5	8	3	4	5	1
Jongphey	10	27	31	10	5	39	4
Wochethangka	3	13	15	6	5	13	2
Gazhikha	3	10	10	2	2	12	2
Rampana	1	3	2		1	4	
Baley Goenpa	3	6	11	1	2	13	1
Soeberam	5	15	21	7	10	17	1
Bjichuna	3	6	7	1	1	9	3
Gangrichen	8	20	23	5	10	25	2
Soebisa	10	29	41	6	15	39	7
Shubesa	6	18	6		2	24	6
Sewgang	4	13	14	4	1	20	2
Tashitokha	1	NA	NA	NA	NA	NA	NA
Eusa	2	5	4	2	1	6	0
TOTAL	**111**	**311**	**360**	**66**	**104**	**446**	**55**

3.2.Agriculture and Farming System

People living in Khotokha are mostly subsistence farmers depending highly on agriculture and livestock for their livelihood. They maintain two homes i.e. summer and winter home. The farmers consider the winter home (Maylo) as their first home, which is evident from the bigger size of the houses. During summer season, agriculture crops are grown in the lowland valleys especially rice. Potatoes are grown in the upland valleys which are harvested in autumn season, the cattle are taken to the upland forest for grazing. Potatoes are grown as the main cash crop. Buckwheat, millet, chilli, radish, maize, pumpkin, cucumber and other leafy vegetables are also grown which are mostly for home consumption.


Figure 1.7: Potato cultivation, the major cash crop of local communities

People grew more buckwheat in the past than now. According to people, blue pine has colonised open rangelands where buckwheat was cultivated in the past.

3.3.Traditional Use of Forest System

The entire timber requirement for the communities in and around the KFMU is met from the FMU. After the FMU plan was endorsed, the rural timber demands were being met from the designated local use areas. They use forest resources to construct and repair their houses, making small animal sheds, making farm implements etc. Shingles were used as roofing materials but it has been replaced by CGI sheets over the course of time.

Besides timber, other forest resources like firewood, fodder, leaf litters, fencing materials, medicinal plants, and NWFPs are also extracted from the FMU by the local people. Blue pine is the most commonly used fuel wood species as hardwoods (Oaks and Rhododendron) are difficult to obtain in appreciable quantity. The NWFPs are important to the people mostly for subsistence use.

3.4.Grazing

The information about pattern of grazing, number of cattle and grazing land were acquired from the socio-economic survey data. As per the survey data, it was found that there are about 728 cattle, 5 horses and 23 poultry owned by the people residing within KFMU (Table 1.5).

The heaviest grazing pressure is in the forest areas close to the settlements. The Improved Pasture Development Program started in the valley in 1989.

Many households maintain pasture gardens near their homesteads, which are harvested and stall fed. The local cow herders mostly practice migratory grazing. All cattle from the lower valley (Maylo) move to Khotokha from April-May. The cattle remain in Khotokha for six months i.e. from April to September, so that there is no cattle nuisance during the rice-growing season in Maylo. Grazing at current rate will have little impact on soil and water quality, but uncontrolled grazing could lead to poor regeneration and soil compaction in the near future. However, livestock rearing being one of the main occupations of people, there is higher chances of increase in livestock population which ultimately creates pressure on the nearby forest. In order to reduce the grazing pressure on forest, introduction of improved varieties of livestock and awareness to the people may be looked upon by relevant agencies.

Figure 1.8: Cattles and horses grazing at the Khotokha Ramsar site (traditional grazing ground)

Table 1.5: Livestock data of hamlets falling within FMU compiled from socio-economic survey.

Cattle	Cows		Bulls		Total Cattle	Poultry		Horse	
Hamlet	**Local**	**Impvd.**	**Local**	**Impvd.**		**Local**	**Impvd.**	**Local**	**Impvd.**
Shelley	104	81	29	11	225	5	13	0	0
Goensa	31	1	12	0	44	0	0	0	0
Jongphey	42	9	21	0	72	0	0	0	0
Penjorling	41	0	27	0	68	0	0	3	0
Chuba	15	0	5	0	20	5	0	0	0
Changmilo	6	6	4	0	16	0	0	0	0
Wochethangka	21	1	10	0	32	0	0	0	0
Gazhikha	13	0	11	0	24	0	0	0	0
Rampana	0	0	0	0	0	0	0	0	0
Baley Goenpa	20	0	2	0	22	0	0	0	0
Soeberam	7	0	1	1	9	0	0	0	0
Bjichuna	6	8	1	3	18	0	0	0	0
Gangrichen	10	8	1	0	19	0	0	0	0
Soebesa	54	16	15	0	85	0	0	2	0
Shubesa	18	16	4	8	46	0	0	0	0
Sewgang	3	5	8	0	16	0	0	0	0
Eusa	8	0	4	0	12	0	0	0	0
Total	**399**	**151**	**155**	**23**	**728**	**10**	**13**	**5**	**0**

Table 1.6: Livestock data of two Gewogs (Areas within and outside FMU).

Cattle	Cows		Bulls		Total cattle	Poultry		Horse		Pigs
Gewog	**Local**	**Impvd.**	**Local**	**Impvd.**		**Local**	**Impvd.**	**Local**	**Impvd.**	
Bjena	1228	485	415	148	**2276**	945	1357	89	0	12
Bubeisa	764	402	433	148	1561	359	5285	12	0	26
Total	**1992**	**887**	**848**	**296**	**3837**	**1304**	**6642**	**101**	**0**	**38**

Source: Gewog Livestock office, Bjena and Rubeisa

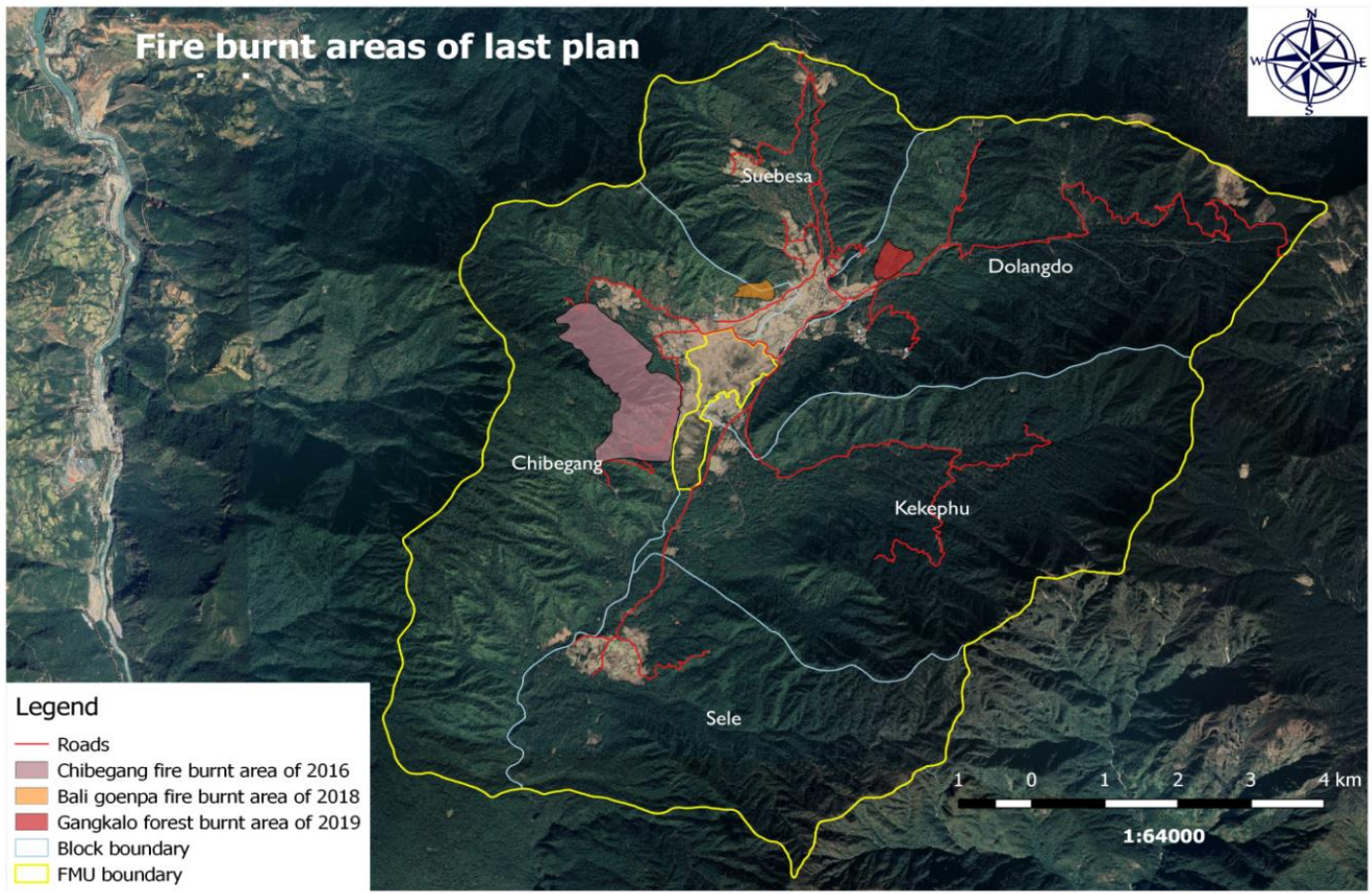
*3.5.*Forest Fires

Forest fire is not a regular phenomenon within the FMU and fire outbreaks are very rare. However, during the last management plan period, there were three incidences of forest fire. One fire outbreak in Rubeisa Geog in the year 2016 and the other two in Bjena Geog in the year 2017 and 2018 subsequently. The FMU being dominated by Coniferous forest is susceptible to fire especially during the dry winter months. Therefore acute vigilance during the forest fire season and conducting yearly forest fire awareness campaigns for the local people is crucial to prevent forest fire incidences

Table 1.7: Forest fire incidence in the FMU

Year	Geog	Location	Area Burnt(ha)	Vol. (m^3)
2016	Rubeisa	Chibegang	228.14	821.376
2017	Bjena	Baligoenpa	11.7	-
2018	Bjena	Gangakalo	21.27	-
TOTAL			**261.11**	

Map 1.3: Fire burnt area of last plan period



3.6.Pest and Diseases

The forest is found to be susceptible to pest and diseases since there have been many outbreaks of bark beetle and fungal infection leading to root and butt rot (*Heterobasidion annosum* and *Armillaria myles*) in the last plan period. An outbreak of beetle in Kekephu block was observed in 2008. The outbreak extended to an area of approximately 30 ha. 2017 trees were marked for removal from the area which amounted to 15,487.81 m^3. Sanitation felling was carried out in the year 2010-2013. The cull percentage was reported to be very high. Out of 63 trees randomly felled, only 10 trees were found to be sound and rest of them rotten. Sanitation operation amounting to 16,288.2 m^3has been carried out over the last ten years.

Table 1.8: Account of sanitation operations carried out in KFMU during the previous plan period.

Year	Area	Volume Extracted (m^3)	Area (ha)
2010	Kekephu Block	5,033.96	15
2011	Kekephu Block	4,668.27	
2012	Kekephu Block	1,132.5	26.18
2013	Kekephu Block	5,453.47	14.26
TOTAL		**16,288.2**	**55.44**

3.7.Non-wood Forest Produce

In Bhutan, non-wood forest products (NWFPs) form the major source of peoples' livelihood in the rural communities. NWFPs play an important role in the daily lives and overall well-being of the Bhutanese people especially among the rural farming community; for instance they are a major source of off-farm income, food, medicinal and aromatic products, fodder, fibre, and also used for local construction materials. NWFPs often are a safety net for poor people in the off-farm season and/or whenever needed as a food security measure. NWFPs offer a lifeline for many rural Bhutanese households.

Bamboos and mushroom are some of the most commonly used NWFPS and used mostly for self and domestic purposes. They also collect *Paris polyphylla* for their medicinal value and very few individuals of Khotokha FMU have now started selling some of the NWFPs like mushroom although the amount is very small.

Many varieties of mushrooms are found and collected by the local population within the FMU, mostly for self-consumption. Matsutake mushroom (Sangay shamu) are also collected from the blue pine forest in Subesa Block and sold within and outside FMU. Bamboos are also collected, which are used as tying materials for fences and for making mats and baskets. During the fieldwork, few households were observed to have bamboo growing in their home garden. These were planted through rhizomes taken from the local forest and were used for making baskets. Few households in Shelley had clumps of bamboo popularly known as Dew yangka, used for making traditional bow and arrow. Rhododendron species, Junipers and Artemisia were also valued by the local residents to be burned as incense. Pteridophytes like Fern and conifers like Blue Pine needles were said to be used for composting manure to be used in farms. Stones and sands are other useful NWFPs.

There are many other plants species found within the FMU area which are used as NWFP whose various properties are valued by locals and put into use. Some of the NWFPs found in the FMU are grouped as per their uses and are listed accordingly in the following tables:

Table 1.9: List of medicinal plants found in the KFMU

Sl. No.	Botanical Name	Local Name	Parts used
1	*Artimisia myrianthia*	Khempa	Leaves
2	*Astilbe rivularis*		
3	*Aconitum bisma*	Tsendug (Dz)	Root
4	*Aconitum ferox*	Tsendug (Dz)	Root
5	*Berberis aristata*	Kepaitshang (Dz)	Root
6	*Berberis wallichiana*	Kepaitshang (Dz)	Root
7	*Betula utilis*	Taap (Dz)	
8	*Cannabis sativa*	Kenam (Dz)	Leaves
9	*Daphne bholua*	Dey Shing (Dz)	Bark
10	*Elsholtzia fructicosa*		
11	*Gentianella moorcroftiana*		
12	*Gaultheria pyroloides*		
13	*Houttuynia cordata*		Whole plant
14	*Oxalis cornucullata*		
15	*Plantago erosa*		Whole plant
16	*Phytolacca acinosa*		
17	*Pteris formosa*		
18	*Panax pseudo ginseng*	Jenshing (Dz)	Root

19	*Rhododendron arboretum*		
20	*Rubus cordifolia*	Tsoe (Dz)	
21	*Rubus ellipticus*	Tshematsheloo (Dz)	Root
22	*Verbascum thapsis*	Sergi met (Dz)	
23	*Viscum nepalensis*		Bark
24	*Zanthoxylum nepalense*	Thinge (Dz)	Fruits
25	*Zanthoxylum oxyphyllum*	Thinge (Dz)	Fruits

Table 1.10: List of fodder species of Khotokha

Sl. No.	Botanical Name	Local Name
1	*Aconogonum molle*	
2	*Malas baccata*	Tapsi Shing(Dz)
3	*Schefflera impressa*	Chindey(Lh)
4	*Yushinia microphylla*	

Table 1.11: List of plant species valued/used for its fruits

Sl. No.	Botanical Name	Local Name
1	*Benthamidia capitate*	Phoetse(Dz)
2	*Elaegnus parviflora*	Bji(Dz)
3	*Fragaria nubicola*	
4	*Parthenococssus semicordata*	
5	*Rubus andersonii*	
6	*Rubus ellipticus*	

Table 1.12: List of Fibre

Sl. No.	Botanical Name	Local Name
1	*Cannabis sativa*	Kenam(Dz)
2	*Daphne bholua*	Dey Shing(Dz)
3	*Daphne papyracea*	Dey Shing(Dz)

Table 1.13: List of dye

Sl. No.	Botanical Name	Local Name
1	*Berberis aristata*	Keypaitshang(Dz)
2	*Berberis wallichiana*	Keypaitshang(Dz)

3	*Elscholtzia fructicosa*	
4	*Rubia cordifolia*	Tsoe(Dz)

Table 1.14: List of plants used for Incense

Sl. No.	Botanical Name	Local Name
1	*Anaphalis triplinervus*	
2	*Artemesia myrianthia*	Khempa(Dz)
3	*Berberis aristata*	Keypaitshang(Dz)
4	*Cupressus corneyana*	
5	*Gaultheria fragrantessima*	
6	*Juniperus squamata*	Shoop(Dz)
7	*Juniperus recurve*	Shoop(Dz)
8	*Rhododendron ciliatum*	Etho Metho(Dz)

Table 1.15: List of edible mushrooms in KFMU

Sl. No.	Botanical Name	Local Name	Availability Zone
1	*Auricularia auricular*	Jili namcho(Dz)	
2	*Cantherellius cibarus*	Sisi shamoo(Dz)	Blue pine to spruce zone
3	*Clavaria botrytis*	Jichu Kangroo(Dz)	Blue pine zone
4	*Grisola frondosa*	Ram Shamoo(Dz)	
5	*Hericium ramose*	Rapey Honrey(Dz)	
6	*Lentinus edodes*	Sokey Shamoo(Dz)	
7	*Pleurotus cornucopiae*	Sey Shing Shamoo(Dz)	Hemlock zone
8	*Polyporus badius*	Kou Shamoo(Dz)	
9	*Razites caperata*	Dungshing Shamoo(Dz)	Fir zone
10	*Suillus pictus*	Keysa Lusa Shamoo(Dz)	

4. ECOLOGY

Bhutan known as the Ecological heart of the Eastern Himalaya comprises an important part of the Eastern Himalayan Biodiversity hotspot which stretches across Nepal, north eastern states of India, Southeast Tibet (China) and Northern Myanmar.

The abrupt rise of the Himalayan Mountain from less than 500 meters to more than 8000 meters results in a diversity of ecosystem that range in only a couple of hundred kilometres from alluvial grasslands and subtropical broadleaf forest along the foothills to temperate broadleaf forest in the mid hills, mixed conifer forest in the higher hills and alpine meadows above the tree line.

Bhutan's location at the interface of the Indo-Malayan and Palearctic Realms and other factors such as variation in altitude, slope and aspect within a short latitudinal range and varied climate contributes to existence of rich biodiversity. Bhutan exhibits exceptional concentration of species and endemism.

4.1.Floral Association

Khotokha FMU consists of temperate Blue Pine Forest (comprising of both young and mature stands). Blue pine forms mainly pure stands, which occupy the lower slopes and valley bottom of the management unit. There is also a small portion of Mixed Broadleaf Forest in the southern parts of Sele Block, along the Paza chu. The altitude ranges from 2500 m to almost 3100 m on the south-eastern slopes. Mixed Conifer Forests is the dominating forest type of Khotokha FMU, which are mostly mature and over mature. Young forest almost doesn't exist. They appear in a zone above Blue pine forest. Mixed conifer forest mainly composed of Hemlock and Blue pine with scattered patches of Fir and Spruce stands. Mature Fir stands occur at higher altitudes (3,300 m to tree line). As one ascends the hill, stunted growth of Junipers are found.

4.2.Flora

Khotokha FMU is dominantly a coniferous forest which gives the general appearance being uniform in composition. The floristic diversity can however, be appreciated upon observing the composition of a lower strata which comprises of varied species. The different species listed in the table below includes the ground vegetation to the dominant principal species.

Table 1.16: List of plant species found in the KFMU and recorded during the inventory

Sl. No.	Scientific Name	Common Name	Local Name
1	Acer oblungum	Maple	Chalam(Dz)
2	Acer pectinate	Maple	Chalam(Dz)
3	Acer campbelli	Maple	
4	Abies densa	Fir	Dungshing(Dz)
5	Aconitum bisma		Tsendug(Dz)
6	Aconitum ferox		Tsendug(Dz)
7	Artimesia myranthia		Khempa(Dz)
8	Berberis wallichiana	Bar berry	Kepaitshang(Dz)
9	Berberis aristata	Bar berry	Kepaitshang(Dz)
10	Betula utilis	Betula	Tap Shing(Dz)
11	Carpinus viminia		
12	Daphne bholua		Dey Shing(Dz)
13	Elsholtzia fruticose		
14	Ilex dipreyana		
15	Juniperus squamata	Juniper	Shoop Shing(Dz)
16	Juniperus recurve	Juniper	Shoop Shing(Dz)
17	Phytolacca acinosa		Zangiro(Dz)
18	Picea spinulosa	Spruce	Bashing(Dz)
19	Pinus wallichiana	Blue pine	Tongphu(Dz)
20	Primula denticulate		
21	Primula glomerata		
22	Primula sikkimensis		
23	Primula stuartii		
24	Quercus semicarpifolia	Oak	Bjishing(Dz)
25	Rhododendron arboretum	Rhododendron	Etho Metho(Dz)
26	Rhododendron falconeri	Rhododendron	Etho Metho(Dz)
27	Raos webbiana		
28	Rosa brunonii		
29	Rubus cordifolia		Tsoe(Dz)
30	Rubus ellipticus		Tsoe(Dz)
31	Taxus baccata		Lhashing(Dz)
32	Tsuga dumosa	Hemlock	Seyshing(Dz)
33	Zanthoxylum oxyphyllum		Thinge(Dz)
34	Zanthoxylum nepalense		Thinge(Dz)

4.3.Fauna

Owing to the rich and diverse habitat constituted by varied floral species, the FMU is home to various species of birds and animals. The wildlife listed here are those which have been observed and spotted by the local residents and recorded during the inventory.

Further the field visits had indicated that all the forest types are potential wildlife habitat for one species or the other. It was found that wild boars were a huge menace to the people especially during the potato season. Kalij Pheasant, Procupines, Grey Langur and Barking Deers are also responsible for crop damage. During the maize season, bears not only cause crop damage but also attack and kill livestock. Wild dogs are reported to attack their livestock especially those sent off into the forest for grazing.

The following mammals have been recorded in the FMU during the inventories and reconnaissance visits:

Table 1.17: List of mammals in KFMU

Sl. No	Common Name	Scientific Name
1	Common Leopard	Panthera pardus
2	Common Pika	Ochotona roylei
3	Barking Deer	Munticus muntjac
4	Otter	
5	Grey Langur	Semnopithecus entellus
6	Himalayan Musk Deer	Moschus chrysogaster
7	Orange Bellied Squirrel	Dremoys lokria
8	Himalayan Crestless Porcupine	Hystrix indica
9	Sambar Deer	Cervus unicolor
10	Himalayan Black Bear	Ursus thibetanus
11	Asiatic Wild Dog	Cuon alpinus
12	Wild Pig	Sus scrofa
13	Yellow-throated Marten	Martes flavigula

4.4.Avifauna

The diversity of avifauna found in the FMU is extremely rich sustained by the diverse habitat type. Most of the birds are already recorded in the previous plan and the list has been further extended using the record maintained during the field visit.

Direct sightings and indirect sightings (through bird calls) were used to identify the birds.

All the birds are maintained to have the status of "Least Concern" in IUCN Red list except for the Black Necked Crane which is considered "Endangered" in the same list. The valley of the FMU (Ramsar site) provides a winter roosting place for these endangered birds. As per the local residents, Black Necked cranes are yearly visitors arriving in the valley by the mid-ninth months of Bhutanese calendar (November) and leave by the second month of the Bhutanese calendar. The residents state that there have not been any significant changes in the number of Black Necked Cranes visiting the valley and are more or less constant. In fact, according to the record maintained by KFMU there has been an increase in number of Black Necked Cranes visiting the valley over the course of time as follows:

Table 1.18: Number of cranes visiting Khotokha valley

Year	No. of cranes recorded
2012	6
2013	5
2014	7
2015	9
2016	10
2017	12
2018	13

Table 1.19: List of birds found in KFMU

Sl. No.	Common Name	Scientific Name	Status
1	Black Bulbul	*Hypsipetus leucocephalus*	Least concern
2	Black Drongo	*Dicrurus macrocercus*	Least concern
3	Black Necked Crane	*Grus nigricolis*	Vulnerable
4	Blue Whistling Laughing Thrush	*Myophonus caeruleus*	Least concern
5	Brown Bullfinch	*Pyrrhula nipalensis*	Least concern
6	Brown Parrot Bill	*Paradoxornis unicolor*	Least concern
7	Brown Throated Tree creeper	*Certhia discolor*	Least concern
8	Chestnut crowned Laughing Thrush	*Garrulax erythrocephallus*	Least concern

9	Chestnut headed Tesia	*Tesia castoneocoronata*	Least concern
10	Common Kestrel	*Falco tinnunculus*	Least Concern
11	Common Stone Chat	*Saxicola torquata*	Least concern
12	Great Tit	*Parus major*	Least concern
13	Green Backed Tit	*Parus monticolus*	Least concern
14	Grey backed Shrike	*Lanius tephronotus*	Least concern
15	Grey Bush Chat	*Saxicola ferrea*	Least concern
16	Grey crested Tit	*Parus dichrous*	Least concern
17	Grey Headed Canary Flycatcher	*Culiciipa hodgsonii*	Least concern
18	Kalij Pheasant	*Lophura leucomelonus*	Least concern
19	Little Forktail	*Enicurus scouleri*	Least concern
20	Long-billed Thrush	*Zoothera monticola*	Least concern
21	Long-tailed Minivet	*Pericrocotus ethologus*	Least concern
22	Mrs. Gould's Sunbird	*Aethopyga gouldiae*	Least concern
23	Olive-backed Pipit	*Anthis hodgsonii*	Least concern
24	Oriental Turtle Dove	*Streptopelia orientalis*	Least concern
25	Plain Mountain Finch	*Leucosticte nemoricola*	Least concern
26	Plumbeous Water Redstart	*Rhyacornis fuligenosus*	Least concern
27	Pygmy Blue Flycatcher	*Muscicapella hodgsonii*	Least concern
28	Red-billed Chough	*Phyrrhocorax graculus*	Least concern
29	Red-billed Liothrix	*Liothrix lutea*	Least concern
30	Red-throated Flycatcher	*Ficedula parva*	Least concern
31	Rufuous-bellied Woodpecker	*Dendroccopos hyperythrus*	Least concern
32	Rufuous-fronted Tit	*Aegithalos couschitos*	Least concern
33	Rufuous-winged Fulvetta	*Alcippe castanaceps*	Least concern
34	Rufuous Sibia	*Heterophasia capisfrata*	Least concern
35	Russet Sparrow	*Passer rutilans*	Least concern
36	Rusty-flanked Tree Creeper	*Certhia nepalensis*	Least concern
37	Speckled Wood pigeon	*Columa hodgsonii*	Least concern

38	Spotted Nutcracker	*Nucifraga caryocatactes*	Least concern
39	Striped-throated Yuhinia	*Yuhinia gularis*	Least concern
40	Ultra-marine Flycatcher	*Ficedula supercilliaris*	Least concern
41	White-collared Blackbird	*Turdus albocinctus*	Least concern
42	White-tailed Nuthatch	*Sitta himalayensis*	Least concern
43	White-throated Laughing Thrush	*Garrulax albogularis*	Least concern
44	White Wagtail	*Motacillia alba*	Least concern
45	Yellow-bellied Fantail	*Rhiphidura hypoxantha*	Least concern
46	Yellow-billed Blue Magpie	*Urocissa flavirostris*	Least concern
47	Yellow-breasted Greenfinch	*Carduelis spinoides*	Least concern

5. SILVICULTURAL ASSESSMENT

5.1.Present Forest Types

The forest types found in Khotokha FMU are briefly described here;

Mixed Broad-leaved Forest is found to occur in southern part of the management unit along Paza Chhu. It occupies the altitudinal range 2,300 m to 2,500 m.

Blue Pine Forest is the dominating forest types in the KFMU and is found throughout the FMU. It occupies the mid-elevation zone of 2,100-3,000m and occurs in the drier inner valleys on the south-eastern slope. Blue pines usually form pure stands with diverse understorey of xerophytic shrubs apart from *Quercus griffithii* which is the only associated tree species. Blue pine forests appear gradually after the evergreen oak forest and are the pioneer species appearing after the disturbance in the Cool Moist Broad-leaved forest.

Mixed Conifer Forest is mainly composed of Hemlock, Blue pine, Spruce and Fir forests.

Hemlock Forest occupies the montane clouded forest zone like the Spruce but require higher precipitation. Within the FMU, it is found in the upper ridges of Suebesa extending towards Chibegang, Dolangdo and Kikephu also have a vast stretch if Hemlock forest. Hemlock is associated with shrubby and arborescent

rhododendron along with dense growth of epiphytic and terrestrial ferns, lichens and bryophytes.
Mixed stands with other conifers are common occurrence. Fir Forest occurs in the highest elevation forest zone-ranging from 3,200-3,800m and therefore has been found along the highest ridges of Dolangdo and Kekephu Block.

Luxuriant growth of rhododendrons, other shrubs and herbs e.g. Primula species are commonly found in the understorey promoted by the humid environment. With the ascent of elevation, firs become more stunted and are found to be mixed with Junipers and rhododendron species.

5.2.Past Silvicultural Treatment

Khotokha FMU was commercially managed from the year 1984 by the territorial Division with the help of Bhutan Logging Corporation (now renamed as NRDCL). The FMU plan was revised for another ten years from June 1998 to June 2008 during which commercial harvesting operation took place mainly in Dolangdo and Kekephu Block. Requirement for local needs for construction timber and firewood was met from Sele and Suebesa Block. During the previous plan period (2009-2019) commercial requirements were met from Kekephu Block (sanitation area and cable lines) and two cable lines at Dolangdo Block. Thelocal requirements were met from the Local use areas of Chebigang, Shubesa, Goensa, Dolangdo and Selley.

Group Selection System was applied for Blue Pine, Mixed conifer, and Hemlock Forest. For local use and Mixed Broadleaf Forest, individual trees were selected and marked on Single Tree Selection System basis by the forestry staff as required and then permitted for removal.

6. SOCIO-ECONOMICS

6.1.Common Source of Income

There are 19 hamlets within the KFMU which consist of population who are dominantly dependent on farming as a source of their livelihood with few employed in government service and some in monk and army. This has been inferred from the Socio-economic survey data.

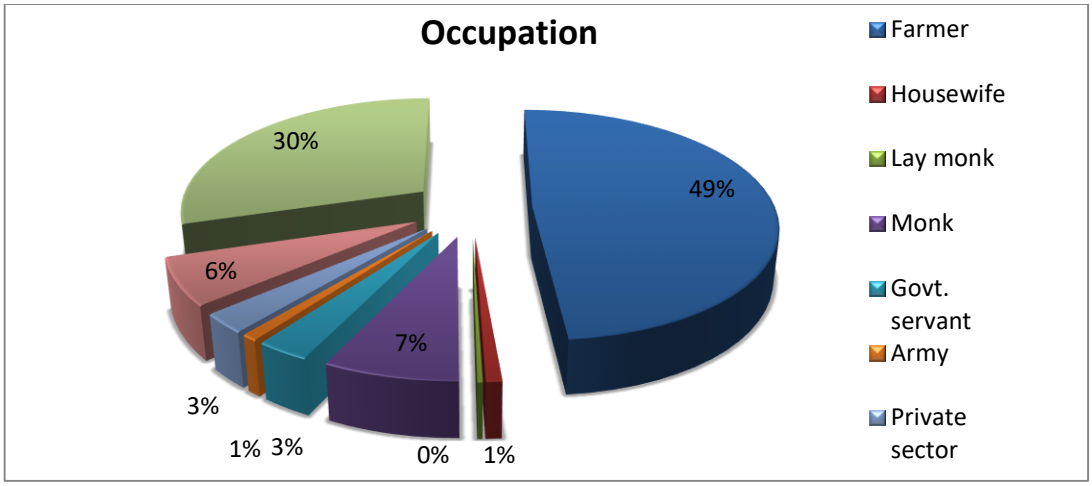


Figure 1.9: Occupations (%) of local communities residing within KFMU

The majority of local communities are farmers having individual landholdings. The main cash crop grown by the local communities is potato. It was observed that large scale of the income is contributed by the sale of potatoes, followed by sale of livestock products. The people are self-reliant without any dependence on their family members in town for remittances.

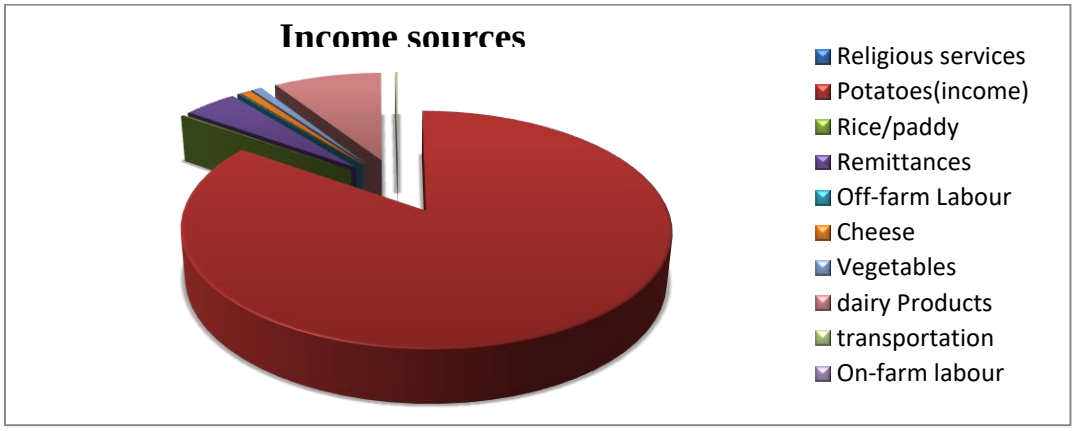


Figure 1.10: Income sources (%) of communities residing in KFMU

Most of the household income is used for food, religious ceremonies and clothing expenses followed by expenditure on their children's education.

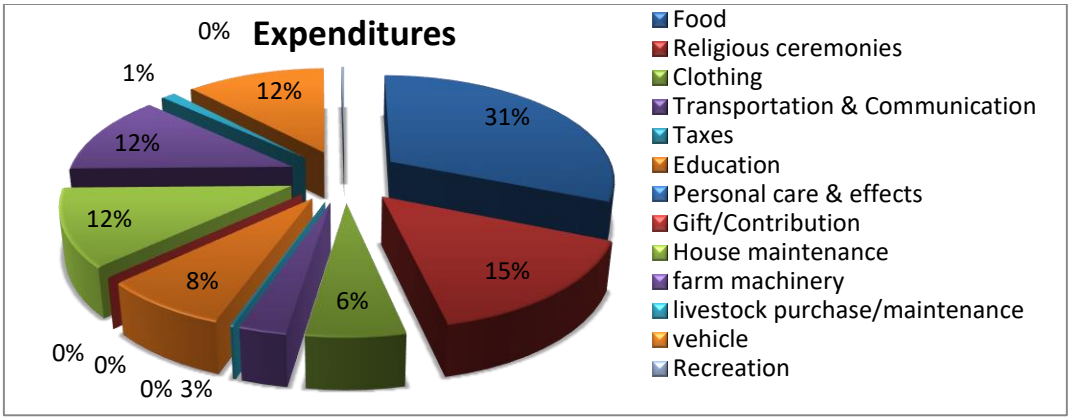


Figure 1.11: Expenditures (%) of local communities residing within KFMU

7. CURRENT TIMBER DEMAND AND SUPPLY

With the ever increasing population, increased economic and developmental activities the demand for the timber is on the rise. From building a simple house to high rise buildings, trees and forest produce are used in varying degrees. Bhutan over the last few years has seen a drastic upsurge of developmental activities distinguished by escalated construction of building and other infrastructures which suggest or support the rise in timber demand.

The Annual Allowable Cut (AAC) of the third Management Plan has been set at 7,500 m^3 for commercial use. Against this prescribed allowable cut a total standing volume of **72,824.558 m^3** (timber record as of August 2019) of commercial timbers was harvested during the second management plan period against a total standing volume of **75,000 m^3** (7,500 X 10) allotted to NRDCL for commercial harvesting. There is an undercut of 2,175.442 m^3 of timbers in standing volume as compared to the AAC prescribed in the Management Plan (this undercut volume may be met in the months of September-December of the Operational plan period 2019-2020). The details of the allotment are as indicated below.

Table 1.20: Commercial timber allotted during the last plan from FMU

Year	Timber standing vol. (m^3)	Timber log vol. (m^3)	Firewood (m^3)	Woodchips (m^3)	Total standing vol. (m^3)
2010	7,500	4,500	2,104	896	7,500
2011	12,886.7	7,732.02	4,938.68	216	12,886.7
2012	7,085.9	4,251.54	2,834.36	0	7,085.9
2013	7,549.5	4,529.7	2,283.8	736	7,549.5

2014	6,501	3,900.6	2,600.4	0	6,501
2015	6,500	3,900	2,600	0	6,500
2016	6,370.63	3,822.38	2,548.252	0	6,370.63
2017	7,016.7	4,210.02	2,806.68	0	7,016.7
2018	5,141.65	3,084.99	2,056.66	0	5,141.65
2019	6,272.478	3,763.4868	2,508.9912	0	6,272.478
TOTAL	**72,824.558**	**43,694.7348**	**27,281.8232**	**1,848**	**72,824.558**

Note: The timber record for the year 2019 is only as of August 2019

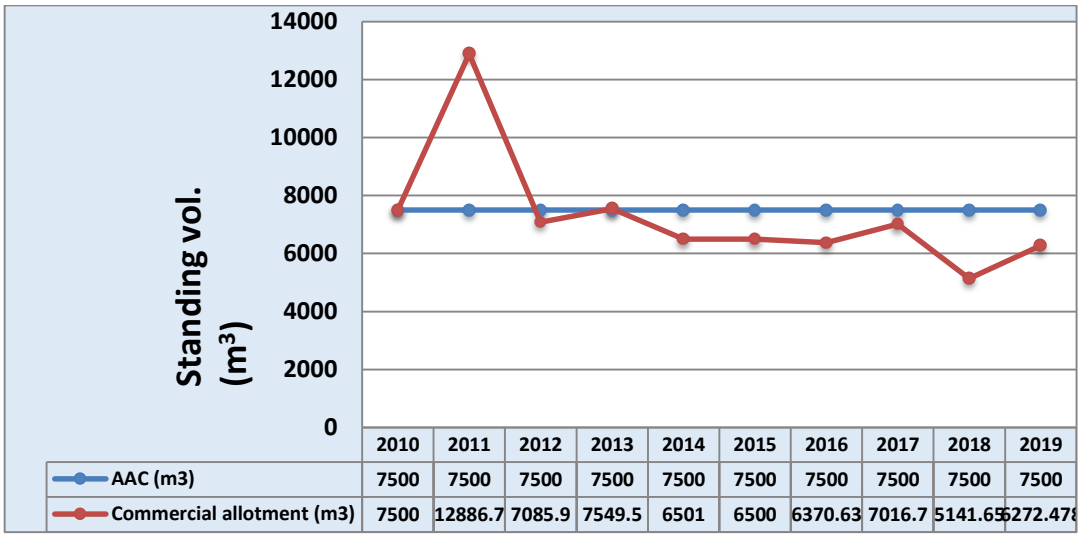


Figure 1.12: Comparison of commercial Timber Allotment against the Commercial AAC

There was a drastic rise in commercial timber extraction in the year 2011, this was mainly due to the bark beetle sanitation extraction in Kekephu Block.

The clear-cut area (Table 22) includes the area of forest clear felled for forest road and farm road constructions, and the patch cut for extraction of commercial timber including the cable corridor area of the operated cable lines. During the last 10 years the clear-cut area was 225.14ha, and the total clear-cut area for the FMU as per the management plan was 244.9 ha. The fire burnt area of Chibegang Block (104.53ha out of the total burnt area of 228.14 ha was accessible and operable), which had to be clear felled for sanitation purposes in the operational plan period of 2019-2020. It was observed that almost all the trees in the fire burnt area were attacked by insects and the quality of the timber was also deteriorating with time. Therefore, clear felling of the fire burnt area was prescribed in order to extract the timber before the timber quality deteriorates further and becomes unusable.

Table 1.21: Clear-cut area during the last plan period in Khotokha FMU

Year	Patch cut (ha)	Corridor	Roads and others	Total (ha)	Clear-cut Equivalent
2010	2.5	1.08	18	21.58	24.49
2011	-	-	26.18	26.18	24.49
2012	-	-	0.6	0.6	24.49
2013	-	-	14.26	14.26	24.49
2014	5.5	1.53	0.75	7.78	24.49
2015	6.74	1.92	-	8.66	24.49
2016	7.7	1.92	-	9.62	24.49
2017	13	2.28	-	15.28	24.49
2018	14.5	1.65	0.5	16.65	24.49
2019	-	-	104.53	104.53	24.49
TOTAL	**49.94**	**10.38**	**164.82**	**225.14**	**244.9**

7.1.Supply of Rural Timber

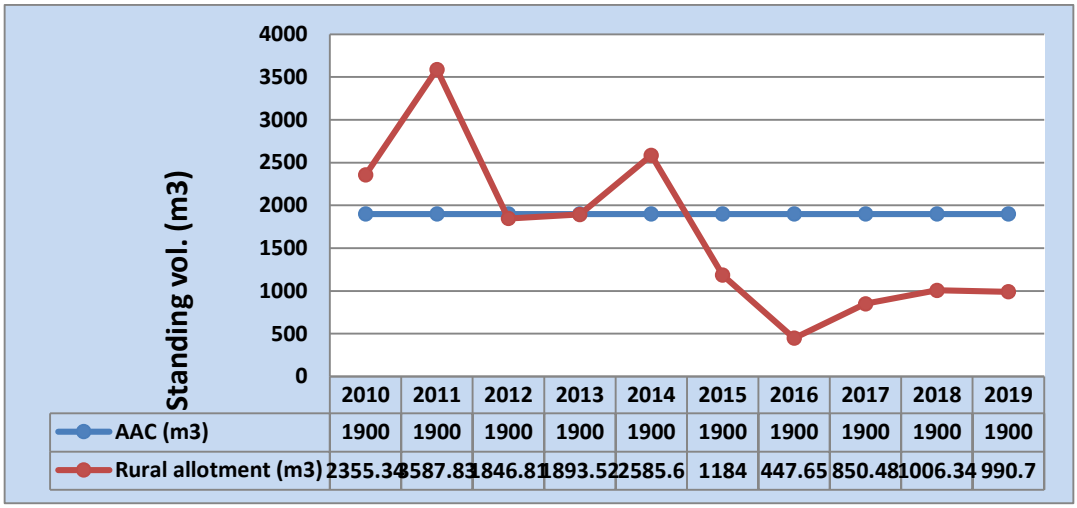
People residing within the KFMU extract rural house building timbers and firewood from the FMU. It is utilised for construction of new houses, repair, renovation and extension of rural houses, shed for livestock, farm guard shed, watch tower, toilet and machinery sheds. Besides, it is also used for agricultural implements, furniture, flag poles and fencing poles. The following table shows the general trend of supply of rural timber from the KFMU for 10 years, the data has been represented with graph as well.

Table 1.22: Rural timber allocation from Khotokha FMU (2010 - August, 2019)

Year	AAC (m^3)	Rural Allotment (m^3)
2010	1,900	2,355.34
2011	1,900	3,587.83
2012	1,900	1,846.81
2013	1,900	1,893.52
2014	1,900	2,585.6
2015	1,900	1,184
2016	1,900	447.65
2017	1,900	850.48
2018	1,900	1,006.34
2019	1,900	990.7

TOTAL	**19,000**	**16,748.27**

The rural timber allotment from the FMU is 16,748.27 m^3. It is about 88% of the Rural AAC allocated in the plan. There was a rise in demand for rural timber in the year 2011 due to the new town planning of Bajo Town under Wangdue Phodrang Dzongkhag. In the previous years, rural timber was allotted to areas outside Bjena and Rubeisa Gewog. In the later years, in order to control the AAC, rural timber was then only allotted to the two gewogs i.e. Bjena and Rubeisa. The comparison of rural timber allotment (as of August, 2019) and rural AAC is shown in the figure below.



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
AAC (m3)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Rural allotment (m3)	2355.34	3587.83	1846.81	1893.52	2585.6	1184	447.65	850.48	1006.34	990.7

Figure 1.13: Rural Timber Allotment against the Rural AAC

8. ORGANISATION AND ADMINISTRATION

8.1.Organization

Khotokha FMU is under the jurisdiction of Wangdue Territorial Division directly administered by the CFO. The CFO will be supported by Unit-in-charge who will supervise activities within the FMU. Unit In-charge is supported by four field staffs that assist him in implementation of management plan.

Operational plans will be developed and written by Unit-in-charge of the FMU with the support of CFO, Wangdue Territorial Division. Operational plans will be reviewed by the FRMD to ensure that the prescriptions are within the norms of prescribed management plan.

8.2.Health and Safety

It is of utmost importance to ensure the health and safety of the workers in the areas of work. As mentioned in the management code, health and safety is about preventing people from being harmed at work by taking necessary precautions and employers providing satisfactory working environment.

A Generic Risk Assessment must be done which will examine proposed harvesting sites and record any hazards contained within them. The areas of concern are hazardous areas like cliff edges, very steep terrain, road, overhead power cables, streams and right of way. The assessment should identify probable people at risk and the level of risk and have a proper control measures in place.

A Site Specific Risk Assessment should also be done to address the hazards imposed by felling, harvesting and transportation operations. NRDCL being the implementers needs to address these issues in liaison with Unit-in-charge. Given below are some of the recommendations to minimize the 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.

8.3.Record Keeping

The FMU office shall maintain the records of all the activities within the FMU as per the record keeping format of the Forest Management Code of Bhutan (FMCB,

2004). Maintenance of proper and adequate records in the FMU office was seen as a concern, as some important information were lost, which otherwise would have been very useful for the planning and management purposes.

9. INFRASTRUCTURE, TRANSPORT AND EQUIPMENT

9.1.Roads

A total length of 39 km of forest road was constructed during the first two plan periods by NRDCL to facilitate the extraction and transportation of harvested commercial as well as rural timber. During the last plan period, a total of 11.5 km forest road was constructed within the FMU. The construction of a stretch of 7.5 km of forest road connects Dolangdo Block to Kekephu block and the remaining 4 km of forest road was constructed within Kekephu block.

9.2.Buildings

The KFMU unit office was shifted from Chuzomsa to Khotokha in the year 2007. Currently the office is run at a rented house constructed using timber off-cuts. The Unit office will be soon shifted to the new office which is currently under construction through funding support from RGoB. Two new staff quarters are also being constructed along with the new KFMU office. A house constructed using timber off-cutsissituated within the FMU is used by NRDCL as their Unit office. The field staffs reside in similar houses close to the office.

(a)

(b)

Figure 1.14: Newly constructed KFMU office(a), NRDCL unit Office (b)

9.3.Transport

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

9.4.Equipment

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

- Computer Set- 2
- Printer- 2
- Xerox Machine- 1
- Laptop- 1
- Bark gauge-1
- Clinometer- 2
- Altimeter- 1
- Diameter tape- 3
- Measuring tape- 2
- Compass- 2
- Increment borer-1
- GPS Garmin- 1
- Scanner-1
- Walkie Talkie Set-5

10. EVALUATIONS OF PREVIOUS PLAN

The past harvesting activities and other associated activities in Khotokha 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. It is important to evaluate the past management plan to review whether or not the activities are carried out in line with the management plan prescription. Revisiting the areas and the plan would help identify areas for improvement or those aspects which has been overlooked. The required remedial measures can be accordingly incorporated in the new plan. The past plan is reviewed for its goals and objectives and evaluated for the on-field activities carried within the FMU.

Figure 1.15: Final monitoring and evaluation of KFMU

10.1. Review of Goals and Objective

Goal:

The goal set for the previous plan was to *'scientifically manage the FMU to ensure sustainable production of timber, fuelwood and NWFPs for perpetuity'.* The broad goal of managing the forest on a multiple use, sustained yield basis for the production of timber, fuel wood and other forest products was not achieved

completely. This 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 hence, the activities implemented in the last plan period was geared towards achieving this goal.

Objectives:

To improve the forest stand of Khotokha FMU by removing the old forest stand and replacing it with new forest growth through natural or artificial regeneration.

Trees are marked and extracted from cable lines every year as per the target AAC reflected in the Operational Plan. Old forest stand is removed with minimum disturbance to soil and the under growths/regenerations. The harvested/operated areas are allowed to regenerate. In KFMU, there is profuse natural regeneration so no artificial regenerations were required. Hence, the old forest stands were removed and replaced by new forest growth.

To ensure sustainable supply of timber, fuel wood and other forest resources.

The AAC of the FMU was calculated at 9,400m^3, of which 7,500m^3 was allocated as the commercial AAC to NRDCL and 1,900m^3 was allocated as the rural AAC for rural allotment. The total commercial and rural AAC for last nine years is 67,500 m^3 and 17100 m^3 respectively. As per the record obtained from the Unit Office and the Operational plans of last nine years, the actual commercial and rural harvesting was 65,838.69m^3 and 15,757.57m^3 respectively. Therefore, the commercial and rural timber harvesting were found to be as per the prescription and has not exceeded for last nine years. Taking this into consideration, the objective of sustainable supply of timber (both commercial and rural) was achieved.

Other forest resources like sand; NWFPs, Bamboos, etc. were also supplied from the FMU. No annual harvesting limit was fixed for NWFPs. NWFP harvesting in the FMU must be done based on prescribed management prescription in the future management plan for major NWFPs. Management prescription for important NWFP species should be identified and prioritised and management plans must be developed in close consultation with Social Forestry and Extension Division of the Department.

To create awareness about the FMU among the local communities and generate active participation of people in sustainable management of forest.

Various meeting such as FMU-level management committee meetings, public extension meetings etc. were conducted within the FMU with the aim to secure local people views in the management of the local forest resources. These meetings were

planned activities, and have been reflected in the operational plans of the FMU and therefore have allocated budget for such activities. All these were aimed at involving the local people in the management of local forest resources.

To regulate grazing to maintain the natural regeneration capacity of the forest.
Impacts of grazing are not very severe in the FMU. The harvested areas were regenerated by means of natural regeneration which is adequate and well established. Most of the local people rear improved breed of cattle and are mostly stall fed. Those villagers rearing cattle should be encouraged to grow fodder species in their uncultivated private land to reduce grazing pressure on the FMU in the future.

To generate local employment opportunities.
FMU provided opportunities for local employment as local people were hired to carry out the activities of the FMU. Although skilled works were contracted out, the local people were involved in most of the works that can be performed by unskilled labours.

To promote local research, demonstration, aesthetic and education of natural forest ecosystem.
No research, demonstration, aesthetic and education of natural forest ecosystem were conducted in the FMU. However, in the future, it is essential to carry out research in the FMU area to better understand the impact of logging on the forest ecosystem as well as to study the benefits of low impact logging techniques on forest.

10.2. Review of Harvesting Activities

Commercial timber harvesting operations in Khotokha FMU was carried out by skyline cable system. Gravity machines (cable cranes) reduce soil disturbances/erosions, minimize log damage and leaves regeneration largely undisturbed. This system has also reduced the extensive construction of road thus reducing environmental damages and the expenditure on road.

While reviewing the harvesting activities carried out in Khotokha FMU during the plan period (2009-2019), the following observations were made;

- Cable line corridor width of 4m was maintained in the Blue pine operated area. However, few cable corridors in mixed conifer working circle were

more than 4m (the prescribed cable corridor width in the management plan), which increases the clear cut area.

- Incidences of illegal timber extraction from the FMU were evident. Most of the illegal activities were carried out along the road connecting Khotokha and Gogona FMU. Therefore, Wangdue Forest Division and Khotokha FMU office should strictly monitor the illegal activities by conducting regular and adhoc patrolling activities in the FMU. All illegal timbers should be accounted in total commercial AAC of the FMU.
- Cable line signage reflecting the cable line number and the year of operation were placed properly in all the operated areas. These signage are important for future identifications and references.
- Proper inspection of harvest coupe should be carried out by the Unit prior to issuance of coupe clearance.
- The fire burnt area of 2008 under Chibegang Block was planned for timber extraction as per Operational Plan 2019-2020. Though the extraction operations were initiated, NRDCL raised issues on poor timber quality as most of the timbers were rotten, non-feasibility of extraction due to steep slopes and difficult terrain and the total recovery volume from the fire burnt site being less than the volume allotted for extraction. However NRDCL is to expedite extraction of timbers from the fire burnt site and if the recovery volume is lower that the allotted volume, NRDCL will be allotted with additional area for extraction to meet the target volume after the submission of joint verification report on timber extraction from the fire burnt area and other allotment sites by NRDCL and Wangdue Forest Division. Therefore, in this plan period other fire burnt areas are to be given priority for extraction before the timber quality deteriorates and also to prevent any pest/disease outbreak.
- NRDCL should carry out plantation if the natural regeneration fails to come up within 3yrs from the fire incidence.
- The Division and Unit in-charge should maintain proper records of FMU activities including volume of timber extracted (both rural and commercial) as per format circulated by the Department. The Unit in-charge must maintain check and balance on AAC both b volume and Clear cut Area as mentioned in the management plan.

10.3. Review of Road Building Activities

Although, roads are considered to raise the highest environmental concerns due to its negative impact on the environment at large, roads running within the FMU have been constructed so as to reduce its negative impacts. During the last management plan 11.5 kms of forest road was constructed from Dolangdo to Kekephu where the logging activities have taken plan .The road has benefitted local people residing both within and outside KFMU.

The conditions of the roads were found to be generally good and pliable. Drainage and culverts have been provided and the roads are found to be stable. However, the side drains along forest roads are not present at certain place or are blocked by wooden debris or mud. The forest road was maintained well but some sections of the forest road required immediate maintenance. NRDCL should provide adequate budget for maintenance of road (particularly for side drains and construction of culverts/cross drains where required) in the FMU. It is also necessary to extract trees felled during road construction trees/logs from the site immediately.

Table 1.15.1: Road Construction Information

Block/ Compartment	Year	Road (km)
Kekephu/Dolangdo/Tashila	2010	6
Kekephu	2010	3
Kekephu	2011	1.5
Kekephu	2018	1
Total		**11.5**

10.4. Review of Reforestation

Regeneration of principal species in coniferous forest is comparatively better than in broad-leaved forest. Therefore reforestation of harvested or operated areas in Khotokha is through natural regeneration only. Natural regeneration in most operated areas was found to be adequate and well established. The operated area is to be monitored for three consecutive years after operation so that the area may be reforested artificially by planting the principal species, should natural regeneration fail. Monitoring form for 2011, 2012, 2013 and 2014 operated lines were available in the FMU office and according to field report, there are more than 2000 seedling/ha. As per the regeneration survey, the regeneration of desired tree species is found to be adequate in the harvested areas. Due to this, artificial regeneration in

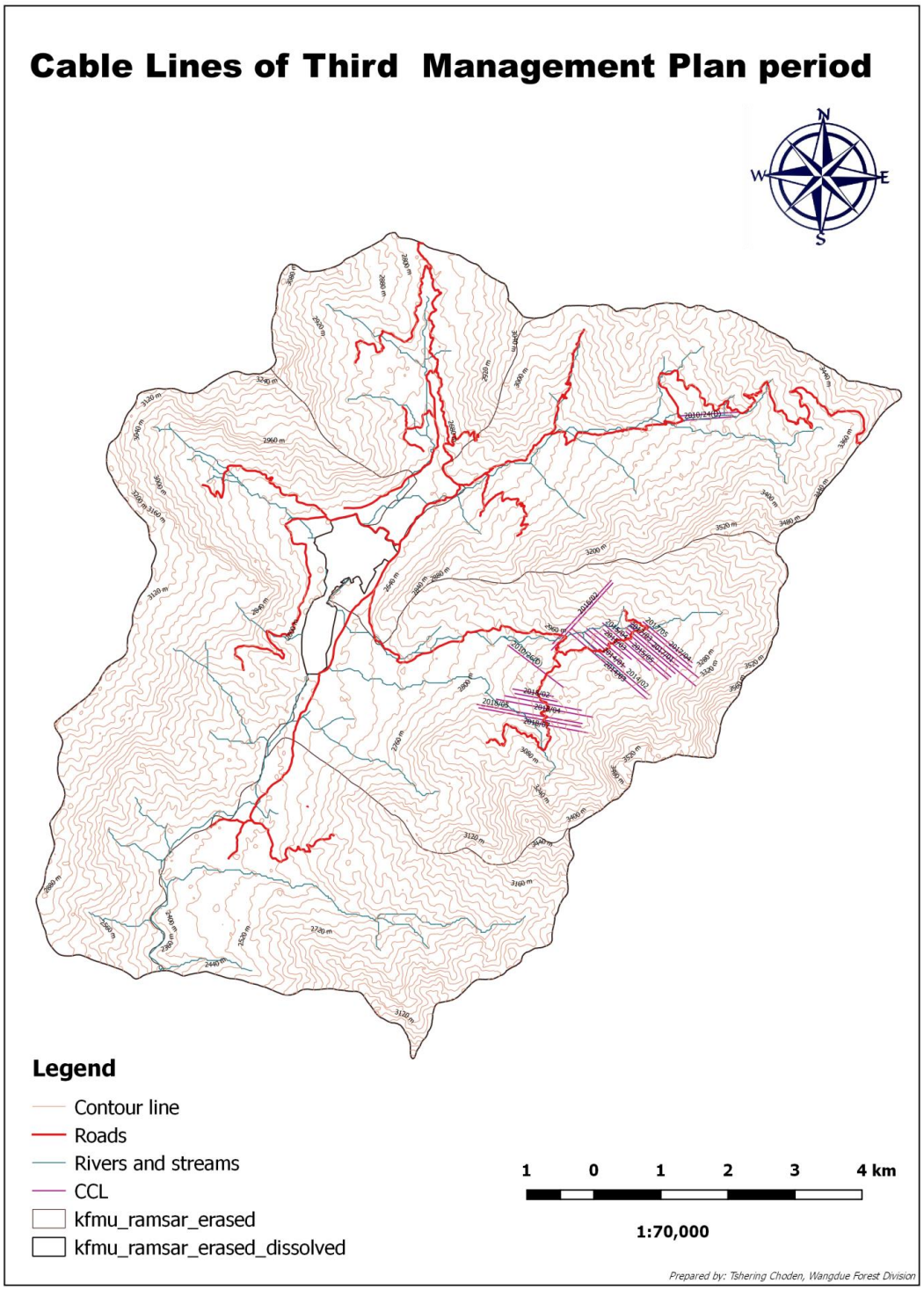
the form of plantations was not carried out. It was observed that there was profuse regeneration of Hemlock and Blue pine along the road sides and in places where the soil was disturbed. Hence, it is recommended that NRDCL should carry out soil disturbance works in the harvested lines so that it will be easier for the seeds to come in contact with the soil to ensure germination.

10.5. Review of AAC

The AAC fixed as per the previous management plan 9,400 m^3 per annum.AAC for KFMU was calculated using the formula which is a combination of area, volume and rotation. The potential commercial AAC for Khotokha was 7,500 m^3 of standing volume considering various factors such as forest condition of Khotokha and the AAC for previous plan. The AAC during past plan was determined taking into consideration the extraction capacity of NRDCL along with the capacity of the forest.

However the trend of timber extraction in Khotokha FMU during the last ten years (plan period) reveals that the full AAC was not extracted in most of the year by NRDCL due to various limitations in the field. Scarcity of enough man power/labour and machineries to carry out the range of activities (related to felling, road construction and maintenance, transportation) and the difficult weather conditions greatly hindered the performance of NRDCL. In the future, KFMU will be under tremendous pressure to meet the timber demand (from people living outside FMU) with increasing developmental activities.

Map 2: Roads and cable lines operated in past management plan



PART 2: THE FUTURE MANAGEMENT

PART 2: THE FUTURE MANAGEMENT

11. INTRODUCTION

The constitution of Bhutan necessitates the government to maintain the forest cover of 60% for all times to come. Article V, Section 3 of the constitution (Royal Government of Bhutan, 2008) states "the government shall ensure that, in order to conserve the countries natural resources and to prevent degradation of the fragile mountain ecosystem, a minimum of 60% of Bhutan's total land shall be maintained under forest cover for all times to come". This important provision of the constitution has also been re-emphasized in the National Forest Policy, 2011 which 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 will not only help us in managing our forest sustainably but also full fill the social, economic, ecological and cultural needs of the present and future generations.

11.1. Forest Policy

The Forest and Nature Conservation Act of Bhutan 1995 mentions the requirement of management plans to be approved and implemented for all protected areas and for all forests where commercial logging is to be undertaken. This plan has been prepared in line with the Forest and Nature Conservation Act 1995 and the Forest and Nature Conservation Rules and Regulations of Bhutan, 2017 in close adherence to the guidelines provided in the Forest Management Code of Bhutan, 2004. The National Forest Policy of Bhutan, 2011 consist of long term goal, major policy objectives and specific statements to enable various aspects of forest production, use and management. It has five guiding principle which is, equity and justice in terms of accessibility, poverty alleviation through integrated approach, deregulation and devolution, integration of science and indigenous knowledge and allowing import of logs and sawn timbers (Department of Forest and Park Services, 2011).

This plan has been prepared in line with the Forest and Nature Conservation Act (1995), Forest and Nature Conservation Rules and Regulations (2017), National Forest Policy 2011 and Forest Management Code of Bhutan (2004).

11.2. Overall Goals

The overall goal of Khotokha FMU is to "*to manage the forest on a multiple use, sustained yield basis for the production of timber, fuel wood and other forest products and for watershed, wildlife and environmental protection*"

11.3. Objectives

The objectives of Khotokha Forest Management Unit were framed based on different management circles identified to ease the implementation of the plan. The three Management Circles identified are **Protection**, **Production** and **Non-Production** Management Circles. As different management circles are managed for different purposes, framing separate objectives can help manage, monitor and evaluate the areas with ease. However, there are instances where different management circles share similar objectives. The objectives of each Management circles are listed below.

Protection Management Circle

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

Non-Production Management Circle

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

Production Management Circle

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

11.4. Management Based on Forest Function

11.4.1. Introduction

Commercial harvesting is not feasible in all the areas of FMU. The reason could be either economically or environmentally based. Some areas have to be restricted from harvesting and therefore placed for conservation purposes, either due to steepness of its slope, to avoid destroying the habitat of some endangered species or to protect the water source of the local inhabitants. The function of that area differs from that of area designated for commercial harvesting. Thus, forest function is a term which defines the definite purpose (their influence on forest management) of an area within FMU by which the areas are differentiated and grouped as per their potential uses.

The values and rankings of such functions with each other are different from each FMU and depend on location, site, forest type, accessibility, landscape and host of other factors (Schindele and Dhital, 1997). Some functions may be fulfilled from large, connected forest areas (nature conservation, watershed conservation, wildlife protection). While others may be satisfied by small forest patches (e.g. habitat for rare plants or insects). There are functions such as soil conservation, which depend on time constant factors (topographic features such as slopes) and are easier to demarcate and map while some functions, such as social functions and wildlife conservations, which are dependent on time variable factors, are comparatively difficult to map. Functions may overlap (e.g. environment conservation and wildlife conservation) or maybe mutually exclusive (e.g. wildlife protection and intensive agriculture). FMCB (2004) describes forest function as, the forest area within the FMU and can be categorized as ecological, environmental and social functions. It serves to balance the often diverging interests of commercial logging, local forest use and nature conservation.

The whole process of forest function planning and mapping yields forest function maps, which forms the bridge between planning and implementation. Forest function maps along with management prescriptions are the basic tools for the FMU in-charge for field implementation of this management plan.

11.4.2. Objectives of Forest Function Mapping

The main objectives of forest function planning are:

- To define different ecological, environmental and social function of the forest and depict them on maps.
- To identify Production, Non-production and Protection area within the FMU.

- To provide a tool for the management planners to balance the different requirements of nature conservation, environment protection, social forestry and commercial timber production among others and also to provide the spatial information required computing the sustainable AAC while at the same time, satisfying the management prescriptions and restrictions for the different forest functions.
- To provide the FMU in-charge with information on location of different forest functions in order to enable him/her to specify the required management prescriptions on the ground and to control the implementation.

11.4.3. Function Groups

The functions used in this management plan are listed in the table below. Some of these groups include functions that differ only in the degree of intensity of their management prescriptions.It is to be noted that the term" protection" has been used for functions where commercial operations is prohibited and "conservation" has been used where function imposes management restrictions on the commercial use.

Table 2.1: List of different forest function groups and functions

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*			

11.4.4. Mapping of Forest Functions

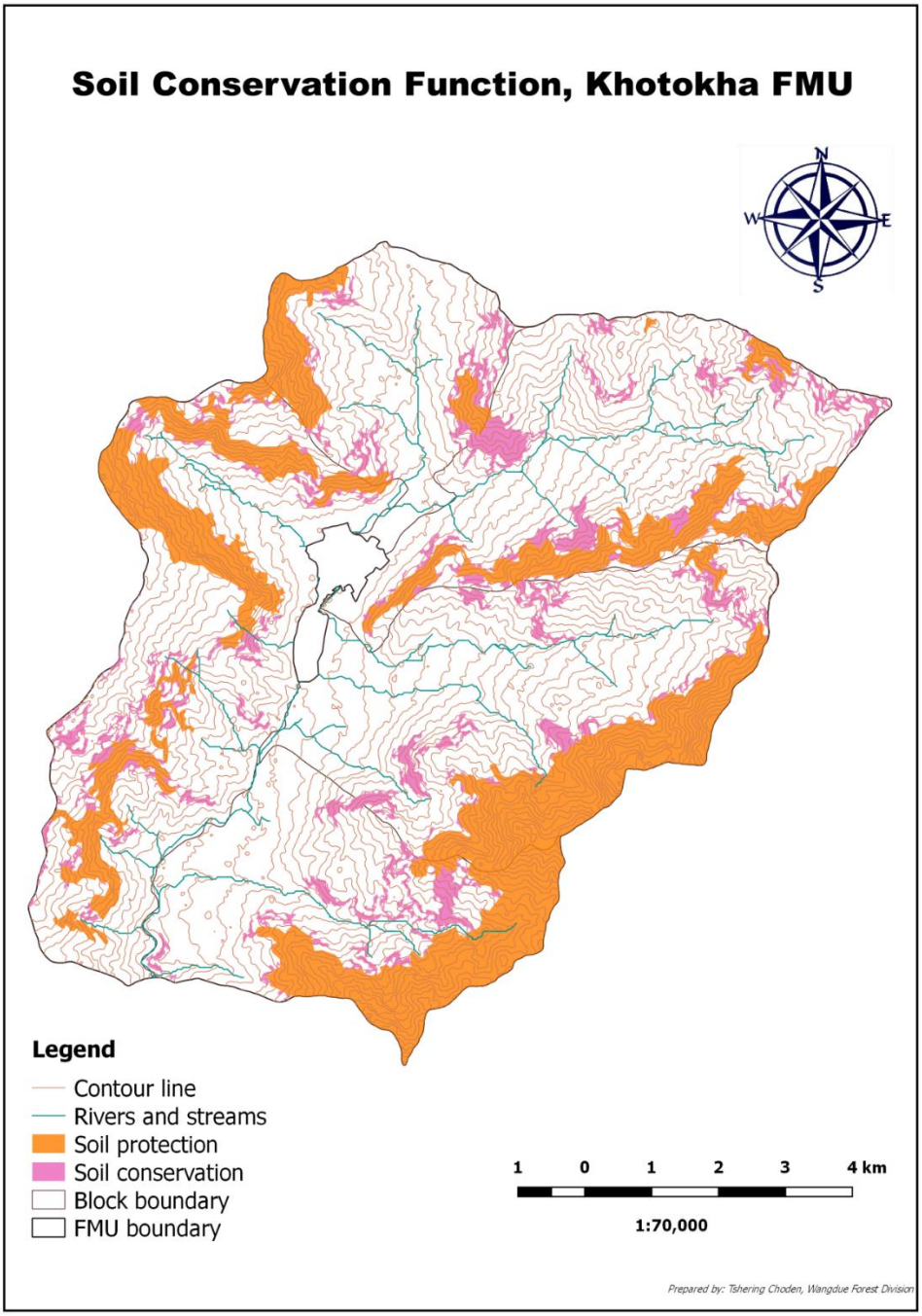
The criteria to prepare forest Function Maps for the FMU are given to the table below. In this table, information for some criteria is not available or cannot be mapped at the scale used for planning. These criteria are indicated in italics. New

details are to be collected when operational plans are prepared and should be implemented accordingly.

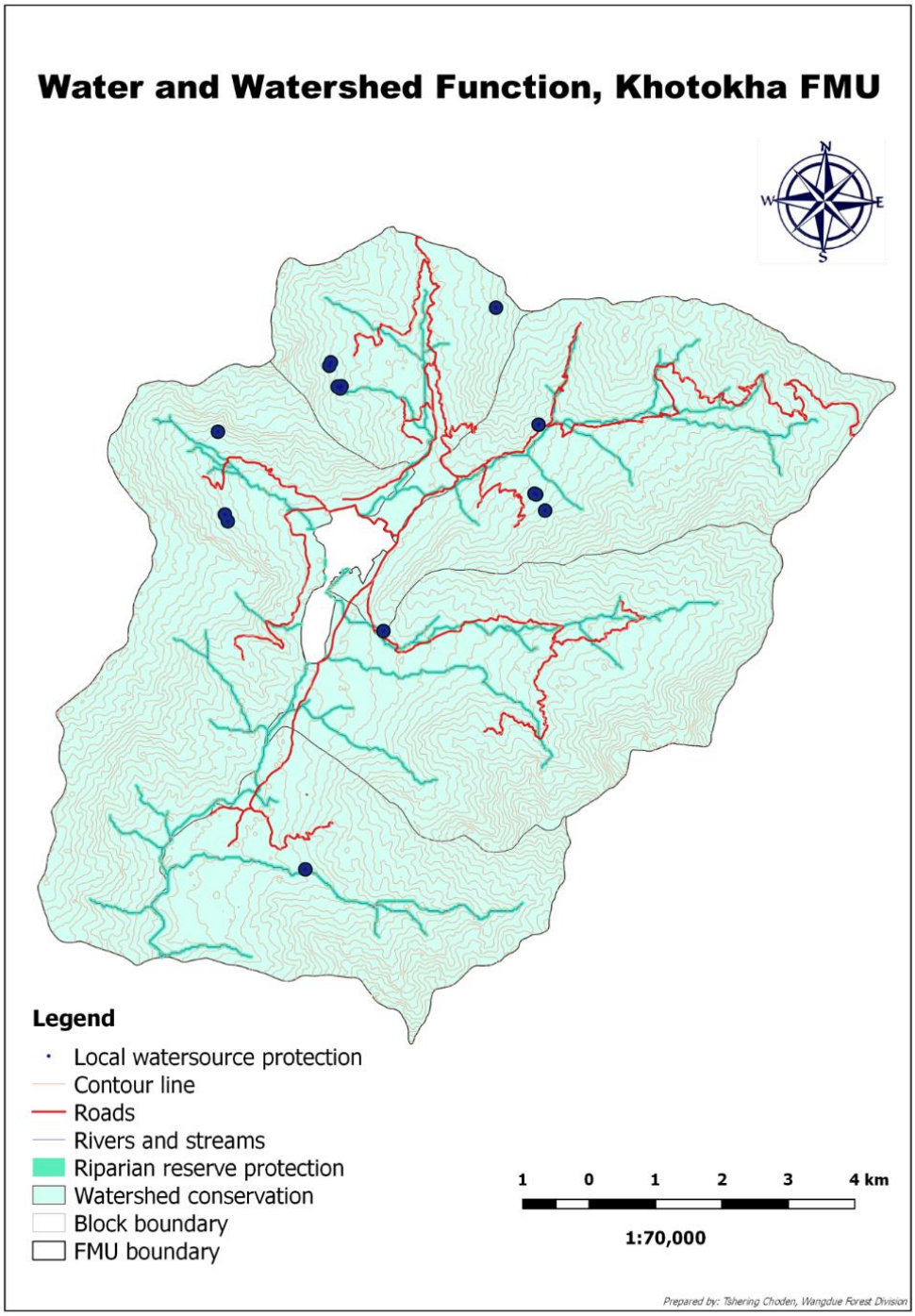
Table 2.2: Criteria for Mapping of Forest Functions

Function Group and Code	Criteria for Mapping
Soil Conservation	**SP:** very steep areas (slopes greater than 100*%), areas with indication of slight to moderate erosion.* **SC:** steep or sensitive areas (slopes of 76-100%)
Water and Watershed Conservation	**WSh:** Catchment areas of water courses, water retention areas **WRR:** areas within 30m along all the perennial streams, water-logged areas, swamps, etc. **WLS:** upper catchment areas of streams serving as drinking water source for settlement downstream
Nature Conservation	**NWC:** areas rich in wildlife, both in species and in number, breeding areas, watering places **NWP:***Ecosystems of high conservation values*
Social Function	**SocL:** Area close to or accessible to settlement or village, the areas traditionally used already, with definite boundaries. **SocRS:** 100 m buffer radius around *Lhakhangs/Goenpas*, *Gneys* and other religious sites.

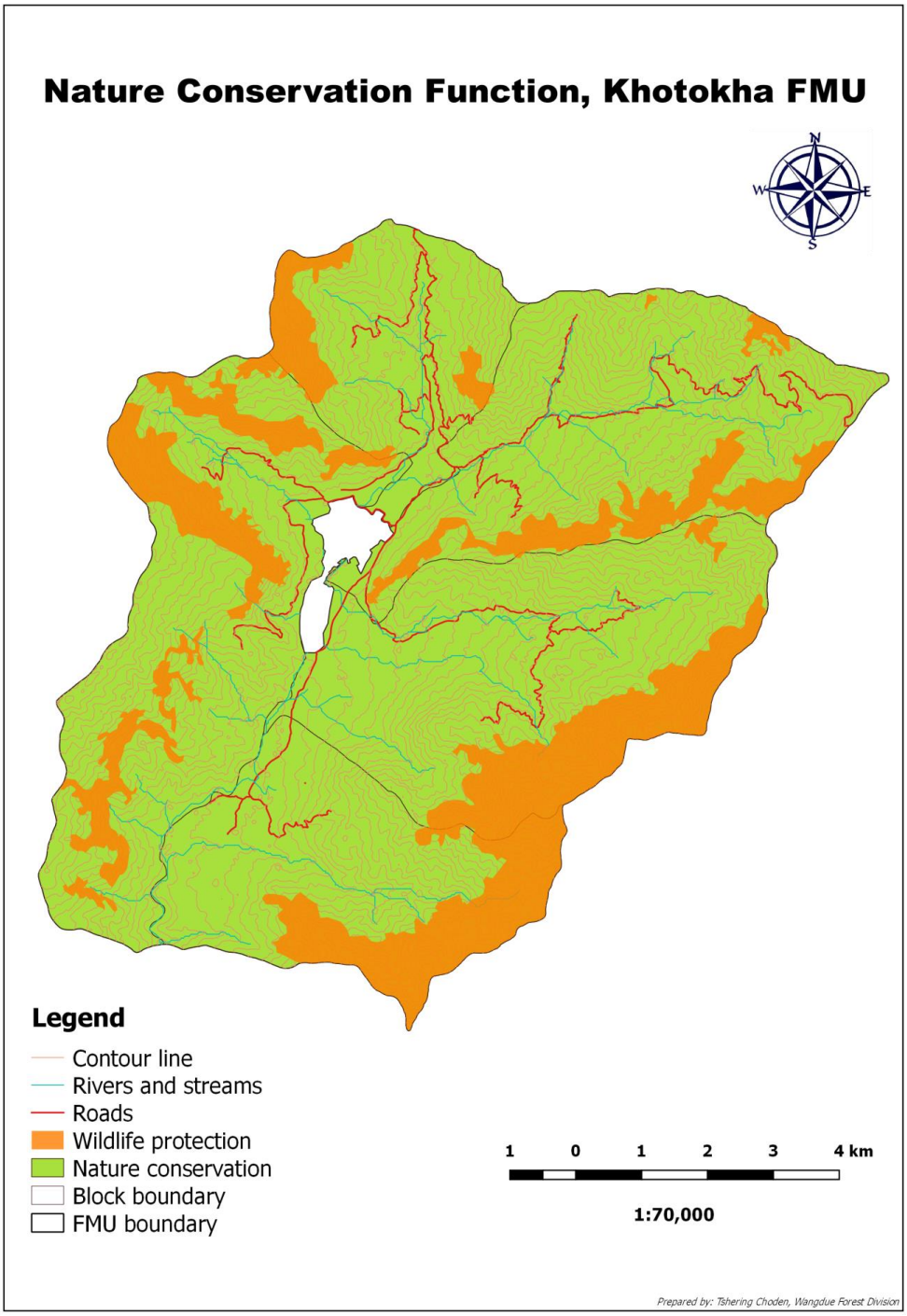
Map 1.5: Soil Conservation Function



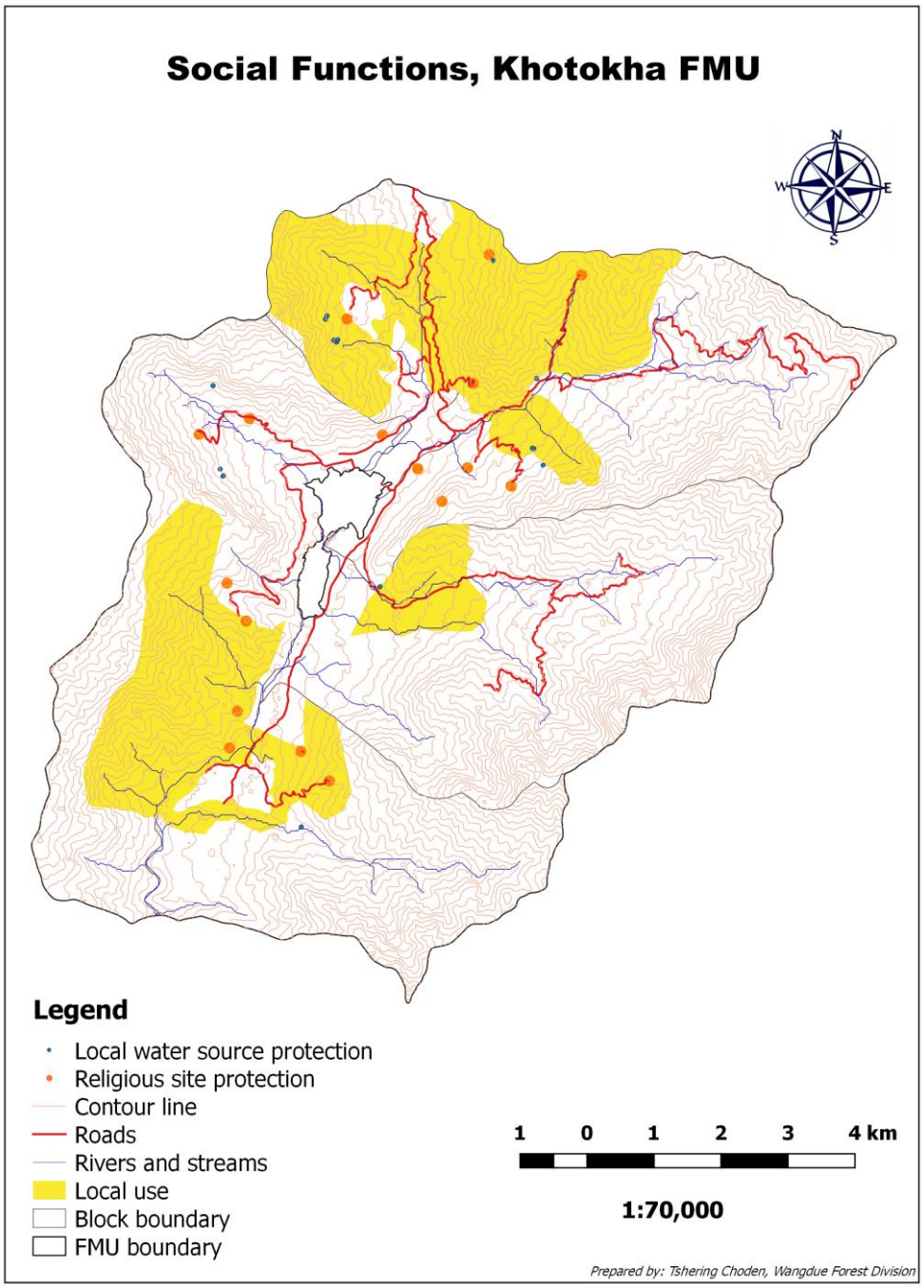
Map 1.6: Water and Watershed Conservation Function



Map 1.7: Nature Conservation Functions



Map 1.8: Social Function



11.4.5. Restrictions of Forest Functions

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

Table 2.3: Forest Function Restrictions

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

11.5. Identification and description of functions

11.5.1. Soil Protection and Conservation

11.5.1.1. Soil Protection (SP)

Soil Protection includes all areas, which are extremely sensitive to soil erosion, land and snow slides. These areas include in particular very steep slopes, rocky and stony areas, water logged gleys and already eroded areas. Unstable slopes above or near important objects such as villages, settlements, individual houses, roads, agricultural land, etc. are defined for protection reasons as Soil Protection. The objectives of this function are to prevent damages caused to the environment and infrastructure by landslides, snow slides, falling stones and other physical impacts and to protect the soil from erosion and to sustain soil fertility. Soil Protection is subjected to complete protection with no commercial activity. However, some degree of interference is permitted for *bona-fide* use only (i.e. collection of minor forest produce).

11.5.1.2. Soil Conservation (SC)

The function "Soil Conservation" covers all areas, which are sensitive to soil erosion, which are, for instance steep slopes; water logged areas and exposed sites. The objective is to minimize or prevent negative impacts due to forest resource use in order to protect the soil from erosion and other degradation processes and to sustain soil fertility. Harvesting operations is permissible under strict management prescriptions in Soil Conservation area. There should be minimum disturbance and damage to the under storey vegetation and/or residual trees. Indiscriminate grazing should be strictly prohibited in regeneration areas.

11.5.2. Water and Watershed Conservation

11.5.2.1. Riparian Reserve Protection (WRR)

Riparian areas occur along the banks of rivers and streams. They include the water body itself, areas subject to periodic inundation and flooding, areas with high water tables and immediate adjacent uplands. Riparian areas often contain the highest plant and animal diversity, and some of the highest valued non-timber forest resources in the forest landscape. They provide critical habitats, home ranges, travel corridors for many mammal and bird species, and maintain ecologically important vertical and horizontal linkages throughout the forest landscape. The objectives are to prevent negative impacts due to forest resource use on stream channel stability, water

quality, and aquatic ecosystem productivity and diversity and to protect and sustain plant diversity associated with riparian areas.

11.5.2.2 Local Water Supply (WLS)

Buffer zones have to be defined for all areas in the immediate vicinity of water resources used for the local water supply and including, the water-body itself and swampy or water logged catchment areas. The objectives are to prevent negative impacts due to forest resource use on water quality and stream channel stability. All the water sources that are located in the forest areas used by the villagers have been identified. Local Water Supply area is also strictly protected with a buffer of 100 m along the water source. The buffer zone is devoid of tree felling, intensive cattle grazing, chemical application, and disposal of garbage and infrastructure establishment.

11.5.2.3. Watershed Conservation (WSh)

Watershed conservation forest covers the upper catchment areas of watercourses on steep slopes and poorly drained or permanently waterlogged areas and all other sites serving as water retention or water feeding bodies. The objective is to maintain the cleanliness of ground and surface water (water quality) and to prevent surface run-off of precipitation and to sustain continuous water supply.

The entire forest area of Khotokha FMU is classified under Watershed Conservation area because of the presence of steep areas having slope greater than 10 degrees. Water quality can be affected through the fast decomposition of raw humus layer, the application of chemicals or fertilizers, the wash out of the top soil and increased surface run-off of precipitation and intensive forest pasture. To sustain and maintain continuous water supply the water infiltration rate should be kept as high as possible. Therefore, forest harvesting operations should minimize disturbance to under-storey vegetation. Clear felling and conversion of natural forests into plantations is prohibited. Efforts should be made to develop multi-storied structure of forest. Indiscriminate grazing should not be allowed in the area. The use of heavy machines, application of fertilizers and changing of oils is strictly prohibited.

11.5.3. Social Functions

The social functions and local uses of the forest were identified and described during the course of the Socio-Economic Study.

11.5.3.1. Local Use Only (SocL)

Forest areas which are and have been, traditionally used intensively by the local population and which are an integrated and indispensable component of their subsistence have been set aside for Local Use (Only) in order to provide the local population with sufficient forest products for their subsistence needs in a sustainable way and to exclude forest areas from commercial logging, where the commercial use of the forest is in contradiction with the objectives.

For this purpose all areas in the immediate vicinity of settlements were classified as Local Use Only. The size and boundary was determined based on the present forest use, the resource and site condition, the vicinity to the settlements, and on demand/supply considerations.

Fig 2.1. Demarcation of Local use area during the public consultation meeting at Khotokha

11.5.3.2. Religious Site Protection (SocRS)

Religion plays an important role in Bhutan. Within Khotokha FMU, there are many religious sites such as monasteries, gneys, meditation houses and other religious objects. To respect the sanctity of these holy places and in order, not to disturb people in their religious practice, any kind of forestry operations should not be permitted within a distance of 100 m around the site.

11.5.4. Nature Conservation

It is the objective of the nature conservation functions to balance the diverging interests of commercial logging with that of nature conservation and environment protection.

11.5.4.1. Wildlife Protection (NWP)

This function includes all habitats and other areas where rare or endangered mammals and birds occur and where the protection of these animals gains highest priority. The objective of this function is to conserve the habitat of protected wild animals and corridors for their movement and to prevent the protected animals from human disturbances.

11.5.4.2. Wildlife Conservation (NWC)

All forest areas rich in plant species variety and wildlife, in particular, mammals and birds, have been defined as Wildlife Conservation Areas in order to minimise or prevent negative impacts due to forest resources use in or near the wildlife habitats and to minimise disturbances due to human impacts.

11.5.4.3. Road Buffer

In order to protect the road from rock fall, land and snow slides, surface run-off of precipitation and erosion, zones along roads were determined as a buffer where the implementation of forest activities may have direct negative impact on the road itself or on the security of the traffic. According to section 14 a(i) of the Forest and Nature Conservation Act (1995) it states that " no permit to fell or to take any timber within 200 m uphill and 100 m downhill along motorable roads will be allowed". Forest road buffer will be determined once forest road is constructed. Harvesting operations should be restricted within 30 m uphill and 10 m downhill on unstable terrain along the forest road.

A road along steep slopes, poor drainage or watershed areas, clayish soil texture, high stoniness and fragile geologic formations requires the need of a road buffer. Commercial logging has to be prohibited, particularly, within this zone. Besides, the collection of NWFP such as fruits, medicinal herbs, etc. for the local use and deadwood and fallen branches for firewood are permitted.

12. QUANTITATIVE RESOURCE ASSESSMENT

12.1. Forest Management Inventory

Inventory Design of Khotokha Forest Management Unit

The forest management inventory of Khotokha FMU was conducted in 2018 for the preparation of the fourth management plan. The standard FMU inventory technique was used, with data being collected for trees >10 cm DBH (OB). A total of 375 plots were laid in the operable areas of the FMU at a more practical spacing of 500 m × 500 m, thus a plot representing an area of 25 ha. The inventory was designed with target sampling error of +/- 10% at 90 % confidence level. All the plots were designated as special plots. The data in the field was collected using the SUMSUNG GALAXY TAB with the help of Collect Mobile application.

The general objective of the inventory was to make available essential background information for the 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. It also provides useful information to compare and observe the change in analysed inventory data of previous and initial plan period.

12.2. Forest Management Inventory Result

The data obtained from the forest management inventory was analysed using statistical software called 'R'. As per the data analysed, the average standing volume per hectare was found to be 351.33 m^3/ha with a standard error of 7.95%. The average number of trees per hectare in the FMU was estimated at 399.17 with a standard error of 7.00%. The basal area per hectare was estimated to be around 38.184 m^2 with a standard error of 1.55%. The summary of the inventory results is shown in the table below:

Table 2.4: Summary of Inventory Results for overall FMU area

Result Type	Measures	Absolute Error	T-value at 90%	SE/MoE for Total tree count	SE %	Lower value	Upper value
Total tree volume	3,294,541.56	157,769.64	1.66	261,897.60	7.95	3,032,643.97	3,556,439.16
Mean tree volume	351.33	16.83	1.66	27.93	7.95	323.40	379.26
Total tree count	3,743,151.50	157,870.24	1.66	262,064.60	7.00	3,481,086.90	4,005,216.10

Mean tree count	399.17	16.84	1.66	27.95	7.00	371.22	427.12
Total tree basal area	358,059.07	14,525.86	1.66	24,112.92	6.73	333,946.14	382,171.99
Mean tree basal area	38.184	1.55	1.66	2.57	6.73	35.61	40.75

Based on the Inventory results the RME (Reliable Minimum Estimate) determined for Standing volume per hectare (vol/ha) is 323.40 m^3/ha with standard error of 7.95%.

13. AREA ORGANISATION

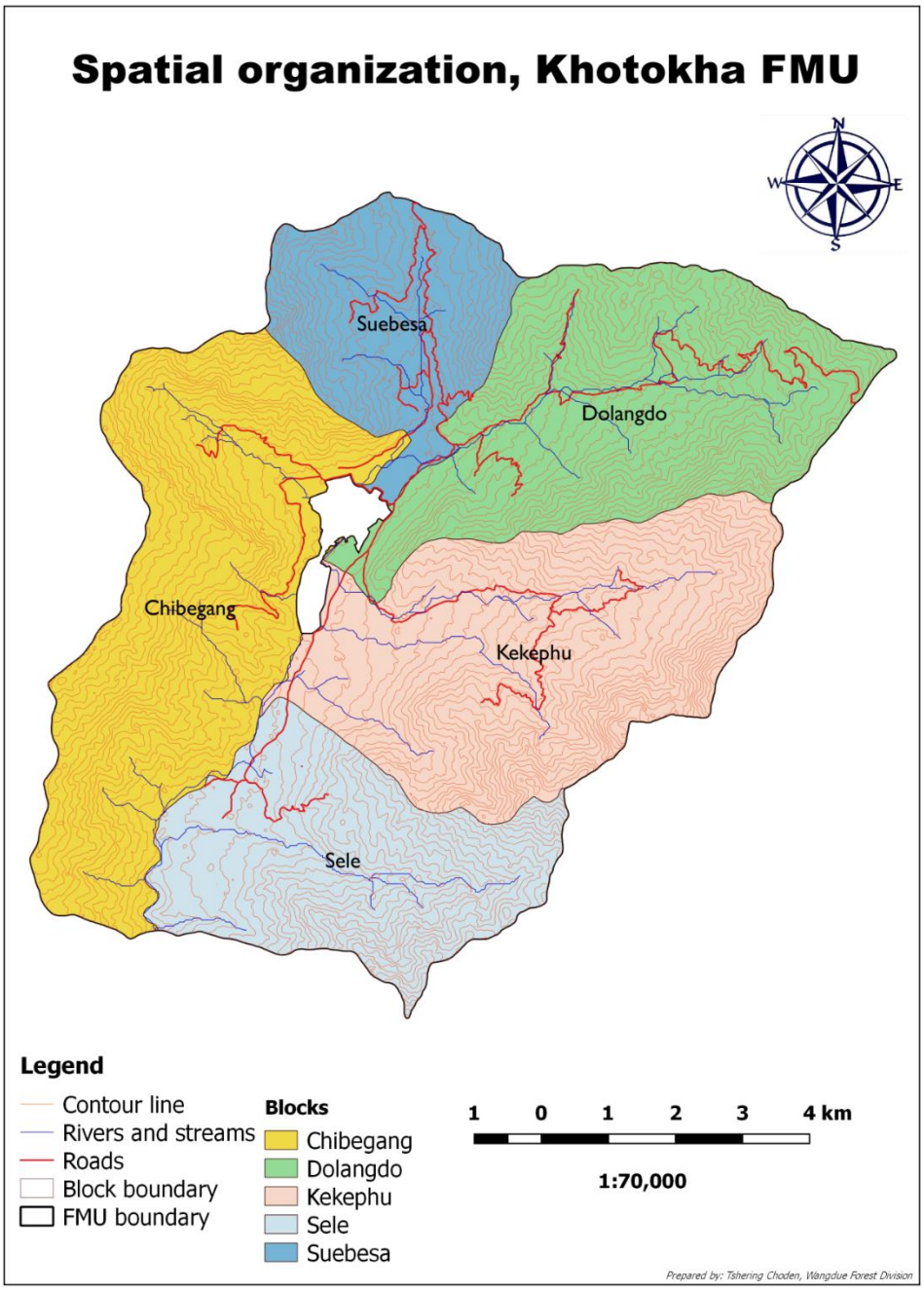
13.1.Spatial Organization

In order to ensure systematic and ease of implementation of management prescriptions, the Forest Management Unit is divided into blocks. Blocks have been demarcated according to natural drainage and terrain features wherever possible. The Khotokha FMU is divided into five blocks as follows.

Block	Area (Ha)
Dolangdo	2080.506
Suebesa	1037.087
Chibegang	2345.244
Kekephu	2275.118
Shelley	1543.070

Cable lines should be aligned along the stable, well-stocked ridges/spurs and away from environmentally sensitive and unstable gullies and sites. Block boundaries have been demarcated, as far as possible, to follow natural water ways, ridges and easily recognisable spurs or other terrain/physical features for ease of management and implementation of field activities. Given the constraints of accessibility and diverse terrain features, such simplified and recognizable mapping features become highly essential for field staff.

Map 1.9.Block and Compartments of FMU



13.2.Determining Operable Area

FMUs are managed for many purposes, which are generally protective, climatic, productive, scientific, recreational, etc. But while managing a unit area of forest, all such purposes cannot be given equal importance. 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%) and Soil conservation
- Agricultural uses
- Riparian buffers and zones
- Local water supply protection
- Biodiversity areas (wildlife conservation and protection)
- Religious site protection
- Road buffers.

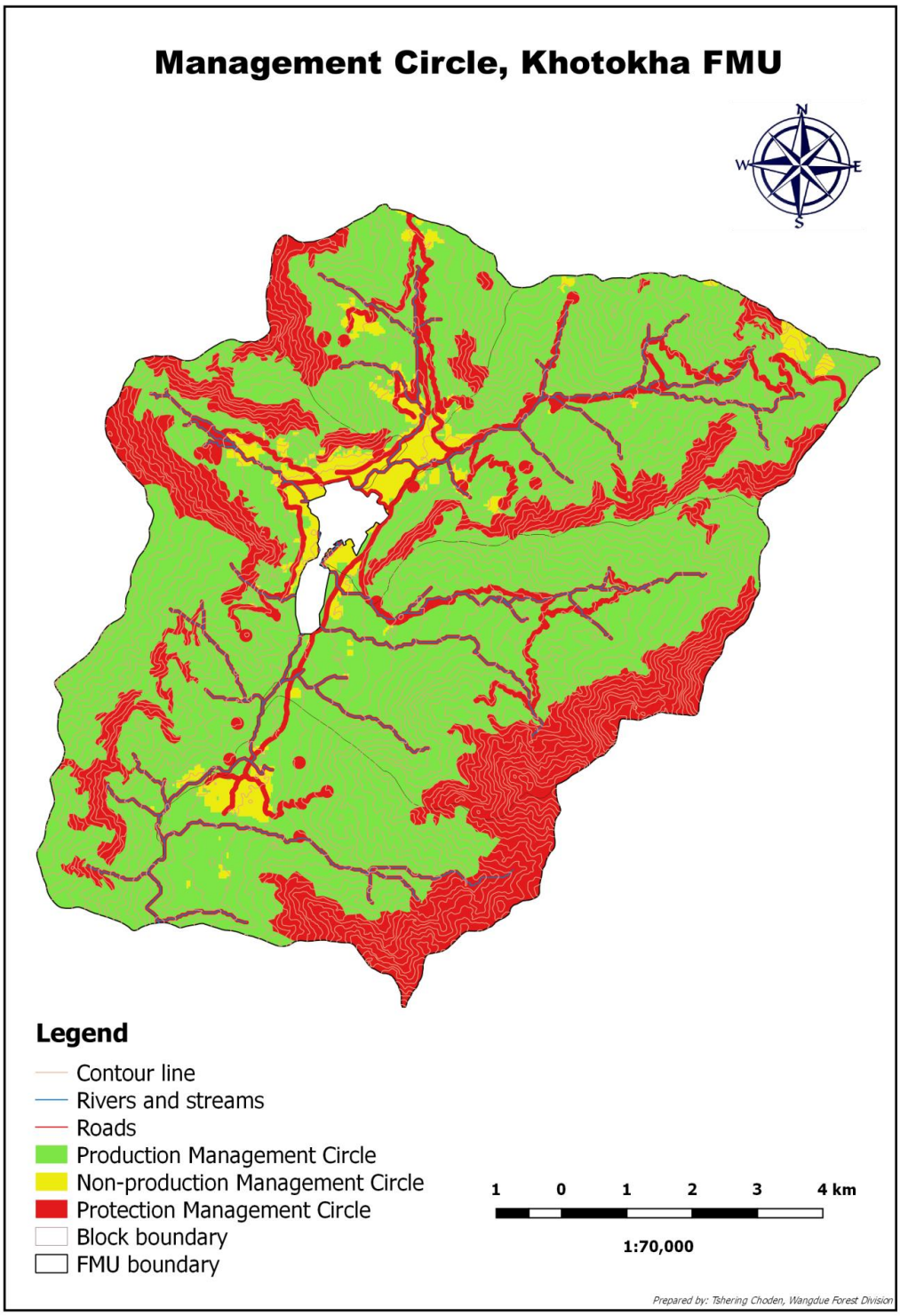
13.3.Organization into Management Circles and Working circle

Three broad management circles are delineated for Khotokha FMU using function mapping. The three broad management circles are Protection, Production and Non-production Management Circles. The Production Management Circle is further divided into three working circles: Mixed conifer working circle, Blue pine working circle and Broadleaf working circle. There is no community forest working circle within the current boundaries of Khotokha FMU. Working circles are managed for objectives specific to that working circle.

Table 2.5: Area Statement for Management Circles and Working Circles

Management and Working Circles	Area (ha)
Protection Management Circle (2,930.324 ha)	
Soil Protection	2,015.534
Local Water Source Protection	28.359
Riparian Reserve Protection	433.754
Religious Site Protection	38.091
Road Buffers Protection	414.585
Non-production Management Circle (340.064 ha)	
Shrubs	88.455
Build-up Areas	4.1004
Agricultural Land/ Cultivated Land	198.099
Meadows	49.409
Production Management Circle (6,010.638 ha)	
Blue Pine Working Circle	1,484.333
Mixed Broadleaf Working Circle	215.832
Mixed Conifer Working Circle	4,310.473
TOTAL	**9,281.027**

Map 1.10. Management Circles



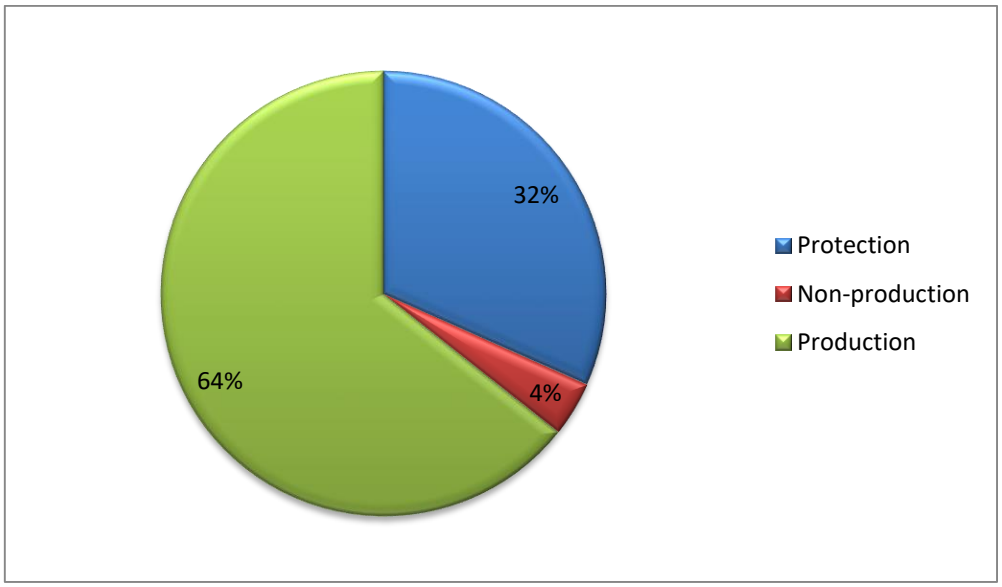


Figure 2.2: Management circle area statement in percentage

13.4.Management of Working Circles

13.4.1. Protection Working Circle

The protection working circle constitutes all the areas with protection functions; wildlife protection, soil protection, riparian reserve protection, religious site protection, road buffer protection and local water supply protection. Therefore no commercial harvesting activities will be permitted in these areas that have been designated as protection working circle.

In Khotokha FMU, an area of 2930.324ha is designated as protection working circle, which accounts for 32% of the total FMU area. The combination of sites that are protected within (buffers and steep sites) and outside the productive areas provide a matrix and continuous sites that has the potential to maintain the integrity and function of the ecosystems at local scale.

Removal of infested trees and sanitation operation/measures may be permitted in all forest functions to deal with outbreak of pest and diseases wherever necessary, silviculture operations may be carried out in all forest functions to improve stocking and reforest the degraded areas. The management objectives and options are briefly outlined below:

Table 2.6: Protection Working Circle

Management Objectives	Management Prescriptions	Responsibility
To conserve and enhance wildlife habitats and biodiversity.	Avoid disturbance. Promote research and habitat improvement activities.	All Parties Territorial Division
To conserve the water catchment functions and watershed values of the FMU.	Minimal intervention	All Parties
To protect the forest from grazing, fire, pest, diseases and deter illegal activities.	Involve local people in mitigating impacts.	Territorial
To raise awareness of the important biodiversity areas.	Awareness campaign/field visits. Research	Territorial
To respect the sanctity of the religious sites and avoid unnecessary disturbances of such areas.	No interventions.	All Parties
To meet the local demand for NWFPs on sustainable basis in order to improve socio-economic status of the people.	Regulate extraction of NWFP on sustainable basis. Carry out resource assessment.	Territorial Division

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 340.064ha, which accounts for 4 % of the total FMU area.

Table 2.7: Non-production Management Circle

Management Objectives	Management Prescriptions	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 commercial harvesting under the normal set of management prescriptions. It is the area left after delineation of protection and non-production management circles. This management circle comprises of areas which are well stocked with species which can be harvested on sustainable basis for both local and commercial uses. The total area under this management circle is 6010.6388 ha. A small area of Fir (22.16 ha) falling under Chibegang Block has been merged and placed under the Mixed conifer working circle owing to its insignificant area coverage and for the ease of silvicultural implementation.

Table 2.8: Production Management Circle

Management Objectives	Management Prescriptions	Responsibility
To meet local requirements, as priority, for timber, fuel wood and other forest produce on a sustainable basis.	On the basis of single tree selection system from the identified local use area	Territorial Division
To manage and harvest commercial timber on sustainable basis.	Group selection system in mixed conifer, seed tree system in blue pine working circle and patch-cut system	Territorial Division and NRDCL

	for mixed broadleaf working circle.	
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

13.4.4. Non-wood Management Circle (Overlapping)

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

Table 2.9: Non-wood Management Circle

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

13.5.Organization of Working Circles

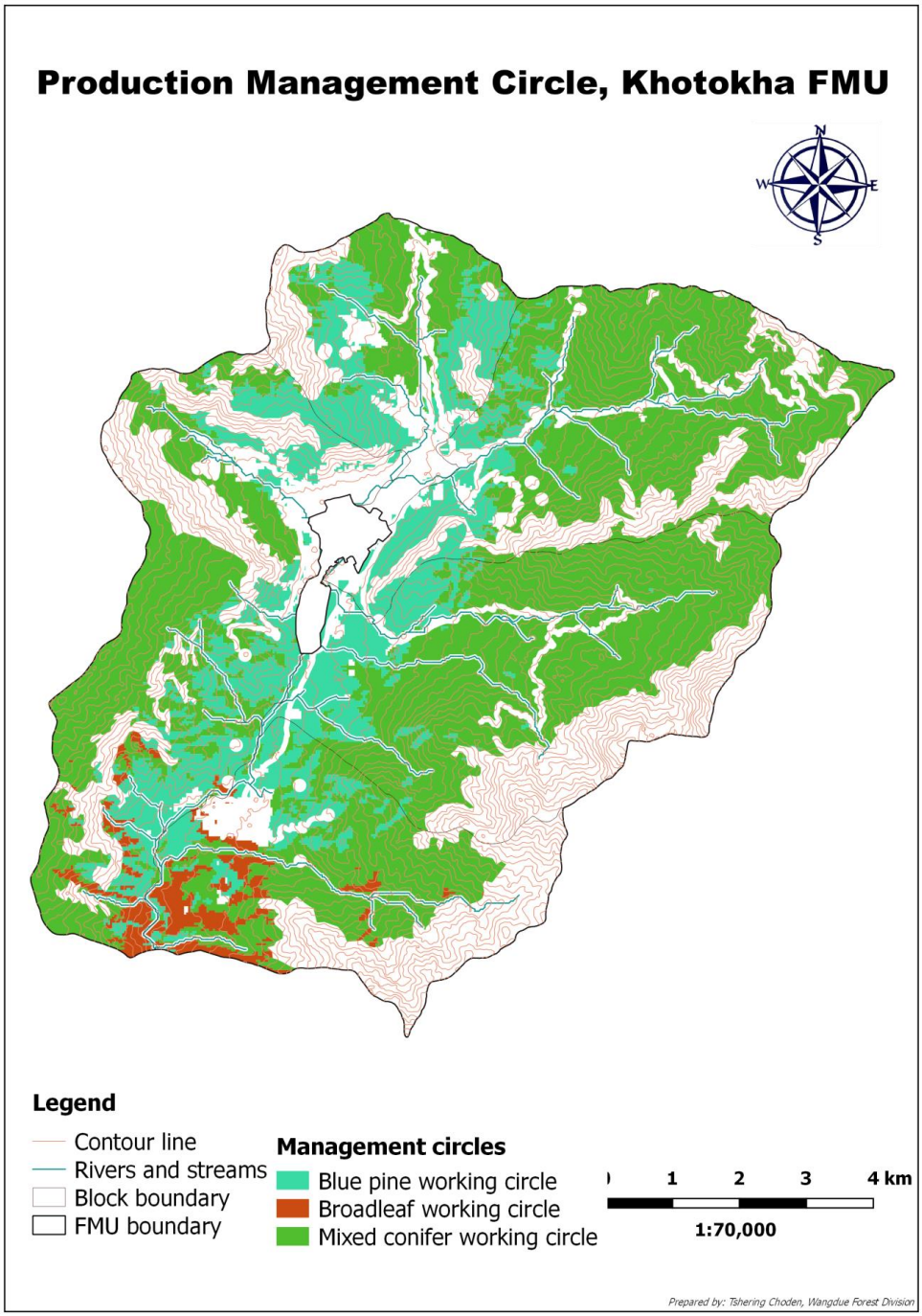
The Production Management Circle is further divided into three regular working circles according to the vegetation type. The working circles have been created on the consideration of stands requiring similar silvicultural treatment and having similar rotation age. Brief descriptions of the silviculture characteristics are provided to facilitate implementation of appropriate silvicultural practices.

Table 2.10: Working Circles

Working Circle	Area	Silvicultural System
Blue Pine Working Circle	1,484.333	Seed tree System
Mixed Conifer Working Circle	4,310.474	Group Selection
Mixed Broadleaf Working Circle	215.832	Patch cut System
TOTAL	**6,010.638**	

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

Map 1.11: Production Working Circles



Map 1.12.Production Zone

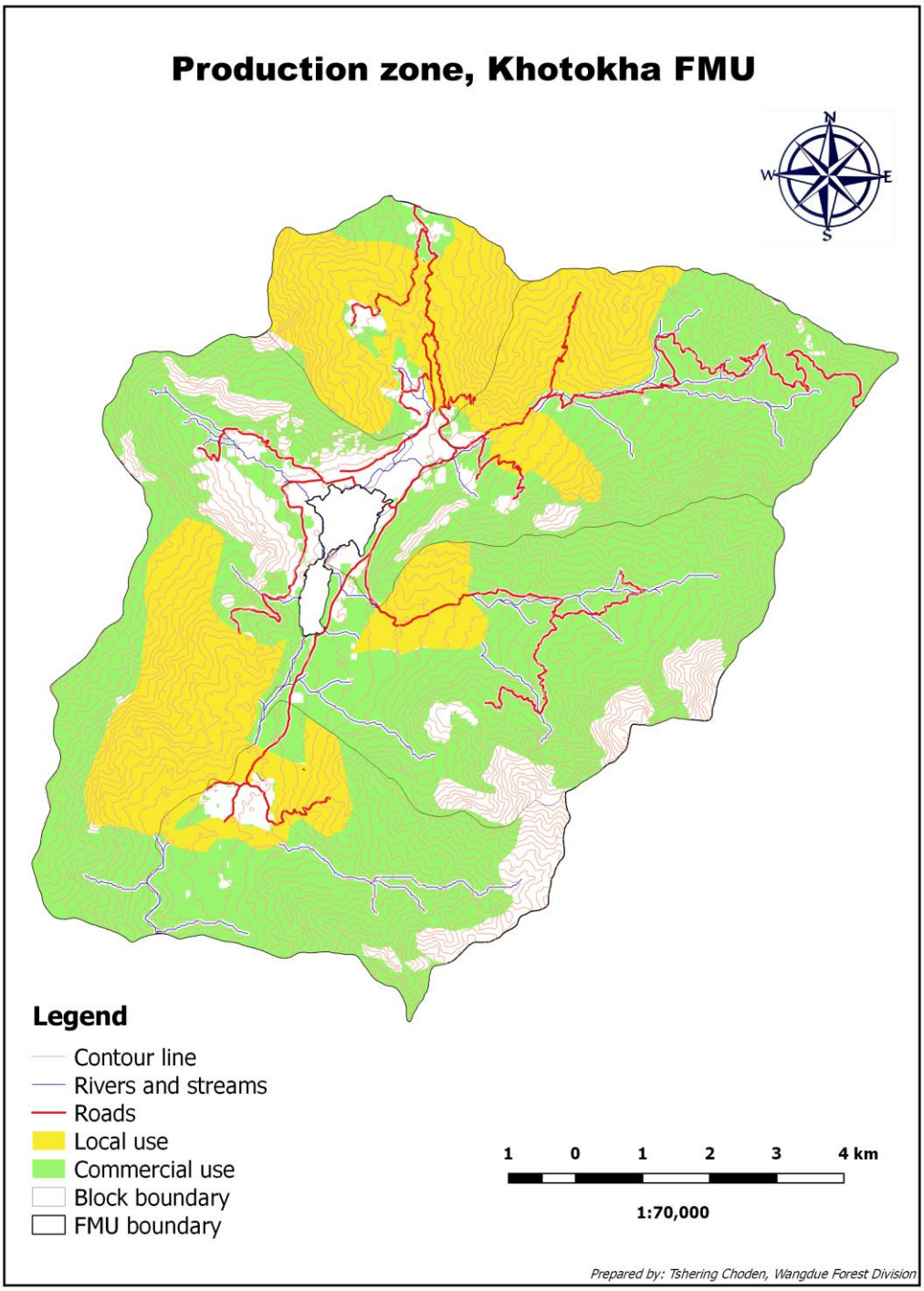


Table 2.11: Blue Pine Working Circle

WORKING CIRCLE: BLUE PINE				
Management objectives	**Management options**	**Responsibility**	**Monitoring**	**Silviculture system**
To meet local requirements, as priority, for timber, fuel wood and other forest produce on a sustainable basis.	1. Controlled marking of trees 2. Systematic thinning	1.Territorial 2.Territorial/ NRDCL	1. Territorial 2. Territorial	***Thinning*** The young Blue Pine stands will be worked under thinning. Marking trees will depend on the number of stem per hectare, age or size class and spatial distribution. The detailed marking guideline for thinning in Blue Pine stand is given in Annexure 3. Dead, dying, malformed and diseased trees will be thinned on priority basis. ***Seed Tree System*** For cable harvesting, felling areas of 1000 m × 30 m can be logged, leaving 20-25 trees/ha as a seed source. The cable line should be laid to the full length and not to be limited to
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	1000 m. Harvesting line must not run directly downhill. Lines must be 90 m apart to allow two interlines operation. On exposed or sensitive sites harvesting must leave 40-50 trees/ha and all under-story vegetation. Seed tree must be of good form, not over matured and representative of existing stand. In mixed stand, equal distribution of seed tree must be left (Forest Resources Development Division, 2004).
To create local employment opportunities	1. Employ local contractors and people. 2. Provide proper training.	1.NRDCL 2.NRDCL/ Territorial	1. NRDCL 2. Territorial	
To protect the forest from overgrazing, fire and illegal activities	1. Control overgrazing, poaching, prevent fire and illegal activities with local participation	1.Territorial	1. Territorial	
To conserve the water catchment functions.	1. Minimal intervention. 2. Abide by stream buffer regulations	1.Territorial 2.NRDCL/ Territorial	1. Territorial 2. Territorial	

Table 2.12: Mixed Conifer Working Circle

WORKING CIRCLE: MIXED CONIFER				
Management objectives	**Management options**	**Responsibility**	**Monitoring**	**Silviculture system**
To meet local requirements, as priority, for timber, fuel wood and other forest produce on a sustainable basis.	1. Controlled marking of trees	1. Territorial	1. Territorial	***Group Selection System*** Due to the lack of research into the light requirements needed for regeneration, the coupe sizes are a guideline that must be followed unless new information on silvicultural system is obtained. Cable lines will be laid to their full capacity. Cable corridors will be no more than 4m wide. Group opening will not exceed 0.15ha.The distance between the cable lines will not less than 60m and between groups along cable line will not less than 50m. All merchantable trees >10cm DBH (OB) will be felled. Dead, dying, malformed and diseased tree will be felled by priority. Opening can be irregular shapes and should be based on
To manage and harvest commercial timber 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	
To enhance and improve forest 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 opportunities	1. Employ local contractors and people. 2. Provide proper training.	1.NRDCL 2.NRDCL/ Territorial	1. NRDCL 2. Territorial	

				terrain features and stand condition. However, size of the opening should be not more than 0.15 ha. Damage to residual tree must be minimized.
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 regulations	1.Territorial 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	

Table2.13: Mixed Broadleaf Working Circle

WORKING CIRCLE: MIXED BROADLEAF				
Management objectives	**Management options**	**Responsibility**	**Monitoring**	**Silviculture system**
To meet local requirements, as priority, for timber, fuel wood and other forest produce on a sustainable basis.	1. 1.Consult with local community to ensure their needs for hardwood products (including lopping, etc.) are being met and resource is not diminished	1.Territorial	1. Territorial	Patch-cut System The research finding has suggested that Patch Cut System is the appropriate silvicultural system apt for broadleaf forest. The patch will not exceed more than 0.25 ha and will be spaced in the interval of 50 m. 4 m cable corridor will be maintained (Wangdi, 2016). Artificial regeneration will be taken up immediately after coupe clearance is issued. NRDCL to maintain nursery at the site for artificial regeneration. Nursery to be stocked with local and commercial species.
To manage and harvest commercial timber on sustainable basis.	1. 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	
To improve forest condition and other vegetation cover of the area.	1. Minimal intervention	1.Territorial/ NRDCL	1.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 opportunities	1. Employ local contractors and people. 2. Provide proper training.	1.NRDCL 2.NRDCL/ Territorial	1. NRDCL 2. Territorial	
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 regulations	1.Territorial 2.NRDCL/ Territorial	1. Territorial 2. Territorial	

14. YIELD REGULATIONS AND HARVESTING

14.1.Determination of Annual Allowable Cut (AAC)

14.1.1. Introduction

Forest management is based on the principle of sustainability that 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, indefinitely, without impairing the productivity of the soil. The calculation of sustained yield is expressed as AAC.

14.1.2. Increment Based AAC

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

14.1.3. The Most Appropriate AAC Method

Gauging the pros and cons of different approaches and formulae available, it was found that this formula is comparatively simple and more robust for calculating the AAC in standing volume equivalent. This method is not entirely dependent on inventory data with strong focus on the volume of the mature forest which is of greatest interest for medium term planning. The formula used for calculation of AAC for Khotokha FMU is a combination of area, volume and rotation and is calculated as under:

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

14.1.4. Calculation of AAC for Khotokha FMU

The total operable area was identified through mapping using GIS 2.18.17 with GRASS 7.4.0. 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 damage that total removal of that over-storey would cause, thus, losing more areas for harvesting. In such challenging terrains of Bhutan, exact geometric-shape group layout is rarely possible.

Due to the above inevitable fact, around 20% of area from the gross operable area has been reduced to calculate the net operable area in commercial Working Circles (Table 2.14). 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 2.14: Calculation of Net Production Area

Forest Types	Gross Operable Area (ha)	Calculation	Net Production Area (ha)
Blue Pine	1,484.333	In order to calculate the net production area, 20% from the gross operable area has been reduced.	1187.47
Mixed Conifer	4,310.474		3448.38
Mixed Broadleaf	215.832		172.67
TOTAL	**6,010.638**		**4808.51**

Rotation and Regeneration Period

Species rotation is an imprecise concept in silvicultural system other than clear cutting and replanting. Since reliable increment data is still very limited for Bhutan, while assuming rotation lengths, we need to be cautious. For Group Selection System, the objective is to have more or less even aged regeneration in areas worked out at each cut. The assumed rotation length for mixed conifer is 160 years. The assumed rotation length for Blue pine which grows at relatively lower altitude is 110years and 120 for mixed broadleaf. Consideration of regeneration period while calculating rotation lengths is a crucial factor. Therefore while calculating AAC in Khotokha FMU, for this plan period a 20 years of regeneration period has been

added to the rotation age of mixed conifer (which also includes Fir), while for Blue pine, 10 years of regeneration period has been added. The assumed rotation lengths for the calculation of AAC in Khotokha FMU are:

- ***Bluepine working circle:*** ***110+10 years***
- ***Mixed Conifer working circle:*** ***160+20 years***
- ***Mixed Broadleaf working circle:*** ***120 years***

Average Standing Volume

The mature average standing volume is derived from management forest inventory data statistically analyzed using "R". The forest management inventory of Khotokha FMU is designed based on the entire forest type and not based on individual stratum. Therefore, the average standing volume obtained from the analyzed data is kept the same irrespective of the stratum. Hence, the average standing volume for all the strata is considered as 351.331 m^3/ha with a standard error of 7.95%. The reliable minimum estimate of standing volume thus obtained was 323.402 m^3/ha for all stratum. The sampling error and RME for each stratum is given below:

Table 2.15: Average result of the forest management inventory

Result Type	Average Measures	Sampling Error %	Reliable Minimum Estimate (m^3/ha)
Tree Volume	351.331	7.95	323.402
Tree Count	399.171	7.00	371.224
Tree Basal Area	38.184	6.73	35.612

AAC for Each Working Circle

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

Table 2.16: AAC for Working Circles in standing volume

Strata	Net operable area (ha)	Rotation (Year)	RME of Average Standing	AAC (m^3/year)	Clear-cut Equivalent (ha/yr)

			Volume (m^3/ha)		
Blue Pine	1187.47	120	323.402	3,200.24	9.90
Mixed Conifer	3448.38	180	323.402	6,195.63	19.16
Mixed Broadleaf	172.67	120	323.402	465.34	1.44
TOTAL	**4808.51**			**9,861.20**	**30.49**

Therefore, the total workable AAC for Khotokha FMU is fixed at 9800 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, illegal seized timber volume and thinning within the FMU should also be accounted.

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 totalled on annual basis from the Tree Marking Register.

AAC for FMU has been calculated on the basis of the whole production area and the expected rotation. Thus, all material removed from of the Production Working Circle, including the volumes that is extracted from the group and cable corridor, must be accounted in the AAC. This includes timber cut for rural use, timber from normal cable lines, sanitation of pests and disease infested trees, fire burnt areas, ad hoc removal, wind-thrown& uprooted trees, fire burnt areas, illegally harvested timbers, road construction, etc. It is also crucial that all material felled but not removed is included in the 'actual cut'.

In case of KFMU, the rural timber is being supplied for not just the local residents but also for the people from Punakha and other villages of Wangdue, hence the Unit In-charge may maintain two separate registers for recording rural timber allocation. One register will record the trees marked for the local people of Khotokha only and the other register will maintain record for applicants who are not local residents, with columns to mention the name of the village and Dzongkhag to which the applicants belongs to. This will provide a more accurate picture of demand of the local residents

and others separately. The information can be used by the planner during the next plan revision.

14.3.Allocation of AAC

Allocation of AAC has taken into account the need of rural people (living within and near to Khotokha FMU). The AAC for rural use has been allotted based on the average supply trend. The AAC for commercial and rural has been allotted as follows:

Table 2.17: Allocation of AAC

Purpose	AAC(Standing Volume)	Remarks
Local Use	**1,900 m^3**	AAC for this area will cater to local community demands (of Khotokha). The Territorial Division, Wangdue will be responsible for allocating the volume
Commercial	**7,900 m^3**	Allocated to NRDCL to meet commercial demand

Rural demand has been estimated from the supply trend for the last ten years. There was no segregation of data for rural timber supply for local community for Khotokha and timber supply for people of other Gewogs of different Dzongkhags.

In the previous plan the rural allotment was well within the total allotment set for 10 years. Preference of allotment was first given to the local community residing within and near FMU and then to the people of the two Gewogs (Bjena and Rubeisa). Rural allotment for the people of Punakha and Wangdue Dzongkhag were allotted if there were balance AAC after the above allotment. This allotment system will also be followed in this plan period.

If the demand for rural timber exceeds that of prescribed AAC, the CFO may meet the excess from the commercial AAC. The allocation for commercial use for that given year will therefore be reduced by that much. When the demand for rural timber reduces and appears to be less than allocated AAC, the outstanding volume may be allocated to NRDCL, to meet the commercial demand. Thus, the adjustment will in no way increase the AAC of any working circle.

Unit in-charge shall propose any necessary changes in consultation with the CFO and reflect the changes in the annual operation plan.

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 interpreted as individual cut for each working circle. The number of cable lines to be harvested annually should be mentioned in the Annual Operational Plan.

The AAC calculated is volume and area based, so it is essential to regulate the AAC through volume or the clear-cut equivalent of each year. In this plan period, the total clear-cut area per year for FMU is 30.49 ha, meaning area cut through cable corridors, group openings, road construction, sanitation operation, etc. should not exceed more than 30.49 ha per year. If AAC achieved through clear-cut area is equivalent to 30.49 ha and even if there are remaining normal cable lines, FMU should immediately stop harvesting timber from cable lines. The balance cable lines should be operated only in next operational year. Therefore, if the UIC notices that more cable lines (or less) are being harvested annually then the AAC must be adjusted.

15. SILVICULTURAL SYSTEMS

15.1.Group Selection System

Group selection system is considered to be appropriate silviculture system for managing temperate conifer forest as per a study of silvicultural system conducted in mixed conifer forest (Thimphu and Bumthang). The system promotes natural regeneration and requires no treatment of the forest floor to induce natural regeneration (Moktan, 2003). This system suits a range of species, ranging from light demanders, through moderate shade bearers to shade enduring species (Mathews, 1999). The group size can varied according to the light requirements.

The forest in KFMU is dominantly composed of mixed conifer (Blue Pine, Hemlock, Fir and Spruce) and small patches of broad-leaved forest towards the southern boundary. Considering the vegetation types and the natural course of growth in natural forest, group selection system is the most appropriate silvicultural system for the area. Diebacks, storms, bark beetle attacks, fire etc. are common occurrences, which create gaps in natural forest. The regeneration therefore, occurs in patches or

groups and thus, justifies group selection system as it would imitate the natural pattern.

Working Pattern

Under the Group Selection System, small openings will be created in the stand allowing light to reach the forest floor and creating conducive micro climate for seed germination and establishment of seedlings. The opening will be no longer than one and half tree length in the Hemlock, Spruce and Fir Stand.

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

The individual openings need not be uniform in shape or size and systematically located along cable lines. In most cases the openings will be irregular in shape and systematic location of groups will be almost impossible. Aspect, slope and silvicultural requirement would influence the actual size of the groups. Group size depends on the characteristics of the species that are expected to regenerate in the group and on the presence of competing weeds. An average of 0.15 ha opening is recommended. However, group opening in fir working circle will not exceed 0.1 ha if the understory conditions is with bamboo/large rhododendron understory and 0.25 ha is the understory conditions is herbaceous/moss understory, no major competitors.

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 or bark beetles marked on priority basis and should be used as a nucleus for creating and group openings. However in Hemlock forest, it would be beneficial to maintain some large coarse woody debris by not filling all dying trees and snags because Hemlock depends on substrates (Nurse logs, moss pads) ensuring continuous moisture supply (a research findings from CORET II, RNRRC). 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. Care must be taken in choosing the boundary of the opening. Trees which are 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. The tree should be felled towards the centre of the group opening whenever possible to avoid damage to the unmarked trees. Trees damaged during harvesting will be cut and removed in the subsequent cleaning operations. 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 with 10 numbers of group opening of 0.15 ha each in mixed conifer working circle, the approximate number of cable lines that can be installed to achieve the annual allowable cut is worked out below:

Assuming,

Length of the cable line = *1,000 meters*

Clear-felled area of cable line corridor = *4 m × 1,000 m*

= *4,000 m*

= 0.4 ha.

Clear-felled area of groups *= 10 × 0.15 ha*

= 1.5 ha

Total clear felled area per line (in Mixed Conifer WC) = 0.4 ha + 1.5 ha

= 1.9 ha

Total clear-cut equivalent of all Working Circle = 24.42 ha (only for commercial AAC)

Therefore, total cable lines that can be installed annually to achieve the AAC is

= (24.42 ha / 1.9 ha)

= 13 cable lines/year

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. 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

This system is applicable to stands in need of thinning as well. In single tree selection system, sustained yield must be maintained by making thinning among the various age classes to ensure that:

- Stands are maintained in their correct proportions
- A suitable mixture of species is maintained
- Young saplings are freed from suppression
- Defective stands are removed wherever they are hampering better ones.

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 neighbouring 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, if in case the identified harvesting area is pure blue pine stratum as Blue Pine regenerates very easily under Seed Tree System. This system involves retaining certain number of trees to supply seed for regeneration after rest of the trees are harvested. 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. Blue pine regenerates easily when light is ample and ground vegetation is sparse. In applying this system, site condition like aspect must be considered as Seed Tree System is not suitable on steep and exposed south and southwest sites; rather group selection system should be preferred on such condition.

Working Pattern

For cable line harvesting, the felling area of 1000 x 30 m can be logged, if the felling is confined only to Blue pine stand stratum with the retention of about 20-25 trees/ha that are phenotypically superior. 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. The distance between the seed bearers should not be more than one crown length as it can be easily colonized by weeds and/or regeneration of unwanted species.

Seed Tree System has the Following Advantages;

- Compared to artificial sowing, the seed from seed trees is gradually released over the time and this can increase the probability of seed being on the ground when the desired germination conditions occur.
- The expense of collecting and sowing of seed is avoided where there is suitable on-site seed
- The local gene pool is more closely reproduced, leading to better adaptation to the site
- Harvesting is more concentrated, so logging cost is reduced
- Aesthetically and environmentally more acceptable than clear cutting

15.4.Thinning

Thinning is an important silviculture activity. It is particularly important where there is dense stocking of young trees (Kekephu and Chibegang Block) of similar age and size. The objective of thinning is primarily for improvement (of stand increment and quality) although poles and fuel wood will also be produced.

The young Blue Pine stands (Blue Pine Working Circle) will be worked under thinning. Thinning will be done by positive selection with due consideration to stabilize the structure of the stands. This type of thinning will be to direct the growth potential of the stand and site to the most promising individuals of the tree populations to maximize volume and quality production. The stand to be thinned will be identified from the treatment map and field visit. Pruning in the appropriate stands will also improve the value of the forests. Marking of trees will depend on the number of stem per hectare, age or size class and spatial distribution. 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.

The marking guidelines for thinning are as under;

- Mark 20% of the standing volume for thinning
- Marking of trees will depend on number of trees per ha, age or size class and spatial distribution
- Only low thinning will be done in most stands, where only dead, dying, suppressed, diseased and defective trees will be marked first.
- In stands less than 20 m average height, the target spacing should be approximately 4.5m x 4.5m or about 500 trees per ha.

- In stands with pole crop (average height 10-20m), the spacing of trees after the thinning should be no more than 5-6m, or approximately, 300-400 trees per ha
- In stands which at present have less than desired tree density and spacing, only tree that grows in cluster, very close together and competing for light and nutrients can be removed, diseased trees, especially those infected with mistletoe can be removed
- Care must be taken not to create large opening in the thinned stands.

15.5. Coupe Clearance

Territorial Division and Khotokha FMU should follow the following procedure for issuance of coupe clearance for execution of timber extraction from planned cable lines in this plan period. The following procedure was recommended by FRMD on issuance of coupe clearance certificate in FMUs vide No. FRMD/MPS/2(1)2018-2019/708 dated 17/01/2019.

- The concern Territorial Division through Unit office must issue coupe clearances to NRDCL prior to execution of timber extraction works from planned cable lines. The operation of cable lines by NRDCL must commence only upon obtaining the coupe clearance issued by the division.
- Coupe clearance for the 1st cable line to be issued prior to installation of cable cranes. Further the cable crane in the 1stline will be removed only upon complete extraction of lops and tops from the cable corridor and are brought to the landing site.
- Coupe clearance for the 2nd cable line to be issued while 1st cable line is still under Operation so as to enable marking of trees and installation of cable crane in the end cable line.
- Coupe clearance for the 3rd line to be issued only after lops and tops extracted from 1st cable line is completely disposed from the landing site. The same procedure must be followed for the operation of following consecutive lines.

16. FOREST PROTECTION

16.1. Fire

KFMU majorly consist of coniferous forest which is very much prone to forest fires. Although very few incidences of forest fires have been recorded in Khotokha. It cannot be overlooked because a single incidence of uncontrolled fire can destroy

extensive forest areas. It causes damages to trees, regeneration, soil (exposing it to elements of nature that can lead to erosion), and productive power of the forest, protective power of the forest, wild animals and the recreational and scenic value of the forest.

Figure 2.3: Khotokha forest fire of 2016
Picture courtesy:Kuensel

Forest fires in Bhutan are mostly caused by human activities and are due to either carelessness/ accidental or deliberate. Therefore it is of utmost importance to educate the people and to garner their goodwill and corporation to not just to prevent forest fire but also gain support during such outbreaks. Fire management covers all activities concerned with prevention, control and use of fire in forests.

Fire Management Procedures:

- Obtain the necessary permit or authority to conduct prescribed burn,
- Observe weather conditions to determine when to carry out the prescribed burn,
- Always extinguish the fire before leaving,
- Use ground fires to reduce the amount of inflammable fuel in forests (dead branches and leaf litter),
- Create fire breaks around forest fringes and in sensitive areas to stop fires spreading. Establish and maintain these in October-November (before the fire season). Fire breaks (Fire line) width may depend on the slope,

- Reduce fuel loads inside high-risk forest stands. This means removing dry woody material that is likely to burn. This can be done by controlled burning or physical removal.

Strict vigilance should also be in place with regular review of forest fire protection programme by the unit in-charge and the Production In-charge of NRDCL, in close consultation with the local communities and the various stakeholders involved with activities of FMU. The 2016 fire burnt area was prescribed as the operational area for the 2019-2020 OP. During the extraction of timbers it was observed that almost all the trees in the fire burnt area were rotten to some extent. The timber quality of the trees in the fire burnt areas deteriorated after the fire outbreak. Hence, it is recommended to extract the trees in fire burnt area of 2018 and 2019 before the timber quality deteriorates any further. The regeneration in the fire burnt area of Chibegang Block of the year 2016 is mostly *Populus sp*. and covered by *Piptanthus nepalensis*. *Populus sp*. and *Piptanthus nepalensis* which are invasive in nature. Therefore, NRDCL is recommended to carryout cleaning operations. Plantations should also be carried out if natural regeneration of Blue pine is poor or if no regeneration comes up within 3 years from the fire incidence..

Figure 2.4: Fire burnt area covered by Piptanthus nepalensis and deteriorated timber quality

16.2. Pest and Disease Management

The Eastern Himalayan spruce bark beetle, *Ips schmutzenhoferi*, is a serious pest of *Picea spinulosa* and *Pinus wallichiana* in Bhutan. Sanitation operations at Kekephu Block have been carried out in the past to control the spread of such infections in the forests. Therefore, periodic monitoring of the forests to check any outbreak of pest and diseases will be done. In order to detect and report any outbreak of pest diseases, the FMU staffs will conduct regular inspection to enable the initiation of earliest

possible remedial and preventive measures. Report should be submitted to the CFO, Wangdue and also to the Specialist(s) with the Department.

The following are the control measures suggested:

- Regular periodic survey of the forest and removal of deformed trees.
- Regular survey of regenerated areas and burning of infected plants after slashing and debarking.
- Education extension program for the people and the workers in the forest to report symptoms of the disease will be part of the pest and disease management program within the FMU.
- The planting stock at any nursery, which will be supplied to the Unit for further plantation, will need to be monitored for pest and diseases. The infected seedlings should not be supplied, instead destroy by burning at the nursery itself.

16.3. Grazing

In line with the multiple-use of the forests and as provided in the National Forest Policy of Bhutan, 2011, grazing will be allowed to continue in some parts of the FMU. Generally in KFMU, the cattle graze in the Ramsar area (which is the traditional grazing ground) and areas near settlements. Grazing should not be allowed in protection functions while permitting monitored grazing conservation functions. The plan should however promote strategies aimed at reducing and regulating grazing in the forest and at improving breeds of cattle. Development of improved pastures near villages, planting of fodder trees, introduction of high yielding breeds of cattle and encouraging stall feeding are some of the strategies. It is important to secure the corporation of the local villagers in keeping the cattle out of the environmentally-sensitive areas and away from the regeneration areas. These strategies should be implanted through the combined efforts of the Department of Livestock and DoFPS. Regenerated areas must be fenced with timely monitoring and supervision of the fences by the FMU unit in-charge if the grazing pressure increases in the harvested areas.

Figure 2.5: Grazing pressure near settlement areas

17. ENVIRONMENTAL STATEMENT

As per the provision of the Environmental Assessment Act, 2000, all developmental proposals in Bhutan have to fulfil certain environmental criteria. 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

Bhutan Forest Act, 1969 provided the first legal framework for regulating forest resources in the country than National Forest Policy of 1974 provided focused and objective to the directives with regards to forest and its management. The revised policy of 1991 has four main objectives for which the forest are to be managed, one of it being, to meet the long term needs of all the people for woods and other forest product by placing the country's productive forest areas under sustainable forest management. Numerous forest management units were identified across the country to manage the forest scientifically and sustainably. Khotokha FMU was established

and managed scientifically since the year 1984, with its first management plan (1984-1994). The plan was revised for another 10 years in 1998 and expired in 2008. The third management plan had a plan period of 2009-2019. This will be the third revision for KFMU since its establishment.

Khotokha FMU will be worked on the principle of sustainability to meet the timber for commercial as well as bona fide rural requirements. The FMU will be managed on the basis of sustainability principles which will ultimately improve the forest stands. In order to transport the harvested timber out of the unit, a total of approximately 8.6 km forest road needs to be constructed during this plan period of ten years.

17.1.2. Objectives

The main objectives of KFMU are;

- To maintain and improve the forest stand of KFMU by removing the old forest stand and replacing it with new forest growth through natural or artificial regeneration.
- To ensure sustainable supply of timber, fuel wood and other forest resources for local supply through regulated harvesting and collection.
- To create awareness about the FMU among the local communities and generate active participation of people in protection and conservation of the forest.
- To ensure that multiple use of forest does not result in unacceptable level of ecological and environmental disturbances.
- To regulate grazing to maintain the natural regeneration capacity of the forest.
- To generate local employment opportunities.
- To promote local research, demonstration, aesthetic and educational values of natural forest ecosystem.

17.1.3. Project Location and Area

Khotokha Forest Management Unit is located in two Gewogs under Wangdue Phodrang Dzongkhag situated in Ruebisa Gewog and Bjenag Gewog. It lies between 90° 15’ 5” to 90° 32’ 20” East longitude and 27° 26’5” to 27° 32’20” North latitude (Toposheet no. 78 E/15 and 78 i/13). The total area of Khotokha FMU is 9281.027 ha. The entire area will not be subjected to harvesting. Only about 6,010.638 ha of

area will be subjected to timber harvesting in a scientific and sustained manner. Rest of the area is categorized under various protection and non-production zones.

17.1.4. Benefits

Some of the mixed conifer stand in Khotokha FMU are over matured, hence does not put on significant increment. Thus, these over matured stands can be harvested so that it creates space for regeneration to establish. This not only benefits in terms of generating revenues but also help improve the forest conditions. The FMU activities can also contribute towards providing employment opportunities to the local communities. Local people can be involved as unskilled labour during maintenance of road, construction of forest road, extraction of timber and transportation. This will help improve the livelihood of the people residing in and near by the Forest Management Unit.

The existing FMU road and the proposed new roads will benefit the settlements within the FMU. The FMU road will also help people extract rural timber for their house construction and renovation purposes. The harvesting of matured trees as per the prescription of the plan will allow the extraction on sustainable basis and also contribute towards government revenues. Managed forest will definitely ensure future sustainability of the resources.

17.2. Forest Management Unit: Planning and Zoning

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

The FMU resource inventory was carried out in 2018 by a team from Wangdue Territorial Division with technical backstopping from FRMD, 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.

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. 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. The Mixed-broadleaf working circle will be worked under Patch-cut system.

Harvesting and Extraction

Fixed volume of timber expressed as Annual Allowable Cut (AAC) is prescribed in this Management Plan. The AAC prescribed is **9,800 m^3** in Standing Volume per year. This means that the maximum volume that can be harvested from Khotokha FMU will not exceed **9,800 m^3** per year. Out of **9,800 m^3**, **7,900m^3** will be allotted to NRDCL for commercial harvesting and **1,900 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.

FMU will start timber extraction from Kekephu Block. However, FMU shall remove timbers from fire burnt areas first and then only harvest timbers from the normal cable lines after construction of forest road.

17.3. Road Construction and Maintenance

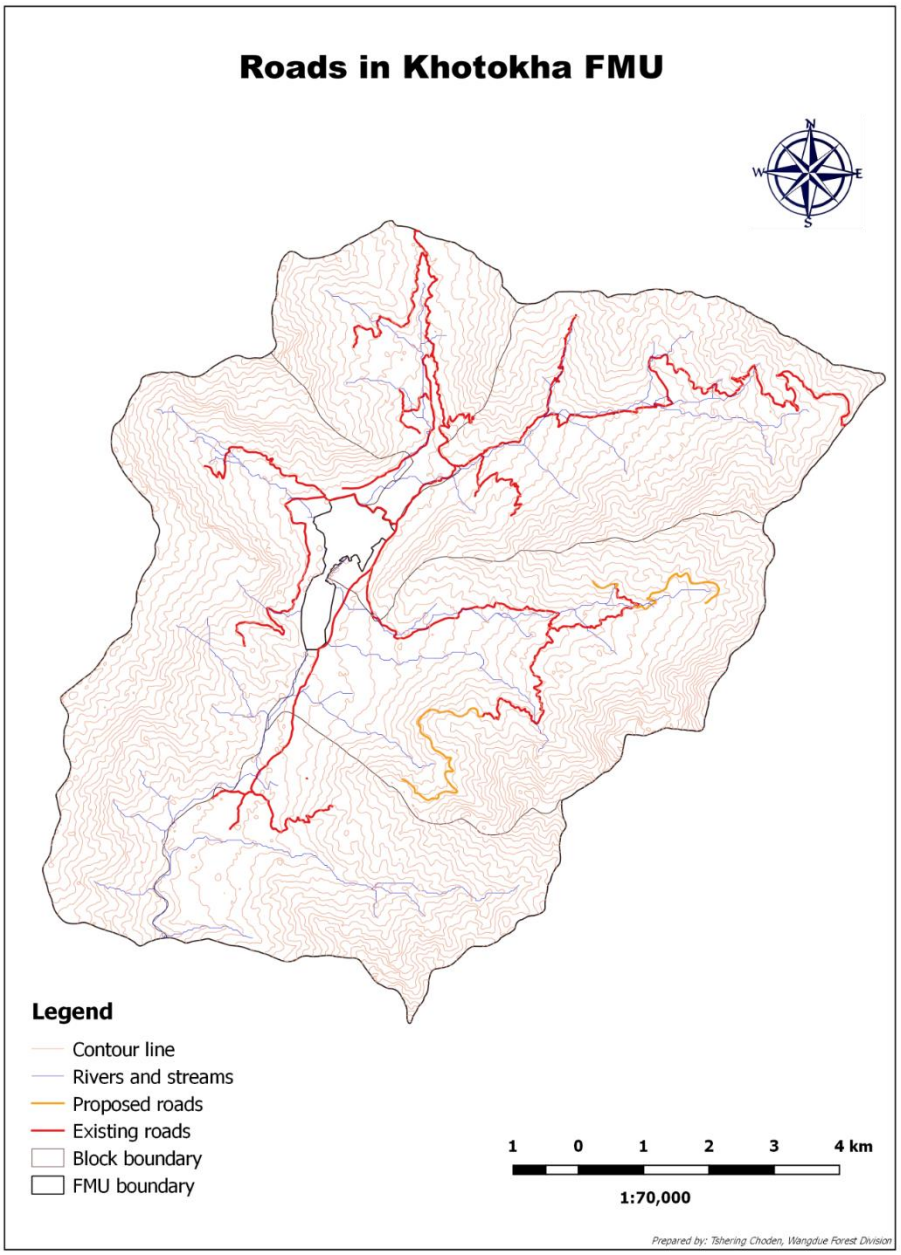
The forest road construction in Khotokha FMU is aimed at minimum negative environmental impacts. The physical assessment for the road construction in Khotokha FMU was carried out by the team comprising of Engineer from NRDCL, Unit staffs both from NRDCL and Wangdue Territorial Division.

The proposed road of 8.6 km in Kekephu Block 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 proposed road and the alignment has been agreed by the general public residing within the FMU area and the Local Government Leaders of Bjena and Rubeisa Gewog during the consultation meeting held at Khotokha on 27th April 2019.

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.

Map 1.13: Proposed Roads of Khotokha FMU



Map: Proposed Roads of Khotokha FMU

17.4. 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 by NRDCL. 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. CFO, Wangdue Territorial Division shall monitor establishment of regeneration in harvested areas at the end of three years. 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. In the operated fire burnt areas, if the regeneration of preferable species does not come up within 3yrs from the fire incidence, NRDCL should carry out plantation.

17.5. Existing Environment

17.5.1. Topography and Geology

KFMU comprise of broad valley encompassed by rising hills of moderate slopes generally 40 degrees slope class. The elevation of the KFMU ranges from 2,300 meters at the valley to 3,800 meters at the ridge top.

Major part of FMU falls within 0^0 to 25^0 slope class. Slope classification was done with the help of Quantum GIS by using terrain analysis. Areas that were considered over 100% were delineated on the Function Map as SP-Soil Protection where no activities can take place. Slopes that ranged from 76-100% are classified as SC-Soil Conservation where limited activities can take place.

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

17.5.2. Hydrology

Three main rivers namely, Paza Chhu, Lae Chhu and Keke chhu flows through the FMU along with many other small rivulets. The management unit forms the watershed of Paza Chhu.

The residents of the FMU are dependent heavily upon these water sources for drinking and cultivation. These smaller streams are also the source of water for the livestock. The water sources are clean but simultaneously cattle grazing in these watersheds should be regulated to minimize the surface run off. In addition, appropriate silvicultural systems, prescriptions and harvesting methods are implemented in order to ensure that the quality and quantity of water is not affected by forestry operations.

17.5.3. Air Quality and Noise

The quality of air within the FMU is very good as the pollution is negligible as there are no on-going developmental activities within the FMU area. Though Khotokha is a beautiful valley with many sacred places scattered all over the valley, it does not receive many tourists mainly due to the difficult road conditions especially during monsoon seasons. Therefore, the noise pollution is also very negligible within the FMU area.

17.5.4. Plant, Animal Species and Habitat

Multi-resource inventory was carried out by inventory crew in September 2019. During the inventory, the crew recorded various signs and sighting of wild animals over the entire period and corresponding data were collected based on indirect/direct evidences (footprints, scats, droppings, pellets etc.).Wild animals like barking deer, Sambar deer, wild boar and Himalayan black beer were recorded. Khotokha FMU has good floral and avi-faunal diversity due to its altitudinal variation, aspects and different forest composition. Khotokha valley is also internationally recognized as a Ramsar site. This site provides one of the main wintering sites in the bio-geographic region for the vulnerable Black-necked Crane (*Grus nigricollis*) and is also home to other endangered species such as the Asiatic Wild Dog (*Cuon alpines primaevus*).

17.5.5. Scenic Qualities

Khotokha valley is blessed with unique and beautiful landscapes, especially the Ramsar wetland area. The plains of ramsar site are locally known as Kateythang. The plain is grazing ground for the cattle of Bjena and Rubeisa gewog. Khotokha

valley resembles the valley of Phobjikha with similar climatic conditions. Phobjikha is a tourist hotspot, known for its scenic values and Ramsar site, hence, Khotokha valley also holds a potential to develop as a tourists hotspot, provided the road conditions are improved and well maintained.

17.5.6. Cultural Significant Sites

There are numerous Lhakhangs, Goenpa, Gney (sacred sites), Chortens and other religious sites found scattered over the Khotokha valley. Most of the Lhakhangs and Goenpas are more than 300 years old. The most important and visited cultural site are *Rinchenling Shedra, Dechen draphu, Dolung goenpa, Goensa, Balue Goenpa, Drubchhu of Yen Lag Geden, Drubchhu of sa Karpo, Drubchhu of Dakini.* There are also several privately managed Lhakhangs and Gneys.

Detailed information on the important cultural significant sites is given in the preceding chapter.

17.6. Assessment of Impacts and Mitigating Measures

17.6.1. 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

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

Mitigations

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

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

17.6.2. 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 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. CFO, Wangdue, will be responsible for deputing adequate staff for effective functioning of FMU. 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. The Unit-in-Charge should monitor community activities outside Production Working Circle to ensure that they are not locally concentrated to the extent that they affect biodiversity, water quality and soil stability.

17.6.3. Impacts on the Faunal Diversity

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

Mitigations

Certain areas within the FMU have been designated as wildlife protection areas while the remaining areas are designated as nature conservation areas. No harvesting operations will be allowed in area designated as wildlife protection function. As all forest areas are not subjected to harvesting operations, enough areas have been kept for free movement of wild animals. Sufficient number of snag trees and fruit bearing trees will be retained to provide enough food for survival and reproduction of wild animals. Moreover, as certain portion of biological corridors also falls within the Forest Management Unit, these areas are excluded from commercial harvesting to enable movement of wildlife from one protected area to another.

In the interest of wildlife, clear felling of large stretch of forest will be avoided so that sufficient forest is retained for forage, shelter and cover. In operated areas, if natural regeneration fails to establish, artificial regeneration by native trees will be undertaken and subsequently fenced to avoid grazing by domestic as well as wild

animals. Regular monitoring and patrolling of the forest area will be carried out in order to minimize poaching and other illegal activities within the FMU.

17.6.4. Impacts on Ecology (Flora)

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

Mitigations

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

17.7. Monitoring and Evaluation

The Management Plan, which is for the period of ten years, will be prepared by Territorial Divisional Office of Wangdue. It will be approved by the Minister, Ministry of Agriculture and Forests. The Plan will be implemented by CFO, Wangdue Forest Division, who will be engaging NRDCL for harvesting timber. Annual Operational Plans will be prepared by Wangdue 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 Wangdue 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 2.18: 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 Sitting					
1. Watershed Areas					
a) erosion	a) downstream economic losses	*			
b) siltation	b) downstream economic losses	*			
c) hydrology	c) increased peak and flood flows	*			
d) water quality	d) loss of downstream beneficial uses	*			
2. Relation to other dedicated land uses					
a) conservation areas	a) impaired ecological and recreational opportunities	*			
b) economic ventures	b) possible economic loss	*			
3. Traditional forest uses	3. Impaired beneficial uses	*			
4. Rehabitation	4. Social Problems	*			
5. Relation to regional/national forestry plans	5. Possible conflicts with established management policies	*			
6. Critical environmental areas	6. Downstream economic losses				
a) erosion	a) downstream economic losses	*			
b) siltation	b) downstream economic losses	*			
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					
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			*	
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. Socio-economic losses	*			
3. Chemical and fertilizers	3. Impaired fisheries and aquatic systems	*			
4. First-year operations	4. Increased erosion due to soil disturbance		*		
5. Soil conservation benefits					
a) erosion			*		
b) sedimentation		*			
c) soil capacity		*			
d) soil surface moisture		*			
e) soil nutrients		*			
6. 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

The financial analysis involves estimation of profit according to the project operating entity, NRDCL in case of FMP whereas economic analysis measures the effect of the project on the national economy. For a project to be economically viable, it must be financially sustainable.

In financial analysis, all expenditure incurred and revenue resulting are taken into account. Financial forecast for the plan period is done as a means to carry out financial appraisal. This will identify the revenue accruing to and borne by NRDCL and to the income in royalties accruing to the Royal Government of Bhutan. Figures are based on the best available information (previous years cost and rate estimation available from NRDCL and collected from the previous operations.

The estimates are however based on certain assumptions. Forecast is only a projection of the possible cash flow and therefore should be used as a guide only.

Table 2.19: Financial Forecast Assumptions

Particulars	Assumptions
m^3 to cft	35.31
Recover Volume NRDCL (%/AAC)	60% for chirpine and 40% for hardwood
Commercial harvesting	9,800 m^3
Road construction (Nu/km)	2,500,000.00
Length of proposed new road (km)	8.6
New road construction (km/yr)	0.86
Road maintenance (Nu/km/yr)	15,000.00
Distance to Depot (km)	8.90
Cable crane (Nu/cft) (Nu/m^3)	Nu. 20/cft
Rural Allotment (m^3)	3,780
Regeneration maintenance per cable line (Nu/ha)	2,500.00
Existing plantation (ha)	0
Plantation cost (as per plantation norms and standard, SFD for 5 ha model plantation)	50,000.00
Royalty for timber (Nu/cft)	11

Table 2.20: Financial forecast summary

Financial Summary for Plan Period	
Total Revenue NRDCL	295,334,958.60
Total Costs NRDCL	88,127,014.72
Total Royalty NRDCL	38,074,960.00
Total Revenue less Royalty less Costs NRDCL	169,132,983.88

19. RESEARCH

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

- Determination of Annual Allowable harvest of NWFPs in the FMU.
- Colonization studies of Blue Pine Species.
- Impact of commercial harvesting on wildlife population.
- Timber recovery rate for particular FMU.
- Forest composition change overtime due to commercial harvesting.
- Human wildlife conflict.
- Failure of regeneration of Fir
- Invasion of operated blue pine areas by bamboos
- Rotation of fir and age at which it starts degenerating
- Development of new Local volume table for KFMU

Table 2.21: 10 year financial forecast for Khotokha FMU

	AAC (m^3)	Rec. Volume (m^3)	Nu/cft	Nu/m^3	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	10 Years
					Nu	Nu	Nu	Nu	Nu	Nu	Nu	Nu	Nu	Nu	Total (Nu)
Revenue: NRDCL															
Timber- Commercial	9800	5400	154.89	5,469.17	29,533,495.86	29,533,495.86	29,533,495.86	29,533,495.86	29,533,495.86	29,533,495.86	29,533,495.86	29,533,495.86	29,533,495.86	29,533,495.86	295,334,958.60
Timber- Rural	2500														
Total Revenue NRDCL					**29,533,495.86**	**29,533,495.86**	**29,533,495.86**	**29,533,495.86**	**29,533,495.86**	**29,533,495.86**	**29,533,495.86**	**29,533,495.86**	**29,533,495.86**	**29,533,495.86**	**295,334,958.60**
Costs: NRDCL															
Bridge Construction															
Road Construction		2,500,000			2150000	2150000	2150000	2150000	2150000	2150000	2150000	2150000	2150000	2150000	21,500,000.00
Road Maintenance			15,000		75750	75750	75750	75750	75750	75750	75750	75750	75750	75750	757,500.00
Marking Cost			0.08	2.82	27691	27691	27691	27691	27691	27691	27691	27691	27691	27691	276,908.80
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		5880	1.95		404979.12	404979.12	404979.12	404979.12	404979.12	404979.12	404979.12	404979.12	404979.12	404979.12	4,049,791.20
Debarking		5880	0.35		72688.56	72688.56	72688.56	72688.56	72688.56	72688.56	72688.56	72688.56	72688.56	72688.56	726,885.60
Cable Craning		5880	20		4153632	4153632	4153632	4153632	4153632	4153632	4153632	4153632	4153632	4153632	41,536,320.00
Transportation to Depot		5880	8.32		1727910.912	1727910.912	1727910.912	1727910.912	1727910.912	1727910.912	1727910.912	1727910.912	1727910.912	1727910.912	17,279,109.12
Stand Tending (Spacing etc.)															-
Coupe Regeneration															-
Regeneration Maintenance		3,500/cable line			17,500.00	35,000.00	52,500.00	70,000.00	87,500.00	105,000.00	122,500.00	140,000.00	157,500.00	175,000.00	962,500.00
Creation of Plantation		50,000/ha				50,000.00	50,000.00	50,000.00	50,000.00	50,000.00	50,000.00	50,000.00	50,000.00	50,000.00	450,000.00
Plantation Maintenance		8,000/ha					8,000.00	16,000.00	24,000.00	32,000.00	40,000.00	48,000.00	56,000.00	64,000.00	288,000.00
Total Costs NRDCL					**8,660,151.47**	**8,727,651.47**	**8,753,151.47**	**8,778,651.47**	**8,804,151.47**	**8,829,651.47**	**8,855,151.47**	**8,880,651.47**	**8,906,151.47**	**8,931,651.47**	**88,127,014.72**
Total Revenue less Total Costs NRDCL					**20,873,344.39**	**20,805,844.39**	**20,780,344.39**	**20,754,844.39**	**20,729,344.39**	**20,703,844.39**	**20,678,344.39**	**20,652,844.39**	**20,627,344.39**	**20,601,844.39**	**207,207,943.88**
Royalty															
Royalty- Commercial	9800		11	388.41	3807496	3807496	3807496	3807496	3807496	3807496	3807496	3807496	3807496	3807496	38,074,960.00
Royalty- Rural															
Total Royalty NRDCL					**3,807,496.00**	**3,807,496.00**	**3,807,496.00**	**3,807,496.00**	**3,807,496.00**	**3,807,496.00**	**3,807,496.00**	**3,807,496.00**	**3,807,496.00**	**3,807,496.00**	**38,074,960.00**
Revenue less Royalties NRDCL															
Timber- Commercial					25,725,999.86	25,725,999.86	25,725,999.86	25,725,999.86	25,725,999.86	25,725,999.86	25,725,999.86	25,725,999.86	25,725,999.86	25,725,999.86	257,259,998.60
Timber-Rural															
Total Revenue less Royalty NRDCL					**25,725,999.86**	**25,725,999.86**	**25,725,999.86**	**25,725,999.86**	**25,725,999.86**	**25,725,999.86**	**25,725,999.86**	**25,725,999.86**	**25,725,999.86**	**25,725,999.86**	**257,259,998.60**
Total Revenue less Royalty Less Costs NRDCL					**17,065,848.39**	**16,998,348.39**	**16,972,848.39**	**16,947,348.39**	**16,921,848.39**	**16,896,348.39**	**16,870,848.39**	**16,845,348.39**	**16,819,848.39**	**16,794,348.39**	**169,132,983.88**

PART 3: IMPLEMENTATION OF THE PLAN

PART 3: IMPLEMENTATION OF THE PLAN

20. IMPLEMENTING AGENCY

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

20.1. Cutting cycles

For sustainability of the forest resources in the FMU, the cable line spacing must be properly laid to enable subsequent passes in the future. A minimum of 60 meters needs to be kept in between the cable lines so that two passes can be enabled in the future. Mixed Conifer Working Circle has a rotation period of 160 years with additional 20 years regeneration period, which means that the two cable lines that will be implemented in the future are occurring at year 61 and year 121. The original line will therefore, be harvested in year 180 (*Figure 3.1*). This gives sufficient time to the adjacent area to regenerate and also prevents the area from large opening.

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 40 and 80, with original line being harvested at year 120.

Problem of laying cable line is inevitable in the field due to the unavoidable rough terrain. The layout in the field must be tailored to suit the terrain and to the best possible guidelines must be followed.

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

The Mixed Broadleaf working circle will be worked under Patch-cut System. The patch will not exceed more than 0.25 ha and will be spaced in the interval of 50 m. 4 m cable corridor will be maintained. Artificial regeneration will be taken up immediately after coupe clearance is issued. NRDCL should maintain nursery at the

site for artificial regeneration. Nursery should be well stocked with local and commercial species for replantation. 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.

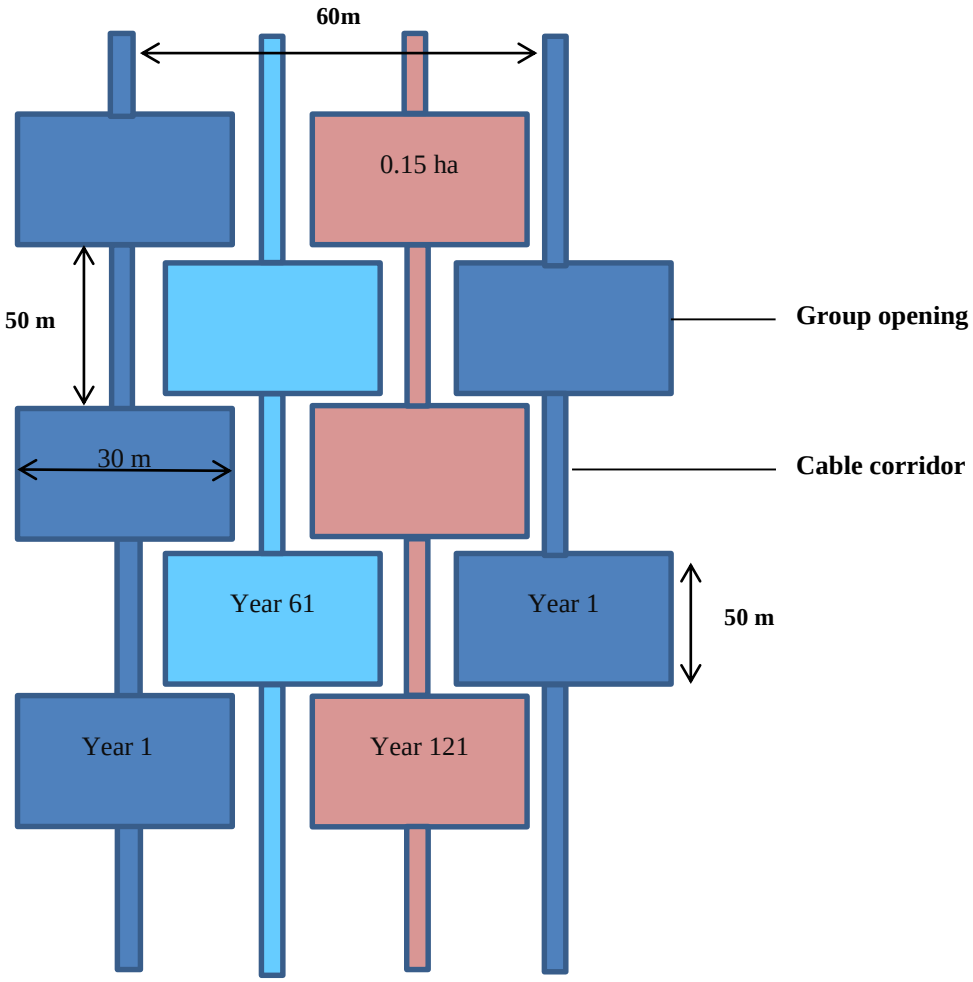


Figure 3.1: Layout for group selection system

20.2. Annual Coupe

Accessibility, slope, stand condition and other environmental conditions are criteria for selecting the annual coupe for harvesting in the operable area. Coupes must comply with the following conditions:

- Based on the silvicultural systems for each working circle, the annual coupe will follow the required spacing designed.

- The UIC, in consultation with NRDCL, will determine the extent of plan for harvesting operations which will include location of cable cranes, alignment of cable lines and designated landing points. Environmentally sensitive areas designated in the forest function map will be identified, their position indicated and taken care to ensure the appropriate prescription and restrictions are followed.
- All prescriptions and restrictions laid down in the plan must be considered and adhered completely.
- The UIC will then arrange to mark the trees.
- Cable line layout will be based on safety, stand composition, environment and cost considerations. Alignment of cable line must be done in consultation with the unit in-charge. NRDCL, in consultation with the UIC may align the cable lines diagonally across contour lines in order to avoid environmentally sensitive sites to secure a more stable landing point or to achieve a more cost effective harvesting.

Cable lines may traverse slopes greater than 100% but the extraction should not be carried out.

20.3. Tree marking guidelines

In general the following factors are to be considered while determining the spatial framework and sequential order of the patches selected for harvesting:

- Groups of mature and over mature trees are selected systematically according to the patch size given in the plan.
- Trees within stream buffer strips and on slopes greater than 100% must not be marked.
- The direction of the tree lean and the topography has to be taken into account to prevent large trees 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 close to the ground level by unit staff with authorized marking hammer and diameter measurements along with total tree height and the 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.
- Adequate seed trees should be retained to serve as potential seed source in interlines adjacent to operated cable lines for seedling regeneration in the openings.
- The trees for harvesting should be marked along the extraction corridors.
- The minimum distance between the cable lines should be approximately 60 meters for Mixed Conifer Working Circle.
- The distance between openings along the cable lines should be not less than 50 meters.
- During the tree marking, the mitigating measure against the impacts recognized during the Environment Impact Assessment must be referred to.

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:

- Minimize soil disturbances and initiation of soil erosion
- Maximize worker's safety (if used correctly, according to manufacturer's directions and according to the safety practices in the Code of Logging Practices)
- Avoids damage to residual reserve stands
- Avoids disruption to wildlife corridors in the valley bottoms
- Minimizes noise and dust pollution on any adjacent farmlands 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 harvesting operations after the logging coupe has been demarcated. Suitable log landings should be identified and incorporated into the forest road design.
- Care should be taken to avoid locating lines in and along gullies and other protected areas but lines may cross these at any angles. Trees to be felled will be enumerated and marked in time so as not to delay harvesting operations.
- The cable corridor shall not exceed 4m width in respect of marked tree boles. It is recognized that final opening may be wider than this, following felling of large broad leaved trees along the corridor.
- Trees will be felled, de-limbed, cross cut, extracted on the cable, loaded and hauled to the log depot. Only chain saws and hand saws will be permitted in felling operations. In each sub-coupe felling will begin at the downhill end and proceed progressively uphill. The prescribed felling direction will be strictly enforced to reduce chance of damage to residual standing trees and surrounding intact stands. Damage to soil should be minimized at all times. Lops and tops from the felled areas will be taken to log depots wither by cable crane or by other means.
- The use of axe 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 spread of bark beetles.
- All logs will be measures and recorded in Log Yard Register. This should be kept up-to-date and made available to inspecting officers as required. A copy of logs/timber entered in the Log Yard Register will be submitted to the DFO 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. Plying of lorry shall be avoided during the winter season when the Black-necked Cranes arrive at the valley to minimize the disturbance to cranes.
- Records of all trees marked and issued fir 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, Wangdue.

- ❖ The CFO and Regional Manager, NRDCL will co-operate and co-ordinate to ensure that logging operations and log outturn are conducted smoothly and in accordance with local and other demands.
- ❖ Fuel wood will be collected from the harvesting residues. It is important that all lops and tops are collected along the entire cable lines and not just from the easily accessible areas. It is desirable that the trees to become fuel wood area extracted with the cable lines and fuel wood conversion occurs at the designated log landing areas.

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

20.5. Reforestation of Harvested Sites

It is vital to reforest the harvested area immediately after the harvesting operations. Most conifer types in most situations show good regeneration potential, however a variety of factors such as grazing, protracted harvesting periods and weed/bush growths limits the success. It is highly imperative that the harvested areas are regenerated successfully and adequate time and resources are invested in this program to ensure better seedling survival, if the FMUs are to be managed on a sustainable basis. The future yield of the FMU is dependent on the success of the reforestation program in the FMU.

Preferably, natural regeneration should be encouraged over the artificial regeneration. If natural regeneration fails, either enrichment or complete stocking by planting must be carried out. For artificial regeneration, prior to plantation, nursery shall be raised for local species. The maintenance of plantation should be carried out as per the Norms for Plantation and Nursery, 2016. The area shall be planted with commercially viable local species with no more than three species on each site. Regular maintenance of plantation shall be done to ensure better survival of plants. The CFO shall evaluate the plantation at the end of three years and if the survival percentage is lower than 80%, immediate beating up shall be carried out with the same species.

Weeding, tending and cleaning has to be carried out promptly, at the right time, which will prove to be more cost effective as clearing and replanting a failed area

would cost much more than initial tending for natural regenerations. It would also ensure better chance for seedlings to survive.

Although a monitoring process has been adopted in FRMD, it is recommended that regeneration surveys be conducted every three years, until the regeneration has reached a height that will ensure its survival. If the second survey (6^{th} year) indicates poor stocking, remedial measures must be taken during the following planting season. The FMU in-charge will ensure that the stocking of natural regeneration is monitored within three years following completion of the harvesting operation.

The right size of opening differs from species to species. Through recent research and experiences, it has been observed that hemlock can cope with larger openings than spruce and being light demanding, blue pine regenerates well even in large openings. In transition areas between one species zones to another, opening size may help target the desired species. It is vital that this silvicultural knowledge is utilized and implemented. Openings that are too large or too small for the target species can again lead to excessive weed and bush growth before regeneration can become established (Whitfield, 2001).

Enrichment planting if necessary, will be carried out by NRDCL. Depending upon the cattle population and site condition, barbed wire fencing shall be done in the plantation area and plantation watchmen shall be deployed. Fencing and other actions to protect regenerations will be carried out by NRDCL, in consultation with FMU in-charge and the FMU level management committee. All regeneration surveys and regeneration activities will be funded by the implementing agency-NRDCL. Budgetary requirement surveys will be written in the Operation Plan in consultation with NRDCL.

FRMD recommends that the target stocking density in plantations to be up to 1600 stems per hectare. Any plantation with survival rate below 80% will require beating up.

Looking at the regeneration survey reports of the past operated cable lines, we can infer that the regeneration rate is high and the operated areas are well stocked. However, it is recommended that NRDCL should carryout necessary weddings and thinnings to promote the growth of quality timber for future.

20.6. Sequence of Operations Relating to Annual Coupe

The operations relating to the annual coupe should follow the sequence given in Table 3.1.

Table 3.1: Sequence of operations relating to the annual coupe

Operation Description	Timing (months) (-before felling; + after felling)
UIC decides on the location and size of annual coupe in accordance with the Biennial OP.	-12
NRDCL and UIC prepare an estimate of human, material, equipment and financial resources required.	-10
UIC finalises the annual coupe size, demarcates the coupe and instructs the NRDCL to carry out the pre-logging planning.	-6
NRDCL prepares cable line layout and alignment plan as well as proposed log depot and landing points and submits these to UIC for approval.	-3
UIC marks the carriage corridor trees and 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 cable crane.	-1
NRDCL commences systematic harvesting and extraction operations according to the approved sequence in the Biennial OP.	0
NRDCL/contractor completes the harvesting and extraction.	When completed
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 and all the timber is removed from the annual coupe.	When works are completed
DoFPS assess success of natural regeneration	As per guidelines
NRDCL completes post harvesting operations.	As per unit in-charge instructions

20.7. Road Construction

Forest roads are essential component for efficient management of forest. It allows transportation of timber from the landing sites to the depot at the right time. It also provides access to the forest areas for management and monitoring.

Road construction in the FMU requires extra precaution to achieve the environmental best practice. The basic necessity in the forest road construction is to avoid steep and fragile areas, to provide proper drainage system, especially for safe discharge of run-off water during monsoon, with enough culverts and cross drains, to have an efficiently drained compacted road surface.

Khotokha FMU is approached from Gogona through Shobela top. A 6km road is constructed for connecting the Shobela top to the interior of KFMU. 34kms of road network already existed with KFMU. Additional 11.5 km of road was constructed in Kekephu block to access the harvestable stock present. For this plan period 8.6 km of road is proposed. Road survey, design and construction will be carried out by NRDCL. The road is to be located by marking a grade line on the ground. This grade line is then used as a basis for road design, which will vary with the location of the road as necessary to meet the standards mentioned below in terms of bend radius, proportion of cut/ fill for various slopes, etc. NRDCL will mark the design centreline in the field so that contractor compliance to it can be monitored effectively.

Road Standards

A set of road standards have been developed by the forest engineers of TFDP. These road standards although developed in the east, address policies that are required throughout Bhutan. These standards will be adopted for Khotokha FMU and NRDCL engineers must follow these standards, given in annexure 2during designing and estimation and provide supervision during construction to ensure that the standards are met. The impact management recommendations from National Environment Commission (1999) and sectoral guidelines for Road must also be referred, where in general principle and practices to minimize negative economic and environmental impacts of road are cited.

Road design in the Khotokha FMU should follow the recommended road profile in *Figure 3.2* to avoid excessive water pooling leading to rutted road surfaces that inhibit access during monsoon season. Improper drainage may also lead to landslides. Following recommended road design would also decrease maintenance cost for future.

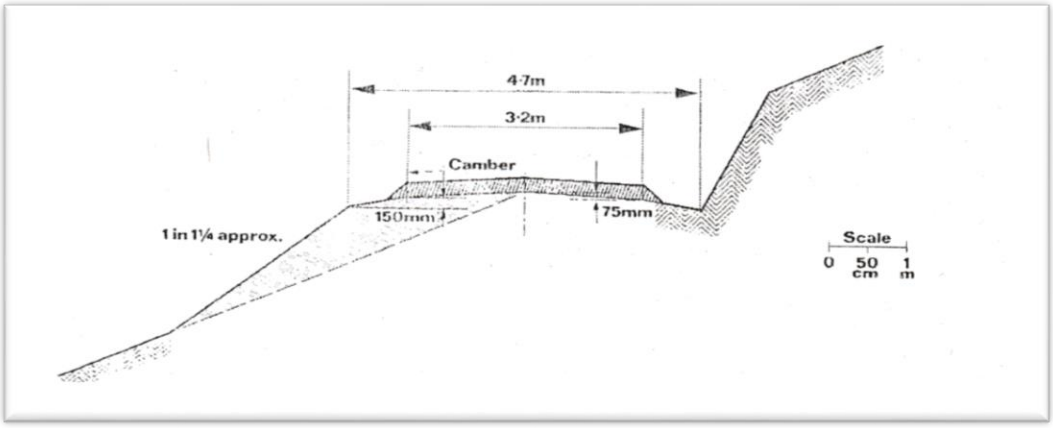


Figure 3.2: Recommended road profile

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, Territorial Division, Wangdue 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 3.2). This has important implication on budgeting (since it 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 3.2: 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 3.3.

Table 3.3 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 discussion with stakeholders and their representatives
	To involve relevant stakeholders in planning for activities which have a direct impact on 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 combined 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 activities Calculate cost for each planned activities		Each activity with identified responsibility for implementation, estimated cost, and site-specific location
6. FMU annual report presented to the FMU-level Management Committee	To review process and identify and address any implementation problems	FMU Annual report endorsed by FMU-level Management Committee	FMU Manager presents to the FMU-level Management Committee	During FMU-level Management Committee meeting
7. OP review by FMU Level Management	For the FMU Level Management Committee to	OP endorsed by FMU Level Management Committee	FMU Manager presents to the FMU Level	During FMU Level Management Committee annual meeting

Committee and endorsed	endorse the OP (prior to approval by DoFPS) To endorse expenditure estimates for the coming financial year		Management Committee	
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 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 assess the level of achievement of planned activities	Information for FMU annual report	FMU In-charge	DoFPS responsibility is to monitor the implementation of activities carried by NRDCL Monitoring cost need to appear in the OP
12. DoFPS, Unit Incharge	To report progress	FMU Annual report	FMU In-charge	Prepared annually

prepares FMU annual report	against planned activities To highlight any problems being encountered in implementation			Progress is reported against each FMP objective and the associated activities
13. Prepare the next year's 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

The Head, FRMD will ensure that the plan is evaluated at an interval of five years, based on the information collected by annual monitoring and other necessary information. The evaluation should be based on the review of the objectives and options, to see how well the management plan is being implemented. If objectives are not achieved this should be examined, reasons determined and activities redefined if appropriate. Corrective actions may be required to be incorporated in a range of inputs or to the implementation methodology.

The results of Mid-term Review should be discussed with the FMU Level Management Committee.

21.3. FMU-level Management Committees

A management committees chaired by the CFO, Wangdue will be formed to ensure a smooth implementation of the management plan. The committee will include the following members:

- Chief Forestry Officer, Wangdue (Chairman)
- Regional Manager, Rinpung Region, NRDCL
- Unit In-charge, Khotokha FMU
- Production In-Charge, NRDCL, Khotokha FMU
- Gup, Mangmi, Tshogpa, of Rubesa and Bjena Gewog
- FRMD Representative (if possible)
- Key village elders

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

During FMU Management Plan Preparation:

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

During the Operational Planning, Implementation and Monitoring:

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

21.4. Staff

The Chief Forestry Officer, Wangdue is the overall controlling Officer of the area. The controlling and management of Khotokha FMU will be looked after by the FMU In-charge. They will be under the administrative control of the Chief Forestry Officer, Wangdue 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.

21.5. Responsibilities

As per the Organizational Development Exercise by Royal Civil Service Commission 5 nos. of staffs are recommended for all FMUs but with the rise in timber demand and illegal timber extractions KFMU will require following staffs (Table 3.4) for the smooth monitoring and implementation of the plan in the KFMU.

Table 3.4: Staff requirement in the FMU

Sl. No.	Designation	Staff Numbers
1.	Unit In-charge (Sr. Range Officer/ Forestry Officer)	1
2.	Forest Ranger II/ Sr. Forester/ Forester	6

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, Wangdue.

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, monitoring of pest/diseases outbreak and any illegal activities in the FMU. The Forester will be assigned to help the Unit In-charge and the Forest Ranger.

21.6. Buildings

A new unit office has been constructed within FMU for efficient implementation of the plan. Two staff quarters have also been constructed within FMU for better working environment for the field staffs. Check post has to be constructed at Tashila and Shobela top which would form the two approach points to Khotokha. Check post are extremely necessary to check and curb illegal timber transportation from the FMU.

21.7. Vehicles and Equipment

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

Items	Quantity	Items	Quantity
Computer (Desktop) set	2 sets	Measuring tape	2 nos.
Printer	2 nos.	Suunto Compass	2 nos.
Xerox Machine	1 nos.	GPS Garmin	1 nos.
Laptop	1 set	Walkie Talkie Sets	5 nos.
Suunto Clinometer	2 nos.	Scanner	1 nos.
Altimeter	1 nos.	Diameter tape	3 nos.
Bark Gauge	1 nos.	Increment borer	1 nos.

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

Items	Quantity	Items	Quantity
Motor cycle	2 nos.	Walkie-talkie	5 nos.
Computer (desk top)	2 sets	Hypsometer	3 nos.
Laptop	2 sets	Binocular	2 nos.
Suunto clinometers	3 nos.	GPS	5 nos.
Suunto Compass	5 nos.	Digital Camera	1 no.
Diameter tapes	5 nos.	Printer	2 nos.
Distance measuring tape	5 nos.	Scanner With Photocopy	2 nos.
Bark guage	2 nos.	Increment borer	2 nos.
Crown densiometer	2 nos.		

There is a requirement of at least one bike or a four wheel vehicle for the unit for day to day implementation of the forestry activities and to liaise with the Divisional Headquarter.Walkie talkie sets are also provided to improve the implementation of plan by reducing the time taken to relay important communications and thus reducing the delay in follow-up activities.

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, Wangdue 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

There are always many constraints face during the implementation of the plan which acts as impediments to smooth functioning. Some of which are,

- Lack of research information
- Insufficient trained manpower and limited capacity for resources assessment and management planning
- Lack of skilled and trained forest workers
- Lack of sufficient support staff for unit in-charge
- Lack of locomotives for field staffs, leading to an inability of the staff to supervise any management activities in the FMU.
- No regular training for field staffs on preparation of operational plans and other related surveys.
- Inadequately trained Unit staffs to carry out cable line profiling. Insufficient technical staff in the FMU.
- Increased illegal activities within the FMU.
- Financial feasibility for commercial extraction by NRDCL.

There are risk involved in the smooth functioning of the implementation and achieving the targeted objectives which are listed below;

- Inadequate funds for forest management activities
- Natural regeneration may be uncertain due to grazing and undergrowth competition.
- Failure of regeneration due to cattle grazing

All unit operations and activities should be properly estimated for cost and records maintained to ensure proper and efficient utilization of funds. This would enable sufficient funds to be provided to CFO, Wangdue. It is also important to set up necessary institutional set up to improve the technical capacities of staff in management plan implementation.

24. DEVIATIONS FROM PLAN PRESCRIPTIONS

The annual harvested area should be managed to allow for unforeseen situations. For these and any other *bona fide* reasons, the annual coupe may vary ±10%. However, the total volume harvested over successive five years period must be no more than five times the AAC volume. Unforeseen other circumstances may warrant deviation from the Plan prescriptions. In such an event, the CFO Wangdue 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 National Environment Commission Secretariat (NECS) or the Competent Authority established by the Ministry must be informed of the plan deviations approved by the Head of Department if any.

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ANNEXURES

ANNEXURE 1: COMPARTMENT DESCRIPTION AND PRESCRIPTIONS

Chibegang Block

Protection:	663.7544
Production:	1,565.764
Non-production:	115.7255
Total area:	2,345.244
Altitude:	2,452m – 3,241 m

Forest Description:

No commercial operation had taken place in the past. This block consists of blue pine, mixed conifer and a small portion of mixed broadleaf forests. Blue pine occurs in the dry inner valleys on the south-eastern slopes. Blue Pine (both young and mature) forms pure and dense stand with diverse under storey of xerophytic shrubs apart from *Quercus griffithii*. The mixed conifer forest consists of Hemlock, Fir, Blue pine and spruce. Small patches of mixed broadleaf forest are found in the southern parts at lower elevation along Paza Chhu. The forest areas near settlements have been designated as the Local Use area in the previous plan.

Future Management Prescription:

In areas where dense regeneration of blue pine occurs, thinning is prescribed. This is mainly to improve the quality of the stand which can help obtain good timber in the future. Mature trees should be harvested on the basis of Single Tree Selection System for rural allotment. Grazing needs to be controlled and regulated strictly. In the previous plan period, a forest fire broke out in the year 2016 in Chibegang Block and burnt an area of 202ha. Therefore, for this management plan the fire burnt area has been placed under protection zone. This area shall he monitored and plantations should be carried out by NRDCL if the regenerations is poor or if the regeneration are of undesired species (*Populus spps*. and other invasive species).

Dolangdo Block

Protection:	470.0425
Production:	1,465.283
Non-production:	145.1804

Total area:	2,080.506
Altitude:	2,642m-3,573 m

Forest Description:

This block is dominated by Mixed Conifer Forest. The mixed conifer forest is mainly mature and over mature, young forest almost doesn't exist. They appear in zone above the Blue pine. It consists of vast stretch of Hemlock. Scattered Fir and Spruce are also found mixed with Hemlock. Fir occurs in the highest elevation forest zone and therefore is found along the highest ridges of Dolangdo. Luxuriant growth of Rhododendrons, other shrubs and herbs, eg.*Primula species* are commonly found in the under storey promoted by the humid environment. With the ascent of elevation, Firs become more stunted and are found to be mixed with Junipers and small *Rhododendron species*. Small patches of Blue pine forest occur nearby the settlement areas in the southern parts of the block. This Block was logged during the past three plan periods. There is adequate regeneration but these harvested areas (Fir and Hemlock) are now being replaced by Blue pine regenerations. This Block also has areas designated for local use in the third plan period.

Future Management Prescription:

There will be no commercial logging in this plan period but as commercial harvesting was carried out in this Block in the past three plan periods, the cable corridors and groups should be monitored regularly for regenerations. There is an area designated for local use to meet the timber demands of the people, which will be worked under single tree selection system.

Subesa Block

Protection	254.8665
Production	678.7039
Non-production	103.5172
Total area	1,037.088
Altitude	2,611 m - 3,185 m

Forest Description:

This Block consists of Blue pine and Mixed Conifer Forest. Blue pines mostly occur in the areas near settlement and are mostly young stands. There was no commercial logging in the past plan periods, however the areas near the settlements were set aside for local use in the past three plan periods.

Future Management Prescription:
No commercial harvesting shall take place in this plan period. However, timber will be allotted from the designated area for local use on single tree selection basis.

Kekephu Block

Protection	615.8058
Production	1,644.113
Non-production	15.19991
Total area	2,275.118
Altitude	2610 m - 3622 m

Forest Description:
Mixed Conifer Forest dominates this Block. Mixed Confer Forest consists of vast stretch of Hemlock forest, which occupies the montane cloud-forest zone with high precipitation. Scattered Fir and spruce occur in the Mixed Conifer Forest. Fir occupies the highest ridges of Kekephu. Blue Pine is found at the lower elevation in the south-western portion of the Block. Blue Pine forest form pure stands and are mostly young and very dense. This Block was logged commercially in the 2nd and 3rd plan period. There was also an incidence of Bark beetle attack in the previous plan period.

Future Management Prescription:
Commercial harvesting was carried out in this Block in the previous plan periods; hence the cable corridors and groups should be monitored regularly for regenerations. In areas where dense regeneration of blue pine occurs, thinning is prescribed. Mature trees should be harvested on the basis of Single Tree Selection System for rural allotment. Grazing needs to be controlled and regulated strictly. There are areas set aside for commercial harvesting in this plan period which will be worked under Group Selection System.

Sele Block

Protection	602.6396
Production	882.3313
Non-production	58.10005
Total area	1,543.071
Altitude	2,472 m – 3,357 m

Forest Description:

Patches of Mixed Broadleaf Forest occurs in the south-western portion of the Block. There are also pure young Blue pine stands that are usually dense. Mixed conifer forest dominant in this Block with Hemlock and scattered Spruce and Fir (at higher elevations). The Eastern and South-eastern part of the Block is mostly rocky, inaccessible and have patches of sub-alpine shrubs. This Block has not yet been put under commercial logging but will be logged commercially in this plan period. Timber for local use has been allotted from this Block and will be continued for this plan period too.

Future Management Prescription:

In areas where dense regeneration of blue pine occurs, thinning is prescribed. Mature trees should be harvested on the basis of Single Tree Selection System for rural allotment. Commercial harvesting will be worked under Group Selection System.

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 Khotokha FMU.

- Road lengths and density should be minimised, 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 slope allowed in all areas except rock is 100%.
- Roads must be constructed in such a way that no earthworks or soil spill into watercourses or watercourse buffer areas. Care should also be taken to ensure that no earthworks or soil is allowed to spill onto agricultural land, near houses or main roads.
- Roads should be planned in such a way as to balance cut and fill to minimise transport of construction material.
- Roads should not be constructed in steep and unstable areas where there is the possibility of landslide. A thorough survey of any area suspected of being unstable should be undertaken prior to work commencing.
- 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 metres) if they reduce the length of the road, reduce environmental damage and are properly drained.
- Minimum radius formed by curves or corners should be 15 metres and should where possible fit the topography of the land.
- Roads should be located on elevated areas where possible to minimise side-cutting, width of clearing and drainage problems.
- Side cutting should be carried out leaving a stepped batter, each step no more than 3 metres in vertical height and no more than 100% gradient with a 1.5 metre horizontal step.
- Convex road surface should be maintained at all times with the centre line 30 cm higher than the edges.
- Stabilise 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 season.

Drainage

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

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

- 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.
- Culvert 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 reaching the road.
- Drains should not be allowed to directly enter a watercourse but should be diverted into surrounding vegetation at least 50 metres before a watercourse.
- Sumps or silt traps should be placed in drains every 50 metres in erodable soils and must be cleaned regularly.

Road Construction

- All timber over 30cm diameter must be felled and removed from the road alignment; the remaining timber should be cut and burnt (no organic material should be used as fill).
- Primary excavation should be done in such a manner as to remove the topsoil and place it on the downward slope of the road. This will allow vegetation to regenerate and stabilise the slope.
- Where side slopes of 70% or more extend more than 100 metres downhill no side casting of spoil should be allowed. In this situation end haul methods must be used.
- 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 walls should be built to support both batter and fill (this is not required in solid rock).
- On side slopes of over 70% all of the load-carrying surface of the road must be built on stable ground. The road should not be supported by fill.
- The adverse gradient should not exceed 10%. However, grades of up to 12% will be allowed for distances of up to 300 metres if this substantially reduces road length. Following this incline a minimum distance of 100 metres of grades of 10% or less must be maintained.
- The favourable gradient should not exceed 12%. However, grades of up to 15% for distances of up to 300 metres will be allowed if this substantially reduces road length. These grades should be followed by grades of less than 10% for distances of 100 metres or more.

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

out of the proposed opening must be left standing so as to minimize damage to the remaining stand.

- Trees damaged during harvesting will be cut and removed in the subsequent cleaning operations.
- Fruiting trees and some hollow trees which will have less economic value will not be harvested; it will be left for preserving biodiversity.

Marking guidelines for Single Tree Selection System

- Felling under the Single Tree Selection System should be done in accordance with the following guidelines:
- Trees marked for harvesting will be evenly distributed throughout the stand.
- Diseased, malformed, dead and decaying trees will be marked on a priority basis; especially these are hampering the better ones (unless objectives of biodiversity conservation dictate otherwise). These trees can be marked even if below the set diameter limit of 50 cm. However, care should be taken that no large openings are created in the stand by marking these trees.

- Trees of exploitable size should be marked, particularly if defective or lacking in vigor; mature and over-mature trees over 50 cm DBH outside bark to be marked.
- No more than one third of the stand volume should be marked for harvesting.
- In mixed stands, an even and suitable distribution of species should be left standing.
- Fruiting trees and some hollow trees which will have less economic value will not be harvested; it will be left for preserving biodiversity.

Marking Guidelines for Blue Pine under Seed Tree System

- The seed tree system is used in pure pine stands or mixed stands consisting of mixture of pine and spruce with pine predominating.
- The Seed Tree System will be used in the above stands only on suitable sites. The system will not be used on steep and exposed,

South or South-West sites. In mixed stands, an equal distribution of pine and spruce will be left standing. Slope characteristics, wind firmness and aesthetic value will be considered.

- About 20 to 25 trees per hectare (i.e. approximately 22 to 26 meters apart) will be left standing.
- Diseased, malformed and dying trees will be cut on priority basis.
- Trees left standing will be of good health and form to ensure good seed source. The shape of the area chosen for the seed tree can be irregular.
- Maximum size of a contiguous area harvested using this system should not exceed one hectare.
- Fruiting trees and some hollow trees which will have less economic value will not be harvested; it will be left for preserving biodiversity.

Marking Rules for Patch Clear-cut System

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

- Dead, dying, malformed, or damaged (snags etc.) trees will be retained in between patch clear-cut, and in the interline spaces, to safeguard flora and fauna niches or habitats, but not in the harvested groups themselves, where there is the risk of wind throw and danger to personnel working underneath. Diseased trees will be removed to protect the quality of the remaining stand.
- All species listed for protection under the Forest and Nature Conservation Act (1995) must be protected if encountered.
- All species listed for protection under the Forest and Nature Conservation Act (1995) must be protected if encountered.
- Sufficient seed trees in the interline space adjacent to the cable lines opened up should be retained as potential seed source for seedling regeneration in the patch cuts.
- The trees selected will be marked with the authorized marking hammer close to ground level 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 volumes at the NRDCL Depot will also be recorded.

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 favoured tree (plus tree or other) has a crown ratio below half or an asymmetric crown, remove maximum one competitor in order not to jeopardize stability.
- Remove trees affected by dwarf mistletoe on a top priority basis.

- The stems of forked trees belong to the same vegetative individual and have to be treated together- if you remove one, you have to remove both.
- Remove malformed trees and trees with other diseases than dwarf mistletoe. Marking should not result in creation of gaps in the canopy.
- Focus on maintaining a well-structured stand.
- Focus on promoting a mixed-species stand.
- Do not blaze trees in the remaining stand. Blazing wounds weaken the trees and provide entry point for pathogens, devaluating the most valuable first log of the tree.
- Remove wolf trees (large emergent trees remaining from an earlier cohort) in a priority basis and do not consider their volume within the target of 25% volume removal.
- Do not worry about having to induce regeneration in the course of thinning.
- Thinning is primarily about stand improvement and is not a regeneration cut (Darabant, Rai, Eckmullner, Gratzer, & Gyeltshen, 2012).

Marking for Rural Uses

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

ANNEXURE 4: TOTAL VOLUME PER HECTARE IN KHOTOKHA FMU

Trees	Tree Volume (m^3)
Eurya cavinervis	25.092
Acer sp.	3,842.810
Acer campbellii	12,750.117
Persea sp.	6,206.129
Cornus sp.	1,338.625
Cornus capitata	2,641.664
Pentapanax sp.	7,741.107
Viburnum sp.	563.653
Quercus sp.	4,927.983
Quercus glauca	140,472.144
Quercus griffithii	669.359
Quercus lamellosa	9,925.699
Quercus lanata	4,789.722
Quercus semecarpifolia	565,322.049
Quercus semicarpifolia	652.410
Betula sp.	12,327.666
Betula alnoides	2,708.040
Betula utilis	13,245.541
Ilex sp.	7,360.545
Ilex dipyrena	4,883.757
Abies densa	379,470.912
Rhododendron sp.	34,200.888
Rhododendron arboreum	28,999.925
Rhododendron barbatum	5,822.397
Rhododendron campylocarpum	996.073
Rhododendron cinnabarinum	16.280
Rhododendron falconeri	3,619.763
Rhododendron hodgsonii	2,194.504
Rhododendron thomsonii	578.815
Rhododendron setosum	32.755
Rhododendron keysii	65.470
Rhododendron lanatum	454.922
Lindera sp.	697.762
Tsuga dumosa	1,049,901.270

Salix sp.	156.137
Juniperus sp.	383.454
Juniperus recurva	2,142.926
Juniperus squamata	8,054.215
Pinus wallichiana	833,303.932
Populus sp.	310.726
Populus ciliata	5,520.014
Castanopsis sp.	12,428.719
Not known	18,773.662
Sorbus sp.	7,666.227
Sorbus microphylla	705.351
Lyonia sp.	3,196.004
Lyonia ovalifolia	5,144.187
Enkianthus deflexus	96.034
Symplocos sp.	9,948.779
Symplocos lucida	155.828
Symplocos glauca	224.085
Prunus sp.	13,468.283
Picea spinulosa	48,721.689
Larix griffithii	4,228.017
Rhus sp.	2,130.043
Taxus baccata	7,920.962
Cinnamomum sp.	416.442
TOTAL	**3,294,541.562**

NNEXURE 5: DZONGKHAG ADMINISTRATIVE APPROVAL

དབུས་ཕྱོགས་འབྲུག་གཞུང་།
དབང་འདུས་ཕོ་བྲང་རྫོང་ཁག།
ROYAL GOVERNMENT OF BHUTAN
WANGDUE PHODRANG DZONGKHAG
Environment Sector
Tel. No. 02 481229/Fax No. 02 481380

DAW/Env-09/2018-19/ 576 25 March 11, 2019

Administrative Approval

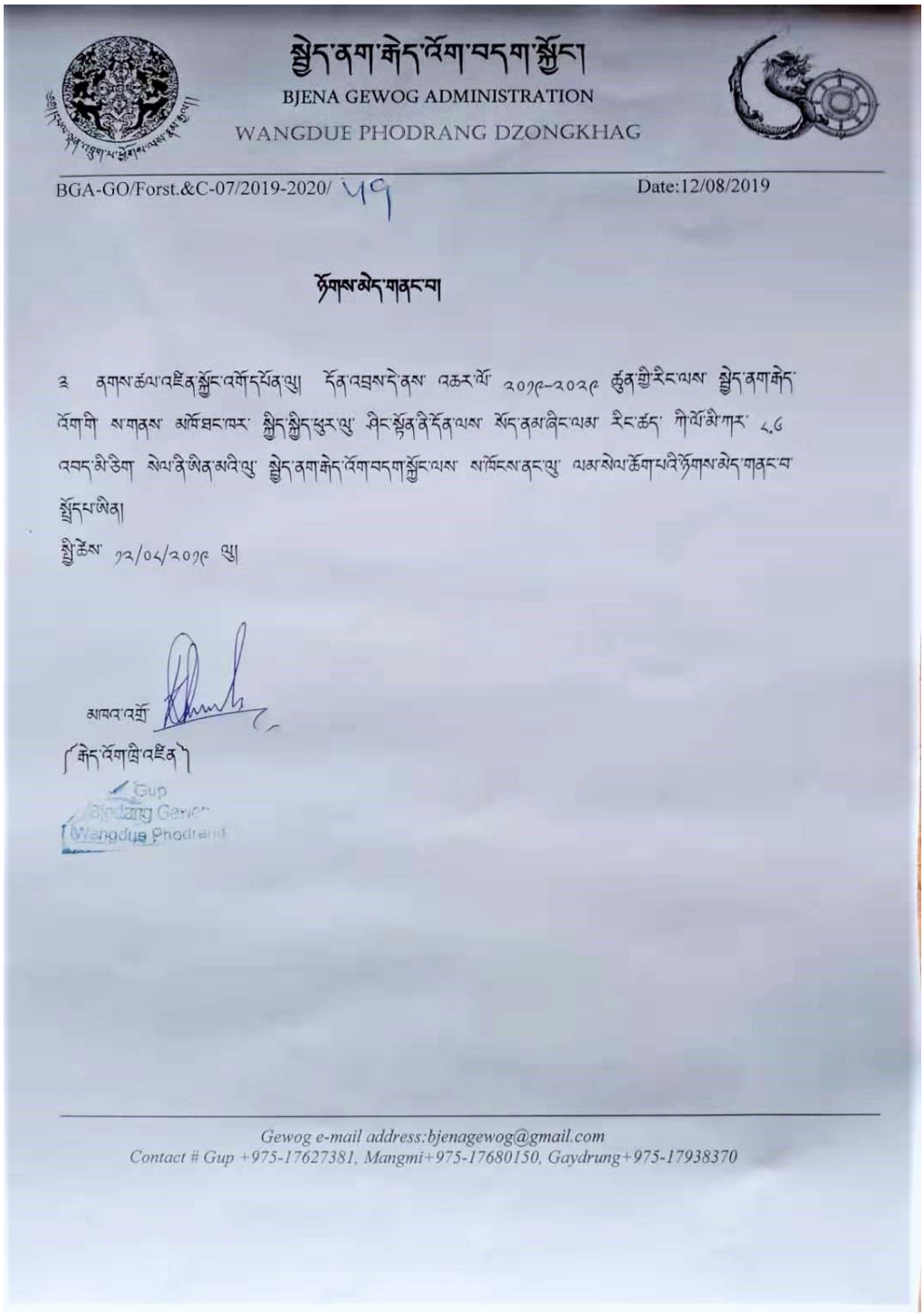
The Dzongkhag Administration is pleased to issue the administrative approval for the revision of the Forest Management Plan and activities of the existing Forest Management Unit, Khotokha.

However, the proponent shall process and obtain other relevant clearances required as per the rule.

(Sonam Jamtsho)
DZONGDAG

CFO
Lhuntse

ANNEXURE 6: GEWOG ADMINISTRATIVE APPROVAL



སྦྱོད་ནག་ཆེད་འཛིན་བདག་སྐྱོང་།
BJENA GEWOG ADMINISTRATION
WANGDUE PHODRANG DZONGKHAG

BGA-GO/Forst.&C-07/2019-2020/ ५१७ Date:12/08/2019

ཉེགས་ཚོགས་གནང་བ།

༡ ནགས་ཚལ་འཛིན་སྐྱོང་འགོ་དཔོན་ལུ། དེན་འཐས་དེ་ནས་ འཆར་ཡོ་ ༢༠༡৯–༢༠২৫ ཚུན་གྱི་རིང་ལས་ སྦྱོད་ནག་ཆེད་ འཛིགས་ སས་གནས་ མཐོ་ཐང་བར་ སྐྱིད་སྐྱིད་ཕུར་ལུ་ ཤིང་སྡོན་ནི་དོན་ལས་ སོད་ནམ་ཞིང་ལས་ རིང་ཚད་ གི་ཡོ་མི་གར་ ५.৬ འབད་མི་ཅིག་ སེལ་ནི་ཚིན་མའི་ལུ་ སྦྱོད་ནག་ཆེད་འཛིགས་བདག་སྐྱོང་ལས་ ས་ཁོངས་ནང་ལུ་ ལས་སེལ་ཆོགས་འི་ཉེགས་མེད་གནང་བ་ སྤྲོད་པ་ཡིན།

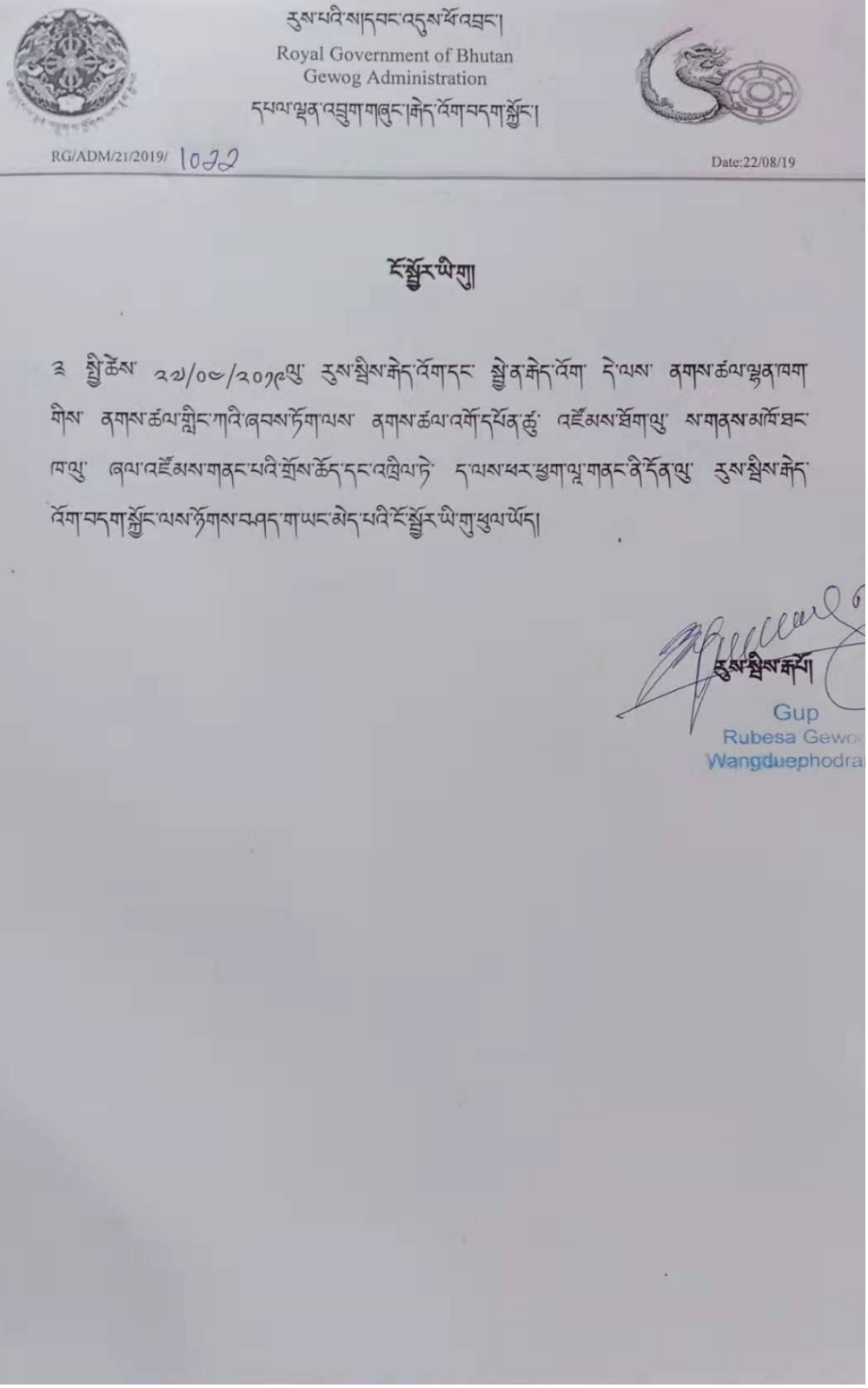
སྤྱི་ཟླ་ ৭২/০৮/২০১৯ ལུ།

མགའ་འགྲོ་

ཁ་ཆེད་འཛིགས་ཐི་འཛིན་ཀ།

Gup
Bjedrung Gewog
Wangdue Phodrang

Gewog e-mail address:bjenagewog@gmail.com
Contact # Gup +975-17627381, Mangmi+975-17680150, Gaydrung+975-17938370



རྒྱལ་ཡོངས་འབྲུག་གཞུང་།
Royal Government of Bhutan
Gewog Administration
དཔལ་ལྡན་འབྲུག་གཞུང་ཁེད་འཚབ་བགས་སྐྱོང་།

RG/ADM/21/2019/ 1022 Date:22/08/19

དངོས་ཡིག

ཟླ ཐྲིམ་ཆེས་ ཨ།/০৮/২০১৯ལུ་ རྒྱལ་སྡེལ་ཤེད་འཚགདང་ སྒྲིན་ཤེད་འཚག དེ་ལས་ ནགས་ཚལ་ལྷན་ཁག གིས་ ནགས་ཚལ་གྲིང་ཀའི་ཞབས་ཏོག་ལས་ ནགས་ཚལ་འགོ་དཔོན་ཚུ་ འཛོམས་ཐོག་ལུ་ ས་གནས་མཁོ་ཐང་ ཁ་ལུ་ ཞལ་འཛོམས་གནང་བའི་ གྲོས་ཆོད་དང་འགྲིལ་ཏེ་ དཔལ་ཕར་ཕྱག་ལྟ་གནང་ནི་དོན་ལུ་ རྒྱལ་སྡེལ་ཤེད་ འཚག་བཏགས་སྐྱོང་ལས་ཀྱི་གས་ཀཤད་གཡང་མེད་པའི་དངོས་ཡིག་ཕྱལ་ཡོད།

རྒྱལ་སྡེལ་རྫོང་།
Gup
Rubesa Gewo
Wangduephodra

ANNEXURE 7: ENVIRONMENTAL IMPACT ASSESSMENT REPORT OF PROPOSED FOREST ROAD

རང་བཞིན་འཕོག་བསྒྲུངས་གོང་འཕེལ་ལས་འཛིན་ཚོད།
Natural Resources Development Corporation Limited
ROYAL GOVERNMENT OF BHUTAN
THIMPHU, BHUTAN

No. NRDCL/HQ/Engg-Sec/11/2019/ 789 May 16, 2019

The Chief Forestry Officer
Wangdue Forest Division
Wangduephodrang

Sub: **Environment Impact Assessment Report of Forest Road, Khotokha FMU**

Ref: **WFD/FRMS-16/2019/1432 dated February 20, 2019**

Sir,

With reference to the letter No. cited above, please find enclosed herewith the Environment Impact Assessment report of forest road for the revision of FMU plan. The report consists of Environment Management Plan including Google earth images exhibiting tentative alignment of proposed road, dump sites & labour camp locations.

For any queries please contact Mr.Nidup Dorji, Jr. Engineer, Forest Resource Division at 02-323868/323834 (143) or email: nidup.dorji@ nrdcl.bt.

This is for your kind information and further necessary action please.

Yours sincerely,

(Sonam Wangchuk)
Chief Executive Officer

Copy to:

1. The Director, DoFPs, for kind information.
2. The Chief Forestry Officer, FRMD, DoFPS, for kind information.
3. The Dy. General Manager, Forest Resource Division, NRDCL HO, for necessary action.
4. The Regional Manager, Rinpung Regional Office, Thimphu, for follow up actions.

To be the premier institution in providing reliable and quality natural resource products and services to support nation building.
Post Box No. 192. Telephone - CEO: 00-975-2-322615, EPABX: 00-975-2-323834/323868/ 328959. Fax No.: 00975-2-325585, E-mail: info@nrdcl.bt website: www.nrdcl.bt

ENVIRONMENTAL IMPACT ASSESSMENT REPORT FOR CONSTRUCTION OF FOREST ROAD AT KHOTOKHA FMU, KEKEPHU BLOCK, WANGDUE DZONGKHAG

1	**Name of the applicant**	: Natural Resources Development Corporation Ltd.
2	**Name of project**	: Construction of forest road
3	**Present mailing address**	: Chief Executive Officer, NRDCL Thimphu, P.O. Box no. 192, Tel. no. 326749, EPABX no. 00975-02-323834/323868. Fax no. 00975-02-325585. Email: info@nrdcl.bt
4	**Name of environmental focal person**	: Mr. Nidup Dorji, Junior Engineer, Forest Resources Division, NRDCL HQ, Thimphu. Tel. no. 02-323834/323868. Email: nidupdorji@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,19,858,900.00
8	**Project description**	
	8.1 Project location	: Khekhephu block (27°24'16.36"N 90°00'38.70"E)

Table 1: Road location details by Dzongkhag and Geog

Road chainage		Dzongkhag	Gewog	Town	Village
From	To				
0 + 000	0 + 8600	Wangdue	Rubisa & Bjena	None	Khotokha

8.2 Category of road : Access road

8.3 Road specification Forest Road

Table 2. Road Specification/Quantities (For chaninage 0 + 8600)

Item	Unit	Specification/Quantities
Right of way clearing	m	10.00
Formation Width	m	5.00
Pavement Width including edging	m	3.50
Pavement material (Edging, soling & agttes)	cum	8,643.00
Volume of excavated material		
a) Excavation in soil all type	cum	31,070.13
b) Excavation in rock all type	cum	20,266.82
Average road gradient	%	±7
Maximum road gradient	%	±12
Cross drain	no	NIL
Box/Hume pipe culvert	no	17
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	8,549.00
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 excavators and tripper trucks or hydrualic tractor

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

Sl.No	Particulars	Quantity	Unit	Remarks
1	Safety fuse	1035	coils	(Approx)
2	Detonator	1806	Nos	(Approx)
3	D-chord	1462	m	(Approx)
4	Jelatine	2322	Kgs	(Approx)

Control single sho blasting techique will be adopted with the engagement of trained and 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 + 8600	8600m (Khekhephu block)	10 -120	Thimphu Formation & no problem foreseen	Normal Bio-engineering + Retaining & Breast wall structure works wherever required.
Total		**8,600.00**			

11.2 Water Course Crossings

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

Chainage at which road crosses water course	Name of water course	Type of crossing	If bridge, Length of bridge (m)	Down stream water users- details		
				Name of community or individual	House hold (no)	Type of use
0000 + 061	N A	Hume pipe culvert	NIL	Khotokha	NONE	NONE
061+ 0834	N A	Hume pipe culvert	NIL	Khotokha		
0834+ 0918	NA	Hume pipe culvert	NIL	Khotokha		
0918 + 1215	NA	Hume pipe culvert	NIL	Khotokha		
1215 + 1734	NA	Hume pipe culvert	NIL	Khotokha		
1734 + 2076	NA	Hume pipe culvert	NIL	Khotokha		
2076 + 2384	NA	Hume pipe culvert	NIL	Khotokha		
2384 + 2445	NA	Hume pipe culvert	NIL	Khotokha		
2445 + 2645	NA	Hume pipe culvert	NIL	Khotokha		

2645 + 3167	NA	Hume pipe culvert	NIL	Khotokha	NONE	NONE
3167 + 4677	NA	Hume pipe culvert	NIL	Khotokha		
4677 + 4871	NA	Hume pipe culvert	NIL	Khotokha		
4871 + 5310	NA	Hume pipe culvert	NIL	Khotokha		
5310 + 6005	NA	Hume pipe culvert	NIL	Khotokha		
6005 + 6590	NA	Hume pipe culvert	NIL	Khotokha		
6590 + 7482	NA	Hume pipe culvert	NIL	Khotokha		
7482 + 8155	NA	Hume pipe culvert	NIL	Khotokha		

12 Project Site Ecological Description

12.1 Land Use/Vegetation

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

Chainage from take off		Land use	Area (M^2)	Tenure	Affected House hold no
From	To				
0 + 000	8600 + 000	Mixed Conifer	100,000.00	10 years	NIL

Table 6: Areas Required for Project Facilities

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

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

13 Project social environment

13.1. Population

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

Dzongkhag	Gewog	Households (No)
Wangdue	Rubisa	49

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

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13.2 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

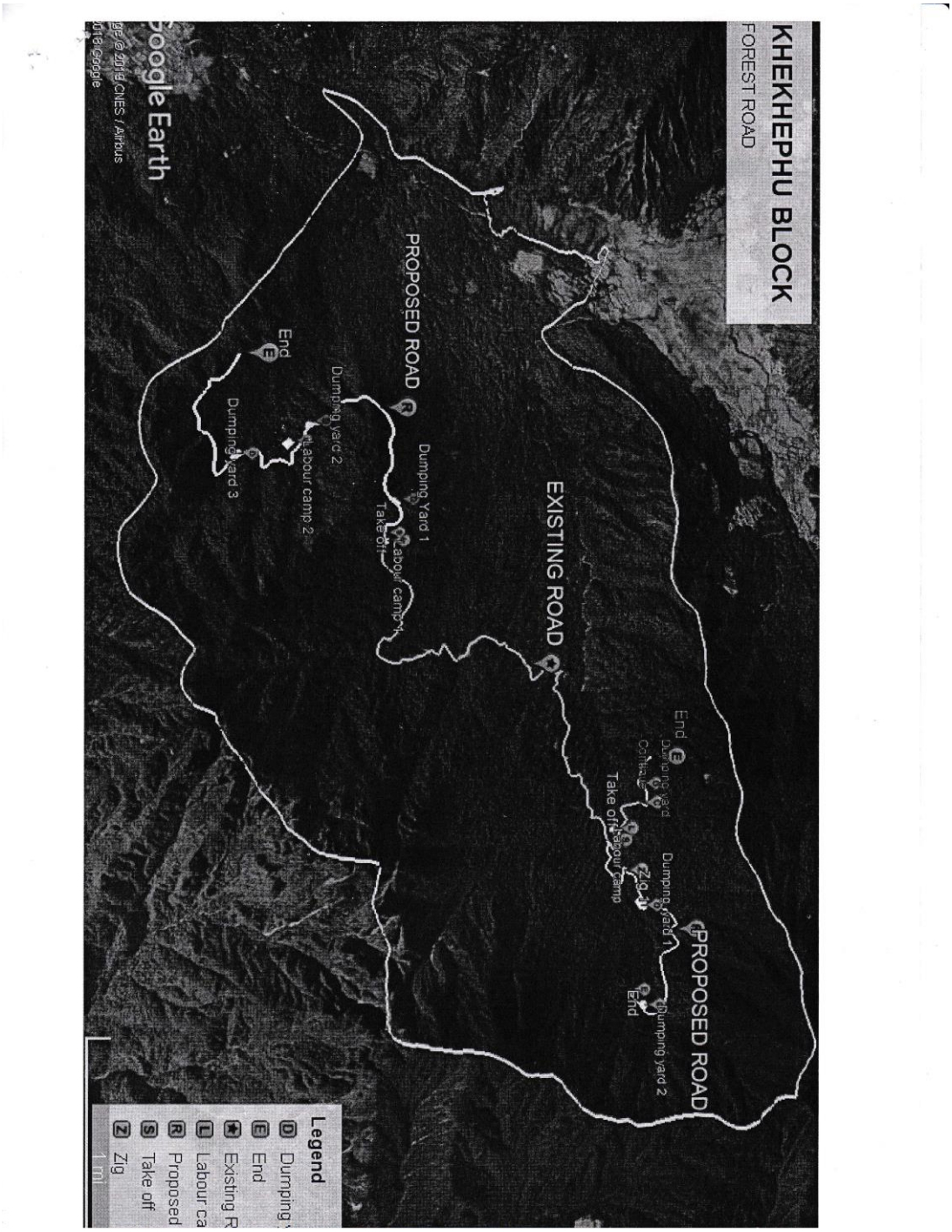
Monitoring of the construction works will be done by Site supervisor, Khotokha Unit, NRDCL, including time to time monitoring by the Unit Manager, Khotokha Unit under Rinpung Regional Office, Paro. The Regional Manager, Paro Regional Office, NRDCL Paro, shall also carry out the frequent monitoring. Also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

Nidup Dorji
Jr. Engineer
Forest Resouce Division,HO,NRDCL

ENVIRONMENTAL MANAGEMENT PLAN FOR CONSTRUCTION OF 8.60km FOREST ROAD AT KHOTOKHA FMU UNDER RINPUNG REGIONAL OFFICE, NRDCL, WANGDUEPHODRANG DZONGKHAG.

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

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


KHEKHEPHU BLOCK
FOREST ROAD
PROPOSED ROAD
EXISTING ROAD
End
Dumping yard
Take off
Labour camp
Zig
Dumping yard 1
Dumping yard 2
PROPOSED ROAD
Dumping Yard 1
Labour camp 1
Take off
Dumping yard 2
Labour camp 2
End
Dumping yard 3
Google Earth
Legend
Dumping
End
Existing R
Labour ca
Proposed
Take off
Zig

ANNEXURE 8: CLEARANCE FROM PUBLIC CONSULTATION MEETING

དཔལ་ མགོ་ཐང་ཁ་སྤོབ་གླིང་ཚའི་ནང་གི་ ཐུན་ཚོད་ ༢ ཀྱི་མི་ལེར་དང་ ནགས་ཚལ་འཛིན་སྐྱོང་དེ་ཡོན་ཏན་ཁག་ལ་ཁ་ཤས་ཆེ་ཆུང་ཡོད་པའི་ཐོག་ནས་ ཁོང་ཚོའི་ཞུ་ཐུབ་ཀྱི་ཡོད་ཚད་ཀྱི་ཐབས་ལམ་ཁག་ཅིག་ཡོད་པ་ཞིག་ཐོན་ཡོད་པ་ཡིན།

༡/ ནགས་ཚལ་འཛིན་སྐྱོང་དེ་ཡོན་ནང་ལས་ མི་ལེར་གྱི་ཤེད་བཟོན་ཀྱི་ལས་རིམ་དེས་འཛིན་བཟང་མི་ ཞུ་ཐུབ་ལ། ཐབ་ཀྱི་ལ་ཁ་ལས་རྟོག་དོ་ཞུ་དང་ རོ་གླང་དོ་ལས་སྐྱེས་ཀྱི་ཀ་ སྐྱེས་ཀྱི་ཡུ་འཛིན་སྐྱོང་འཆར་གཞི་ཀི་ལ་ཁོང་ལས་སྒོ་ལོག་ཁ་ལས་ ཤེས་ལེགས། ལྷུ་ཁའི་སྐད་ཀ། དཔལ་འབྱོར་གླིང་། དཔལ་ཁོག་སར།

༢/ ནགས་ཚལ་འཛིན་སྐྱོང་དེ་ཡོན་ཀྱི་ཁ་སྐོག་ལས་ དེབ་འཛིན་ཁཐད་ཡོད་པའི་ལ་ཁོང་ནང་ལས་ཡར་ ལམ་ལེའུ་ནི་ལུ་ མི་ལེར་ཀྱི་ཁོང་ལས་ ཉེནས་ག་ནི་ཐང་མེད།

༣/ གོང་འཁོད་ལས་ལྷ་ཚུ་ ཆུའི་ཤུ་དང་ གནས་ཁང་ཡོད་པའི་ལས་སྒོ་ནང་ལས་ཡར་ ཁཐད་མི་ཆོག། གལ་སྲིད་ གོང་གི་རྟེན་ཚན་ ༢ ལས་ བརྒལ་བའི་བྱ་དན་ཅེ་ ཁབྱུང་པ་ཅིམ་ ནགས་ཚལ་གྱི་རགོང་ལ་རྟེན་ ཉེས་བྱ་ ཀུན་ཐུག་ཁུངས་གོ་ལའི་ཐྲེལ་ཆོད་ ལྷག་ཆོས་ ༢༠/০৫/২০ ལུ་ བཐུག།

ཕུན་ཚོགས་རྟེ་རྗེ། གཙུག་རྟེ་རྗེ། ཆོས་རིད་དོངས་གྲུབ།

དཔོན་ལར་ཆོགས་པ། ཁོང་ལེགས་ཆོགས་པ། སྐང་རི་ཅན་ཆོགས་པ།

མཁའ་འགྲོ།

སྤྱི་ནགས་ཚུལ།

Gup
Bjednag Gewog
Wandue Phodrang

བཅའ་སྐྱོགས་རྟེ་རྗེ།

རྩལ་པའི་དམངས་མི།

27/04 2019.

List of participation for public consultation meeting(Khotokha FMU Management plan revision) 27/04/2019

Sl No	Name	Geog	Village	Signature
1	Sangay Dema	Bjena	Tashitokha	
2	Gyembo.	-n-	Chaykpati	
3	Namgay	-n-	Kinchenling.	
4	Kinga Payzo	-n-	Gyenaling.	
5	Karma Thendup	-n-	Jenchena	
6	Tashi Wangdi	-n-	Sejay.	
7	Chim.	Rubesa	Depalis	[illegible]
8	Jamgay Tenzin	Bjena	Khotokha-	[illegible]
9	Sangay Choden	-n-	Genseg	
10	Kinley Om	-n-	Khotokha-	
11	Ramo.	-n-	Sese.	
12	Chado	-n-	Genja	
13	Gyembo	-n-	Khotokha	
14	Wangmo.	-n-	Khotokha	
15	Thinley Dema	-n-	Kho Garichen.	
16	Sangay Dawa	-n-	-n-	
17	Thinley Om	-n-	-n-	
18	Chim Om	-n-	-n-	
19	Phub Dem	-n-	-n-	
20	Tshering Choden	-n-	Rampang	
21	Dema	-n-	-n-	
22	Nim Dem	-n-	Balanggoempa	
23	Lagey Tshering	-n-	Gaimachu.	
24	Sonam Dema	-n-	Khotokha	
25	Om.	-n-	Sebesa.	
26	Nagom	-n-	Rampang.	
27	Sangay Chem	-n-	Madlaygoempa.	
28	Kinley Wangmo.	-n-	-n-	
29	Yeshi Wangmo	-n-	Sebesa	
30	Thinley Om	-n-	-n-	
31	Dawa	-n-	Dalaygoempa.	
32	Phub Dorji	-n-	Garichen.	
33	Phuntsho Om	-n-	Khotokha.	
34	Karma Om	-n-	Garama	
35	Tenzin	Rubesa	Genseg	[illegible]
36	Sangay Dorji	-n-	-n-	[illegible]
37	Phub Dema	Bjena.	Gaimachu	.
38	Tashi Dem	-n-	Rampang.	
39	Chencho Dorji	Rubesa	Damchukha	[illegible]
40	Tshering	Bjena	Chidha	[illegible]
41	Kinley Wangdi	-n-	Khotokha	

ANNEXURE 9: RECORD KEEPING FORMS

Block: Compartment: Sub-compartment:

MC	WC	Date	Name and Address	Permit No.	TMB No.	Particulars			Volume (m3)			Comments
						Species	Product Type	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 (FDC)	Firewood (lops/tops)			
			Line No.	Length (m)	Azimuth	Tot No.	Total Area (ha)	No. of trees	Vol.					

Stand Tending and Regeneration

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 or survival percent)	Resurvey?	

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

Khotokha FMU inventory team during inventory training organized by FRMD.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