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GOVERNMENT OF INDIA

MINISTRY OF AGRICULTURE
(DEPARTMENT OF AGRICULTURE & COOPERATION)

REPORT ON PREINVESTMENT SURVEY OF FOREST RESOURCES IN CENTRAL AND EASTERN BHUTAN

VOLUME I

FOREST RESOURCES

PREINVESTMENT SURVEY OF FOREST RESOURCES
DEHRA DUN
1980

Contents

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GOVERNMENT OF INDIA
MINISTRY OF AGRICULTURE
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REPORT
ON
REINVESTMENT SURVEY OF FOREST RESOURCES
IN
CENTRAL AND EASTERN
BHUTAN

VOLUME-I
FOREST RESOURCES

REINVESTMENT SURVEY OF FOREST RESOURCES
DEHRADUN
1980

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ACKNOWLEDGEMENTS

The Preinvestment Survey of Forest Resources Team is grateful to the Royal Government of Bhutan for their continued cooperation for enabling them to conduct the survey in areas covered by this report. A deep sense of gratitude towards HRH N. Wangchuck, Honourable Minister for Trade, Industry and Forests, is placed on record for the keen interest he has been taking in working of the team.

Thanks are due to the Secretary and Officers of Ministry of Trade, Industry and Forests of the Royal Govt. of Bhutan for their kind cooperation rendered to the team.

Dasho G. Dorji, Director of Forests, Royal Govt. of Bhutan continued to take personal interest in day-to-day working of the team. The team is indebted to him and thanks him for all he did in successful implementation of its work. The Officers and members of staff of the Forest Department, Royal Govt. of Bhutan are also thanked for their cooperation.

His Excellency J.R. Hiremath, the Ambassador of India in Bhutan and the Officers of Indian Embassy, Thimphu took great interest in the activities of the Project and provided all possible help for which the team is thankful to them.

Thanks are due to the Officers and staff at the Head-quarters Office of the Preinvestment Survey of Forest Resources, Dehra Dun and 70-Forest Party of Survey of India for their collaboration with the team.

DEHRADUN

CHIEF COORDINATOR
PREINVESTMENT SURVEY OF FOREST
RESOURCES.

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PREFACE

This is the second report by the Preinvestment Survey of Forest Resources Organisation of Govt. of India. The first report, which covers 7960.21 km^2 (geographical area) in North-Western parts of Bhutan, was presented in December, 1976.

The present report covers North-Central (6760.72 km^2) and North-Eastern (4137.19 km^2) parts of the country. The field team of the Preinvestment Survey of Forest Resources which was in Bhutan from August 1974, took up field operations in the areas covered by this report from February, 1976. Consolidation of results of survey deduced through scientific and technical aids, as enshrined in this project has been a stupendous task involving action, on priority, by various expertise and specialists. Able and valued guidance of Shri C.L. Bhatia, Chief Coordinator, Dehra Dun and expert advice of the various concerned officers of the Hqrs. office having helped the Bhutan Forest Survey team, in completion of this task.

6760.72
4137.19
10897.91

The work in Bhutan was continued to be supervised by Shri J.N. Mullick, I.F.S., Project Director with keen perception and adept guidance. He had to leave the organisation in April 1980 for posting as the Chief Conservator of Forests, Himachal Pradesh, on promotion. He deserves full praise and credit for conducting the work smoothly.

The following other officers were associated with field work and compilation of report :

(i)	Shri P.M. Sangal, DCF	- IFS Officer of Union Territory Cadre - from the beginning till February 79 when he was repatriated to his parent cadre.
(ii)	Shri A.S. Sadashivaiah, DCF.	- IFS Officer of Karnataka Cadre - from the beginning to June 1979 on repatriation to his parent State.
(iii)	Shri H.C. Joshi, DCF	- IFS Officer of U.P. Cadre - August 1976 onwards.
(iv)	Shri S.S. Saini, ACF	- An Officer of Himachal Pradesh Forest Service - throughout the period of survey.
(v)	Shri B.N. Kalita, DCF	- IFS Officer of Assam Cadre - From August 1979.
(vi)	Shri M.C. Singh, ACF	- An Officer of Manipur Forest Service From July 1977 to May 1978.
(vii)	Shri A.R. Yadav, ACF	- An Officer of Madhya Pradesh Forest Service - from March 1979 to Aug.79.

Contents

Names of Senior Technical Assistants viz. S/Shri O.P. Ahlawat (from the beginning till Sept. 1978, O.P. Gaba, B.R. Pande and D.S. Bist (all, throughout the survey) deserve specific mention. Besides, Shri G.S. Grover, Administrative Officer was associated with the Project throughout the survey. The survey was carried out by field staff drawn from Northern, Eastern, Central Zones and Hqrs. Office, Dehra Dun of P.I.S. Organisation. It is heartening to record that technical personnel recruited locally (most of who are Bhutanese Nationals) associated with the team, have picked up PIS techniques. They deserve full appreciation for their hard work.

With the presentation of this report, total geographical area of 18,858.12 km^2 in Bhutan has been covered by the Preinvestment Survey of Forest Resources team. The field work in fourth and last phase, covering an area of 10,531.11 km^2 in Southern Bhutan, has already been completed and report is expected shortly.

It is hoped that this report and resources maps which are also being presented with it, would be useful to the Royal Government of Bhutan.

Inspector General of Forests,
Government of India,
Ministry of Agriculture,
(Department of Agric. & Coop)
New Delhi.

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LIST OF ABBREVIATIONS

BAF	-	Basal Area Factor
BT	-	Bark Thickness
^{o}C	-	degree centigrade
CCGR	-	Cluster Centre Grid Reference
cm	-	centimetre
Col.	-	Column
cu.m.	-	cubic metre
d.b.h.	-	diameter at breast height
DFO	-	Divisional Forest Officer
DGS&D	-	Director General of Supplies & Disposals
dia	-	diameter
d.o.b.	-	diameter over bark
DPU	-	Data Processing Unit
d.u.b.	-	diameter under bark
E	-	East
e.g.	-	exempli gratia (for example)
etc.	-	etcetra
GSI	-	Geological survey of India
ha.	-	hectare
i.e.	-	id est (that is)
km	-	kilometre
KW	-	Kilo Watt
KWH	-	Kilo Watt Hour

Contents

m	-	metre
m^2	-	square metre
m^3	-	cubic metre
MFP	-	Minor Forest Produce
mm	-	millimetre
m.s.l.	-	mean sea level
MW	-	Mega Watt
N	-	North
NH	-	National Highway
Nu	-	Ngultrum (Nu.1 = Re.1)
ob	-	overbark
PAI	-	Periodic Arnual Increment
PC	-	Point Centre
PDF	-	Point Description Form
PWD	-	Public Works Department
Rs.	-	Rupees (Re.1 = Nu.1)
SP	-	Sample Point
STF	-	Sample Tree Form
UNDP	-	United Nations Development Programme
UP	-	Uttar Pradesh
WRE	-	Wood Round Equivalent

Contents

INTRODUCTION

The first report, covering North-Western Bhutan (Phase I) was presented by the Project to the Royal Government of Bhutan** in December 1976.

2. The present report deals with the results of the survey in North-Central (Phase II) and North-Eastern (Phase III) parts of the country. The area is covered by the following Survey of India Map Sheets:

Phase No.	Description	Survey of India Sheet Nos.	Area km^2
II	Chirang, Tongsa (Beyakher), Shemgang areas.	78 I/4,6,7,8, 10,11,12,14, 15 & 16	6,760.72
III	Lhuntshi, Monger, Tashigong and Shumar areas.	78 M/3,4,7,8, 11(part) and 12	4,137.19
			10,897.91

3. The programme for survey in Phase II and III together with Phase I, was approved by Royal Govt. of Bhutan under their letter No.F.10/74/3641 dated 14-12-1974. Permission to take up work was also accorded by them simultaneously. The Govt. of India, Ministry of Agriculture & Irrigation, Department of Agriculture, vide their letter No.3-21/74-F.II, dated the 11th August, 1975 approved the proposal for taking up work in Phase II. Later on, on the advice of Royal Government of Bhutan, the area of Phase III was curtailed from 9424.50 km^2 to 4,137.19 km^2 and compilation of a consolidated report for both the phases was agreed upon. These proposals were finally approved by Govt. of India, Ministry of Agriculture & Irrigation, Department of Agriculture, vide their letter No.3-21/74-F.II, dated the 5th January, 1976.

** The location of Bhutan and her surrounding countries has been shown in Figure I on opposite page (reproduced from the first report).

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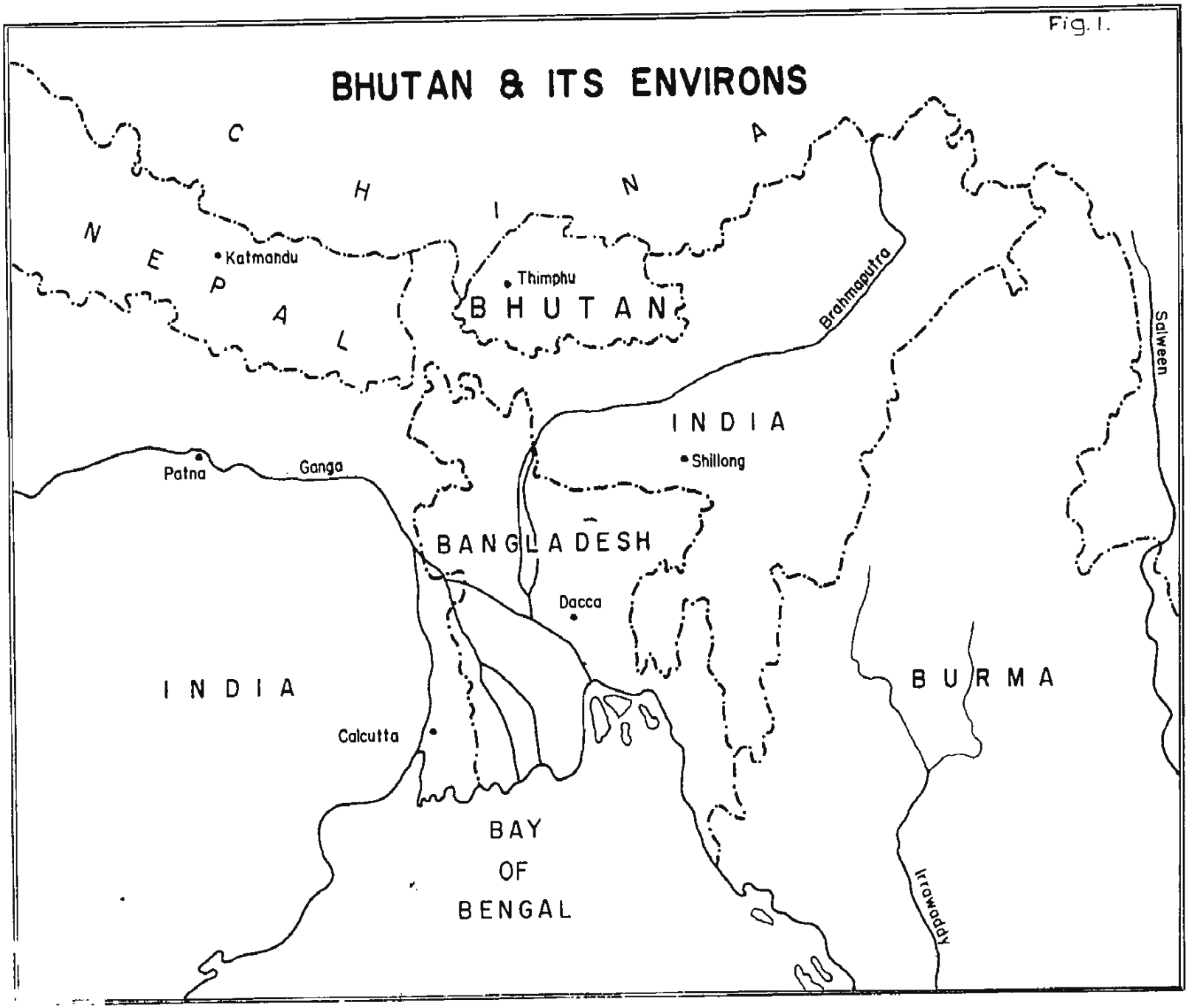


Fig. 1.
BHUTAN & ITS ENVIRONS
C H I N A
N E P A L
Katmandu
Thimphu
B H U T A N
Brahmaputra
Salween
INDIA
Shillong
Patna
Ganga
BANGLADESH
Dacca
INDIA
Calcutta
BURMA
BAY OF BENGAL
Irrawaddy

Contents

4. The field operations in Phase II (North-Central Bhutan) were started from 6th February 1976 and inventory work was completed in April, 1977. The survey in Phase III (North-Eastern Bhutan) commenced from 10th May 1977 and completed in February, 1978. The Volume studies conducted for this report during March to May and September to December 1977 cover certain areas of Phase IV (Southern Bhutan) also, in addition to those within the survey area.

5. Detailed "Demand and Market" Studies were conducted and data from survey area were collected. In addition, a study to determine the potential demand for wood in the timber markets of adjoining areas of Goalpara, Kamrup and Darrang districts of Assam State (India) was also undertaken. A separate chapter on the subject (Chapter XII - "Demand and Market" Studies) has been included in the report.

6. Attempts have been made to present more elaborate details, than those included in first report, on "Accessibility & Cost" Studies (Chapter XI) and "Industrial Investigations" (Chapter XIV), in collaboration with the Technical Officers in Headquarter Office, Dehra Dun.

7. The wood balances have been calculated in Chapter XIII after deducting total demand (Chapter XII) from the annual cut (Chapter X). Investment calculations have been done in Chapter XV which gives an idea of magnitude of the problems, involved in working of the forests. In the same chapter (Chapter XV), certain investment recommendations have been made, on the basis of results of the survey.

8. Some of the factual details given in various chapters of this report are enlisted hereunder:

S.No.	Details		Referred to in para no. of the report
1.	AREA (km^2)		
	Tree forest	: 8,241.26	
	Alpine pastures & blanks	: 844.43	
	Non forested	: 1,723.63	
	Under clouds & photo gaps	: 88.59	
	Total geographical area	: 10,897.91	6.2.3
	Total operable forest area	7,571.97	9.3.2

Contents

S.No.	Details			Referred to in para no. of the report
2.	GROWING STOCK ('000' m^3)			
	Total gross volume	:	2,13,977.1	
	Cull volume	:	31,923.8	
	Net volume	:	1,82,053.3	7.10.1
	Bark volume	:	33,300.1	7.11.3
	Accessible growing stock	:	1,98,052.6	
	Conifers 74,569.7 B/leaved 123,482.9			9.4.1
3.	ANNUAL CUT ('000' m^3)			
	Gross annual cut		7,369.8	
	Conifers 1,912.7 B/leaved 5,457.1			
	Net annual cut		6,079.0	
	Conifers 1,341.9 B/leaved 4,737.1			10.4.2
4.	DEMAND ('000' m^3 WRE)			
	Total demand for the year 1978.		1,426.694	
	Conifers 286.923 Broadleaved 1,139.771			
	Total projected demand for the year 1983.		1,587.500	
	Conifers 319.716 Broadleaved 1,267.784			
	Total projected demand for the year 1988		1,763.024	
	Conifers 355.230 Broadleaved 1,407.794			12.5.9

Contents

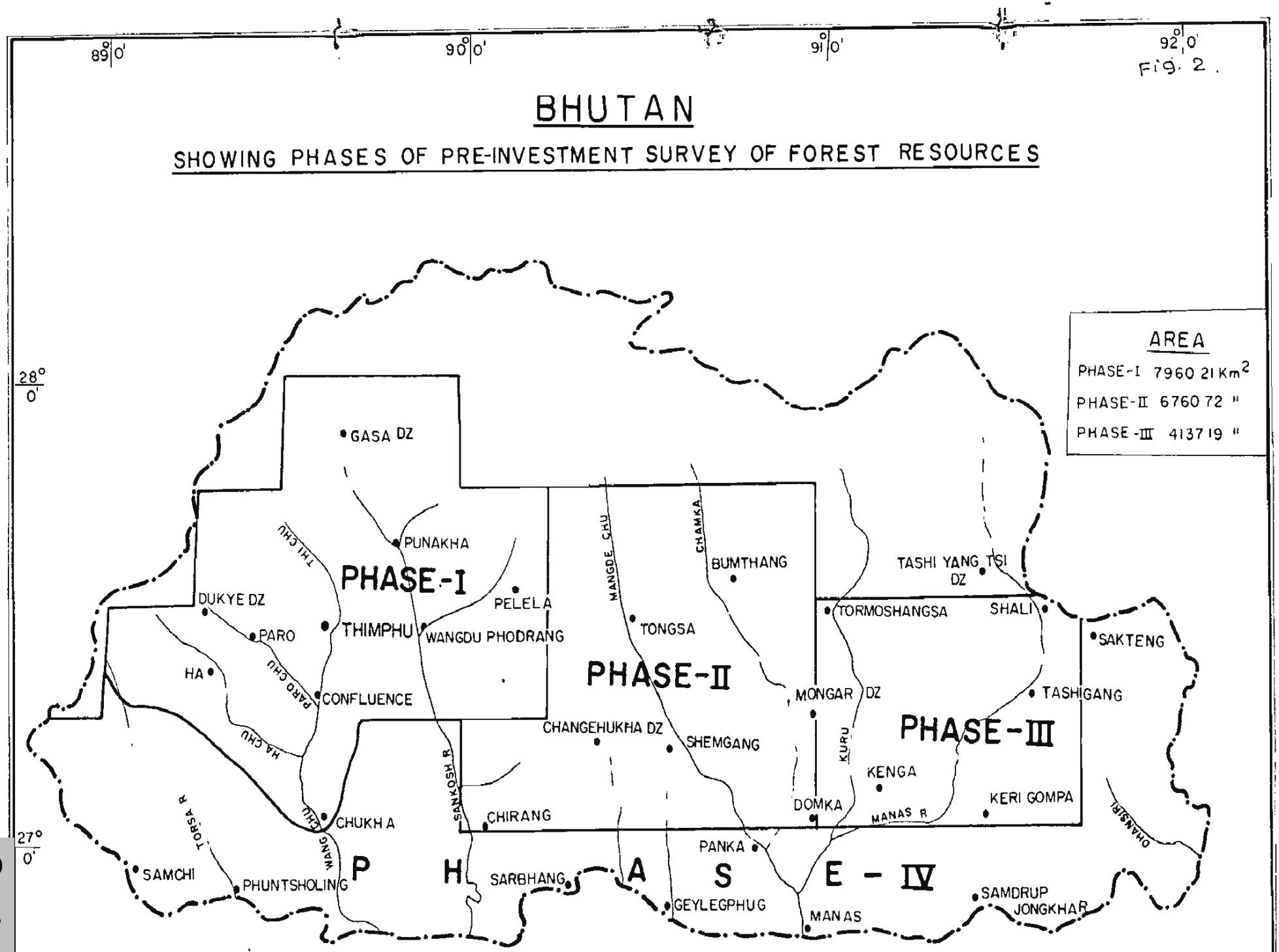
S.No.	Details			Referred to in para no. of the report
5.	WOOD BALANCES ('000' m^3)			
	Total available wood for industrial use in 1978		718	
	Conifers	326		
	Broadleaved	392		
	Total available wood for industrial use in 1983		1,085	
	Conifers	412		
	Broadleaved	673		
	Total available wood for industrial use in 1988		1,451	
	Conifers	504		
	Broadleaved	947		13.5.5

Contents

Fig. 2.

BHUTAN

SHOWING PHASES OF PRE-INVESTMENT SURVEY OF FOREST RESOURCES



Contents

CHAPTER-I

THE SURVEY AREA

1.1.1 The area covered by this report is located in Central and Eastern Bhutan and would be referred to as the 'Survey Area' or simply as the 'area'.

1.2.1 AREA

The total geographical area surveyed for this report is 10,897.91 km^2 and is covered by 16 map sheets (1:50,000) Nos. 78/I 4, 6, 7, 8, 10, 11, 12, 14, 15 & 16; 78/M 3, 4, 7, 8, 11 & 12 (Details given in para 3.3.1 of Volume II).

1.3.1 LOCATION

The survey area lies between 27° N to 27° 45' N latitude and 90° E to 91° 45' E longitude.

1.3.2 The area is approachable from the Southern border towns of Sarbhang, Gaylegphug and Samdrup Jongkhar and also from Thimphu over Palela.

1.4.1 CIVIL BOUNDARIES

The survey area lies in parts of Daga, Chirang, Gaylegphug, Tongsa, Wangde Phodrang, Byakar, Shemgang, Tashigang, Mongar, Shumar and Samdrup Jongkhar Civil districts.

1.5.1 TOPOGRAPHY AND DRAINAGE

The survey area is entirely mountainous with the main ranges following the general north-south direction. The main ranges branch off in a maze of spurs running in all directions with the result that all aspects are almost equally represented. However, southern aspect appears to be more preponderant.

1.5.2 Manas and its tributaries (Mangde chu or Tongsa, Bhumthang, Gamri and Kuru chu), Sankosh, Ai chu or Mao and Nyera Ama are the main rivers which drain the survey area. Manas, Sankosh, Ai chu or Mao and Nyera Ama flow out of Bhutan to join the mighty Brahmaputra. Mangde chu or Tongsa, Bhumthang or Chamkar chu, Kuru chu and Gamri Join Manas within Bhutan territory. For the purpose of this survey, however, the following individual catchments were identified.

Contents

Catchment	Area (km^2)
Sankosh	1,045.38
Ai chu or Mao	640.70
Mangde chu (Tongsa)	2,951.67
Bhumthang	2,178.92
Gamri	1,245.65
Kuru chu	1,185.47
Manas	1,074.19
Nyera Ama	487.34
	10,809.32
Gaps and Clouds	88.59
Total	10,897.91

1.5.3 Altitude varies considerably within the survey area resulting in a great diversity of climate and vegetation. The range of elevation is 240 m to 5123 m above mean sea level. Calculations done from the map sheets covering the survey area have revealed the following distribution of the geographical area under survey by altitude classes.

Elevation (meters)	Area (km^2)
0 - 500	66.07
500 - 1000	680.19
1000 - 1500	1579.52
1500 - 2000	2039.92
2000 - 2500	1742.65
2500 - 3000	1657.81
3000 - 3500	1508.48
3500 - 4000	1046.48
Above 4000	576.79
Total	10897.91

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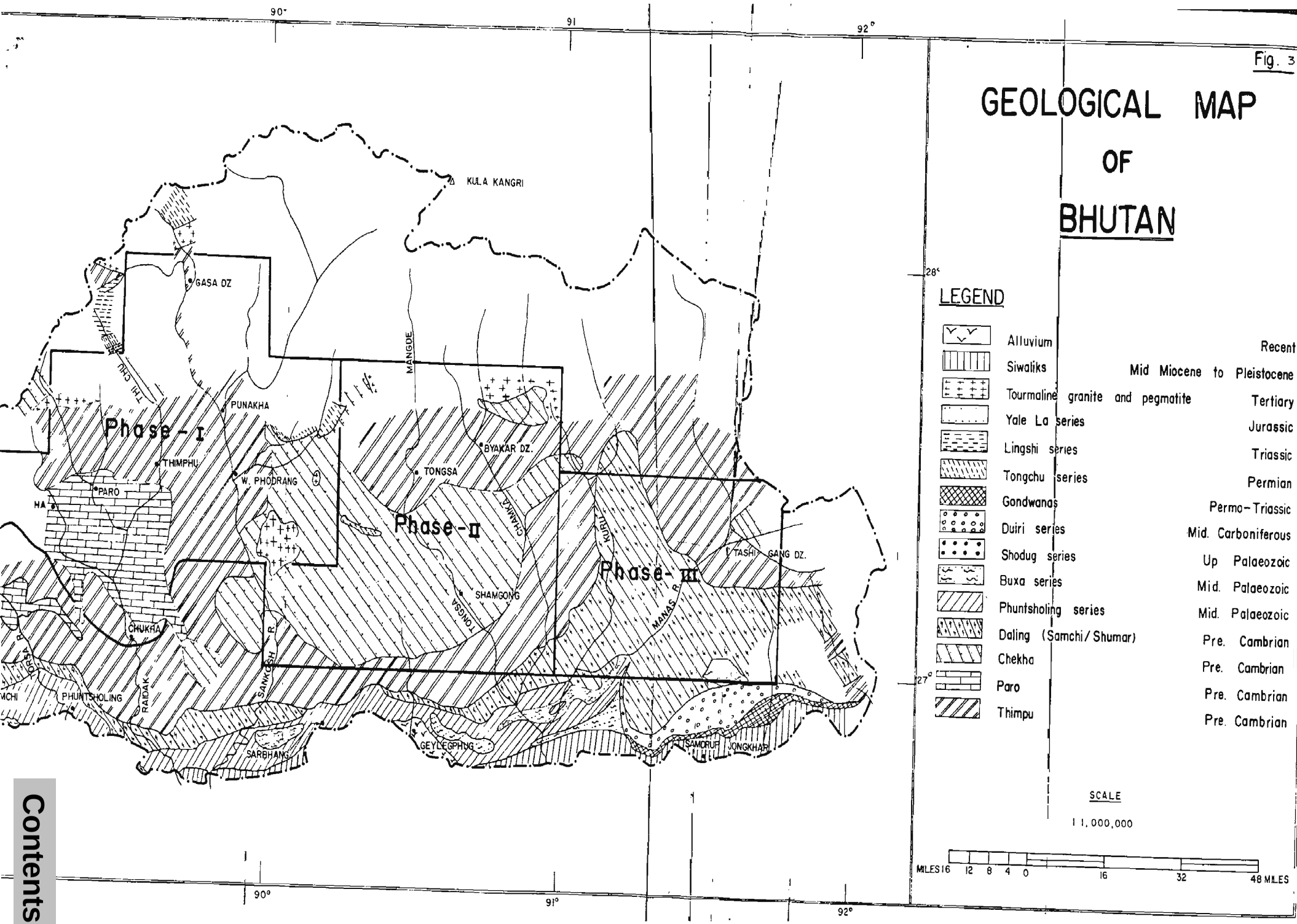
Fig. 3

GEOLOGICAL MAP OF BHUTAN



Contents

1.5.4 The slope in the survey area varies considerably. Bhumthang valley has by and large, easy slopes. In other parts of Bhumthang catchment, however, slopes are moderate to precipitous particularly in lower areas and in the catchment of its tributaries. The precipitous slopes are often met with particularly in Mangde chu (Tongsa) catchment and higher areas of Manas, Kuru chu and Gamri catchments. The slopes in alpine pastures are often easy or moderate. The majority of survey area has moderate to steep slopes.

1.6.1 GEOLOGY AND ROCKS

The main geological formations in Central and Eastern Bhutan are Chekha, Thimphu and Shumar. All of these formations are of pre-Cambrian origin.

1.6.2 The Chekha formation is represented by a thick pile of meta sediments comprising crystalline limestone, mica schists, graphitic schists, quartzite, phyllite and intrusions of acidic and basic igneous rocks. This formation is found in parts of Sankosh, Mangde chu (Tongsa) and Bhumthang catchments including the Black Mountain range.

1.6.3 Thimphu formation comprises of biotite gneisses interbedded with quartzite, quartz-mica-schists, crystalline limestone and garnetiferous schists intruded by basic sills, aplites, quartz veins and pegmatites. This formation is found around Tongsa, in Bhumthang valley as well lower portions of Bhumthang, Mangde chu (Tongsa) and Sankosh catchments. It is also found in upper areas of Manas catchment, particularly in Kuru chu section where it has formed a pseudo-window and the quartzitic unit widest attaining a width of 70 km (Nautiyal et al, 1964).

1.6.4 Shumar formation comprises of phyllites and phyllitic slates containing gypsum and underlain by limestones, flaggy quartzites, phyllites and massive quartzites. This formation is found in Namgkur-Shumar areas of Eastern Bhutan.

1.6.5 General geology of Bhutan is depicted in Fig.3 (source: G.S.I. Map, Bhutan Unit). The boundaries of survey area have been marked in this figure.

1.7.1 SOIL

The soil in the survey area varies from sandy loam to clay loam depending upon the geological formation of the area. Out of the total tree forest area, about 59% has soil depth of 30 cm and more, 22% has 20-30 cm, 15% has depth of 10-20 cm and 4% has depth of less than 10 cm. Open and degraded forests with low density cover have shallow soils. This gives an indication of the useful role played by the forests in conservation of soil and protection of hill slopes.

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1.8.1 CLIMATE

Very diverse climatic conditions are met with due to variations in altitude in the survey area. At lower elevations, along the banks of rivers like Sankosh, Ai chu or Mao, Manas etc. the climate is sub-tropical characterised by very hot months of May and June. With the rise in elevation, the climate becomes more equable and on the whole salubrious. In high hills the climate is temperate and often severe. Seasons are well defined. Winter is most severe from mid December to mid March when snow falls in higher altitudes and the lower areas get rain. At higher altitudes, specially in northern aspect and sheltered places, snow does not melt easily and may stay till end of April. The change from winter to summer is rather gradual. Temperature continues to rise from mid March and rains often start in lower areas during April. Otherwise March to May is a dry period in higher areas. Regular monsoons break sometime during mid June and continue right upto end of September particularly in lower areas. The period from mid September to mid December is generally clear, rather cold and dry.

1.8.2 Temperature:- Generally speaking temperature decreases with increase in altitudes. On the high mountains, exposure to the sun determines the temperatures. Fog and frost are frequent particularly in winter. In lower areas during the summer months the temperature can be quite high. The following table shows the mean monthly temperature from 1974 to 1977 for some centres of the survey area recorded by the Border Roads Organization.

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MEAN MONTHLY TEMPERATURE OF SELECTED STATIONS IN THE SURVEY AREA PHASE II & III (in °c)

Name of the Station (with altitude in Mtr. within bracket)		Maximum and Minimum temperature during the months												Max. & Min. of the year
		Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
1. TASHIGONG (970)	Max.	17.6	19.4	23.0	24.2	27.6	30.0	29.6	29.0	28.2	26.2	22.4	19.6	30.0
	Min.	12.6	13.6	16.6	18.6	18.8	21.2	23.6	22.6	21.6	17.5	16.2	12.4	12.4
2. LIMITHANG (685)	Max.	19.0	22.0	28.0	30.0	34.0	32.0	30.0	30.0	28.0	30.0	26.0	20.0	34.0
	Min.	9.0	10.0	12.5	16.0	19.0	19.0	21.0	23.0	22.0	15.0	13.0	8.0	8.0
3. KANGLUM (1440)	Max.	20.3	26.0	36.0	35.0	35.3	37.6	36.0	34.6	34.3	25.0	24.0	18.0	37.6
	Min	2.0	4.5	6.5	14.6	17.6	20.3	19.6	16.0	15.0	10.6	6.6	1.6	1.6
4. GEYSTA (2927)	Max.	21.0	22.5	22.0	25.0	26.3	29.6	31.0	28.5	25.0	24.0	23.0	23.5	31.0
	Min.	(-11.0)	(- 6.0)	(-2.5)	(-4.5)	3.3	7.0	8.6	17.5	8.0	(- 5.0)	(-9.0)	(-4.0)	(-11.0)
5. TONGSA (2200)	Max.	14.67	17.3	19.3	18.6	21.0	23.3	23.0	23.6	22.6	22.0	19.6	21.33	23.6
	Min.	(-3.6)	(-2.8)	0.7	3.6	6.0	8.3	8.6	9.3	9.0	10.0	2.3	(-3.0)	(-3.6)
6. BUBJA (1868)	Max.	16.0	22.0	24.0	25.0	28.0	24.0	25.0	24.0	23.0	23.0	23.0	28.0	28.0
	Min.	1.0	2.0	8.0	8.0	8.0	9.0	10.0	10.0	10.0	8.0	4.0	0.0	0.0
7. NENCALA (1800)	Max.	18.0	23.5	25.5	26.0	34.0	30.0	27.0	-	-	27.0	26.0	23.0	34.0
	Min.	6.0	13.0	9.5	9.0	8.0	14.0	17.0	-	-	11.0	10.5	11.0	6.0

Note:- The figures given in the table are averages of different calendar years as under:-
(Abnormal figures were excluded for the purpose of calculations)

i). For serial No.2, 4 & 7 the averages are for the years 1974, 1975 &1976
ii). For serial No.1 the averages are for the years 1974, 1975, 1976, 1977 & 1978.
iii). For serial No.3 the averages are for the years 1974, 1975, 1976 & 1978
iv). For serial No.5 the averages are for the years 1976, 1977 & 1978.
v). For serial No.6 the figures are for the year 1977.

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1.8.3 Precipitation:- The survey area is influenced by the south-west monsoon which accounts for 90% of the annual precipitation. The actual precipitation varies with exposure to the rain bearing monsoon winds. The following table shows the mean monthly precipitation for some centres of the survey area as calculated from the records maintained by the Border Roads Organization from 1973 to 1977.

MEAN MONTHLY RAINFALL OF SELECTED STATIONS IN THE SURVEY AREA PHASE II & III

(in m.m.)

Name of the Station (Altitude in M)	Average rainfall in mm during the months												Total annual rain-fall
	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. BATASE (1480)	58.3	38.3	72.3	152.3	245.3	1156.3	2019.0	739.0	662.7	215.7	20.0	40.0	5419.2
2. NINGALA (1800)	1.7	10.6	15.8	29.9	175.0	441.6	289.4	203.2	191.2	17.6	0.0	0.0	1376.0
3. BUBJA (1868)	10.0	24.6	21.8	139.5	242.1	333.5	497.9	572.4	462.5	181.6	46.2	35.0	2567.1
4. TONGSA (2200)	9.5	12.7	36.2	98.7	111.5	252.3	295.5	371.0	296.7	70.8	31.0	14.0	1599.9
5. MANGDECHU (1990)	20.0	22.5	38.7	32.8	159.3	443.3	384.8	280.2	154.1	188.3	40.0	7.5	1771.5
6. SHEMGONG (1916)	61.2	45.0	28.7	55.0	213.3	473.3	1030.0	608.7	242.8	119.6	14.5	16.7	2909.7
7. KHOSELA (1400)	13.7	18.7	25.0	34.2	103.3	172.5	327.2	419.8	179.5	163.0	30.0	22.5	1509.4
8. RUKUSJI (2980)	65.0	88.7	23.8	182.8	240.9	403.0	447.5	272.5	206.6	183.3	38.5	75.8	2228.6
9. LIMITHANG (685)	17.2	10.9	22.8	46.7	75.9	153.3	181.4	148.8	208.5	107.4	63.4	29.3	1065.6
10. TASHIGONG (970)	1.7	10.5	19.8	56.6	91.8	165.6	164.9	177.9	83.7	18.7	33.1	1.5	825.8

Continued...

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Continued..

1	2	3	4	5	6	7	8	9	10	11	12	13	14
11. GEYSTA (2927)	12.0	0.0	16.7	37.6	86.6	171.0	145.5	119.5	81.6	62.2	11.6	25.0	769.3
12. KANGLUM (1440)	3.8	53.6	58.9	72.5	118.2	225.9	259.0	232.9	155.1	35.9	26.4	5.1	1247.3
13. CHANKHA (2382)	5.8	15.7	26.7	50.0	222.3	363.5	470.5	279.2	266.7	176.7	22.5	5.0	1904.6
14. GONGLEPOKEE (2536)	17.5	41.7	45.0	85.0	276.7	451.8	602.5	404.2	608.3	286.8	24.0	40.0	2883.5

Note:- The figures given in the table are averages of different calendar years as under:-

i) For serial No. 1, 5, 6, 7, 8, 13 & 14 the averages are for the years 1973, 74 & 75.

ii) For serial No. 9, 10 & 12 the averages are for the years 1974, 75, 76, 77 & 78.

iii) For serial No.2 the averages are for the years 1974, 75 & 76.

iv) For serial No.3 the averages are for the years 1973, 74, 75 & 77.

v) For serial No.4 the averages are for the years 1973, 75, 76, 77 & 78.

vi) For serial No.11 the averages are for the years 1974, 75, 76 & 77.

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1.9.1 NATURAL VEGETATION

Natural vegetation is undisturbed in the higher slopes and cultivation is confined to the valleys and easier slopes. The survey area supports sub-tropical to alpine vegetation. The altitudinal zonation of species follows the same lines as already described in the first report. Biotic influences have, however, adversely affected the natural vegetation particularly in Eastern Bhutan where forests have been depleted in easily approachable areas. The tree line extends upto about 4500 m. Areas under perpetual snow, devoid of natural vegetation are negligible in the survey area.

1.10.1 POPULATION

The average density of population in the entire country was 23.25/km^2 in 1969 and is 27.5/km^2 at present (Anonymous, 1977). The total population of the survey area works out to 4,33,925 (para 12.5.2). The local dialect of the people is Bhumthangka and Sarchopa although the national language is Dzongkha and Nepali as well as Hindi are also understood by a sizeable section of the local population. The people are hardy, cheerful and simple by nature. Weaving is an art in which almost the entire population is skilled. Cloth of intricate and beautiful design and bright colours is woven in handlooms. Generally speaking the economy of the villages is self-sufficient.

1.10.2 Main occupation of the local population is agriculture. Unfortunately shifting cultivation is still practiced in remote localities although the National Forest Policy of Bhutan has banned this practice. The land is cleared of forests and rice grown on it for 3 or 4 years after which the site is abandoned when the soil is exhausted. His Majesty's Government is trying to settle the population to permanent agriculture by providing facilities of irrigation and fertiliser etc.

1.10.3 The local population, situated as it is, is heavily dependent on forest for fuel wood, agriculture implements, construction and repairs of houses etc. Houses consume considerable quantity of timber and the demand is rather high.

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CHAPTER-II

THE FORESTS

2.1.1 Like the forests of hilly areas everywhere else, the forests of the survey area perform, or are capable of performing, the productive, protective and aesthetic functions. They are the source of timber, fuelwood and various types of minor forest products apart from protecting the hill sides, providing shelter to wildlife and adding to the scenic beauty. If managed and developed properly, they are capable of playing a pivotal role in the development of Bhutan.

2.2.1 AREA

Total forest area is 9085.69 km^2 i.e. 83.3% of the total geographical area of 10,897.91 km^2 under survey. This compares favourably with the target of maintaining a minimum of 60% land area under forests as envisaged in the National Forest Policy of Bhutan (Anonymous, 1974). However, the above forest area includes blanks, alpine pastures, scrub forests as well as degraded open forests of poor quality. Moreover, the estimate is based on old aerial photographs taken during 1956-58 and the latest position is likely to be slightly different, particularly in view of the hitherto prevalent practice of shifting cultivation.

2.3.1 OWNERSHIP

The Government Reserved Forests have been defined by Bhutan Forest Act of 1969 (Anonymous, 1969) to mean any land under forest on which no person has acquired a permanent, heritable and transferable right of use and occupancy. Some of the areas allotted to individuals for orchard purposes, still have forest growth. However, as per the Act, His Majesty's Government have reserved the right to the absolute ownership of tree timber and other forest produce on private land also. Extent of private forests in the survey area is not known.

2.4.1 DEMARCATION AND SETTLEMENT

The Forest Department, Royal Government of Bhutan has started the demarcation of forests in 1974 and by the end of 1977-78, 4,752 km^2 have been demarcated. So far very little area has been demarcated in the survey area. During the settlement work all rights are proposed to be purchased, denied or admitted in whole or parts as deemed necessary by the Royal Government of Bhutan.

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2.5.1 FOREST TYPES

The forest types as per Champion and Seth's classification have been described in the First Report (Anonymous, 1976). Except types 2 B/C 1a, 3 C/C 1a and 3 C/C 1b, other types listed in the First Report and occurring in Bhutan are found in the survey area. For ground inventory, however, 12 types were recognised. Difficulties were experienced in identifying these 12 forest types on the available aerial photographs. Since the forest types area has been calculated from the interpreted aerial photographs, it was found necessary to group the 12 forest types recognized on the ground into 6 types for facility of identification on aerial photographs and calculation of the area. The 12 forest types for ground inventory and grouping of these types for photointerpretation are as under:

Code	Forest types recognised on the ground	Forest types recognised on the aerial photographs
01	Chir pine	Chir pine
02	Blue pine	Blue pine
03	Fir & Spruce	Fir & Spruce
04	Hemlock	Mixed conifers
05	Larch	
06	Junipers	
07	Mixed conifers	
08	Conifers mixed with broadleaved	Conifers mixed with broadleaved
09	Upland hardwoods	Broad leaved
10	Oaks	
11	Lowland hardwoods	
12	Sal	

2.5.2 The description of various forest types found in the survey areas is given below as per the groupings finalised for photointerpretation.

2.5.3 Chir:- Chir forests occupy an area of 74,829 ha which constitutes 8.2% of the forest area and 6.9% of the total geographical area under survey. The Chir forests are found generally between 1000 to 1500 meters m.s.l. though they also occur even below 500 meters m.s.l. and may go upto at an elevation of about 2000 meters. Chir occurs in Sankosh, Gamri (including Sheri Chu), Kuru Chu, lower areas of Mangde chu (Tongsa) catchment and along Manas and its tributaries. Small patches of Chir are also found along Nyera Ama and Bhumthang. Majority of Chir forests have low to medium density and are deficient in regeneration. The Chir forests are open to heavy grazing and fire hazard since they are located near habitations.

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2.5.4 Chir normally occurs in pure crops but i oc asionally associated with other broad leaved species p.rtic.larly Rhododendron spp., Quercus spp., Schima wallichii Castanopsis spp., Kydia calycina, Phylanthus emblica, etc. In eastern Bhutan, Chir is also associated with an under growth of lemon grass.

2.5.5 Kail:- Kail forests occupy an area of 16,615 ha which constitutes 1.8% of the forest area and 1.6% of the total geographical area under survey.

2.5.6 Kail forests generally occur between 2500 - 3500 m above m.s.l. though the range of occurrence extends down to 1500 m. Kail normally occurs in pure patches in shady localities in the lower range of distribution. In upper elevation, it occurs on all aspects and is often found mixed with upland hardwoods and other conifers particularly spruce, hemlock, maple, rhododendrons, oaks, birch etc.

2.5.7 In the survey area Kail forests occur mainl in Bhumthang catchment and in small patches in Mangde chu (Tongsa) and Sankosh catchments. They are conspicuous by their absence from other parts.

2.5.8 Kail forests generally have good density and usually there is no dearth of regeneration except in areas around habitations. However, these forests are subjected to a high incidence of grazing and fire.

2.5.9 Fir and Spruce:- Fir and Spruce forests occupy an area of 104,418 ha which constitutes 11.5% of forests area and 9.7% of total geographical area under survey.

2.5.10 Over 50% of the total Fir-Spruce area under survey is located in upper Bhumthang catchment where it is found extensively in the high hills draining into Bhumthang river and its tributaries particularly Chomkha Chu and Tong Chu. Fir-Spruce forests are also found in the higher areas of Mangde Chu (Tongsa), Sheri Chu (Gamri), Kuru Chu, Jiri Chu (Manas), Nyera Ama and parts of Sankosh drainages.

2.5.11 Fir-Spruce forests mainly occur in almost pure patches at elevations from 3000 to 4000 meters above m.s.l. Some of the species found mixed with Fir and Spruce forests are Junipers, hemlock, bluepine, maple and rhododendrons, birch, etc. These forests are usually deficient in regeneration. The Fir and Spruce forests, particularly the grassy blank areas or alpine pastures located above these areas, are heavily grazed by herds of Yak and cattle during summer months. They are also prone to fire hazard.

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2.5.12 Mixed Conifers:- Mixed conifers include Hemlock, Larch, Juniper and mixed conifers which were recognised as separate forest types on the ground. Larch is found scattered and often mixed with hemlock. Hemlock is found in small patches around 3000 meters in upper reaches of Gamri, Nyera Ama and Kuru Chu drainages apart from the upper ridges of Bhumthang Chu and Mangde chu (Tongsa). Junipers are found in small patches on ridge tops about 4000 meters elevation e.g. near Tungila and Wanche Gompa. Mixed conifers including mixtures of Hemlock, Juniper, Spruce, Kail etc. are found at higher elevation in Bhumthang and Mangde chu (Tongsa) catchments. Small patches of Mixed conifers are also found in higher areas of Gamri, Sankosh and Kuru chu catchments. Tsuga and Junipers form about 1/4th of the crop; other species are Rhododendron, Maple, Birch, Yew etc.

2.5.13 Mixed conifers occupy an area of 44,687 ha which constitutes about 4.9% of forest area and 4.1% of the total geographical area under survey. This type group is deficient in regeneration and is subject to grazing and fire hazards.

2.5.14 Broad leaved mixed with conifers:- This forest type occupies an area of 100,697 ha which constitutes 11.1% of total forest area and 9.3% of total geographical area under survey.

2.5.15 This forest type denotes a tension belt between broad leaved and coniferous zone. Both the species groups are found in almost equal proportion and the composition may vary within the zone according to altitude. The predominant species are Chir pine, Fir, Hemlock, Rhododendron, Birch, Castanopsis and Oaks.

2.5.16 This type is found in the survey area at an elevation from 2000 to 4000 meters above m.s.l., in small patches, in all the river catchments including Kuru Chu, Manas, Nyera Ama, Mangde Chu (Tongsa), Bhumthang and Sankosh.

2.5.17 Regeneration of broad leaved species is generally more than of coniferous species. The grazing and fire incidence in this forest type is generally low.

2.5.18 Broad leaved:- Broad leaved forests occupy an area of 482,880 ha which constitutes 53.2% of total forest area and 44.7% of total geographical area under survey. Thus broad leaved forests occupy more than half of the survey area particularly in Mangde chu (Tongsa) catchment.

2.5.19 Broad leaved forests are found below 2000 meters near river beds and occur extensively in lower areas of the survey area. Main species are Albizzia spp., Sterculia spp., Schima spp., Amoora spp., Castanopsis spp., Terminalia spp. etc. Oaks are found in patches of varying sizes between 2000 - 3000 meters

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elevation in Nyera Ama, Gamri, Manas, Kuru chu, Mangde chu (Tongsa), Ai chu or Mao and Bhumthang catchments often mixed with other broad leaved species like Maple, low level Birch, Champ etc.

2.5.20 Upland hard woods are found above 3000 meters elevation in large patches. Such patches are found on the hills between Kuru Chu and its tributary Shongar Chu, Korila ridge between Kuru Chu and Sheri Chu, upper areas of Manas drainage etc. Patches of varying size are found in Nyera Ama drainage, lower slopes of black mountain, lower areas of Bhumthang catchment, a large part of Mangde chu (Tongsa) catchment and fairly large portion of Ai chu or Mao catchment. Main species are Acer spp., Quercus spp., Machilus spp., Michelia spp., Altingia spp. etc.

2.5.21 The upland hardwoods have very good density, are usually free from the fire hazard and grazing incidence is low particularly in remote localities. The low land hardwoods have a comparatively lower density and are subjected to fires and moderate grazing.

2.6.1 INJURIES TO FORESTS

The forests of the survey area particularly in Eastern Bhutan are liable to injuries from the following causative agencies.

2.6.2 Man:- As elsewhere, man causes the most grievious injuries to forests. The forests have been subjected to serious pressure from human population. The forest areas have been badly depleted through continous mis-use. Trees are cut down ruthlessly for meeting various requirements of the population including fuelwood, timber for house construction and agricultural implements etc. The practice of shifting cultivation has caused considerable damage to the forests.

2.6.3 Animals:- Wild animals do not cause any appreciable damage to the forest in the survey area. The forests are, however, subjected to severe grazing by domestic cattle in the absence of regular grazing lands. Apart from the alpine pastures which are used for grazing during summer months, the forest areas situated near the habitations are subjected to heavy grazing. The following table shows the grazing incidence in tree forests areas which has been worked out on the basis of proportional distribution of sample points for which this information was collected by ocular estimate.

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Table

GRAZING INCIDENCE BY FOREST TYPES

(% age area)

FOREST TYPE	GRAZING INCIDENCE CLASSES		
	Absent	Moderate	Heavy
Chir	26.81	52.90	20.29
Kail	11.29	54.84	33.87
Fir-Spruce	73.62	22.13	4.25
Mixed conifers	53.49	31.39	15.12
Broad leaved mixed with conifers	64.00	28.00	8.00
Broad leaved	47.36	36.72	15.92
ALL FOREST TYPES	48.69	36.23	15.08

2.6.4 Fire:- Fire causes considerable damage to the forests particularly in coniferous areas. No estimates of area burnt or extent of damage to standing crops are available. Most of the fires are started by human beings. The following table shows the fire incidence in different forest types as estimated by occular observation during the survey work.

Table

FIRE INCIDENCE BY FOREST TYPES

(% age area)

FOREST TYPE	FIRE INCIDENCE		
	No incidence	Occasional	Frequent
Chir	5.80	65.22	28.98
Kail	67.74	25.81	6.45
Fir-Spruce	94.04	5.11	0.85
Mixed Conifers	90.70	6.98	2.32
Broad leaved mixed with conifers	76.00	20.00	4.00
Broad leaved	75.46	22.92	1.62
ALL FOREST TYPES	72.59	23.17	4.24

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2.6.5 Pests and Diseases:- No survey has been carried out so far, to identify the pests and diseases affecting the forest crops in the survey areas and the damage caused by them (or in the rest of the country). *Loranthus* and other tree parasites are occasionally noticed in the forest areas. Sporophores of *Fomes* were also occasionally met with. Ficus bound trees are also found. However, the damage caused by pests and diseases in the survey area is not of an alarming nature.

2.7.1 COMMON SPECIES

A list of local and botanical names of trees, shrubs, bamboos, grasses, climbers etc. common in the area is given in Appendix 13.1.

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CHAPTER-III

INFRASTRUCTURE

3.1.1 Infrastructural facilities as existed in Bhutan in the beginning of 1976 have been described in the previous report (Anonymous, 1976). There has been only slight improvement in infrastructural facilities since that report was submitted but as far as the area covered by the present survey is concerned, the position has not altered. Considering the present state of infrastructure in the survey area, it can be stated at the outset that the infrastructural facilities will have to be developed and strengthened considerably before forestry and forest based industries could be developed to any considerable extent in the region. An assessment of the available infrastructure in the survey area, with a general reference to the entire country, wherever necessary, is given hereunder. Some recommendations have also been made for minimum improvement of the infrastructure.

3.2.1 MANPOWER

The density of population is 27.5 persons per km^2 and the annual rate of growth is estimated to be 2.1%. Literacy is 17.5% and varies from 8.6% for females to 31.0% for males (Anonymous, 1977). In 1977 there were 122 schools of various types with a total enrolment of 20,839 students. His Majesty's Government is extending the education facilities rapidly within the country and a large number of students (133 in 1977) are being sent for higher education and training to India and other countries. The survey area has a Junior College and two Central Schools apart from several Primary Schools in important villages.

3.2.2 Majority of the people are engaged in agriculture and have a self sufficient type of living off the land. There is, therefore, an acute shortage of unskilled labour in the survey area. However, for Government work, labour force can be requisitioned by the Civil authorities. An extension of any activity like forest exploitation or industrial development has, therefore, of necessity to depend on imported labour atleast in initial stages. This has to be taken into consideration while formulating plans for forestry development. Small labour force of Nepalese origin work in the survey area. Entry of fresh labour from outside is strictly controlled.

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3.2.3 Even though promising students are being trained in India and other countries, experienced technical and managerial personnel are not readily available in the survey area at present. In order to accelerate the pace of development, there is no alternative, but to import skilled workers and experienced technical and managerial personnel for the time being. This has also to be taken into consideration while formulating plans for development of forests and forest based industries.

3.3.1 FOREST ADMINISTRATION

The present strength of the Department is as under:-

Strength of Executive Staff & Officers in Forest Department, Royal Government of Bhutan as on 1.11.1978.

Post	Deputationists (Indian)	Direct Recruits Bhutanese	Direct Recruits Non-National	Total on roll
Director of Forests	-	1	-	1
Dy. Director of Forests	1	-	-	1
Divisional Forest Officer	5	3	-	8
Road Construction Engineer	1	-	-	1
Asstt. Director of Forests	-	2	-	2
Forest Ranger	-	34	4	38
Foresters	-	90	6	96
Forest Guard	-	311	1	312
Total	7	441	11	459

(Source: Director of Forests, Thimphu)

3.3.2 The Director, three Divisional Forest Officers and two Assistant Directors are Bhutanese nationals and the remaining Officers are on deputation from India. All the Officers are professional foresters trained in the Indian Forest College or Rangers College at Dehradun. A large majority of the Rangers have also been trained in the Ranger's Colleges in India. Some of the Foresters were trained in West Bengal Foresters' School, Dow Hill, Kurseong. The Forest Guards are being trained in the Bhutan Forest School started at Kalikhola in 1971 and later shifted to Thimphu. 198 candidates have so far been trained in this school.

Contents

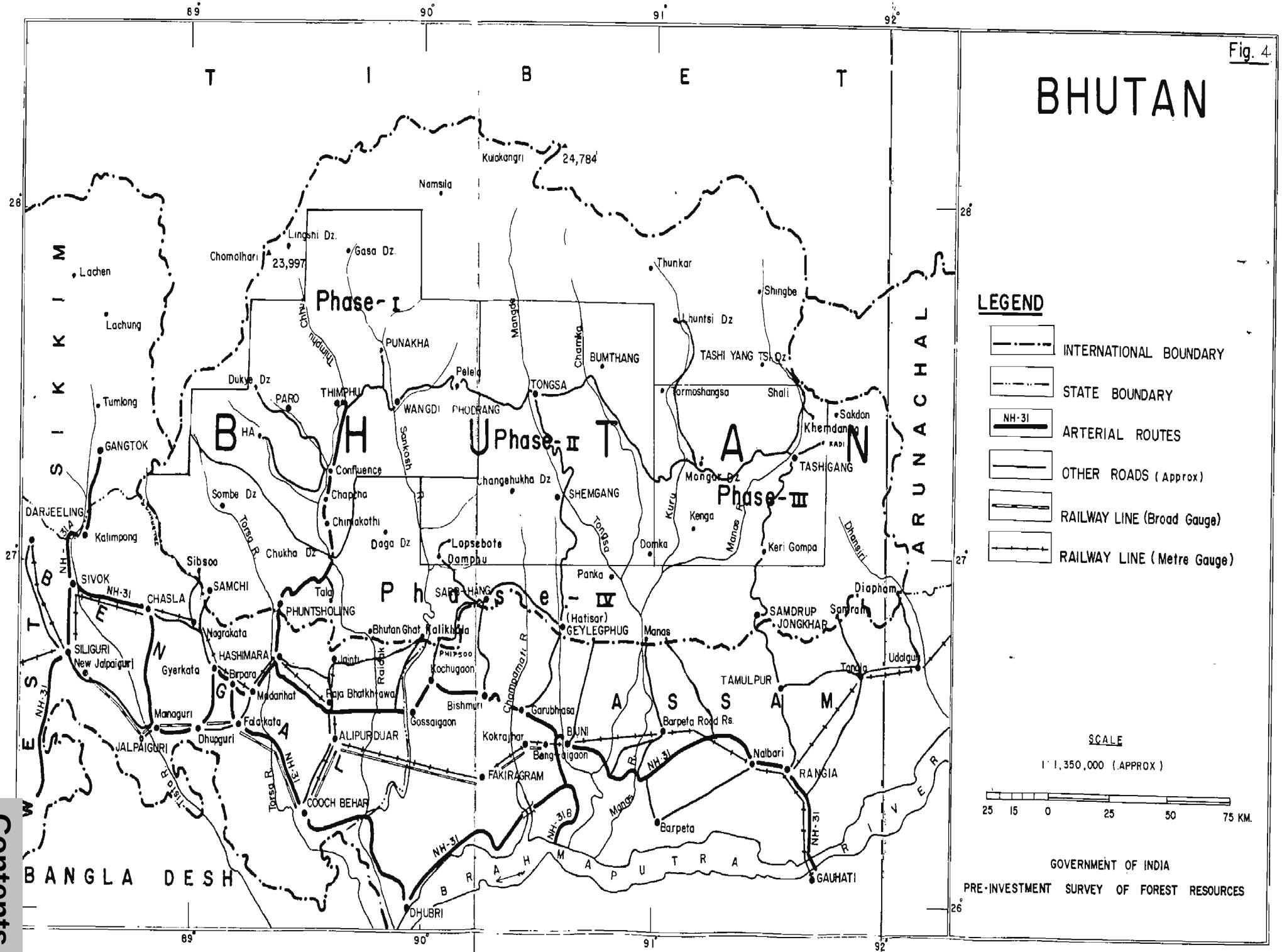
Fig. 4
BHUTAN
LEGEND
INTERNATIONAL BOUNDARY
STATE BOUNDARY
NH-31
ARTERIAL ROUTES
OTHER ROADS (Approx)
RAILWAY LINE (Broad Gauge)
RAILWAY LINE (Metre Gauge)
SCALE
1" 1,350,000 (APPROX)
25 15 0 25 50 75 KM.
GOVERNMENT OF INDIA
PRE-INVESTMENT SURVEY OF FOREST RESOURCES
TIBET
SIKKIM
ARUNACHAL
ASSAM
BANGLA DESH
WEST BENGAL
BHUTAN
Phase-I
Phase-II
Phase-III
Phase-IV
Kulakangri 24,784
Namsila
Chomolhari 23,997
Lingshi Dz.
Gasa Dz.
Thunkar
Shingbe
Lhuntsi Dz
TASHI YANG TSE Dz
Lachen
Lachung
Tumlong
GANGTOK
DARJEELING
Kalimpong
SIVOK
CHASLA
SILIGURI
New Jalpaiguri
Gyerkata
Managuri
JALPAIGURI
Dukye Dz
PARO
THIMPHU
PUNAKHA
WANGDI PHODRANG
Pelela
TONGSA
BUMTHANG
Karmoshangsa
Shali
Sakdon
Khermdang
TASHIGANG
Confluence
Chapcha
Chimakothi
Sombe Dz
Chukha Dz
Daga Dz
Lopsebota
Damphu
Changehukha Dz
SHEMGANG
Mongar Dz
Kenga
Domka
Keri Gompa
Panka
Sibsoo
SAMCHI
Nagrakata
HASHIMARA
Birpara
Madanhat
Falakata
Dhupguri
PHUNTSHOLING
Bhutan Ghat
Kalikhola
Jaintu
Raja Bhatkhawa
ALIPURDUAR
COOCH BEHAR
Gossaigaon
Kochugaon
Bishmuri
Kokrajhar
FAKIRAGRAM
Garubhasa
BUNI
Bongaigaon
(Hatisar)
GEYLEGPHUG
Manas
Barpeta Road Rs.
Barpeta
SAMDRUP JONGKHAR
Sonrai
Diapham
TAMULPUR
Tangla
Udalguri
Nalbari
RANGIA
GAUHATI
DHUBRI
BRAHMAPUTRA RIVER
Torsa R.
Raidak
Sankosh
Mangde
Chamka
Kuru
Manas R.
Dhansiri
Champamati R.
NH-31
NH-31A
NH-31B

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3.3.3 There are four territorial Forest Divisions. The average area covered by each division works out to 11,650 km^2 (or about 8150 km^2 forest area). This is too big an area for the D.F.O. to supervise, control and inspect, particularly in view of the remoteness. Experience of forest management extending over a century in India has shown that the average area of a Forest Division was about 1878 km^2 in 1961 and even then it was felt that for intensively managed forests, the area should be 250 km^2 or even less (Anonymous, 1961). However, considering the entirely hilly terrain and limited availability of trained personnel, creation of a large number of territorial divisions may neither be desirable nor even necessary. There are at present 18 civil districts in Bhutan, and it might be useful to cover two or three districts by suitable regrouping in a forest division. Thus about 8 territorial Forest Divisions could cover the entire country for the present which would give an average of about 5825 km^2 geographical area (or about 4075 km^2 forest area). It would, therefore, appear desirable to create four more territorial Forest Divisions in the country.

3.3.4 For the survey area two additional territorial divisions with full complement of staff with headquarters at Tongsa and Mongar (or Tashigang) can be created for better forest management and for implementing the forest developmental activities proposed in this report. The additional expenditure in this respect is estimated to be about Rs.10 lakhs per annum for both divisions apart from a non-recurring expenditure of about Rs.8 lakhs on buildings and furniture etc.

3.4.1 EXTERNAL COMMUNICATIONS

The nearest approach by air for the survey area is from Gauhati for Eastern Bhutan and Bagdogra for Western Bhutan. However, indications are that in foreseeable future Bhutan may have an air link from Paro airport located outside the survey area in Western Bhutan.

3.4.2 The nearest approach by railway is New Bongaigaon (Broad and meter gauge) for Central Bhutan and from Rangia (Meter gauge) for Eastern Bhutan.

3.4.3 The survey area is approachable from the lateral route of NH 31 in India running parallel to the Southern boundary of Bhutan from Bijni to Birpara. The entry for Central Bhutan is from Bismuri or Gorubasa situated on lateral route and for Eastern Bhutan from Rangia on the NH 31. Figure 4 shows external communication to Bhutan by road and railways.

3.4.4 International telephone and telegraph facilities exist only at Thimphu and Phuntsholing in Western Bhutan which are outside the survey area.

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3.5.1 INTERNAL COMMUNICATIONS

The state of internal communications at present is given in the paras that follow.

3.5.2 Roads:- As at the end of 1978 Bhutan had a total of 1880 km. of roads including roads under construction but excluding roads in Townships and small approach roads. This gives an average road density of 0.47 m/ha. These roads are maintained by different agencies and the break up by agencies and type of roads is given in the following table.

Table

ROAD LENGTHS MAINTAINED BY DIFFERENT AGENCIES IN BHUTAN

Km

Agency	Black topped	Others	Total
Dantak	843	507	1350
P.W.D.	121	338	459
G.S.I.	-	22	22
Forest Deptt.	-	17	17
Forest Contractors	-	32	32
Total	964	916	1880

3.5.3 The survey area has 829 km of road length out of which 360 km is black topped. The following table shows the existing roads in the survey areas.

Contents

Table

ROAD LENGTH IN PHASE II AND III

Km

	Sl.No.	From/To	Black topped	Others	Total	Remarks
A	1.	Khosela to Sure Lekha	133	13	146	46.55 Km more to Indian border.
	2.	Khosela to Palela (via Tongsa)	-	143	143	
	3.	Tongsa to Tashigang	89	256	345	
	4.	Tashigang to Narphung	121	-	121	59.00 Km more to Indian border
		Total	343	412	755	
B	5.	Tashigang to Buna	-	14	14	
	6.	Chasam bridge to Tashiyangtshi	-	36	36	
	7.	Damphu to Lobsibottey	5	7	12	
	8.	Chirang to Phase II boundary	12	-	12	52.00 Km more to Indian border
		Total	17	57	74	
		Grand Total	360	469	829	

A = maintained by 'Dantak'

B = maintained by Bhutan P.W.D.

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3.5.4 Although road construction has opened up more and more forest areas in recent years, the road net work is still not sufficient for proper management of forest and development of forest based industries. However, the terrain being hilly and cost of construction and maintenance of roads in such terrain being very high, an intensive road net work only for forest management and extraction of the produce will not be economical. Considering all aspects of the problem, it is estimated that a road density of at least 2 m/ha should be aimed for the survey area to begin with, as suggested in the First Report also. Such additional roads should be constructed partly as a component of national roads and partly as feeder roads connected to the main roads already existing. A total of 1350 km of roads should, therefore, be constructed in the survey area. This is estimated to cost Rs.2025 lakhs.

3.5.5 The construction of 1350 km of roads recommended above would not be sufficient to realise the potential annual cut from the survey area. Additional forest roads may have to be constructed for the purpose.

3.5.6 Transport Department of the Royal Government of Bhutan has a large fleet of trucks. The privately owned trucks meant as public carriers are now operated by the Bhutan Transport Syndicate. The rates are fixed by the Government from time to time. At present the rates are Rs.1.20 per tonne per km for black topped roads and Rs.1.35 per tonne per km for metalled/ kuchha roads in hills and Rs.0.54 per tonne per km for plain roads.

3.5.7 Post, Telegraph and Telephones:- Most of the important towns and villages in the survey area have branch Post Offices and most of the villages are on runner routes where the letters are delivered by special messengers. Tashigang has a telegraph service upto Samdrup Jongkhar on the Indian border. Civil wireless facilities are available at important places within the survey area for internal communication. Steps are already being taken by the Government of Bhutan to improve the post, telegraph and telephone facilities.

3.5.8 Rivers:- The length of the principal perennial rivers in the survey area as measured from the maps is given in the following table:-

Contents

Table

LENGTH OF MAIN RIVERS IN PHASES I & II

Km

River	Length of main rivers inside the survey area	Length of perennial tributaries inside the survey area
Sankosh	30	40
Ai chu or Mao	28	87
Mangde chu (Tongsa)	128	222
Bhumthang	111	110
Kuru chu	67	65
Gamri	47	52
Manas	40	89
Nyera Ama	48	11
Total	499 km	683 km

3.5.9 The rivers within the survey area flow through hilly terrain and are not navigable. Hence they cannot be used for transport of goods. However, they could be used for free floating of coniferous timber after making necessary improvements wherever necessary. On a conservative estimate an amount of Nu. 5 lakhs would, therefore, have to be spent on improvement of rivers for floating of timber.

3.6.1 WATER SUPPLY

The main rivers have sufficient water flow even during the dry season to meet the requirements of any industry. However, certain portions of the survey area are prone to drought. For Kheng area of Shemgang district a Colombo Plan Expert is reported to have pointed out that due to the uncontrolled destruction of forests water sources had dried up. Perennial streams had become seasonal streams and there was a growing scarcity of water in most parts of the district. He expressed the fear "that water sources will be completely dried in a few years time. Even drinking water will not be available" (Anonymous, 1978 a).

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3.7.1 POWER SUPPLY

There were six hydel stations in whole country at the end of 1977-78 with a total installed and generating capacity of 3420 KW and 2530 KW1 respectively. Besides, 1416 KW electricity was available from generating (diesel) sets. 11,82,264 KWH electricity was purchased during 1977-78 from India mainly for electrification of towns in southern parts of the country. (Statistics at a Glance, Bhutan, 1977).

3.7.2 The above stations cannot meet the power requirements of any industry. The Hydro-electric Project coming up at Chukha in Western Bhutan, when completed in 1984, may be able to supply the power requirements of big industries which could be set up based on the resources of the survey area. The installed capacity of this Project when completed will be 336 MW. The entire project is expected to cost Rs.1500 millions (Statistics at a Glance - Bhutan, 1977).

3.8.1 AUXILIARIES

The Bank of Bhutan established under Royal Charter of 1969 with Headquarters at Phuntsholing has only two branches one at Tashigang and one at Damphu within the survey area. Medical facilities are available only at important places. Provisions are available through the Food Corporation of Bhutan in important towns. Provisions as well as other necessities are also available through shop-keepers in important towns and villages. Housing facilities are extremely limited and very few houses, if any, are available for renting.

3.8.2 Apart from the general expansion of banking, medical, educational, postal and other services, the Royal Government of Bhutan, provide such services specifically for important projects, as has been done in case of Chukha Hydel Project in Western Bhutan. This, even, though the Survey area may be lacking in such facilities at present, any sound developmental project in the region is likely to get the backing of the Royal Government of Bhutan for provision of minimum infrastructural facilities.

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CHAPTER-IV

FOREST MANAGEMENT - PRESENT AND FUTURE

4.1.1 HISTORICAL BACKGROUND

Like forests in the rest of the country, the forests of the survey area have been subjected to various types of unplanned and uncontrolled use and misuse by local population for a long time. Forests were virtually the home of the people and provided a variety of their requirements including timber for building Dzongs, monastries and houses, fuelwood for cooking and heating, grazing for their cattle etc. Since forests were no man's property in olden days, the people felt free to take whatever they wanted. Huge quantity of timber is reported to have been used for house construction in the past.

4.1.2 The practice of shifting cultivation, prevalent in the survey area and elsewhere, has caused extensive damage. Due to this practice, which has been going on for a long period, vast stretches of forest areas once supporting luxuriant tree growth, have been reduced to scrub and denuded hill slopes. Year after year new areas were deforested for shifting cultivation and abandoned in turn as soon as the land was impoverished.

4.1.3 The Royal Government of Bhutan recognised the need for scientific management of forests and organised a Forest Department in 1959. The entire forest area of the country including the survey area, was allotted to different territorial forest divisions. However, even the boundaries of the Forest Divisions, Ranges and Beats continued to be rather vague. Lack of trained staff continued to hamper the activities of the Forest Department. Notmuch work could be done in initial stages although a beginning was made to start organised extraction in accessible areas and small plantations were also raised. Forests in the interior remained untouched and continue to be so even today.

4.1.4 The Bhutan Forest Act was passed by His Majesty's Government in 1969 to consolidate the law relating to forest, transit of forest produce and the duty leviable on forest produce. The Act declared all forest lands on which no person had a permanent, heritable and transferable right as Reserved Forests. Fresh clearance of forest for shifting cultivation was prohibited and felling of trees and grazing were brought under the control of the Forest Department for the fir time.

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4.1.5 The building of roads since 1961 opened up the hitherto inaccessible forest areas and this resulted in forests being exploited in comparatively accessible areas. Thus, in short, the forests of the survey area, as in the rest of the country, were gradually brought under some form of management but are still awaiting the adoption of modern scientific management techniques.

4.2.1 PRESENT FOREST MANAGEMENT

The first attempt at bringing some forest areas under scientific management was made in early sixties when P.C. Purkayastha prepared two small working plans for the present Sarbhang and Samdrup Jongkhar Forest Divisions covering small parts of the survey area. These working plans expired in the early seventies and in any case were not followed to any great extent. There is no working plan for any part of the survey area at present.

4.2.2 Perhaps the most important reason for the slow progress towards scientific forest management was the lack of policy direction. This deficiency was removed in 1974 when His Majesty's Government declared a National Forest Policy dealing with the various aspects of forest conservation, utilization and management in a comprehensive manner. The paramount objectives of forest management laid down in the policy were to preserve and promote the vital role of the forests in the national economy and to manage them with a view to obtain maximum revenues for the country, compatible with the general welfare of the nation.

4.2.3 The declaration of the National Forest Policy spurred the Forest Department to a greater activity. Wild life sanctuaries and National Parks were created and a comprehensive schedule of royalty rates for forest produce was prepared and is revised from time to time. Forest resources survey including mapping of forest areas was entrusted to the Preinvestment Survey of Forest Resources, Government of India. A forest development programme was initiated in collaboration with the UNDP. Demarcation of forest areas was taken up in the country and as far as the survey area is concerned, a small beginning has been made in Chirang district in 1978.

4.2.4 At present small scale organised exploitation of forests has started in the survey area. Some coupes have been sold in the broad leaved forests marked on selection system. Korila Saw Mills in Samdrup Jongkhar Forest Division are also working forest marked for them on selection system. Trees are allotted to local villagers from accessible areas for bonafide domestic use. Small plantations of conifers and broad leaved species are also being raised.

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4.2.5 The Forest Department has prepared Working Plans for small isolated pockets in Western Bhutan in 1975 and 1976 for a period of 10 years. The total area covered by these plans in Changkaphu, Chimakothi, Gedu and Paro areas is only 322.05 km^2. Some of these Working Plans cover forest areas similar to parts of the survey area and have prescribed selection-cum-improvement fellings as the silviculture system minimum exploitable diameters are 60 or 80 cm dbh in different Working Plans.

4.2.6 Clear cut strips of varying width (30 to 60 m) running across the contours in fir and mixed coniferous forests of Dochula (covered by Changkaphu management plan) for introduction of skyline crane have so far not regenerated naturally. Efforts are now being made to regenerate these strips artificially. Whether this system of clear cutting in strips for mechanized logging can be adopted economically and successfully as a regular management practice is still to be seen.

4.2.7 The activities of Bhutan Timber Corportion, Logging and Working Plan Divisions of the Forest Department and the Industries Development Corporation are mainly confined to Western Bhutan and have not been extended to the survey area so far.

4.3.1 MANAGEMENT CONSIDERATIONS FOR FUTURE

It is not an easy task to prescribe a silvicultural system for a forest area which is to be brought under scientific management for the first time particularly when no research has been done regarding the behaviour of the forest to various types of treatment under local conditions. However, the fact remains that for bringing a forest area under regular management one need not wait for the time consuming process of research work for evolution of a proper silvicultural system and management techniques. A beginning with techniques found suitable in similar conditions of climate and terrain could usefully be made.

4.3.2 Considering the terrain, soil and climate conditions as well as the condition of the forest crop, it appears that the forests of the survey area can best be managed under some form of selection system except Chir and blue pine for which shelterwood systems are more suitable. Some of the forest areas may have to be maintained only as protection forests in order to protect the hill slopes.

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4.3.3 Some of the management considerations for future have been enumerated in the first report. When deciding upon the best tools and techniques of forest management for the survey area, the specific requirements of the survey area should be kept in view. The following paragraphs describe some factors which deserve particular consideration.

4.3.4 The pressure of human and cattle population on forest land appears to be quite high in Chirang, Mongar and Tashigang Districts. In order to ensure an equitable regional distribution of forest areas, a soil and land use capability survey should be carried out so as to determine the rational land use pattern. Such survey coupled with an assessment of the land requirement of the growing population for agriculture, horticulture, grazing land, fuel wood land etc. could determine the rational allocation of land so that a minimum of 60% area can perpetually be kept under forests as envisaged in the National Forest Policy of Bhutan. This will ensure that forests do not come under undue pressure from the local population. While deciding allocation of land, however, the claim of forestry should not be lost sight of and it should be remembered that forests also require good soil to grow well. A soil and land-use survey could be carried out by a specialised agency. Such a survey would benefit the future forest management considerably in many ways and such benefits will far outweigh the expenditure involved.

4.3.5 Out of 9085.69 km^2 of total forest land in the survey area, 50.97 km^2 are estimated to be scrub forests, 106.56 km^2 open and degraded forest and 112.38 km^2 blanks inside the forest. Thus an area of 269.91 km^2 has very little or no forest cover at all. In fact this area is likely to be even more since the present calculations have been done on the basis of information available from aerial photographs taken in 1956-58 and the practice of shifting cultivation has been going on in the meantime. All such areas which are fit for afforestation and reforestation should be identified and urgent action should be taken to bring them under forest cover. It is estimated that about 125 km^2 area would be available for afforestation/reforestation and could be covered in 20 years if an area of 625 ha is covered every year. At an average cost of Rs.1000/- per ha the afforestation/reforestation programme is estimated to cost Nu 7 lakhs per annum including the beating up of failure etc. Such programme will be a wise investment since this will increase the volume and value of the growing stock considerably.

4.3.6 Before taking up afforestation/reforestation programme it will be necessary to identify the species suitable for the soil, climate and terrain keeping in view the ultimate economic utility. Although the Forest Department already has some experience in raising small plantations, an ambitious afforestation programme has to be backed by considerable research work and preparation.

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4.3.7 The survey area is obviously a part of the catchment where severe soil erosion is taking place resulting in the loss of valuable top soil. Soil conservation measures, particularly in the eastern portion of the survey area, should be taken up urgently. The sore spots and erosion prone areas should be identified and investigations should be initiated to determine the causes of soil erosion in each case (including deforestation, shifting cultivation, road constructions, nature of bed rock and soil etc.). The efficacy of soil conservation techniques under Bhutan conditions should be carefully studied by suitable experiments. Detailed soil conservation plans should be prepared for forest as well as non-forest areas.

4.3.8 A strong backing of silvicultural research is essential to provide the necessary information for sound forest management. Such research work should, therefore, be organised speedily to determine the rate of growth and decay, thinning regime, nursery behaviour and plantation techniques of important species etc. under local conditions. Species trials for afforestation of denuded hill slopes and erosion prone areas should also be started. The Forest Department should have a separate silviculture Research Division for the purpose.

4.3.9 Various types of minor forest products are an important source of revenue from the survey area. An assessment of MFP resources of various types and possibilities of their development, particularly pine resin, orchids and medicinal plants should be undertaken for which special survey are needed. A 'minor' can be 'major' and a sound forest management plan should take into account the potential of MFP in the area.

4.3.10 Some research efforts could be helpful in the development of wildlife population and tourist potential of the area.

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CHAPTER-V

INVESTIGATIONS AND METHODOLOGY

5.1.1 GENERAL

The objectives of the present survey were to undertake similar investigations and collect basic data as was done for the first (Phase I) report. The following investigations were undertaken:-

(i) An inventory of the forest resources.

(ii) Demand and Market Studies.

(iii) Accessibility and cost studies.

(iv) Industrial possibilities.

5.1.2 The methodology for the first two investigations referred to above have been discussed, in detail in Volume II of this report and that for the latter two detailed in the concerning chapters (XI - Accessibility and Cost Studies and XIV - Industrial Investigations and Possibilities) of Volume I. Some of the important points are, however, described in the following paragraphs.

5.2.1 INVENTORY OF THE FOREST RESOURCES

The main objects of the forest resources inventory were as under:

(i) Estimation of the total area under forest and important forest types and other land uses.

(ii) Estimation of the total growing stock and that of the important species groups.

(iii) Estimation of growth rate and cull (decay) in standing crops.

(iv) Calculation of the potential annual cut.

5.2.2 To achieve these objectives in a short time, a survey using aerial photo-interpretation techniques, supported by ground sampling, was considered to be the best method. The aerial photographs were to give the area estimates and the ground sampling to provide the data on growing stock, increment, cull and supplementary information.

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5.2.3 The methodology for photointerpretation, preparation of resource maps and area calculations has been described, in detail in Chapter-III, Volume II. The following information was provided by photointerpretation.

(a) an estimate of area under forest and other land use classes;

(b) an estimate of area under different forest types; and

(c) forest type maps for planning and management.

5.2.4 The assessment of total growing stock under each type was aimed at the following precision limits:

(a) total growing stock	± 10% error at 0.95 probability level.
(b) volume of each group of species	± 20% error at 0.95 probability level.

5.2.5 The methodology of inventory work, particularly the details of sampling design adopted to achieve the above precision, are given in Chapter I - Volume II. The procedure adopted for Volume Studies and Data Processing has been described in Chapter II and Chapter IV respectively of Volume II.

5.3.1 DEMAND AND MARKET STUDIES

The object of these studies was to assess, within the survey area and adjacent portions of Sarbhang and Samdrup Jongkhar Forest Divisions, (i) wood production (ii) wood consumption (iii) wood export and (iv) projections of demand of wood.

5.3.2 A study to determine the potential demand for wood in the timber markets of adjoining areas of Goalpara, Kamrup and Darrang Districts of Assam State (India) was also undertaken.

5.3.3 The methodology for these studies has been described in Chapter V - Volume II.

5.4.1 ACCESSIBILITY AND COST STUDIES

The main objectives of these studies were to ascertain the present delivery costs of available wood from operable forests to main markets/industrial sites and to suggest the possible improvement in logging and means of transport of wood to make it more economical.

5.4.2 The details of studies undertaken and methodology have been described in Chapter XI - Volume I. The terrain and accessibility data collected in inventory survey, were analysed and results have been given in para 11.5, 11.6 and 11.7 - Volume I.

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5.5.1 INDUSTRIAL POSSIBILITIES

Wood of different species occurring in Phase I area were got tested at the Forest Research Institute, Dehra Dun during survey for first (Phase I) report. The results of such tests also appear in the first report. Most of the species in Phase II and III, occur in Phase I also and as such results of wood tests are already available. No separate wood tests were got done for this report and available data were made use of in conducting studies for industrial possibilities.

5.5.2 The main objective of these studies was to indicate the possibilities of establishment of new industries according to the economic availability of surplus raw material.

5.5.3 The present infrastructure was studied to assess the possibility for establishing new industries. The details are given in Chapter III - Volume I.

5.5.4 A separate chapter on "Industrial Investigations and Possibilities" (Chapter XIV - Volume I) has been included in this report wherein all the relevant details of available wood for industrial use, existing wood based industries, likely sites for wood based industrial units, immediate and future industrial possibilities etc. have been given.

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CHAPTER-VI

LAND USE PATTERN AND FOREST TYPES

6.1.1 GEOGRAPHICAL AREA

The total Project area under the survey has been worked out as 10,897.91 km^2.

6.2.1 LAND USE PATTERN

The break-up of total geographical area into various land use classes was obtained by 100% interpretation of 717 aerial photographs which cover the entire area. The technique used for the purpose has been described in Chapter III - Volume II.

6.2.2 72.17 km^2 of the Project area is not covered by aerial photographs. This area has been shown as unsurveyed in the relevant map sheets. An area of 16.42 km^2 is under clouds in the aerial photographs. Photointerpretation of this area under clouds could not be done. However, these two areas viz. 72.17 km^2 and 16.42 km^2, totalling 88.59 km^2, have been included in the Project area. The distribution of this area in different catchments is as under.

Table

DISTRIBUTION OF AREAS UNDER PHOTO GAPS AND CLOUDS BY CATCHMENT

Km^2

Catchments	Area under		
	Photo gaps	Clouds	Total
Bhumthang	4.23	-	4.23
Kuru Chu	28.06	6.56	34.62
Gamri	5.02	9.86	14.88
Manas	17.46	-	17.46
Neyera Ama	17.40	-	17.40
Total	72.17	16.42	88.59

Contents

6.2.3 The following table shows the land use pattern of the Project area.

Table

LAND USE PATTERN

Land use class	Area km^2	Percentage of geographical area
FOREST AREA	9085.69	83.3
(a) Tree Forest	8241.26	75.6
(b) Alpine pastures	732.05	6.7
(c) Blanks	112.38	1.0
NON FORESTED AREA	1723.63	15.8
(a) Snow covered	0.50	-
(b) Lakes and water spreads	18.53	0.2
(c) Exposed rocks and Barren slopes	695.89	6.4
(d) Cultivation and habitation including terraced cultivation and orchards	1008.71	9.2
AREA UNDER CLOUDS	16.42	0.2
AREA UNDER PHOTO GAPS	72.17	0.7
TOTAL GEOGRAPHICAL AREA	10897.91	100.0

6.2.4 The distribution of the Project area, forest and non-forest, by catchments (excluding photo gaps and area under clouds) has been calculated as under:

Contents

Table

DISTRIBUTION OF THE PROJECT AREA BY CATCHMENTS

Km^2

Catchment	Total geographical area	%	Forest Area	%	Non-forest Area	%
Sankosh	1045.38	9.7	917.74	10.1	127.64	7.4
Ai Chu or Mao	640.70	5.9	576.20	6.3	64.50	3.7
Mangde Chu (Tongsa)	2951.67	27.3	2536.69	27.9	414.98	24.1
Bhumthang	2178.92	20.2	1714.01	18.9	464.91	27.0
Kuru Chu	1185.47	11.0	1057.85	11.6	127.62	7.4
Gamri	1245.65	11.5	995.88	11.0	249.77	14.5
Manas	1074.19	9.9	877.01	9.7	197.18	11.4
Neyera Ama	487.34	4.5	410.31	4.5	77.03	4.5
Total	10809.32	100.0	9085.69	100.0	1723.63	100.0

6.2.5 The percentages of forest and non-forest area in each catchment has been worked out as under. Area under photo gaps and clouds has not been considered in working out these percentages.

Table

DISTRIBUTION % OF FOREST AND NON-FOREST AREAS WITHIN THE CATCHMENTS

Catchment	Forest area %	Non-forest area %
Sankosh	87.8	12.2
Ai Chu or Mao	89.9	10.1
Mangde Chu (Tongsa)	86.0	14.0
Bhumthang	78.7	21.3
Kuru Chu	89.2	10.8
Gamri	79.9	20.1
Manas	81.6	18.4
Neyera Ama	84.2	15.8
Total	84.1	15.9

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6.3.1 DISTRIBUTION OF FOREST TYPES

Twelve forest types were recognised and differentiated for recording in field forms in ground sampling. These types have been listed and criteria for their determination in the field, described in Chapter I, Volume II, para 1.4.1 (instructions for filling up columns 17.18 of the P.D.F.). In aerial photographs all these types could not be recognised. Only six categories (which include all the twelve types recognised in the ground sampling) could be recognised and delineated in photointerpretation. The twelve forest types (ground sampling) have been re-grouped into six categories (photo-interpretation) as under:

Sl.No.	Ground Forest Type	Sl.No.	Photointerpretation Type
1.	Chir	1	Chir
2.	Kail	2	Kail
3.	Fir and Spruce	3	Fir
4.	Tsuga	4	Mixed conifers
5.	Larix		
6.	Junipers		
7.	Mixed conifers		
8.	Conifers mixed with broad leaved	5	Broad leaved mixed with conifers
9.	Upland hardwoods	6	Broad leaved
10.	Oaks		
11.	Low land hardwoods		
12.	Sal		

6.3.2 A possible matching of the forest types recognised on the aerial photographs with the corresponding types as per classification of Champion and Seth (1968) is as under:

Sl.No.	Photointerpretation type	Champion and Seth's Forest Type
1.	Chir	9/C1 b
2.	Kail	12/2 S1
3.	Fir and Spruce	13/C6 14/C2
4.	Mixed conifers)	12/C3 a
5.	Broad leaved mixed with conifers)	
6.	Broad leaved	8B/C1 11B/C1
7.	Alpine pastures & scrubs	15/C1 15/C3

6.3.3 The distribution of total area of forests into different forest types as recognised on the aerial photographs is as under.

Table

DISTRIBUTION OF FOREST AREA BY FOREST TYPES

Sl. No.	Forest Type	Area (ha)	Percentage of total forest area
1.	Chir	74,829	8.2
2.	Kail	16,615	1.8
3.	Fir & Spruce	104,418	11.5
4.	Mixed conifers	44,687	4.9
5.	Broad leaved mixed with conifers	100,697	11.1
6.	Upland and low land hardwoods	482,880	53.2
	Total Tree forest	824,126	90.7
7.	Alpine pastures	73,205	8.1
8.	Blanks	11,238	1.2
	Total Forest Area	908,569	100.0

Contents

6.3.4 On detailed checking of the resource maps, certain mistakes were detected in map sheet Nos.78 M/4 and 78 M/11. The area figures were recomputed on the basis of corrected copies of resource maps. Accordingly, some minor changes in the table under para 6.3.3 above, had to be made. The revised (correct) distribution is given in the following table.

Table

DISTRIBUTION OF FOREST AREA BY FOREST TYPES(CORRECTED)

Sl. No.	Forest Type	Area (ha)	Percentage of total forest area
1.	Chir	74,845	8.3
2.	Kail	16,615	1.8
3.	Fir & Spruce	104,446	11.5
4.	Mixed Conifers	44,687	4.9
5.	Broad leaved mixed with conifers	100,888	11.1
6.	Upland and lowland hardwoods	482,639	53.1
	Total Tree Forest	824,120	90.7
7.	Alpine pastures	73,205	8.1
8.	Blanks	11,245	1.2
	Total Forest Area	908,570	100.0

6.3.5 The effects of these changes in the area figures, on distribution of total number of stems and growing stock have been worked out at + 0.008% and - 0.0018% respectively which are insignificant. The calculations of number of stems, growing stock etc. in the subsequent chapters are based on area figures given in the table under para 6.3.3.

6.3.6 The land use pattern by catchments is given in the following table. In this table for each catchment, the percentages have been expressed as those of total geographical areas after excluding areas under aerial gaps and clouds. The distribution of forest area by forest types as given in the table of para 6.3.3 has been taken as final for working out the figures in the following table. Changes as per para 6.3.4 were not made due to the reasons stated in para 6.3.5.

Contents

Distribution of Forest Types and other Land uses by Catchments

(ha)

		Catchments								
		Sankosh	Ai Chu or Mao	Mangde chu (Tongsa)	Bhumthang	KuruChu	Gamri	Manas	Neyera Ama	Total
A-FOREST TYPE										
Chir	Area	18131	1029	6437	425	14350	18178	15368	911	74829
	%	17.4	1.6	2.2	0.2	12.1	14.6	14.3	1.9	6.9
Kail	Area	185	-	259	16171	-	-	-	-	16615
	%	0.2	-	0.1	7.4	-	-	-	-	1.6
Fir & Spruce	Area	6820	374	26924	53243	8359	5708	908	2082	104418
	%	6.5	0.6	9.1	24.4	7.0	4.6	0.8	4.3	9.7
Mixed Conifers	Area	2931	32	4738	29622	2974	4061	30	299	44687
	%	2.8	-	1.6	13.6	2.5	3.3	-	0.6	4.1
Braad leaved mixed with conifers	Area	14321	1383	39564	7327	15716	8172	10055	4159	100697
	%	13.7	2.2	13.4	3.4	13.3	6.5	9.4	8.5	9.3
Upland and low land hardwoods	Area	45167	53426	149117	45875	57281	48751	52846	30417	482880
	%	43.2	83.4	50.5	21.1	48.3	39.1	49.2	62.4	44.7
Tree Forest	Area	87555	56244	227039	152663	98680	84870	79207	37868	824126
	%	83.8	87.8	76.9	70.1	83.2	68.1	73.7	77.7	76.3
Alpine pastures	Area	3672	545	22306	14448	6382	14480	8265	3107	73205
	%	3.5	0.8	7.6	6.6	5.4	11.6	7.7	6.4	6.8
Blanks	Area	547	831	4324	4290	723	238	229	56	11238
	%	0.5	1.3	1.5	2.0	0.6	0.2	0.2	0.1	1.0
TOTAL FORESTS	Area	91774	57620	253669	171401	105785	99588	87701	41031	908569
	%	87.8	89.9	86.0	78.7	89.2	79.9	81.6	84.2	84.1

Continued...

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Continued..

		Catchments								
		Sankosh	Ai Chu or Mao	Mangde Chu (Tongsa)	Gamthang	Kuru Chu	Gamri	Manas	Neyera Ama	Total
B-NON FORESTS										
Snow covered	Area	37	-	13	-	-	-	-	-	50
	%	-	-	-	-	-	-	-	-	-
Lakes & water spreads	Area	18	324	609	553	72	128	149	-	1853
	%	-	0.5	0.2	0.3	0.1	0.1	0.1	-	0.2
Exposed rocks & Barren slopes	Area	4365	774	28759	33854	456	239	707	435	69589
	%	4.2	1.2	9.7	15.5	0.4	0.2	0.7	0.9	6.4
Cultivation & Habitation including terraced cultivation & Orchards	Area	8344	5352	12117	12084	12234	24610	18862	7268	100871
	%	8.0	8.4	4.1	5.5	10.3	19.8	17.6	14.9	9.3
TOTAL NON-FOREST	Area	12764	6450	41458	46491	12762	24977	19718	7703	172363
	%	12.2	10.1	14.0	21.3	10.8	20.1	18.4	15.8	15.9
TOTAL FOREST & NON-FOREST	Area	104538	64070	295167	217852	118547	124565	107419	48734	1080932
	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
C-CLOUDS	Area	-	-	-	-	656	986	-	-	1642
	%	-	-	-	-	0.5	0.8	-	-	0.2
D-PHOTO GAPS	Area	-	-	-	423	2806	502	1746	1740	7217
	%	-	-	-	0.2	2.3	0.4	1.6	3.4	0.7
GRAND TOTAL	Area	104538	64070	295167	218315	122009	126053	109165	50474	1089791

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6.4.1 FOREST TYPES AND RESOURCE MAPS

The map on opposite page (scale 1:2,50,000) shows the land use pattern including distribution of forest types over the project area as obtained by interpretation of aerial photographs. Since the photographs pertain to aerial photography dating back to 1956-58, the present land use pattern might be different from that shown in the map, at many places. The map may therefore have to be up-dated after carrying out fresh aerial photography.

6.4.2 Resource maps on 1:50,000 scale survey sheets (16 sheets in all) have also been prepared for detailed management and logging plans.

Contents

CHAPTER-VII

GROWING STOCK

7.1.1 GENERAL

The growing stock has been assessed by computation of volume of each tree, tallied at a sample point, using the selected local volume equations. Volume per ha by species and diameter classes at all the sample points was calculated. The estimate of volume per ha by species and diameter classes for each forest type or group of forest types was made by averaging of all the sample points falling in that type. The product of estimate of volume per ha and the area of the forest type gives the total growing stock for the type.

7.1.2 The trees tallied at each sample point were classified by species and diameter classes. An assessment of stems per ha by species and diameter classes for each sample point was made on the basis of basal area. Averaging the figures for all the sample points in a forest type, number of stems per ha in the type was obtained. Total number of stems in each type was compiled by multiplying per ha figures with the total area of the forest type.

7.1.3 General and local volume tables for some important species were constructed.

7.1.4 The "Methodology" for computation of growing stock, number of stems and construction of general and local volume tables has been described in Chapter IV, Volume II.

7.2.1 NUMBER OF STEMS PER HECTARE

The species and diameter class-wise distribution for different forest types are given in APPENDICES 1.1 to 1.6. The grouping of species have been described in para 7.2.3.

7.2.2 The distribution of total number of stems by species and diameter classes for the survey area is given in APPENDIX 2.1.

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7.2.3 Broad leaved species have been grouped according to their present commercial value as defined in Royal Govt. of Bhutan, Forest Department's Notification No.TIF-45/79/7-365 dated 1-5-74. The number of stems per ha have also been calculated for each group of species. The groups are:

GROUP - A

1. *Betula* spp.
2. *Juglans regia*
3. *Michelia* spp.
4. *Morus laevigata*
5. *Phoebe goalparensis*
6. *Terminalia myriocarpa*

GROUP - B

1. *Acer* spp.
2. *Ailantus grandis*
3. *Altingia excelsa*
4. *Amoora wallichii*
5. *Cedrela* spp.
6. *Cinnamomum cecicodaphne*
7. *Duabanga sonneratioides*
8. *Phoebe hainesiana*
9. *Salmalia malabaricum*
10. *Schima wallichii*
11. *Tetrameles nudiflora*

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GROUP - C

1. Acrocarpus fraxinifolius
2. Albizzia spp.
3. Alnus spp.
4. Bucklandia populnea
5. Castanopsis spp.
6. Machilus spp.

GROUP - D

1. Bischofia javanica
2. Garuga pinnata
3. Lagerstroemia parviflora
4. Populus spp.
5. Prunus spp.
6. Pterospermum acerifolium
7. Quercus spp.
8. Sterculia villosa
9. Syzigium spp.

GROUP - E

1. Aesculus punduana
2. Amoora rohituka
3. Cinnamomum tamala
4. Engelhardtia spicata
5. Ficus spp.
6. Kydia calycina
7. Macaranga spp.
8. Ostodes paniculata
9. Rhododendron spp.
10. Symplocos spicata
11. Vitex heterophylla
12. Miscellaneous spp.

Contents

7.2.4 An abstract of number of trees per ha (for each coniferous species and broad leaved species in groups) separately for each type are given in the following table.

Table

STEMS PER HECTARE BY SPECIES AND DIAMETER CLASSES

Spp./Spp. GROUP	DIAMETER CLASSES (cm) 5-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80+	Total
CHIR TYPE										
Pinus roxburghii	18.836	37.795	21.143	13.280	10.554	6.270	2.301	0.453	0.367	110.999
Broad leaved Group A	-	-	-	-	-	-	0.057	-	-	0.057
Broad leaved Group B	-	2.943	1.127	0.199	0.110	0.153	-	-	0.028	4.560
Broad leaved Group C	-	0.348	1.927	1.162	0.400	0.218	0.200	-	-	4.755
Broad leaved Group D	-	1.965	1.167	1.195	0.528	0.069	0.106	0.040	-	5.070
Broad leaved Group E	22.765	18.022	5.717	0.808	0.499	-	0.057	-	-	47.868
TOTAL BROAD LEAVED	22.765	23.778	9.938	3.364	1.537	0.440	0.420	0.040	0.028	62.310
Total	41.601	61.573	31.081	16.644	12.091	6.710	2.721	0.493	0.395	173.309
KAIL TYPE										
Pinus wallichiana	89.510	52.497	23.052	13.109	6.404	3.763	0.783	1.040	0.526	190.684
Other conifers	18.401	17.373	5.925	2.703	2.916	0.886	0.116	-	0.058	48.378
Total conifers	107.911	69.870	28.977	15.812	9.320	4.649	0.899	1.040	0.584	239.062
Broad leaved Group A	-	9.278	-	-	-	-	-	-	-	9.278
Broad leaved Group B	5.778	10.095	1.809	-	-	-	-	-	-	17.682
Broad leaved Group D	-	4.520	1.097	1.658	1.662	0.164	0.099	0.082	-	9.282
Broad leaved Group E	22.476	11.994	6.025	1.600	-	-	-	-	-	42.095
TOTAL BROAD LEAVED	28.254	35.887	8.931	3.258	1.662	0.164	0.099	0.082	-	78.337
Total	136.165	105.757	37.908	19.070	10.982	4.813	0.998	1.122	0.584	317.399

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Spp./Spp. GROUP	DIAMETER CLASSES (cm) 5-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80+	Total
					FIR SPRUCE					
Abies densa	18.292	42.853	32.819	25.331	28.228	22.265	15.371	9.822	12.031	207.012
Picea spinulosa	3.701	3.876	2.045	1.075	0.300	0.346	0.248	0.134	0.254	11.979
Other conifers	1.312	4.595	3.260	1.269	0.480	0.197	0.084	0.189	0.779	12.165
Total conifers	23.305	51.324	38.124	27.675	29.008	22.808	15.703	10.145	13.064	231.156
Broad leaved Group A	9.982	21.408	6.684	4.407	1.541	0.664	0.085	0.024	-	44.795
Broad leaved Group B	10.845	24.389	7.433	1.060	-	0.038	-	-	-	43.765
Broad leaved Group D	3.163	6.349	0.954	-	-	-	-	-	-	10.466
Broad leaved Group E	319.691	287.496	33.374	4.465	1.356	0.278	0.091	0.087	-	646.838
TOTAL BROAD LEAVED	343.681	339.642	48.445	9.932	2.897	0.980	0.176	0.111	-	745.864
Total	366.986	390.966	86.569	37.607	31.905	23.788	15.879	10.256	13.064	977.020

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Spp./Spp. GROUP	DIAMETER CLASSES ([redacted])									
	5-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80+	Total
					MIXED CONIFERS					
Abies densa	6.578	4.182	0.370	1.527	1.760	1.765	1.607	1.140	1.464	20.393
Cupressus spp.	-	-	0.477	0.884	0.516	0.246	-	-	-	2.123
Juniperus spp.	36.081	22.974	6.355	3.808	1.034	0.230	0.085	0.057	0.021	70.645
Larix griffithii	-	-	-	-	-	0.115	0.072	0.051	-	0.238
Picea spinulosa	-	2.299	2.863	1.442	2.229	1.055	1.133	0.613	0.761	12.395
Pinus wallichiana	-	-	1.872	1.490	2.011	1.133	0.638	0.125	0.319	7.588
Taxus baccata	-	3.285	1.623	1.049	0.645	0.228	0.150	-	0.082	7.062
Tsuga brononiana	17.701	48.244	11.610	11.079	7.094	6.330	5.057	3.524	7.357	117.996
Total conifers	60.360	80.984	25.170	21.279	15.289	11.102	8.742	5.510	10.004	238.440
Broad leaved Group A	-	14.552	8.275	3.519	1.172	0.561	0.083	-	-	28.162
Broad leaved Group B	8.954	18.472	11.510	1.412	1.053	0.555	0.079	-	-	42.035
Broad leaved Group C	-	3.245	-	-	0.152	-	-	-	-	8.397
Broad leaved Group D	-	2.664	2.135	1.427	0.472	0.109	0.084	-	-	6.891
Broad leaved Group E	258.906	170.539	26.036	7.825	1.785	0.448	0.241	0.120	0.038	465.938
Total Broad leaved spp.	267.860	214.472	47.956	14.183	4.634	1.673	0.487	0.120	0.038	551.423
Total	328.220	295.456	73.126	35.462	19.923	12.775	9.229	5.630	10.042	789.863

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Spp./Spp. GROUP	DIAMETER CLASSES (cm)									
	5-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80+	Total
	CONIFERS MIXED WITH BROAD LEAVED									
Abies densa	-	6.027	3.094	3.235	5.697	2.468	0.951	0.360	1.770	23.602
Juniperus spp.	-	-	-	-	-	-	-	-	0.113	0.113
Pinus roxburghii	-	20.800	8.182	2.293	2.944	1.411	-	-	-	35.630
Pinus wallichiana	-	-	-	-	1.048	-	0.543	-	-	1.591
Taxus baccata	-	-	3.144	-	1.455	0.325	0.261	0.373	-	5.558
Tsuga brunoniana	-	5.589	1.397	3.052	1.531	0.698	0.762	0.554	3.851	17.434
Total conifers	-	32.416	15.817	8.580	12.675	4.902	2.517	1.287	5.734	83.928
Broad leaved Group A	-	30.512	16.076	9.103	5.134	1.590	0.517	0.208	-	63.140
Broad leaved Group B	12.575	51.359	29.692	5.656	3.571	0.308	-	-	-	103.161
Broad leaved Group C	-	-	1.926	0.808	0.526	1.105	-	0.176	0.073	4.614
Broad leaved Group D	-	-	-	1.501	1.501	0.694	0.774	-	0.380	4.850
Broad leaved Group E	253.396	493.980	87.252	19.712	5.487	1.846	0.535	0.543	0.336	868.087
Total Broad leaved	265.971	580.851	134.946	36.780	16.219	5.543	1.826	0.927	0.789	1043.852
Total	265.971	613.267	150.763	45.360	28.894	10.445	4.343	2.214	6.523	1127.780

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Spp./Spp. GROUP	DIAMETER CLASSES (cm)									
	5-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80+	Total
					HARD WOODS					
Broad leaved Group A	6.837	9.263	4.922	2.299	1.585	0.904	0.526	0.329	0.501	27.166
Broad leaved Group B	8.265	14.227	3.988	1.869	1.299	0.958	0.698	0.436	0.571	32.311
Broad leaved Group C	13.070	17.965	8.633	4.616	3.126	1.860	0.789	0.504	0.343	50.906
Broad leaved Group D	32.141	41.976	14.207	8.792	5.064	2.796	1.929	1.233	1.705	109.843
Broad leaved Group E	177.227	188.272	54.485	20.769	8.062	4.049	1.935	0.918	1.050	456.767
Total Broad leaved spp.	237.540	271.703	86.235	38.345	19.136	10.567	5.877	3.420	4.170	676.993
Total conifers	0.315	0.317	0.443	0.203	0.420	0.338	0.150	0.147	0.304	2.637
Total	237.855	272.020	86.678	38.548	19.556	10.905	6.027	3.567	4.474	679.630

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7.2.5 The diameter class-wise distribution of stems of coniferous species in each type was compared with corresponding figures for normal forest from yield tables after applying suitable reduction factors. Since yield tables are for pure crops and coniferous species occur in mixture in Project area, the figures had to be reduced in proportion to their basal areas. For broad leaved species, a general study of their distribution was made because yield tables are not available for quantitative comparison. The distribution comparison with Phase I is given in the following table:

Table

COMPARISON OF PER HECTARE DISTRIBUTION OF STEMS IN DIFFERENT FOREST TYPES IN PHASE I & PHASE II & III

Forest Type	Species		No.of stems/ha	
			Phase I	Phase II & III
Chir	Chir	Below 30 cm dia	71.283	77.774
		Above 30 cm dia	30.370	33.225
		Total	101.653	110.999
Kail	Kail	Below 30 cm dia	303.617	165.059
		Above 30 cm dia	18.073	25.625
		Total	321.690	190.684
Fir & Spruce	Fir & Spruce	Below 30 cm dia	77.321	103.586
		Above 30 cm dia	94.207	115.405
		Total	171.528	218.991

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Forest Type	Species		No. of stems/ha Phase I	Phase II & III
Mixed Conifers	Conifers	Below 30 cm dia	192.076	166.514
		Above 30 cm dia	63.119	71.926
		Total	255.195	238.440
	Broad-leaved	Below 30 cm dia	361.766	530.288
		Above 30 cm dia	15.844	21.135
		Total	377.610	551.423
	'Total'	Below 30 cm dia	553.842	696.802
		Above 30 cm dia	78.963	93.061
		Total	632.805	789.863
Conifers mixed with Broad-leaved	Conifers	Below 30 cm dia	198.652	48.233
		Above 30 cm dia	40.844	35.695
		Total	239.496	83.928
	Broad-leaved	Below 30 cm dia	360.178	981.768
		Above 30 cm dia	57.054	62.084
		Total	417.232	1043.852
	'Total	Below 30 cm dia	558.830	1030.001
		Above 30 cm dia	97.898	97.779
		Total	656.728	1127.780
Hardwood	Conifers	Below 30 cm dia	16.670	1.075
		Above 30 cm dia	5.868	1.562
		Total	22.538	2.637
	Broad-leaved	Below 30 cm dia	652.489	595.478
		Above 30 cm dia	97.348	81.515
		Total	749.837	676.993
	'Total'	Below 30 cm dia	669.159	596.553
		Above 30 cm dia	103.216	83.077
		Total	772.375	679.63[illegible]

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7.2.6 The following general inferences may be drawn:

(i) In "Chir type" the overall stocking of Chir is deficient and lower diameter classes are poorly represented.

(ii) In "Kail type", the distribution and overall stocking of Kail is unsatisfactory.

- The area under 'Kail' in Phase II and III is however insignificant - 1.8% of total forest area. The corresponding figure for Phase I is 10.0%.

(iii) In "Fir and Spruce" type occurrence of mature and overmature trees of Fir and Spruce is appreciable but proportion of stems in lower diameter classes is low.

- Occurrence of other conifers (Kail, Tsuga, Junipers) in this type is insignificant.

- Among broad leaved species Rhododendron occurs in large number constituting 49.3% of total number of stems occurring in the type. Trees of this species above 60 cm dia are however not found.

- Betula and Acer are among the other important broad leaved species which occur in this type.

(iv) In "Mixed Conifers type" Tsuga and Junipers mostly occur among the coniferous species and their distribution is satisfactory. Rhododendron is the most dominant among broad leaved species in this type also constituting 26.8% of the total number of stems.

(v) In "Conifers Mixed with Broad Leaved type" Picea, Larix and Cupressus are totally absent.

- Other conifers do occur but their number particularly in lower diameter classes is very small.

- Except for Acer, Betula and Castanopsis none of the broad leaved species of known economic importance are found in the type.

- The maximum number of stems are of Rhododendron and miscellaneous species which constitute 31.3 and 45.7% respectively of total number.

(vi) In "Hard Wood type" occurrence of coniferous species is almost negligible. Overall stocking and distribution of broad leaved species are satisfactory.

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7.3.1 VOLUME TABLES

As explained in First Report (p.43), general and local volume tables were constructed for chir, fir tsuga, larix, kail, spruce, birch, maple, juniper, oaks and miscellaneous hardwoods. For this report 1,239 trees of different species, in different diameter classes (above 10 cm dbh (ob) were selected at random, not only in the area but also in the southern belt. Details of trees felled are given in para 2.2.1 of Volume II. This was done to construct well represented General Volume Tables for the various species and also to obviate the necessity of further fellings for Phase IV area for the construction of General Volume Tables. The procedure adopted for conducting volume studies, data processing and details of volume equations used have been described in Chapter II & IV of Volume II.

7.3.2 The felled tree data collected for Phase I and collected now for Phase II & III has been used for construction of General Volume Tables by merging and reprocessing where necessary. The General Volume Tables derived now can be used for whole of Bhutan.

7.4.1 GENERAL VOLUME TABLES

The data base used for construction of General Volume Tables for different species is as follows:

A. Species for which merged data of Phase I & Phase II & III has been used.

1. *Pinus roxburghii*
2. *Picea spinulosa*
3. *Abies densa*
4. *Acer* species

The general volume tables for these species are given in APPENDICES 3.1 to 3.4

B. Species for which felled tree data from Phase II & III has been used:

5. *Castanopsis* spp.
6. *Michelia* spp.
7. *Terminalia myriocarpa*
8. *Phoebe goalparensis*
9. *Amoora rohituka*

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10. Ailantus grandis

11. Tetrameles nudiflora

12. Machilus spp.

13. Symplocos spicata

14. Salmalia malabaricum

15. Sterculia villosa

16. Engelhardtia spicata

These species were differentiated for this report because of their economic importance and wide occurrence in the area and Phase IV. No data had been collected for these species in Phase-I due to comparative sparse distribution. They were lumped in 'Miscellaneous hardwoods' in Phase-I.

General Volume Tables of these species are given in APPENDICES 3.5 to 3.16.

C. Species for which Phase-I General Volume Tables have been used:

17. Pinus wallichiana

18. Tsuga brunoniana

19. Quercus species

20. Betula species

21. Miscellaneous hardwoods

These species occur sparsely in Phase II & III and their felling was not considered necessary. For Rhododendron species which occur abundantly in Phase II & III, it was considered necessary to have separate local volume tables. These were based on general volume table of "Miscellaneous hardwoods."

The general volume tables for these species are given in APPENDICES 3.17 to 3.21.

7.5.1 LOCAL VOLUME TABLES

The data base for construction of Local Volume Tables was as follows for different species:

A. Species for which sample tree data of Phase II & III was used.

1. *Pinus roxburghii*
2. *Abies densa*
3. *Acer* spp.
4. *Castanopsis* spp.
5. *Michelia* spp.
6. *Machilus* spp.
7. *Symplocos spicata*
8. *Pinus wallichiana*
9. *Tsuga brunoniana*
10. *Quercus* species
11. *Betula* species
12. *Rhododendron* spp.
13. *Miscellaneous* hardwoods

For *Rhododendron* spp. and *Miscellaneous* hardwoods sample tree data collected for this report was used for construction of Local Volume Tables.

B. Species for which felled tree data and sample tree data were used because sample tree data was not considered adequate:

14. *Picea spinulosa*
15. *Phoebe goalparensis*
16. *Engelhardtia spicata*

7.5.2 The Local Volume Tables derived are given in the following table. Data for other species was not considered adequate for construction of Local Volume Tables.

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Table

LOCAL VOLUME TABLE

Sl. No.	SPECIES	DIAMETER (cm)										
		10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	100-110	110-120
1.	Abies densa	0.170	0.520	1.060	1.791	2.713	3.825	5.128	6.622	8.306	10.180	12.246
2.	Picea spinulosa	0.113	0.428	1.028	1.978	3.338	5.158	7.490	10.378	13.867	17.999	22.815
3.	Pinus roxburghii	0.066	0.344	0.937	1.904	3.283	5.103	7.387	10.151	13.410	17.178	21.463
4.	Pinus wallichiana	0.094	0.437	1.104	2.095	3.409	5.047	7.009	9.294	11.903	14.836	18.092
5.	Tsuga brunoniana	0.089	0.460	1.080	1.927	2.989	4.261	5.734	7.407	9.274	11.334	13.584
6.	Betula spp.	0.113	0.394	0.897	1.660	2.712	4.081	5.792	7.868	10.330	13.196	16.486
7.	Michelia spp.	0.653	1.345	2.283	3.469	4.902	6.583	8.510	10.684	13.106	15.775	18.691
8.	Phoebe goalparensis	0.079	0.408	0.991	1.828	2.921	4.267	5.869	7.725	9.835	12.201	14.820
9.	Acer spp.	0.126	0.382	0.848	1.556	2.526	3.775	5.317	7.161	9.316	11.790	14.587
10.	Castanopsis spp.	0.066	0.257	0.627	1.222	2.081	3.243	4.740	6.607	8.876	11.575	14.736
11.	Machilus spp.	0.104	0.400	0.952	1.758	2.819	4.134	5.704	7.529	9.609	11.943	14.532
12.	Quercus spp.	0.101	0.417	0.986	1.826	2.949	4.363	6.073	8.086	10.405	13.033	15.973
13.	Engelhardtia spicata	0.106	0.384	0.897	1.689	2.800	4.265	6.116	8.383	11.094	14.276	17.953
14.	Rhododendron spp.	0.076	0.260	0.611	1.155	1.910	2.892	4.111	5.575	7.293	9.269	11.510
15.	Symplocos spicata	0.089	0.400	0.933	1.686	2.659	3.851	5.263	6.894	8.744	10.812	13.099
16.	Miscellaneous spp.	0.091	0.350	0.813	1.498	2.415	3.572	4.976	6.631	8.541	10.709	13.139

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7.6.1 VOLUME PER HECTARE

The underbark volume of each tallied tree was computed from local volume equation. The computation of volume per ha by species and diameter classes and total volume per ha irrespective of species and diameter classes was done by using volume of each tallied tree.

7.6.2 The volume per ha by species and diameter classes for each forest type or a group of forest types was assessed from the estimates of all sample points falling in that type.

7.6.3 The distribution of volume per ha by species and diameter classes, above 10 cm diameter, in different forest types are given in APPENDICES 4.1 to 4.6.

7.6.4 An abstract of volume per ha for each coniferous species and broad leaved species in groups, separately for each forest type is given in the following table:

Contents

Table

DISTRIBUTION OF VOLUME/HECTARE IN m^3 BY SPECIES AND FOREST TYPES

SPECIES	FOREST TYPES					
	Chir	Kail	Fir and spruce	Mixed conifers	Conifers mixed with broad leaved	Upland and lowland hard-woods
1	2	3	4	5	6	7
Abies densa	-	-	372.821	35.524	45.681	2.460
Cupressus spp.	-	-	0.255	2.016	-	-
Juniperus spp.	-	-	2.734	9.646	0.964	0.160
Larix griffithii	-	0.299	-	0.819	-	-
Picea spinulosa	-	10.402	9.559	31.061	-	0.212
Pinus roxburghii	78.993	-	-	-	14.402	0.750
Pinus wallichiana	-	70.706	0.350	17.525	4.478	0.322
Taxus baccata	-	-	-	4.627	6.898	0.697
Tsuga brunoniana	-	5.452	11.756	181.901	66.851	2.281
Total for coniferous spp.	78.993	86.859	397.475	283.119	139.274	6.882
Betula spp.	-	0.561	12.901	11.736	31.183	5.208
Juglans regia	-	-	-	-	-	0.258
Michelia spp.	0.189	-	-	-	-	10.414

Contd...

Contents

Contd.....

1	2	3	4	5	6	7
Morus laevigata	-	-	-	-	-	0.888
Phoebe goalparensis	-	-	-	-	-	2.082
Terminalia myriocarpa	-	-	-	-	-	0.365
Total for Group 'A' (Broad leaved) spp.	0.189	0.561	12.901	11.736	31.183	19.215
Acer spp.	-	1.245	6.384	10.954	25.896	7.336
Ailantus grandis	-	-	-	-	-	0.187
Altingia excelsa	-	-	-	-	-	1.590
Amoora wallichii	-	-	-	-	-	0.205
Cedrela spp.	-	-	-	-	-	1.051
Cinnamomum cecicodaphne	-	-	-	-	-	0.856
Duabanga sonneratioides	0.288	-	-	-	-	0.299
Phoebe hainesiana	-	-	-	-	-	2.981
Salmalia malabaricum	0.187	-	-	-	-	0.226
Schima wallichii	0.779	-	-	-	-	4.553
Tetrameles nudiflora	-	-	-	-	-	0.052
Total for Group 'B' (Broad leaved) spp.	1.254	1.245	6.384	10.954	25.896	19.336

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Contd...

1	2	3	4	5	6	7
Acrocarpus fraxinifolius	-	-	-	-	-	0.134
Albizzia spp.	0.362	-	-	-	-	0.602
Alnus spp.	-	-	-	0.482	-	3.797
Bucklandia populnea	-	-	-	-	-	1.509
Castanopsis spp.	2.544	-	-	-	5.596	4.524
Machilus spp.	-	-	-	0.290	-	16.017
Total for Group 'C' (Broad leaved) spp.	2.906	-	-	0.772	5.596	26.583
Bischofia javanica	-	-	-	-	-	0.237
Garuga pinnata	-	-	-	-	-	0.352
Lagerstroemia parviflora	-	-	-	-	-	0.223
Populus spp.	-	0.281	-	0.244	-	0.265
Prunus spp.	-	-	0.804	0.698	-	0.088
Pterospermum acerifolium	-	-	-	-	-	0.150
Quercus spp.	3.613	6.580	-	2.350	14.374	72.090
Sterculia villosa	0.125	-	-	-	-	0.409
Syzigium spp.	-	-	-	-	-	0.325
Total for Group 'D' (Broad leaved) spp.	3.743	6.861	0.804	3.292	14.374	74.139

Contd...

Contents

Contd....

1	2	3	4	5	6	7.
Aesculus punduana	-	-	-	0.257	0.938	1.657
Amoora rohituka	-	-	-	-	-	0.437
Cinnamomum tamala	-	-	-	0.596	-	0.801
Engelhardtia spicata	-	-	-	-	-	2.240
Ficus spp.	0.239	-	-	-	-	2.448
Kydia calycina	-	-	-	-	-	0.321
Macaranga spp.	0.119	-	-	-	-	1.448
Ostodes paniculatus	-	-	-	-	-	0.767
Rhododendron spp.	1.721	0.838	20.269	15.078	36.726	9.649
Symplocos spicata	-	-	-	0.686	-	2.412
Vitex heterophylla	-	-	-	-	-	0.180
Miscellaneous spp.	2.287	2.899	11.222	11.032	45.266	66.272
Total for Group 'E' (Broad leaved) spp.	4.366	3.737	31.491	27.649	82.930	88.632
Total broad leaved spp.	12.458	12.404	51.580	54.403	159.979	227.905
Total for conifers and broad leaved spp.	91.451	99.263	449.055	337.522	299.253	234.787

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7.6.5 The figures of volume per ha as given in APPENDICES 4.1 to 4.6 were compared with those of normal growing stock from yield tables after applying necessary reduction factors as described in para 7.2.5. Comparison was also done with corresponding figres of Phase I area. In doing so volume of trees of 5-10 cm diameter class in Phase I was ignored because volume under this class has not been computed for this report.

7.6.6 The following inferences may be drawn:

(i) In "Chir Type", chir constitutes 86.4% of the total growing stock which is much higher than corresponding figure 70.1% in Phase I.

- The volume of Chir is maximum in 40-50 and 50-60 cm diameter classes.
- The volume per ha in this type (91.451 m^3) is low but is higher than that of Phase I area (80.940 m^3).

(ii) In "Kail Type", volume of Kail is 70.706 m^3 per ha and is 71.2% of the total volume. The corresponding figures for Phase I are 47.315 m^3 and 70.8%.

- The proportion of Spruce and Tsuga among conifers is adequate.
- Other conifers and broad leaved species do not contribute much to the growing stock.
- The volume of conifers is high in middle diameter classes (30-40, 40-50 and 50-60 cm).
- The total volume (99.263 m^3 per ha) though low is much higher than that of Phase I area (66.838 m^3 per ha).

(iii) In "Fir and Spruce Type", Fir contributes maximum volume (83.0% of the total volume).

- The volume of coniferous species in higher diameter classes (above 40 cm) is quite high.
- The statement given below indicates that volume (total and of conifers) is much higher in this area when compared with that of Phase I area:

	Phase I m^3/ha	Phase II & III m^3/ha
Total Volume	352.683	449.055
Volume of coniferous species	307.538	397.475

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(iv) In "Mixed Conifers Type", Tsuga contributes maximum volume which is 53.9% of the total.

- The volumes of conifers and broad leaved species are 83.9 and 16.1 percents respectively.
- The volume in higher diameter classes for coniferous spp. is quite appreciable.
- The comparison of stockings with that of Phase I area is as under:

	Phase I m^3/ha	Phase II & III m^3/ha
Total volume	269.110	337.522
Volume of coniferous species	222.520	283.119

(v) In "Conifers Mixed with Broad Leave Type", the percentage by volume of conifers is 46.5 which is lesser than that of Phase I area (49.4%).

- Among conifers Tsuga and Abies contribute maximum volume.
- Total volume (conifers and broad leave taken together) is maximum (26.3%) in 80 cm and above diameter class.
- The contribution of lower diameter classes i.e. 10-20 and 20-30 cm is also quite appreciable (28.6%).
- The total volume per ha (299.253 m^3) is higher than that of Phase I area (238.871 m^3).

(vi) In "Hard Woods Type", the volume contribution of conifers is almost negligible (3.0% as compared to 8.3% in Phase I area).

- Total volume (234.787 m^3 per ha) in this type is also low in comparison to that of Phase I area (267.967 m^3 per ha).
- The contribution of 80 cm and above diameter class is maximum (23.2%).

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7.7.1 TOTAL VOLUME AND PRECISION

Total volume and precision derived for each type are given in the following table:

Table

TYPE-WISE TOTAL VOLUME WITH ERROR PERCENTAGE

Sl.No.	Forest Type	Total Volume (000 m3)	Standard Error %
1.	Chir	6843.3	7.68
2.	Kail *	1649.2	21.71
3.	Fir & Spruce	46889.3	3.83
4.	Mixed Conifers	15082.9	8.02
5.	Conifers mixed with broad leaved	30134.2	9.90
6.	Hardwoods	113377.9	3.16
	All Forest Types	213976.8	2.44

* The area under this type is only 1.8% of the total forest area. Very few (64) sample points were taken in this type.

7.8.1 TOTAL GROWING STOCK

APPENDICES 5.1 to 5.6 show the estimated total volume by species and diameter classes in '000' m^3 in different forest types. Diameter class-wise break-up of this total growing stock is given in APPENDIX 6.1. The following table gives an abstract of total estimated growing stock by species and species groups for the entire area.

Table

TOTAL GROWING STOCK IN SURVEY AREA

'000' m^3

Species	Growing stock	%
1	2	3
Abies densa	46304.3	21.6
Cupressus spp.	116.8	0.1
Juniperus spp.	890.6	0.4
Larix griffithii	41.6	-
Picea spinulosa	2661.1	1.2
Pinus roxburghii	7724.2	3.6
Pinus wallichiana	2600.7	1.2
Taxus baccata	1237.6	0.6
Tsuga brunoniana	17279.7	8.1
TOTAL FOR CONIFEROUS SPP.	78856.6	36.8
Betula spp.	7536.6	3.5
Juglans regia	124.4	0.1
Michelia spp.	5043.1	2.4
Morus laevigata	429.1	0.2
Phoebe goalparensis	1006.0	0.5
Terminalia myriocarpa	176.2	0.1
TOTAL GROUP 'A' (BROAD LEAVED) SPP.	14315.4	6.8

Contd...

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1	2	3
Acer spp.	7327.6	3.4
Ailantus grandis	90.5	-
Altingia excelsa	768.9	0.4
Amoora wallichii	99.4	-
Cedrela spp.	507.4	0.2
Cinnamomum cecicodaphne	413.6	0.2
Duabanga sonneratioides	166.1	0.1
Phoebe hainesiana	1440.3	0.7
Salmalia malabaricum	123.3	0.1
Schima wallichii	2256.3	1.1
Tetrameles nudiflora	25.0	-
TOTAL GROUP 'B' (BROAD LEAVED) SPP.	13218.4	6.2
Acrocarpus fraxinifolius	64.9	-
Albizzia spp.	318.0	0.1
Alnus spp.	1855.2	0.9
Bucklandia populnea	728.9	0.3
Castanopsis spp.	2939.1	1.4
Machilus spp.	7747.6	3.6
TOTAL GROUP 'C' (BROAD LEAVED) SPP.	13653.7 *	6.3
Bischofia javanica	114.3	-
Garuga pinnata	170.1	0.1
Lagerstroemia parviflora	108.0	-
Populus spp.	143.8	0.1
Prunus spp.	157.9	0.1
Pterospermum acerifolium	72.0	-

Contd..

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1	2	3
Quercus spp.	36743.7	17.2
Sterculia villosa	206.6	0.1
Syzigium spp.	157.4	0.1
TOTAL GROUP 'D' (BROAD LEAVED) SPP.	37873.8	17.7
Aesculus punduana	906.1	0.4
Amoora rohituka	210.6	0.1
Cinnamomum tamala	413.1	0.2
Engelhardtia spicata	1081.3	0.5
Ficus spp.	1199.9	0.6
Kydia calycina	155.0	0.1
Macaranga spp.	707.5	0.3
Ostodes paniculata	370.7	0.2
Rhododendron spp.	11290.5	5.3
Symplocos spicata	1194.5	0.5
Vitex heterophylla	86.7	-
Miscellaneous spp.	38443.3	18.0
TOTAL GROUP 'E' (BROAD LEAVED) SPP.	56059.2 *	26.2
Total Broad leaved spp.	135120.5 *	63.2
Total for conifers & broad leaved spp.	213977.1 *	100.0

* Difference as compared to Appendix 6.1 is due to the rounding off.

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7.8.2 The species-wise estimate of total growing stock in different catchments is given in APPENDIX 7.1.

7.9.1 CULL

'Cull' as used in the Report includes not only hollowness but all the defects like knots, callus formation, twisted or spiral grain and damage by pathological, entomological, climatic or biotic agencies including fire. In order to assess the occurrence of 'cull' and the degree of cull in different species, data was collected from trees felled for Volume Studies. (Please refer to Field Manual of Volume & Cull Studies). Cull data collected for *Juniperus* spp., *Larix griffithii*, *Pinus wallichiana*, *Tsuga brunoniana*, *Betula* spp., *Quercus* spp., and Miscellaneous hardwoods, in Phase I fellings was used, as fellings of these species were not done for this Report.

The percentage of trees having cull, irrespective of the quantum of 'cull', in different species was found to be as under:

Species	Percentage of trees having cull	Remarks
Abies densa	75.8	
Juniperus spp.	56.0	Figure of percentage of cull taken from Phase I report.
Larix griffithii.	51.2	-do-
Picea spinulosa	30.6	
Pinus roxburghii	19.3	
Pinus wallichiana	17.9	From Phase I report.
Tsuga brunoniana	37.2	-do-
Betula spp.	48.0	-do-
Michelia spp.	85.1	
Phoebe goalparensis	91.2	
Terminalia myriocarpa	75.0	
Acer spp.	84.9	
Ailanthus grandis	79.6	
Salmalia malabaricum	90.2	
Tetrameles nudiflora	67.4	
Castanopsis spp.	70.7	
Machilus spp.	91.0	
Quercus spp.	62.6	From Phase I report.
Sterculia villosa	97.3	
Amoora rohituka	79.2	
Engelherdtia spicata	67.5	
Symplocos spicata	69.6	
Miscellaneous hardwoods	56.0	From Phase I report.

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7.9.2 Cull factors were derived from detailed measurements on the felled trees of different diameter classes. These are shown as cull volume expressed as percentage of total gross volume (under bark) in Appendix 8.1. Phase I cull factors have been used for Pinus wallichiana, Tsuga brunoniana, Quercus species, Betula species, Juniperus species, Larix griffithii and misc. hard woods. For Cupressus species and Taxus baccata average Phase II & III figures of all the conifers except Abies densa have been used.

7.10.1 NET GROWING STOCK

The net growing stock for different species and species groups in all forest types, over the entire survey area, after deduction of cull, works out as under:

Contents

Table

GROSS AND NET TOTAL VOLUME BY SPECIES

'000' m^3

Species	Gross Volume	Cull Volume	Net Volume	Percentage of cull
1	2	3	4	5
Abies densa	46304.3	15879.9	30424.4	34.3
Cupressus spp.	116.8	5.0	111.8	4.3
Juniperus spp.	890.6	231.6	659.0	26.0
Larix griffithii	41.6	0.4	41.2	1.0
Picea spinulosa	2661.1	396.1	2265.0	14.9
Pinus roxburghii	7724.2	167.1	7557.1	2.2
Pinus wallichiana	2600.7	54.3	2546.4	2.1
Taxus baccata	1237.6	85.5	1152.1	6.9
Tsuga brunoniana	17279.7	924.6	16355.1	5.4
Total conifers	78856.6	17744.5	61112.1	22.5
Betula spp.	7536.6	298.2	7238.4	4.0
Michelia spp.	5043.1	65.6	4977.5	1.3
Phoebe goalparensis	1006.0	33.9	972.1	3.4
Terminalia myriocarpa	176.2	2.3	173.9	1.3
Rest of the Group 'A' species	553.5	110.1	443.4	19.9
Total Group 'A' spp.	14315.4	510.1	13805.3	3.6
Acer spp.	7327.6	404.5	6923.1	5.5
Ailantus grandis	90.5	1.3	89.2	1.4
Salmalia malabaricum	123.3	2.4	120.9	1.9
Tetrameles nudiflora	25.0	1.1	23.9	4.4
Rest of the Group 'B' species	5652.0	1055.7	4596.3	18.7
Total Group 'B' spp.	13218.4	1465.0	11753.4	11.1

Contd...

Contents

Contd..

1	2	3	4	5
Castanopsis spp.	2939.1	124.6	2814.5	4.2
Machilus spp.	7747.6	722.6	7025.0	9.3
Rest of the Group 'C' species.	2967.0	478.3	2488.6	16.1
Total Group 'C' spp.	13653.7*	1325.5	12328.1	9.7
Quercus spp.	36743.7	3647.9	33095.8	9.9
Sterculia villosa	206.6	19.2	187.4	9.3
Rest of the Group 'D' species.	923.5	132.9	790.6	14.4
Total Group 'D' spp.	37873.8	3800.0	34073.8	10.0
Amoora rohituka	210.6	9.6	201.0	4.6
Engelhardtia spicata	1081.3	23.4	1057.9	2.2
Symplocos spicata	1194.5	20.3	1174.2	1.7
Rest of the Group 'E' species	53572.8	7025.4	46547.4	13.1
Total Group 'E' spp.	56059.2*	7078.7	48980.5	12.6
Total Broad leaved spp.	135120.5*	14179.3	120941.1	10.5
Total Broad leaved and Conifers	213977.1*	31923.8	182053.2	14.9

* Difference as compared to Appendix 6.1 is due to rounding off adjustments.

Contents

7.11.1 BARK VOLUME

Bark percentages were derived from the felled trees data. Data of Phase I was used for four species and one species group for which no fellings were done. Figures of Phase I have been used for *Larix griffithii* also. Average figures of all conifers except *Chir*, have been adopted for *Cupressus* spp., *Taxus baccata* and *Juniperus* spp.

7.11.2 Bark volume expressed as percentage of under bark volume by species and diameter classes has been given in APPENDIX 9.1.

7.11.3 The total bark volume for different species works out as:

Table

TOTAL BARK VOLUME FOR DIFFERENT SPECIES

'000' m^3

Species	Gross volume	Bark volume
1	2	3
Abies densa	46304.3	6707.3
Cupressus spp.	116.8	19.2
Juniperus spp.	890.6	152.5
Larix griffithii	41.6	10.1
Picea spinulosa	2661.1	366.2
Pinus roxburghii	7724.2	1207.4
Pinus wallichiana	2600.7	308.5
Taxus baccata	1237.6	196.9
Tsuga brunoniana	17279.7	2822.0
Total conifers	78856.6	11790.1
Betula spp.	7536.6	942.8
Michelia spp.	5043.1	643.4
Phoebe goalparensis	1006.0	125.7
Terminalia myriocarpa	176.2	23.3
Rest of the Group 'A' spp.	553.5	79.5
Total Group 'A' species	14315.4	1814.7
Acer spp.	7327.6	887.6
Ailantus grandis	90.5	11.3
Salmalia malabaricum	123.3	30.5
Tetrameles nudiflora	25.0	3.3
Rest of the Group 'B' spp.	5652.0	861.3
Total Group 'B' species	13218.4	1794.0

Contd...

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Contd....

1	2	3
Castanopsis spp.	2939.1	1020.8
Machilus spp.	7747.6	1057.3
Rest of the Group 'C' spp.	2967.0	456.6
Total group 'C' species	13653.7*	2534.7
Quercus spp.	36743.7	6449.1
Sterculia villosa	206.6	52.1
Rest of the Group 'D' spp.	923.5	144.1
Total Group 'D' species	37873.8	6645.3
Amoora rohituka	210.6	26.8
Engelhardtia spicata	1081.3	134.2
Symplocos spicata	1194.5	161.6
Rest of the Group 'E' spp.	53572.8	8398.7
Total Group 'E' species	56059.2*	8721.3
Total Broad leaved spp.	135120.5*	21510.0
Total for broad leaved and conifers.	213977.1*	33300.1

* Difference as compared with Appendix 6.1 is due to rounding off adjustments.

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CHAPTER-VIII

RATE OF GROWTH

8.1.1 INCREMENT

The periodic increment for coniferous species was assessed on the basis of STF (Sample Tree Form) data. During ground sampling radial increment at breast height of coniferous sample trees was recorded for the last 10 years and 20 years respectively. On these basis, annual increment percentages of basal area for each diameter class for the last 10 years and again for 10 years previous to that were calculated for Abies densa, Picea spinulosa, Pinus roxburghii, Pinus wallichiana and Tsuga brunoniana. The mean of the two has been taken as annual increment percent. The increment figures of Phase I report have been used for Larix griffithii. The details for computation are given in para 4.13.4 and 4.13.5 of Volume II. Since adequate data was not available for other coniferous species and increment figures were not computed for Phase I, the figures of Abies densa (having minimum increment among coniferous species) were adopted for these species.

8.1.2 In the absence of any additional data, the figures of annual increment percentages of basal area arrived at for Phase I report for broad leaved species have been used for this report. The figures for various groups of broad leaved species (as described in para 7.2.3) have been adopted on the assumption that increment behaviour of all the species included in a group is similar. Since increment data of none of the species in group B and E were available, the figures of Group D (Quercus spp.) which has minimum increment have been adopted for B and E groups.

8.1.3 The basal area annual increment percentages for trees of different species and group of species in different diameter classes are given in the following table.

Contents

Table

BASAL AREA ANNUAL INCREMENT PERCENT (TREES)

Species	Diameter classes (cm)								Remarks
	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80+	
Abies densa	3.00	1.82	1.21	0.88	0.69	0.57	0.48	0.42	-
Larix griffithii	5.06	3.30	1.68	1.01	0.64	0.46	0.35	-	From Phase I
Picea spinulosa	5.47	3.41	2.09	1.38	0.99	0.75	0.59	0.47	-
Pinus roxburghii	4.81	3.57	2.10	1.38	1.04	0.83	0.69	0.59	-
Pinus wallichiana	5.47	4.36	2.76	1.88	1.39	1.11	0.92	0.79	-
Tsuga brunoniana	2.41	1.85	1.33	0.96	0.73	0.60	0.51	0.43	-
Other coniferous species (Cupressus, Juniperus; Taxus baccata)	3.00	1.82	1.21	0.88	0.69	0.57	0.48	0.42	(as of Abies densa)
Betula and other Group 'A' broad leaved species.	7.20	3.96	2.57	2.35	1.77	1.27	0.92	0.66	From Phase I
Group 'B' Broad leaved species	7.27	3.27	1.87	1.36	1.08	0.70	0.58	0.28	(as of Group D)
Alnus and other Group 'C' Broad leaved spp.	10.37	5.71	3.60	3.47	2.65	1.81	1.53	1.20	From Phase I
Quercus and other Group 'D' Broad leaved spp.	7.27	3.27	1.87	1.36	1.08	0.70	0.58	0.28	From Phase I
Group 'E' Broad leaved spp.	7.27	3.27	1.87	1.36	1.08	0.70	0.58	0.28	(as of Group D)

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8.2.1 CROP BASAL AREA INCREMENT

The basal area (per ha) figures for different species and groups of species are given in Appendices 10.1 to 10.6. The tree basal area increment percentages (table in para 8.1.3) have been converted into crop basal area increment percentages by giving weightage to basal area in each diameter class, for all the species and species groups in each forest type.

8.2.2 The crop basal area increment percentages are given in the following table.

Contents

Table

CROP BASAL AREA INCREMENT PERCENTAGES

Species or species groups.	FOREST TYPES					
	Chir	Kail	Fir and Spruce	Mixed conifers	Conifers mixed with broad leaved	Hardwoods
Abies densa	-	-	0.74	0.65	0.74	0.54
Larix griffithii	-	1.01	-	0.48	-	-
Picea spinulosa	-	2.57	1.76	1.17	-	1.27
Pinus roxburghii	1.96	-	-	-	2.54	1.34
Pinus wallichiana	-	2.74	3.81	1.73	1.49	2.12
Tsuga brunoniana	-	1.51	0.53	0.75	0.58	0.57
Other coniferus species (Cupressus, Juniperus, Taxus baccata)	-	-	1.61	1.55	0.89	0.76
Group 'A' species	1.27	7.20	3.68	3.82	3.19	2.29
Group 'B' species	3.00	5.66	4.93	3.65	3.87	1.76
Group 'C' species	3.95	-	-	9.01	2.93	3.86
Group 'D' species	2.51	2.19	5.93	2.31	0.94	1.82
Group 'E' species	4.36	4.29	5.63	4.85	4.75	3.16

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8.3.1 PERIODIC ANNUAL INCREMENT

The crop basal area increment percentages also represent volume increment percentages for different species and species groups in different forest types. The periodic annual increment per ha by species and forest types, calculated from per ha volume figures (para 7.6.4) are given in the following table.

Table

PERIODIC ANNUAL INCREMENT / HA BY FOREST TYPES

Forest Type	Species Group	Species	Volume/ha (m^3)	Crop volume increment percent	PAI/ha. (m^3)
CHIR	Conifers	Pinus roxburghii	78.993	1.96	1.548
	A	Michelia spp.	0.189	1.27	0.002
	B	Duabanga sonneratioides	0.288		0.009
		Salmalia malabaricum	0.187	3.00	0.006
		Schima wallichii	0.779		0.023
		Total Group B	1.254		0.038
	C	Albizzia spp.	0.362	3.95	0.014
		Castanopsis spp.	2.544		0.101
		Total Group C	2.906		0.115
	D	Quercus spp.	3.618	2.51	0.091
		Sterculia villosa	0.125		0.003
		Total Group D	3.743		0.094
	E	Ficus spp.	0.239		0.010
		Macaranga spp.	0.119	4.36	0.005
		Rhododendron spp.	1.721		0.075
		Miscellaneous spp.	2.287		0.100
		Total Group E	4.366		0.190
		Total Broad leaved spp	12.458		0.439
		Total Conifers and Broad leaved spp.	91.451		1.987

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Forest Type	Species Group	Species	Volume/ha (m^3)	Crop volume increment percent	PAI/ha. (m^3)
KAIL	Conifers	Pinus wallichiana	70.706	2.74	1.937
		Larix griffithii	0.299	1.01	0.003
		Picea spinulosa	10.402	2.57	0.267
		Tsuga brunoniana	5.452	1.51	0.082
		Total Conifers	86.859		2.289
	A	Betula spp.	0.561	7.20	0.040
	B	Acer spp.	1.245	5.66	0.070
	D	Populus spp.	0.281)	2.19	0.006
		Quercus spp.	6.580)		0.144
		Total Group D	6.861		0.150
	E	Rhododendron spp.	0.838)	4.29	0.036
		Miscellaneous spp.	2.899)		0.124
		Total Group E	3.737		0.160
		Total broad leaved spp.	12.404		0.420
		Total conifers & broad leaved spp.	99.263		2.709
FIR & SPRUCE	Conifers	Abies densa	372.821	0.74	2.759
		Picea spinulosa	9.559	1.76	0.168
		Pinus wallichiana	0.350	3.81	0.013
		Tsuga brunoniana	11.756	0.53	0.062
		Cupressus spp.	0.255)	1.61	0.004
		Juniperus spp.	2.734)		0.044
		Total conifers	397.475		3.050

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Forest Type	Species Group	Species	Volume/ha (m^3)	Crop Volume increment percent	PAI/ha (m^3)
	A	Betula spp.	12.901	3.68	0.475
	B	Acer spp.	6.384	4.93	0.315
	D	Prunus spp.	0.804	5.93	0.048
	E	Rhododendron spp.	20.269	5.63	1.141
		Miscellaneous spp.	11.222		0.632
		Total Group E	31.491		1.773
		Total broad leaved spp.	51.580		2.611
		Total conifers and broad leaved spp.	449.055		5.661
MIXED CONIFERS	Conifers	Abies densa	35.524	0.65	0.231
		Larix griffithii	0.819	0.48	0.004
		Picea spinulosa	31.061	1.17	0.363
		Pinus wallichiana	17.525	1.73	0.303
		Tsuga brunoniana	181.901	0.75	1.364
		Cupressus spp.	2.016	1.55	0.031
		Juniperus spp.	9.646		0.150
		Taxus baccata	4.627		0.072
		Total conifers	283.119		2.518
	A	Betula spp.	11.736	3.82	0.448
	B	Acer spp.	10.954	3.65	0.400
	C	Alnus spp.	0.482	9.01	0.043
		Machilus spp.	0.290		0.026
		Total Group C	0.772		0.069*

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Forest Type	Species Group	Species	Volume/ha (m^3)	Crop Volume increment percent	PAI/ha. (m^3)
	D	Populus spp.	0.244)		0.006
		Prunus spp.	0.698)	2.31	0.016
		Quercus spp.	2.350)		0.054
		Total Group D	3.292		0.076
	E	Aesculus punduana	0.257		0.013*
		Cinnamomum tamala	0.596		0.029
		Rhododendron spp.	15.078	4.85	0.731
		Symplocos spicata	0.686		0.033
		Miscellaneous spp.	11.032		0.535
		Total Group E	27.649		1.341
		Total broad leaved spp.	54.403		2.334
		Total conifers and broad leaved spp.	337.552		4.852
CONIFERS MIXED WITH BROAD-LEAVED	Conifers	Abies densa	45.681	0.74	0.338
		Pinus roxburghii	14.402	2.54	0.366
		Pinus wallichiana	4.478	1.49	0.067
		Tsuga brunoniana	66.851	0.58	0.388
		Juniperus spp.	0.964)	0.89	0.009
		Taxus baccata	6.898)		0.061
		Total conifers	139.274		1.229
	A	Betula spp.	31.183	3.19	0.995
	B	Acer spp.	25.896	3.87	1.002
	C	Castanopsis spp.	5.596	2.93	0.164
	D	Quercus spp.	14.374	0.94	0.135

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Forest Type	Species Group	Species	Volume/ha (m^3)	Crop Volume increment percent	PAI/ha (m^3)
	E	Aesculus punduana	0.938		0.045
		Rhododendron spp.	36.726	4.75	1.744
		Miscellaneous spp.	45.266	---	2.150
		Total Group E	82.930		3.939
		Total broad leaved spp.	159.979		6.235
		Total conifers and broad leaved spp.	299.253		7.464
HARDWOODS	A	Betula spp.	5.208		0.119
		Juglans regia	0.258		0.006
		Michelia spp.	10.414		0.239*
		Morus laevigata	0.888	2.29	0.020
		Phoebe goalparensis	2.082		0.048
		Terminalia myriocarpa	0.365		0.008
		Total Group A	19.215		0.440
	B	Acer spp.	7.336		0.129
		Ailantus grandis	0.187		0.003
		Altingia excelsa	1.590		0.028
		Amoora wallichii	0.205		0.004
		Cedrela spp.	1.051		0.019*
		Cinnamomum secicodaphne	0.856	1.76	0.015
		Duabanga sonneratioides	0.299		0.005
		Phoebe hainesiana	2.981		0.052
		Salmalia malabaricum	0.226		0.004
		Schima wallichii	4.553		0.080
		Tetrameles nudiflora	0.052		0.001
		Total Group B	19.336		[illegible]

Contd...

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Contd..

Forest Type	Species Group	Species	Volume/ha (m^3)	Crop Volume increment percent	PAI/ha (m^3)
	C	Acrocarpus fraxinifolius	0.134		0.005
		Albizzia spp.	0.602		0.023
		Alnus spp.	3.797		0.147
		Bucklandia populnea	1.509	3.86	0.058
		Castanopsis spp.	4.524		0.175
		Machilus spp.	16.017		0.618
		Total Group C	26.583		1.026
	D	Bischofia javanica	0.237		0.004
		Garuga pinnata	0.352		0.006
		Lagerstroemia parviflora	0.223		0.004
		Populus spp.	0.265	1.82	0.005
		Prunus spp.	0.088		0.002
		Pterospermum acerifolium	0.150		0.003
		Quercus spp.	72.090		1.312
		Sterculia villosa	0.409		0.007
		Syzigium spp.	0.325		0.006
		Total Group D	74.139		1.349
	E	Aesculus punduana	1.657		0.053*
		Amoora rohituka	0.437		0.014
		Cinnamomum tamala	0.801		0.025
		Engelhardtia spicata	2.240		0.071
		Ficus spp.	2.448	3.16	0.077
		Kydia calycina	0.321		0.010
		Macaranga spp.	1.448		0.046

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Forest Type	Species Group	Species	Volume/ha (m^3)	Crop Volume increment percent	PAI/ha (m^3)
		Ostodes paniculata	0.767)		0.024
		Rhododendron spp.	9.649)		0.305
		Symplocos spicata	2.412)	3.16	0.076
		Vitex heterophylla	0.180)		0.006
		Miscellaneous spp.	66.272)		2.094
		Total Group E	88.632		2.801
	Conifers	Abies densa	2.460	0.54	0.013
		Picea spinulosa	0.212	1.27	0.003
		Pinus roxburghii	0.750	1.34	0.010
		Pinus wallichiana	0.322	2.12	0.007
		Tsuga brunoniana	2.281	0.57	0.013
		Juniperus spp.	0.160)	0.76	0.001
		Taxus baccata	0.697)		0.005
		Total conifers	6.882		0.052
		Total broad leaved species	227.905		5.956
		Total conifers and broad leaved spp.	234.787		6.008

* These figures have been adjusted to avoid contradiction with the figures of the group total.

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8.4.1 ROTATION

The exploitable diameters for conifers and broad leaved species considered suitable are 60 cm and 40 cm respectively. These have been proposed after studying the present utilization patterns. The same diameters were adopted in Phase I report also.

8.4.2 The ages corresponding to these diameters as read from age-diameter curves from Phase I and/or Phase II & III data are given in the following table:

Table

ROTATION AGE FOR DIFFERENT SPECIES

Species	Age to reach exploitable sizes(in years)	Rotation (in years)
Abies densa	163	160
Larix griffithii	232.0	160
Picea spinulosa	173	160
Pinus roxburghii	76.5	90
Pinus wallichiana	144.0	140
Tsuga brunoniana	166.0	160
Juniperus spp.	242.5	160
Taxas baccata	213.5	160
Cupressus spp.	-	160
Betula spp.	X + 55	80
Populus spp.	X + 48	80
Quercus spp.	X + 91.6	80

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8.4.3 For broad leaved species the correct age (denoted by 'X' in the table above) of the crop at the time of formation of sample plot was not known, it was not possible to estimate correctly the age corresponding to the exploitable size. Hence a common rotation of 80 years which is on higher side for all the broad leaved species, except Quercus spp., is considered suitable. The management for Oaks will ultimately aim at maximum volume production and a shorter rotation of 80 years for these species be a step in the right direction.

CHAPTER - IX

ACCESSIBLE GROWING STOCK

9.1.1 CRITERIA FOR OPERABLE/INOPERABLE CLASSES

The criteria for present classification of forests into physically operable and inoperable categories, were again discussed with the Forest Department of Royal Government of Bhutan with reference to Phase II & III areas under survey. The Director of forests, Forest Department, Royal Government of Bhutan did not propose any change in the criteria for the present classification, and rightly so, because hardly any significant development had taken place in the transportation methods or facilities and other factors affecting the physical or economic accessibility of forest areas under survey.

9.2.1 The following criteria have been used for classification of forests into physically operable and inoperable forests:

1. Forest areas above 4000 metres elevation have been classified as inoperable. They will remain so for quite some time.

2. Forest areas above 60° slope have also been classed as inoperable since working in such areas will be extremely difficult.

3. Forest areas under Wildlife Sanctuaries and National Parks have also been classified as inoperable as no commercial forest working is to be permitted in these areas.

4. There are no areas in the area under survey, which have to be excluded on account of their proximity to borders of Bhutan. Such areas have been excluded while selecting the areas for survey.

9.3.1 OPERABLE AREA

Areas of forests situated above 4000 metres elevation and forest areas having slopes above 60° (but situated below 4000 metres elevation) were calculated on the basis of proportionate weightage to the inventory sample points falling in these areas. Areas of Game Sanctuaries and National Parks, were calculated from the map sheets.

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9.3.2 The following table shows inoperable and operable forest areas, calculated on the above basis:

Table

Inoperable and operable tree forest area

ha

Forest Type	Total tree forest from para 6.3.3	Inoperable/Inaccessible area				Operable Area
		Above 4000 m altitude	Below 4000 m altitude but above 60° slope	Within Game Sanctuary below 4000 m altitude & below 60° slope	Total	
Chir	74,829	-	9,782	-	9,782	65,047
Kail	16,615	-	260	-	260	16,355
Fir-Spruce	1,04,418	3,018	3,022	1,057	7,097	97,321
Mixed Conifers	44,687	-	812	365	1,177	43,510
Broad leaved mixed with conifers	1,00,697	-	-	26	26	1,00,671
Upland & Low-land hardwoods	4,82,880	386	48,174	27	48,587	4,34,293
Total	8,24,126	3,404	62,050	1,475	66,929	7,57,197

9.3.3 The catchment-wise break up has been worked out on the basis of proportionate distribution of sample points over total (operable and inoperable) area. The proportion of operable area has been assumed to be same as that of the total area. Based upon this presumption, the distribution of operable area into catchments and forest types has been worked out and is given in the following table:

Contents

Table

OPERABLE FOREST AREA BY FOREST TYPE AND CATCHMENTS

ha

Forest Type	Sankosh	Tongsa	Bhumthang	Ai Chu	Kuru Chu	Gamri	Manas	Neyera Ama	Total
Chir	18,131	5,446	425	1,029	10,668	16,313	12,124	911	65,047
Kail	183	207	15,965	-	-	-	-	-	16,355
Fir-Spruce	5,578	24,970	49,342	374	8,359	5,708	908	2,082	97,321
Mixed Conifers	2,877	4,427	28,810	32	2,974	4,061	30	299	43,510
Conifers mixed with Broad-leaved	14,295	39,564	7,327	1,383	15,716	8,172	10,055	4,159	1,00,671
Hardwoods	42,992	1,43,732	39,485	50,023	48,188	45,490	45,556	18,827	4,34,293

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9.4.1 ACCESSIBLE GROWING STOCK

Based on the operable areas given in para 9.3.2 detailed calculations were made for growing stock in the accessible areas for each type and species. This growing stock has been referred to as 'Accessible Growing Stock'. The details have been given in APPENDICES 11.1 to 11.6 and 12.1. An abstract of the 'Accessible Growing Stock' is given below:

Species	Volume ('000' m^3)
Abies densa	43496.075
Cupressus spp.	112.534
Juniperus spp.	852.309
Larix griffithii	40.525
Picea spinulosa	2543.951
Pinus roxburghii	6913.841
Pinus wallichiana	2543.618
Taxus baccata	1198.452
Tsuga brunoniana	16868.366
Total conifers	74569.671
Betula spp.	7176.368
Juglans regia	112.048
Michelia spp.	4535.021
Morus laevigata	385.654
Phoebe goalparensis	904.198
Terminalia myriocarpa	158.518
Total Group 'A'	13271.807

Contents

Species	Volume ('000' m^3)
Acer spp.	6911.220
Ailantus grandis	81.213
Altingia excelsa	690.527
Amoora wallichii	89.030
Cedrela spp.	456.442
Cinnamomum cecicodaphne	371.755
Duabanga sonneratioides	148.586
Phoebe hainesiana	1294.626
Salmalia malabaricum	110.314
Schima wallichii	2028.007
Tetrameles nudiflora	22.583
Total Group 'B'	12204.303
Acrocarpus fraxinifolius	58.195
Albizzia spp.	284.991
Alnus spp.	1669.983
Bucklandia populnea	655.347
Castanopsis spp.	2693.578
Machilus spp.	6968.689
Total Group 'C'	12330.783
Bischofia javanica	102.927
Garuga pinnata	152.872
Lagerstroemia parviflora	96.848
Populus spp.	130.300
Prunus spp.	146.834

Contents

Species	Volume ('000' m^3)
Pterospermum acerifolium	65.143
Quercus spp.	33200.434
Sterculia villosa	185.758
Syzigium spp.	141.145
Total Group 'D'	34222.261
Aesculus punduana	825.233
Amoora rohituka	189.785
Cinnamomum tamala	373.800
Engelhardtia spicata	972.816
Ficus spp.	1078.695
Kydia calycina	139.407
Macaranga spp.	636.598
Ostodes paniculata	333.103
Rhododendron spp.	10642.033
Symplocos spicata	1077.361
Vitex heterophylla	78.172
Miscellaneous spp.	35106.753
Total Group 'E'	51453.756
TOTAL BROAD LEAVED SPP.	123482.910
TOTAL FOR CONIFERS AND BROAD LEAVED SPP.	198052.581

9.4.2 The average growing stock for operable area (7,57,197 ha) works out at 261.56 m^3 per ha.

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CHAPTER-X

ANNUAL CUT

10.1.1 GENERAL

The annual cut has been calculated on the accessible growing stock. The cut has been calculated for each species in each forest type, on considerations of system of management likely to be adopted for the species, growing stock (total and its distribution among various diameter classes), rate of growth, rotation, felling cycle etc.

10.2.1 FORMULAE USED FOR DETERMINING ANNUAL CUT

Hanzlik's formula with modifications to suit different conditions of crops has been used to calculate the annual cut. One formula has been applied for a particular species, occurring in all forest types.

10.2.2 The modifications of Hanzlik's formula for applying to different species are:-

(i) For Chir and Kail:- Since stocking of these species, particularly in Chir and Kail types, is poor and lower diameter classes are also poorly represented, the increment is proposed to be retained. The mature and over mature stock can, however, be removed within a reasonably short period. The following formula has, therefore, been applied for these species:

$$\text{Annual cut} = \frac{Vm}{n}$$

Where Vm = Volume of growing stock above exploitable size (60 cm dbh)

n = 30 years

(ii) For Fir, Spruce and other conifers:- The stocking of Fir and Spruce in "Fir-Spruce Type" is fairly satisfactory. The occurrence of cull in fir is quite high. Accordingly the following formula has been applied:

Contents

Annual cut = $I + \frac{Vm}{n}$

Where I = Mean annual increment of growing stock

Vm = Growing stock (volume) above exploitable size (60 cm dbh)

n = 30 years

(iii) For broad leaved species:- The cull in these species is low. A large number of broad leaved species have not known industrial or other use at present. Retention of larger sized trees, till such time as they can economically be exploited, is therefore, considered desirable. The formula in the following form has been used on these considerations:

Annual cut = $I + \frac{Vm_1}{n}$

Where I = Mean annual increment of the growing stock.

Vm_1 = Volume of the over mature trees i.e. over one diameter class above the exploitable size (i.e. above 50 cm dbh)

10.3.1 Vm, Vm_1 and I :- The values of Vm (growing stock above exploitable size), and Vm_1 (over mature growing stock) have been determined from the tables of total volume in '000' m^3 by species for operable forest area as given in APPENDICES 11.1 to 11.6. The details of exploitable size and rotation proposed to be fixed are given in para 8.4.1 and 8.4.2.

Contents

10.3.2 The "I" (Mean annual increment of growing stock) has been calculated by multiplication of figures of PAI/ha as given in para 8.3.1 and total operable forest area under the relevant forest type (para 9.3.1).

10.3.3 The values of "Vm" (for coniferous species), "Vm_1" (for broad leaved species) and "I" for different species in different forest types, calculated as explained in para 10.3.1 and 10.3.2 above, are given in the following table:

Contents

Table

EXPLOITABLE GROWING STOCK (Vm) FOR CONIFEROUS AND OVER MATURE GROWING STOCK (Vm_1) FOR BROAD LEAVED SPECIES AND INCREMENT (I) BY FOREST TYPES AND SPECIES

'000' m^3

Type / Species	Chir		Kail		Fir & Spruce	
	Vm/Vm_1	I	Vm/Vm_1	I	Vm/Vm_1	I
1	2	3	4	5	6	7
Abies densa	-	-	-	-	20694.435	268.509
Cupressus spp.	-	-	-	-	10.219	0.389
Juniperus spp.	-	-	-	-	19.464	4.282
Larix griffithii	-	-	-	0.049	-	-
Picea spinulosa	-	-	7.949	4.367	535.655	16.350
Pinus roxburghii	1177.806	100.693	-	-	-	-
Pinus wallichiana	-	-	283.350	31.680	-	1.265
Taxus baccata	-	-	-	-	-	-
Tsuga brunoniana	-	-	7.000	1.341	1049.218	6.034
Total conifers	1177.806	100.693	298.299	37.437	22308.991	296.829
Betula spp.	-	-	-	0.654	208.170	46.228
Juglans regia	-	-	-	-	-	-
Michelia spp.	12.294	0.130	-	-	-	-

(See next page for col. No. 8 to 13 of this table)

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Contd.

Type / Species	Mixed Conifers		Conifers mixed with Broad leaved		Hardwoods	
	Vm/Vm_1	I	Vm/Vm_1	I	Vm/Vm_1	I
1	8	9	10	11	12	13
Abies densa	1091.318	10.051	2358.117	34.027	850.346	5.646
Cupressus spp.	-	1.349	-	-	-	-
Juniperus spp.	38.333	6.526	97.047	0.906	-	0.434
Larix griffithii	24.583	0.174	-	-	-	-
Picea spinulosa	869.286	15.794	-	-	30.401	1.303
Pinus roxburghii	-	-	-	36.846	157.648	4.343
Pinus wallichiana	314.098	13.183	240.302	6.745	32.138	3.040
Taxus baccata	65.439	3.133	266.174	6.141	175.020	2.171
Tsuga brunoniana	5605.829	59.348	5756.670	39.060	832.540	5.646
Total conifers	8008.886	109.558	8718.310	123.725	2078.093	22.583
Betula spp.	75.490	19.492	652.046	100.168	631.027	51.681
Juglans regia	-	-	-	-	90.333	2.606
Michelia spp.	-	-	-	-	3450.458	103.796

Contents

Contd.

Type / Species	Chir		Kail		Fir & Spruce	
	Vm/Vm_1	I	Vm/Vm_1	I	Vm/Vm_1	I
1	2	3	4	5	6	7
Morus laevigata	-	-	-	-	-	-
Phoebe goalparensis	-	-	-	-	-	-
Terminalia myriocarpa	-	-	-	-	-	-
TOTAL GROUP 'A' (BROAD LEAVED SPP.)	12.294	0.130	-	0.654	208.170	46.228
Acer spp.	-	-	-	1.145	9.732	30.656
Ailantus grandis	-	-	-	-	-	-
Altingia excelsa	-	-	-	-	-	-
Amoora wallichii	-	-	-	-	-	-
Cedrela spp.	-	-	-	-	-	-
Cinnamomum cecicodaphne	-	-	-	-	-	-
Duabanga sonneratioides	10.277	0.586	-	-	-	-
Phoebe hainesiana	-	-	-	-	-	-
Salmalia malabaricum	12.164	0.390	-	-	-	-
Schima wallichii	10.342	1.496	-	-	-	-
Tetrameles nudiflora	-	-	-	-	-	-
TOTAL GROUP 'B' (BROAD LEAVED SPP.)	32.783	2.472	-	1.145	9.732	30.656

Contents

Contd.

Type / Species	Mixed Conifers		Conifers mixed with Broad leaved		Hardwoods	
	Vm/Vm_1	I	Vm/Vm_1	I	Vm/Vm_1	I
1	8	9	10	11	12	13
Morus laevigata	-	-	-	-	320.075	8.686
Phoele goalparensis	-	-	-	-	646.663	20.846
Terminalia myriocarpa	-	-	-	-	109.877	3.474
TOTAL GROUP 'A' (BROAD LEAVED SPP.)	75.490	19.492	652.046	100.168	5248.433	191.089
Acer spp.	70.660	17.404	87.181	100.872	1920.878	56.024
Ailantus grandis	-	-	-	-	77.304	1.303
Altingia excelsa	-	-	-	-	617.131	12.160
Amoora wallichii	-	-	-	-	31.703	1.737
Cedrela spp.	-	-	-	-	362.635	8.252
Cinnamomum cecicodaphne	-	-	-	-	186.746	6.514
Duabanga sonneratioides	-	-	-	-	101.190	2.172
Phoebe hainesiana	-	-	-	-	1041.000	22.583
Salmalia malabaricum	-	-	-	-	29.966	1.737
Schima wallichii	-	-	-	-	1394.080	34.744
T[illegible]meles nudiflora	-	-	-	-	22.583	0.434
T[illegible] GROUP 'B' ([illegible]D LEAVED SPP.)	70.660	17.404	87.181	100.872	5785.216	147.660

Contents

Contd.

Type / Species	Chir		Kail		Fir & Spruce	
	Vm/Vm_1	I	Vm/Vm_1	I	Vm/Vm_1	I
1	2	3	4	5	6	7
Acrocarpus fraxinifolius	-	-	-	-	-	-
Albizzia spp.	10.733	0.911	-	-	-	-
Alnus spp.	-	-	-	-	-	-
Bucklandia populnea	-	-	-	-	-	-
Castanopsis spp.	57.697	6.570	-	-	-	-
Machilus spp.	-	-	-	-	-	-
TOTAL GROUP 'C' (BROAD LEAVED SPP.)	68.430	7.481	-	-	-	-
Bischofia javanica	-	-	-	-	-	-
Garuga pinnata	-	-	-	-	-	-
Lagerstroemia parviflora	-	-	-	-	-	-
Populus spp.	-	-	-	0.098	-	-
Prunus spp.	-	-	-	-	-	4.671
Pterospermum acerifolium	-	-	-	-	-	-
Quercus spp.	53.858	5.919	20.755	2.355	-	-
Sterculia villosa	-	0.195	-	-	-	-
Syzigium spp.	-	-	-	-	-	-
TOTAL GROUP 'D' (BROAD LEAVED) SPP.	53.858	6.114	20.755	2.453	-	4.671

Contents

Contd.

Type / Species	Mixed conifers		Conifers mixed with Broad leaved		Hardwoods	
	Vm/Vm_1	I	Vm/Vm_1	I	Vm/Vm_1	I
1	8	9	10	11	12	13
Acrocarpus fraxinifolius	-	-	-	-	50.812	2.171
Albizzia spp.	-	-	-	-	53.852	9.989
Alnus spp.	-	1.871	-	-	841.226	63.841
Bucklandia populnea	-	-	-	-	399.115	25.189
Castanopsis spp.	-	-	409.429	16.510	869.455	76.001
Machilus spp.	-	1.131	-	-	3833.071	268.393
TOTAL GROUP 'C' (BROAD LEAVED)SPP.	-	3.002	409.429	16.510	6047.531	445.584
Bischofia javanica	-	-	-	-	44.731	1.737
Garuga pinnata	-	-	-	-	88.596	2.606
Lagerstroemia parviflora	-	-	-	-	-	1.737
Populus spp.	-	0.261	-	-	93.373	2.171
Prunus spp.	-	0.696	-	-	33.441	0.869
Pterospermum acerifolium	-	-	-	-	30.834	1.303
Quercus spp.	27.890	2.350	999.764	13.591	20178.122	569.792
Sterculia villosa	-	-	-	-	107.705	3.040
Syzigium spp.	-	-	-	-	22.148	2.606
TOTAL GROUP 'D' (BROAD LEAVED)SPP.	27.890	3.307	999.764	13.591	20598.950	585.861

Contents

Contd.

Type Species	Chir		Kail		Fir & Spruce	
	Vm/Vm_1	I	Vm/Vm_1	I	Vm/Vm_1	I
1	2	3	4	5	6	7
Aesculus punduana	-	-	-	-	-	-
Amoora rohituka	-	-	-	-	-	-
Cinnamomum tamala	-	-	-	-	-	-
Engelhardtia spicata	-	-	-	-	-	-
Ficus spp.	-	0.650	-	-	-	-
Kydia calycina	-	-	-	-	-	-
Macaranga spp.	-	0.325	-	-	-	-
Ostodes paniculata	-	-	-	-	-	-
Rhododendron spp.	8.716	4.879	-	0.589	7.494	111.043
Symplocos spicata	-	-	-	-	-	-
Vitex heterophylla	-	-	-	-	-	-
Miscellaneous spp.	-	6.505	-	2.028	124.279	61.507
TOTAL GROUP 'E' (BROAD LEAVED)SPP.	8.716	12.359	-	2.617	131.773	172.550
Total Broad leaved spp.	176.081	28.556	20.755	6.869	349.675	254.105

Contents

Contd.

Type / Species	Mixed Conifers		Conifers mixed with Broad leaved		Hardwoods	
	Vm/Vm_1	I	Vm/Vm_1	I	Vm/Vm_1	I
1	8	9	10	11	12	13
Aesculus punduana	11.182	0.565	94.429	4.530	320.942	23.018
Amoora rohituka	-	-	-	-	116.824	6.080
Cinnamomum tamala	-	1.262	-	-	85.121	10.857
Engelhardtia spicata	-	-	-	-	664.468	30.835
Ficus spp.	-	-	-	-	416.921	33.441
Kydia calycina	-	-	-	-	42.126	4.343
Macaranga spp.	-	-	-	-	109.876	19.977
Ostodes paniculata	-	-	-	-	50.378	10.423
Rhododendron spp.	37.984	31.806	190.369	175.570	580.651	132.459
Symplocos spicata	-	1.436	-	-	252.758	33.006
Vitex heterophylla	-	-	-	-	53.852	2.606
Miscellaneous spp.	59.305	23.278	800.737	216.443	11113.992	909.410
TOTAL GROUP 'E' (BROAD LEAVED)SPP.	108.471	58.347	1085.535	396.543	13807.909	1216.455
Total Broad leaved spp.	282.511	101.552	3233.955	627.684	51488.039	2586.649

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10.4.1 ANNUAL CUT

The annual cut for different species in different forest types have been calculated on the basis of the formulae given in para 10.2.2. Reduction on account of cull has also been done from the total gross annual cut. For doing so, the weighted cull percentages, for coniferous species (above 60 cm dbh) and broad leaved species (above 50 cm dbh) were also computed.

10.4.2 The species-wise annual cut, under different forest types and total under all types, is given in the following table:-It may be stated that the annual cut has been calculated on the presumption that the total growing stock above exploitable size will be removed within 30 years. The annual cut after expiry of 30 years may, therefore, go down considerably. The total available volume for industrial purposes has been calculated separately vide para 13.3.1 and 13.3.2 of the report wherein it has been stated that total potential cut may not be explited due to lack of infrastructure.

Contents

Table

ANNUAL CUT BY SPECIES AND FOREST TYPES

GROSS ANNUAL CUT AND CULL % FOR FOREST TYPES

'000' m^3

SPECIES	CHIR		KAIL		FIR/SPRUCE		MIXED CONIFERS	
	Gross annual cut	Weight-ed cull %	Gross annual cut	Weight-ed cull %	Gross annual cut	Weight-ed cull %	Gross annual cut	Weight-ed cull %
1	2	3	4	5	6	7	8	9
Abies densa	-	-	-	-	958.324	43.532	46.428	43.951
Cupressus spp.	-	-	-	-	0.730	10.560	1.349	-
Juniperus spp.	-	-	-	-	4.931	37.000	7.804	36.999
Larix griffithii	-	-	0.049	-	-	-	0.993	1.155
Picea spinulosa	-	-	4.632	14.100	34.205	21.588	44.770	20.748
Pinus roxburghii	39.260	1.971	-	-	-	-	-	-
Pinus wallichiana	-	-	9.445	4.235	-	-	10.470	4.153
Taxus baccata	-	-	-	-	-	-	5.314	12.071
Tsuga brunoniana	-	-	1.574	7.200	41.008	6.956	246.209	6.187
Total conifers	39.260	-	15.700	-	1039.198	-	363.337	-
Betula spp.	-	-	0.654	-	53.167	9.747	22.008	8.957
Juglans regia	-	-	-	-	-	-	-	-
Michelia spp.	0.540	1.040	-	-	-	-	-	-
Morus laevigata	-	-	-	-	-	-	-	-

(See next page for Col.10 to 15 of this table)

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SPECIES	CONIFERS MIXED WITH BROAD LEAVED		HARDWOODS		TOTAL GROSS ANNUAL CUT	NET ANNUAL CUT (GROSS CUT MINUS CULL)
	Gross annual cut	Weighted cull %	Gross annual cut	Weighted cull %		
1	10	11	12	13	14	15
Abies densa	112.631	46.390	33.991	45.988	1151.374	645.910
Cupressus spp.	-	-	-	-	2.079	2.002
Juniperus spp.	4.141	37.000	0.434	-	17.310	11.066
Larix griffithii	-	-	-	-	1.042	1.031
Picea spinulosa	-	-	2.316	14.100	85.923	68.270
Pinus roxburghii	-	-	5.255	2.519	44.515	43.609
Pinus wallichiana	8.010	2.600	1.071	5.600	28.996	27.893
Taxus baccata	15.013	9.634	8.005	12.922	28.332	25.210
Tsuga brunoniana	230.949	6.855	33.397	6.649	553.137	516.886
Total conifers	370.744	-	84.469	-	1912.708	1341.877
Betula spp.	121.903	12.513	72.715	13.074	270.447	238.533
Juglans regia	-	-	5.617	21.413	5.617	4.414
Michelia spp.	-	-	218.811	0.886	219.351	217.407
Morus laevigata	-	-	19.355	21.392	19.355	15.215

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Contd.

SPECIES	CHIR		KAIL		FIR/SPRUCE		MIXED CONIFERS	
	Gross annual cut	Weight-ed cull %	Gross annual cut	Weight-ed cull %	Gross annual cut	Weight-ed cull %	Gross annual cut	Weight-ed cull %
1	2	3	4	5	6	7	8	9
Phoebe goalparensis	-	-	-	-	-	-	-	-
Terminalia myriocarpa	-	-	-	-	-	-	-	-
TOTAL GROUP 'A' (BROAD LEAVED) SPP.	0.540	-	0.654	-	53.167	-	22.008	-
Acer spp.	-	-	1.145	-	30.980	6.550	19.759	6.792
Ailantus grandis	-	-	-	-	-	-	-	-
Altingia excelsa	-	-	-	-	-	-	-	-
Amoora wallichii	-	-	-	-	-	-	-	-
Cedrela spp.	-	-	-	-	-	-	-	-
Cinnamomum cecicodaphne	-	-	-	-	-	-	-	-
Duabanga sonneraticides	0.929	17.800	-	-	-	-	-	-
Phoebe hainesiana	-	-	-	-	-	-	-	-
Salmalia malabaricum	0.795	2.820	-	-	-	-	-	-
Schima wallichii	1.841	17.800	-	-	-	-	-	-

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Contd.

SPECIES	CONIFERS MIXED WITH BROAD LEAVED		HARDWOODS		TOTAL GROSS ANNUAL CUT	NET ANNUAL CUT (GROSS CUT MINUS CULL)
	Gross annual cut	Weighted cull %	Gross annual cut	Weighted cull %		
1	10	11	12	13	14	15
Phoebe goalparensis	-	-	42.401	3.000	42.401	41.129
Terminalia myriocarpa	-	-	7.137	0.458	7.137	7.104
TOTAL GROUP 'A' (BROAD LEAVED)SPP.	121.903	-	366.036	-	564.308	523.802
Acer spp.	103.778	6.550	120.053	9.681	275.715	253.924
Ailantus grandis	-	-	3.880	1.494	3.880	3.822
Altingia excelsa	-	-	32.731	22.142	32.731	25.484
Amoora wallichii	-	-	2.794	20.711	2.794	2.215
Cedrela spp.	-	-	20.340	22.215	20.340	15.821
Cinnamomum cecicodaphne	-	-	12.739	20.972	12.739	10.067
Duabanga sonneraticides	-	-	5.545	21.067	6.474	5.140
Phoebe hainesiana	-	-	57.283	20.496	57.283	45.542
Salmalia malabaricum	-	-	2.736	1.996	3.531	3.454
Schima wallichii	-	-	81.213	20.618	83.054	65.982

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Contd.

SPECIES	CHIR		KAIL		FIR/SPRUCE		MIXED CONIFERS	
	Gross annual cut	Weight-ed cull %	Gross annual cut	Weight-ed cull %	Gross annual cut	Weight-ed cull %	Gross annual cut	Weight-ed cull %
1	2	3	4	5	6	7	8	9
Tetrameles nudiflora	-	-	-	-	-	-	-	-
TOTAL GROUP 'B' (BROAD LEAVED)SPP.	3.565	-	1.145	-	30.980	-	19.759	-
Acrocarpus fraxinifolius	-	-	-	-	-	-	-	-
Albizzia spp.	1.269	17.800	-	-	-	-	-	-
Alnus spp.	-	-	-	-	-	-	1.871	-
Bucklandia populnea	-	-	-	-	-	-	-	-
Castanopsis spp.	8.493	5.213	-	-	-	-	-	-
Machilus spp.	-	-	-	-	-	-	1.131	-
TOTAL GROUP 'C' (BROAD LEAVED)SPP.	9.762	-	-	-	-	-	3.002	-
Bischofia javanica	-	-	-	-	-	-	-	-
Garuga pinnata	-	-	-	-	-	-	-	-
rstroemia iflora	-	-	-	-	-	-	-	-

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Contd.

SPECIES	CONIFERS MIXED WITH BROAD LEAVED		HARDWOODS		TOTAL GROSS ANNUAL CUT	NET ANNUAL CUT (GROSS CUT MINUS CULL)
	Gross annual cut	Weighted cull %	Gross annual cut	Weighted cull %		
1	10	11	12	13	14	15
Tetrameles nudiflora	-	-	1.187	4.539	1.187	1.133
TOTAL GROUP 'B' (BROAD LEAVED)SPP.	103.778	-	340.501	-	499.728	432.584
Acrocarpus fraxinifolius	-	-	3.865	22.699	3.865	2.988
Albizzia spp.	-	-	11.784	20.001	13.053	10.470
Alnus spp.	-	-	91.882	20.294	93.753	75.106
Bucklandia populnea	-	-	38.493	21.477	38.493	30.226
Castanopsis spp.	30.158	5.796	104.983	5.706	143.634	135.453
Machilus spp.	-	-	396.162	8.211	397.293	364.764
TOTAL GROUP 'C' (BROAD LEAVED)SPP.	30.158	-	647.169	-	690.091	619.007
Bischofia javanica	-	-	3.228	21.292	3.228	2.541
Garuga pinnata	-	-	5.559	21.774	5.559	4.349
Lagerstroemia parviflora	-	-	1.737	-	1.737	1.737

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Contd.

SPECIES	CHIR		KAIL		FIR/SPRUCE		MIXED CONIFERS	
	Gross annual cut	Weight-ed cull %	Gross annual cut	Weight-ed cull %	Gross annual cut	Weight-ed cull %	Gross annual cut	Weight-ed cull %
1	2	3	4	5	6	7	8	9
Populus spp.	-	-	0.098	-	-	-	0.261	-
Prunus spp.	-	-	-	-	4.671	-	0.696	-
Pterospermum acerifolium	-	-	-	-	-	-	-	-
Quercus spp.	7.714	11.196	3.047	11.096	-	-	3.280	13.062
Sterculia villosa	0.195	-	-	-	-	-	-	-
Syzigium spp.	-	-	-	-	-	-	-	-
TOTAL GROUP 'D' (BROAD LEAVED)SPP.	7.909	-	3.145	-	4.671	-	4.237	-
Aesculus punduana	-	-	-	-	-	-	0.938	17.800
Amoora rohituka	-	-	-	-	-	-	-	-
Cinnamomum tamala	-	-	-	-	-	-	1.262	-
Engelhardtia spicata	-	-	-	-	-	-	-	-
Ficus spp.	0.650	-	-	-	-	-	-	-
Kydia calycina	-	-	-	-	-	-	-	-
Mangifera spp.	0.325	-	-	-	-	-	-	-
Dysoxylum paniculata	-	-	-	-	-	-	-	-

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Contd.

SPECIES	CONIFERS MIXED WITH BROAD LEAVED		HARDWOODS		TOTAL GROSS ANNUAL CUT	NET ANNUAL CUT (GROSS CUT MINUS CULL)
	Gross annual cut	Weighted cull %	Gross annual cut	Weighted cull %		
1	10	11	12	13	14	15
Populus spp.	-	-	5.283	22.351	5.642	4.461
Prunus spp.	-	-	1.984	21.746	7.351	6.920
Pterospermum acerifolium	-	-	2.331	18.999	2.331	1.888
Quercus spp.	46.916	7.408	1242.396	6.557	1303.353	1216.783
Sterculia villosa	-	-	6.630	5.860	6.825	6.436
Syzigium spp.	-	-	3.344	20.589	3.344	2.656
TOTAL GROUP 'D' (BROAD LEAVED)SPP.	46.916	-	1272.492	-	1339.370	1247.771
Aesculus punduana	7.678	22.700	33.716	19.201	42.332	33.948
Amoora rohituka	-	-	9.974	2.000	9.974	9.775
Cinnamomum tamala	-	-	13.694	20.024	14.956	12.214
Engelhardtia spicata	-	-	52.984	2.585	52.984	51.614
Ficus spp.	-	-	47.338	21.039	47.988	38.029
Kydia calycina	-	-	5.747	19.266	5.747	4.640
Macaranga spp.	-	-	23.640	18.459	23.965	19.601
Ostodes paniculata	-	-	12.102	18.897	12.102	9.815

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Contd.

SPECIES	CHIR		KAIL		FIR/SPRUCE		MIXED CONIFERS	
	Gross annual cut	Weight-ed cull %	Gross annual cut	Weight-ed cull %	Gross annual cut	Weight-ed cull %	Gross annual cut	Weight-ed cull %
1	2	3	4	5	6	7	8	9
Rhododendron spp.	5.170	19.500	0.589	-	111.293	17.800	33.072	19.619
Symplocos spicata	-	-	-	-	-	-	1.436	-
Vitex heterophylla	-	-	-	-	-	-	-	-
Miscellaneous spp.	6.505	-	2.028	-	65.650	19.304	25.255	19.897
TOTAL GROUP 'E' (BROAD LEAVED)SPP.	12.650	-	2.617	-	176.943	-	61.963	-
Total Broad leaved spp.	34.426	-	7.561	-	265.761	-	110.969	-
Total Conifers and Broad leaved spp.	73,686	-	23.261	-	1304.959	-	474.306	-

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SPECIES	CONIFERS MIXED WITH BROAD LEAVED		HARDWOODS		TOTAL GROSS ANNUAL CUT	NET ANNUAL CUT (GROSS CUT MINUS CULL)
	Gross annual cut	Weighted cull %	Gross annual cut	Weighted cull %		
1	10	11	12	13	14	15
Rhododendron spp.	181.916	17.800	151.814	19.061	483.854	395.229
Symplocos spicata	-	-	41.431	2.474	42.867	41.842
Vitex heterophylla	-	-	4.401	20.593	4.401	3.495
Miscellaneous spp.	243.134	20.526	1279.876	20.402	1622.448	1293.724
TOTAL GROUP 'E' (BROAD LEAVED) SPP.	432.728	-	1676.717	-	2363.618	1913.926
Total Broad leaved spp.	735.483	-	4302.915	-	5457.115	4737.090
Total Conifers and Broad leaved spp.	1106.227	-	4387.384	-	7369.823	6078.967

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CHAPTER-XI

ACCESSIBILITY AND COST STUDIES

11.1.1 OBJECTIVES

Study of the existing infrastructure, logging methods, equipments, techniques and costs is important for finding out the possibilities of regular supplies of large quantities of wood at economic costs to main markets/industrial sites. These studies also determine the 'stumpage' or 'royalty' on trees. The main objectives of these studies were:

(i) to ascertain the present delivery costs of available wood from operable forests to main markets/industrial sites.

(ii) the possible improvement in logging and means of transport of wood to make it more economical.

11.1.2 'Case Studies' were undertaken to arrive at average cost of logging and transport at present price level. The actual cost of raw material delivered to the definite market/industrial sites will depend besides royalty, on location of delivery sites, the labour rates and productivity, markings, terrain conditions, logging methods and techniques used, off-road and on-road distances involved, assortment required by the market, the regional development of technology and local socio-economic factors.

11.2.1 EXISTING INFRASTRUCTURE

(a) Roads: Details of existing roads are given in paras 3.5.2 & 3.5.3. Average road density for Bhutan works out to 0.47 m/ha. Present long distance transport to market/industrial sites is by motor transport using the existing roads.

11.2.2 (b) Rivers: Rivers and streams in the survey area have been detailed in para 3.5.8. These are not being utilized for timber transport. For soft woods these can be utilized for timber transport by improving. Funds required for improvements in these rivers and streams have been estimated in para 3.5.9.

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11.3.1 LOGGING PRACTICES AND COSTS

Felling is generally carried out by axe and saw; de-limbing is done mostly by axe; cross cutting is normally done, at the stump, by felling crews themselves. 2 pairs, i.e. 4 persons, are employed for felling and cross-cutting. Hollow, crooked and malformed stems are not logged; generally, logs having less than 100 cm mid-girth and 3 metres length are not logged.

11.3.2 Where carriage involved is up-hill to the roads, hand sawing of logs is done *in situ*. Planks 3.6 m long, having a maximum width of 30 cm are sawn. The thickness in general varies from 4 cm to 12 cm and over, according to the requirement and 'what a man can carry' up hill.

11.3.3 For down-hill transport, generally logs are extracted. Logs are rolled down from the hill on a make shift path and often wooden pieces are used as rollers.

11.4.1 COSTS

The logging costs (1977) are:

1.	Felling including delimbing	Nu 9/m^3
2.	Cross cutting	Nu 9/m^3
3.	Rolling of logs including path making	Nu 60/m^3/km
4.	Loading into trucks	Nu 27/m^3
5.	Unloading from trucks	Nu 9/m^3
6.	Road transport (trucks)	Nu 1/m^3/km
7.	Hand sawing (average)*	Nu 75/m^3
8.	Over-heads	Nu 27/m^3

* Varies from Nu 50/- to 140/- according to size.

11.4.2 The above costs are based on only one case study available in the area. However the cost factors have been cross checked with similar data from outside survey area and can be taken as fairly representative for the survey area.

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11.4.3 It must be mentioned that logging on any appreciable scale has not yet been done in the area. Very few trees are felled, at a time, in a particular site. Few saw mills have allotments of trees for felling near the roads and within short distance from the mills. Thus the costs are not yet fully developed and have not yet reached an equilibrium. Therefore, it must be appreciated that the logging costs quoted above may not be very accurate for future planning.

11.5.1 TERRAIN CLASSIFICATION

Characteristics of soil (texture & stoniness), altitude, slopes and slope distances have an important bearing on the type of vehicles and attachments that would be required for transport of timber/wood. The data collected is given and analysed in the following paras.

11.5.2 (a) Soil Texture: Soil data for 1532 plots (out of 1961 forested plots) was recorded and was analysed for soil texture classification for the purposes of logging. It was found that 99% of the area has clayey loam to sandy soil and only 1% of the area has clayey soil. There was no plot falling in the 'pebbles' or 'without soil' class. In clayey soil it may be difficult to use rubber tyre vehicles, specially during the rainy season. The soil texture, may become a determining factor, in the use and choice of ground vehicles even when degree of slope and off road distance warrant it. The soil texture may warrant the use of belts or chains with rubber tyre vehicles or use of crawler type of machines may be necessary. The clayey loams and sandy soils do not pose any problem for normal vehicles.

11.5.3 (b) Stoniness: The data analysed show that about:

- 64% of the area has less than 30% of the surface covered with stones and boulders* and poses no problem for vehicles.

- 27% of the area has stones and boulders covering 30-60% of the surface; vehicles can be used with some difficulty.

- 9% of the area has stones and boulders covering 60% and more of the surface and makes the use of vehicle perhaps uneconomical.

* Stones and boulders have been defined as having diameters above 25 cm and weighing above 40 kg.

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11.5.4 (c) Altitude: Variation in energy out put at various elevations has to be kept in mind for calculating the efficiency of machines. Study and analysis of altitude data of 1961 sample points (total forested area) reveal that about:

- 21% of the area lies upto 1500 m above m.s.l. This does not involve appreciable efficiency loss of a reciprocating engine.
- 35% of the area lies between altitudes of 1500 to 2500 m. In this range the reciprocating engine loses upto 25% of its efficiency.
- 43.5% of the area falls between elevation of 2500 to 4000 m. Here the engine loses its efficiency appreciably.
- 0.5% of the area lies above 4000 m and has been defined as 'in-operable'.

11.5.5 (d) Slopes: Forest areas above 60° (173%) slope have been classes as 'in-operable'. Slopes and slope distances affect the construction of roads and determine the type of machine required. Use of special adoptations can enable the use of ropeways, skidders and cranes on slopes beyond the normal range for which these ropeways and cable cranes are designed. In Canada, skidders have been used for down-hill transport upto 31° slope (60%) under Saguecy System (Bjerkelund, 1971) whereas under Swiss conditions the skidder is not used beyond 14° slope (25%) (Wettstein, 1971).

11.5.6 Analysis of the data from 1961 sample points gives the following percentages for slopes and altitude distribution of the total forested area.

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Table

PERCENTAGE AREA DISTRIBUTION IN SLOPES AND ALTITUDINAL CLASSES (FROM SAMPLE POINT DATA)

m above m.s.l.

Slope	Altitudes				Total
	upto 1500	1500 to 2500	2500 to 4000	Above 4000	
0° - 20° (below 36.4%)	1.73	3.41	7.50	0.21	12.85
20° - 30° (36.5 to 57.7%)	4.44	8.26	13.77	0.15	26.62
30° - 60° (57.8 to 173.2%)	12.49	19.54	20.24	0.15	52.42
Above 60° (above 173.2%)	2.45	3.62	2.04	-	8.11
Total	21.11	34.83	43.55	0.51	100

From the above table it can be seen that:-

- in 8.11% of the area on account of slope, and in 0.51% of the area on account of altitude, no operations are possible.
- in 52.27% (52.42 - 0.15) of the area cable cranes can be normally used. In this area upto 45° slope gravity ropeways can also be used.
- in 26.47% (26.62 - 0.15) area gravity ropeways can be used.
- in 12.64% (12.85 - 0.21) of the area ground machines can be used.

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11.5.7 (d) Slope Lengths: For analysis and study of slope lengths, the information was gathered from topo map sheets by recording the area, the average slope and average slope length of the hill face having the cluster centre. This information for slope area of 898.2328 km^2 was analysed and the proportions arrived at were applied to the 'operable forest area'. The distribution, thus arrived at of 'operable forest area' into slope, and slope length classes is given in the following table:-

Table

DISTRIBUTION OF 'OPERABLE FOREST AREA' INTO SLOPE AND SLOPE LENGTH CLASSES (FROM MAP SHEETS)

Km^2

Slope classes		Slope length (m)					Total
		Upto 300	301 to 500	501 to 1000	1001 to 2000	Above 2000	
0°-20° (below 36.4%)	Area	4.17	13.64	158.78	601.74	471.58	1249.91
	%	0.1	0.2	2.1	7.9	6.2	16.5
20°-30° (36.5 to 57.7%)	Area	30.14	49.50	583.11	1872.79	761.16	3296.70
	%	0.4	0.7	7.7	24.7	10.0	43.5
30°-45° (57.8 to 100%)	Area	8.74	61.66	731.48	1755.68	393.20	2950.76
	%	0.1	0.8	9.7	23.2	5.2	39.0
45°-60° (100.1 to 173.2%)	Area	-	-	41.94	32.66	-	74.60
	%	-	-	0.6	0.4	-	1.0
Total	Area	43.05	124.80	1515.31	4262.87	1625.94	7571.97
	%	0.6	1.7	20.1	56.3	21.4	100.0

It may be seen from this table that of 'operable forest area'

- 43.5% falls in 20°-30° slope class followed by 39% in 30°-45° slope class. Gravity ropeways can be used in 30°-45° slopes also.
- 56.3% has slope lengths 1001-2000 m followed by above 2000 m (21.4%) and 501-1000 m (20.1%) lengths.

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11.6.1 OFF ROAD TRANSPORT DISTANCE

It is the distance from the working site to the main landing from where the material is transported by major or long-distance transport methods, which can be trucks, river floating or rail transport, etc. In the present case two possible modes of major transport i.e. road and river are considered. Therefore, distance to nearest motorable road and to nearest perennial stream (except in case of hard wood forests) has been studied.

11.6.2 (a) Distance to the nearest road: Distance to the nearest existing road was measured in a straight line from the map sheet and classified into 7 classes. This was further classified into three slope classes. The percentage of the 'operable forest' area thus arrived at, in different off road distance and slope classes, are given in the following table:-

Table

PERCENTAGE OF OPERABLE AREA CLASSIFIED INTO OFF ROAD TRANSPORT DISTANCES AND SLOPE CLASSES

Slope Class	0°-20°	20°-30°	30°-60°	Total
Distance off road (km)	(% operable area)			
1	1.39	2.00	3.55	6.94
1-3	2.00	3.77	5.50	11.27
3-5	1.17	31.11	6.22	10.50
5-7	1.44	2.89	4.83	9.16
7-10	2.05	4.39	5.94	12.38
10-15	2.50	5.10	10.33	17.93
15	3.44	7.72	20.66	31.82
Total	13.99	28.98	57.03	100.00

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- The average weighted off road transport distance works out to about 11 Km (taking average distance of last class as 20 Km). Allowing a winding factor of 1.5 to 2.0 (average 1.75) the actual off road transport works out to 19.25 Km or say 20 Km.

- The road net work is very poorly developed; only 6.94% of the area has less than 1 Km off road transport whereas 31.82% of the area has more than 15 Km off road transport distance.

- Maximum area - 20.66% - falls in the slope between 30° -60° having off road distance more than 15 Km followed by off road transport class of 10 to 15 Km - 10.33% in the same slope class.

11.6.3 (b) Distance to the nearest perennial river or stream: The horizontal distances to the nearest perennial river or stream were measured in a straight line for 733 sample plots, in soft wood forests (41.4% of tree forest area). From the analysis of data it was found that :

- 73% of soft wood forests are within 1 Km from stream/river.

- 25% of soft wood forests are within 1-3 Km from stream/river.

- 2% of soft wood forests are within 3-5 Km from stream/river.

Note: 58.6% hardwoods were not considered for the study.

11.6.4 It may be seen that the soft wood forests are within economic reach of rivers and streams and suitable for water transport or 'chutes' using water can be utilized for their transport. The average weighted off road transport for soft wood forests comes to 1 Km. An average winding factor of 2.25 has been presumed as the stream banks are generally vertical or steep. The average distance to the nearest river or stream, therefore, works out to 2.25 Km or say 2.5 Km.

11.6.5 It was also seen, from the study of slopes, that most of the area, with a distance of less than 1 Km from the river, lies in 30°-60° slope and carriage to river bank will not pose any problem. The streams were not studied by the Project from the point of view of floating and would need to be surveyed before taking a decision for floating of timber. By and large, all the streams can be used for floating, as demonstrated by the Project in Ha Chu.

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11.7.1 ROAD DISTANCES

There are two types of roads (i) "kacha" and (ii) "pacca". "Kacha" roads are un-metalled roads and "pacca" roads are metalled and may or may not be black topped. The total distance for road transport ("kacha" and "pacca") to the main market/industrial site has been found for each cluster and weighted average worked out to 197.8 Km or say 200 Km. Out of this about 70 Km is on "kacha" road and about 130 Km on "pacca" road. It has been seen that 16.6% of the area is between 45-75 Km from the main markets/industrial sites and 23.9% is 305 to 405 Km from the market.

11.8.1 PRESENT LANDED COSTS

Based on the logging costs and existing average 'off road' and 'on road' distances, described in the foregoing paras, the present (1977) landed cost of timber in log form, to the main markets/industrial sites would, excluding royalty, works out as under:

			Cost/m^3
1.	Felling	Nu	9.00
2.	Cross cutting	Nu	9.00
3.	'off road' transport - log rolling - 20 Km x Nu 60/Km	Nu	1200.00
4.	Loading into trucks	Nu	27.00
5.	'On road' transport 200 Km x Nu 1/Km	Nu	200.00
6.	Unloading	Nu	9.00
7.	Overheads	Nu	27.00
	Total	Nu	1481.00

Note: 1. Average sawing costs are Nu 75/m^3 have not been considered, as very little sawing is done *in situ* at present.

2. Though rivers and streams can be used for floating of coniferous timber as demonstrated by the Project, yet these are not being utilized for the purpose.

11.8.2 The costs are prohibitive and no market or industry can afford it. Thus, either more roads are to be constructed or only forests along roads and near market can be worked. And this is what is being done or is possible, at present.

11.9.1 IMPROVEMENT IN LOGGING TECHNIQUES

The existing logging practices have been described in paras 11.3.1 to 11.3.3. These logging operations can be split as follows:

A. Stump Operations: Manual saw, axe or power chain or combinations thereof can be used for felling, limbing, topping and cross cutting. There can be three alternatives:

Alternative	Felling	Limbing	Cross cutting
I	Saw	Axe	Saw
II	Axe	Axe	Saw
III	Power Chain Saw	Power Chain Saw	Power Chain Saw

B. Conversion:

I No conversion of logs

II Logs can be converted into scantlings or other sizes *in situ* by pit sawing or frame saws.

III Logs collected at the main landing and sawn by portable saw mills before long distance transport.

C. Off-road Transport: Considering classification and characteristics of terrain, this can be by

I tractors
II gravity ropeways
III cable cranes

D. On-road Transport: For the present all 'on-road' transport will be by motor trucks. River floating is viable alternative for conifers.

E. Loading & Unloading. It can be either crane of self loading trucks or by self propelled loaders or manually.

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11.9.2 The local techno-economic and social considerations will determine the technology for each operation or sub-operation. This involves decisions, having far reaching consequences and repercussions on the local socio-economic set-up, and should be made at the highest level, keeping in view the Government policy, the intensity of operations and the time factor when the decisions are being made.

11.10.1 DEVELOPMENT OF TIMBER TRANSPORT

For reducing the landed costs and to make extraction possible from forest areas away from the present road net work, (i) a net work of roads has to be developed (ii) improved and modern 'off-road' transports and techniques have to be used and (iii) water transport through rivers and streams have to be developed/improved and utilized for softwoods.

11.10.2 (i) Development of road net work

Para 3.5.2 gives the present (1978) details of existing roads in Bhutan which gives an average road density of 0.47 m/ha. Details of roads in the survey area are given in para 3.5.3. In para 3.5.4 it has been suggested that for the time being a road density of 2 m/ha may be aimed at. This would involve construction of 1350 Km of road as a component of national roads and feeder roads. In Phase I Report it has been pleaded that construction and maintenance of roads to open inaccessible areas and hinter lands cannot and should not be amortised only on the wood expected to be extracted but should be considered as general development expenditure. Additional forest roads made solely for the transport of timber may be debited to the Forest Department Budget. The development of road net work to achieve a road density of 2 m/ha will open up vast areas of forest and reduce cost on the 'off-road' transport of wood.

11.10.3 (ii) 'Off-road Transport'

(a) Trucks - Even when a road density of 2 m/ha has been achieved for the country, as suggested, 'forest roads' for transport of timber within the forest areas shall have to be constructed. The road transport by trucks, with a winding factor of 3, within the forest areas should not be more than 2 Km. This gives a road density of 3.75 m/ha in the forest areas (Samset, 1967). To realise the available yield from 7571.97 km^2 of operable area about 1325 km of forest roads would be needed.

(b) Tractor Transport - About 1250 km^2 (para 11.5.7) of operable area have less than 36% slope and are fit for tractor transport. Average tractor skidding distance should not be more than 0.5 km. In these areas fair weather roads, class II or III types truckable roads have to be constructed to keep the tractor skidding distances within 0.5 km. The traffic on these types of roads will be mostly uni-directional and the steeper gradients are acceptable.

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Therefore the winding factor will be 2.00 to 3.00 or 2.5. Since the areas have gentler slope a winding factor of 2 will suffice. The road density of 10 m/ha is required for tractor transport. Consequently about 6.25 m/ha of roads, have to be made in the area of operation or about 780 km of tractor roads would be required in operable area.

(c) Gravity Ropeways - About 3300 km^2 of operable area has slopes between 36 to 57% where gravity ropeways can be used. The utility of gravity ropeways have been demonstrated by the Project and these are being extensively used by the Department and forest lessees, saving on labour and costs of "off-road transport." The local people are also picking up the technique of working these gravity ropeways.

(d) Cable Cranes - Cable crane can be used for areas having slope from 57% to 173%. Slopes above 173% are being treated as in-accessible. Medium distance cable cranes, with transport distances upto 1000 metres are considered useful. About 2200 km^2 of the operable forest areas having slope lengths more than 1000 metres are suitable for cable crane transport. The Forest Department with help from UND Project is experimenting with different cable cranes and getting the staff trained in the use of these cable cranes.

11.10.4. (iii) Water Transport

Floating trials were conducted by the Project from Onakha to Chukha in Ha Chu and partly in Wang Chu. Ha Chu was selected for the trial because it was considered as an impossible streams for floating of timber. Expert floating technicians, along with imported labour expert in floating and local labour demonstrated it successfully that even in Ha Chu floating of timber is possible. In other streams like Paro, Wang Chu, Sankosh, Manas and its tributaries, the floating will be much easier. The Chukha Project authorities have been requested to allow passage of timber over or through the Chukha Dam so that timber can be floated in Wang Chu, downstream of Chukha. For transport of soft wood on large scale, use of water ways and techniques using water as means of transport would be the cheapest method for bringing the converted or semi-converted timber to the market or industrial sites. Side streams and the main rivers would need improvement works for making the floating easier.

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CHAPTER-XII

DEMAND AND MARKET STUDIES

12.1.1 OBJECTIVES

The study was carried out:

(i) to quantify the present (1978) level of wood removals and pattern of wood consumption by various users.

(ii) to forecast the level and trends of wood consumption in the year 1983 and 1988 for the survey area.

(iii) to assess the potential demand for industrial wood in the markets outside survey area (both in lower reaches of Bhutan and timber distribution centres in Assam bordering Bhutan).

12.2.1 METHODS

The details of methodology and procedure adopted for the study are given in Chapter V - Volume II of the report.

12.3.1 WOOD PRODUCTION

Due to lack of infrastructure, remote location and absence of wood based industries, large scale commercial exploitation of wood and other forest produce has so far not been made in the survey area. The present production mostly caters to the timber and firewood needs of the local population and developmental requirements of the Government departments. Wood production figures were available mostly in the form of number of trees without species break-up. On the basis of average outturn in the worked areas of survey area, a volume factor of 3 m^3/tree has been adopted for deriving the volume figures. Considering the proportion of population distribution in different vegetation zones and location of worked areas, the contribution of coniferous and broad leaved species to the total timber production is assumed to be 30% and 70% respectively.

12.3.2 Large quantities of fuelwood are removed for meeting the domestic requirements of the local population. But only negligible quantity has appeared on records. The proportion of coniferous and broad leaved species is assumed to be 20% and 80% respectively for firewood.

12.3.3 Total Production:- Average annual quantity of wood harvested is 59,128 m^3. The agency-wise details are given in the following table:

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Table

AVERAGE ANNUAL PRODUCTION OF WOOD & BAMBOO IN SURVEY AREA

(Average of 1974-75 to 1977-78)

m^3 (WRE)

Agency	Broadleaved (70%)	Conifers (30%)	Total
A. TIMBER			
1. Forest lessees/ Contractors.	15542	6661	22203
2. Concessionists (recorded)	17355	7438	24793
3. Govt. Departments (direct from Forest Deptt.)	2737	1173	3910
4. Special permits	2514	1078	3592
5. Free grant	131	56	187
6. Miscellaneous removals	109	46	155
TOTAL	38388	16452	54840
B. FUELWOOD (recorded)	3430 (80%)	858 (20%)	4288
TOTAL (A+B)	41818	17310	59128
C. BAMBOOS			34846 Nos

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12.3.4 Minor Forest Produce:- Apart from timber, fuelwood and bamboos; certain minor forest produces are annually removed from the area. Excepting bamboos, other minor forest produces are sold in the form of 'Mahals' on annual or biannual lease. The details are given in the following table:-

Table

AVERAGE ANNUAL PRODUCTION OF MINOR FOREST PRODUCE IN SURVEY AREA (AVERAGE OF 1974-75 to 1977-78)

Sl.No.	Produce	Quantity (tonnes)
1.	Cane	330.3
2.	Agar wood	2.4
3.	Resin	18.0
4.	Daphne bark	2.9
5.	Dal chini	33.2
6.	Katha	5.0
7.	Timur	0.1
8.	Pipla	16.5
9.	Kulki	1.5
10.	Mugita	0.5
11.	Lac	0.6
12.	Bee wax	1.7
13.	Stones & Boulders	5697.0
14.	Sand, Chips & Gravels	111.0
15.	Broom	336.5
16.	Thatch	59.5

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12.4.1 WOOD CONSUMPTION

In the absence of any large scale organised timber harvesting agency in the area, most local consumers extract the timber allotted/sold to them directly from forests. The following categories of wood consumers are recognised.

12.4.2 Local Population:

(a) House building and repairs:- Survey area has wide range of altitudes ranging from 240 m to 5123 m above m.s.l. Winter is severe in most portions and certain localities experience occasional snow falls. The pattern of house building in Bykar, Tongsa and Shemgong districts is similar to areas of Western Bhutan. In Mongar, Tashigang and Schumar districts, the houses are comparatively of smaller size. In Chirang district, the house pattern is distinctly different from other areas.

Depending upon the location of the village to the type of forest, the species preferences for house building and repairs differ from one region to the other. Blue pine and Chir pine are most commonly used species for construction purpose in coniferous region whereas in broad leaved zone, Champ, Bonsom, Chilaune, Jhikri etc., are preferred. Spruce and Castanopsis are preferred for roof shingles. As in Western Bhutan, there is large conversion wastage due to the practice of rough dressing of timber by axe that is in vogue in most parts.

To assess the quantity of timber used for construction of houses in various localities of survey area, a sample survey was conducted covering 154 samples representing all patterns and sizes of houses. The details of method adopted for the study can be seen in Chapter V - Volume II of report. The study revealed that on an average, 35.3 m^3 of timber is used for construction of a house. In the lower reaches, bamboos are used in increased proportion for building houses. On an average 625 bamboos are used per house. In Bykar district the average consumption is 65 m^3/house while the consumption in Chirang district is the lowest with 15 m^3/house. 55% of the houses are single storeyed and the double storeyed houses form 41%. Only 4% of the houses fall under more than two storeyed category.

It is assumed that the average life of a house is about 50-60 years. Enquiries revealed that roof repairs take place on a 5 year cycle. Major repairs like replacement of rafters, planks etc. are generally undertaken at 10 years interval.

In the absence of statistics regarding annual house construction activity, the requirement of timber for house construction and repairs is derived from the average quantity of timber sanctioned to villagers in the ranges covered by survey area. - Study of last 4 years' records of the Range Offices of the survey area shows that on an average, 1936 persons are allotted trees for house building and repairs annually. Number of big sized trees and poles allotted annually to concessionists are 7660 and 2460 respectively. The average number of trees and poles allotted to each concessionist works out to 5. The total quantity of timber annually consumed for house construction and repairs is 24,793 m^3(WRE).

(b) Agricultural Implements:- The most commonly used species for agricultural implements are Pyrus, Chilaune and Oaks. The number of agricultural households in the survey area was estimated to be 65088 in the year 1978. The annual consumption of wood for agricultural implements worked out on this basis comes to 8590 m^3 (WRE). Study conducted over 183 house-holds in survey area revealed that on an average, each agricultural house-hold requires 0.132 m^3 of wood for agricultural implements.

(c) Fuelwood:- Wood is the most commonly used domestic fuel in the survey area. The practice of making charcoal is not prevalent in the area. Electricity is available only in two small towns and is used only for lighting. Winter consumption of fuelwood in the upper parts of the survey area is considerably high for heating the houses.

A detailed study covering 183 representative households was carried out to determine the daily per capita fuelwood consumption. The study was conducted both during winter and summer months covering more or less equal number of samples in each season. Taking into consideration the increased winter consumption, the average per capita consumption of fuelwood is 7.3 kg/day. The annual per capita consumption works out to 2.66 tonnes or 3.19 m^3. Oaks and Castanopsis are the most preferred species for fuelwood. Survey results indicate that Castanopsis spp., Oaks, Mixed Broad leaved spp., and Conifers are used by 8.2, 25.1, 46.5 and 20.2 percent/household respectively. About 64% of the households have given preference for Castanopsis spp. and Oaks. Only 12% (mostly living in coniferous zone)households have given preference for coniferous fuelwood. With the exception of Bykar district, the population of most parts of the survey area use broad leaved species. The present annual consumption based on the estimated population of 4,33,925 is 11,54,240 tonnes (13,85,088 m^3).

The recorded production of fuelwood in survey area is a small fraction of the consumption calculated on the basis of population. This enormous difference is due to the fact that removals made by rural population have not come on official records.

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12.4.3 Saw Mills and Wood Working Industries:- There is only one saw mill (Blue Point Saw Mill at Korilla) in the survey area. This unit annually consumes 1500 m^3 timber from survey area. The mill mostly caters to the timber requirements of Government Departments in the Eastern Bhutan. There is no wood working unit in the survey area.

12.4.4 Free Grantees:- Flood and fire victims get timber free of royalty. Such instances are not many in the area. The total annual consumption of timber is 187 m^3.

12.4.5 Government Departments:- Government Departments consume 6536 m^3 of wood annually. They obtain their requirements through forest department and also from saw mills/forest lessees.

12.4.6 Total Consumption:- The estimated annual consumption of timber and fuelwood at present is 41,606 m^3 and 13,85,088 m^3 respectively.

The proportion of coniferous and broad leaved species in the timber consumed under various consumption categories except agricultural implements is assumed to be 30% and 70% respectively. In case of agricultural implements the entire requirement is placed under broad leaved species on the basis of findings of sample survey. Fuel wood consumption of conifers and broad leaved species is in the proportion of 20% and 80% respectively (based on sample survey findings). The details are given in the following table:

Table

AVERAGE ANNUAL CONSUMPTION OF TIMBER AND FUELWOOD

m^3 (WRE)

S.No.	Consumption Category	Conifers	Broad-leaved	Total
	A. TIMBER			
1.	House Construction and repairs (Concessionists)	7,438	17,355	24,793
2.	Agricultural implements	-	8,590	8,590
3.	Saw Mill Industry	450	1,050	1,500
4.	Government Departments	1,961	4,575	6,536
5.	Free Grants	56	131	187
	Total Timber (1 to 5)	9,905	31,701	41,606
	B. FUELWOOD	277,018	1,108,070	1,385,088
	TOTAL (A + B)	286,923	1,139,771	1,426,694

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12.5.1 FORECAST OF FUTURE DEMAND

Important factors that help in forecasting the demand at a future date are population growth, increase in per capita disposable income, relative prices of timber and its substitutes, change in technology and consumer preferences. In the absence of time series data and cross sectional data for most of these variables, accurate forecast of future demand is difficult. At present, there is no industrial activity in the survey area. In view of land locked condition of area, sparse distribution of population and low per capita income, technological innovations and consumer preferences would have no effect on demand projections for near future. Since the future demand of wood for house construction, agricultural implements, fuelwood, etc., are mostly dependent on increase in population, number of houses, number of house holds, number of cultivators etc., projections for future are made considering these factors only.

Projections for a short period of 10 years are considered sufficient in the absence of sufficient data. Demand projection has been made for the year 1983 and 1988.

12.5.2 Population Estimates:- As per the statistics published by the Royal Government of Bhutan (1977 - Central Statistical Organisation), the total population of Bhutan in 1977 was 1.10 millions with an annual rate of growth of 2.1 percent. Based on the average density of population of 27.5 persons per Km^2 with due weightage for higher density of population in Eastern region (Tashigang and Mongar districts), the estimated present and projected population of the survey area is as under:-

Year	Population
1978	4,33,925
1983	4,81,440
1988	5,34,160

12.5.3 Wood for House Construction and Repairs:- Assuming that the number of persons per house hold (six) remains the same, the number of houses required for population will be:-

Year	No. of houses required	Number required during Five Year period.
1978	72,320	-
1983	80,240	7,920
1988	89,027	8,787

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Assuming that:-

(i) During the period 1983 and 1988, the average annual number of houses to be constructed would be 792 and 878 respectively (only 50% of the annual increase in the number of house holds are expected to construct houses);

(ii) the level of consumption of timber of 35.3 m^3 per house for construction would remain same as at present; and

(iii) only 10% of the timber required annually for house construction is needed for house repairs, the projected demand will be as under:

m^3 (WRE)

Year	New Construction		Repairs		Total
	Conifers	Broad-leaved	Conifers	Broad-leaved	
1983	8387	19570	839	1957	30,753
1988	9298	21695	930	2169	34,092

12.5.4 Wood for Agricultural Implements:- Over 90% of the population comprises of agriculturists. During next 10 years there may not be much change in this pattern. Based on the estimated agricultural house holds in the year 1983 and 1988 and assuming that 90% of the people continue to practice agriculture, the demand for wood for agricultural implements at 0.132 m^3/house hold would be:

m^3 (WRE)

Year	No. of agricultural house holds	Wood requirement (Broadleaved spp.)
1983	72,216	9,530
1988	80,124	10,575

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12.5.5 Fuelwood:- Assuming that the population will be the only factor affecting the consumption of fuelwood and alternate domestic fuel will not be used and the per capita consumption pattern remain same, the future demand for fuelwood has been worked out and given as under:

			m^3 (WRE)
Year	Conifers	Broadleaved	Total
1983	307,351	1,229,404	1,536,755 (12,80,630 tonnes)
1988	341,009	1,364,035	1,705,044 (14,20,870 tonnes)

12.5.6 Saw Milling Industry:- Saw milling industry is in the initial stages of development. With the progressively increased development projects undertaken by the Government through Five Year Plans, the industry is likely to grow at a fast rate to cater to the constructional timber requirement of survey area and adjacent areas. Keeping in view the outlays during the last 4 Five Year Plans, timber requirement of saw milling industry is expected to grow at the rate of 5% per annum. Accordingly the future demand from this sector would be as follows:

			m^3 (WRE)
Year	Conifers	Broadleaved	Total
1983	575	1,340	1,915
1988	733	1,712	2,445

12.5.7 Free Grants:- The present level of consumption is negligible and does not provide any indication of future requirement. The future requirement is roughly estimated by assuming an annual increase of 2%.

			m^3 (WRE)
Year	Conifers	Broadleaved	Total
1983	62	145	207
1988	68	160	228

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12.5.8 Government Departments:- Under Five Year Plans of Royal Government of Bhutan, increased financial outlays are made for developmental projects to be implemented by Government Departments. This would involve progressively increased use of wood for construction purposes. Assuming the annual rate of growth of 5%, the wood requirement has been worked out as under:-

			m^3 (WRE)
Year	Conifers	Broadleaved	Total
1983	2,502	5,838	8,340
1988	3,192	7,448	10,640

12.5.9 Total Demand Forecast for Timber and Fuelwood:- The total demand for wood in the years 1983 and 1988 would be 1,587,500 m^3 and 1,763,024 m^3 respectively. The details are given in the following tables:-

Table

Sector-wise Projected Demand of Timber and Fuelwood

m^3 (WRE)

Year	Sector	Conifers	Broad leaved	Total
1983	House building & Repairs	9,226	21,527	30,753
	Agricultural Implements	-	9,530	9,530
	Saw Milling Industry	575	1,340	1,915
	Free grants	62	145	207
	Govt. Departments	2,502	5,838	8,340
	Fuelwood	307,351	1,229,404	1,536,755
	Total	319,716	1,267,784	1,587,500
1988	House building & Repairs	10,228	23,864	34,092
	Agricultural Implements	-	10,575	10,575
	Saw Milling Industry	733	1,712	2,445
	Free Grants	68	160	228
	Govt. Departments	3,192	7,448	10,640
	Fuelwood	341,009	1,364,035	1,705,044
	Total	355,230	1,407,794	1,763,024

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Table

Total Projected Demand of Timber and Fuelwood

m^3 (WRE)

Kind of wood	Year		
	1978	1983	1988
Conifers			
Timber	9,905	12,365	14,221
Fuelwood	277,018	307,351	341,009
Total	286,923	319,716	355,230
Broad leaved			
Timber	31,701	38,380	43,759
Fuelwood	1,108,070	1,229,404	1,364,035
Total	1,139,771	1,267,784	1,407,794
Conifers & Broad leaved			
Timber	41,606	50,745	57,980
Fuelwood	1,385,088	1,536,755	1,705,044
Total	1,426,694	1,587,500	1,763,024

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12.6.1 TIMBER MARKETS

At present, there is no timber market in the survey area. Even in the Southern parts of Bhutan Phase IV area adjacent to Assam State of India, there is no established timber market. Off and on, some timber transactions take place at Gaylegphug. Most of the timber from survey area is directly sent to timber markets of Assam and is further ~~exported~~. distributed to other places in India.

12.6.2 A survey covering timber markets and wood based industries in the adjoining districts of Goalpara, Kamrup and Darrang of Assam was carried out. This survey has revealed that out of 2,39,100 m^3 timber exported, as per 1976-77 records, from these three districts. Bhutan timber contributed 33,640 m^3.

12.6.3 Study of last four years' exports records of survey area and adjacent parts, within Bhutan, indicated that on an average, 55,000 m^3 of timber and 19,400 m^3 of fuelwood is exported annually through Goalpara, Kamrup and Darrang districts of Assam. Some limited quantity of fuelwood that enters Assam, mainly from foot hills of Bhutan, is locally consumed in nearby towns. At present, only 3.6% of timber entering Assam market from Bhutan is from survey area and the rest is from the forest areas located south of the survey area within Bhutan (Phase IV area). Excepting a negligible quantity of about 260 m^3 conifers, the bulk of timber exported comprises of miscellaneous broad leaved species. Only about 6% of wood entering Assam timber markets from Bhutan is in sawn form. 61% of the timber coming into the three districts of Assam from Bhutan is further distributed [redacted] to various wood consuming regions in India. About 55% of Bhutan timber [redacted] from these Assam markets finds entry into Calcutta. The remaining material goes to other destinations in Bihar, U.P., Rajasthan etc. 90% of Bhutan timber exported through Assam to various destinations is transported by rail and the rest by road.

12.7.1 WOOD BASED INDUSTRIES

Results of a survey of wood based industries both within Bhutan and in the adjoining areas is as follows:-

(a) Industries located south of survey area within Bhutan
Wood based industries located in the foot hill of Bhutan consume about 11,700 m^3 of timber annually. Industry-wise details are given below:

(i) Saw Mills:- There are four saw mills located in border towns (two at Gaylegphug, one each at Samdrup Jongkhar and Diapham) with an annual intake of about 7000 m^3 timber. At present, the entire timber consumed by these units is from outside survey area.

(ii) Veneering/Plywood Industry:- There is only one unit (Druk Veneering Industry) located at Gaylegphug. The annual wood requirement is about 4200 m^3. Till recently this unit was making tea chest veneers and selling them to plywood industries of West Bengal. With the recent addition of a cold press unit, the industry has started making tea chest plywood also. At present, the wood supply is obtained from foot hill forests. But, with the depletion of conventional plywood species in the nearby areas, the industry will have to partly depend on the forests of survey areas for future supplies.

(iii) Match Industry:- The Pelri Match Factory at Gaylegphug requires about 500 m^3 of wood annually. So far, the unit was depending on the forests located close to the industry for wood. The main species consumed are *Salmalia malabaricum* and *Ailantus grandis*. With the depletion of match wood species in the foot hills, the industry will have to depend on species like *Machilus* spp., *Buklandia populnea*, *Symplocos spicata* etc. found in good proportion in the survey area for its future requirements.

(b) Industries located in Assam area (Goalpara, Kamrup and Darrang Districts):

Wood based industries in the three districts of Assam consume about 218,000 m^3 timber annually. Bhutan contributes 10.5% of the total intake. Wood requirements of various industries is briefly given below:

(i) Saw milling Industry:- There are 150 saw mills in the area. Total annual timber consumption is about 212,000 m^3. About 9.3% of the requirement is met from Bhutan timber. 46% of the wood handled by saw mills is sal and 54% consists of miscellaneous hardwoods and soft wood species. At present, only 60% of the installed capacity of saw mills is being worked. Amongst other factors, non-availability of required quantity of timber is an important factor contributing to the low utilization of the installed capacity. As the demand for packing cases and miscellaneous hardwoods from Calcutta is very high, the saw mills located close to Bhutan areas can take in additional 20,000 m^3 timber of miscellaneous hardwoods annually from Bhutan.

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(ii) Veneering & Plywood Industry:- There are three veneering units (2 at Bongaigaon and one at Borgong) and one tea chest plywood unit at Dhubri. The most preferred species is Chilaune. Other species used are Mandane, Behera, Hatipaile, Kadam, Gokul, Chakrasy etc. Landed cost of timber ranges from Rs.280 to Rs.350 per m^3. The total annual requirement of wood by this industry is about 8500 m^3. All the units are experiencing difficulty in procuring the required quantity of wood from Assam forests and are looking for alternate sources of supply. Only about 800 m^3 of Bhutan wood is consumed by the veneering industry of Assam. Apart from the veneering/plywood units located within the three districts where study has been conducted, there is one plywood industry (Meghalaya Plywoods Ltd., Barnihat) located in Meghalaya (near Gauhati) which requires about 14,000 m^3 of wood annually for manufacturing both commercial and tea chest plywood. The industry is looking for additional sources of timber for increasing the intake. The industry can pay upto Rs.420/- per m^3 of wood.

(iii) Match Industry:- There are two units with a total annual wood requirement of 26,250 m^3. Assam Match Company at Dhubri consumes about 24,000 m^3 annually whereas the match splint factory at Bijni consumes only 2,250 m^3. Main species used are Semal and Odal. A small quantity of Khasi pine from Meghalaya is also being used. The landed cost of wood is about Rs.280 per m^3. Assam Match Co., is interested in Chir pine, Pipli, Kawla & Kharane species which are found in good proportion in the survey area. At present, Bhutan timber is not being used by Match Industry of Assam.

(iv) Katha Industry:- There are three Katha Manufacturing Units which consume about 480 m^3 of Acacia catechu wood per annum. The units are not working to full capacity due to shortage of wood.

(v) Hardboard Industry:- There is one unit at Gauhati which consumes about 34,000 m^3 of fuelwood of miscellaneous species. The average landed cost of wood presently procured by the industry is Rs.6.00/m^3.

(vi) Paper Industry:- Ashok Paper Mill is located at Jogigopa near Goalpara. 1;10,000 tonnes of Bamboo is consumed annually. The industry has started trying mixture of bamboos and some of the hardwoods and pines. Some of the coniferous wood of survey area can be absorbed by this industry.

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(vii) Miscellaneous Industries:- This category includes small scale industries like cart wheel, motor body building, carpentry, wood craft, photo frame etc., which consume wood to the extent of about 4,200 m^3 (sawn form). There are 180 such small units in the three districts. These units do secondary conversion by obtaining sawn wood from saw mills.

12.8.1 TIMBER MARKETS OF ASSAM

The average recorded annual production of wood in the seven forest divisions in Goalpara, Kamrup & Darrang districts is 158,000 m^3 (average of three years). Apart from this, large quantity of timber coming from Bhutan, Meghalaya, Arunachal Pradesh and private lands is handled by the timber markets. The important timber markets in Goalpara district are Kokrajhar, Bijni, Sapatgram, Bongaigaon, Dhubri, Goalpara and Gosaigaon. Most of the timber from Sarbhang, Phipsoo and Gaylegphug areas of Bhutan finds entry into Kokrajhar, Bijni, Sapatgram and Bongaigaon timber markets. Udalguri, Tangla, Barpeta Road, Palasbari and Gauhati are the important timber markets in Kamrup district. About 75% of timber handled in markets of Udalguri and Tangla is from Diapham and Samrang ranges of Bhutan. Tejpur, Rangapara & Dhekia Juli are the major timber markets in Darrang district. Very little Bhutan timber enters the timber markets of Darrang district.

12.8.2 187 prominent timber merchants and forest lessees were interviewed. The study reveals that on an average, 278,000 m^3 of round wood and 66,500 m^3 of sawn wood (95,000 m^3 WRE) is annually handled in the timber markets of the three districts of Assam. This includes 153,000 m^3 (WRE) from Meghalaya and 21,000 m^3 (WRE) from Arunachal Pradesh. The average selling prices (1977) were as under:-

Species	Price (Rs. per m^3)	
	Round	Sawn
Sal	770.00	910.00
Pine (Khasi pine)	-	450.00
Other species	375.00	440.00

12.8.3 Amongst organized sectors, Railways get about 49,000 m^3 of timber annually (about 46,000 m^3 in sleeper form) from the three districts. Out of the acceptable species for sleepers by Railways, the survey area has fairly good proportion of *Abies densa*, *Altingia excelsa*, *Castanopsis* species and *Terminalia myriocarpa*. As the price offered by the Railways for sleepers is normally higher than the general market price, it may be advantageous to enter into agreement with them for bulk supply on sustained basis.

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12.8.4 Oil Refinery and Petrochemicals Ltd., coming up at Dhaligaon (near Bongaigaon) requires large quantity of constructional timber. Developing marketing strategy can help in selling large quantities of sawn wood of miscellaneous timber species to this industry from survey area during constructional stage. Saw milling industries at Gaylegphug area can play an important role in meeting this supply.

12.8.5 Gaylegphug and Samdrup Jongkhar have potentialities to develop as important timber markets. Both the places are located close to rail heads for long distant rail transportation to the consumption centres in Eastern and Northern India.

CHAPTER-XIII

WOOD BALANCES

13.1.1 GENERAL

"Wood balances" are the quantities of wood that are available for industries or export from the area, after meeting the local demand of the people and after catering to development requirements of the existing industries.

13.2.1 POTENTIAL ANNUAL CUT

The summary of potential annual cut as calculated in para 10.4.2 is given below:

Table

POTENTIAL ANNUAL CUT

'000' m^3 Solid Volume (ub)

Species Groups	Gross Annual cut	Cull Volume	Net annual cut
Conifers	1912.708	570.831	1341.877
Broadleaved			
Group A	564.308	40.506	523.802
Group B	499.728	67.144	432.584
Group C	690.091	71.084	619.007
Group D	1339.370	91.599	1247.771
Group E	2363.618	449.692	1913.926
Total Broad leaved spp.	5457.115	720.025	4737.090
Total Conifers and Broad leaved spp.	7369.823	1290.856	6078.967

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13.2.2 The net potential annual cut of 6078.967 thousand m^3 represents the net solid volume under bark in the forest. In order to calculate the wood balances it will be necessary to convert this volume to log volume (WRE). The loss in felling and cross cutting, including the volume left in the forest in the shape of stump, breakage during felling and off road carriage, is estimated to be roughly 15% of the standing volume. Therefore, the net log volume will be as follows:

Table

NET LOG VOLUME

'000' m^3 (ub)

Species Groups	Net annual cut	Conversion losses in forest	Net WRE
Conifers	1341.877	201.282	1140.595
Broadleaved			
Group A	523.802	78.570	445.232
Group B	432.584	64.888	367.696
Group C	619.007	92.851	526.156
Group D	1247.771	187.166	1060.605
Group E	1913.926	287.089	1626.837
Total Broad leaved spp.	4737.090	710.564	4026.526
Total Conifers and Broad leaved spp.	6078.967	911.846	5167.121

13.3.1 AVAILABILITY OF WOOD

With the existing infrastructure and market trends, economic extraction of 60, 40 and 30 percents of the total volume of potential annual cut of conifers, group "A", "B" and "C", "D" & "E" of broad leaved species respectively is considered feasible at present (1978).

13.3.2 With further developments of road net work, river improvements and modern logging techniques, the economic extraction (in terms of percentages of total potential annual cut) may increase to 70, 50 and 40 in 1983 and 80, 60 and 50 in 1988.

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13.3.3 It would be of interest to mention that percentage figures for economically feasible extraction were taken as 60 and 40 for the base year 1975 for conifers and broad leaved species respectively in the first report. The corresponding figures for the years 1980 and 1985 were "80 and 60" and "100 and 80" respectively. It has, however, been observed that level of extraction has not risen as was expected.

13.3.4 Based on the presumptions, in para 13.3.1 and 13.3.2 above, the availability of wood in 1978, 1983 and 1988 has been worked out as under:

Table

AVAILABILITY OF WOOD IN DIFFERENT YEARS

'000' m^3 (WRE)

Species Groups	Year		
	1978	1983	1988
Conifers	684.357	798.416	912.476
Broad leaved			
Group A	178.093	222.616	267.139
Group B	147.078	183.848	220.618
Group C	157.847	210.462	263.078
Group D	318.182	424.242	530.302
Group E	488.051	650.735	813.418
Total Broad leaved spp.	1289.251	1691.903	2094.555
Total Conifers and Broad leaved spp.	1973.608	2490.319	3007.031

13.4.1 DEMAND

The total projected demand for timber and fuel wood has been given in table under para 12.5.9. It is estimated that about 25% of the requirement of fuel wood of both conifers as well as broad leaved species is presently met out of dead and fallen trees, branches of conifers and twigs etc., which do not form a part of the growing stock and, therefore, have not been included in the calculation of annual cut. For the purpose of calculation of wood balances, the fuel wood demand has, therefore, been reduced by 25%.

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13.4.2 From the general observations on utilisation of broad leaved species, it has been assumed that consumption of timber of species in groups A, B, C, D and E is in the ratio of 6:6:4:1:3. The ratio of fuel wood of species in these groups has been estimated as 1:1:2:6:10.

13.4.3 Demand of timber and fuel wood to be met from the annual cut for the years 1978, 1983 and 1988 has been re-estimated after reducing 25% for fuel wood and applying the ratios. The details are given in the following table:-

Table

DEMAND OF TIMBER AND FUELWOOD TO BE MET FROM THE ANNUAL CUT

'000' m^3 (WRE)

Species Group		Year		
		1978	1983	1988
1		2	3	4
Conifers				
	Timber	9.905	12.365	14.221
	Fuelwood	207.764	230.513	255.757
	Total	217.669	242.878	269.978
Broad leaved				
Group A				
	Timber	9.510	11.514	13.128
	Fuelwood	41.553	46.103	51.151
	Total	51.063	57.617	64.279
Group B				
	Timber	9.510	11.514	13.128
	Fuelwood	41.553	46.103	51.151
	Total	51.063	57.617	64.279

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1	2	3	4
Group C			
Timber	6.340	7.676	8.752
Fuelwood	83.105	92.205	102.303
Total	89.445	99.881	111.055
Group D			
Timber	1.585	1.919	2.188
Fuelwood	249.315	276.615	306.908
Total	250.900	278.534	309.096
Group E			
Timber	4.756	5.757	6.563
Fuelwood	415.527	461.027	511.513
Total	420.283	466.784	518.076
Total Broad leaved spp.			
Timber	31.701	38.380	43.759
Fuelwood	831.053	922.053	1023.026
Total	862.754	960.433	1066.785
Total Conifers and Broad leaved spp.			
Timber	41.606	50.745	57.980
Fuelwood	1038.817	1152.566	1278.783
Total	1080.423	1203.311	1336.763

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13.5.1 WOOD BALANCES

The wood balances have been arrived at from figures of "availability of wood" and "present and projected demand" as given in tables under paragraphs 13.3.4 and 13.4.3 respectively and are given in the following table:

Table

WOOD BALANCES

'000' m^3 (WRE)

Species group	Year		
	1978	1983	1988
1	2	3	4
Conifers			
Available	684.357	798.416	912.476
Demand	217.669	242.878	269.978
Surplus	466.688	555.538	642.498
Broad leaved			
Group A			
Available	178.093	222.616	267.139
Demand	51.063	57.617	64.279
Surplus	127.030	164.999	202.860
Group B			
Available	147.078	183.848	220.618
Demand	51.063	57.617	64.279
Surplus	96.015	126.231	156.339
Group C			
Available	157.847	210.462	263.078
Demand	89.445	99.881	111.055
Surplus	68.402	110.581	152.023

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1	2	3	4
Group D			
Available	318.182	424.242	530.302
Demand	250.900	278.534	309.096
Surplus	67.282	145.708	221.206
Group E			
Available	488.051	650.735	813.418
Demand	420.283	466.784	518.076
Surplus	67.768	183.951	295.342
Total Broad leaved spp.			
Available	1289.251	1691.903	2094.555
Demand	862.754	960.433	1066.785
Surplus	426.497	731.470	1027.770
Total Conifers and Broad leaved spp.			
Available	1973.608	2490.319	3007.033
Demand	1080.423	1203.311	1336.763
Surplus	893.185	1287.008	1670.268

13.5.2 The available quantity shown in the above table includes underbark volume down to 5 cm. diameter over bark. The demand is inclusive of fuel wood which can mostly be met from the small sized material. The surplus volume will therefore, mainly constitute bigger sized material.

13.5.3 The entire material cannot be extracted in log form due to difficulties in transportation etc. Moreover, conversion at site is suitable for coniferous species for convenience in transport by river. It is presumed that economic conversion at site is feasible to the extent of 70, 60 and 50 percents of available volume in respect of coniferous species in 1978, 1983 and 1988 respectively. As regards broad leaved species, conversion at site of 20% of the available volume is estimated for all the years.

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13.5.4 The loss in conversion at site for all the species (conifers and broad leaved) is estimated to be 40% of the WRE volume. In addition, loss of 5% in the volume of coniferous species can take place in transport by rivers.

13.5.5 The net quantities of wood available for industries have been worked out after giving allowance for loss in conversion and transport by river as described in paras 13.5.3 and 13.5.4 above and are given in the following table.

Table

WOOD AVAILABLE FOR INDUSTRIAL USE

'000' m^3 (Rounded off)

Species group	Year		
	1978	1983	1988
Conifers	326	412	504
Broad leaved			
Group A	117	152	187
Group B	88	116	144
Group C	63	102	140
Group D	62	134	204
Group E	62	169	272
Total Broad leaved spp.	392	673	947
Total Conifers and Broad leaved spp.	718	1085	1451

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CHAPTER-XIV

INDUSTRIAL INVESTIGATIONS AND POSSIBILITIES

14.1.1 INVESTIGATIONS

During the Phase I survey various woods from Bhutan were tested at Forest Research Institute, Dehra Dun to ascertain their properties for different end uses. The results of such tests have been detailed in Phase I Report. It was observed that the properties of Bhutan woods are no different than the properties of same species growing in India that have been tested already. Since the main species, occurring in Phase II & III, had already been tested, it was considered not necessary to have the tests carried out on the same species from Phase II & III area. Moreover for the time being more than sufficient data and information was available for Bhutan woods for setting up of wood based industries. Any specific test on any wood that may be required can be got carried out at the Forest Research Institute, Dehra Dun (India), at a short notice. The available data and information has been utilized for the following paras.

14.2.1 POTENTIAL

The analysis of survey results shows that species available in Central and Eastern Bhutan are very similar to North-Western Bhutan. The estimated availability of major species and groups from the survey are for industrial uses (possible cut minus local demands) during 1983 and 1988 have already been given in para 13.5.1. The following table gives the suitability of different species/groups and their availability:

Table

AVAILABILITY OF DIFFERENT WOODS FOR INDUSTRIAL USES

(cf. para 13.5.1)

'000' m^3 WRE

Species/ Species group	Suitable for	Availability in 1983	1988
1	2	3	4
1. Coniferous	T.C.Ply	555.538	642.498
2. Broadleaved			
Group A			
Betula spp.	Ply		
Juglans regia	Ply		
Michelia spp.	Ply, Pencil		
Morus laevigata		164.999	202.860
Phoebe goalparensis			
Terminalia myriocarpa	Ply		

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1	2	3	4
Group B			
Acer spp.	Pencil, Shuttle, Bobbins		
Ailantus grandis	Pencil		
Altingia excelsa			
Amoora wallichii	Ply		
Cedrela spp.		126.231	156.339
Cinnamomum cecicodaphne			
Duabanga Sonneratioides	Ply		
Phoebe hainesiana			
Salmalia malabaricum	Match		
Schima wallichii	Ply		
Tetrameles nudiflora			
Group C			
Acrocarpus fraxinifolius	Ply		
Albizzia spp.	Ply		
Alnus spp.	Pencil		
Bucklandia populnea		110.581	152.023
Castanopsis spp.	Sports goods		
Machilus spp.	Pencil		
Group D			
Bischofia javanica			
Garuga pinnata			
Lagerstroemia parviflora		145.708	221.207
Populus spp.	Pencil		
Prunus spp.			

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1	2	3	4
Group D (Contd.)			
Pterospermum acerifolium			
Quercus spp.	Agriculture Implements.	145.708	221.207
Sterculia villosa			
Syzigium spp.			
Group E			
Aesculus punduana			
Amoora rohituka			
Cinnamomum tamala			
Engelhardtia spicata			
Ficus spp.			
Kydia calycina			
Macaranga spp.			
Ostodes paniculata		183.951	295.343
Rhododendron spp.			
Symplocos spicata	Pencil		
Vitex heterophylla			
Miscellaneous spp.			

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14.3.1 EXISTING WOOD-BASED INDUSTRIES IN CENTRAL & EASTERN BHUTAN

There is considerable scope for development of wood-based industries even in the Central and Eastern Bhutan. Forests of these regions can supply raw material for different industries on a sustained basis. Lack of infrastructural development and consequent high costs of wood extraction throttles the growth of industries. In addition the power supply is another bottleneck. With the result the development of wood-based industries has been able to contribute to the development of areas, in spite of vast resources. At present only the following industries based on forest products exist in the area:-

1. Saw mill at Samdrup Jongkhar
2. Tashi Rosin & Turpentine Factory, Samdrup Jongkhar.
3. Blue Point Saw Mill, Korilla
4. Swiss Dairy and Forestry Project - Hand Sawing Unit, Bayakar. Power operated Saw Mill has not been installed so far by Swiss Project for want of electric power.
5. Druk Saw Mill and Veneering Industries, Gaylegphug.

In addition to the above, there are a number of village sawers and furniture makers.

14.4.1 LIKELY SITES FOR WOOD BASED INDUSTRIAL UNITS

Considering existing availability of land, electric power, transportation facilities and availability of other inputs the following places appear to be suitable for different types of wood based industrial units:-

14.4.2 Samdrup Jongkhar

It is located at the foot hills and is very close to Assam border. The nearest railway station Rangia, is about 50 km. There is ample flat land, which can be made available for industries. The electric power which is presently being drawn from India will be able to feed new wood based industries. There is a small river in which sufficient water flows throughout the year to meet the requirements of the industries. The place is ideal for setting up a plywood unit.

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14.4.3 Konglum

The town is about 160 km from Samdrup Jongkhar. The power is drawn from Tashigang Power Station. The peak capacity of Tashigang Power Station is 750 KW and can be increased. At present only 160 KWH is being produced for local consumption. Some flat land is available around the town which can be utilised for setting up small saw mill.

14.4.4 Limithang

The place is about 300 km from Samdrup Jongkhar via Tashigang. It is situated at the bank of Songer river. Flat area is available for industrialisation. There is no problem of water throughout the year, as two big rivers namely Siri Chu and Soner Chu have sufficient water throughout the year. The river Siri Chu can also be used for floating of timber. Monger Power Station is producing 440 KWH of power at present. The capacity of Monger Power Station can be increased to feed industries. A small plywood unit and a small unit producing lemon grass oil can be set up.

14.4.5 Singur

The place is situated at the height of 2,730 m. There is ample of flat area for industries. Water requirements can easily be met from the local streams which are perennial. There is no electric power available in the area. However, there is enough scope for setting up small hydro-electric power stations at different places. Singur is about 330 km from Samdrup Jongkhar via Tashigang. It is an ideal place for setting up a plywood unit producing commercial ply from soft wood resources.

14.4.6 Ura and Tangsbi Valley

The places are situated at the height of about 3,000 m. These two places are also possible sites for setting up saw mills.

14.4.7 Bhumthang (Bayakar)

Bayakar is about 410 km from Samdrup Jongkhar via Tashigang and about 330 km from Gaylegphug via Tongsa. From Thimphu the place is around 330 km. The town is situated at the bank of Bhumthang river. The height of town is 2,600 m from the sea level. There is a Swiss Dairy and Forestry Project. The Project has a hand saw mill which is exclusively sawing the timber for their own use. However, small

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fraction of sawn timber is also being supplied to the local population. The Project has got power-operated saw mill, which has so far not been installed, due to non-availability of electric power. The Project obtains wood from Bapatithang forest area by gravity ropeway. About 10 km towards Ura, there is UNDP Project (Yak and Sheep Development Project). They have also their own generator by which Project's electricity demands are met with.

The whole area is excellent and has almost flat terrain and ideal place for any new industry. Considering the type of species available in the area and availability of land etc., the place may be considered even for a bigger wood-based unit like Pulp and Paper. A 50 tonnes/day cable-insulation paper plant would be ideal for the place, provided the roads are widened to facilitate transportation of heavy pulp and paper machineries. The present cost of transportation of goods by truck from Gaylegphug to Bayakar is about 1.05 Nu per kilogram.

14.4.8 Mangde Chu

The place is situated on the confluence of River Tongsa and Burunda. The distance from Gaylegphug is only 130 km. Not much of plain area is available but sufficient area is available for setting up a small saw mill. There is no electric power, but can easily be produced locally.

14.4.9 Gaylegphug

The town is situated at the foot-hills near Assam border. There are two major wood-based units viz. Pelri Match Factory and Druk Saw Mill and Veneering Industries. The power is obtained from India for meeting the requirements of the industries and local population. The place is ideal for setting up any large scale wood-based industry.

14.4.10 Sarbhang

This town is also situated at the foot-hills near Assam border. Electric power is obtained from India for local consumption. This is also an ideal place for setting up large scale wood-based unit when Damphu is connected to Wangdiphodrang by road as suggested in Phase I Report. All pre-requisites for industries are available in the area.

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14.5.1 IMMEDIATE INDUSTRIAL POSSIBILITIES

Establishment of some of the wood industries based on the basis of existing facilities will enhance the economy of the nation and help to improve the standard of living of the people. Based on the available resources in Phase II & III, the following wood-based industries may be possible in immediate future after feasibility studies are done.

14.5.2 Integrated Half Wrought Unit:- This unit can manufacture pencil slats, shuttles and bobbin blocks. Based on the available information on forest resources the half wrought unit of about 6 tonnes per day capacity can easily be set up. The unit will use 3 tonnes/day wood for pencil slats from which 600 gross pencil slats of 6 ply can be produced.

The species suitable for pencil slat and shuttle and bobbin viz. Maple, Castanopsis and Celtis australis are available in sufficient quantity within Phase II & III areas. The major species which are suitable for pencil are Symplocos spicata, Ailantus grandis, Juniperus spp., Alnus spp. Machillus spp., Populus spp. etc.

The capital required for setting up such a unit will be around Nu. 2 million.

14.5.3 Saw Milling, manufacture of furniture and packing cases:- A number of saw mills can easily be set up on the basis of existing available forest resources. The items which can be manufactured from the available species in Phase II & III are household and office furniture and fruit packing cases & shooks. It is suggested that a wooden packing case manufacturing unit at selected location may be set up. The capital required for a unit manufacturing 60,000 packing cases per annum would be approximately Nu. 1.5 lakhs.

14.5.4 Plywood Unit:- The major species suitable for plywood as recommended by I.S.I. are available in Phase II & III in substantial quantity, as may be seen from the table under para 14.2.1. Commercial and tea-chest quality plywood can be manufactured from the resources available.

The ideal location for setting up of plywood factory, based on Phase II & III resources are Samdrup Jongkhar, Gaylegphug and Bayakar (Bhumthang). In the former two locations all necessary facilities for setting up of plywood units are available. However, transport of ply logs from forest areas will pose some problem. In Bhumthang at present the facilities are not available for establishing industries. However, in near future this may be an ideal location for the industry.

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A plywood unit producing more than 10 m sq.m. can easily be set up at the proposed locations. The capital required for setting up an economical unit of 5 m. sq. m. will be around Nu. 2.5 crores.

14.6.1 FUTURE POSSIBILITIES

The following industries may be considered for future planning as and when the infrastructure facilities are developed and enough electric power becomes available.

14.6.2 Fibre Board:- Fibre board can be manufactured from the waste wood available from plywood and saw milling industries. A minimum 50 tonnes/day capacity will be economical and will require about Nu.150 lakhs as capital. A list of fibre board machinery suppliers is given below:

1. M/s International Trading Corporation, G.P.O. Box 378, Calcutta-1.
2. M/s Project Machine Tools Co. Pvt., Ltd., Bell Building, Sir P.M. Road, Bombay-1.
3. M/s Reliable Machines Tools Company, 31, Canning Street, Calcutta.
4. M/s Siempelkanp & Company, Maschiner Fabrik, Krefeld, West Germany.
5. M/s J.M. Voith, Gm DH 7920 - Heidenheim (Brenz), Germany.
6. M/s Beeker & Van Hillen, Krefeld, West Germany.
7. M/s Karlstadt Mekanika Workstad, Sweden.
8. M/s International Design Corporation, 3824, South Pine Street, Tacoma, Washington - 98411. U.S.A.

14.6.3 Pulp and Paper:- Forest resources from Phase I, II & III areas can be used for the manufacture of speciality papers like cable insulation, sack kraft etc. These papers require mostly coniferous wood. The capital required for setting up such a unit will be around Nu.40 crores. Detailed feasibility report is, however, necessary to be carried out for such industries.

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CHAPTER-XV

INVESTMENT RECOMMENDATIONS

15.1.1 GENERAL

Forests of Central and Eastern Bhutan have enough resources of wood to feed small, medium and large sized wood based industries as stated in the previous Chapters. However, harvesting of such large quantities of wood requires heavy investment in building up managerial skills and man-power, purchase of machines, construction of roads and development of transport systems.

15.1.2 Silvicultural skills and organisation to regenerate the harvested areas and to plant more areas are necessary concommittants of wood harvesting on sustained basis. This also needs expertise to study the problems and evolve techniques suitable for local conditions and workers to execute the regeneration programmes. Utmost caution is advocated to handle these problems against any hurried cutting of forests without proper solution of regeneration and silvicultural problems.

15.1.3 The expansion of the Department of Forestry has to precede the forestry development, harvesting of wood and setting up of big sized industries. The forests have to be properly demarcated and brought under scientific management plans. The Forest Department would need professionally trained foresters and skilled workers to handle the forestry development plans and wood harvesting.

15.1.4 'Pre-investment' study of the planning and investment calculations presented in this report are of macro-level where problems are dealt with on over-all basis. The time horizon for macro planning is generally 25 years and may go upto the rotation age of forests, say 100 years or more. The detailed or micro-level planning can be done with the help of data presented, calculations done, back ground and principles discussed. The final decision of alternative technology to be used are left at the discretion of the local manager, who will have to keep in mind the policies of the Royal Government of Bhutan, the local cultural, socio-economic and technological conditions and help available at the site.

15.1.5 The report discusses the possibible investments to be made in presently accessible areas for timber extraction on rational basis. The investment for various machines and requirement of man-power have been discussed. Information for other possible points for timber extraction and setting up of wood based industries can be interpolated or extrapolated as required.

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15.2.1 INVESTMENT CALCULATIONS

For calculations of investment requirement, operation-wise details of tools/machines necessary, their cost (1978-79 level in Indian markets), average annual out-put (production) of each tool/machine and manpower needed for handling them, have been worked out and are given in the following table.

Table

INVESTMENT REQUIREMENT FOR VARIOUS OPERATIONS

Sl. No.	Operation	Tools	Average annual production m^3(r)/year	Cost of each unit of tool	Manpower required (Nos) for each unit of tools			
					Total	Skilled	Semi skilled	Unskilled
1	2	3	4	5	6	7	8	9
1.	Felling & cross-cutting	Manual saw	300	200	2	2	-	-
2.	Felling & Delimbing	Axe	300	50	1	1	-	-
3.	Delimbing	Axe	500	50	1	1	-	-
4.	Cross Cutting	Manual saw	500	200	2	2	-	-
5.	Felling, Delimbing & Cross cutting.	Power saw	1,500	5,000	2	1	1	-
6.	Conversion at stump	Saw	100	200	2	2	-	-
7.	Conversion	Portable saw	2,000	35,000	7	1	2	4
8.	Off road transport	Tractor	2,000	70,000	6	1	1	4
9.	-do-	Gravity Ropeways	6,000	8,000	8	1	1	6
10.	-do-	Cable crane	4,000	1,00,000	6	1	1	4
11.	On road transport	Truck	1,000	1,50,000	6	1	1	4

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15.2.2 It was not possible to ascertain the economic life of the individual tools/machines and the depreciation shall have to be calculated at the time of the capital investment, depending on the quality of the tools/machines available and the conditions under which these have to be used.

15.2.3 Depending upon the total available volume, volume proposed to be extracted, the assortment required and the technology and transport to be utilized, the total investments and requirement of manpower can be calculated. The training of managers, supervisors, technicians and skilled & semi-skilled labour shall also have to be planned before hand while taking up any logging project.

15.2.4 Costs on management, supervision and wages have to be provided for as working capital.

15.2.5 The area and total growing stock of the "operable forests" work out at 7,57,197 ha (para 9.3.2) and 198,052,581 m^3 (para 9.4.1) respectively. The average growing stock of operable forests is, therefore, 261.56 m^3/ha.

15.2.6 It has been estimated in para 13.3.4 that in the base year 1978, 1,973,608 m^3 of wood in round can be available, after allowing 15% conversion losses. This equals to 2.3 million m^3 standing volume in the forests. To extract this volume after the requisite infrastructure has been built up and managerial and supervisory skills are available, the estimated capital investment and manpower are given in the following table.

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Table

INVESTMENT REQUIRED FOR PURCHASE OF TOOLS AND MACHINES AND MANPOWER REQUIREMENT FOR EXTRACTING 2.3 MILLION m^3 OF WOOD

Tools/Machines	Number required	Cost		Manpower required for tools & machines annually			
		Each Rs.	Total '000' Rs.	Total	Skilled	Semi skilled	Un-skilled
1	2	3	4	5	6	7	8
1. Axe	7,740	50	387	7,740	7,740	-	-
2. Manual Saws	4,644	200	929	9,288	9,288	-	-
3. Portable Saws	35	35,000	1,225	245	35	70	140
4. Tractors (17% operable area)	150	70,000	10,500	900	150	150	600
5. Gravity Ropeways (44% operable area)	132	8,000	1,056	1,056	132	132	792
6. Cable Cranes (39% operable area)	182	1,00,000	18,200	1,092	182	182	728
7. Trucks	1,817	1,50,000	2,72,550	10,902	1,817	1,817	7,268
Total			3,04,847	31,223	19,344	2,351	9,528

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15.2.7 The table in the above para would give an idea of magnitudes of the various problems. The requirement of manpower, in spite of the possible mechanization alone would be a problem that shall have to be tackled and may slow down all the forestry operations for utilization of available wood. In this table the use of tractors, gravity ropeways and cable cranes have been provided according to the results of studies conducted for "Accessibility and Cost" (Chapter XI - Volume I).

15.3.1 INVESTMENT ESTIMATES

Based upon the discussions in the preceding paragraphs, the estimates for total investment required in various sectors of forestry by 1988, to realize the available yield with proper scientific management of the forests of the area under report, have been worked out and are given in the following table:

Table

INVESTMENT REQUIREMENT UNDER VARIOUS FORESTRY SECTORS

Sector	Investment Nu Million	Period (years)	Average annual investment Nu million
Training of staff	3	5	0.6
Survey & Demarcation	3	5	0.6
Preparation of logging & regeneration plans	3	5	0.6
River improvements	1.5	5	0.3
Construction & maintenance of buildings.	4	8	0.5
Construction & maintenance of -			
(a) Pucca Roads	220	8	27.5
(b) Forest Roads	110	8	13.8
Purchase of logging & other machinery including trucks etc.	300	8	37.5
Regeneration & planting.	12.5	8	1.6
	657	8	83.0

15.3.2 As suggested in para 11.10.2 the expenditure on construction and maintenance of new roads which are required for general area development may not be charged entirely to the forestry sector.

15.3.3 The purchase of logging and other machinery provides for maximum possible mechanization, as can be anticipated. However, in spite of the possible mechanization, adequate manpower would be required. The estimates of manpower requirement are given in the table of para 15.2.6.

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A P P E N D I C E S

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APPENDIX 1.1 (VIDE PARA 7.2.1 OF THE REPORT)

STEMS PER HECTARE BY SPECIES AND DIAMETER CLASSES

FOREST TYPE - CHIR

SPECIES	DIAMETER CLASSES (cm)										
	5-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80+	Total	%
1	2	3	4	5	6	7	8	9	10	11	12
Pinus roxburghii	18.836	37.795	21.143	13.280	10.554	6.270	2.301	0.453	0.367	110.999	64.1
Total for coniferous spp.	18.836	37.795	21.143	13.280	10.554	6.270	2.301	0.453	0.367	110.999	64.1
Michelia spp.	-	-	-	-	-	-	0.057	-	-	0.057	-
TOTAL FOR GROUP 'A' (BROAD LEAVED) SPP.	-	-	-	-	-	-	0.057	-	-	0.057	-
Duabanga Sonneratioides	-	-	-	0.199	-	0.078	-	-	-	0.277	0.2
Salmalia malabaricum	-	-	-	-	-	-	-	-	0.028	0.028	-
Schima wallichii	-	2.943	1.127	-	0.110	0.075	-	-	-	4.255	2.5
TOTAL FOR GROUP 'B' (BROAD LEAVED) SPP.	-	2.943	1.127	0.199	0.110	0.153	-	-	0.028	4.560	2.7
Albizzia spp.	-	0.848	0.339	-	-	0.063	-	-	-	1.250	0.7
Castanopsis spp.	-	-	1.588	1.162	0.400	0.155	0.200	-	-	3.505	2.0
TOTAL FOR GROUP 'C' (BROAD LEAVED) SPP.	-	0.848	1.927	1.162	0.400	0.218	0.200	-	-	4.755	2.7

Contents

Contd.

1	2	3	4	5	6	7	8	9	10	11	12
Quercus spp.	-	1.965	0.933	1.195	0.528	0.069	0.106	0.040	-	4.836	2.8
Sterculia villosa	-	-	0.234	-	-	-	-	-	-	0.234	0.1
TOTAL FOR GROUP 'D' (BROAD LEAVED) SPP.	-	1.965	1.167	1.195	0.528	0.069	0.106	0.040	-	5.070	2.9
Ficus spp.	-	-	0.421	0.176	-	-	-	-	-	0.597	0.3
Kydia calycina	3.622	-	-	-	-	-	-	-	-	3.622	2.1
Macranga spp.	-	-	0.279	-	-	-	-	-	-	0.279	0.2
Rhododendron spp.	-	1.190	3.081	0.282	0.409	-	0.057	-	-	5.019	2.9
Miscellaneous spp.	19.143	16.832	1.936	0.350	0.090	-	-	-	-	38.351	22.1
TOTAL FOR GROUP 'E' (BROAD LEAVED) SPP.	22.765	18.022	5.717	0.808	0.499	-	0.057	-	-	47.868	27.6
Total for Broad leaved spp.	22.765	23.778	9.938	3.364	1.537	0.440	0.420	0.040	0.028	62.310	35.9
TOTAL FOR CONIFEROUS AND NON-CONIFEROUS SPP.	41.601	61.573	31.081	16.644	12.091	6.710	2.721	0.493	0.395	173.309	
%	24.0	35.5	17.9	9.6	7.0	3.9	1.6	0.3	0.2		100

Contents

APPENDIX 1.2 (VIDE PARA 7.2.1 OF THE REPORT)

STEMS PER HECTARE BY SPECIES AND DIAMETER CLASSES

FOREST TYPE - KAIL

SPECIES	DIAMETER CLASSES (cm)										
	5-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80+	Total	%
1	2	3	4	5	6	7	8	9	10	11	12
Pinus wallichiana	89.510	52.497	23.052	13.109	6.404	3.763	0.783	1.040	0.526	190.684	60.1
Larix griffithii	-	-	-	-	0.242	-	-	-	-	0.242	0.1
Picea spinulosa	8.520	8.128	4.665	1.739	1.593	0.737	0.116	-	-	25.498	8.0
Tsuga brunoniana	9.881	9.245	1.260	0.964	1.081	0.149	-	-	0.058	22.638	7.1
Total for coniferous spp.	107.911	69.870	28.977	15.812	9.320	4.649	0.899	1.040	0.584	239.062	75.3
Betula spp.	-	9.278	-	-	-	-	-	-	-	9.278	2.9
TOTAL GROUP 'A' (BROAD LEAVED) SPP.	-	9.278	-	-	-	-	-	-	-	9.278	2.9
Acer spp.	5.778	10.095	1.809	-	-	-	-	-	-	17.682	5.6
TOTAL GROUP 'B' (BROAD LEAVED)SPP.	5.778	10.095	1.809	-	-	-	-	-	-	17.682	5.6
Populas spp.	-	-	-	0.322	-	-	-	-	-	0.322	0.1
Quercus spp.	-	4.520	1.097	1.336	1.662	0.164	0.099	0.082	-	8.960	2.8
TOTAL GROUP 'D' (BROAD LEAVED)SPP.	-	4.520	1.097	1.658	1.662	0.164	0.099	0.082	-	9.282	2.9

Contents

Contd.

1	2	3	4	5	6	7	8	9	10	11	12
Rhododendron spp.	16.698	6.458	0.903	0.815	-	-	-	-	-	24.874	7.9
Miscellaneous spp.	5.778	5.536	5.122	0.785	-	-	-	-	-	17.221	5.4
TOTAL GROUP 'E' (BROAD LEAVED) SPP.	22.476	11.994	6.025	1.600	-	-	-	-	-	42.095	13.3
Total broad leaved spp.	28.254	35.887	8.931	3.258	1.662	0.164	0.099	0.082	-	78.337	24.7
TOTAL CONIFEROUS & (BROAD LEAVED) SPP.	136.165	105.757	37.908	19.070	10.982	4.813	0.998	1.122	0.584	317.399	
%	42.9	33.3	11.9	6.0	3.5	1.5	0.3	0.4	0.2		100

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APPENDIX 1.3 (VIDE PARA 7.2.1 OF THE REPORT)

STEMS PER HECTARE BY SPECIES AND DIAMETER CLASSES

FOREST TYPE - FIR SPRUCE

SPECIES	DIAMETER CLASSES (cm)										
	5-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80+	Total	%
1	2	3	4	5	6	7	8	9	10	11	12
Abies densa	18.292	42.853	32.819	25.331	28.228	22.265	15.371	9.822	12.031	207.[illegible]	21.2
Picea spinulosa	3.701	3.876	2.045	1.075	0.300	0.346	0.248	0.134	0.254	11.79	1.2
Cupressus spp.	-	-	0.206	-	0.067	-	-	0.020	-	0.293	-
Juniperus spp.	-	2.989	2.739	0.877	0.358	0.044	0.058	-	-	7.065	0.7
Pinus wallichiana	1.312	0.493	0.146	0.214	-	-	-	-	-	2.165	0.2
Tsuga brunoniana	-	1.113	0.169	0.178	0.055	0.153	0.026	0.169	0.779	2.642	0.3
Total for coniferous spp.	23.305	51.324	38.124	27.675	29.008	22.808	15.703	10.145	13.064	231.156	23.6
Betula spp.	9.982	21.408	6.684	4.407	1.541	0.664	0.085	0.024	-	44.795	4.6
TOTAL GROUP 'A' (BROAD LEAVED)SPP.	9.982	21.408	6.684	4.407	1.541	0.664	0.085	0.024	-	44.795	4.6
Acer spp.	10.845	24.389	7.433	1.060	-	0.038	-	-	-	43.765	4.5
TOTAL GROUP 'B' (BROAD LEAVED)SPP.	10.845	24.389	7.433	1.060	-	0.038	-	-	-	43.765	4.5

Contents

Contd.

1	2	3	4	5	6	7	8	9	10	11	12
Prunus spp.	3.163	6.349	0.954	-	-	-	-	-	-	10.466	1.1
TOTAL GROUP 'D' (BROAD LEAVED)SPP.	3.163	6.349	0.954	-	-	-	-	-	-	10.466	1.1
Rhododendron spp.	229.183	227.338	22.033	2.447	0.549	0.035	-	-	-	481.585	49.3
Miscellaneous spp.	90.508	60.158	11.341	2.018	0.807	0.243	0.091	0.087	-	165.253	16.9
TOTAL GROUP 'E' (BROAD LEAVED)SPP.	319.691	287.496	33.374	4.465	1.356	0.278	0.091	0.087	-	646.838	66.2
Total (Broad leaved) spp.	343.681	339.642	48.445	9.932	2.897	0.980	0.176	0.111	-	745.864	76.4
TOTAL CONIFEROUS AND BROAD LEAVED SPP.	366.986	390.966	86.569	37.607	31.905	23.788	15.879	10.256	13.064	977.020	
%	37.6	40.0	8.9	3.9	3.3	2.4	1.6	1.0	1.3		100

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APPENDIX 1.4 (VIDE PARA 7.2.1 OF REPORT)

STEMS PER HECTARE BY SPECIES AND DIAMETER CLASSES

FOREST TYPE - MIXED CONIFERS

SPECIES	DIAMETER CLASSES (cm)										
	5-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80+	Total	%
1	2	3	4	5	6	7	8	9	10	11	12
Abies densa	6.578	4.182	0.370	1.527	1.760	1.765	1.607	1.140	1.464	20.393	2.6
Cupressus spp.	-	-	0.477	0.884	0.516	0.246	-	-	-	2.123	0.3
Juniperus spp.	36.081	22.974	6.355	3.808	1.034	0.230	0.085	0.057	0.021	70.645	8.9
Larix griffithii	-	-	-	-	-	0.115	0.072	0.051	-	0.238	-
Picea spinulosa	-	2.299	2.863	1.442	2.229	1.055	1.133	0.613	0.761	12.395	1.6
Pinus wallichiana	-	-	1.872	1.490	2.011	1.133	0.638	0.125	0.319	7.588	1.0
Taxus baccata	-	3.285	1.623	1.049	0.645	0.228	0.150	-	0.082	7.062	0.9
Tsuga brunoniana	17.701	48.244	11.610	11.079	7.094	6.330	5.057	3.524	7.357	117.996	14.9
Total coniferous	60.360	80.984	25.170	21.279	15.289	11.102	8.742	5.510	10.004	238.440	30.2
Betula spp.	-	14.552	8.275	3.519	1.172	0.561	0.083	-	-	28.162	3.6
TOTAL GROUP 'A' (BROAD LEAVED)SPP.	-	14.552	8.275	3.519	1.172	0.561	0.083	-	-	28.162	3.6
Acer spp.	8.954	18.472	11.510	1.412	1.053	0.555	0.079	-	-	42.035	5.3
TOTAL GROUP 'B' (BROAD LEAVED)SPP.	8.954	18.472	11.510	1.412	1.053	0.555	0.079	-	-	42.035	5.3

Contents

Contd.

1	2	3	4	5	6	7	8	9	10	11	12
Alnus spp.	-	4.039	-	-	0.152	-	-	-	-	4.191	0.5
Machilus spp.	-	4.206	-	-	-	-	-	-	-	4.206	0.5
TOTAL GROUP 'C' (BROAD LEAVED)SPP.	-	8.245	-	-	0.152	-	-	-	-	8.397	1.0
Populus spp.	-	-	-	-	0.143	-	-	-	-	0.143	-
Prunus spp.	-	-	2.135	0.325	-	-	-	-	-	2.460	0.3
Quercus spp.	-	2.664	-	1.102	0.329	0.109	0.084	-	-	4.288	0.6
TOTAL GROUP 'D' (BROAD LEAVED)SPP.	-	2.664	2.135	1.427	0.472	0.109	0.084	-	-	6.891	0.9
Aesculus punduana	-	-	-	-	-	0.107	-	-	-	0.107	-
Cinnamomum tamala	4.461	9.962	-	-	-	-	-	-	-	14.423	1.8
Rhododendron spp.	99.395	86.933	17.757	6.197	0.844	0.217	-	0.120	-	211.463	26.8
Symplocos spicata	-	6.351	0.666	-	-	-	-	-	-	7.017	0.9
Miscellaneous spp.	155.050	67.293	7.613	1.628	0.941	0.124	0.241	-	0.038	232.928	29.5

Contents

Contd.

1	2	3	4	5	6	7	8	9	10	11	12
TOTAL GROUP 'E' (BROAD LEAVED)SPP.	258.906	170.539	26.036	7.825	1.785	0.448	0.241	0.120	0.038	465.938	59.0
Total Broad leaved spp.	267.860	214.472	47.956	14.183	4.634	1.673	0.487	0.120	0.038	551.423	69.8
TOTAL CONIFEROUS AND BROAD LEAVED SPP.	328.220	295.456	73.126	35.462	19.923	12.775	9.229	5.630	10.042	789.863	
%	41.5	37.4	9.3	4.5	2.5	1.6	1.2	0.7	1.3		100

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APPENDIX 1.5 (VIDE PARA 7.2.1 OF REPORT)

STEMS PER HECTARE BY SPECIES AND DIAMETER CLASSES

FOREST TYPE - CONIFERS MIXED WITH BROAD LEAVED

SPECIES	DIAMETER CLASSES (cm)										
	5-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80+	Total	%
1	2	3	4	5	6	7	8	9	10	11	12
Abies densa	-	6.027	3.094	3.235	5.697	2.468	0.951	0.360	1.770	23.602	2.1
Juniperus spp.	-	-	-	-	-	-	-	-	0.113	0.113	-
Pinus roxburghii	-	20.800	8.182	2.293	2.944	1.411	-	-	-	35.630	3.2
Pinus wallichiana	-	-	-	-	1.048	-	0.543	-	-	1.591	0.1
Taxus baccata	-	-	3.144	-	1.455	0.325	0.261	0.373	-	5.558	0.5
Tsuga brunoniana	-	5.589	1.397	3.052	1.531	0.698	0.762	0.554	3.851	17.434	1.6
Total coniferous spp.	-	32.416	15.817	8.580	12.675	4.902	2.517	1.287	5.734	83.928	7.5
Betula spp.	-	30.512	16.076	9.103	5.134	1.590	0.517	0.208	-	63.140	5.6
TOTAL GROUP 'A' (BROAD LEAVED)SPP.	-	30.512	16.076	9.103	5.134	1.590	0.517	0.208	-	63.140	5.6
Acer spp.	12.575	51.359	29.692	5.656	3.571	0.308	-	-	-	103.161	9.1
TOTAL GROUP 'B' (BROAD LEAVED)SPP.	12.575	51.359	29.692	5.656	3.571	0.308	-	-	-	103.161	9.1

Contents

Contd.

1	2	3	4	5	6	7	8	9	10	11	12
Castanopsis spp.	-	-	1.926	0.808	0.526	1.105	-	0.176	0.073	4.614	0.4
TOTAL GROUP 'C' (BROAD LEAVED)SPP.	-	-	1.926	0.808	0.526	1.105	-	0.176	0.073	4.614	0.4
Quercus spp.	-	-	-	1.501	1.501	0.694	0.774	-	0.380	4.850	0.4
TOTAL GROUP 'D' (BROAD LEAVED)SPP.	-	-	-	1.501	1.501	0.694	0.774	-	0.380	4.850	0.4
Aesculus punduana	-	-	-	-	-	-	-	-	0.138	0.138	-
Rhododendron spp.	51.063	237.099	48.831	12.444	2.272	1.097	-	-	-	352.806	31.3
Miscellaneous spp.	202.333	261.881	38.421	7.268	3.215	0.749	0.535	0.543	0.198	515.143	45.7
TOTAL GROUP 'E' (BROAD LEAVED) SPP	253.396	498.980	87.252	19.712	5.487	1.846	0.535	0.543	0.336	868.087	77.0
Total Broad leaved spp.	265.971	580.851	134.946	36.780	16.219	5.543	1.826	0.927	0.789	1043.852	92.5
TOTAL CONIFEROUS AND BROAD LEAVED SPP.	265.971	613.267	150.763	45.360	28.894	10.445	4.343	2.214	6.523	1127.780	
%	23.6	54.4	13.4	4.0	2.5	0.9	0.4	0.2	0.6		100

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APPENDIX 1.6 (VIDE PARA 7.2.1 OF REPORT)

STEMS PER HECTARE BY SPECIES AND DIAMETER CLASSES

FOREST TYPE - BROAD LEAVED

SPECIES	DIAMETER CLASSES (cm)										
	5-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80+	Total	%
1	2	3	4	5	6	7	8	9	10	11	12
Betula spp.	6.393	7.017	2.499	1.147	0.718	0.305	0.088	0.020	0.020	18.207	2.7
Juglans regia	-	-	0.118	-	0.017	-	0.013	0.015	0.007	0.170	-
Michelia spp.	0.444	1.231	1.742	0.791	0.675	0.409	0.304	0.226	0.377	6.199	0.9
Morus laevigata	-	-	0.113	0.067	0.040	0.060	0.022	0.010	0.042	0.354	-
Phoebe goalparensis	-	1.015	0.376	0.236	0.107	0.121	0.099	0.048	0.046	2.048	0.3
Terminalia myriocarpa	-	-	0.074	0.058	0.028	0.009	-	0.010	0.009	0.188	-
TOTAL GROUP 'A' (BROAD LEAVED)SPP.	6.837	9.263	4.922	2.299	1.585	0.904	0.526	0.329	0.501	27.166	3.9
Acer spp.	3.667	7.922	2.099	0.741	0.500	0.282	0.246	0.151	0.191	15.799	2.3
Ailantus grandis	-	0.215	-	-	-	-	0.007	0.016	0.011	0.249	-
Altingia excelsa	2.274	0.381	0.077	0.050	0.039	0.008	0.043	0.030	0.091	2.993	0.4
Amoora wallichii	-	0.722	0.042	0.052	0.012	0.010	-	0.005	0.004	0.847	0.1
Cedrela spp.	-	0.509	0.199	0.051	0.058	0.022	0.008	0.015	0.048	0.910	0.1

Contents

Contd.

1	2	3	4	5	6	7	8	9	10	11	12
Cinnamomum cecido-daphne	0.444	1.593	0.362	0.094	0.101	0.039	0.014	0.022	0.019	2.688	0.4
Duabanga Sonnera-tioides	0.351	-	0.131	0.026	-	0.008	0.013	0.015	0.006	0.550	0.1
Phoebe hainesiana	0.444	0.286	0.102	0.176	0.263	0.252	0.169	0.068	0.069	1.829	0.3
Salmalia malabaricum	-	-	0.262	0.047	0.027	0.019	0.007	-	-	0.362	0.1
Schima wallichii	1.085	2.599	0.714	0.632	0.299	0.318	0.185	0.114	0.129	6.075	0.9
Tetrameles nudiflora	-	-	-	-	-	-	0.006	-	0.003	0.009	-
TOTAL GROUP 'B' (BROAD LEAVED)SPP.	8.265	14.227	3.988	1.869	1.299	0.958	0.698	0.436	0.571	32.311	4.7
Acrocarpus froxini-folius	-	-	0.036	-	-	-	-	-	0.006	0.042	-
Albizzia spp.	1.239	2.096	0.322	0.096	0.096	0.019	0.007	0.005	0.001	3.881	0.6
Alnus spp.	5.160	4.032	1.299	0.723	0.469	0.259	0.129	0.046	0.058	12.175	1.8
Bucklandia populnea	-	1.123	1.033	0.136	0.017	0.057	0.034	0.011	0.041	2.452	0.4
Castanopsis spp.	3.381	3.644	2.409	1.355	0.761	0.377	0.123	0.101	0.048	12.199	1.8
Machilus spp.	3.290	7.070	3.534	2.306	1.783	1.148	0.496	0.341	0.189	20.157	3.0
TOTAL GROUP 'C' (BROAD LEAVED)SPP.	13.070	17.965	8.633	4.616	3.126	1.860	0.789	0.504	0.343	50.906	7.6

Contd.

1	2	3	4	5	6	7	8	9	10	11	12
Bischofia javanica	-	0.075	0.033	0.023	0.057	0.010	-	0.006	0.005	0.209	-
Garuga pinnata	-	0.098	0.036	0.096	0.025	-	-	0.025	0.012	0.292	-
Lagerstroemia parviflora	0.315	1.501	0.187	-	0.016	-	-	-	-	2.019	0.3
Populus spp.	-	-	0.110	0.018	-	-	-	0.010	0.017	0.155	-
Prunus spp.	-	0.135	-	-	-	-	0.008	-	0.006	0.149	-
Pterospermum acerifolium	-	0.270	0.036	0.032	0.015	0.017	-	0.006	-	0.376	0.1
Quercus spp.	31.067	39.099	13.609	8.337	4.906	2.739	1.893	1.181	1.654	104.485	15.4
Sterculia villosa	0.444	0.168	0.045	0.121	0.032	0.020	0.028	0.005	0.009	0.872	0.1
Syzigium spp.	0.315	0.630	0.151	0.165	0.013	0.010	-	-	0.002	1.286	0.2
TOTAL GROUP 'D' (BROAD LEAVED)SPP.	32.141	41.976	14.207	8.792	5.064	2.796	1.929	1.233	1.705	109.843	16.1
Aesculus punduana	-	1.675	0.762	0.447	0.146	0.139	0.069	0.022	0.004	3.264	0.5
Amoora rohituka	-	0.994	0.186	0.031	0.015	0.049	0.019	-	0.008	1.302	0.2
Cinnamomum tamala	-	1.195	0.397	0.250	0.103	0.019	0.029	-	0.005	1.998	0.3
Engelhardtia spicata	0.787	1.952	0.297	0.249	0.146	0.033	0.014	0.035	0.068	3.581	0.5
Ficus spp.	3.596	3.500	1.390	0.651	0.172	0.116	0.022	0.005	0.035	9.487	1.4

Contents

Contd.

1	2	3	4	5	6	7	8	9	10	11	12
Kydia calycina	-	0.083	0.356	0.041	0.043	0.028	-	-	0.002	0.553	0.1
Macranga spp.	1.461	3.513	0.792	0.556	0.186	0.078	0.014	0.006	-	6.606	1.0
Ostodes paniculata	2.614	3.059	0.547	0.185	0.112	0.039	-	-	0.004	6.560	1.0
Rhododendron spp.	33.052	41.040	10.955	3.434	1.086	0.368	0.153	0.033	0.018	90.139	13.3
Symplocos spicata	7.169	7.943	2.539	0.241	0.142	0.079	0.014	0.024	0.017	18.168	2.7
Vitex hetero-phylla	-	0.493	-	0.046	-	0.010	0.014	-	0.006	0.569	0.1
Miscellaneous spp.	128.548	122.825	36.264	14.638	5.911	3.091	1.587	0.793	0.883	314.540	46.3
TOTAL GROUP 'E' (BROAD LEAVED)SPP.	177.227	188.272	54.485	20.769	8.062	4.049	1.935	0.918	1.050	456.767	67.4
Total Broad leaved spp.	237.540	271.703	86.235	38.345	19.136	10.567	5.877	3.420	4.170	676.993	99.7
Abies densa	-	0.182	-	0.019	0.084	0.112	0.082	0.053	0.149	0.681	0.1
Juniperus spp.	-	0.135	0.061	-	0.024	0.038	-	-	-	0.258	-
Picea spinulosa	-	-	0.061	-	0.013	0.027	0.013	-	-	0.114	-
Pinus roxburghii	-	-	0.139	0.024	0.084	0.045	0.022	0.022	0.012	0.348	-
Pinus wallichiana	0.315	-	0.091	0.023	0.053	0.020	-	-	0.007	0.509	0.1

Contents

Contd.

1	2	3	4	5	6	7	8	9	10	11	12
Taxus baccata	-	-	-	0.078	0.078	0.058	0.007	0.027	0.022	0.270	-
Tsuga brunoniana	-	-	0.091	0.059	0.084	0.038	0.026	0.045	0.114	0.457	0.1
Total conifers	0.315	0.317	0.443	0.203	0.420	0.338	0.150	0.147	0.304	2.637	0.3
TOTAL CONIFEROUS AND BROAD LEAVED SPP.	237.855	272.020	86.678	38.548	19.556	10.905	6.027	3.567	4.474	679.630	
%	35.0	40.0	12.7	5.7	2.9	1.6	0.9	0.5	0.7		100

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APPENDIX 2.1 (VIDE PARA 7.2.2 OF REPORT)

TOTAL STEMS IN '000' BY SPECIES AND DIAMETER CLASSES OVER ALL FOREST TYPES

SPECIES	DIAMETER CLASSES (cm)										
	5-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80+	Total	%
1	2	3	4	5	6	7	8	9	10	11	12
Abies densa	2203.966	5356.214	3755.032	3048.194	3640.163	2706.159	1812.107	1138.240	1571.798	25231.873	42
Cupressus spp.	-	-	42.779	39.524	30.063	10.988	-	2.113	-	125.467	-
Juniperus spp.	1612.354	1403.982	599.721	261.802	95.243	33.077	9.841	2.527	12.287	4030.834	0.7
Larix griffithii	-	-	-	-	4.027	5.128	3.209	2.279	-	14.643	
Picea spinulosa	528.032	642.509	448.718	205.548	163.497	108.746	84.891	41.389	60.511	2283.841	0.4
Pinus roxburghii	1409.490	4922.661	2473.096	1236.154	1126.709	632.977	182.800	44.598	33.440	12061.925	2.0
Pinus wallichiana	1776.307	923.708	525.875	317.964	327.469	123.020	96.219	22.879	26.568	4140.009	0.7
Taxus baccata	-	146.799	389.079	84.702	213.021	70.771	36.170	50.364	14.133	1005.039	0.2
Tsuga brunoniana	955.177	2988.446	742.200	865.642	535.208	390.168	318.105	252.580	853.639	7901.165	1.3
Total for conifers	8485.326	16384.319	8976.500	6059.530	6135.400	4081.034	2543.342	1556.969	2572.376	56794.796	9.5
Betula spp.	4129.188	9500.851	3893.148	2087.809	1076.934	401.773	107.318	33.146	9.629	21239.796	3.6
Juglans regia	-	-	57.173	-	7.968	-	6.438	7.154	3.429	82.162	

Contents

Contd.

1	2	3	4	5	6	7	8	9	10	11	12
Michelia spp.	214.433	594.573	841.136	381.892	325.809	197.408	151.128	108.905	181.810	2997.094	0.5
Ilorus lanvigata	-	-	54.611	32.348	19.319	28.734	10.549	4.784	20.396	170.741	0.2
Ihoebe goalparansis	-	490.013	181.677	113.839	51.773	58.619	47.878	23.177	22.105	989.081	0.2
Terminalia myriocarpa	-	-	35.861	28.112	13.554	4.455	-	4.948	4.258	91.188	
TOTAL FOR GROUP 'A' (BROAD LEAVED) SPI.	4343.621	10585.437	5063.606	2644.000	1495.357	690.989	323.311	182.114	241.627	25570.062	4.3
Acer spp.	4665.533	12536.919	5323.980	1101.072	648.047	195.979	122.458	72.726	92.007	24758.721	4.1
Ailantus grandis	-	103.771	-	-	-	-	3.403	7.766	5.156	120.096	
Altingia excelsa	1097.897	183.797	37.197	24.040	18.879	3.942	20.959	14.282	44.009	1445.002	0.2
Amoora wallichii	-	348.631	20.301	24.932	5.834	4.795	-	2.227	1.733	408.453	0.1
Cedrela spp.	-	245.558	96.121	24.507	27.865	10.664	3.628	7.336	23.371	439.050	0.1
Cinnamomum cecicodaphne	214.433	769.017	174.766	45.159	48.852	18.722	6.549	10.488	9.372	1297.358	0.2
Duabanga Sonneratioides	169.429	-	63.078	27.489	-	9.871	6.515	7.102	3.057	286.541	0.1
Phoebe hainesina	214.433	138.240	49.067	85.025	127.203	121.549	81.674	32.847	33.150	883.188	0.1
malia malabaricum	-	-	126.561	22.733	12.860	9.286	3.458	-	2.085	176.983	

Contents

Contd.

1	2	3	4	5	6	7	8	9	10	11	12
Schima wallichii	524.054	1475.172	429.256	305.045	152.693	159.099	89.476	54.918	62.450	3252.163	0.5
Tetrameles nudiflora	-	-	-	-	-	-	2.841	-	1.372	4.213	-
TOTAL GROUP 'B' (BROAD LEAVED) SPP.	6885.779	15801.105	6320.327	1660.002	1042.233	533.907	340.961	209.692	277.762	33071.768	5.4
Acrocarpus fraxinifolius	-	-	17.505	-	-	-	-	-	3.091	20.596	
Albizzia spp.	598.294	1075.341	180.731	46.237	46.116	13.710	3.151	2.376	0.671	1966.627	0.3
Alnus spp.	2491.468	2127.388	627.287	349.178	233.208	124.908	62.061	22.433	28.159	6066.090	1.0
Bucklandia populnea	-	542.190	499.041	65.744	8.367	27.441	16.642	5.407	19.933	1184.765	0.2
Castanopsis spp.	1632.762	1759.817	1475.775	822.692	450.472	305.140	74.300	66.695	30.317	6617.970	1.1
Machilus spp.	1588.783	3602.107	1706.541	1113.677	860.795	554.285	239.682	164.849	91.055	9921.774	1.7
TOTAL GROUP 'C' (BROAD LEAVED) SPP.	6311.307	9106.843	4506.880	2397.528	1598.958	1025.484	395.836	261.760	173.226	25777.822	4.3
Bischofia gavanica	-	36.091	15.770	11.203	27.439	4.886	-	2.761	2.593	100.743	
ruga pinnata	-	47.487	17.505	46.357	11.917	-	-	11.896	5.620	140.782	
gerstroemia rviflora	152.063	724.627	90.458	-	7.780	-	-	-	-	974.928	0.2
pulus spp.	-	-	53.051	14.148	6.384	-	-	4.894	8.137	86.614	

Contents

Contd.

1	2	3	4	5	6	7	8	9	10	11	12
Prunus spp.	330.275	728.266	195.054	14.517	-	-	3.812	-	2.978	1274.902	0.2
Pterospermum acerifolium	-	130.189	17.505	15.249	7.422	8.166	-	2.722	-	181.253	0.1
Quercus spp.	15001.445	19221.291	6659.745	4337.600	2601.926	1405.177	1005.377	574.460	837.115	51644.136	8.6
Sterculia villosa	214.433	81.205	39.475	58.200	15.391	9.531	13.346	2.199	4.331	438.111	0.1
Syzigium spp.	152.063	304.268	72.854	79.608	6.083	4.979	-	-	0.753	620.608	0.1
TOTAL FOR GROUP 'D' (BROAD LEAVED) SPP.	15850.279	21273.424	7161.417	4576.882	2684.342	1432.739	1022.535	598.932	861.527	55462.077	9.3
Aesculus punduana	-	809.010	367.779	215.897	70.275	71.843	33.464	10.399	15.580	1594.247	0.3
Amoora rohituka	-	479.934	89.595	14.753	7.253	23.595	9.000	-	4.051	628.181	0.1
Cinnamomum tamala	199.369	1022.396	191.844	120.714	49.819	9.250	13.999	-	2.546	1609.937	0.3
Engelhardtia spicata	379.895	942.523	143.470	120.010	70.384	15.832	6.827	16.747	32.902	1728.590	0.3
Ficus spp.	1736.293	1689.993	702.579	327.539	83.017	56.147	10.839	2.199	17.074	4625.680	0.8
Fydia calycina	271.006	40.099	171.971	19.686	20.662	13.628	-	-	0.812	537.864	0.1
Macaranga spp.	705.354	1696.550	403.131	268.367	89.954	37.861	6.608	2.761	-	3210.586	0.5
Nestodes paniculata	1262.282	1477.027	264.313	89.430	54.151	18.594	-	-	2.144	3167.941	0.5

Contents

Contd.

1	0	2	3	4	5	6	7	8	9	10	11	12
Rhododendron spp.	49752.093	71511.748	13546.968	3478.091	878.769	301.402	78.195	21.453	8.834	139577.553	23.4
Symplocos spicata	3461.657	4119.399	1255.694	116.400	68.510	38.128	6.717	11.587	8.128	9086.220	1.5
Vitex heterophylla	-	237.897	-	22.093	-	4.979	6.780	-	3.130	274.879	0.1
Miscellaneous spp.	100355.103	96320.625	23134.187	8122.834	3310.955	1598.732	840.724	446.871	447.971	234578.002	39.3
TOTAL GROUP 'E' (BROAD LEAVED) SPP.	158123.052	180347.201	40271.531	12915.814	4703.749	2189.991	1013.153	512.017	543.172	400619.680	67.2
Total Broad leaved spp.	191514.038	237114.010	63323.761	24194.226	11524.639	5873.110	3095.796	1764.515	2097.314	540501.409	90.5
TOTAL FOR BROAD LEAVED AND CONIFERCUS SPP.	199999.364	253498.329	72300.261	30253.756	17660.039	9954.144	5639.138	3321.484	4669.690	597296.205	
%	33.5	42.4	12.1	5.1	3.0	1.7	0.9	0.5	0.8	100	

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APPENDIX 3.1 (VIDE PARA 7.4.1 OF REPORT)

GENERAL VOLUME TABLE

SPECIES - PINUS ROXBURGHII

DIAMETER CLASS (cm)	HEIGHT IN METRE									
	10	15	20	25	30	35	40	45	50	55
10-20	0.071	0.107	0.143	0.179	0.216	0.252	0.288	0.324	0.360	0.396
20-30	0.199	0.300	0.400	0.501	0.601	0.702	0.802	0.903	1.003	1.104
30-40	0.392	0.589	0.786	0.983	1.180	1.377	1.574	1.771	1.968	2.165
40-50	0.650	0.975	1.301	1.626	1.952	2.278	2.603	2.929	3.255	3.580
50-60	0.971	1.458	1.944	2.430	2.917	3.403	3.890	4.376	4.862	5.349
60-70	1.357	2.037	2.716	3.395	4.075	4.754	5.433	6.113	6.792	7.471
70-80	1.807	2.712	3.616	4.521	5.425	6.330	7.234	8.139	9.043	9.948
80-90	2.322	3.484	4.645	5.807	6.969	8.131	9.292	10.454	11.616	12.778
90-100	2.901	4.352	5.803	7.254	8.705	10.157	11.608	13.059	14.510	15.961
100-110	3.544	5.317	7.089	8.862	10.635	12.408	14.181	15.953	17.726	19.499

Contents

APPENDIX 3.2 (VIDE PARA 7.4.1 OF REPORT)

GENERAL VOLUME TABLE

SPECIES - PICEA SPINULOSA

DIAMETER CLASS (cm)	HEIGHT IN METRE									
	10	15	20	25	30	35	40	45	50	55
10-20	0.086	0.131	0.176	0.221	0.267	0.313	0.360	0.406	0.453	0.500
20-30	0.223	0.338	0.455	0.574	0.693	0.812	0.932	1.053	1.174	1.296
30-40	0.417	0.633	0.853	1.074	1.297	1.520	1.745	1.971	2.198	2.426
40-50	0.666	1.012	1.362	1.716	2.071	2.429	2.788	3.149	3.511	3.875
50-60	0.967	1.471	1.980	2.494	3.011	3.530	4.053	4.577	5.104	5.632
60-70	1.321	2.008	2.703	3.404	4.110	4.820	5.533	6.249	6.968	7.689
70-80	1.725	2.622	3.530	4.445	5.367	6.293	7.224	8.160	9.098	10.040
80-90	2.178	3.311	4.457	5.613	6.777	7.947	9.123	10.303	11.488	12.677
90-100	2.679	4.074	5.484	6.906	8.338	9.778	11.224	12.677	14.135	15.598
100-110	3.229	4.909	6.608	8.322	10.048	11.783	13.526	15.276	17.034	18.797

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APPENDIX 3.3 (VIDE PARA 7.4.1 OF REPORT)

GENERAL VOLUME TABLE

SPECIES - ABIES DENSA

DIAMETER CLASS (cm)	HEIGHT IN METRE									
	10	15	20	25	30	35	40	45	50	55
10-20	0.096	0.147	0.198	0.250	0.303	0.355	0.409	0.462	0.516	0.570
20-30	0.237	0.362	0.489	0.618	0.747	0.878	1.009	1.141	1.274	1.407
30-40	0.430	0.657	0.888	1.121	1.356	1.593	1.831	2.070	2.311	2.553
40-50	0.672	1.026	1.385	1.749	2.115	2.485	2.857	3.231	3.606	3.984
50-60	0.958	1.463	1.976	2.495	3.018	3.545	4.075	4.608	5.144	5.683
60-70	1.288	1.967	2.656	3.353	4.056	4.765	5.477	6.194	6.915	7.638
70-80	1.659	2.534	3.422	4.320	5.226	6.138	7.057	7.980	8.908	9.841
80-90	2.071	3.162	4.270	5.391	6.522	7.661	8.807	9.960	11.118	12.281
90-100	2.521	3.851	5.200	6.564	7.941	9.328	10.724	12.127	13.537	14.954
100-110	3.010	4.597	6.208	7.837	9.480	11.136	12.802	14.478	16.161	17.853

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APPENDIX 3.4 (VIDE PARA 7.4.1 OF REPORT)

GENERAL VOLUME TABLE

SPECIES - ACER SPECIES

DIAMETER CLASS (cm)	HEIGHT IN METRE									
	10	15	20	25	30	35	40	45	50	55
10-20	0.120	0.161	0.202	0.243	0.284	0.324	0.365	0.406	0.447	0.488
20-30	0.265	0.379	0.492	0.605	0.719	0.832	0.945	1.059	1.172	1.286
30-40	0.483	0.705	0.927	1.150	1.372	1.594	1.816	2.038	2.260	2.483
40-50	0.773	1.141	1.508	1.875	2.242	2.610	2.977	3.344	3.711	4.079
50-60	1.136	1.685	2.233	2.782	3.331	3.879	4.428	4.976	5.525	6.074
60-70	1.571	2.338	3.104	3.870	4.636	5.403	6.169	6.935	7.701	8.468
70-80	2.079	3.099	4.119	5.140	6.160	7.180	8.200	9.220	10.240	11.261
80-90	2.659	3.970	5.280	6.591	7.901	9.211	10.522	11.832	13.142	14.453
90-100	3.312	4.949	6.586	8.223	9.860	11.496	13.133	14.770	16.407	18.044
100-110	4.038	6.037	8.037	10.036	12.036	14.036	16.035	18.035	20.034	22.034

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APPENDIX 3.5 (VIDE PARA 7.4.1 OF REPORT)

GENERAL VOLUME TABLE

SPECIES - CASTANOPSIS SPECIES

DIAMETER CLASS (cm)	HEIGHT IN METRE									
	10	15	20	25	30	35	40	45	50	55
10-20	0.070	0.109	0.148	0.188	0.227	0.266	0.305	0.344	0.383	0.422
20-30	0.209	0.318	0.427	0.535	0.644	0.752	0.861	0.970	1.078	1.187
30-40	0.418	0.631	0.844	1.057	1.269	1.482	1.695	1.908	2.121	2.334
40-50	0.696	1.048	1.400	1.752	2.104	2.456	2.808	3.159	3.511	3.863
50-60	1.044	1.569	2.095	2.621	3.146	3.672	4.198	4.724	5.249	5.775
60-70	1.461	2.195	2.929	3.663	4.398	5.132	5.866	6.601	7.335	8.069
70-80	1.947	2.925	3.902	4.880	5.858	6.835	7.813	8.790	9.768	10.746
80-90	2.503	3.759	5.015	6.270	7.526	8.782	10.037	11.293	12.549	13.804
90-100	3.129	4.698	6.266	7.835	9.403	10.972	12.540	14.109	15.677	17.246
100-110	3.824	5.740	7.656	9.572	11.489	13.405	15.321	17.237	19.153	21.069

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APPENDIX 3.6 (VIDE PARA 7.4.1 OF REPORT)

GENERAL VOLUME TABLE

SPECIES - MICHELIA SPECIES

DIAMETER CLASS (cm)	HEIGHT IN METRE									
	10	15	20	25	30	35	40	45	50	55
10-20	0.081	0.118	0.155	0.192	0.229	0.266	0.303	0.340	0.377	0.411
20-30	0.213	0.316	0.419	0.521	0.624	0.727	0.830	0.933	1.036	1.139
30-40	0.410	0.612	0.814	1.016	1.217	1.419	1.621	1.823	2.025	2.226
40-50	0.674	1.007	1.341	1.675	2.008	2.342	2.675	3.009	3.343	3.676
50-60	1.003	1.502	2.000	2.498	2.997	3.495	3.993	4.492	4.990	5.488
60-70	1.399	2.095	2.791	3.487	4.183	4.879	5.575	6.271	6.967	7.663
70-80	1.860	2.787	3.713	4.640	5.566	6.493	7.420	8.346	9.273	10.200
80-90	2.387	3.577	4.768	5.958	7.148	8.338	9.528	10.719	11.909	13.099
90-100	2.980	4.467	5.954	7.440	8.927	10.414	11.901	13.387	14.874	16.361
100-110	3.639	5.455	7.271	9.088	10.904	12.720	14.536	16.352	18.169	19.985

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APPENDIX 3.7 (VIDE PARA 7.4.1 OF REPORT).

GENERAL VOLUME TABLE

SPECIES - TERMINALIA MYRIOCARPA

DIAMETER CLASS (cm)	HEIGHT IN METRE									
	10	15	20	25	30	35	40	45	50	55
10-20	0.087	0.128	0.168	0.208	0.249	0.289	0.330	0.370	0.411	0.451
20-30	0.231	0.343	0.456	0.568	0.680	0.792	0.905	1.017	1.129	1.242
30-40	0.447	0.667	0.887	1.107	1.327	1.547	1.767	1.987	2.207	2.428
40-50	0.734	1.098	1.462	1.826	2.189	2.553	2.917	3.281	3.645	4.009
50-60	1.093	1.637	2.180	2.724	3.268	3.811	4.355	4.898	5.442	5.985
60-70	1.525	2.284	3.043	3.802	4.561	5.320	6.080	6.839	7.598	8.357
70-80	2.028	3.038	4.049	5.060	6.071	7.081	8.092	9.103	10.113	11.124
80-90	2.603	3.901	5.199	6.497	7.795	9.094	10.392	11.690	12.988	14.286
90-100	3.250	4.871	6.493	8.114	9.736	11.358	12.979	14.601	16.222	17.844
100-110	3.968	5.949	7.930	9.911	11.892	13.873	15.854	17.835	19.816	21.797

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APPENDIX 3.8 (VIDE PARA 7.4.1 OF REPORT)

GENERAL VOLUME TABLE

SPECIES - PHOEBE GOALPARENSIS

DIAMETER CLASS (cm)	HEIGHT IN METRE									
	10	15	20	25	30	35	40	45	50	55
10-20	0.038	0.079	0.120	0.161	0.201	0.242	0.283	0.324	0.364	0.405
20-30	0.183	0.296	0.410	0.523	0.636	0.749	0.862	0.975	1.089	1.202
30-40	0.400	0.622	0.844	1.066	1.288	1.510	1.732	1.953	2.175	2.397
40-50	0.690	1.057	1.424	1.790	2.157	2.524	2.891	3.257	3.624	3.991
50-60	1.052	1.600	2.148	2.696	3.244	3.792	4.339	4.887	5.435	5.983
60-70	1.487	2.252	3.017	3.783	4.548	5.313	6.078	6.843	7.608	8.373
70-80	1.994	3.013	4.032	5.050	6.069	7.088	8.106	9.125	10.144	11.162
80-90	2.574	3.882	5.191	6.499	7.807	9.116	10.424	11.733	13.041	14.350
90-100	3.226	4.860	6.494	8.129	9.763	11.398	13.032	14.667	16.301	17.935
100-110	3.950	5.947	7.943	9.940	11.937	13.933	15.930	17.926	19.923	21.920

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APPENDIX 3.9 (VIDE PARA 7.4.1 OF REPORT)

GENERAL VOLUME TABLE

SPECIES - AMOORA ROHITUKA

DIAMETER CLASS (cm)	HEIGHT IN METRE									
	10	15	20	25	30	35	40	45	50	55
10-20	0.079	0.168	0.256	0.344	0.433	0.521	0.610	0.698	0.786	0.875
20-30	0.207	0.359	0.511	0.663	0.815	0.967	1.120	1.272	1.424	1.576
30-40	0.398	0.646	0.893	1.141	1.389	1.637	1.885	2.132	2.380	2.628
40-50	0.653	1.028	1.403	1.779	2.154	2.529	2.905	3.280	3.655	4.030
50-60	0.972	1.506	2.041	2.576	3.110	3.645	4.180	4.714	5.249	5.784
60-70	1.354	2.080	2.806	3.532	4.258	4.984	5.710	6.435	7.161	7.887
70-80	1.800	2.749	3.698	4.647	5.597	6.546	7.495	8.444	9.393	10.342
80-90	2.310	3.514	4.718	5.922	7.127	8.331	9.535	10.739	11.943	13.147
90-100	2.884	4.375	5.866	7.357	8.848	10.339	11.830	13.320	14.811	16.302
100-110	3.522	5.331	7.141	8.951	10.760	12.570	14.380	16.189	17.999	19.809

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APPENDIX 3.10 (VIDE PARA 7.4.1 OF REPORT)

GENERAL VOLUME TABLE

SPECIES - AILANTUS GRANDIS

DIAMETER CLASS (cm)	HEIGHT IN METRE									
	10	15	20	25	30	35	40	45	50	55
10-20	0.079	0.127	0.177	0.230	0.285	0.341	0.398	0.457	0.517	0.578
20-30	0.191	0.306	0.429	0.556	0.688	0.824	0.962	1.104	1.249	1.396
30-40	0.341	0.548	0.767	0.995	1.230	1.473	1.721	1.975	2.233	2.496
40-50	0.527	0.846	1.183	1.535	1.899	2.273	2.657	3.048	3.447	3.852
50-60	0.745	1.196	1.673	2.171	2.686	3.215	3.757	4.311	4.875	5.448
60-70	0.995	1.596	2.233	2.897	3.584	4.290	5.014	5.753	6.505	7.270
70-80	1.273	2.044	2.859	3.710	4.589	5.494	6.420	7.366	8.329	9.309
80-90	1.581	2.537	3.549	4.605	5.697	6.819	7.969	9.143	10.339	11.556
90-100	1.916	3.075	4.301	5.580	6.903	8.264	9.657	11.080	12.530	14.003
100-110	2.277	3.655	5.113	6.633	8.206	9.823	11.480	13.171	14.894	16.646

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APPENDIX 3.11 VIDE PARA 7.4.1 OF REPORT)

GENERAL VOLUME TABLE

SPECIES - TETRAMELES NUDIFLORA

DIAMETER CLASS (cm)	HEIGHT IN METRE									
	10	15	20	25	30	35	40	45	50	55
10-20	0.092	0.138	0.184	0.230	0.275	0.321	0.366	0.412	0.457	0.503
20-30	0.227	0.339	0.452	0.564	0.676	0.788	0.900	1.012	1.124	1.236
30-40	0.410	0.613	0.816	1.019	1.222	1.425	1.627	1.829	2.032	2.234
40-50	0.637	0.954	1.270	1.586	1.902	2.217	2.532	2.847	3.161	3.476
50-60	0.907	1.358	1.808	2.258	2.707	3.156	3.604	4.052	4.500	4.948
60-70	1.217	1.822	2.426	3.030	3.632	4.234	4.836	5.437	6.038	6.638
70-80	1.566	2.344	3.121	3.897	4.672	5.447	6.220	6.994	7.767	8.539
80-90	1.952	2.922	3.890	4.857	5.823	6.788	7.753	8.717	9.680	10.643
90-100	2.374	3.554	4.731	5.907	7.082	8.256	9.429	10.601	11.773	12.944
100-110	2.831	4.238	5.642	7.045	8.446	9.846	11.245	12.643	14.040	15.436

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APPENDIX 3.12 (VIDE PARA 7.4.1 OF REPORT)

GENERAL VOLUME TABLE

SPECIES - MACHILUS SPECIES

DIAMETER CLASS (Cm)	HEIGHT IN METRE									
	10	15	20	25	30	35	40	45	50	55
10-20	0.089	0.127	0.164	0.199	0.233	0.267	0.300	0.332	0.364	0.396
20-30	0.253	0.360	0.463	0.562	0.659	0.754	0.847	0.939	1.029	1.119
30-40	0.501	0.713	0.917	1.114	1.306	1.494	1.679	1.861	2.040	2.217
40-50	0.835	1.189	1.529	1.857	2.178	2.491	2.799	3.102	3.401	3.696
50-60	1.255	1.788	2.299	2.793	3.275	3.746	4.210	4.665	5.115	5.558
60-70	1.763	2.512	3.229	3.923	4.600	5.262	5.912	6.552	7.184	7.807
70-80	2.359	3.360	4.319	5.248	6.153	7.039	7.909	8.765	9.610	10.443
80-90	3.042	4.334	5.571	6.769	7.936	9.079	10.201	11.306	12.395	13.470
90-100	3.814	5.434	6.985	8.486	9.950	11.383	12.790	14.175	15.540	16.888
100-110	4.675	6.660	8.561	10.402	12.196	13.952	15.677	17.374	19.048	20.700

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APPENDIX 3.13 (VIDE PARA 7.4.1 OF REPORT)

- GENERAL VOLUME TABLE

SPECIES - SYMPLOCOS SPICATA

DIAMETER CLASS (cm)	HEIGHT IN METRE									
	10	15	20	25	30	35	40	45	50	55
10-20	0.078	0.116	0.155	0.193	0.231	0.270	0.308	0.346	0.384	0.423
20-30	0.214	0.321	0.427	0.533	0.640	0.746	0.852	0.959	1.065	1.171
30-40	0.418	0.627	0.835	1.044	1.252	1.460	1.669	1.877	2.086	2.294
40-50	0.691	1.035	1.380	1.724	2.069	2.413	2.758	3.102	3.447	3.791
50-60	1.031	1.546	2.060	2.575	3.090	3.604	4.119	4.634	5.148	5.663
60-70	1.439	2.158	2.877	3.596	4.315	5.033	5.752	6.471	7.190	7.909
70-80	1.916	2.873	3.830	4.787	5.744	6.701	7.658	8.615	9.572	10.529
80-90	2.460	3.689	4.919	6.148	7.377	8.606	9.836	11.065	12.294	13.523
90-100	3.073	4.608	6.144	7.679	9.215	10.750	12.286	13.821	15.357	16.892
100-110	3.753	5.629	7.505	9.380	11.256	13.132	15.008	16.884	18.759	20.635

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APPENDIX 3.14 (VIDE PARA 7.4.1 OF REPORT)

GENERAL VOLUME TABLE

SPECIES - SALMALIA MALABARICUM

DIAMETER CLASS (cm)	HEIGHT IN METRE									
	10	15	20	25	30	35	40	45	50	55
10-20	0.070	0.101	0.131	0.161	0.190	0.219	0.247	0.275	0.303	0.330
20-30	0.208	0.301	0.391	0.480	0.566	0.652	0.736	0.819	0.902	0.984
30-40	0.427	0.618	0.803	0.985	1.163	1.338	1.511	1.682	1.852	2.020
40-50	0.731	1.058	1-375	1.685	1.990	2.290	2.586	2.879	3.169	3.457
50-60	1.123	1.625	2.112	2.588	3.055	3.516	3.971	4.421	4.867	5.308
60-70	1.605	2.322	3.018	3.698	4.367	5.025	5.676	6.319	6.955	7.586
70-80	2.179	3.153	4.098	5.022	5.929	6.824	7.707	8.580	9.444	10.301
80-90	2.847	4.120	5.355	6.562	7.749	8.917	10.071	11.212	12.342	13.462
90-100	3.612	5.226	6.792	8.324	9.828	11.311	12.774	14.222	15.655	17.075
100-110	4.473	6.473	8.413	10.310	12.173	14.009	15.822	17.614	19.389	21.149

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APPENDIX 3.15 (VIDE PARA 7.4.1 OF REPORT)

GENERAL VOLUME TABLE

SPECIES - STERCULIA VILLOSA

DIAMETER CLASS (cm)	HEIGHT IN METRE									
	10	15	20	25	30	35	40	45	50	55
10-20	0.079	0.117	0.155	0.194	0.232	0.270	0.308	0.347	0.385	0.423
20-30	0.215	0.321	0.428	0.534	0.640	0.746	0.853	0.959	1.065	1.172
30-40	0.419	0.627	0.836	1.044	1.252	1.461	1.669	1.878	2.086	2.294
40-50	0.691	1.036	1.380	1.724	2.069	2.413	2.758	3.102	3.447	3.791
50-60	1.031	1.546	2.060	2.575	3.089	3.604	4.118	4.633	5.148	5.662
60-70	1.440	2.158	2.877	3.595	4.314	5.033	5.751	6.470	7.189	7.907
70-80	1.916	2.873	3.829	4.786	5.743	6.700	7.656	8.613	9.570	10.527
80-90	2.460	3.689	4.918	6.147	7.376	8.605	9.834	11.062	12.291	13.520
90-100	3.072	4.607	6.143	7.678	9.213	10.748	12.283	13.818	15.353	16.888
100-110	3.753	5.628	7.503	9.378	11.254	13.129	15.004	16.879	18.755	20.630

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APPENDIX 3.16 (VIDE PARA 7.4.1 OF REPORT)

GENERAL VOLUME TABLE

SPECIES - ENGELHARDTIA SPICATA

DIAMETER CLASS (cm)	HEIGHT IN METRE									
	10	15	20	25	30	35	40	45	50	55
10-20	0.084	0.115	0.143	0.170	0.195	0.220	0.243	0.266	0.288	0.310
20-30	0.253	0.345	0.430	0.510	0.586	0.660	0.730	0.799	0.866	0.932
30-40	0.522	0.712	0.887	1.052	1.210	1.361	1.508	1.650	1.788	1.923
40-50	0.897	1.223	1.524	1.808	2.078	2.338	2.590	2.834	3.072	3.304
50-60	1.382	1.885	2.348	2.785	3.202	3.602	3.990	4.366	4.732	5.089
60-70	1.981	2.700	3.365	3.991	4.588	5.162	5.717	6.255	6.780	7.293
70-80	2.695	3.675	4.579	5.431	6.243	7.024	7.780	8.513	9.227	9.924
80-90	3.529	4.812	5.995	7.111	8.175	9.197	10.186	11.146	12.081	12.994
90-100	4.484	6.114	7.618	9.035	10.387	11.686	12.942	14.162	15.350	16.510
100-110	5.562	7.584	9.450	11.208	12.884	14.496	16.055	17.568	19.041	20.481

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APPENDIX 3.17 (VIDE PARA 7.4.1 OF REPORT)

GENERAL VOLUME TABLE*

SPECIES - PINUS WALLICHIANA

DIAMETER (cm)	HEIGHT (m)	10	15	20	25	30	35	40
5-10		0.0194	0.0287	0.0379	0.0470	0.0561	0.0651	0.0741
10-20		0.0788	0.1166	0.1541	0.1912	0.2281	0.2648	0.3013
20-30		0.2164	0.3203	0.4232	0.5251	0.6265	0.7272	0.8275
30-40		0.4184	0.6194	0.8182	1.0154	1.2113	1.4061	1.6001
40-50		0.6831	1.0114	1.3360	1.6579	1.9778	2.2960	2.6126
50-60		1.0095	1.4945	1.9742	2.4499	2.9226	3.3927	3.8607
60-70		1.3965	2.0674	2.7310	3.3892	4.0430	4.6934	5.3407
70-80		1.8434	2.7290	3.6050	4.4738	5.3369	6.1954	7.0499
80-90		2.3496	3.4784	4.5949	5.7022	6.8024	7.8966	8.9857
90-100		2.9145	4.3147	5.6996	7.0732	8.4379	9.7952	11.1462

* This General Volume Table has been taken from Phase I report.

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APPENDIX 3.18 (VIDE PARA 7.4.1 OF REPORT)

GENERAL VOLUME TABLE*

SPECIES - TSUGA BRUNONIANA

DIAMETER (cm)	HEIGHT (m)	10	15	20	25	30	35	40	45	50
5-10		0.0200	0.0305	0.0413	0.0521	0.0630	0.0741	0.0852	0.0963	0.1075
10-20		0.0767	0.1172	0.1583	0.1999	0.2419	0.2842	0.3268	0.3696	0.4127
20-30		0.2020	0.3087	0.4170	0.5266	0.6373	0.7487	0.8609	0.9738	1.0872
30-40		0.3801	0.5808	0.7847	0.9909	1.1991	1.4088	1.6199	1.8322	2.0456
40-50		0.6082	0.9294	1.2556	1.5956	1.9186	2.2542	2.5920	2.9317	3.2731
50-60		0.8844	1.3514	1.8257	2.3055	2.7897	3.2777	3.7688	4.2628	4.7593
60-70		1.2072	1.8446	2.4920	3.1469	3.8078	4.4738	5.1442	5.8185	6.4962
70-80		1.5753	2.4071	3.2519	4.1066	4.9691	5.8382	6.7131	7.5929	8.4773
80-90		1.9878	3.0375	4.1035	5.1820	6.2704	7.3671	8.4711	9.5814	10.6973
90-100		2.4439	3.7344	5.0450	6.3709	7.7090	9.0574	10.4146	11.7797	13.1517

* This General Volume Table has been taken from Phase I report.

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APPENDIX 3.19 (VIDE PARA 7.4.1 OF REPORT)

GENERAL VOLUME TABLE*

SPECIES - QUERCUS SPECIES

DIAMETER CLASS (cm)	HEIGHT IN METRE						
	10	15	20	25	30	35	40
5-10	0.0213	0.0310	0.0406	0.0502	0.0598	0.0694	0.0790
10-20	0.0846	0.1259	0.1671	0.2084	0.2496	0.2909	0.3321
20-30	0.2376	0.3554	0.4732	0.5909	0.7087	0.8265	0.9442
30-40	0.4691	0.7027	0.9362	1.1697	1.4032	1.6367	1.8702
40-50	0.7791	1.1676	1.5561	1.9446	2.3332	2.7217	3.1102
50-60	1.1676	1.7503	2.3331	2.9158	3.4985	4.0813	4.6640
60-70	1.6345	2.4507	3.2669	4.0831	4.8993	5.7155	6.5317
70-80	2.1799	3.2688	4.3577	5.4467	6.5356	7.6245	8.7134
80-90	2.8038	4.2047	5.6055	7.0064	8.4072	9.8081	11.2089
90-100	3.5062	5.2582	7.0102	8.7623	10.5143	12.2664	14.0184
100+	4.2870	6.4295	8.5719	10.7144	12.8568	14.9993	17.1417

*This General Volume Table has been taken from Phase I report.

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APPENDIX 3.20 (VIDE PARA 7.4.1 OF REPORT)

GENERAL VOLUME TABLE*

SPECIES - BETULA SPP.

DIAMETER (cm)	HEIGHT (m)	10	15	20	25	30
5-10		0.0191	0.0268	0.0341	0.0412	0.0479
10-20		0.0844	0.1185	0.1508	0.1818	0.2118
20-30		0.2460	0.3455	0.4397	0.5300	0.6174
30-40		0.4946	0.6946	0.8838	1.0654	1.2411
40-50		0.8313	1.1674	1.4854	1.7906	2.0860
50-60		1.2570	1.7652	2.2461	2.7076	3.1542
60-70		1.7724	2.4890	3.1671	3.8179	4.4477
70-80		2.3782	3.3398	4.2496	5.1228	5.9679

* This General Volume Table has been taken from Phase I report.

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APPENDIX 3.21 (VIDE PARA 7.4.1 OF REPORT)

GENERAL VOLUME TABLE*

SPECIES - MISC. HARDWOODS

DIAMETER CLASS (cm)	HEIGHT IN METRE					
	10	15	20	25	30	35
5-10	0.0193	0.0269	0.0341	0.0410	0.0476	0.0541
10-20	0.0819	0.1143	0.1448	0.1740	0.2022	0.2295
20-30	0.2318	0.3236	0.4101	0.4928	0.5725	0.6500
30-40	0.4573	0.6384	0.8089	0.9720	1.1293	1.2821
40-50	0.7578	1.0580	1.3406	1.6108	1.8715	2.1247
50-60	1.1331	1.5819	2.0045	2.4085	2.7984	3.1769
60-70	1.5839	2.2100	2.8003	3.3647	3.9094	4.4382
70-80	2.1072	2.9418	3.7276	4.4790	5.2041	5.9079
80-90	2.7056	3.7772	4.7862	5.7510	6.6819	7.5857

* This General Volume Table has been taken from Phase I report.

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APPENDIX 4.1 (VIDE PARA 7.6.3 OF REPORT)

VOLUME PER HECTARE BY SPECIES AND DIAMETER CLASSES

FOREST TYPE - CHIR

SPECIES	DIAMETER CLASSES (cm)									
	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80+	Total	%
1	2	3	4	5	6	7	8	9	10	11
Pinus roxburghii	2.541	6.916	12.355	19.651	19.423	11.205	3.176	3.726	78.993	86.4
Total conifers	2.541	6.916	12.355	19.651	19.423	11.205	3.176	3.726	78.993	86.4
Michelia spp.	-	-	-	-	-	0.189	-	-	0.189	0.2
TOTAL GROUP 'A' (BROAD LEAVED)SPP.	-	-	-	-	-	0.189	-	-	0.189	0.2
Duabanga Sonneratioides	-	-	0.130	-	0.158	-	-	-	0.288	0.3
Salmalia malabaricum	-	-	-	-	-	-	-	0.187	0.187	0.2
Schima wallichii	0.142	0.330	-	0.148	0.159	-	-	-	0.779	0.8
TOTAL GROUP 'B' (BROAD LEAVED)SPP.	0.142	0.330	0.130	0.148	0.317	-	-	0.187	1.254	1.3
Albizzia spp.	0.084	0.113	-	-	0.165	-	-	-	0.362	0.4
astanopsis spp.	-	0.427	0.736	0.494	0.268	0.619	-	-	2.544	2.8
OTAL GROUP 'C' BROAD LEAVED)SPP.	0.084	0.540	0.736	0.494	0.433	0.619	-	-	2.906	3.2

Contents

Cont'd.

1	2	3	4	5	6	7	8	9	10	11
Quercus spp.	0.317	0.418	1.144	0.911	0.198	0.414	0.216	-	3.618	4.0
Sterculia villosa	-	0.125	-	-	-	-	-	-	0.125	0.1
TOTAL GROUP 'D' (BROAD LEAVED)SPP.	0.317	0.543	1.144	0.911	0.198	0.414	0.216	-	3.743	4.1
Ficus spp.	-	0.106	0.133	-	-	-	-	-	0.239	0.3
Macaranga spp.	-	0.119	-	-	-	-	-	-	0.119	0.1
Rhododendron spp.	0.148	0.762	0.212	0.465	-	0.134	-	-	1.721	1.9
Miscellaneous spp.	1.174	0.690	0.269	0.154	-	-	-	-	2.287	2.5
TOTAL GROUP 'E' (BROAD LEAVED)SPP.	1.322	1.677	0.614	0.619	-	0.134	-	-	4.366	4.8
Total Broad leaved spp.	1.865	3.090	2.624	2.172	0.948	1.356	0.216	0.187	12.458	13.6
TOTAL CONIFERS AND BROAD LEAVED SPP.	4.406	10.006	14.979	21.823	20.371	12.561	3.392	3.913	91.451	
%	4.8	10.9	16.4	23.9	22.3	13.7	3.7	4.3		100

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APPENDIX 4.2 (VIDE PARA 7.6.3 OF REPORT)

VOLUME PER HECTARE BY SPECIES AND DIAMETER CLASSES

FOREST TYPE - KAIL

SPECIES	DIAMETER CLASSES (cm)									
	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80+	Total	%
1	2	3	4	5	6	7	8	9	10	11
linus wallichiana	4.451	9.156	14.780	12.865	12.129	3.997	7.283	6.045	70.706	71.2
Larix griffithii	-	-	-	0.299	-	-	-	-	0.299	0.3
Picea spinulosa	1.097	2.027	1.752	2.779	2.261	0.486	-	-	10.402	10.5
Tsuga brunoniana	0.894	0.628	1.117	1.975	0.410	-	-	0.428	5.452	5.5
Total conifers	6.442	11.811	17.649	17.918	14.800	4.483	7.283	6.473	86.859	87.5
Betula spp.	0.561	-	-	-	-	-	-	-	0.561	0.6
TOTAL GROUP 'A' (BROAD LEAVED)SPP.	0.561	-	-	-	-	-	-	-	0.561	0.6
Acer spp.	0.756	0.489	-	-	-	-	-	-	1.245	1.3
TOTAL GROUP 'B' (BROAD LEAVED)SPP.	0.756	0.489	-	-	-	-	-	-	1.245	1.3
Populus spp.	-	-	0.281	-	-	-	-	-	0.281	0.3

Contents

Contd.

1	2	3	4	5	6	7	8	9	10	11
Quercus spp.	0.354	0.593	1.355	3.009	0.394	0.431	0.444	-	6.580	6.6
TOTAL GROUP 'D' (BROAD LEAVED)SPP.	0.354	0.593	1.636	3.009	0.394	0.431	0.444	-	6.861	6.9
Rhododendron spp.	0.278	0.162	0.398	-	-	-	-	-	0.838	0.8
Miscellaneous spp.	0.751	1.611	0.537	-	-	-	-	-	2.899	2.9
TOTAL GROUP 'E' (BROAD LEAVED)SPP.	1.029	1.773	0.935	-	-	-	-	-	3.737	3.7
Total Broad leaved spp.	2.700	2.855	2.571	3.009	0.394	0.431	0.444	-	12.404	12.5
TOTAL FOR CONIFERS AND BROAD LEAVED SPP.	9.142	14.666	20.220	20.927	15.194	4.914	7.727	6.473	99.263	
%	9.2	14.8	20.4	21.1	15.3	4.9	7.8	6.5		100

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APPENDIX 4.3 (VIDE PARA 7.6.3 OF REPORT)

VOLUME PER HECTARE BY SPECIES AND DIAMETER CLASSES

FOREST TYPE - FIR SPRUCE

SPECIES	DIAMETER CLASSES (cm)									
	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80+	Total	%
1	2	3	4	5	6	7	8	9	10	11
Abies densa	7.172	16.844	26.863	50.065	59.236	58.211	49.431	104.999	372.821	83.0
Picea spinulosa	0.500	0.698	1.097	0.576	1.184	1.309	0.931	3.264	9.559	2.1
Cupressus spp.	-	0.065	-	0.085	-	-	0.105	-	0.255	-
Juniperus spp.	0.366	0.841	0.709	0.525	0.093	0.200	-	-	2.734	0.6
Pinus wallichiana	0.051	0.092	0.207	-	-	-	-	-	0.350	0.1
Tsuga brunoniana	0.089	0.091	0.212	0.114	0.469	0.120	0.966	9.695	11.756	2.6
Total conifers	8.178	18.631	29.088	51.365	60.982	59.840	51.433	117.958	397.475	88.5
Betula spp.	1.905	2.440	4.014	2.403	1.679	0.342	0.118	-	12.901	2.9
TOTAL GROUP 'A' (BROAD LEAVED) SPP.	1.905	2.440	4.014	2.403	1.679	0.342	0.118	-	12.901	2.9
Acer spp.	2.797	2.678	0.809	-	0.100	-	-	-	6.384	1.4
TOTAL GROUP 'B' (BROAD LEAVED)SPP.	2.797	2.678	0.809	-	0.100	-	-	-	6.384	1.4

Contents

Contd.

1	2	3	4	5	6	7	8	9	10	11
Prunus spp.	0.470	0.334	-	-	-	-	-	-	0.804	0.2
TOTAL GROUP 'D' (BROAD LEAVED)SPP.	0.470	0.334	-	-	-	-	-	-	0.804	0.2
Rhododendron spp.	13.238	5.096	1.256	0.602	0.077	-	-	-	20.269	4.5
Miscellaneous spp.	4.026	3.422	1.370	1.127	0.564	0.296	0.417	-	11.222	2.5
TOTAL GROUP 'E' (BROAD LEAVED)SPP.	17.264	8.518	2.626	1.729	0.641	0.296	0.417	-	31.491	7.0
Total Broad leaved spp.	22.436	13.970	7.449	4.132	2.420	0.638	0.535	-	51.580	11.5
TOTAL CONIFERS AND BROAD LEAVED SPP.	30.614	32.601	36.537	55.497	63.402	60.478	51.968	117.958	449.055	
%	6.8	7.3	8.1	12.3	14.1	13.5	11.6	26.3		100

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APPENDIX 4.4 (VIDE PARA 7.6.3 OF REPORT)

VOLUME PER HECTARE BY SPECIES AND DIAMETER CLASSES

FOREST TYPE - MIXED CONIFERS

SPECIES	DIAMETER CLASSES (cm)									
	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80+	Total	%
1	2	3	4	5	6	7	8	9	10	11
Abies densa	0.734	0.274	1.677	3.136	4.621	6.128	5.878	13.076	35.524	10.5
Cupressus spp.	-	0.184	0.627	0.704	0.501	-	-	-	2.016	0.6
Juniperus spp.	1.967	2.160	2.721	1.409	0.508	0.268	0.286	0.327	9.646	2.9
Larix griffithii	-	-	-	-	0.254	0.275	0.290	-	0.819	0.2
Picea spinulosa	0.346	1.075	1.671	4.420	3.570	5.421	4.765	9.793	31.061	9.2
Pinus wallichiana	-	0.943	1.400	4.370	3.593	3.059	0.793	3.367	17.525	5.2
Taxus baccata	0.262	0.541	0.860	0.951	0.509	0.547	-	0.957	4.627	1.4
Tsuga brunoniana	4.013	5.196	11.936	13.817	18.099	20.766	19.700	88.374	181.901	53.9
Total conifers	7.322	10.373	20.892	28.807	31.655	36.464	31.712	115.894	283.119	83.9
Betula species	1.850	3.264	3.057	1.830	1.429	0.306	-	-	11.736	3.5
TOTAL GROUP 'A' (BROAD LEAVED)SPP.	1.850	3.264	3.057	1.830	1.429	0.306	-	-	11.736	3.5

Contents

Contd.

1	2	3	4	5	6	7	8	9	10	11
Acer spp.	2.405	4.365	1.103	1.457	1.338	0.286	-	-	10.954	3.2
TOTAL GROUP 'B' (BROAD LEAVED)SPP.	2.405	4.365	1.103	1.457	1.338	0.286	-	-	10.954	3.2
Alnus spp.	0.241	-	-	0.241	-	-	-	-	0.482	0.1
Machilus spp.	0.290	-	-	-	-	-	-	-	0.290	0.1
TOTAL GROUP 'C' (BROAD LEAVED)SPP.	0.531	-	-	0.241	-	-	-	-	0.772	0.2
Populus spp.	-	-	-	0.244	-	-	-	-	0.244	0.1
Prunus spp.	-	0.494	0.204	-	-	-	-	-	0.698	0.2
Quercus spp.	0.102	-	1.028	0.579	0.313	0.328	-	-	2.350	0.7
TOTAL GROUP 'D' (BROAD LEAVED)SPP.	0.102	0.494	1.232	0.823	0.313	0.328	-	-	3.292	1.0
Aesculus punduana	-	-	-	-	0.257	-	-	-	0.257	0.1
Cinnamomum tamala	0.596	-	-	-	-	-	-	-	0.596	0.2
Rhododendron spp.	5.763	4.253	3.282	0.907	0.406	-	0.467	-	15.078	4.5
Symplocos spicata	0.497	0.189	-	-	-	-	-	-	0.686	0.2
Miscellaneous spp.	4.412	2.280	1.542	1.435	0.250	0.811	-	0.302	11.032	3.2

Contents

Contd.

1	2	3	4	5	6	7	8	9	10	11
TOTAL GROUP 'E' (BROAD LEAVED)SPP.	11.268	6.722	4.824	2.342	0.913	0.811	0.467	0.302	27.649	8.2
Total Broad leaved spp.	16.156	14.845	10.216	6.693	3.993	1.731	0.467	0.302	54.403	16.1
TOTAL CONIFERS AND BROAD LEAVED SPP.	23.478	25.218	31.108	35.500	35.648	38.195	32.179	116.196	337.522	
%	7.0	7.5	9.2	10.5	10.6	11.3	9.5	34.4		100

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APPENDIX 4.5 (VIDE PARA 7.6.3 OF REPORT)

VOLUME PER HECTARE BY SPECIES AND DIAMETER CLASSES

FOREST TYPE - CONIFERS MIXED WITH BROAD LEAVED

SPECIES	DIAMETER CLASSES (cm)									
	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80+	Total	%
1	2	3	4	5	6	7	8	9	10	11
Abies densa	0.740	1.700	3.531	9.901	6.385	3.690	1.857	17.877	45.681	15.3
Juniperus spp.	-	-	-	-	-	-	-	0.964	0.964	0.3
Pinus roxburghii	1.095	2.005	2.433	4.511	4.358	-	-	-	14.402	4.8
Pinus wallichiana	-	-	-	2.091	-	2.387	-	-	4.478	1.5
Taxus baccata	-	1.157	-	2.279	0.818	0.850	1.794	-	6.898	2.3
Tsuga brunoniana	0.316	0.790	3.652	2.902	2.008	3.073	3.113	50.997	66.851	22.3
Total conifers	2.151	5.652	9.616	21.684	13.569	10.000	6.764	69.838	139.274	46.5
Betula spp.	2.441	5.703	8.232	8.330	3.520	1.940	1.017	-	31.183	10.4
TOTAL GROUP 'A' (BROAD LEAVED)SPP.	2.441	5.703	8.232	8.330	3.520	1.940	1.017	-	31.183	10.4
Acer spp.	6.955	8.454	4.153	5.468	0.866	-	-	-	25.896	8.7
TOTAL GROUP 'B' (BROAD LEAVED)SPP.	6.955	8.454	4.153	5.468	0.866	-	-	-	25.896	8.7

Contents

Contd.

1	2	3	4	5	6	7	8	9	10	11
Castanopsis spp.	-	0.396	0.527	0.606	2.047	-	0.866	1.154	5.596	1.9
TOTAL GROUP 'C' (BROAD LEAVED)SPP.	-	0.396	0.527	0.606	2.047	-	0.866	1.154	5.596	1.9
Quercus spp.	-	-	1.683	2.760	1.978	3.123	-	4.830	14.374	4.8
TOTAL GROUP 'D' (BROAD LEAVED)SPP.	-	-	1.683	2.760	1.978	3.123	-	4.830	14.374	4.8
Aesculus punduana	-	-	-	-	-	-	-	0.938	0.938	0.3
Rhododendron spp.	15.445	10.755	6.384	2.251	1.891	-	-	-	36.726	12.3
Miscellaneous spp.	15.822	11.701	5.318	4.471	1.596	1.693	2.704	1.961	45.266	15.1
TOTAL GROUP 'E' (BROAD LEAVE)SPP.	31.267	22.456	11.702	6.722	3.487	1.693	2.704	2.899	82.930	27.7
Total Broad leaved spp.	40.663	37.009	26.297	23.886	11.898	6.756	4.587	8.883	159.979	53.5
TOTAL CONIFERS AND BROAD LEAVED SPP.	42.814	42.661	35.913	45.570	25.467	16.756	11.351	78.721	299.253	
%	14.3	14.3	12.0	15.2	8.5	5.6	3.8	26.3		100

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APPENDIX 4.6 (VIDE PARA 7.6.3 OF REPORT)

VOLUME PER HECTARE BY SPECIES AND DIAMETER CLASSES

FOREST TYPE - HARD WOODS

SPECIES	DIAMETER CLASSES (cm)									
	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80+	Total	%
1	2	3	4	5	6	7	8	9	10	11
Betula spp.	0.725	0.904	1.021	1.105	0.783	0.356	0.117	0.197	5.208	2.2
Juglans regia	-	0.030	-	0.020	-	0.048	0.076	0.084	0.258	0.1
Michelia spp.	0.068	0.574	0.686	1.141	1.132	1.185	1.200	4.428	10.414	4.4
Morus laevigata	-	0.030	0.057	0.064	0.135	0.071	0.050	0.481	0.888	0.4
Phoebe goalparensis	0.065	0.121	0.230	0.177	0.357	0.399	0.265	0.468	2.082	0.9
Terminalia myriocarpa	-	0.034	0.036	0.042	0.023	-	0.050	0.180	0.365	0.2
TOTAL GROUP 'A' (BROAD LEAVED)SPP.	0.858	1.693	2.030	2.549	2.430	2.059	1.758	5.838	19.215	8.2
Acer spp.	0.838	0.705	0.608	0.762	0.741	0.912	0.775	1.995	7.336	3.1
Ailantus grandis	0.009	-	-	-	-	0.024	0.075	0.079	0.187	0.1
Altingia excelsa	0.035	0.033	0.037	0.064	0.023	0.142	0.151	1.105	1.590	0.7
Amoora wallichii	0.057	0.016	0.037	0.022	0.022	-	0.025	0.026	0.205	0.1

Contents

Contd.

1	2	3	4	5	6	7	8	9	10	11
Cedrela spp.	0.032	0.063	0.037	0.084	0.044	0.024	0.075	0.692	1.051	0.5
Cinnamomum cecicodaphne	0.096	0.108	0.076	0.146	0.090	0.048	0.099	0.193	0.856	0.4
Luabanga sonneratioides	-	0.048	0.018	-	0.023	0.048	0.076	0.086	0.299	0.1
Phoebe hainesiana	0.022	0.031	0.130	0.401	0.587	0.600	0.325	0.885	2.981	1.3
Salmalia malabaricum	-	0.077	0.038	0.042	0.045	0.024	-	-	0.226	0.1
Schima wallichii	0.220	0.218	0.464	0.441	0.773	0.647	0.551	1.239	4.553	1.9
Tetrameles nudiflora	-	-	-	-	-	0.025	-	0.027	0.052	-
TOTAL GROUP 'B' (BROAD LEAVED)SPP.	1.309	1.299	1.445	1.962	2.348	2.494	2.152	6.327	19.336	8.3
Acrocarpus fraxinifolius	-	0.017	-	-	-	-	-	0.117	0.134	0.1
Albizzia spp.	0.143	0.112	0.075	0.148	0.045	0.024	0.025	0.030	0.602	0.3
Alnus spp.	0.243	0.386	0.563	0.668	0.584	0.456	0.226	0.671	3.797	1.6
Bucklandia populnea	0.107	0.349	0.114	0.020	0.136	0.120	0.049	0.614	1.509	0.6
Castanopsis spp.	0.228	0.581	0.808	0.905	0.782	0.391	0.479	0.350	4.524	1.9

Contents

Contd.

1	2	3	4	5	6	7	8	9	10	11
Machilus spp.	0.754	1.363	2.025	3.049	3.109	1.965	1.897	1.855	16.017	6.8
TOTAL GROUP 'C' (BROAD LEAVED)SPP.	1.475	2.808	3.585	4.790	4.656	2.956	2.676	3.637	26.583	11.3
Bischofia javanica	0.014	0.017	0.019	0.084	0.022	-	0.025	0.056	0.237	0.1
Garuga pinnata	0.013	0.017	0.075	0.043	-	-	0.126	0.078	0.352	0.2
Lagerstroemia parviflora	0.139	0.064	-	0.020	-	-	-	-	0.223	0.1
Populus spp.	-	0.030	0.020	-	-	-	0.050	0.165	0.265	0.1
Prunus spp.	0.011	-	-	-	-	0.023	-	0.054	0.088	-
Pterospermum acerifolium	0.023	0.017	0.018	0.021	0.046	-	0.025	-	0.150	0.1
Quercus spp.	3.422	5.392	7.951	8.863	7.937	8.112	7.008	23.405	72.090	30.7
Sterculia villosa	0.010	0.016	0.094	0.041	0.045	0.096	0.026	0.081	0.409	0.2
Syzigium cumini	0.074	0.047	0.132	0.021	0.022	-	-	0.029	0.325	0.1
TOTAL GROUP 'D' (BROAD LEAVED) SPP.	3.706	5.600	8.309	9.093	8.072	8.231	7.260	23.868	74.139	31.6
Aesculus punduana	0.138	0.213	0.358	0.209	0.341	0.239	0.100	0.059	1.657	0.7
Amoora rohituka	0.065	0.064	0.018	0.021	0.113	0.073	-	0.083	0.437	0.2

Contents

Contd.

1	2	3	4	5	6	7	8	9	10	11
Cinnamomum tamala	0.105	0.145	0.209	0.146	0.045	0.095	-	0.056	0.801	0.3
Engelhardtia spicata	0.171	0.125	0.179	0.235	0.076	0.057	0.218	1.179	2.240	1.0
Ficus spp.	0.272	0.458	0.506	0.252	0.271	0.071	0.026	0.592	2.448	1.0
Kydia caly-cina	0.013	0.109	0.039	0.063	0.068	-	-	0.029	0.321	0.1
Macranga spp.	0.287	0.252	0.408	0.248	0.180	0.048	0.025	-	1.448	0.6
Ostodes paniculata	0.163	0.192	0.128	0.168	0.090	-	-	0.026	0.767	0.3
Rhododendron spp.	2.601	2.616	1.927	1.168	0.678	0.425	0.122	0.112	9.649	4.1
Symplocos spicata	0.499	0.881	0.241	0.209	0.199	0.052	0.134	0.197	2.412	1.0
Vitex heterophylla	0.018	-	0.038	-	0.022	0.048	-	0.054	0.180	0.1
Miscellaneous spp.	9.202	11.506	11.363	8.610	7.204	5.534	3.862	8.991	66.272	28.2
TOTAL GROUP 'E' (BROAD LEAVED)SPP.	13,534	16.561	15.414	11.329	9.287	6.642	4.487	11.378	88.632	37.6
Total Broad leaved spp.	20.882	27.961	30.783	29.723	26.793	22.382	18.333	51.048	227.905	97.0
Abies densa	0.020	-	0.025	0.151	0.306	0.309	0.259	1.390	2.460	1.1
Juniperus spp.	0.011	0.015	-	0.043	0.091	-	-	-	0.160	0.1
Picea spinulosa	-	0.018	-	0.029	0.095	0.070	-	-	0.212	0.1

Contents

Contd.

1	2	3	4	5	6	7	8	9	10	11
Pinus roxburghii	-	0.048	0.021	0.161	0.157	0.100	0.145	0.118	0.750	0.3
Pinus wallichiana	-	0.040	0.026	0.119	0.063	-	-	0.074	0.322	0.1
Taxus baccata	-	-	0.055	0.103	0.136	0.024	0.125	0.254	0.697	0.3
Tsuga brunoniana	-	0.042	0.048	0.162	0.112	0.115	0.261	1.541	2.281	1.0
Total conifers	0.031	0.163	0.175	0.768	0.960	0.618	0.790	3.377	6.882	3.0
TOTAL BROAD LEAVED AND CONIFERS	20.913	28.124	30.958	30.491	27.753	23.000	19.123	54.425	234.787	
%	8.9	12.0	13.2	13.0	11.8	9.8	8.1	23.2		100

Contents

APPENDIX 5.1 (VIDE PARA 7.8.1 OF REPORT)

ESTIMATED TOTAL VOLUME IN '000' m^3 BY SPECIES AND DIAMETER CLASSES

FOREST TYPE - CHIR

SPECIES	DIAMETER CLASSES (cm)									
	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80+	Total	%
1	2	3	4	5	6	7	8	9	10	11
Pinus roxburghii	190.140	517.487	924.493	1470.495	1453.391	838.486	237.636	278.837	5910.965	86.4
Total for coniferous spp.	190.140	517.487	924.493	1470.495	1453.391	838.486	237.636	278.837	5910.965	86.4
Michelia spp.	-	-	-	-	-	14.156	-	-	14.156	0.2
TOTAL GROUP 'A' (BROAD LEAVED)SPP.	-	-	-	-	-	14.156	-	-	14.156	0.2
Duabanga sonneratioides	-	-	9.702	-	11.836	-	-	-	21.538	0.3
Salmalia malabaricum	-	-	-	-	-	-	-	14.014	14.014	0.2
Schima wallichii	10.621	24.699	-	11.069	11.922	-	-	-	58.311	0.8
TOTAL GROUP 'B' (BROAD LEAVED)SPP.	10.621	24.699	9.702	11.069	23.758	-	-	14.014	93.863	1.3
Albizzia spp.	6.316	8.443	-	-	12.325	-	-	-	27.084	0.4
Castanopsis spp.	-	31.941	55.039	36.986	20.032	46.312	-	-	190.310	2.8
TOTAL GROUP 'C' (BROAD LEAVED)SPP.	6.316	40.384	55.039	36.986	32.357	46.312	-	-	217.394	3.2

Contents

Contd.

1	2	3	4	5	6	7	8	9	10	11
Quercus spp.	23.710	31.241	85.634	68.194	14.812	30.992	16.188	-	270.771	4.0
Sterculia villosa	-	9.319	-	-	-	-	-	-	9.319	0.1
TOTAL GROUP 'D' (BROAD LEAVED)SPP.	23.710	40.560	85.634	68.194	14.812	30.992	16.188	-	280.090	4.1
Ficus spp.	-	7.936	9.985	-	-	-	-	-	17.921	0.3
Macranga spp.	-	8.902	-	-	-	-	-	-	8.902	0.1
Rhododendron spp.	11.048	57.035	15.893	34.770	-	10.045	-	-	128.791	1.9
Miscellaneous spp.	87.842	51.660	20.157	11.519	-	-	-	-	171.178	2.5
TOTAL GROUP 'E' (BROAD LEAVED)SPP.	98.890	125.533	46.035	46.289	-	10.045	-	-	326.792	4.8
Total for Broad leaved spp.	139.537	231.176	196.410	162.538	70.927	101.505	16.188	14.014	932.295	13.6
TOTAL FOR CONIFERS AND BROAD LEAVED SPP.	329.677	748.663	1120.903	1633.033	1524.318	939.991	253.824	292.851	6843.260	
%	4.8	10.9	16.4	23.9	22.3	13.7	3.7	4.3		100

Contents

APPENDIX 5.2 (VIDE PARA 7.8.1 OF REPORT)

ESTIMATED TOTAL VOLUME IN '000' m^3 BY SPECIES AND DIAMETER CLASSES

FOREST TYPE - KAIL

SPECIES	DIAMETER CLASSES (cm) 10-20	20-30	30-40	40-50	50-60	60-70	70-80	80+	Total	%
1	2	3	4	5	6	7	8	9	10	11
Pinus wallichiana	73.956	152.126	245.561	213.744	201.528	66.405	121.008	100.434	1174.762	71.2
Larix griffithii	-	-	-	4.963	-	-	-	-	4.963	0.3
Picea spinulosa	18.227	33.674	29.117	46.173	37.574	8.067	-	-	172.832	10.5
Tsuga brunoniana	14.852	10.426	18.557	32.811	6.815	-	-	7.110	90.571	5.5
Total for coniferous spp.	107.035	196.226	293.235	297.691	245.917	74.472	121.008	107.544	1443.128	87.5
Betula spp.	9.323	-	-	-	-	-	-	-	9.323	0.6
TOTAL GROUP 'A' (BROAD LEAVED) SPP.	9.323	-	-	-	-	-	-	-	9.323	0.6
Acer spp.	12.569	8.131	-	-	-	-	-	-	20.700	1.3
TOTAL GROUP 'B' (BROAD LEAVED) SPP.	12.569	8.131	-	-	-	-	-	-	20.700	1.3
Populus spp.	-	-	4.664	-	-	-	-	-	4.664	0.3

Contents

Contd.

1	2	3	4	5	6	7	8	9	10	11
Quercus spp.	5.890	9.849	22.521	49.993	6.550	7.162	7.381	-	109.346	6.6
TOTAL GROUP 'D' (BROAD LEAVED)SPP.	5.890	9.849	27.185	49.993	6.550	7.162	7.381	-	114.010	6.9
Rhododendron spp.	4.625	2.683	6.615	-	-	-	-	-	13.923	0.8
Miscellaneous spp.	12.483	26.761	8.921	-	-	-	-	-	48.165	2.9
TOTAL GROUP 'E' (BROAD LEAVED)SPP.	17.108	29.444	15.536	-	-	-	-	-	62.088	3.7
Total of Broad leaved spp.	44.890	47.424	42.721	49.993	6.550	7.162	7.381	-	206.121	12.5
TOTAL OF BROAD LEAVED AND CONIFERS SPP.	151.925	243.650	335.956	347.684	252.467	81.634	128.389	107.544	1649.249	
%	9.2	14.8	20.4	21.1	15.3	4.9	7.8	6.5		100

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APPENDIX 5.3 (VIDE PARA 7.8.1 OF REPORT)

ESTIMATED TOTAL VOLUME IN '000' m^3 BY SPECIES AND DIAMETER CLASSES

FOREST TYPE - FIR SPRUCE

SPECIES	DIAMETER CLASSES (cm) 10-20	20-30	30-40	40-50	50-60	60-70	70-80	80+	Total	%
1	2	3	4	5	6	7	8	9	10	11
Abies densa	748.851	1758.775	2804.941	5227.648	6185.309	6078.238	5161.488	10963.820	38929.070	83.0
Picea spinulosa	52.209	72.913	114.561	60.141	123.610	136.712	97.173	340.817	998.136	2.1
Cupressus spp.	-	6.771	-	8.893	-	-	11.006	-	26.670	0.1
Juniperus spp.	38.188	87.824	73.985	54.779	9.673	20.839	-	-	285.288	0.6
Pinus wallichiana	5.309	9.648	21.565	-	-	-	-	-	36.522	0.1
Tsuga brunoniana	9.323	9.474	22.134	11.854	48.969	12.506	100.844	1012.372	1227.476	2.6
TOTAL FOR CONIFEROUS SPP.	853.880	1945.405	3037.186	5363.315	6367.561	6248.295	5370.511	12317.009	41503.162	88.5
Betula spp.	198.871	254.813	419.151	250.938	175.334	35.754	12.349	-	1347.210	2.9
TOTAL GROUP 'A' (BROAD LEAVED) SPP.	198.871	254.813	419.151	250.938	175.334	35.754	12.349	-	1347.210	2.9
Acer spp.	292.032	279.594	84.519	-	10.403	-	-	-	666.548	1.4
TOTAL GROUP 'B' (BROAD LEAVED) SPP.	292.032	279.594	84.519	-	10.403	-	-	-	666.548	1.4

Contents

Contd.

1	2	3	4	5	6	7	8	9	10	11
Prunus spp.	49.077	34.871	-	-	-	-	-	-	83.948	0.2
TOTAL GROUP 'D' (BROAD LEAVED) SPP.	49.077	34.871	-	-	-	-	-	-	83.948	0.2
Rhododendron spp.	1382.321	532.140	131.145	62.896	8.017	-	-	-	2116.519	4.5
Miscellaneous spp.	420.391	357.332	143.103	117.666	58.916	30.935	43.553	-	1171.896	2.5
TOTAL GROUP 'E' (BROAD LEAVED) SPP.	1802.712	889.472	274.248	180.562	66.933	30.935	43.553	-	3288.415	7.0
Total for Broad leaved spp.	2342.692	1458.750	777.918	431.500	252.670	66.689	55.902	-	5386.121	11.5
TOTAL FOR CONIFERS AND BROAD LEAVED SPP.	3196.572	3404.155	3815.104	5794.815	6620.231	6314.984	5426.413	12317.009	46889.283	
%	6.8	7.3	8.1	12.3	14.1	13.5	11.6	26.3		100

Contents

APPENDIX 5.4 (VIDE PARA 7.8.1 OF REPORT)

ESTIMATED TOTAL VOLUME IN '000' m^3 BY SPECIES AND DIAMETER CLASSES

FOREST TYPE - MIXED CONIFERS

SPECIES	DIAMETER CLASSES (cm)									
	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80+	Total	%
1	2	3	4	5	6	7	8	9	10	11
Abies densa	32.821	12.237	74.934	140.145	206.479	273.857	262.675	584.320	1587.468	10.5
Cupressus spp.	-	8.243	28.005	31.474	22.407	-	-	-	90.129	0.6
Juniperus spp.	87.893	96.525	121.609	62.967	22.683	11.956	12.768	14.596	430.997	2.8
Larix griffithii	-	-	-	-	11.345	12.299	12.966	-	36.610	0.2
Picea spinulosa	15.464	48.032	74.667	197.515	159.521	242.265	212.951	437.602	1388.017	9.2
Pinus wallichiana	-	42.131	62.543	195.303	160.543	136.719	35.454	150.440	783.133	5.2
Taxus baccata	11.706	24.166	38.426	42.517	22.747	24.437	-	42.775	206.774	1.4
Tsuga brunoniana	179.313	232.209	533.366	617.443	808.803	927.987	880.337	3949.160	8128.618	53.9
Total for conifers spp.	327.197	463.543	933.550	1287.364	1414.528	1629.520	1417.151	5178.893	12651.746	83.8
Betula spp.	82.679	145.869	136.605	81.789	63.865	13.672	-	-	524.479	3.5
TOTAL GROUP 'A' (BROAD LEAVED)SPP.	82.679	145.869	136.605	81.789	63.865	13.672	-	-	524.479	3.5

Contents

Contd.

1	2	3	4	5	6	7	8	9	10	11
Acer	107.456	195.050	49.294	65.127	59.774	12.791	-	-	489.492	3.2
TOTAL GROUP 'B' (BROAD LEAVED)SPP.	107.456	195.050	49.294	65.127	59.774	12.791	-	-	489.492	3.2
Alnus spp.	10.755	-	-	10.748	-	-	-	-	21.503	0.1
Machilus spp.	12.959	-	-	-	-	-	-	-	12.959	0.1
TOTAL GROUP 'C' (BROAD LEAVED)SPP.	23.714	-	-	10.748	-	-	-	-	34.462	0.2
Populus spp.	-	-	-	10.885	-	-	-	-	10.885	0.1
Prunus spp.	-	22.076	9.097	-	-	-	-	-	31.173	0.2
Quercus spp.	4.552	-	45.927	25.875	13.996	14.643	-	-	104.993	0.7
TOTAL GROUP 'D' (BROAD LEAVED)SPP.	4.552	22.076	55.024	36.760	13.996	14.643	-	-	147.051	1.0
Aesculus punduana	-	-	-	-	11.499	-	-	-	11.499	0.1
Cinnamomum tamala	26.640	-	-	-	-	-	-	-	26.640	0.2
Rhododendron spp.	257.524	190.050	146.675	40.551	18.140	-	20.855	-	673.795	4.5
Symplocos spicata	22.199	8.441	-	-	-	-	-	-	30.640	0.2
Miscellaneous spp.	197.175	101.895	68.905	64.145	11.184	36.238	-	13.514	493.056	3.3

Contents

Contd.

1	2	3	4	5	6	7	8	9	10	11
TOTAL GROUP 'B' (BROAD LEAVED)SPP.	503.538	300.386	215.580	104.696	40.823	36.238	20.855	13.514	1235.630	8.3
Total for Broad leaved.spp.	721.939	663.381	456.503	299.120	178.458	77.344	20.855	13.514	2431.114	16.2
TOTAL FOR CONI-FERS AND BROAD LEAVED SPP.	1049.136	1126.924	1390.053	1586.484	1592.986	1706.864	1438.006	5192.407	15082.860	
%	7.0	7.5	9.2	10.5	10.6	11.3	9.5	34.4		100

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APPENDIX 5.5 (VIDE PARA 7.8.1 OF REPORT)

ESTIMATED TOTAL VOLUME IN '000' m^3 BY SPECIES AND DIAMETER CLASSES

FOREST TYPE - CONIFERS MIXED WITH BROAD LEAVED

SPECIES	DIAMETER CLASSES (cm)									
	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80+	Total	%
1	2	3	4	5	6	7	8	9	10	11
Abies densa	74.534	171.227	355.589	996.983	642.997	371.594	187.042	1800.199	4600.165	15.3
Juniperus spp.	-	-	-	-	-	-	-	97.067	97.067	0.3
Pinus roxburghii	110.310	201.872	244.991	454.234	438.824	-	-	-	1450.231	4.8
Pinus wallichiana	-	-	-	210.554	-	240.316	-	-	450.870	1.5
Taxus baccata	-	116.536	-	229.477	82.409	85.598	180.699	-	694.719	2.3
Tsuga brunoniana	31.801	79.509	367.750	292.271	202.177	309.484	313.477	5135.262	6731.731	22.3
Total for coniferous spp.	216.645	569.144	968.330	2183.519	1366.407	1006.992	681.218	7032.528	14024.783	46.5
Betula spp.	245.775	574.318	828.895	838.847	354.407	195.350	102.415	-	3140.007	10.4
TOTAL GROUP 'A' (BROAD LEAVED)SPP.	245.775	574.318	828.895	838.847	354.407	195.350	102.415	-	3140.007	10.4
Acer spp.	700.397	851.291	418.165	550.615	87.215	-	-	-	2607.683	8.7
TOTAL GROUP 'B' (BROAD LEAVED)SPP.	700.397	851.291	418.165	550.615	87.215	-	-	-	2607.683	8.7

Contents

Contd.

1	2	3	4	5	6	7	8	9	10	11
Castanopsis spp.	-	39.925	53.018	61.001	206.168	-	87.185	116.224	563.521	1.9
TOTAL GROUP 'C' (BROAD LEAVED)SPP.	-	39.925	53.018	61.001	206.168	-	87.185	116.224	563.521	1.9
Quercus spp.	-	-	169.497	277.893	199.131	314.517	-	486.352	1447.390	4.8
TOTAL GROUP 'D' (BROAD LEAVED)SPP.	-	-	169.497	277.893	199.131	314.517	-	486.352	1447.390	4.8
Aesculus punduana	-	-	-	-	-	-	-	94.446	94.446	0.3
Rhododendron spp.	1555.262	1083.041	642.824	226.645	190.447	-	-	-	3698.219	12.3
Miscellaneous spp.	1593.214	1178.218	535.495	450.247	160.685	170.497	272.299	197.504	4558.159	15.1
TOTAL GROUP 'E' (BROAD LEAVED)SPP.	3148.476	2261.259	1178.319	676.892	351.132	170 497	272.299	291.950	8350.824	27.7
Total for Broad leaved spp.	4094.648	3726.793	2647.894	2405.248	1198.053	680.364	461.899	894.526	16109.425	53.5
TOTAL FOR CONIFERS AND BROAD LEAVED SPP.	4311.293	4295.937	3616.224	4588.767	2564.460	1687.356	1143.117	7927.054	30134.208	
%	14.3	14.3	12.0	15.2	8.5	5.6	3.8	26.3		100

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APPENDIX 5.6 (VIDE PARA 7.8.1 OF REPORT)

ESTIMATED TOTAL VOLUME IN '000 m^3 BY SPECIES AND DIAMETER CLASSES

FOREST TYPE - HARD WOODS

SPECIES	DIAMETER CLASSES (cm)									
	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80+	Total	%
1	2	3	4	5	6	7	8	9	10	11
Betula spp.	350.094	436.722	493.245	533.573	378.035	172.144	56.683	95.104	2515.600	2.2
Juglans regia	-	14.343	-	9.819	-	23.255	36.558	40.428	124.403	0.1
Michelia spp.	32.687	277.347	331.143	551.182	546.488	572.063	579.693	2138.352	5028.955	4.5
Morus laevigata	-	14.595	27.686	30.792	65.150	34.357	24.353	232.149	429.082	0.4
Phoebe goalparensis	31.615	58.669	110.883	85.358	172.472	192.876	128.154	226.009	1006.036	0.9
Terrinalia myriocarpa	-	16.252	17.268	20.330	10.991	-	24.230	87.083	176.154	0.2
TOTAL GROUP 'A' (BROAD LEAVED)SPP.	414.396	817.928	980.225	1231.054	1173.136	994.695	849.671	2819.125	9280.230	8.3
Acer spp.	404.719	340.536	293.775	368.193	357.973	440.336	374.346	963.308	3543.186	3.1
Ailantus grandis	4.517	-	-	-	-	11.514	36.093	38.329	90.453	0.1
Altingia excelsa	16.950	16.097	18.000	30.926	11.230	68.799	73.139	533.723	768.864	0.7
Amoora wallichii	27.433	7.854	17.785	10.454	10.846	-	12.307	12.759	99.438	0.1
Cedrela spp.	15.562	30.319	17.970	40.435	21.272	11.391	36.415	334.061	507.425	0.4

Contents

Contd.

1	2	3	4	5	6	7	8	9	10	11
Cinnamomum cecicodaphne	46.265	52.069	36.460	70.728	43.637	23.176	48.029	93.215	413.579	0.4
Duabanga sonneratioides	-	23.376	8.864	-	11.197	23.202	36.603	41.332	144.574	0.1
Phoebe hainesiana	10.775	14.926	62.761	193.807	283.533	289.967	157.020	427.472	1440.261	1.3
Salmalia malabaricum	-	37.289	18.162	20.521	21.853	11.484	-	-	109.309	0.1
Schima wallichii	106.381	105.031	223.894	212.787	373.074	312.410	266.245	598.159	2197.981	1.9
Tetrameles nudiflora	-	-	-	-	-	11.856	-	13.165	25.021	-
TOTAL GROUP 'B' (BROAD LEAVED)SPP.	632.602	627.497	697.671	947.851	1134.615	1204.135	1040.197	3055.523	9340.091	8.2
Acrocarpus fraxinifolius	-	8.168	-	-	-	-	-	56.731	64.899	0.1
Albizzia spp.	68.889	53.993	36.312	71.545	21.964	11.661	12.189	14.330	290.883	0.3
Alnus spp.	117.429	186.334	271.817	322.573	282.073	220.395	108.939	324.105	1833.665	1.6
Bucklandia populnea	51.645	168.595	55.188	9.719	65.696	57.798	23.899	296.313	728.853	0.6
Castanopsis spp.	110.096	280.536	390.399	436.895	377.814	188.966	231.314	169.233	2185.253	1.9
Machilus spp.	364.109	658.288	977.897	1472.104	1501.346	948.726	916.199	895.930	7734.599	6.8
TOTAL GROUP 'C' (BROAD LEAVED)SPP.	712.168	1355.914	1731.613	2312.836	2248.893	1427.546	1292.540	1756.642	12858.152	11.3

Contents

Contd.

1	2	3	4	5	6	7	8	9	10	11
Bischofia javanica	6.636	8.390	9.111	40.567	10.809	-	11.910	26.904	114.327	0.1
Garuga pinnata	6.064	8.168	36.265	20.825	-	-	60.953	37.865	170.140	0.1
Lagerstroemia parviflora	67.293	30.848	-	9.869	-	-	-	-	108.010	0.1
Populus spp.	-	14.572	9.615	-	-	-	24.290	79.803	128.280	0.1
Prunus spp.	5.417	-	-	-	-	11.295	-	26.048	42.760	0.1
Pterospermum acerifolium	11.135	8.168	8.461	9.965	22.326	-	11.936	-	71.991	0.1
Quercus spp.	1652.553	2603.838	3839.538	4279.609	3832.480	3917.115	3384.222	11301.828	34811.183	30.7
Sterculia villosa	4.986	7.687	45.255	19.785	21.724	46.224	12.331	39.243	197.235	0.2
Syzigium spp.	35.896	22.501	63.737	10.370	10.771	-	-	14.150	157.425	0.1
TOTAL GROUP 'D' (BROAD LEAVED)SPP.	1789.980	2704.172	4011.982	4390.990	3898.110	3974.634	3505.642	11525.841	35801.351	31.6
Aesculus punduana	66.443	103.025	172.986	100.833	164.887	115.520	48.101	28.354	800.149	0.7
Amoora rohituka	31.466	30.977	8.531	10.013	54.405	35.265	-	39.899	210.556	0.2
Cinnamomum tamala	50.595	69.985	100.890	70.423	21.837	45.860	-	26.849	386.439	0.3

Contents

Contd.

1	2	3	4	5	6	7	8	9	10	11
Engelhardtia spicata	82.355	60.592	86.624	113.539	36.638	27.368	105.097	569.132	1081.345	1.0
Ficus spp.	131.452	221.355	244.483	121.510	130.872	34.202	12.331	285.737	1181.942	1.0
Kydia calycina	6.415	52.441	18.786	30.417	32.885	-	-	14.031	154.975	0.1
Macranga spp.	138.416	121.474	197.035	119.547	87.052	23.145	11.910	-	698.579	0.6
Ostodes paniculata	78.614	92.736	61.975	81.327	43.659	-	-	12.376	370.687	0.3
Rhododendron spp.	1255.809	1263.146	930.687	564.133	327.356	205.204	58.928	53.988	4659.251	4.1
Symplocos spicata	240.727	425.309	116.442	101.019	95.944	24.945	64.480	94.969	1163.835	1.0
Vitex heterophylla	8.535	-	18.282	-	10.771	23.070	-	26.005	86.663	0.1
Miscellaneous spp.	4443.262	5555.926	5486.902	4157.535	3478.452	2672.333	1864.768	4341.676	32000.854	28.2
TOTAL GROUP 'E' (BROAD LEAVED)SPP.	6534.089	7996.966	7443.623	5470.296	4484.758	3206.912	2165.615	5493.016	42795.275	37.6
Total Broad leaved spp.	10083.235	13502.477	14865.114	14353.027	12939.512	10807.922	8853.665	24650.147	110055.099	97.0
Abies densa	9.857	-	11.984	72.877	147.740	149.058	124.995	671.123	1187.634	1.1
Juniperus spp.	5.417	7.047	-	20.909	43.856	-	-	-	77.229	0.1
Picea spinulosa	-	8.570	-	13.855	45.991	33.662	-	-	102.078	0.1
Pinus roxburghii	-	23.196	10.369	77.855	75.756	48.452	70.215	57.204	363.347	0.3

Contents

Contd.

1	2	3	4	5	6	7	8	9	10	11
Pinus wallichiana	-	19.402	12.368	57.618	30.431	-	-	35.559	155.378	0.1
Taxus baccata	-	-	26.632	49.677	65.514	11.632	60.261	122.435	336.151	0.3
Tsuga brunoniana	-	20.184	22.952	78.421	54.148	55.434	125.947	744.229	1101.315	1.0
Total for conifers	15.274	78.399	84.305	371.212	463.436	298.238	381.418	1630.550	3322.832	3.0
TOTAL CONIFERS AND BROAD LEAVED SPP.	10098.509	13580.876	14949.419	14724.239	13402.948	11106.160	9235.083	26280.697	113377.931	
%	8.9	12.0	13.2	13.0	11.8	9.8	8.1	23.2		100

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APPENDIX 6.1 (VIDE PARA 7.8.1 OF REPORT)

TOTAL VOLUME IN '000' m^3 OVER ALL FOREST TYPES

SPECIES	DIAMETER CLASSES (cm)									
	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80+	Total	%
1	2	3	4	5	6	7	8	9	10	11
Abies densa	866.063	1942.239	3247.448	6437.653	7182.525	6872.747	5736.200	14019.462	46304.337	21.6
Cupressus spp.	-	15.014	28.005	40.367	22.407	-	11.006	-	116.799	0.1
Juniperus spp.	131.498	191.396	195.594	138.655	76.212	32.795	12.768	111.663	890.581	0.4
Larix griffithii	-	-	-	4.963	11.345	12.299	12.966	-	41.573	-
Picea spinulosa	85.900	163.189	218.345	317.684	366.696	420.706	310.124	778.419	2661.063	1.2
Pinus roxburghii	300.450	742.555	1179.853	2002.584	1967.971	886.938	307.851	336.041	7724.243	3.6
Pinus wallichiana	79.265	223.307	342.037	677.219	392.502	443.440	156.462	286.433	2600.665	1.2
Taxus baccata	11.706	140.702	65.058	321.671	170.670	121.667	240.960	165.210	1237.644	0.6
Tsuga brunoniana	235.289	351.802	964.759	1032.800	1120.912	1305.411	1420.605	10848.133	17279.711	8.1
Total conifers	1710.171	3770.204	6241.099	10973.596	11311.240	10096.003	8208.942	26545.361	78856.616	36.8
Betula spp.	886.742	1411.722	1877.896	1705.147	971.641	416.920	171.447	95.104	7536.619	3.5
Juglans regia	-	14.343	-	9.819	-	23.255	36.558	40.428	124.403	0.1
Quercus spp.	32.687	277.347	331.143	551.182	546.488	586.219	579.693	2138.352	5043.111	2.4

Contents

Contd.

1	2	3	4	5	6	7	8	9	10	11
Morus laevigata	-	14.595	27.686	30.792	65.150	34.357	24.353	232.149	429.082	0.2
Phoebe goalparensis	31.615	58.669	110.883	85.358	172.472	192.876	128.154	226.009	1006.036	0.5
Terminalia myriocarpa	-	16.252	17.268	20.330	10.991	-	24.230	87.083	176.154	0.1
TOTAL GROUP 'A' (BROAD LEAVED)SPP.	951.044	1792.928	2364.876	2402.628	1766.742	1253.627	964.435	2819.125	14315.405	6.8
Acer spp.	1517.173	1674.602	845.753	983.935	515.365	453.127	374.346	963.308	7327.609	3.4
Ailantus grandis	4.517	-	-	-	-	11.514	36.093	38.329	90.453	-
Altingia excelsa	16.950	16.097	18.000	30.926	11.230	68.799	73.139	533.723	768.864	0.4
Amoora wallichii	27.433	7.854	17.785	10.454	10.846	-	12.307	12.759	99.438	-
Cedrela spp.	15.562	30.319	17.970	40.435	21.272	11.391	36.415	334.061	507.425	0.2
Cinnamomum cecicodaphne	46.265	52.069	36.460	70.728	43.637	23.176	48.029	93.215	413.579	0.2
Duabanga sonneratioides	-	23.376	18.566	-	23.033	23.202	36.603	41.332	166.112	0.1
Phoebe hainesiana	10.775	14.926	62.761	193.807	283.533	289.967	157.020	427.472	1440.261	0.7
Salmalia malabaricum	-	37.289	18.162	20.521	21.853	11.484	-	14.014	123.323	0.1

Contents

Contd.

1	2	3	4	5	6	7	8	9	10	11
Schima wallichii	117.002	129.730	223.894	223.856	384.996	312.410	266.245	598.159	2256.292	1.1
Tetrameles nudiflora	-	-	-	-	-	11.856	-	13.165	25.021	-
TOTAL GROUP 'B' (BROAD LEAVED)SPP.	1755.677	1986.262	1259.351	1574.662	1315.765	1216.926	1040.197	3069.537	13218.377	6.2
Acrocarpus fraxinifolius	-	8.168	-	-	-	-	-	56.731	64.899	-
Albizzia spp.	75.205	62.436	36.312	71.545	34.289	11.661	12.189	14.330	317.967	0.1
Alnus spp.	128.184	186.334	271.817	333.321	282.073	220.395	108.939	324.105	1855.168	0.9
Bucklandia populnea	51.645	168.595	55.188	9.719	65.696	57.798	23.899	296.313	728.853	0.3
Castanopsis spp.	110.096	352.402	498.456	534.882	604.014	235.278	318.499	285.457	2939.084	1.4
Machilus spp.	377.068	658.288	977.897	1472.104	1501.346	948.726	916.199	895.930	7747.558	3.6
TOTAL GROUP 'C' (BROAD LEAVED)SPP.	742.198	1436.223	1839.670	2421.571	2487.418	1473.858	1379.725	1872.866	13653.529	6.3
Bischofia javanica	6.636	8.390	9.111	40.567	10.809	-	11.910	26.904	114.327	-
Garuga pinnata	6.064	8.168	36.265	20.825	-	-	60.953	37.865	170.140	0.1
Lagerstroemia parviflora	67.293	30.848	-	9.869	-	-	-	-	108.010	-
Populus spp.	-	14.572	14.279	10.885	-	-	24.290	79.803	143.829	0.1

Contents

Contd.

1	2	3	4	5	6	7	8	9	10	11
Prunus spp.	54.494	56.947	9.097	-	-	11.295	-	26.048	157.881	0.1
Pterospermum acerifolium	11.135	8.168	8.461	9.965	22.326	-	11.936	-	71.991	-
Quercus spp.	1686.705	2644.928	4163.117	4701.564	4066.969	4284.429	3407.791	11788.180	36743.683	17.2
Sterculia villosa	4.986	17.006	45.255	19.785	21.724	46.224	12.331	39.243	206.554	0.1
Syzigium spp.	35.896	22.501	63.737	10.370	10.771	-	-	14.150	157.425	0.1
TOTAL GROUP 'D' (BROAD LEAVED)SPP.	1873.209	2811.528	4349.322	4823.830	4132.599	4341.948	3529.211	12012.193	37873.840	17.7
Aesculus punduana	66.443	103.025	172.986	100.833	176.386	115.520	48.101	122.800	906.094	0.4
Amoora rohituka	31.466	30.977	8.531	10.013	54.405	35.265	-	39.899	210.556	0.1
Cinnamomum tamala	77.235	69.985	100.890	70.423	21.837	45.860	-	26.849	413.079	0.2
Engelhardtia spicata	82.355	60.592	86.624	113.539	36.638	27.368	105.097	569.132	1081.345	0.5
Ficus spp.	131.452	229.291	254.468	121.510	130.872	34.202	12.331	285.737	1199.863	0.6
Kydia calycina	6.415	52.441	18.786	30.417	32.885	-	-	14.031	154.975	0.1
Macranga spp.	138.416	130.376	197.035	119.547	87.052	23.145	11.910	-	707.481	0.3
Ostodes paniculata	78.614	92.736	61.975	81.327	43.659	-	-	12.376	370.687	0.2
Rhododendron spp.	4466.589	3128.095	1873.839	928.995	543.960	215.249	79.783	53.988	11290.408	5.3

Contents

Contd

1	2	3	4	5	6	7	8	9	10	11
Symplocos spicata	262.926	433.750	116.442	101.019	95.944	24.945	64.480	94.969	1194.475	0.5
Vitex heterophylla	8.535	-	18.282	-	10.771	23.070	-	26.005	86.663	-
Miscellaneous spp.	6754.367	7271.792	6263.483	4801.112	3709.237	2910.003	2180.620	4552.694	38443.308	18.0
TOTAL GROUP 'E' (BROAD LEAVED) SPP.	12104.813	11603.060	9173.341	6478.735	4943.646	3454.627	2502.322	5798.480	56059.024	26.2
Total Broad leaved spp.	17426.941	19630.001	18986.560	17701.426	14646.170	11740.986	9415.890	25572.201	13120.175	63.2
TOTAL FOR CONIFEROUS AND BROAD LEAVED SPP.	19137.112	23400.205	25227.659	28675.022	25957.410	21836.989	17624.832	52117.562	213976.791	
%	9.0	10.9	11.8	13.4	12.1	10.2	8.2	24.4		100

Contents

APPENDIX 7.1 (VIDE PARA 7.8.2 OF REPORT)

ESTIMATED TOTAL VOLUME IN '000' m^3 BY CATCHMENTS

SPECIES	CATCHMENTS								Total
	Sankosh	Ai chu or Mao	Mangda chu (Tongsa)	Bhumthang	Kuru chu	Gamri	Manas	Nyera ama	
1	2	3	4	5	6	7	8	9	10
Abies densa	2464.800	-	8179.584	26063.093	4117.141	2795.408	934.576	1749.735	46304.337
Cupressus spp.	-	-	22.733	80.521	-	-	13.545	-	116.799
Juniperus spp.	312.269	-	301.390	210.384	-	-	18.322	48.216	890.581
Larix griffithii	-	-	-	28.402	-	-	-	13.171	41.573
Picea spinulosa	358.674	-	-	2302.389	-	-	-	-	2661.063
Pinus roxburghii	2615.894	-	465.724	217.971	2529.024	815.777	1009.721	70.132	7724.243
Pinus wallichiana	-	-	718.288	1727.251	14.829	-	24.532	115.765	2600.665
Taxus baccata	-	57.258	507.015	121.410	22.745	457.263	27.105	44.848	1237.644
Tsuga brunoniana	-	-	4226.980	8844.175	1409.313	2716.472	-	82.771	17279.711
Total for coniferous spp.	5751.637	57.258	14421.714	39595.596	8093.052	6784.920	2027.801	2124.638	78856.616
Betula spp.	224.236	199.238	2564.637	2176.225	812.719	904.834	152.817	501.913	7536.619

Contents

Contd.

1	2	3	4	5	6	7	8	9	10
Juglans regia	-	-	96.696	-	27.707	-	-	-	124.403
Michelia spp.	518.218	812.683	2330.951	427.772	203.547	423.188	180.737	146.015	5043.111
Morus laevigata	17.139	33.460	195.090	27.335	125.685	20.730	9.643	-	429.082
Phoebe goalparensis	83.018	64.145	642.099	-	180.030	23.423	13.321	-	1006.036
Terminalia myriocarpa	22.930	-	16.543	9.966	-	36.996	89.719	-	176.154
TOTAL GROUP 'A' (BROAD LEAVED)SPP.	865.541	1109.526	5846.016	2641.298	1349.688	1409.171	446.237	647.928	14315.405
Acer spp.	194.670	277.462	2961.466	1624.373	771.079	756.893	366.188	375.478	7327.609
Ailantus grandis	-	-	15.455	20.211	-	-	54.787	-	90.453
Altingia excelsa	73.880	214.293	329.167	19.406	-	60.593	18.663	52.862	768.864
Amoora wallichii	16.068	19.902	13.760	-	12.114	26.339	11.255	-	99.438
Cedrela spp.	31.502	70.151	225.244	27.029	80.344	9.857	30.054	33.244	507.425
Cinnamomum cecicodaphne	5.645	44.218	177.179	85.238	62.669	-	38.630	-	413.579
Duabanga sonneratioides	27.844	16.959	14.606	30.524	9.384	-	66.795	-	166.112
Phoebe hainesiana	73.102	690.664	332.717	6.488	266.145	24.732	46.413	-	1440.261

Contd.

	1	2	3	4	5	6	7	8	9	10
Salmalia malabaricum	51.319	-	-	72.004	-	-	-	-	-	123.323
Schima wallichii	248.633	24.668		689.196	118.290	532.034	213.446	210.756	219.269	2256.292
Tetrameles nudiflora	-	-	-	-	25.021	-	-	-	-	25.021
TOTAL GROUP 'B' (BROAD LEAVED) SPP.	722.663	1358.317		4830.794	1956.580	1733.769	1091.860	843.541	680.853	13218.377
Acrocarpus fraxinifolius	58.671	-	-	-	-	6.228	-	-	-	64.899
Albizzia spp.	18.842	29.517		121.013	42.932	24.692	29.644	42.438	8.889	317.967
Alnus spp.	322.333	150.658		293.726	41.459	390.011	413.066	47.774	196.141	1855.168
Bucklandia populnea	62.295	281.290		255.742	24.234	29.080	29.710	21.875	24.627	728.853
Castanopsis spp.	178.634	19.348		1044.529	-	435.679	643.300	236.907	380.687	2939.084
Mackilus spp.	473.710	1038.780		3119.152	338.884	1007.759	913.881	814.233	41.159	7747.558
TOTAL GROUP 'C' (BROAD LEAVED) SPP.	1114.485	1519.593		4834.162	447.509	1893.449	2029.601	1163.227	651.503	13653.529
Bischofia javanica	-	-	-	33.644	-	23.418	-	57.265	-	114.327
Garuga pinnata	-	-		105.243	28.995	-	6.943	5.546	23.413	170.140

Contents

Contd

1	2	3	4	5	6	7	8	9	10
Lagerstroemia parviflora	103.163	-	4.847	-	-	-	-	-	108.010
Populus spp.	-	-	18.290	7.141	64.610	33.976	-	19.812	143.829
Prunus spp.	-	-	-	109.877	30.325	-	17.679	-	157.881
Pterospermum acerifolium	-	-	48.671	-	-	-	23.320	-	71.991
Quercus spp.	3658.055	3463.521	13952.695	2558.978	3762.510	4336.935	3538.627	1472.362	35743.683
Sterculia villosa	-	9.491	113.691	34.929	48.443	-	-	-	206.554
Syzigium spp.	-	26.034	78.459	5.404	9.156	26.361	-	12.011	157.425
TOTAL GROUP 'D' (BROAD LEAVED)SPP.	3761.218	3499.046	14355.540	2745.324	3938.462	4404.215	3642.437	1527.598	37873.840
Aesculus punduana	-	317.869	276.178	-	12.605	59.827	55.544	184.071	906.094
Amoora rohituka	-	23.067	-	-	40.612	-	146.877	-	210.556
Cinnamomum tamala	-	30.190	54.954	15.828	-	135.533	176.574	-	413.079
Engelhardtia spicata	198.711	246.648	236.521	47.893	156.037	12.647	71.253	111.635	1081.345
Ficus spp.	266.580	148.393	291.516	105.654	154.371	36.362	147.587	49.400	1199.863
Xydia calycina	-	-	88.538	16.914	7.539	35.914	6.070	-	154.975

Contents

Contd.

1	2	3	4	5	6	7	8	9	10
Macaranga spp.	27.318	136.250	145.415	56.674	82.340	32.276	146.793	80.415	707.481
Rhododendron spp.	654.380	206.325	3627.739	2057.001	1427.549	2347.277	431.317	538.910	11290.498
Ostodes paniculata	-	26.027	33.812	10.376	178.878	18.409	103.185	-	370.687
Symplocos spicata	223.224	38.288	522.413	101.580	79.071	188.031	41.868	-	1194.475
Vitex hetcrophylla	15.852	10.675	19.359	-	40.777	-	-	-	86.663
Miscellaneous spp.	4848.812	4708.592	12214.302	2386.719	4326.992	3780.034	3954.384	2223.473	38443.308
TOTAL GROUP 'E' (BROAD LEAVED)SPP.	6234.877	5892.324	17510.747	4798.639	6506.771	6646.310	5281.452	3187.904	56059.024
Tctal Broad leaved spp.	12698.784	13378.806	47377.259	12589.350	15422.139	15581.157	11376.894	6695.786	135120.175
TOTAL FOR CONIFERS AND BROAD LEAVED SPP.	18450.421	13436.064	61798.973	52184.946	23515.191	22366.077	13404.695	8820.424	213976.791

Total for conifers and Broad leaved spp. = 213976.791

Contents

APPENDIX 8.1 (VIDE PARA 7.9.2 OF REPORT)

CULL VOLUME EXPRESSED AS A PERCENTAGE OF UNDER BARK VOLUME

SPECIES	DIAMETER CLASSES (cm)							
	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80+
1	2	3	4	5	6	7	8	9
Abies densa	6.00	10.80	16.00	21.75	28.00	34.60	41.80	49.30
Juniperus spp.*	9.50	16.50	25.50	37.00	(37.00)	(37.00)	(37.00)	(37.00)
Larix griffithii*	0.30	0.30	0.40	0.40	0.70	1.00	1.30	(1.70)
Picea spinulosa	1.25	3.15	5.28	7.75	10.50	14.10	18.75	25.40
Pinus roxburghii	0.10	0.10	0.18	0.32	0.63	1.26	2.37	3.77
Pinus wallichiana*	0.80	0.90	1.00	1.20	1.60	2.60	4.00	5.60
Tsuga brunoniana*	0.10	0.30	0.50	0.90	1.60	3.00	5.00	7.20
Other conifers**	0.68	1.62	2.73	4.04	5.56	7.68	10.56	14.58
Betula spp.*	0.50	0.80	1.10	3.50	7.60	15.30	24.20	(24.20)
Michelia spp.	7.11	4.30	2.55	1.60	1.26	1.04	0.88	0.75
Phoebe goalparensis	6.10	5.00	4.00	3.50	3.00	3.00	3.00	3.00
Terminalia myriocarpa	1.70	2.80	3.40	3.32	2.82	2.00	1.02	0.00
Acer spp.	2.65	3.43	4.30	5.32	6.55	7.92	9.42	11.75
Ailantus grandis	1.08	1.02	1.01	1.05	1.10	1.21	1.38	1.69

Contents

Contd.

1	2	3	4	5	6	7	8	9
Salmalia malabaricum	1.65	1.67	1.71	1.78	1.92	2.14	2.45	2.82
Tetrameles nudiflora	1.19	1.27	1.41	1.67	2.15	3.05	4.30	5.92
Castanopsis spp.	1.65	1.35	3.08	3.80	4.60	5.48	6.42	7.45
Machilus spp.	5.62	9.42	11.58	11.97	11.12	9.39	6.80	3.53
Quercus spp.*	9.80	14.80	17.40	17.20	14.80	11.40	7.50	1.80
Sterculia villosa	23.60	17.90	13.33	10.00	8.10	6.50	5.10	4.10
Amoora rohituka	12.12	7.72	5.11	3.77	2.78	2.03	1.39	0.91
Engelhardtia spicata	0.98	1.12	1.31	1.49	1.72	1.99	2.31	2.72
Symplocos spicata	1.27	1.45	1.63	1.82	2.04	2.29	2.58	2.89
Miscellaneous hardwoods*	6.10	9.60	12.60	15.40	17.80	19.50	21.20	22.70

Note; 1. Figures in the brackets have been obtained by extrapolation.

2. *Phase I figures.

3.**Average of the figures of coniferous spp. except Abies densa of Phase II & III. These figures have been used for Cupressus spp. and Taxus baccata for calculation of cull volume.

4. Cull percentages figures for diameter classes 80-90, 90-100 and above 100 cm, were worked out separately also. But for calculation of cull volume, cull percentage figures of 80-90 cm diameter class have been adopted for all trees above 80 cm diameter.

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APPENDIX 9.1 (VIDE PARA 7.11.2 OF REPORT)

BARK VOLUME EXPRESSED AS A PERCENTAGE OF UNDERBARK VOLUME

SPECIES	DIAMETER CLASSES (cm)							
	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80+
1	2	3	4	5	6	7	8	9
Abies densa	19.25	18.00	16.93	16.00	15.13	14.25	13.50	12.63
Larix griffithii*	29.40	26.00	24.20	22.80	22.00	21.50	21.30	(21.20)
Picea spinulosa	15.25	14.50	14.00	13.75	13.50	13.63	13.63	13.63
Pinus roxburghii	34.25	23.75	18.50	15.00	12.75	11.00	10.00	9.00
Pinus wallichiana*	17.80	15.20	13.30	12.00	11.30	10.70	10.30	9.00
Tsuga brunoniana*	20.00	17.00	16.80	16.80	16.50	16.30	16.30	16.30
Other conifers**	20.34	18.14	17.05	16.27	15.69	15.28	15.01	14.55
Betula spp.*	14.90	12.90	12.00	12.00	12.00	12.00	12.00	(12.00)
Michelia spp.	16.50	15.00	14.00	13.25	12.80	12.50	12.40	12.25
Phoebe goalparensis	19.00	17.50	16.50	15.80	15.40	15.00	14.75	(14.70)
Terminalia myriocarpa	18.70	16.50	15.10	14.00	13.50	12.90	12.50	12.25
Acer spp.	14.88	13.13	12.00	11.13	10.63	10.25	9.88	9.63
Ailantus grandis	17.38	15.00	13.75	13.00	12.50	12.38	12.25	12.25

Contents

Contd.

1	2	3	4	5	6	7	8	9
Salmalia malabaricum	17.50	33.00	26.70	22.30	20.00	18.30	17.00	16.50
Tetrameles nudiflora	17.25	15.25	14.25	13.50	13.20	13.00	13.00	13.00
Castanopsis spp.	50.25	44.00	39.50	35.75	32.50	29.50	27.00	24.75
Machilus spp.	18.50	15.50	14.00	13.38	13.20	12.90	12.75	12.75
Quercus spp.*	21.20	19.30	18.30	17.60	17.20	16.90	(16.90)	(16.90)
Sterculia villosa	35.70	31.25	28.38	26.25	24.50	23.12	22.00	21.00
Amoora rohituka	16.50	14.38	13.12	12.25	11.75	11.38	11.25	11.13
Engelhardtia spicata	37.60	26.20	19.62	15.00	11.60	9.40	8.00	6.70
Symplocos spicata	16.25	15.00	13.88	13.25	12.75	12.50	12.25	(12.20)
Misc. hardwoods*	17.00	15.70	15.20	15.20	15.20	15.10	(15.10)	(15.10)

Note: 1. Figures in the brackets have been obtained by extrapolation

2. *Phase I figures

3. **Average figures of all the coniferous species except Pinus roxburghii. These figures have been used for Cupressus spp., Taxus baccata and Juniperus spp.

Contents

APPENDIX 10.1 (VIDE PARA 8.2.1 OF THE REPORT)

BASAL AREA PER HA BY SPECIES AND DIAMETER CLASSES

FOREST TYPE - CHIP

SPECIES OR GROUP OF SPECIES	DIAMETER CLASSES (cm) 10-20	20-30	30-40	40-50	50-60	60-70	70-80	80+	Total
1	2	3	4	5	6	7	8	9	10
	(Basal Area m^2)								
Pinus roxburghii	0.645	1.000	1.274	1.661	1.435	0.742	0.194	0.210	7.161
Total for coniferous spp.	0.645	1.000	1.274	1.661	1.435	0.742	0.194	0.210	7.161
Michelia spp.	-	-	-	-	-	0.016	-	-	0.016
TOTAL GROUP 'A' (BROAD LEAVED) SPP.	-	-	-	-	-	0.016	-	-	0.016
Duabanga sonneratiodes	-	-	0.016	-	0.016	-	-	-	0.032
Salmalia malabaricum	-	-	-	-	-	-	-	0.016	0.016
Schima wallichii	0.032	0.048	-	0.016	0.016	-	-	-	0.112
TOTAL GROUP 'B' (BROAD LEAVED) SPP.	0.032	0.048	0.016	0.016	0.032	-	-	0.016	0.160
Albizzia spp.	0.016	0.016	-	-	0.016	-	-	-	0.048

Contents

Contd.

1	2	3	4	5	6	7	8	9	10
Castanopsis spp.	-	0.081	0.113	0.065	0.032	0.065	-	-	0.356
TOTAL GROUP 'C' (BROAD LEAVED)SPP.	0.016	0.097	0.113	0.065	0.048	0.065	-	-	0.404
Quercus spp.	0.048	0.048	0.113	0.081	0.016	0.032	0.016	-	0.354
Sterculia villosa	-	0.016	-	-	-	-	-	-	0.016
TOTAL GROUP 'D' (BROAD LEAVED)SPP.	0.048	0.064	0.113	0.081	0.016	0.032	0.016	-	0.370
Ficus spp.	-	0.016	0.016	-	-	-	-	-	0.032
Macranga spp.	-	0.016	-	-	-	-	-	-	0.016
Rhododenuron spp.	0.032	0.145	0.032	0.065	-	0.016	-	-	0.290
Miscellanedus spp.	0.242	0.097	0.032	0.016	-	-	-	-	0.387
TOTAL GROUP 'E' (BROAL LEAVED)SPP.	0.274	0.274	0.080	0.081	-	0.016	-	-	0.725
TOTAL BROAD LEAVED SPP.	0.370	0.483	0.322	0.243	0.096	0.129	0.016	0.016	1.675
TOTAL CONIFEROUS AND BROAD LEAVED SPP.	1.015	1.483	1.596	1.904	1.531	0.871	0.210	0.226	8.836

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APPENDIX 10.2 (VIDE PARA 8.2.1 OF THE REPORT)

BASAL AREA PER HA BY SPECIES AND DIAMETER CLASSES

FOREST TYPE - KAIL

SPECIES OR GROUP OF SPECIES	DIAMETER CLASSES (cm)								
	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80+	Total
1	2	3	4	5	6	7	8	9	10
	(Basal Area m^2)								
Pinus wallichiana	0.820	1.049	1.279	0.984	0.852	0.262	0.459	0.361	6.066
Larix griffithii	-	-	-	0.033	-	-	-	-	0.033
Picea spinulosa	0.164	0.230	0.164	0.230	0.164	0.033	-	-	0.985
Tsuga brunoniana	0.164	0.066	0.098	0.164	0.033	-	-	0.033	0.558
Total for coniferous spp.	1.148	1.345	1.541	1.411	1.049	0.295	0.459	0.394	7.642
Betula spp.	0.098	-	-	-	-	-	-	-	0.098
TOTAL GROUP 'A' (BROAD LEAVED)SPP.	0.098	-	-	-	-	-	-	-	0.098
Acer spp.	0.098	0.066	-	-	-	-	-	-	0.164
TOTAL GROUP 'B' (BROAD LEAVED)SPP.	0.098	0.066	-	-	-	-	-	-	0.164

Contents

Contd.

1	2	3	4	5	6	7	8	9	10
Populus spp.	-	-	0.033	-	-	-	-	-	0.033
Quercus spp.	0.066	0.066	0.131	0.262	0.033	0.033	0.033	-	0.624
TOTAL GROUP 'D' (BROAD LEAVED)SPP.	0.066	0.066	0.164	0.262	0.033	0.033	0.033	-	0.657
Rhododendron spp.	0.066	0.033	0.066	-	-	-	-	-	0.165
Miscellaneous spp.	0.131	0.230	0.066	-	-	-	-	-	0.427
TOTAL GROUP 'E' (BROAD LEAVED)SPP.	0.197	0.263	0.132	-	-	-	-	-	0.592
TOTAL BROAD LEAVED SPP.	0.459	0.395	0.296	0.262	0.033	0.033	0.033	-	1.511
TOTAL CONIFEROUS AND BROAD LEAVED SPP.	1.607	1.740	1.837	1.673	1.082	0.328	0.492	0.394	9.153

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APPENDIX 10.3 (VIDE PARA 8.2.1 OF THE REPORT)

BASAL AREA PER HA BY SPECIES AND DIAMETER CLASSES

FOREST TYPE - FIR SPRUCE

SPECIES OR GROUP OF SPECIES	DIAMETER CLASSES (cm)								
	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80+	Total
1	2	3	4	5	6	7	8	9	10
	(Basal Area m^2)								
Abies densa	0.744	1.591	2.437	4.447	5.191	5.051	4.260	8.949	32.670
Picea spinulosa	0.074	0.084	0.102	0.047	0.084	0.084	0.056	0.167	0.698
Pinus wallichiana	0.009	0.009	0.019	-	-	-	-	-	0.037
Tsuga brunoniana	0.019	0.009	0.019	0.009	0.037	0.009	0.074	0.744	0.920
Cupressus spp.	-	0.009	-	0.009	-	-	0.009	-	0.027
Juniperus spp.	0.065	0.121	0.084	0.056	0.009	0.019	-	-	0.354
Other conifers (Total of last two spp.)	0.065	0.130	0.084	0.065	0.009	0.019	0.009	-	0.381
Total for coniferous spp.	0.911	1.823	2.661	4.568	5.321	5.163	4.399	9.860	34.706
Betula spp.	0.307	0.307	0.428	0.233	0.149	0.028	0.009	-	1.461

Contents

Contd.

1	2	3	4	5	6	7	8	9	10
TOTAL GROUP 'A' (BROAD LEAVED)SPP.	0.307	0.307	0.428	0.233	0.149	0.028	0.009	-	1.461
Acer spp.	0.381	0.344	0.093	-	0.009	-	-	-	0.827
TOTAL GROUP 'B' (BROAD LEAVED)SPP.	0.381	0.344	0.093	-	0.009	-	-	-	0.827
Prunus spp.	0.093	0.047	-	-	-	-	-	-	0.140
TOTAL GROUP 'D' (BROAD LEAVED)SPP.	0.093	0.047	-	-	-	-	-	-	0.140
Rhododendron spp.	3.060	0.977	0.205	0.084	0.009	-	-	-	4.335
Miscellaneous spp.	0.828	0.493	0.167	0.121	0.056	0.028	0.037	-	1.730
TOTAL GROUP 'E' (BROAD LEAVED)SPP.	3.888	1.470	0.372	0.205	0.065	0.028	0.037	-	6.065
TOTAL BROAD LEAVED SPP.	4.669	2.168	0.893	0.438	0.223	0.056	0.046	-	8.493
TOTAL CONIFEROUS AND BROAD LEAVED SPP.	5.580	3.991	3.554	5.006	5.544	5.219	4.445	9.860	43.199

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APPENDIX 10.4 (VIDE PARA 8.2.1 OF THE REPORT)

BASAL AREA PER HA BY SPECIES AND DIAMETER CLASSES

FOREST TYPE - MIXED CONIFERS

SPECIES OR GROUP OF SPECIES	DIAMETER CLASSES (cm)								
	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80+	Total
1	2	3	4	5	6	7	8	9	10
	(Basal Area m^2)								
Abies densa	0.076	0.025	0.152	0.278	0.405	0.532	0.506	1.114	3.088
Larix griffithii	-	-	-	-	0.025	0.025	0.025	-	0.075
Picea spinulosa	0.051	0.127	0.152	0.354	0.253	0.354	0.278	0.506	2.075
Pinus wallichiana	-	0.101	0.127	0.329	0.253	0.203	0.051	0.203	1.267
Tsuga brunoniana	0.785	0.557	1.063	1.139	1.443	1.620	1.519	6.785	14.911
Cupressus spp.	-	0.025	0.076	0.076	0.051	-	-	-	0.228
Juniperus spp.	0.380	0.304	0.329	0.152	0.051	0.025	0.025	0.025	1.291
Taxus baccata	0.051	0.076	0.101	0.101	0.051	0.051	-	0.076	0.507
Other conifers (Total of last three spp.)	0.431	0.405	0.506	0.329	0.153	0.076	0.025	0.101	2.026
Total for coniferous spp.	1.343	1.215	2.000	2.429	2.532	2.810	2.404	8.709	23.442

Contents

Contd.

1	2	3	4	5	6	7	8	9	10
Betula spp.	0.278	0.405	0.329	0.177	0.127	0.025	-	-	1.341
TOTAL GROUP 'A' (BROAD LEAVED)SPP.	0.278	0.405	0.329	0.177	0.127	0.025	-	-	1.341
Acer spp.	0.329	0.557	0.127	0.152	0.127	0.025	-	-	1.317
TOTAL GROUP 'B' (BROAD LEAVED)SPP.	0.329	0.557	0.127	0.152	0.127	0.025	-	-	1.317
Alrus spp.	0.051	-	-	0.025	-	-	-	-	0.076
Machilus spp.	0.051	-	-	-	-	-	-	-	0.051
TOTAL GROUP 'C' (BROAD LEAVED)SPP.	0.102	-	-	0.025	-	-	-	-	0.127
Populus spp.	-	-	-	0.025	-	-	-	-	0.025
Prunus spp.	-	0.076	0.025	-	-	-	-	-	0.101
Quercus spp.	0.025	-	0.101	0.051	0.025	0.025	-	-	0.227
TOTAL GROUP 'D' (BROAD LEAVED)SPP.	0.025	0.076	0.126	0.076	0.025	0.025	-	-	0.353
Aesculus punduana	-	-	-	-	0.025	-	-	-	0.025
Cinnamomum tamala	0.127	-	-	-	-	-	-	-	0.127
Rhododendron spp.	1.316	0.810	0.532	0.127	0.051	-	0.051	-	2.887

Contents

Contd.

1	2	3	4	5	6	7	8	9	10
Symplocos spicata	0.101	0.025	-	-	-	-	-	-	0.126
Miscellaneous spp.	0.911	0.329	0.177	0.152	0.025	0.076	-	0.025	1.695
TOTAL GROUP 'E' (BROAD LEAVED) SPP.	2.455	1.164	0.709	0.279	0.101	0.076	0.051	0.025	4.860
TOTAL BROAD LEAVED SPP.	3.189	2.202	1.291	0.709	0.380	0.151	0.051	0.025	7.998
TOTAL CONIFEROUS AND BROAD LEAVED SPP.	4.532	3.417	3.291	3.138	2.912	2.961	2.455	8.734	31.440

Contents

APPENDIX 10.5 (VIDE PARA 8.2.1 OF THE REPORT)

BASAL AREA PER HA BY SPECIES AND DIAMETER CLASSES

FOREST TYPE - CONIFERS MIXED WITH BROAD LEAVED

SPECIES OR GROUP OF SPECIES	DIAMETER CLASSES (cm)								
	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80+	Total
1	2	3	4	5	6	7	8	9	10
	(Basal Area m^2)								
Abies densa	0.080	0.160	0.320	0.880	0.560	0.320	0.160	1.520	4.000
Pinus roxburghii	0.320	0.320	0.240	0.400	0.320	-	-	-	1.600
Pinus wallichiana	-	-	-	0.160	-	0.160	-	-	0.320
Tsuga brunoniana	0.080	0.080	0.320	0.240	0.160	0.240	0.240	3.920	5.280
Juniperus spp.	-	-	-	-	-	-	-	0.080	0.080
Taxus baccata	-	0.160	-	0.240	0.080	0.080	0.160	-	0.720
Other conifers (Total of last two spp.)	-	0.160	-	0.240	0.080	0.080	0.160	0.080	0.800
Total for coniferous spp.	0.480	0.720	0.880	1.920	1.120	0.800	0.560	5.520	12.000
Betula spp.	0.400	0.720	0.880	0.800	0.320	0.160	0.080	-	3.360
TOTAL GROUP 'A' (BROAD LEAVED)SPP.	0.400	0.720	0.880	0.800	0.320	0.160	0.080	-	3.360

Contents

Contd.

1	2	3	4	5	6	7	8	9	10
Acer spp.	0.960	1.120	0.480	0.560	0.080	-	-	-	3.200
TOTAL GROUP 'B' (BROAD LEAVED)SPP.	0.960	1.120	0.480	0.560	0.080	-	-	-	3.200
Castanopsis spp.	-	0.080	0.080	0.080	0.240	-	0.080	0.080	0.640
TOTAL GROUP 'C' (BROAD LEAVED)SPP.	-	0.080	0.080	0.080	0.240	-	0.080	0.080	0.640
Quercus spp.	-	-	0.160	0.240	0.160	0.240	-	0.320	1.120
TOTAL GROUP 'D' (BROAD LEAVED)SPP.	-	-	0.160	0.240	0.160	0.240	-	0.320	1.120
Aesculus punduana	-	-	-	-	-	-	-	0.080	0.080
Rhododendron spp.	3.520	2.080	1.040	0.320	0.240	-	-	-	7.200
Miscellaneous spp.	3.360	1.680	0.640	0.480	0.160	0.160	0.240	0.160	6.880
TOTAL GROUP 'E' (BROAD LEAVED)SPP.	6.880	3.760	1.680	0.800	0.400	0.160	0.240	0.240	14.160
TOTAL BROAD LEAVED SPP.	8.240	5.680	3.280	2.480	1.200	0.560	0.400	0.640	22.480
TOTAL CONIFEROUS AND BROAD LEAVED SPP.	8.720	6.400	4.160	4.400	2.320	1.360	0.960	6.160	34.480

APPENDIX 10.6 (VIDE PARA 8.2.1 OF THE REPORT)

BASAL AREA PER HA BY SPECIES AND DIAMETER CLASSES

FOREST TYPE - HARD WOODS

SPECIES OR GROUP OF SPECIES	DIAMETER CLASSES (cm)								
	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80+	Total
1	2	3	4	5	6	7	8	9	10
	(Basal Area m^2)								
Betula spp.	0.115	0.115	0.111	0.108	0.070	0.029	0.009	0.014	0.571
Juglans regia	-	0.005	-	0.002		0.005	0.007	0.007	0.026
Michelia spp.	0.020	0.081	0.074	0.108	0.099	0.099	0.097	0.332	0.910
Morus laevigata	-	0.005	0.007	0.007	0.014	0.007	0.005	0.038	0.083
Phoebe goalparensis	0.016	0.016	0.023	0.016	0.029	0.032	0.020	0.034	0.186
Terminalia myriocarpa	-	0.005	0.005	0.005	0.002	-	0.005	0.014	0.036
TOTAL GROUP 'A' (BROAD LEAVED)SPP.	0.151	0.227	0.220	0.246	0.214	0.172	0.143	0.439	1.812
Acer spp.	0.115	0.093	0.070	0.079	0.070	0.081	0.065	0.149	0.722
Ailanthus grandis	0.002	-	-	-	-	0.002	0.007	0.007	0.018
Altingia excelsa	0.007	0.005	0.005	0.007	0.002	0.014	0.014	0.088	0.142

Contents

Contd.

1	2	3	4	5	6	7	8	9	10
Amcora wallichii	0.011	0.002	0.005	0.002	0.002	-	0.002	0.002	0.026
Cedrela spp.	0.007	0.009	0.005	0.009	0.005	0.002	0.007	0.054	0.098
Cinnamomum cecicodaphne	0.020	0.016	0.009	0.016	0.009	0.005	0.009	0.016	0.100
Duabanga sonneratiodies	-	0.007	0.002	-	0.002	0.005	0.007	0.007	0.030
Phoebe hainesiana	0.005	0.005	0.016	0.043	0.059	0.056	0.029	0.070	0.283
Salmalia malabaricum	-	0.011	0.005	0.005	0.005	0.002	-	-	0.028
Schira wallichii	0.043	0.032	0.056	0.047	0.077	0.061	0.050	0.102	0.468
Tetrameles nudiflora	-	-	-	-	-	0.002	-	0.002	0.004
TOTAL GROUP 'B' (BROAD LEAVED)SPP.	0.210	0.180	0.173	0.208	0.231	0.230	0.190	0.497	1.919
Acrocarpus fraxinifolius	-	0.002	-	-	-	-	-	0.009	0.011
Albizzia spp.	0.029	0.016	0.009	0.016	0.005	0.002	0.002	0.002	0.081
Alnus spp.	0.052	0.056	0.068	0.072	0.059	0.043	0.020	0.054	0.424
Bucklandia populnea	0.020	0.050	0.014	0.002	0.014	0.011	0.005	0.047	0.163
Castanopsis spp.	0.061	0.113	0.126	0.120	0.090	0.041	0.045	0.029	0.625
Machilus spp.	0.124	0.169	0.210	0.280	0.266	0.160	0.149	0.138	1.496

Contents

Contd.

1	2	3	4	5	6	7	8	9	10
TOTAL GROUP 'C' (BROAD LEAVED)SPP.	0.286	0.406	0.427	0.490	0.434	0.257	0.221	0.279	2.800
Bischofia javanica	0.002	0.002	0.002	0.009	0.002	-	0.002	0.005	0.024
Garuga pinnata	0.002	0.002	0.009	0.005	-	-	0.011	0.007	0.036
Lagerstroemia parviflora	0.027	0.009	-	0.002	-	-	-	-	0.038
Populus spp.	-	0.005	0.002	-	-	-	0.005	0.014	0.026
Prunus spp.	0.002	-	-	-	-	0.002	-	0.005	0.009
Pterospermum acerifolium	0.005	0.002	0.002	0.002	0.005	-	0.002	-	0.018
Quercus spp.	0.619	0.646	0.788	0.781	0.648	0.625	0.517	1.542	6.166
Sterculia villosa	0.002	0.002	0.011	0.005	0.005	0.009	0.002	0.007	0.043
Syzigium spp.	0.014	0.007	0.016	0.002	0.002	-	-	0.002	0.043
TOTAL GROUP 'D' (BROAD LEAVED)SPP.	0.673	0.675	0.830	0.806	0.662	0.636	0.539	1.582	6.403
Aesculus punduana	0.027	0.032	0.043	0.023	0.034	0.023	0.009	0.005	0.196
Amoora rohituka	0.014	0.009	0.002	0.002	0.011	0.007	-	0.007	0.052
Cinnamomum tamala	0.020	0.020	0.025	0.016	0.005	0.009	-	0.005	0.100

Contents

Contd.

1	2	3	4	5	6	7	8	9	10
Engelhardtia spicata	0.029	0.016	0.020	0.023	0.007	0.005	0.016	0.068	0.184
Ficus spp.	0.054	0.065	0.061	0.027	0.027	0.007	0.002	0.045	0.288
Kydia calycina	0.002	0.016	0.005	0.007	0.007	-	-	0.002	0.039
Macaranga spp.	0.056	0.036	0.050	0.027	0.018	0.005	0.002	-	0.194
Ostodes panniculata	0.036	0.027	0.016	0.018	0.009	-	-	0.002	0.108
Rhododendron spp.	0.603	0.503	0.312	0.165	0.086	0.050	0.014	0.011	1.744
Symplocos spicata	0.113	0.113	0.025	0.020	0.018	0.005	0.011	0.016	0.321
Vitex heterophylla	0.005	-	0.005	-	0.002	0.005	-	0.005	0.022
Miscellaneous spp.	1.858	1.657	1.368	0.928	0.720	0.521	0.348	0.731	8.131
TOTAL GROUP 'E' (BROAD LEAVED)SPP.	2.817	2.494	1.932	1.256	0.944	0.637	0.402	0.897	11.379
Total Broad leaved spp.	4.137	3.982	3.582	3.006	2.485	1.932	1.495	3.694	24.313
Abies densa	0.002	-	0.002	0.014	0.027	0.027	0.023	0.120	0.215
Picea spinulosa	-	0.002	-	0.002	0.007	0.005	-	-	0.016
Pinus roxburghii	-	0.007	0.002	0.014	0.011	0.007	0.009	0.007	0.057
Pinus wallichiana	-	0.005	0.002	0.009	0.005	-	-	0.005	0.026

Contents

Contd.

1	2	3	4	5	6	7	8	9	10
Tsuga brunoniana	-	0.005	0.005	0.014	0.009	0.009	0.020	0.120	0.182
Juniperus spp.	0.002	0.002	-	0.005	0.009	-	-	-	0.018
Taxus baccata	-	-	0.007	0.011	0.014	0.002	0.011	0.020	0.065
Other conifers (Total of last two spp.)	0.002	0.002	0.007	0.016	0.023	0.002	0.011	0.020	0.083
TOTAL FOR CONIFEROUS SPP.	0.004	0.021	0.018	0.069	0.082	0.050	0.063	0.272	0.579
TOTAL CONIFEROUS AND BROAD LEAVED SPP.	4.141	4.003	3.600	3.075	2.567	1.982	1.558	3.966	24.892

Contents

APPENDIX 11.1 (VIDE PARA 9.4.1 OF REPORT)

TOTAL VOLUME OF ACCESSIBLE GROWING STOCK BY SPECIES AND DIAMETER CLASSES

FOREST TYPE - CHIR

'000' m^3

SPECIES	DIAMETER CLASSES (cm)									
	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80+	Total	%
1	2	3	4	5	6	7	8	9	10	11
Pinus roxburghii	165.284	449.865	803.656	1278.239	1263.408	728.852	206.589	242.365	5138.258	86.4
Total conifers	165.284	449.865	803.656	1278.239	1263.408	728.852	206.589	242.365	5138.258	86.4
Michelia spp.	-	-	-	-	-	12.294	-	-	12.294	0.2
TOTAL GROUP 'A' (BROAD LEAVED)SPP.	-	-	-	-	-	12.294	-	-	12.294	0.2
Duabanga sonneratioides	-	-	8.456	-	10.277	-	-	-	18.733	0.3
Salmalia malabaricum	-	-	-	-	-	-	-	12.164	12.164	0.2
Schima wallichii	9.237	21.466	-	9.627	10.342	-	-	-	50.672	0.8
TOTAL GROUP 'B' (BROAD LEAVED)SPP.	9.237	21.466	8.456	9.627	20.619	-	-	12.164	81.569	1.3
Albizzia spp.	5.464	7.350	-	-	10.733	-	-	-	23.547	0.4
Castanopsis spp.	-	27.775	47.875	32.133	17.433	40.264	-	-	165.480	2.8

Contents

Contd.

1	2	3	4	5	6	7	8	9	10	11
TOTAL GROUP 'C' (BROAD LEAVED)SPP.	5.464	35.125	47.875	32.133	28.166	40.264	-	-	189.027	3.2
Quercus spp.	20.620	27.190	74.414	59.258	12.879	26.929	14.050	-	235.340	4.0
Sterculia villosa	-	8.131	-	-	-	-	-	-	8.131	0.1
TOTAL GROUP 'D' (BROAD LEAVED)SPP.	20.620	35.321	74.414	59.258	12.879	26.929	14.050	-	243.471	4.1
Ficus spp.	-	6.895	8.651	-	-	-	-	-	15.546	0.3
Macaranga spp.	-	7.741	-	-	-	-	-	-	7.741	0.1
Rhododendron spp.	9.627	49.566	13.790	30.247	-	8.716	-	-	111.946	1.9
Miscellaneous spp.	76.365	44.882	17.498	10.017	-	-	-	-	148.762	2.5
TOTAL GROUP 'E' (BROAD LEAVED)SPP.	85.992	109.084	39.939	40.264	-	8.716	-	-	283.995	4.8
Total Broad leaved spp.	121.313	200.996	170.684	141.282	61.664	88.203	14.050	12.164	810.356	13.6
TOTAL CONIFERS AND BROAD LEAVED SPP.	286.597	650.861	974.340	1419.521	1325.072	817.055	220.639	254.529	5948.614	
%	4.8	10.9	16.4	23.9	22.3	13.7	3.7	4.3		100

Contents

APPENDIX 11.2 (VIDE PARA 9.4.1 OF REPORT)

TOTAL VOLUME OF ACCESSIBLE GROWING STOCK BY SPECIES AND DIAMETER CLASSES

FOREST TYPE - KAIL

'000' m^3

SPECIES	DIAMETER CLASSES (cm)									
	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80+	Total	%
1	2	3	4	5	6	7	8	9	10	11
Pinus wallichiana	72.796	149.746	241.727	210.407	198.370	65.371	119.113	98.866	1156.396	71.2
Larix griffithii	-	-	-	4.890	-	-	-	-	4.890	0.3
Picea spinulosa	17.941	33.152	28.654	45.451	36.979	7.949	-	-	170.126	10.5
Tsuga brunoniana	14.621	10.271	18.269	32.301	6.706	-	-	7.000	89.168	5.5
Total conifers	105.358	193.169	288.650	293.049	242.055	73.320	119.113	105.866	1420.580	87.5
Betula spp.	9.175	-	-	-	-	-	-	-	9.175	0.6
TOTAL GROUP 'A' (BROAD LEAVED)SPP.	9.175	-	-	-	-	-	-	-	9.175	0.6
Acer spp.	12.364	7.998	-	-	-	-	-	-	20.362	1.3
TOTAL GROUP 'B' (BROAD LEAVED)SPP.	12.364	7.998	-	-	-	-	-	-	20.362	1.3
Populus spp.	-	-	4.596	-	-	-	-	-	4.596	0.3

Contents

Contd.

1	2	3	4	5	6	7	8	9	10	11
Quercus spp.	5.790	9.699	22.161	49.212	6.444	7.049	7.262	-	107.617	6.6
TOTAL GROUP 'D' (BROAD LEAVED)SPP.	5.790	9.699	26.757	49.212	6.444	7.049	7.262	-	112.213	6.9
Rhododendron spp.	4.547	2.650	6.509	-	-	-	-	-	13.706	0.8
Miscellaneous spp.	12.283	26.348	8.783	-	-	-	-	-	47.414	2.9
TOTAL GROUP 'E' (BROAD LEAVED)SPP.	16.830	28.998	15.292	-	-	-	-	-	61.120	3.7
Total Broad leaved spp.	44.159	46.695	42.049	49.212	6.444	7.049	7.262	-	202.870	12.5
TOTAL FOR CONIFERS AND BROAD LEAVED SPP.	149.517	239.864	330.699	342.261	248.499	80.369	126.375	105.866	1623.450	
%	9.2	14.8	20.4	21.1	15.3	4.9	7.8	6.5		100

Contents

APPENDIX 11.3 (VIDE PARA 9.4.1 OF REPORT)

TOTAL VOLUME OF ACCESSIBLE GROWING STOCK BY SPECIES AND DIAMETER CLASSES

FOREST TYPE - FIR SPRUCE

'000' m^3

SPECIES	DIAMETER CLASSES (cm)									
	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80+	Total	%
1	2	3	4	5	6	7	8	9	10	11
Abies densa	697.986	1639.275	2614.334	4872.376	5764.907	5665.153	4810.674	10218.608	36283.313	83.0
Picea spinulosa	48.661	67.930	106.761	56.057	115.228	127.393	90.606	317.656	930.292	2.1
Cupressus spp.	-	6.326	-	8.272	-	-	10.219	-	24.817	-
Juniperus spp.	35.619	81.847	69.001	51.094	9.051	19.464	-	-	266.076	0.6
Pinus wallichiana	4.963	8.954	20.145	-	-	-	-	-	34.062	0.1
Tsuga brunoniana	8.662	8.856	20.632	11.095	45.644	11.679	94.012	943.527	1144.107	2.6
Total conifers	795.891	1813.188	2830.873	4998.894	5934.830	5823.689	5005.511	11479.791	38682.667	88.5
Betula spp.	185.397	237.463	390.646	233.862	163.402	33.284	11.484	-	1255.538	2.9
TOTAL GROUP 'A' (BROAD LEAVED)SPP.	185.397	237.463	390.646	233.862	163.402	33.284	11.484	-	1255.538	2.9
Acer spp.	272.207	260.626	78.733	-	9.732	-	-	-	621.298	1.4

Contents

Contd.

1	2	3	4	5	6	7	8	9	10	11
TOTAL GROUP 'B' (BROAD LEAVED)SPP.	272.207	260.626	78.733	-	9.732	-	-	-	621.298	1.4
Prunus spp.	45.741	32.505	-	-	-	-	-	-	78.246	0.2
TOTAL GROUP 'D' (BROAD LEAVED)SPP.	45.741	32.505	-	-	-	-	-	-	78.246	0.2
Rhododendron spp.	1288.335	495.948	122.235	58.587	7.494	-	-	-	1972.599	4.5
Miscellaneous spp.	391.814	333.032	133.330	109.681	54.889	28.807	40.583	-	1092.136	2.5
TOTAL GROUP 'E' (BROAD LEAVED)SPP.	1680.149	828.980	255.565	168.268	62.383	28.807	40.583	-	3064.735	7.0
Total Broad leaved spp.	2183.494	1359.574	724.944	402.130	235.517	62.091	52.067	-	5019.817	11.5
TOTAL CONIFERS AND BROAD LEAVED SPP.	2979.385	3172.762	3555.817	5401.024	6170.347	5885.780	5057.578	11479.791	43702.484	
%	6.8	7.3	8.1	12,3	14.1	13.5	11.6	26.3		100

Contents

APPENDIX 11.4 (VIDE PARA 9.4.1 OF REPORT)

TOTAL VOLUME OF ACCESSIBLE GROWING STOCK BY SPECIES AND DIAMETER CLASSES

FOREST TYPE - MIXED CONIFERS

'000' m^3

SPECIES	DIAMETER CLASSES (cm)									
	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80+	Total	%
1	2	3	4	5	6	7	8	9	10	11
Abies densa	31.936	11.922	72.966	136.447	201.060	266.629	255.752	568.937	1545.649	10.5
Cupressus spp.	-	8.006	27.281	30.631	21 799	-	-	-	87.717	0.6
Juniperus spp.	85.584	93.982	118.391	61.306	22.103	11.661	12.444	14.228	419.699	2.9
Larix griffithii	-	-	-	-	11.052	11.965	12.618	-	35.635	0.2
Picea spinulosa	15.054	46.773	72.705	192.314	155.331	235.868	207.325	426.093	1351.463	9.2
Pinus wallichiana	-	41.030	60.914	190.139	156.331	133.097	34.503	146.498	762.512	5.2
Taxus baccata	11.400	23.539	37.419	41.378	22.147	23.800	-	41.639	201.322	1.4
Tsuga brunoniana	174.606	226.078	519.335	601.178	787.487	903.529	857.147	3845.153	7914.513	53.9
Total conifers	318.580	451.330	909.011	1253.393	1377.310	1586.549	1379.789	5042.548	12318.510	83.9
Betula spp.	80.494	142.017	133.010	79.623	62.176	13.314	-	-	510.634	3.5
TOTAL GROUP 'A' (BROAD LEAVED)SPP.	80.494	142.017	133.010	79.623	62.176	13.314	-	-	510.634	3.5

Contents

Contd.

1	2	3	4	5	6	7	8	9	10	11
Acer spp.	104.642	189.921	47.992	63.394	58.216	12.444	-	-	476.609	3.2
TOTAL GROUP 'B' (BROAD LEAVED)SPP.	104.642	189.921	47.992	63.394	58.216	12.444	-	-	476.609	3.2
Alnus spp.	10.486	-	-	10.486	-	-	-	-	20.972	0.1
Machilus spp.	12.618	-	-	-	-	-	-	-	12.618	0.1
TOTAL GROUP 'C' (BROAD LEAVED)SPP.	23.104	-	-	10.486	-	-	-	-	33.590	0.2
Populus spp.	-	-	-	10.616	-	-	-	-	10.616	0.1
Prunus spp.	-	21.494	8.876	-	-	-	-	-	30.370	0.2
Quercus spp.	4.438	-	44.728	25.192	13.619	14.271	-	-	102.248	0.7
TOTAL GROUP 'D' (BROAD LEAVED)SPP.	4.438	21.494	53.604	35.808	13.619	14.271	-	-	143.234	1.0
Aesculus punduana	-	-	-	-	11.182	-	-	-	11.182	0.1
Cinnamomum tamala	25.932	-	-	-	-	-	-	-	25.932	0.2
Rhododendron spp.	250.748	185.048	142.800	39.464	17.665	-	20.319	-	656.044	4.5
Symplocos spicata	21.624	8.223	-	-	-	-	-	-	29.847	0.2
Miscellaneous spp.	191.966	99.203	67.092	62.437	10.878	35.287	-	13.140	480.003	3.2

Contents

Contd.

1	2	3	4	5	6	7	8	9	10	11
TOTAL GROUP 'E' (BROAD LEAVED)SPP.	490.270	292.474	209.892	101.901	39.725	35.287	20.319	13.140	1203.008	8.2
Total Broad leaved spp.	702.948	645.906	444.498	291.212	173.736	75.316	20.319	13.140	2367.075	16.1
TOTAL CONIFERS AND BROAD LEAVED SPP.	1021.528	1097.236	1353.509	1544.605	1551.046	1661.865	1400.108	5055.688	14685.585	
%	7.0	7.5	9.2	10.5	10.6	11.3	9.5	34.4		100

Contents

APPENDIX 11.5 (VIDE PARA 9.4.1 OF REPOPT)

TOTAL VOLUME OF ACCESSIBLE GROWING STOCK BY SPECIES AND DIAMETER CLASSES

FOREST TYPE - CONIFERS MIXED WITH BROAD LEAVED

'000' m^3

SPECIES	DIAMETER CLASSES (cm)									
	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80+	Total	%
1	2	3	4	5	6	7	8	9	10	11
Abies densa	74.497	171.141	355.469	996.744	642.784	371.476	186.946	1799.695	4598.752	15.3
Juniperus spp.	-	-	-	-	-	-	-	97.047	97.047	0.3
Pinus roxburghii	110.235	201.845	244.933	454.127	438.724	-	-	-	1449.864	4.8
Pinus wallichiana	-	-	-	210.503	-	240.302	-	-	450.805	1.5
Taxus baccata	-	116.476	-	229.429	82.349	85.570	180.604	-	694.428	2.3
Tsuga brunoniana	31.812	79.530	367.650	292.147	202.147	309.362	313.389	5133.919	6729.956	22.3
Total conifers	216.544	568.992	968.052	2182.950	1366.004	1006.710	680.939	7030.661	14020.852	46.5
Betula spp.	245.738	574.127	828.724	838.589	354.362	195.302	102.382	-	3139.224	10.4
TOTAL GROUP 'A' (BROAD LEAVED)SPP.	245.738	574.127	828.724	838.589	354.362	195.302	102.382	-	3139.224	10.4
Acer spp.	700.167	851.073	418.087	550.469	87.181	-	-	-	2606.977	8.7

Contents

Contd.

1	2	3	4	5	6	7	8	9	10	11
TOTAL GROUP 'B' (BROAD LEAVED)SPP.	700.167	851.073	418.087	550.469	87.181	-	-	-	2606.977	8.7
Castanopsis spp.	-	39.866	53.054	61.007	206.074	-	87.181	116.174	563.356	1.9
TOTAL GROUP 'C' (BROAD LEAVED)SPP.	-	39.866	53.054	61.007	206.074	-	87.181	116.174	563.356	1.9
Quercus spp.	-	-	169.429	277.852	199.127	314.396	-	486.241	1447.045	4.8
TOTAL GROUP 'D' (BROAD LEAVED)SPP.	-	-	169.429	277.852	199.127	314.396	-	486.241	1447.045	4.8
Aesculus punduana	-	-	-	-	-	-	-	94.429	94.429	0.3
Rhododendron spp.	1554.864	1082.717	642.684	226.610	190.369	-	-	-	3697.244	12.3
Miscellaneous spp.	1592.817	1177.951	535.368	450.100	160.671	170.436	272.214	197.416	4556.973	15.1
TOTAL GROUP 'E' (BROAD LEAVED)SPP.	3147.681	2260.668	1178.052	676.710	351.040	170.436	272.214	291.845	8348.646	27.7
Total Broad leaved spp.	4093.586	3725.734	2647.346	2404.627	1197.784	680.134	461.777	894.260	16105.248	53.5
TOTAL CONIFERS AND BROAD LEAVED SPP.	4310.130	4294.726	3615.398	4587.577	2563.788	1686.844	1142.716	7924.921	30126.100	
%	14.3	14.3	12.0	15.2	8.5	5.6	3.8	26.3		100

Contents

APPENDIX 11.6 (VIDE PARA 9.4.1 OF REPORT)

TOTAL VOLUME OF ACCESSIBLE GROWING STOCK BY SPECIES AND DIAMETER CLASSES

FOREST TYPE - UPLAND HARD WOODS AND LOWLAND HARDWOODS

'000' m^3

SPECIES	DIAMETER CLASSES (cm)									
	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80+	Total	%
1	2	3	4	5	6	7	8	9	10	11
Betula spp.	314.862	392.601	443.413	479.894	340.051	154.508	50.812	85.556	2261.797	2.2
Juglans regia	-	13.029	-	8.686	-	20.846	33.006	36.481	112.048	0.1
Michelia spp.	29.532	249.284	297.925	495.528	491.620	514.637	521.152	1923.049	4522.727	4.4
Morus laevigata	-	13.029	24.755	27.795	58.630	30.835	21.715	208.895	385.654	0.4
Phoebe goalparensis	28.229	52.549	99.887	76.870	155.043	173.283	115.088	203.249	904.198	0.9
Terminalia myriocarpa	-	14.766	15.635	18.240	9.989	-	21.715	78.173	158.518	0.2
TOTAL GROUP 'A' (BROAD LEAVED)SPP.	372.623	735.258	881.615	1107.013	1055.333	894.209	763.488	2535.403	8344.942	8.2
Acer spp.	363.938	306.177	264.050	330.931	321.811	396.075	336.577	866.415	3185.974	3.1
Ailantus grandis	3.909	-	-	-	-	10.423	32.572	34.309	81.213	0.1
Altingia excelsa	15.200	14.332	16.069	27.795	9.989	61.670	65.578	479.894	690.527	0.7
[illegible]hoora wallichii	24.755	6.949	16.069	9.554	9.554	-	10.857	11.292	[illegible] 030	0.1

Contents

Contd.

1	2	3	4	5	6	7	8	9	10	11
Cedrela spp.	13.897	27.360	16.069	36.481	19.109	10.423	32.572	300.531	456.442	0.5
Cinnamomum cecicodaphne	41.692	46.904	33.006	63.407	39.086	20.846	42.995	83.819	371.755	0.4
Duabanga sonneratioides	-	20.846	7.817	-	9.989	20.846	33.006	37.349	129.853	0.1
Phoebe hainesiana	9.554	13.463	56.458	174.151	254.930	260.576	141.145	384.349	1294.626	1.3
Salmalia malabaricum	-	33.441	16.503	18.240	19.543	10.423	-	-	98.150	0.1
Schima wallichii	95.544	94.676	201.512	191.523	335.708	280.988	239.295	538.089	1977.335	1.9
Tetrameles nudiflora	-	-	-	-	-	10.857	-	11.726	22.583	-
TOTAL GROUP 'B' (BROAD LEAVED)SPP.	568.489	564.148	627.553	852.082	1019.719	1083.127	934.597	2747.773	8397.488	8.3
Acrocarpus fraxinifolius	-	7.383	-	-	-	-	-	50.812	58.195	0.1
Albizzia spp.	62.104	48.641	32.572	64.275	19.543	10.423	10.857	13.029	261.444	0.3
Alnus spp.	105.533	167.637	244.507	290.108	253.627	198.038	98.150	291.411	1649.011	1.6
Bucklandia populnea	46.469	151.568	49.509	8.686	59.064	52.115	21.280	266.656	655.347	0.6
stanopsis spp.	99.019	252.324	350.909	393.035	339.617	169.809	208.026	152.003	1964.742	1.9
chilus spp.	327.457	591.941	879.443	1324.159	1350.217	853.386	823.854	805.614	6956.071	6.8

Contents

Contd.

1	2	3	4	5	6	7	8	9	10	11
TOTAL GROUP 'C' (BROAD LEAVED)SPP.	640.582	1219.494	1556.940	2080.263	2022.068	1283.771	1162.167	1579.525	11544.810	11.3
Bischofia javanica	6.080	7.383	8.252	36.481	9.554	-	10.857	24.320	102.927	0.1
Garuga pinnata	5.646	7.383	32.572	18.675	-	-	54.721	33.875	152.872	0.2
Lagerstroemia parviflora	60.367	27.795	-	8.686	-	-	-	-	96.848	0.1
Populus spp.	-	13.029	8.686	-	-	-	21.715	71.658	115.088	0.1
Prunus spp.	4.777	-	-	-	-	9.989	-	23.452	38.218	-
Pterospermum acerifolium	9.989	7.383	7.817	9.120	19.977	-	10.857	-	65.143	0.1
Quercus spp.	1486.151	2341.708	3453.064	3849.139	3446.984	3522.985	3043.525	10164.628	31308.184	30.7
Sterculia villosa	4.343	6.949	40.824	17.806	19.543	41.592	11.292	35.178	177.627	0.2
Syzigium spp.	32.138	20.412	57.327	9.120	9.554	-	-	12.594	141.145	0.1
TOTAL GROUP 'D' (BROAD LEAVED)SPP.	1609.491	2432.042	3608.542	3949.027	3505.612	3574.566	3152.967	10365.705	32198.052	31.6
Aesculus punduana	59.932	92.504	155.477	90.767	148.094	103.796	43.429	25.623	719.622	0.7
Amoora rohituka	28.229	27.795	7.817	9.120	49.075	31.703	-	36.046	189.785	0.2
Cinnamomum tamala	45.601	62.972	90.767	63.407	19.543	41.258	-	24.320	347.868	0.3

Contents

Contd.

1	2	3	4	5	6	7	8	9	10	11
Ergelherdtia spicata	74.264	54.287	77.738	102.059	33.006	24.755	94.676	512.031	972.816	1.0
Ficus spp.	118.128	198.906	219.752	109.442	117.693	30.835	11.292	257.101	1063.149	1.0
Kydia calycina	5.546	47.338	16.937	27.360	29.532	-	-	12.594	139.407	0.1
Macaranga spp.	124.642	109.442	177.192	107.705	78.173	20.846	10.857	-	628.857	0.6
Ostodes paniculata	70.790	83.384	55.590	72.961	39.086	-	-	11.292	333.103	0.3
Rhododendron spp.	1129.596	1136.110	836.883	507.254	294.451	184.575	52.984	48.641	4190.494	4.1
Symplocos spicata	216.712	382.612	104.665	90.767	86.424	22.583	58.195	85.556	1047.514	1.0
Vitex heterophylla	7.817	-	16.503	-	9.554	20.846	-	23.452	78.172	0.1
Miscellaneous spp.	3996.364	4996.975	4934.871	3739.263	3128.647	2403.377	1677.240	3904.728	28781.465	28.2
TOTAL GROUP 'E' (BROAD LEAVED)SPP.	5877.721	7192.325	6694.192	4920.105	4033.278	2884.574	1948.673	4941.384	38492.252	37.6
Total Broad leaved spp.	9068.906	12143.267	13368.842	12908.490	11636.010	9720.347	7961.892	22169.790	98977.544	97.0
Abies densa	8.686	-	10.857	65.578	132.894	134.197	112.482	603.667	1068.361	1.1
Juniperus spp.	4.777	6.514	-	18.675	39.521	-	-	-	69.487	0.1
Picea spinulosa	-	7.817	-	12.594	41.258	30.401	-	-	92.070	0.1
Pinus roxburghii	-	20.846	9.120	69.921	68.184	43.429	62.972	51.247	325.719	0.3

Contents

Contd.

1	2	3	4	5	6	7	8	9	10	11
Pinus wallichiana	-	17.372	11.292	51.681	27.360	-	-	32.138	139.843	0.1
Taxus baccata	-	-	23.886	44.732	59.064	10.423	54.237	110.310	302.702	0.3
Tsuga brunoniana	-	18.240	20.846	70.355	48.641	49.944	113.350	669.246	990.622	1.0
Total conifers	13.463	70.789	76.001	333.536	416.922	268.394	343.091	1466.608	2988.804	3.0
TOTAL FOR CONIFERS AND BROAD LEAVED SPP.	9082.369	12214.056	13444.843	13242.026	12052.932	9988.741	8304.983	23636.398	101966.348	
%	8.9	12.0	13.2	13.0	11.8	9.8	8.1	23.2		100

Contents

APPENDIX 12.1 (VIDE PARA 9.4.1 OF REPORT)

TOTAL VOLUME OF ACCESSIBLE GROWING STOCK BY SPECIES AND DIAMETER CLASSES

FOREST TYPE - ALL

'000' m^3

SPECIES	DIAMETER CLASSES (cm)									
	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80+	Total	%
1	2	3	4	5	6	7	8	9	10	11
Abies densa	813.105	1822.338	3053.626	6071.145	6741.645	6437.455	5365.854	13190.907	43496.075	22.0
Cupressus spp.	-	14.332	27.281	38.903	21.799	-	10.219	-	112.534	0.1
Juniperus spp.	125.980	182.343	187.392	131.075	70.675	31.125	12.444	111.275	852.309	0.4
Larix griffithii	-	-	-	4.890	11.052	11.965	12.618	-	40.525	-
Picea spinulosa	81.656	155.672	208.120	306.416	348.796	401.611	297.931	743.749	2543.951	1.3
Pinus roxburghii	275.519	672.556	1057.709	1802.287	1770.316	772.281	269.561	293.612	6913.841	3.5
Pinus wallichiana	77.759	217.102	334.078	662.730	382.061	438.770	153.616	277.502	2543.618	1.3
Taxus baccata	11.400	140.015	61.305	315.539	163.560	119.793	234.891	151.949	1198.452	0.6
Tsuga brunoniana	229.701	342.975	946.732	1007.076	1090.625	1274.514	1377.898	10598.845	16868.366	8.5
Total conifers	1615.120	3547.333	5876.243	10340.061	10600.529	9487.514	7735.032	25367.839	74569.671	37.7
Betula spp.	835.666	1346.208	1795.793	1631.968	919.991	396.508	164.678	85.556	7176.368	3.6

Contents

Contd.

1	2	3	4	5	6	7	8	9	10	11
Juglans regia	-	13.029	-	8.686	-	20.846	33.006	36.481	112.048	0.1
Michelia spp.	29.532	249.284	297.925	495.528	491.620	526.931	521.152	1923.049	4535.021	2.3
Morus laevigata	-	13.029	24.755	27.795	58.630	30.835	21.715	208.895	385.654	0.2
Phoebe goalparensis	28.229	52.549	99.887	76.870	155.043	173.283	115.088	203.249	904.198	0.4
Terminalia myriocarpa	-	14.766	15.635	18.240	9.989	-	21.715	78.173	158.518	0.1
TOTAL GROUP 'A' (BROAD LEAVED) SPP.	893.427	1688.865	2233.995	2259.087	1635.273	1148.403	877.354	2535.403	13271.807	6.7
Acer spp.	1453.318	1615.795	808.862	944.794	476.940	408.519	336.577	866.415	6911.220	3.5
Ailantus grandis	3.909	-	-	-	-	10.423	32.572	34.309	81.213	-
Altingia excelsa	15.200	14.332	16.069	27.795	9.989	61.670	65.578	479.894	690.527	0.3
Amoora wallichii	24.755	6.949	16.069	9.554	9.554	-	10.857	11.292	89.030	0.1
Cedrela spp.	13.897	27.360	16.069	36.481	19.109	10.423	32.572	300.531	456.442	0.2
Cinnamomum cecicodaphne	41.692	46.904	33.006	63.407	39.086	20.846	42.995	83.819	371.755	0.2
Duabanga sonneratioides	-	20.846	16.273	-	20.266	20.846	33.006	37.349	148.586	0.1

Contents

Contd.

1	2	3	4	5	6	7	8	9	10	11
Phoebe hainesiana	9.554	13.463	56.458	174.151	254.930	260.576	141.145	384.349	1294.626	0.7
Salmalia malabaricum	-	33.441	16.503	18.240	19.543	10.423	-	12.164	110.314	0.1
Schima wallichii	104.781	116.142	201.512	201.150	346.050	280.988	239.295	538.089	2028.007	1.0
Tetrameles nudiflora	-	-	-	-	-	10.857	-	11.726	22.583	-
TOTAL GROUP 'B' (BROAD LEAVED)SPP.	1667.106	1895.232	1180.821	1475.572	1195.467	1095.571	934.597	2759.937	12204.303	6.2
Acrocarpus fraxinifolius	-	7.383	-	-	-	-	-	50.812	58.195	-
Albizzia spp.	67.568	55.991	32.572	64.275	30.276	10.423	10.857	13.029	284.991	0.2
Alnus spp.	116.019	167.637	244.507	300.594	253.627	198.038	98.150	291.411	1669.983	0.8
Bucklandia populnea	46.469	151.568	49.509	8.686	59.064	52.115	21.280	266.656	655.347	0.3
Castanopsis spp.	99.019	319.965	451.838	486.175	563.124	210.073	295.207	268.177	2693.578	1.4
Machilus spp.	340.075	591.941	879.443	1324.159	1350.217	853.386	823.854	805.614	6968.689	3.5
TAL GROUP 'C' ROAD LEAVED)SPP.	669.150	1294.485	1657.869	2183.889	2256.308	1324.035	1249.348	1695.699	12330.783	6.2
schofia javanica	6.080	7.383	8.252	36.481	9.554	-	10.857	24.320	102.927	-

Contents

Contd.

1	2	3	4	5	6	7	8	9	10	11
Garuga pinnata	5.646	7.383	32.572	18.675	-	-	54.721	33.875	152.872	0.1
Lagerstroemia parviflora	60.367	27.795	-	8.686	-	-	-	-	96.848	-
Populus spp.	-	13 029	13.282	10.616	-	-	21.715	71.658	130.300	0.1
Prunus spp.	50.518	53.999	8.876	-	-	9.989	-	23.452	146.834	0.1
Pterospermum acerifolium	9.989	7.383	7.817	9.120	19.977	-	10.857	-	65.143	-
Quercus spp.	1516.999	2378.597	3763.796	4260.653	3679.053	3885.630	3064.837	10650.869	33200.434	16.8
Sterculia villosa	4.343	15.080	40.824	17.806	19.543	41.692	11.292	35.178	185.758	0.1
Syzigium spp.	32.138	20.412	57.327	9.120	9.554	-	-	12.594	141.145	0.1
TOTAL GROUP 'D' (BROAD LEAVED)SPP.	1686.080	2531.061	3932.746	4371.157	3737.681	3937.311	3174.279	10851.946	34222.261	17.3
Aesculus punduana	59.932	92.504	155.477	90.767	159.276	103.796	43.429	120.052	825.233	0.4
Amoora rohituka	28.229	27.795	7.817	9.120	49.075	31.703	-	36.046	189.785	0.1
Cinnamomum tamala	71.533	62.972	90.767	63.407	19.543	41.258	-	24.320	373.800	0.2
Engelhardtia spicata	74.264	54.287	77.738	102.059	33.006	24.755	94.676	512.031	972.816	0.5
Ficus spp.	118.128	205.801	228.403	109.442	117.693	30.835	11.292	257.101	1078.695	0.5

Contents

Contd.

1	2	3	4	5	6	7	8	9	10	11
Kydia calycina	5.646	47.338	16.937	27.360	29.532	-	-	12.594	139.407	0.1
Macaranga spp.	124.642	117.183	177.192	107.705	78.173	20.846	10.857	-	636.598	0.3
Ostodes paniculata	70.790	83.384	55.590	72.961	39.086	-	-	11.292	333.103	0.2
Rhododendron spp.	4237.717	2952.039	1764.901	862.162	509.979	193.291	73.303	48.641	10642.033	5.4
Symplocos spicata	238.336	390.835	104.665	90.767	86.424	22.583	58.195	85.556	1077.361	0.5
Vitex heterophylla	7.817	-	16.503	-	9.554	20.846	-	23.452	78.172	-
Miscellaneous spp.	6261.609	6678.391	5696.942	4371.498	3355.085	2637.907	1990.037	4115.284	35106.753	17.7
TOTAL GROUP 'E' (BROAD LEAVED) SPP.	11298.643	10712.529	8392.932	5907.248	4486.426	3127.820	2281.789	5246.369	51453.756	25.9
Total Broad leaved spp.	16214.406	18122.172	17398.363	16196.953	13311.155	10633.140	8517.367	23089.354	123482.910	62.3
TOTAL FOR CONIFERS AND BROAD LEAVED SPP.	17829.526	21669.505	23274.606	26537.014	23911.684	20120.654	16252.399	48457.193	198052.581	
%	9.0	10.9	11.7	13.4	12.1	10.2	8.2	24.5		100

Contents

APPENDIX 13.1 (VIDE PARA 2.7.1 OF THE REPORT)

A GLOSSARY OF LOCAL NAMES OF COMMON PLANTS WITH THEIR BOTANICAL EQUIVALENTS

Trees

Local Name	Botanical Name
Agar	Aquilario agallocha
Ajhar, Jorul	Lagerstroemia flosreginae
Akhane	Alangium spp.
Am	Mangifera spp.
Amari, Lali	Amoora wallichii
Amaro, Amara	Spondias mangifera
Ambake, Jamune	Jambosa formosa
Angare	Phoebe hainesiana
Archal	Antidesma diandrum
Arkaula, Amkhola	Quercus spicata
Arupate	Prunus nepalensis
Athor	Artocarpus spp.
Badam	Sterculia alata
Bahuri Kath	Marsdenia spp.
Bajrath	Quercus semiserrata
Bandre, Lemtem	Gynocardia spp.
Bange	Berchemia floribunda
Barahar	Ficus bangalensis
Barkaunle	Casearia gbmerata
Barrar	Artocarpus lakoocha
Behera, Barra/Burna	Terminalia belerica
Bepari	Ostodes paniculata
Bhadrase	Elaeocarpus varunua

Contents

Local Name	Botanical Name
Bhalayo/Bakimlo	Rhus griffithii Semecarpus anacardium
Bhalu Kath	Talauma hodgsoni
Bhelkor	Trewia nudiflora
Bhelu	Tetrameles nudiflora
Bhojpatra/Birth	Betula spp.
Blue pine	Pinus excelsa
Bogipoma	Chuckrassia tabularis
Bohari	Cardia obliqua
Bola, Kimbu	Morus laevigata
Bonsum	Phoebe goalparensis
Buk	Quercus spp.
Buradhoyaro	Lagerstroemia parviflora
Burance	Rhododendron spp.
Champ	Michelia champaca
Chaplash	Artocarpus spp.
Chatiwan	Alstonia scholaris
Chhalegach, Gendhillipoma	Dysoxrlum hamiltonii
Chikrase, Bogipoma	Chuckrassia tabularis
Chilaune, Gogra	Schima wallichii
Chinde	Macropanax spp.
Chir	Pinus roxburghii
Chiwari	Bassia butyracea Mellosma simplicifolia
Chunyel, Thekra	Garcinia tinctoria
Cyprus	Cupressus spp.

Contents

Local Name	Botanical Name
Dabdabe	Garuga Pinnata
Dalchiwari	Elaeocarpus aristatus
Dewa	Artocarpus lakoocha
Dhuna	Canarium sikkimense
Dudhe Lampati	Litsaea spp.
Dudhila	Ficus nemoralis
Dumri	Ficus glomerata
Gamar, Khamar	Gmelina arborea
Ganserai	Cinnamomum cecicodaphne
Gante, Bandre	Dynocardia odorata
Gayo/Gaumbha, Kuhir	Bridelia retusa
Ghoge Champ	Magnolia spp.
Gineri	Premna bengalensis
Gobre	Echinocarpus sterculiaceus
Gobresall	Abies densa
Godgudal	Sterculia villosa
Gogun	Saurauia napaulensis
Gokul	Ailantus grandis
Gokuldhup, Dhuna	Canarium sikkimense
Guenylo	Callicarpa arborea
Haldu	Adina cordifolia
Halonre, Jai	Odina wodier
Hare	Drypetes lancifolia
Harra	Terminalia chebula
Hatipaile	Pterospermum acerifolium
Hemlock	Tsuga brunoniana

Contents

Local Name	Botanical Name
Hollock, Panisaj	Terminalia myriocarpa
Holure	Lannea coromandelica
Jammuna, Jamun	Syzigium spp.
Jarul	Larix griffithii
Jhankri Kath	Phoebe lanceolata
Jhikri	Altingia excelsa
Jhingni	Eurya japonica
Jua	Lannea coromandelica
Juniper	Juniperus spp.
Jutuli	Altingia excelsa
Kabra	Ficus benjamina
Kadam	Anthocephalus cadamba
Kakur	Acacia lenticularis
Kalikath	Sarcosperma arboreum
Kalipahenle	Litsaea oblonga
Kanjal, Uriam	Bischofia javanica
Kapasi/Kapari	Acer spp.
Karan	Adina cordifolia
Kathal	Artocarpus spp.
Katus	Castanopsis spp.
Kawla	Machilus spp.
Khair	Acacia catechu
Khamari	Gmelina arborea
Khanakpa	Evodia spp.
Khanium	Ficus cunia
Kharane	Symplocos spicata

Contents

Local Name	Botanical Name
Khari	Celtis tetrandra
Khhira	Holarrhena antidysenterica
Khokan/Khoku	Duabanga sonneratioides
Kholme	Symplocos spicata
Khorsane	Cinnamomum caudatum
Kimbu	Morus laevigata
Kubinde, Pichala	Kydia calycina
Kulir	Bridelia retusa
Kumbhi	Careya arborea
Kutmero	Litsaea polyantha
Labar	Ficus elastica
Labshi	Firmiana colorata Pterygota alata(Sterculia) Alata
Lahasune	Amoora rohituka
Lake chilaune	Nyssa Javanica
Lali	Amoora wallichii
Lalikaram	Hymenodictyon excelsum
Lampate	Duabanga sonneratioides
Lapcha	Croton tiglium
Lapchi (Phal)	Machilus edulis
Larch	Larix griffithii
Lathi Kath	Glochidion thomsoni
Lathor, Sam	Artocarpus chaplasha
Lati mauwa	Glochidion assamicum
Letar/Lathar	Artocarpus chaplasha
Maina; Bhelu	Tetrameles nudiflora

Contents

Local Name	Botanical Name
Malagiri, Gonserai	Cinnamomum cecicodaphne
Malata	Macaranga spp.
Mandane/Mondaney	Acrocarpus fraxinifolius
Mango, Am	Mangifera sylvatica
Mauwa	Engelhardtia spicata
Maya (Kath)	Eriobotrya bengalensis
Morange	Laportea crenulata
Nageswar	Mensua ferrea
Nebharo	Ficus hookeri Ficus roxburghii
Odal	Sterculia villosa
Okhar	Juglans regia
Pahenle	Neonsucles griffithii
Pakasaj	Terminalia tomentosa
Panchpate	Vitex heterophylla
Panchphal	Dillenia indica
Panisaj	Terminalia myriocarpa
Parari	Stereospermum chelonoides
Patpate	Meliosma simplicifolia
Phalame	Myrsina semiserrata
Phaledo	Erythrina indica
Phurse Champ	Michelia spp.
Pipli	Bucklandia populnea
Pitali, Bhelkor	Trewia nudiflora
Pipalpate	Populus glaucea Sapium eugeniaefolium
Poma	Cedrela spp.

Contents

Local Name	Botanical Name
Popular	Populus spp.
Putli	Acer laevigatum
Rajbrikha	Cassia fistula
Rakat Chandan	Daphni-phyllum himalayense
Ritha	Sapindus detergens
Rohini	Mallotus spp.
Sain	Terminalia tomentosa
Sal	Shorea robusta
Salla	Tsuga brunoniana
Sam	Betula alnoides
Samgata	Duabanga sonneratioides
Sani	Artocarpus spp.
Sarla	Pinus roxburghii
Satisalo	Dalbergia latifolia
Satpati	Aesculus punduana
Seti, Jutuli	Altingia excelsa
Seto-Odal	Firmiana colorata
Sidha, Sida	Lagerstroemia parviflora
Simul, Simal	Salmalia malabaricum
Sindhre	Mallotus philippinensis
Sinkauli, Sinhal	Lindera pulcherrima
Siris	Albizzia spp.
Sissoo/Sissna	Dalbergia sissoo
Sonalu	Cassia fistula
Swami	Ficus spp.
Tanki	Bauhinia spp.
Tarsing	Beilschmiedia spp.

Contents

Local Name	Botanical Name
Tartari	Dillenia pentagyna
Teak	Tectona grandis
Tejpat	Cinnamomum tamala
Tengre	Tsuga brunoniana
Thali	Turpinia pomifera
Thulo pahenla	Litsaea spp.
Toan, Poma	Cedrela toona Cedrela febrifuga
Uriam	Bischofia javanica
Utis	Alnus nepalensis
Walnut	Juglans regia
Yew	Taxus baccata
SHRUBS	
Assamlata	Eupatorium odoratum
Basak	Dichrod febrifuga
Chitu	Clerodendron infortunatum
Dhuptita	Phlogacanthus thyrsiflorus
Hardi Kath	Morinda citrifolia
Mechia sag	Murraya Koenigii
Morange	Laportea crenulata
Pipla	Piper spp.
Sisnu	Girardinia palmata
Taraphul	Coffea bengalensis
Titapat	Artimesia vulgaris

Contents

Local Name	Botanical Name
PALM	
Tarika	Phoenix rupicola
BAMBOOS	
Bhalubans	Dendrocalamus sikkimensis
Choyabans	Dendrocalamus hamiltonii
Gopebans	Cephalostachyum capitatum
Phaling	Pseudostachyum polymorphum
GRASS	
Sau	Pollinia ciliata
CLIMBERS	
Debre lahara	Spatholobus roxburghii
Kurkus	Millettia auricalata Smilax macrophylla
Pani Lahara	Vitis latifolia

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