

DEVELOPMENT
TEN-YEAR FOREST MANAGEMENT PLAN (2012–2022)
FOR 28,000 ha WITHIN FMU 23
GUNUNG RARA FOREST RESERVE



Submitted by

RAKYAT BERJAYA SDN. BHD.
Forestry Division, Wisma Innoprise
Jalan Sulaiman, Teluk Likas
88817 Kota Kinabalu, Sabah
Tel: 088-326300 Fax: 088-244154

As part fulfillment of SFMLA 09/97

April 2012

**ENDORSEMENT OF
THE SABAH FORESTRY DEPARTMENT**

It is hereby notified that in compliance with Clause 44 of Sustainable Forest Management License Agreement 09/97, between The Sabah Foundation and the Sabah State Government, in respect to Gunung Rara Forest Reserve (Part of FMU 23), this Plantation Development Plan is approved for the period commencing 1st May, 2012 to 30th April, 2022.

This Forest Management Plan was prepared by the Forestry Department in consultation with Rakyat Berjaya Sdn. Bhd., a wholly-owned company of the The Sabah Foundation.

Approved By:



Datuk Sam Mannan
Director,
Sabah Forestry Department

Date: 22/5/2012

EXECUTIVE SUMMARY

In February 2012, the Forestry Department approved an area of 28,374 ha within FMU #23 to be rehabilitated and developed mainly by means of mosaic planting, and to a lesser extent for natural forest management. The proposed area also forms part of the Gunung Rara Forest Reserve, which is designated by law as a Commercial Forest Reserve (Class II), meaning that it is intended primarily for timber production. The project area was previously allocated for logging under Coupes BW8/99 and BW8/00-04.

This forest management plan (FMP) is submitted by Rakyat Berjaya in reference to the project area. The plan outlines the development and implementation plan for the 28,374 ha project area over a period of 10 years (i.e. covering the period May 2012–April 2022) for the purpose of intensive forest rehabilitation and timber production. Rakyat Berjaya views this project as a long-term commercial venture that will yield financial benefits through the planting and harvesting of trees in a sustainable manner. Empayar Kejora Sdn. Bhd., a Sandakan-based company, with a long-term interest in the timber industry, has been appointed by Rakyat Berjaya as the contractor to undertake the task of developing the project area.

A field assessment of the project area found existing timber stands to be extremely poor, both in terms of merchantable timber stocking and commercial regeneration. Since prospects for harvesting under a natural forest management regime is poor, Rakyat Berjaya decided that an emphasis on the cultivation of fast-growing trees would be the best development option for the area.

The approach that will be adopted is the 'integrated mosaic planting' design, which combines the cultivation of fast growing trees in blocks that are interspersed amongst patches of natural forest, thereby forming a mosaic of small monocultures, and patches of natural forest. The ratio of planted and natural forest patches is approximately 40:60. All patches of natural forest will be tended to liberate potential crop trees. The species to be planted are mainly batai, laran, binuang, and talisai. All species were selected based on its known commercial value, relatively fast growth, and ease of procuring planting material. All chosen species have an approximate rotation age between 10 and 15 years, and merchantable yields ranging from 250 to 350 m^3ha^{-1} upon clear-felling.

Tree planting will be carried out in 40 compartments ranging in size from 153 to 674ha. Compartment boundaries were delineated to follow existing logging roads and streams. This will provide easy access for planting and maintenance operations, as well as facilitate protection measures. After taking into account roads, swamps, rivers, riparian buffers, the estimated net production area is about 26,364 ha. Twenty one compartments covering about 9,320 ha is designated for natural forest management, and is therefore subject to RIL guidelines. The remaining area of 18,288 ha is allocated for mosaic planting. The ratio of planted and natural forest patches was worked out to be approximately 7,315 ha: 10,973 ha. The entire project area is intended to be completely planted within 7 years.

The total project cost up to year 11, i.e. when 1,460 ha of the planted crop will be harvested (Yr 10: 730 ha & Yr 11: 730 ha), is estimated to be about RM 42,318,000. Based on current log prices, the projected revenue expected from harvesting 1,460 ha in years 10 and 11 is about RM 70,232,557. At a discount rate of 15 %, the net present value of investments is highly positive (RM 44,232,934) and the internal rate of return is about 24 %, thus suggesting that this venture is financially viable.

CONTENTS

ENDORSEMENT OF THE SABAH FORESTRY DEPARTMENT	i
EXECUTIVE SUMMARY	ii
1. INTRODUCTION	1
1.1 Background	1
1.2 Purpose and Scope of Plan	2
1.3 Management Policies and Development Goals	2
1.4 Legal Framework	3
2. GENERAL DESCRIPTION OF THE PROJECT AREA	4
2.1 Location & Access	4
2.2 Compartment Delineation	5
2.3 Rainfall & Temperature	5
2.4 Physical Environment	5
2.5 Vegetation & Wildlife	7
2.6 Settlements & Socio-economic Environment	9
2.7 Infrastructure	9
2.8 Past management	11
3. SILVICULTURAL & TIMBER RESOURCE ASSESSMENT	12
3.1 Inventory Methods	13
3.2 Inventory Results	13
3.3 Overall Assessment of Forest Quality	16
3.4 Prospects for Harvesting	16
4. MANAGEMENT CONSIDERATIONS & PLANNING	18
4.1 Management Options	18
4.2 Choice of Species and Planting Approach	18
4.3 Risks	20
4.4 Environmental Impact Mitigation	21
4.5 Land Use Planning	22
4.6 Financial Considerations	24
5. PRESCRIBED ACTIVITIES & IMPLEMENTATION	27
5.1 Infrastructure & Basic Amenities	27
5.2 Site Preparation & Salvaged Logging	27
5.3 Planting & Tending	29
5.4 Harvesting in Compartments under Natural Forest Management	30
5.5 Treatment of Natural Forest Patches	31

5.6 Protection of Riparian Reserves	31
5.7 Fire Prevention & Control	31
5.8 Site Productivity & Growth Monitoring	32
5.9 Harvesting and Long Term Sustainability	32
5.10 Community Forestry	33
5.11 Environmental Impact Assessment	33
5.12 Research	34
5.12 Staffing & manpower requirements	34
6. MONITORING, CONTROL, & AND REPORTING	34
6.1 Record-keeping	34
6.2 Annual work plans, progress reports, and plan review	34
6.3 Forest Certification	34
6.4 Standard operating procedures & management guidelines	35
REFERENCES	36

APPENDICES

Appendix A Monthly rainfall (in <i>mm</i>) for the period 1999–2007 recorded at the nearest Meteorological Services Department Station in Tongod (Station code: 5372001).	38
Appendix B Major Roads & Topography Map of the Project Area	39
Appendix C Slope Classification of the Project Area	40
Appendix D General wood properties and uses of selected candidate species.	41
Appendix E General silviculture of selected candidate species.	42
Appendix F Projected cash flows from Yr 0 to 11 and associated present value (PV) using a discount rate of 15 % (in RM).	43
Appendix G 2.5 m SPOT Image of the Project Area captured in April 2010	44
Appendix H Organization Chart	45

LIST OF TABLES

Table 2.1:	Facilities within the project area for which occupation permits have been granted by the Forestry Department	10
Table 3.1:	Overall density of trees (ha^{-1}) by species group and diameter class for the project area, regardless of form or bole quality.	14
Table 3.2:	Overall basal area(m^2ha^{-1}) by species group and diameter class for the project area, regardless of form or bole quality.	14
Table 3.3:	Potential Crop Tree stocking for the project area.	15
Table 3.4:	The proportion (in %) of trees ≥ 5 cm DBH having vines (climbing bamboo or woody vines) in either their crowns or boles.	15
Table 3.5:	Vine abundance (density ha^{-1}) for both climbing bamboo and woody vines.	17
Table 3.6:	Projections of diameter class distribution at year 40 for the project area (assuming a cutting cycle of 40 years).	18
Table 4.1:	Species to be planted in Project Area and their approximate rotation ages and potential uses.	20
Table 4.2:	HCVF in the context of this FMP is defined as those having one or more of the following 6 values.	21
Table 4.3:	Net production area for the project area (ha).	23
Table 4.4:	Land Use Planning For the Project Area	23
Table 4.5:	Summary of cumulative cash flows up to year 11, assuming a net harvested area of 1,400 ha in years 10 and 11.	26
Table 5.1:	Fire danger rating and prevention activities.	32

LIST OF FIGURES

Figure 2.1:	Location of the project area in central Sabah.	4
Figure 2.2:	The project area is divided into 63 compartments.	6
Figure 2.3:	Soils Associations of the project area.	7
Figure 2.4:	Original forest cover of the project area based on crown size as interpreted from aerial photographs taken in 1970. (Source: Sabah Forest Inventory 1969-1972, Project No. F 644/2, Canada Colombo Plan Programme).	8
Figure 3.1:	Forest stratum map of the project area.	12
Figure 4.1:	Forest Function Zoning of the Project Area	24
Figure 5.1:	Salvage logging schedule for the project area beginning in year 2012	28
Figure 5.2	Annual planting schedule for the project area beginning in year 2012	29
Figure 5.3:	Harvesting schedule for compartments under natural forest management	30

GLOSSARY

Annual work plan (AWP)	:	An operational plan prepared by the Licensee describing work or activities to be carried out during a calendar year. The AWP should conform to the provisions of an approved forest management plan.
Compartment	:	A permanent unit of forest delineated within a Forest Management Unit for the purpose of forest management at the forest level. Usually delineated following roads, or natural features such as streams and ridges.
Degraded forest	:	A forest poor in standing merchantable timber stock, as well as potential crop trees. If left alone, prospects for timber production by natural regeneration within a cutting cycle of 40 years is extremely poor.
Fast-growing forest plantation	:	A planted crop of trees that reaches commercial maturity in 15 years or less.
Intensive forest restoration	:	Prescribed silvicultural activities aimed at restoring and enhancing timber productivity in degraded forest areas. In the case of this PDP, by means of integrated mosaic planting, whereby the planted crop is established amongst small patches of natural forest within the planted area. The target proportion of planted forest to natural forest is roughly 40 % and 60 % respectively.
Minimum economic cut	:	A level of yield used to determine when a compartment or forest stand is adequately stocked to economically justify a harvest. In natural forest management where logging is selective, this level is about 45 m ³ ha ⁻¹ .
Mosaic Planting		Refers to the establishment of a mosaic of fast growing and high-yielding tree plantations whilst maintaining small patches of natural forest within the planted area. The target proportion of planted forest to natural forest is roughly 40% and 60%, respectively. The scattered patches of natural forest integrate with man-made forest to form a forest mosaic that likely supports a greater level of structural, functional, and biological diversity, than a monoculture.
Plantation Development Plan	:	A strategic plan as part of the larger Forest Management Plan to develop areas designated for conversion and management as plantations. Chapter 3 (clauses 78-82) of the Sustainable Forest Management License Agreement are relevant.
Potential Crop Tree	:	PCTs are defined as those commercially valuable trees below the minimum cutting limit (i.e. 60 cm DBH), of good form and vigour, and most likely to form the future crop of harvestable trees.
Salvage logging	:	Logging carried out during site preparation in order to extract merchantable timber from trees that are removed to pave way for plantation establishment.
Sustainable Forest Management License Agreement	:	A long-term license agreement issued by the State Government of Sabah under Section 15(1) of the Forest Enactment to award management rights over lands classified as Forest Reserve.

1 INTRODUCTION

1.1 Background

The Sabah Foundation (Yayasan Sabah) is a statutory government entity formed by enactment in the Sabah State Legislative Assembly in 1966. Its' general objectives are to provide educational opportunities, social welfare support, as well as equitable economic opportunities for the peoples of Sabah. In order to fulfill these objectives, the Foundation was allocated a large forest concession area in Sabah, comprising 8 Forest Management Units (FMU) which cover a total area of close to 800,000 hectares. This entire concession area is licensed for 100 years to the Foundation under Sustainable Forest Management Licensed Agreement 09/97 (SFMLA). By an agreement in 1971, the Sabah Foundation assigned the rights to manage and conduct all commercial forestry operations related to this concession to Rakyat Berjaya Sdn. Bhd, a wholly-owned subsidiary of The Sabah Foundation. As such, Rakyat Berjaya serves as the commercial arm of the Foundation.

In accordance with Clause 44 of the SFMLA, forest management plans (FMP) have to be prepared for the forest management units within Foundation's concession area. In March 2012, the Sabah Foundation allocated an area of about 28,374 *ha* within FMU #23 to be rehabilitated and developed mainly by a combination of mosaic planting and natural forest management. The proposed area (hereafter referred to as the Project Area; see Figure 2.1), forms part of the Gunung Rara Forest Reserve, which is designated by law as a Commercial Forest Reserve (Class II), meaning that it is intended primarily for timber production. The project area was previously allocated for logging under Coupes BW8/99 and BW8/00-04.

For the purpose of this proposed development, a forest management plan (FMP) is required. In compliance with this requirement, this FMP is submitted by Rakyat Berjaya to the Forestry Department of Sabah in reference to the project area. The plan outlines the development and implementation plan for the project area over a period of 10 years (i.e. covering the period May 2012 to April 2022). Empayar Kejora Sdn. Bhd., a Sandakan-based company, with a long-term interest in the timber industry, has been appointed by Rakyat Berjaya as the contractor to undertake the task of developing the project area.

1.2 Purpose And Scope Of Plan

This FMP defines the scope and prescribed activities for the development and management of the project area over a 10-year period beginning from 1st May, 2012 to 30th April, 2022. The primary long-term goal of the FMP is to ensure the sustainable production of timber from both the cultivation of fast-growing trees and the management of existing natural timber stands, in compliance with all existing rules, regulations and prescribed constraints. Although the stated planning horizon is 10 years, the FMP seeks to optimize economic benefits to Rakyat Berjaya, over and beyond the current planning period.

The planning cycle for the project area is set at 10 years. However, this FMP may be reviewed and revised as and when needed. Any major revisions to the FMP will have to be approved by the Director of Forestry.

1.3 Management Policies And Development Goal

Rakyat Berjaya Sdn. Bhd. forms an important part of Sabah Foundation's group of companies. Its' core business is the management of the Foundation's large forest concession, both for timber production as well as for conservation. It sees this forest development venture as a long-term commercial investment in line with the State Government's policy on sustainable forest management, as well as ensuring a more reliable and sustainable supply of raw material to its downstream operations.

While the Government's prime concern is to restore and enhance timber productivity in areas designated for production, the principal goal of the company in developing the project area is to yield financial benefits from the sustainable production of timber from the intensive cultivation of fast-growing trees, as well as from the natural forest. Nevertheless, all development objectives and activities will be carried out in accordance with the provisions of the joint-venture agreement. In achieving the objectives of the company, Rakyat Berjaya subscribes to the following policies and strategies:

- Management of the area will ensure the sustainable production of timber over the long-term;
- All field operations will give due consideration to environmental protection so as to minimize any negative impact on the natural environment;
- Third party certification of forest management under an accredited scheme would be a desirable objective to aim for;
- Research aimed at improving the timber productivity of the project area will be given due attention;

- Employment preference will be given to local/rural communities wherever possible.

1.4 Legal Framework

All forestry operations within the project area are primarily governed and regulated in accordance with the Forest Enactment, 1968. In addition, other laws and regulations apply. The following are Sabah's legal instruments and guidelines as they relate to the management of the project area:

- State Forest Policy;
- Forest Enactment, 1968;
- Forest Rules, 1969;
- Environmental Protection Enactment, 2002;
- Environmental Protection Enactment (Prescribed Activities), 2005;
- Wildlife Conservation Enactment, 1997;
- Land Ordinance, 1930;
- Water Resources Enactment, 1998;
- Cultural Heritage (Conservation) Enactment, 1997;
- Sabah Conservation Strategy, 1992;
- Biodiversity Enactment, 2000;
- Environmental Quality Act, 1985;
- Sabah Labour Ordinance;
- The Employment Act; and
- Health and Safety Regulations.

2 GENERAL DESCRIPTION OF THE PROJECT AREA

2.1 Location & Access

The project area covers about 28,374 *ha* within FMU 23, which forms part of the Gunung Rara Forest Reserve (Figure 2.1). It is located just northeast of the Maliau Basin Conservation Area, along an all-weather unpaved road that links the towns of Telupid and Luasong. The closest rural settlement to the field operations base is Tongod, i.e about 40 *km* to the north, whereas Luasong is about 35 *km* towards the south. Administratively, the project area comes under the Kalabakan Forestry District. The Kuamut River forms the western and southern boundary of project area (Figure 2.2). The entire project area is within forest reserve land that is licensed to the Sabah Foundation. Therefore, public access to the area is restricted, except with prior consent from the concession holder. The field boundary survey for the project area was completed in March 2012. A field operations base is located in Compartment #1 at the southwestern corner of the project area, only about 1 *km* off the main access road (Figure 2.2).

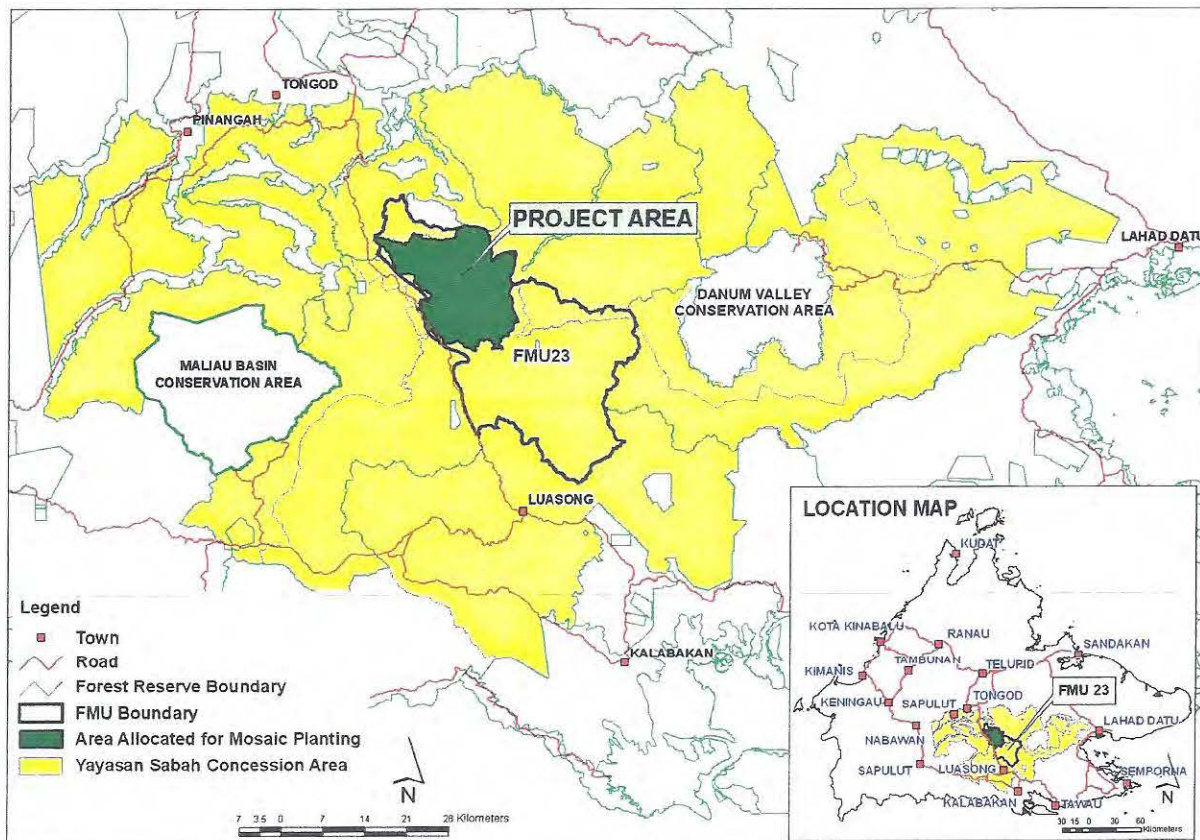


Figure 2.1: Location of the project area.

2.2 Compartment Delineation

The perimeter boundary field survey for the project area was completed in March 2012 by a licensed surveyor. This perimeter boundary is demarcated on the ground with wooden pegs and paint. For the purpose of planning and implementation, the project area is divided into 63 compartments ranging in size from 159 to 674 *ha* (Figure 2.2). With the aid of high resolution satellite imagery (2.5 *m* SPOT image captured in October 2009), compartment boundaries were delineated following former logging roads and natural features, such as streams and ridges.

2.3 Rainfall & Temperature

Mean annual rainfall for the period 2000–2010 recorded at the nearest weather station located in Luasong is 3,063 *mm* (Appendix A, p. 37). Although all months average > 100 *mm* of rainfall, March, April, and October are relatively dry, while December and January are the wettest months. The mean daily temperature is about 27° C, with a mean daily minimum of 23°C and a daily maximum of 31°C.

2.4 Physical Environment

Topography & Hydrology

The project area is generally hilly in the southern half portion, whereas the topography is relatively gentler in the northern half, where it is more suitable for intensive forestry use. The lowest point in the area is about 200 *m*, while the highest point is about 850 *m* above sea level (Appendix B, pg. 38). About 66 % of the area has slopes below 15°, whereas 32 % of the area is between 15° and 25°. An estimated 2 % of the area is considered inoperable, i.e. ≥ 25°.

There is an extensive network of streams within the project area, most of them unnamed (Appendix B). Generally, these streams all flow into the Kuamut River, which forms the western and southern boundary of the project area. The estimated total length of perennial streams within the area is about 345 *km*. Of these, about 51 *km* is considered major rivers, i.e. with a width of greater than 5 *m*. The riparian buffer for these rivers (30 *m* on both sides), as shown in Appendix B, are demarcated in the field. Sg. Kasuyan is the only river with a gazetted name, that flows through the project area.

Soil

The project area is made up of 8 soil associations, with Lokan and Malubuk covering about 81 % of the area (Figure 2.3). Other soil associations are Maliau, Crocker, and Binalik, whereas the rest occur over relatively small areas. The Lokan Association covers the lower lying areas, and is largely derived from mudstone and sandstone parent materials, where orthic acrisols are the dominant soils. Lokan is rated as marginal in terms of suitability for agricultural development, but is likely to support the best growth for forest plantations within the project area (Acres & Folland, 1975).

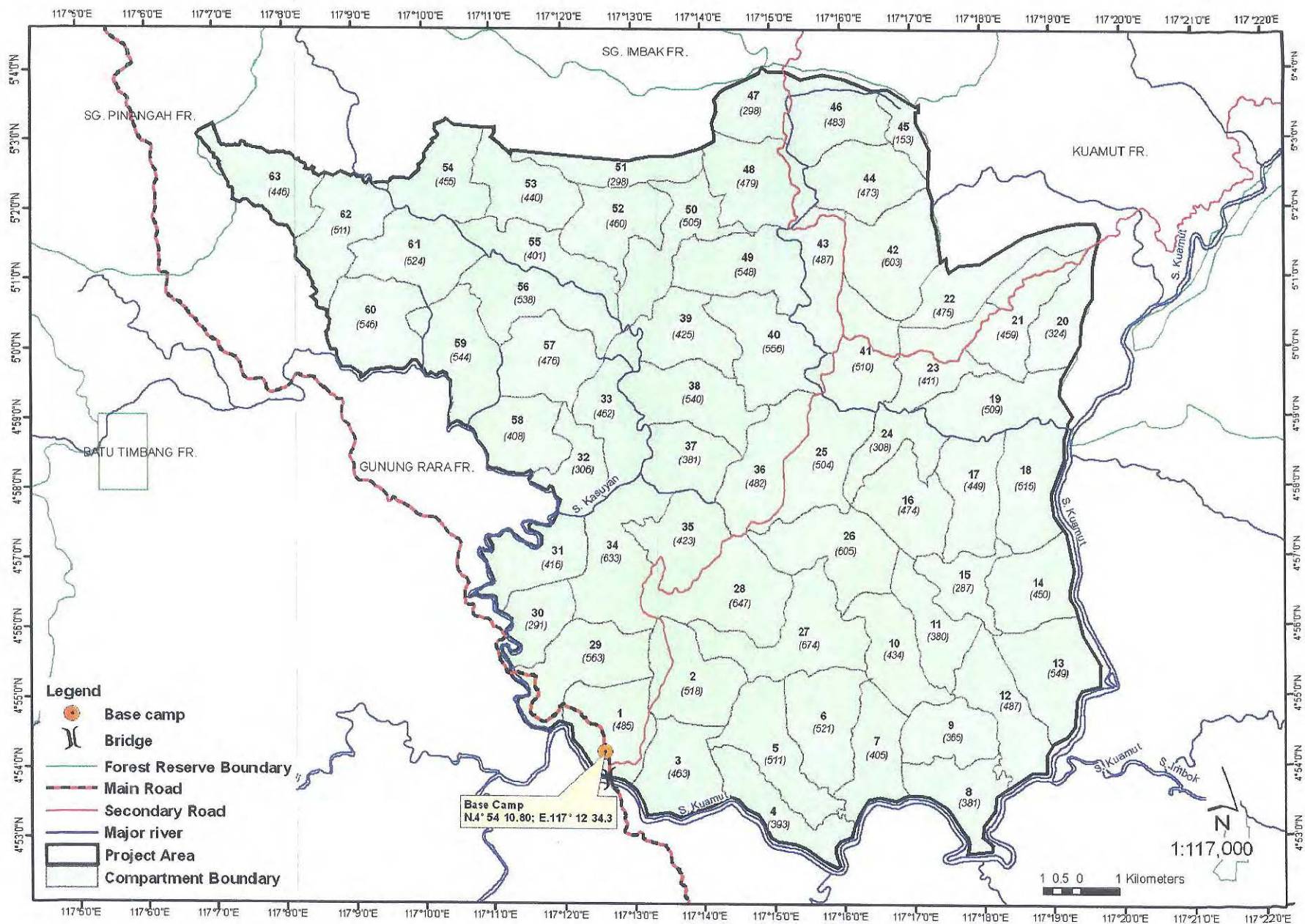


Figure 2.2: The project area is divided into 63 compartments.

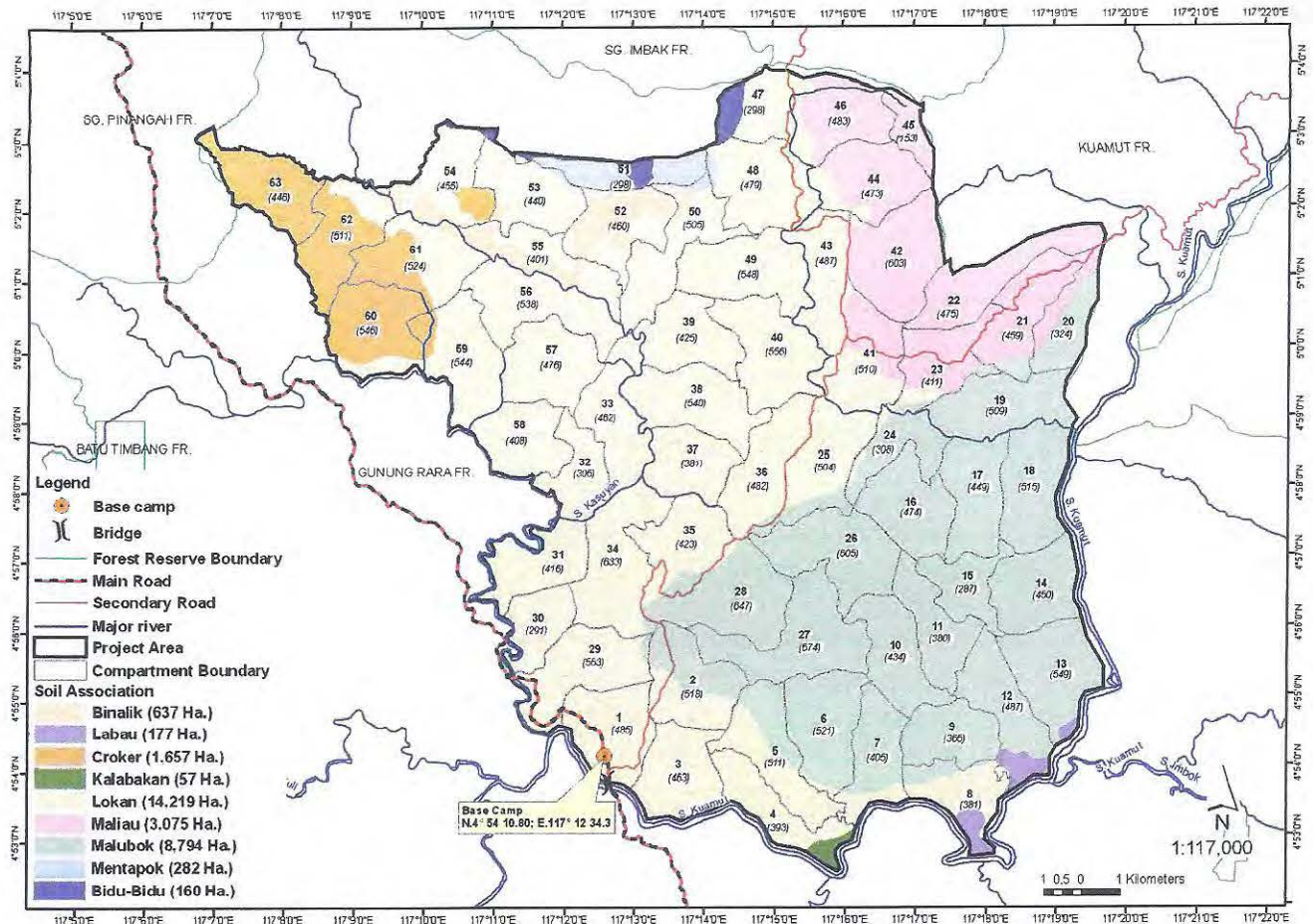


Figure 2.3: Soils association of the project area

2.5 Vegetation & Wildlife

Vegetation

The Project Area once supported rich lowland mixed dipterocarp forests of high stature. However, poor logging practices in the past have reduced the vegetation to a secondary forest of relatively low stature, dominated by *Macaranga* spp. and impoverished of commercial timber trees and regeneration. The project area was most recently logged between 7 to 12 years ago, i.e. between the years 2000 to 2005. The current timber stands in the area are considered 'poor' to 'very poor' (i.e. less than 4 commercial trees > 60 cm DBH ha^{-1}). Vine loads, particularly climbing bamboo, are high, and pose a serious impediment to forest regeneration. Common dipterocarps still found in the residual forests include *Dryobalanops lanceolata*, *Shorea parvifolia*, *S. leprosula*, *S. mecystopteryx* and *Parashorea malanonaan*. Pioneer species of commercial value, such as *Neolamarckia cadamba* (laran) and *Octomeles sumatrana* (binuang) are found in gregarious stands all over the project area. The forest along certain sections of the Kuamut River is highly degraded and will require some form of intensive restoration (Plate 1, p 9).

Figure 2.4 is a map of the original forest cover of the project area according to two classes of timber stand quality classified by crown size. This map was produced from a state-wide forest inventory carried out between 1969 and 1972, under the Canada-Malaysia Colombo Plan Programme with the primary aim of evaluating the state of timber resources in Sabah. Although, the map may not reveal much about species composition, it provides an indication of potential site productivity, with the large crown forest areas likely able to support better growth. A large portion of the area (67 %) was classified as 'large crown' lowland dipterocarp forest with a gross standing volume ranging from 390 to 495 $m^3 ha^{-1}$.

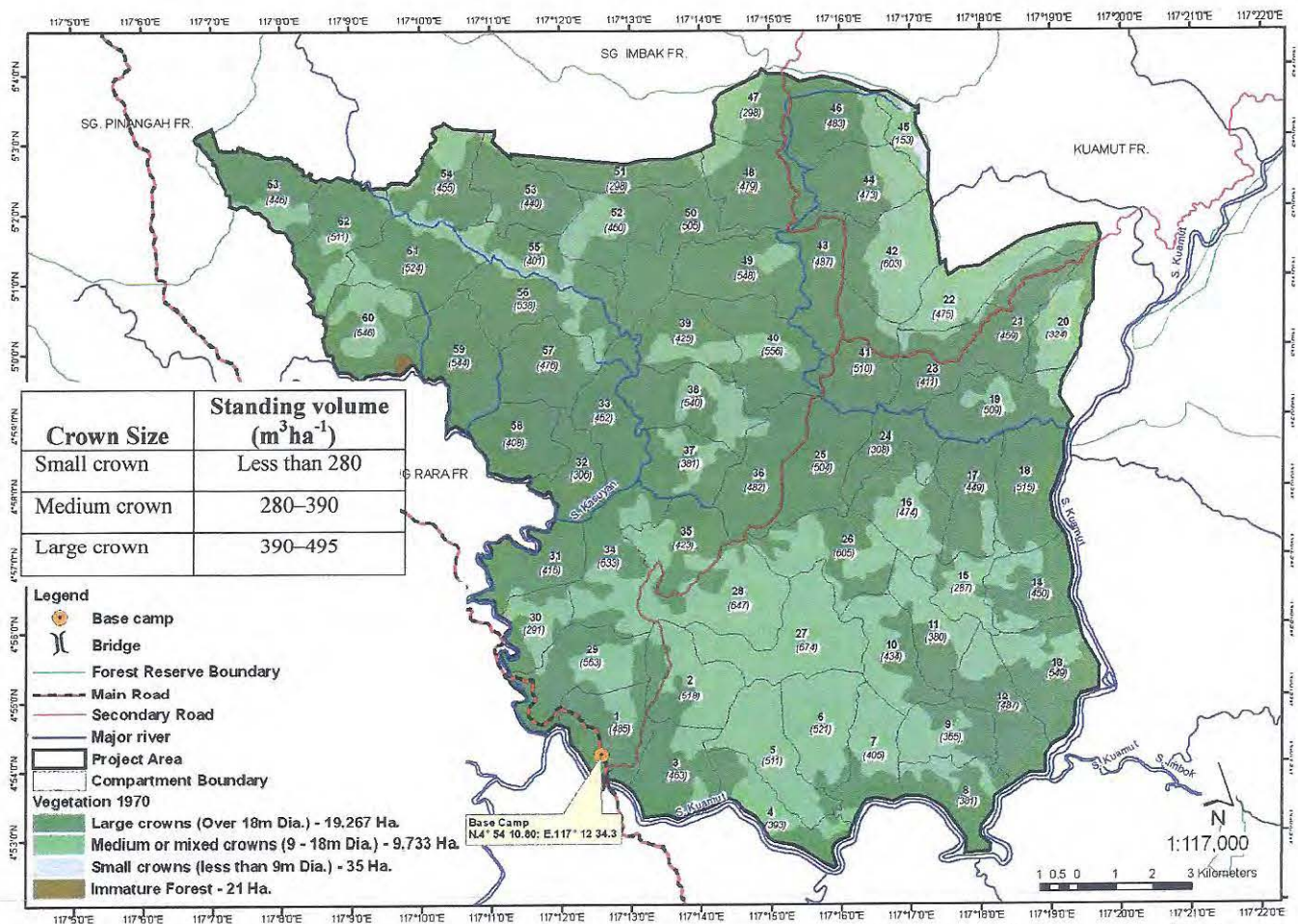


Figure 2.4: Original forest cover of the project area based on crown size as interpreted from aerial photographs taken in 1970. (Source: Sabah Forest Inventory 1969–1972, Project No.F 644/2, Canada Colombo Plan Programme)



Plate 1: Forests along certain sections of the Kuamut River will require intensive rehabilitation due to their degraded nature.

Wildlife

A general wildlife assessment was carried out over the area in 2009, the detail findings of which are provided in a report by Ancrenaz et al. (2009). Overall, the density of iconic species such as orang utan (0.2 km^{-1}) and gibbons was low. Elephants and wild cattle (tembadau) are present, but no population estimates were given. In its current state, the project area is generally poor habitat for wildlife. This can be largely attributed to the fact that poor logging practices have resulted in a residual forest characterized by a very broken canopy, large gaps and open conditions. Forest structure has yet to recover from the last logging, i.e. about 8 years ago. Under such conditions, many arboreal animals are now scarce. Wildlife habitat can be expected to improve as the forest recovers over time.

2.6 Settlements & Socio-Economic Environment

There are no villages or human settlements within the project area. The closest rural settlements of any significance that are connected to the project area by road are Tongod, located some 40 km to the north, and Luasong to the south (Figure 2.1). Kg. Kuamut is accessible by boat when the water level is high enough.

2.7 Infrastructure

Roads

About 5 km of the main log hauling route traverses the project area (Appendix B). A steel bridge (Plate # 2) which crosses the Kuamut River into Compartment #1 is part of this main log hauling route, which also links Luasong in the south with Telupid in the

north. In addition, some 230 km of existing logging roads are found within the area, most of which need to be repaired to reestablish accessibility. These roads also conveniently serve as boundaries of compartments and planting blocks, as well as to facilitate fire prevention and other protection measures.

Buildings

The main field operations base will be established in Compartment #1. Presently, the Forestry Department and Rakyat Berjaya both maintain an outpost there (Plate 2). Occupation permits have been approved by the Forestry Department to establish a nursery, sawmill, staff accommodation facilities, and offices (Table 2.1). An area of 18 ha has also been allocated as a log landing site. The total area for which occupation permits have been approved is 44.88 ha.

Table 2.1: Facilities within the project area for which occupation permits have been granted by the Forestry Department

Facility	Size (ha)	OP No.	Date issued
Nursery	9.14	JP(KA)09/2012	21.03.2012
Camp	7.69	JP(KA)12/2012	19.03.2012
Log landing site	18.03	JP(KA)10/2012	19.03.2012
Sawmill	10.02	JP(KA)11/2012	19.03.2012
Total	44.88		

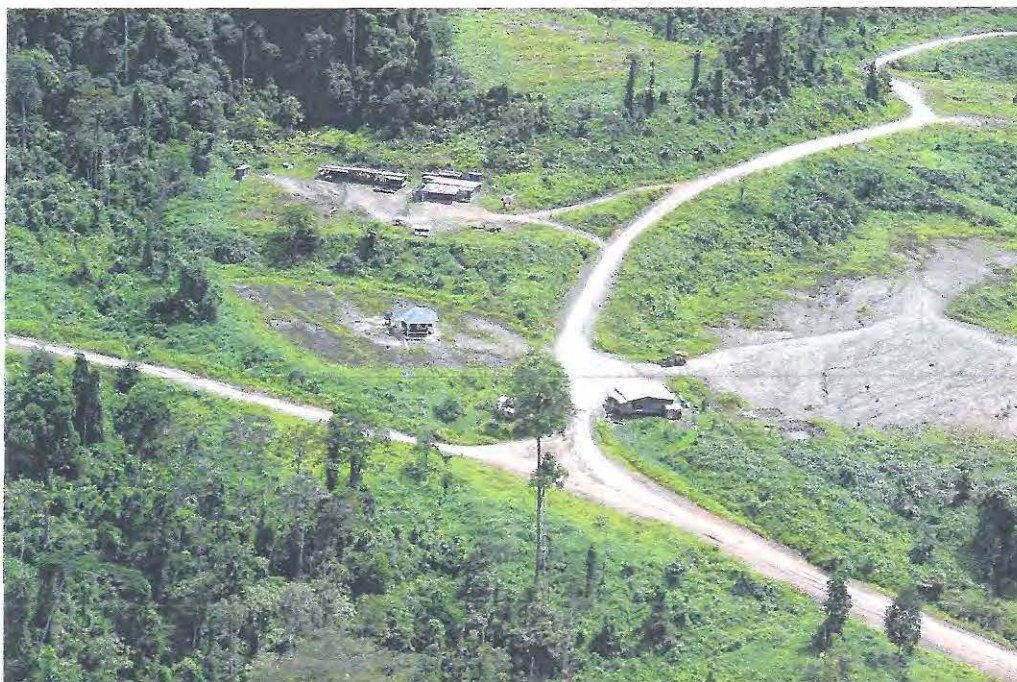


Plate 2: The site of the new field operations base to be established in Compartment #1. Presently, both the Forestry Department and Rakyat Berjaya maintain outposts here.



Plate 3: A steel bridge crosses the Kuamut River into Compartment # 1. A riparian reserve of 100 m has been demarcated along the Kuamut River. No logging is allowed within this area.

2.8 Past Management

The project area is part of the Sabah Foundation concession area within FMU 23. Apart from being subject to log extraction, the project area has never been actively managed. The area was first logged by the Foundation between the period 1999 and 2005, under coupes BW8/99 and BW8/00-04. However, poor logging practices have resulted in a residual forest that is considerably poor in commercial regeneration, extensive pioneer tree cover, and rapidly proliferating vine growth.

3 SILVICULTURAL & TIMBER RESOURCE ASSESSMENT

An important prerequisite for sound decision-making in forest management is accurate information on forest conditions, such as regeneration status, standing timber stock, factors inhibiting growth, prospects for harvesting, etc. Such information is usually derived from a field inventory. From satellite imagery interpretation, virtually the entire project area is classified as Stratum 3 and 4 (Figure 3.1). Stratum 4 is defined as 'very poor' forests, having 1–4 trees ha^{-1} greater than 60 cm DBH, whereas Stratum 3 is 'poor forest,' with 5–9 trees ha^{-1} . Due to poor timber stocking, the project area was largely prescribed for restoration planting.

In preparing the forest management plan for the project area, a quick field inventory of timber resources was carried out to verify these conditions on the ground. Ten inventory plots were located randomly over the entire FMU. These inventory plots are used in this FMP to describe timber resource conditions for the project area. The results represent mean values for the entire project area, with no spatial reference.

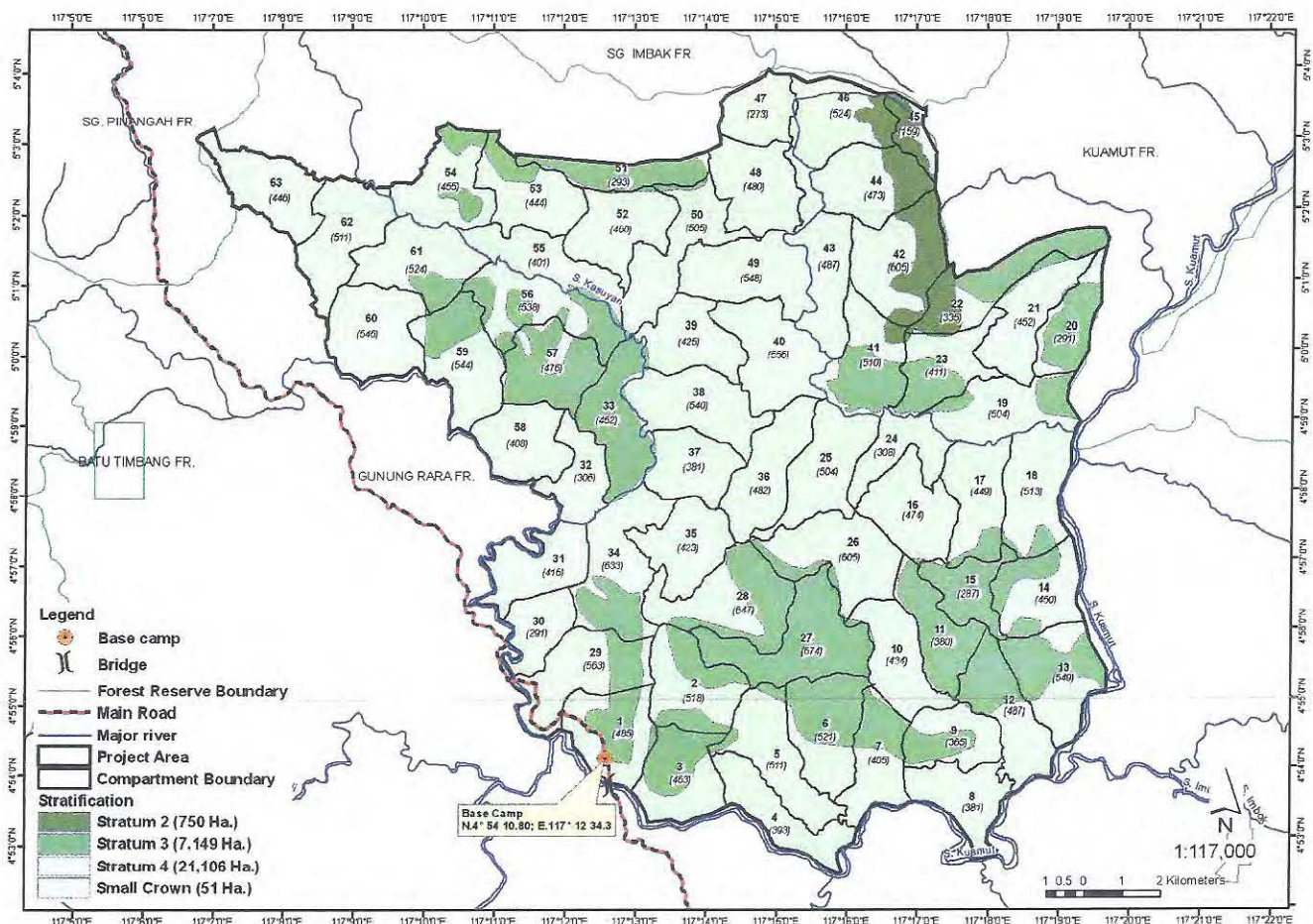


Figure 3.1: Stratum map of the project area

3.1 Inventory Methods

Sixteen inventory plots were placed randomly over the project area. The inventory method used plots arranged continuously along a 20 m wide and 800 m long linear strip.

Standing timber stock— All trees > 30 cm DBH were enumerated on 10 x 20 m plots along the strip, whereas trees $\geq$ 10 cm DBH were enumerated within 10 x 10 m plots along the same strip.

Potential crop trees (PCTs)— PCTs > 5 cm DBH were selected within the 10 x 10 m plots. PCTs are defined as those commercially valuable trees below the minimum cutting limit (i.e. 60 cm DBH), of good form and vigour, and most likely to form the future crop of harvestable trees. A defective commercial tree does not count as a PCT. Defects were defined as those thought to undermine the future survival, suitability and quality of the tree for timber production (e.g., termite infestation, severe bark damage, leaning bole, poor stem form, multiple leaders, and broken crowns). Only 2 PCTs were allowed to be selected within the 10 x 10 m plot, thereby giving a maximum stocking of 200 PCTs ha⁻¹.

Vines—Vine abundance was also evaluated. They were separated into two groups: woody vines and climbing bamboo. Woody vines and climbing bamboo were counted within the 10 x 10 m nested sub-plots. For woody vines, only stems $\geq$ 2.5 cm DBH were enumerated. For climbing bamboo, each clump was counted as one individual. In order to evaluate the proportion of trees affected by vines, all trees > 5 cm DBH within the 10 x 10 m plots were evaluated for the presence or absence of vines, either on their boles or crowns.

3.2 Inventory Results

Standing Timber Stock

The project area is extremely poor in commercial trees greater than 60 cm DBH (Table 3.1). Current standards in natural forest management require a minimum of about 9 harvestable trees $\geq$ 60 cm DBH ha⁻¹ for an economic cut, whereas the commercial stocking of the project area presently stands at 6 trees in this size class. Therefore, by current cutting limits, there is limited commercial volume to be extracted from the area for an economic cut. Most trees are in the 10–20 cm size class. Dipterocarps account for only 21 % in this size class.

Overall stand basal area of trees $\geq$ 10 cm DBH is about 18 m²ha⁻¹ (Table 3.2). This is considered very low when compared to a pristine forest, where basal area usually ranges 30–38 m²ha⁻¹. Pioneer trees (mainly *Macaranga* spp.) and other non-commercial species make up about 41 % of the total basal area.

Table 3.1: Overall density of trees (ha^{-1}) by species group and diameter class for the project area, regardless of form or bole quality. Numbers in parenthesis are the number of trees of good form and quality.

Species group	20-30	30-40	40-60	60-80	> 80
Dipterocarp	6.4 (3.8)	3.1 (1.6)	6.9 (3.1)	4.0(3.1)	2.5
Commercial non-dipterocarps¹	3.8 (2.1)	2.2 (0.3)	1.4 (0.8)	-	0.6
Pioneers²	12.4	4.3	0.7	-	-
Others³	18.2	6.7	8.3	2.0	-
Total	40.8	16.3	17.3	6.0	3.1

Footnote:

¹ Includes laran, binuang, & magas

² Includes *Macaranga* spp. & *Homalantus* spp.

³ Non-commercial species, including fruit trees, & prohibited species

Table 3.2: Overall basal area (m^2ha^{-1}) by species group and diameter class for the project area, regardless of form or bole quality.

Species group	10-20	20-30	30-40	40-60	60-80	> 80	Total
Dipterocarp	0.34	0.40	0.60	1.86	1.50	0.87	5.57
Commercial non-dipterocarps	0.33	0.33	0.58	1.70	0.82	0.50	4.26
Pioneers	0.31	0.82	1.2	0.62	-	-	2.95
Others	1.52	0.75	0.89	1.32	0.80	-	5.28
Total	2.5	2.3	3.27	5.5	3.12	1.37	18.06

Potential Crop Trees

Only 28 % of inventory plots in the project area were found to be stocked with PCTs, i.e. overall PCT stocking is considered low (Table 3.3). Of the PCTs recorded, almost 50 % fall below 20 cm DBH. The distribution of PCTs towards the lower size classes means that the time required for the area to reach harvesting maturity will be longer. About 18 % of plots in the project area were recorded as 'gaps,' meaning that they are actually devoid of trees. Such open conditions are likely to have been created by poor logging practices in the past.

Table 3.3: PCT stocking for the project area

PCT stocking by DBH class (number of trees ha ⁻¹)						Stocked plots (%)	Gap (%)
5-10	10-20	20-30	30-40	40-60	All sizes		
1.7	9.5	5.6	1.9	3.8	22	28	18

Vines

Vines are generally light demanding plants that ascend to the canopy by using tree trunks or other vines as structural support. Their proliferation is usually promoted by an increase in light level, such as that caused by logging. Vines can be expected to impede tree regeneration and growth once established in large quantities. Their habit of twining around and scrambling over surrounding vegetation has also been observed to cause stem deformities in the saplings and poles of commercially valuable trees. Climbing bamboo is a serious problem in the project area (Plate 4, p. 16). Therefore, the suppression of vines is an important practice in production forestry.

In project area, about 74 % of all trees ≥ 5 cm DBH were found to carry either climbing bamboo or woody vines, or both (Table 3.4). When only commercial trees were considered, 58 % of trees were found to be affected by vines. Such a high level of vine occupancy on the boles and crowns of trees is typical of highly disturbed lowland dipterocarp forests in Sabah. In terms of vine density, the area also showed relatively high levels of vine density, when compared with an old growth close-canopy forest. At 425 clumps ha⁻¹, climbing bamboo abundance was particularly higher in the project area than in an old growth forest. The two climbing bamboo species found commonly in the project area are *Dinochloa scabrida* S. Dransf. and *D. trichogona* S. Dransf. (Dransfield, 1992).

Table 3.4: The proportion (in %) of trees ≥ 5 cm DBH having vines (climbing bamboo or woody vines) in either their crowns or boles. Only woody vines ≥ 2.5 cm DBH were enumerated.

Tree group	Project Area (heavily disturbed forest)	Sepilok (old growth forest)
All trees	74 %	48 %
Commercial trees only	58 %	34 %

Table 3.5: Vine abundance (density ha⁻¹) for both climbing bamboo and woody vines. Vine abundance from a study in the close-canopy old growth forest of Sepilok is given for the purpose of comparison.

Vine type	Project Area (heavily disturbed forest)	Sepilok (old growth forest)
Climbing bamboo	402 clumps	53 clumps
Woody vines	412 stems	310 stems



Plate 4: a) Climbing bamboo infestation in the project area is particularly serious where areas have been heavily disturbed by logging, creating forest conditions that are open and suitable for the proliferation of bamboo; b) *Dinochloa scabrida* stems ascend to the canopy by using a dipterocarp sapling as support.

3.3 Overall Assessment of Forest Quality

Generally, the project area supports a degraded forest, poor in standing merchantable timber stock, as well as potential crop trees. Vine loads are very high, a condition that will persist unless they are cut, and their spread is controlled. Although extensive stands of macaranga are found throughout the project area, pioneer species of commercial value, such as *Neolamarckia cadamba* (laran) and *Octomeles sumatrana* (binuang) are also found in gregarious stands all over the area. Generally, the area is not likely to regenerate within a cutting cycle of 40 years without some form of silvicultural intervention.

3.4 Prospects for harvesting

Growth projections were made for the project area based on PCT stocking. Although the management planning period spans over a period of 10-years, growth projections were made for one cutting cycle in order to ensure that harvesting is sustainable over the long-term. For the purpose of yield regulation, a 40-year cutting cycle is assumed for this management plan, and a minimum economic cut of $45 \text{ m}^3 \text{ ha}^{-1}$ is used to determine when a compartment is adequately stocked to justify a harvest. This translates to about 9 extracted trees ha^{-1} between 60 to 80 cm DBH. Therefore, a forest stand is considered ready for harvest when it has at least 9 trees ha^{-1} in this size class that may be extracted. However, the standard used in this evaluation is 15 trees. This is because experience from the previous planning period show that about 40 % of trees marked for harvesting are

actually not removed due to defects and operational constraints. Taking this into account, a stand will need to be stocked with at least 15 trees to get 9 extractable trees per ha⁻¹.

At current cutting limits prescribed for natural forest management, the projections show that the project area is not expected to yield an economic cut within 40 years (Table 3.6), if left alone to regenerate naturally. Therefore, some form of assisted regeneration will have to be carried out.

Table 3.6: Projections of diameter class distribution at year 40 for the project area (assuming a cutting cycle of 40 years). On the average, the area fails to meet the minimum number of harvestable trees, i.e. 15 trees $\geq$ 60 cm DBH per hectare.

Species group	30-40	40-60	60-80	> 80
Dipterocarp	4.5	8.8	6.2	2.9
Commercial non-dipterocarps¹	3.8	1.4	2.2	0.4
Total	8.3	10.2	8.4	3.3

4. MANAGEMENT CONSIDERATIONS & PLANNING

4.1 Management Options

The forest of the project area is considered extremely poor in terms of timber productivity, standing timber stock, as well as regeneration. Therefore, some form of silvicultural intervention or intensive rehabilitation is necessary if timber production is intended to be the principal goal of management, and commercial viability is of concern.

Considering the serious decline in timber production from Sabah's natural forests, short rotation and high-yielding tree plantations are seen as an attractive land use option in support of a wood-based industry that is currently facing an acute shortage of raw material. Prospects for harvesting following a strict natural forest management regime do not look promising in the near future. Therefore, it is decided that **the sustainable production of timber from the cultivation of short-rotation commercial forest plantations in combination with the intensive management of natural forests** will be the main goal of management for the project area.

Justification

Apart from the extremely poor forest quality within the project area, there are numerous points of justification for the decision to opt for development of short-rotation forest plantations. The key ones are:

- The project area is relatively small for natural forest management to be viable;
- HCVF elements are low;
- Forest plantations of fast-growing trees can be expected to yield timber in the fastest possible time, thereby compensating for the declining output from the natural forests;
- The project area is unsuitable for forest recreation due to its remoteness and poor accessibility.

4.2 Choice of Species & Planting Approach

For this planning period, the main species earmarked for planting are batai, laran, binuang, talisai, and magas (Table 4.1). All species were selected based on their known commercial value, relatively fast growth, and ease of procuring planting material. The objective of planting is to produce timber mainly for plywood manufacturing and saw logs (to a lesser extent). Planting material for the species concerned will be largely raised from seeds collected from selected superior trees in the wild. All chosen species have an approximate rotation age between 10 and 15 years, and expected merchantable yields ranging from 250 to 350 m³ha⁻¹ upon clear-felling. The projected DBH of all fast-growing

species (classified as those with rotation ages of 15 years or less) at rotation age is 40–55 cm. Laran and binuang are pioneer species with rapid early growth (Appendix C, p 37). Canopy closure can be achieved in 2-3 years, and therefore they will be planted at final spacing, with no need for intermediate thinnings.

Table 4.1: Species to be planted in the project area and their approximate rotation ages and potential uses. Appendices D and E provide information on the silvics of these species.

Species	Common name	Rotation (yrs)	Common uses
<i>Anthocephalus cadamba</i>	Laran	10-12	face veneer, plywood, paneling
<i>Octomeles sumatrana</i>	Binuang	10-12	core or face veneer, block board
<i>Terminalia spp.</i>	Talisai	12-15	Sawn timber, plywood, general construction
<i>Falcataria moluccana</i>	Batai	8-12	block board core, core veneer

General Plantation Design

The plantation design that will be adopted in the project area will be the *integrated mosaic planting*, using a mix of 3 or 4 tree species (Plate 5). The basic idea behind ‘mosaic planting’ is to establish fast-growing and high-yielding tree plantations whilst maintaining small patches of natural forest within the planted area. The target proportion of planted forest to natural forest is roughly 40 % and 60 % respectively. The scattered patches of natural forest integrate with man-made forest to form a forest mosaic that likely supports a greater level of structural, functional, and biological diversity, than a monoculture; and at the same time be more resistant to pest and disease outbreaks. Such a design, also gives the forest a more natural appearance, thereby resulting in a planted forest of superior aesthetic quality. This will be a departure from the conventional monoculture, where the forest is usually clear felled and planted with a single species.



Plate 5: An example of *Integrated Mosaic Planting* in an area nearby. This approach combines the cultivation of fast growing trees in small blocks that are interspersed amongst patches of natural forest stands, thereby forming a mosaic of small monocultures. The ratio between planted forest patches and natural stands is approximately 40:60.

The integrated mosaic design is also likely to maintain a balanced soil nutrient budget, and therefore sustain long-term site productivity. From a marketing perspective, mixed plantations permit changes in emphasis among species, whereas pure timber stands lack flexibility in meeting changes in market demands.

4.3 Risks

Rakyat Berjaya Sdn. Bhd. fully understands that the project involves certain risks that may affect the success of the project. Drought and fire, for instance, are important risk factors to consider. The relatively long-term nature of the project makes the project vulnerable to such risks.

Market

The market for timber may fluctuate, but market risks can be hedged by harvesting and selling when the price is favourable. Unlike many agricultural produce, standing timber is non-perishable even when trees are considered mature or large enough to be harvested. In fact, trees increase in value as they grow and put on volume. Despite the availability of substitutes, the demand for wood for various uses continue to rise worldwide.

Drought & fire

Prolonged droughts and fires that may follow can be a serious threat. The likelihood of *El Nino* induced droughts occurring within the rotation period cannot be disregarded, considering the relatively long gestation period to crop maturity (12 years). These risks can be mitigated by taking certain preventive and control measures.

Pest and diseases

The selected species (Table 4.1, p 20) are not known to suffer from any serious pest and disease problems in Sabah. However, a gall rust disease caused by *Uromycladium tepperianum* have recently been observed in some Javan plantations. Although monocultures may be susceptible to disease outbreaks, the planting of a mix of species following the mosaic planting approach could buffer against threats from such problems because different species may have different levels of susceptibility or resistance.

Animal damage

Since part of the project area is adjacent to a much larger tract of natural forest, damage of planted trees by animals such as deer, wild boar, or monkey can pose a problem. The location of the area along a main road will hopefully deter animals away from the area. Problems with animal damage will be addressed as they arise.

Declining site productivity

Studies have shown that site productivity may decline over several rotations. This has been reported in Sabah Softwoods' plantations in Brumas, Tawau, where some sites are on their 4th rotation. This problem is a greater cause for concern for plantations established on soils that are inherently nutrient poor. Therefore, soil nutrient management through fertilizer application and other management practices (e.g. no burning, cable yarding to reduce soil disturbance, debarking on-site, etc.) will have to be given special attention in the Project Area.

4.4 Environmental Impact Mitigation

High Conservation Value Forests (HCVF)

Consistent with certification requirements under the Forest Stewardship Council (FSC) scheme (Principle 9), due considerations were given to the maintenance of high conservation value forests (HCVF). The term HCVF as used in the context of this Plan is adopted from the HCVF Tool Kit for Malaysia (WWF Malaysia, 2009) and is summarized in Table 4.2. Evaluated against these set criteria, HCVF values for the project area is generally 'low.' This is attributed largely to the extremely poor quality forest that is supported by the area today.

The only value considered relevant here is HCV 4 – Environmental Services, and this refers to the protection of riparian buffers to ensure that water quality is not adversely affected. There is an estimated 345 *km* of permanent streams within the project area. Forestry regulations provide for a 30 *m* riparian buffer for all perennial streams within the project area. They may also serve as fire breaks, in the event of a wildfire.

Table 4.2: HCVF in the context of this FMP is defined as those having one or more of the following 6 values.

HCV	Elements	Remarks
1	Biodiversity values: Forest area contains globally, regionally, or nationally significant biodiversity values (e.g. endemism, endangered species, sites of critical temporal use)	The forest of the project area is considered heavily degraded by poor logging practices in the past
2	Landscape-level forest: Forest area contains or is part of a globally, regionally, or nationally significant large landscape level forest where viable populations of most, if not all naturally occurring species exist in natural patterns of distribution.	The area no longer supports a forest that resembles its pristine state. Furthermore, similar naturally managed forest types are represented in the nearby Kuamut and Gunung Rara Forest Reserves
3	Ecosystems: Forest area contains or is part of a threatened or endangered ecosystem	As above.
4	Environmental services: Forest area provides basic services of nature in critical situations (e.g. watershed protection, erosion control, fire breaks)	Estimated length of perennial streams within the project area is 345 <i>km</i> . A riparian buffer of 30 <i>m</i> on both sides of these streams will be protected and excluded from logging. The riparian buffer for the Kuamut River, however, will be 100 <i>m</i> . In addition, all compartments adjacent to the Kuamut River is designated for natural forest management.
5	Basic needs of local communities: Forest area is fundamental to meeting basic needs of local communities	There are no settlements. The closest human settlement is about 30 <i>km</i> from the project area.
6	Cultural identity of local communities: Forest area is critical to local communities' traditional cultural identity.	There are no settlements. The closest human settlement is about 30 <i>km</i> from the project area.

Impact of Management Activities on Local Communities

There are no major human settlements within a 30 km radius of the project area. Therefore, the dependence of local communities on the project area for livelihood does not arise. And it is not likely that forestry operations would adversely affect local communities. On the other hand, forestry activities in the Project Area can potentially contribute to the livelihood of rural communities from Luasong and Tongod through employment and service contracts (e.g. tree planting, tending, seedling production, etc), and improved road conditions.

Environmental Impact Assessment & Mitigating Measures

Any development of forest plantations or reforestation covering an area of 500 ha or more is considered a 'prescribed activity' under the Second Schedule of the Environmental Protection Enactment. As such, the proponent for the activities to be undertaken in the project area is required by law to carry out an Environmental Impact Assessment (EIA). This was completed in March 2012 by an appointed consultant and is expected to be submitted to the Environmental Protection Department (EPD) in April, 2012.

The key recommended mitigating measures in the EIA that is associated with land use, are provisions for :

1. **Riparian buffers** - Rivers and streams within the project area should be protected with a 30-m riparian buffer on both sides. Riparian buffers should be demarcated on the ground. Timber extraction is not allowed within riparian buffers. Bare ground within the r buffer should be planted up to reestablish forest cover. A 100 m riparian buffer should be designated along both sides of the Kuamut River;
2. **Steep areas** – All designated steep areas shown on the coupe permit map should be demarcated on the ground and excluded from any harvesting operations. During CHP preparation, areas with slopes > 25° will be mapped out and excluded from logging operations.

4.5 Land Use Planning

Net production area

The entire project area is technically designated for production. However, due to constraints related to steep areas, riparian buffers, and roads, the net area actually available for production forestry is reduced. After accounting for roads, rivers, riparian buffers, conservation areas, and steep areas, etc. (Table 4.3) the net area available for production is estimated at **26,364 ha** (Figure 4.1). This translates to a reduction in the productive area by about 7 % (or 2,010 ha).

Table 4.3: Net production area for the project area (*ha*)

	Size (ha)
Project Area	28,374
Roads & clearings	-230
Streams, ponds, including riparian reserve	- 1,305
Conservation area & steep areas	- 475
Net production area	26,364

Forest Function zoning

All compartments along the Kuamut River are designated for **natural forest management** (NFM). This decision was made in order to maintain a wildlife corridor along the Kuamut River, as well as to protect river water quality. As such, harvesting within this NFM zone will be selective and will strictly follow RIL guidelines. Twenty one compartments covering about **9,320 ha** are designated for natural forest management, whereas 40 compartments totaling **18,288 ha** are allocated for mosaic planting. The remaining two compartments are set aside for conservation and research.

Following the mosaic planting system that will be adopted in the area, the ratio of planted area to natural forest within the mosaic planting area is roughly 40:60. Therefore, the actual area allocated for planting is about **7,315 ha**, whereas the remaining area of **10,973 ha** will be treated by liberation thinning.

Table 4.4: Land use planning for the project area, assuming a gross production area of 28,374 *ha*

Land use	Size (ha)
Mosaic planting (40 compartments)	18,288
Natural forest management (21 compartments)	9,320
Conservation	475
Research	291
Total	28,374

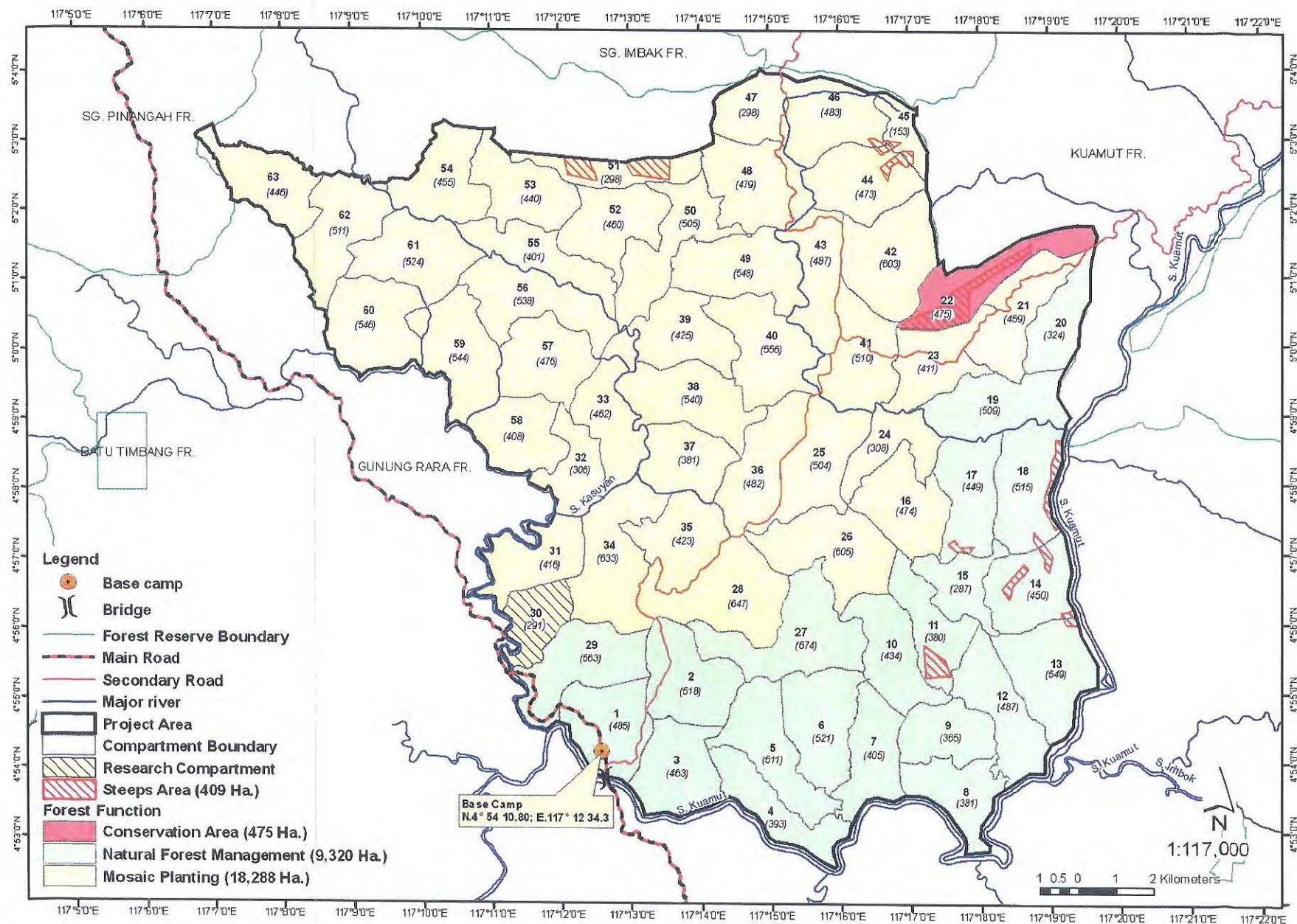


Figure 4.1: Forest function zoning of the project area

4.6 Financial Considerations

Local market prices for binuang and laran (45–60 *cm* DBH) in October 2011 was RM 380 m^{-3} (delivered to the mill). Given the increasing scarcity of raw material, as well as increasingly higher production costs, this price is likely to go up. Shortage of raw material is also leading some mills to import plantation logs from overseas. Despite the relatively long gestation period, plantation forestry is looking increasingly promising as a financial investment, particularly for fast-growing species like laran, binuang, and batai.

Project cash flows

Although the project planning period is 10 years, the projected cash flows as given in Table 4.4 (summarized from Appendix F, p 43) are up to year 11, i.e. when the planted timber crop is expected to be partially harvested. Harvesting of the planted crop is scheduled to commence over 10 successive years beginning in year 10 (730 *ha*). However, in this analysis, only harvest yields up year 11 is taken into account, i.e. two years of yield. For the purpose of demonstrating financial viability of the project, revenue from these two years of timber production is considered sufficient.

The total project cost is estimated to be about RM 42,318,000 over 11 years (Table 4.4). Revenues are derived from salvage harvesting in the first three years, and the harvesting of planted trees in years 10 and 11. The total revenue projected up to year 11 is RM 134,401,800.

Financial feasibility

In order to provide an indication of the financial feasibility of the project, cash flows up to year 11 were evaluated. This period length is considered sufficient to demonstrate the financial viability of the project. Using the net present value (NPV) of cash flows and benefit/cost ratio as criteria to assess financial viability, an analysis was done at a discount rate of 15 %. Private sector investments usually assume rates of at least 10 %

NPV is highly positive (RM 44,323,934) and B/C ratio is about 2.7, thus indicating that this integrated mosaic tree plantation venture is financially viable. The internal rate of return (IRR) is estimated at 24 %. If subsequent harvest yields beyond year 11 are taken into account, the financial outlook of the project will look even more positive. And since standing timber is not a perishable commodity, the financial risks of this venture can be hedged by scheduling harvests only when markets are favourable. As trees grow, they increase in value. Therefore, the decision not to harvest does not necessarily translate to a loss.

Table 4.5: Summary of cumulative cash flows up to year 11, assuming a net annual harvested area of 730 *ha* in years 10 and 11. This period length is considered sufficient to demonstrate the financial viability of the project (See Appendix F, p. 43 for details).

Cost	RM
1. Site preparation	6,552,000
2. Liberation thinning	5,070,000
3. Seedlings & planting	5,824,000
4. Tending	8,962,000
5. Road maintenance	3,400,000
6. Management & administration	6,800,000
7. Transport & fuel	2,800,000
8. Miscellaneous cost	2,910,000
Total cost (Present value)	42,318,000 (25,999,623)
Revenue	
Revenue from salvage harvest in yrs 0, 1, 2, 3, & 4 ($\approx$ yield 594,000 m³)	38,032,800
Revenue from NFM logging in years 0, 1, & 2 ($\approx$ yield 277,200 m³)	22,785,000
Revenue from harvesting 1,000 <i>ha</i> in years 10 & 11 ($\approx$ yield 280,000 m³yr⁻¹)	73,584,000
Total revenue (Present value)	134,401,800 (70,232,557)

5. PRESCRIBED ACTIVITIES & IMPLEMENTATION

The key activities throughout the planning period are 1) site preparation, 2) planting, 3) tending & maintenance, and 4) harvesting. The entire project area is intended to be completely planted within 9 years from the commencement of operations. Salvage logging is scheduled to be completed within three years, thereafter, activities will largely focus on planting and the tending of planted seedlings. The first harvest of planted trees of about 1,000 *ha* is scheduled in year 10, whereas the remaining area will be completely harvested over a 9-year period, i.e. beyond this current planning period.

5.1 Infrastructure & Basic Amenities

Field Base & Nursery

The field operations base, together with the stumping site for this project will be located in Compartment 1. This is expected to be completed in June 2012, and will include a nursery, accommodation facilities, offices, and workshops .

Road maintenance

There is an existing network of logging roads from previous logging operations (Appendix B). These roads will be maintained to ensure accessibility at all times. In addition, all key roads demarcating the block boundaries within the Project Area will be reconstructed and maintained regularly to provide access for field planting operations. The total length of access roads to be reconstructed and maintained is about 230 *km*. These roads will also serve as firebreaks in the event of a fire outbreak.

5.2 Salvage Logging & Site Preparation

DBH felling limits for site preparation within the area designated for mosaic planting is 31–150 *cm* DBH for all species. Trees greater than 150 *cm* DBH is prohibited from felling. Salvage logging will be carried out over the first three years, beginning in year 2012, and is expected to yield a total of about 594,500 *m*³ from site preparation within the estimated 18,579 *ha* allocated for mosaic planting, including the research compartment (i.e. an extraction rate of about 32 *m*³ *ha*⁻¹). The schedule for salvage logging is shown in Figure 5.1. This schedule may change subject to market conditions. For instance, if market prices for timber are low, harvesting may be deferred until they are more favourable.

Excavators will be used for land clearing since experience in their use has found them to be less damaging to the soil than bulldozers. Where appropriate, timber extraction will also employ the use of ‘log fishers,’ modified excavators that have been proven to reduce damage, particularly when used in steep terrain.

All merchantable timber will be extracted, while slash or debris from clearing operations will be spread evenly over the cleared soil surface. This practice can help reduce soil erosion and suppress weeds. Consistent with existing laws, there will be no burning during site preparation. Any logging residue, such as large branches, hollow logs, short logs, and high stumps that are considered usable will also be extracted to minimize wastage. Site preparation may also include the cutting of vines before harvesting operations commence.

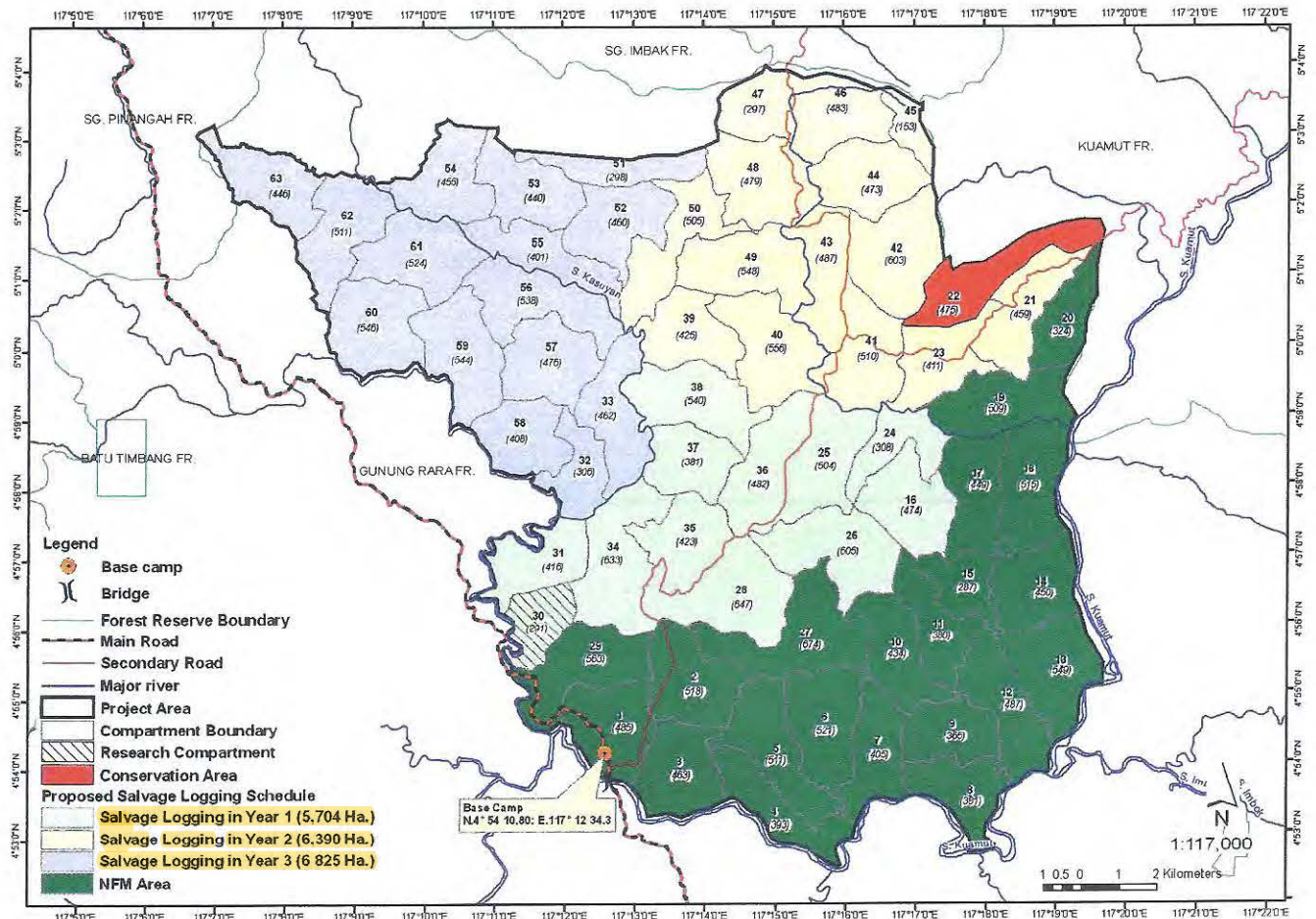


Figure 5.1: Salvage logging schedule for the project area beginning in year 2012. Salvage logging is planned to be carried out over the first 5 years.

5.3 Planting and Tending

Planting

Planting operations is scheduled to begin in 2012 and are expected to be completed within 7 years (Figure 5.2). In the first year, the planting target is set at 500 *ha* (net planted area), followed by a scheduled planting rate of about 1,130 *ha* per year for the

subsequent 6 years. Therefore, the area is expected to be fully planted by year 2018. The actual total planted area is expected to be about 7,300 *ha* upon completion.

Planting density will range between 250 to 400 trees *ha*⁻¹, depending on species. There will be no thinning, and therefore this planting density also represents the spacing of the final crop. Planting material will be seedlings produced at the onsite nursery in Compartment 1. Seeds will be procured from known sources of high quality material.

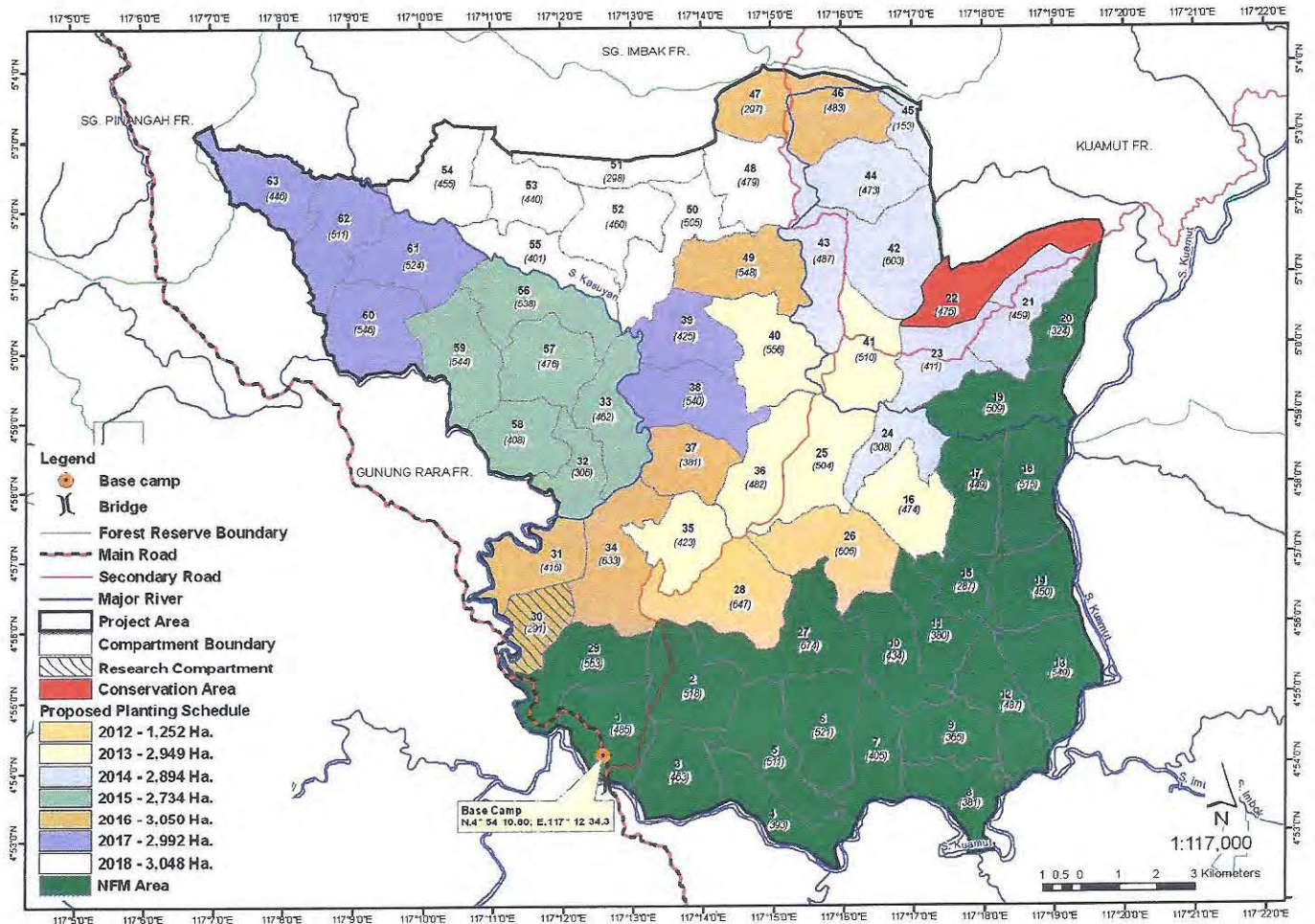


Figure 5.2: Annual planting schedule for the project area beginning in year 2012. The entire area is expected to be planted up in 7 years, i.e. by the end of year 2018

Tending

Planted seedlings are expected to be tended and maintained for 3 or 4 years. Tending operations include circle weeding, vine removal, fertilizer application and pruning as needed. All dead seedlings will be replaced. During the first two years, seedlings will require three to four rounds of tending. In the third year, tending may be reduced to two rounds. Pruning will be carried out if and when necessary during tending operations. The idea is to maintain a single stem, with a clear bole of at least 4 *m*.

5.4 Harvesting in Compartments under Natural Forest Management

All timber extraction within the 21 compartments designated under natural forest management (NFM) will be carried out following reduced-impact-logging guidelines. Therefore, Comprehensive Harvest Plans will have to be prepared and approved by the Forestry Department prior to the commencement of harvesting operations. The cutting limit for NFM compartments is 40 to 150 cm DBH. In addition, all fruit trees listed as prohibited will be retained, e.g. durian, tarap, kedondong, *Ficus* spp., etc. Where appropriate, timber extraction will employ the use of 'log fishers,' modified excavators that have been proven to reduce damage, particularly when used in steep terrain.

Timber extraction from the NFM compartments will be carried out in the first three years (Figure 5.3). However, the scheduling of harvesting may change subject to market conditions. For instance, if market prices for timber are low, harvesting may be deferred until they are more favourable. Where appropriate, timber extraction will employ the use of ‘log fishers,’ modified excavators that have been proven to reduce damage, particularly when used in steep terrain.

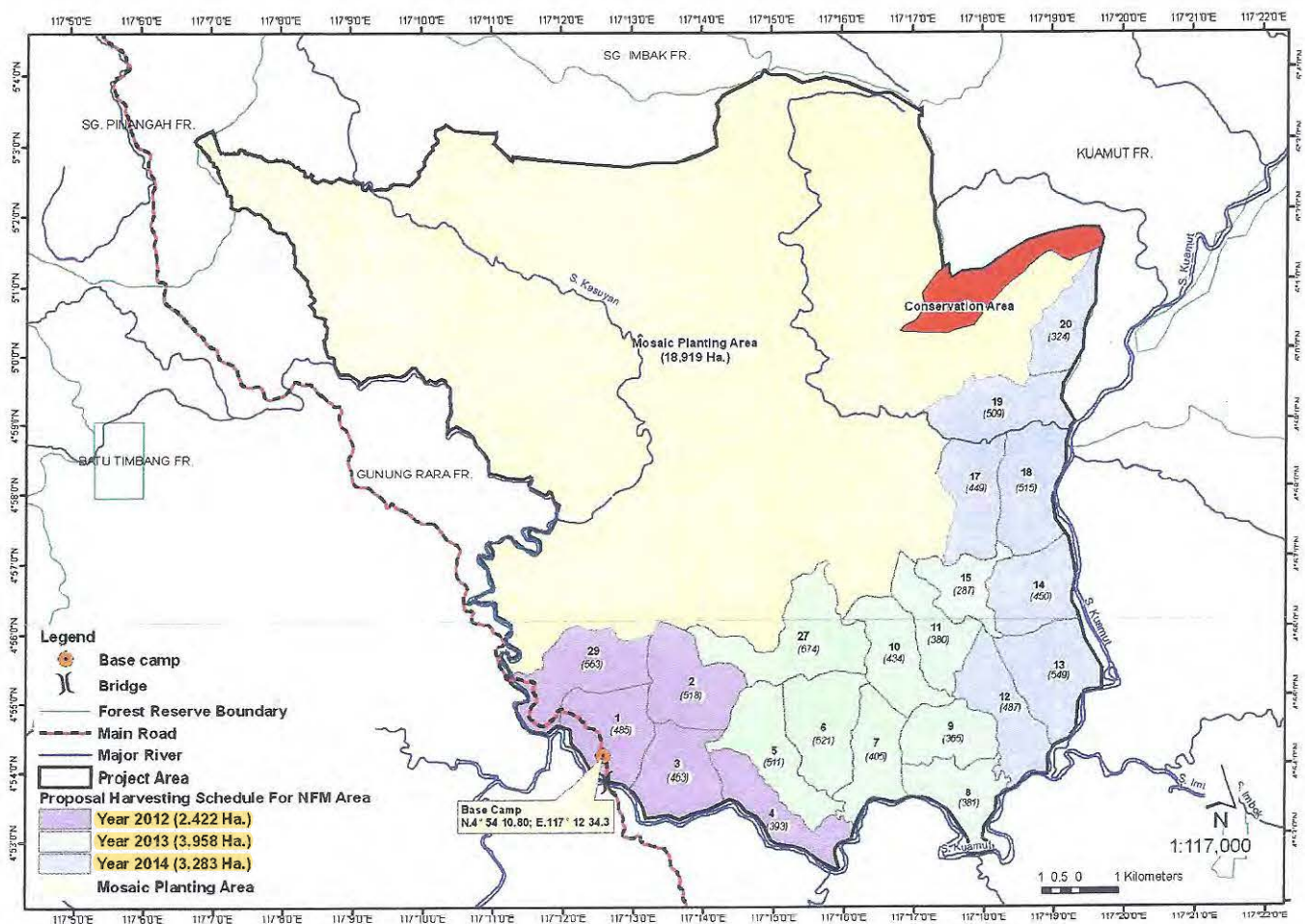


Figure 5.3: Harvesting schedule for compartments under natural forest management.

5.5 Treatment of Natural Forest Patches

There will be an estimated 10,973 *ha* of natural forest patches interspersed amongst the planted patches. These patches of forest will be tended by liberating PCTs and commercial regeneration. In addition, enrichment planting with native commercial species will be carried out where necessary to enhance long-term timber productivity. Liberation treatments include blanket vine cutting and the removal of weed species (*Macaranga* spp) and defective trees where they hinder the growth of PCTs. This may be carried out both before and after timber extraction. Some 9,300 *ha* within the NFM zone will also be treated. The treatment of natural forests within the project area will be scheduled over a 6-year period, beginning in 2013.

5.6 Protection of Riparian Reserves

As required under existing forestry regulations, a riparian reserve 30 *m* in width shall be demarcated and maintained along either side of all perennial streams and rivers. However, a riparian buffer of 100 *m* is prescribed along the Kuamut River. Riparian buffers are prescribed to protect river water quality and also serve as a wildlife corridor. Some 345 *km* of perennial streams occur within the project area. No commercial timber extraction is allowed within the riparian reserve. In addition, where there are no trees along a designated riparian buffer, the restoration of forest cover will be carried out as a means of enhancing its environmental service functions (HCV-4). For this purpose, tree species that are indigenous to the area will be used.

5.7 Fire Prevention And Control

Certain measures will have to be taken to reduce the risk of fires. This includes maintaining an understorey of green vegetation consisting of ferns and soft weeds. Roads will be maintained, not just to provide access for fire fighting, but also to serve as fire breaks. Field supervisors will be trained in fire prevention and control.

The likelihood of fire outbreaks is expected to be highest during prolonged drought periods. A fire danger rating system as shown in Table 5.1 will be adopted. The system will generally follow the Keetch-Byram Drought Index (KBDI) as recommended by the Forestry Department. Rainfall monitoring will be monitored in the project area. The KBDI will be evaluated daily at 1500 hrs for the purpose of fire danger rating. These are based on dry bulb temperature and precipitation. Fire danger is rated as 'moderate' for continuous no-rain periods of 2 to 4 weeks. Fire danger is 'high' when dry days extend beyond 4 weeks. Specialised fire fighting equipment such as water pumps and knapsack pumps will be stored at the field camp. Table 5.1 also shows the measures to be taken to prevent and control fire outbreaks.

In the case of a fire outbreak, the field supervisor will monitor the ground situation and organize fire-fighting operations in the project area. Assistance will also be requested from the District Forestry Officer. Fire prevention and control measures will be elaborated in greater detail in a fire management plan that will be prepared for the project area.

Table 5.1: Fire danger rating and prevention activities

Danger Rating	Prevention Activities
Low	None
Moderate	Notify all nearby communities & contractors regarding fire danger and precautionary measures
High	Regular patrolling of block boundaries for early detection Firefighting machinery & equipment to be on site Form firefighting crews Notify all relevant agencies Stop all forms of open burning Identify water sources, e.g. ponds and rivers in close proximity

5.8 Site Productivity & Growth Monitoring

Site productivity monitoring—Soil sampling to establish initial nutrient status will be carried out for selected blocks upon the completion of planting. Thereafter, sampling will be carried out at 5 year intervals. This repeated sampling is done to monitor trends in site productivity over the long-term. Declining site productivity would mean that remedial measures will have to be considered. Soil sampling will be done with the assistance of the Forest Research Centre in Sandakan.

Growth monitoring—A sampling system will be put in place in order to monitor the growth of trees and overall plantation development. This will provide accurate information on growth and potential yield.

5.9 Harvesting & Long-term Sustainability

At the initial stage, timber production will come from salvage logging that will be carried out over a period of about 5 years. Timber extraction is also planned to be carried out in the NFM compartments in the first 4 years.

By the end of the planning period, there will be approximately 7,315 *ha* of planted forest within the project area. The first harvest of 730 *ha* of planted forest is scheduled in year 10, i.e. in 2022, when the first planted crop is about 10 years old. It is planned that this will be followed consecutively at equal proportions of more or less 730 *ha* a year so that the entire planted crop will be harvested within 10 years. In the long-term, the planted forest is expected to yield 180,000-200,000 m³ annually. Harvesting is not expected in the treated natural forest patches within the next 15 to 20 years.

Harvesting will employ some form of cable yarding in order to minimise soil disturbance. The burning of felling waste will not be allowed. The entire area will be replanted during the next planning period.

Managed alongside its vast area of natural forests and other forest plantation ventures, Rakyat Berjaya expects to be able to regulate yield such that harvesting can be sustained more evenly throughout their entire concession area in the long term.

5.10 Community Forestry

Although the local communities presently has no cultural links or direct dependence on the project area for their livelihoods, this could change in the future. Management activities may create employment, as well as economic opportunities for rural communities. Both Rakyat Berjaya and Empayar Kejora will continuously explore ways to see how forest management activities within the area may benefit rural communities.

5.11 Environmental Impact Assessment

Any development of forest plantations or reforestation covering an area of 500 *ha* or more is considered a 'prescribed activity' under the Second Schedule of the Environmental Protection Enactment. As such, the proponent for the activities to be undertaken in the project area is required by law to carry out an Environmental Impact Assessment (EIA). This was completed in March 2012 by an appointed consultant and is expected to be submitted to the Environmental Protection Department (EPD) in April, 2012.

The EIA recommends fourteen (14) parameters to be monitored on a regular basis (as listed below). An Environmental Monitoring Report is required to be submitted to the EPD once every four (4) months commencing from the date the Environmental conditions in the 'Surat Akujanji' is signed. Field monitoring and the preparation of this report will be done by Empayar Kejora on behalf of Rakyat Berjaya.

- Soil conservation practices
- Riparian reserve
- Protection of steep areas
- Hazardous waste management
- Phased development
- Biomass management
- Pest and diseases management
- Fire prevention
- Ecological protection
- Noise and air pollution
- Traffic and transportation control
- Socio-economic consideration
- Occupational safety and health practices
- Abandonment plan

5.12 Research

Compartment #30, covering about 290 *ha*, is specifically allocated for research, such as spacing and species trials. This compartment was selected due to its proximity to the main field operations base, therefore making it convenient for intensive monitoring activities. No specific time frame has been set to establish these.

5.13 Staffing & Manpower Requirement

Empayar Kejora, being the appointed contractor for the development of the project area, has the proven capacity to undertake this project, both in terms of manpower resources and technical expertise. Existing staff and workers from its current forestry operations nearby will be deployed to supervise and oversee field operations in the project area. In addition, Empayar Kejora will have to recruit additional temporary field workers. As far as possible, these workers will be sourced from the nearby villages. Empayar Kejora's organization chart for the project area is shown in Appendix H (p. 45).

6. MONITORING, CONTROL, AND REPORTING

6.1 Record-keeping

All information and records on planting and tending (e.g. tending record, fertilizer application, growth, standing stock inventory, yield, etc.) will be documented by compartment. This will serve as a permanent record to monitor growth and yield for each block. These compartment record books will be updated periodically as needed, and maintained systematically so as to facilitate project monitoring and auditing.

6.2 Annual Work Plans, Progress Reports and Plan Review

Annual work plans (AWP) will be submitted to the Forestry Department at the beginning of each year. The AWP outlines the schedules, targets, and details of all activities to be carried out during the year.

A compliance report on the progress of planting and other associated activities will be provided to the Forestry Department on an annual basis, or whenever required by the Department. Progress reports will also elaborate on plantation performance, particularly in regard to survival and growth.

As required by law, an Environmental Monitoring report has to be submitted to the Environmental Protection Department every four months. The field monitoring and report preparation will be carried out by Rakyat Berjaya.

A mid-term review of the forest development plan is planned in the year 2016. However, FMP for the project area may be reviewed and revised as and when needed, depending on progress, plantation performance, or changes in development objectives. For instance, although the first harvest of crop trees is scheduled in year 10, the rotation could be brought forward to year 9, depending on plantation performance and market demands. This change may require a review of the FMP. However, any major revisions to the FMP will have to be approved by the Director of Forestry.

6.3 Forest Certification

Rakyat Berjaya intends ultimately to have the project area certified under a credible forest certification scheme (e.g. Malaysian Timber Certification Scheme or the Forest Stewardship Council), including the project area. Such independent third party assessments will not only be important for market access, but also to ensure that management standards are of a high quality.

6.4 Standard Operating Procedures & Guidelines

Clearly documented standard operating procedures (SOP) and guidelines has been drawn up to ensure that certain key activities are carried out according to established procedures or guidelines. This will also provide a means to objectively assess compliance to prescribed activities, such as planting, herbicide application, harvesting, and occupational safety.

REFERENCES

ACRES, B.D., BOWER, R.P., BURROUGH, P.A., FOLLAND, C.J., KALSI, M.S., THOMAS, P., and WRIGHT, P.S. 1975. *The Soils of Sabah*. Volumes 1-5. Land Resource Study 20, Land resources Division, Ministry of Overseas Development, Surbiton, Surrey, England.

MacKENSEN, J. 1999. *Nutrient Management for Industrial Tree Plantations in Indonesia*. Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH. 96 p.

RAKYAT BERJAYA SDN. BHD. 2010. Forest Management Plan 2011- 2020, Forest Management Units 15 & 16. 118 p.

SABAH FORESTRY DEPARTMENT. 2010. Forest Management Plan 2010-2019, Sg. Mangkuwagu Forest Reserve. 67 p.

TI TEOW CHUAN & TANGAU, W.M. 1991. Cultivated and Potential Forest Plantation Tree Species With Special Reference to Sabah. Insitute for Development Studies. 111 p.

WWF MALAYSIA. 2009. High Conservation Value Forests (HCVF) Tool Kit For Malaysia: A national guide for identifying, managing, and monitoring High Conservation Value Forests. 84 p.

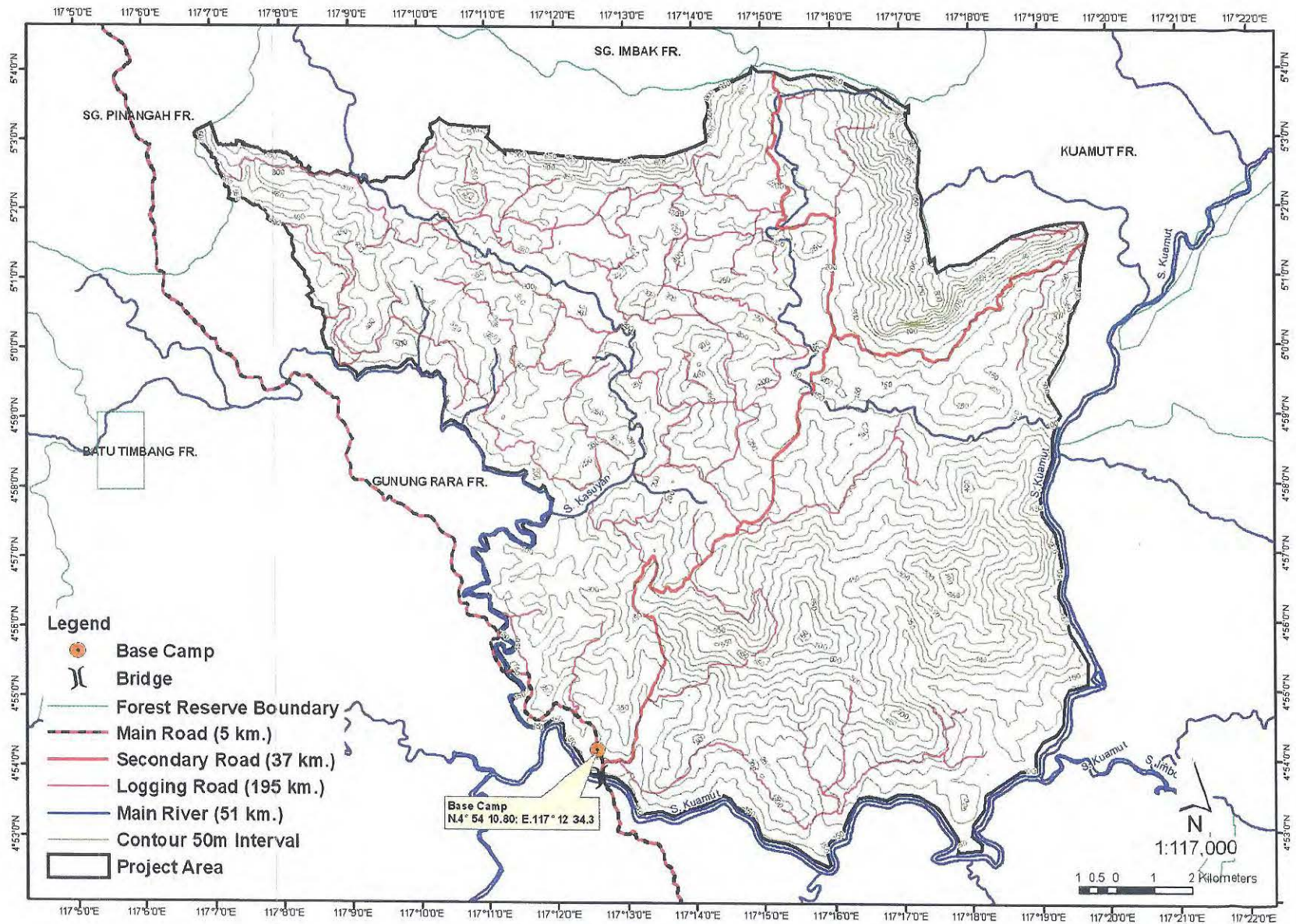
Appendix A

**Monthly rainfall (in *mm*) for the period 2001–2010) recorded at the nearest
Meteorological Station in Luasong (Station code: 5372001)**

Month	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Monthly mean
Jan	211	533	376	356	266	490	254	312	556	394	350
Feb	382	228	267	206	141	215	82	648	112	511	279
Mac	281	465	299	75	290	365	159	156	89	312	261
Apr	384	280	111	242	171	109	141	87	119	209	190
May	549	201	209	147	157	324	340	361	133	344	275
Jun	195	222	34	17	188	179	185	421	155	289	145
Jul	145	229	383	35	233	27	141	496	210	378	170
Aug	405	?	184	?	428	261	167	?	185	299	289
Sep	192	342	142	?	411	362	211	?	228	371	276
Oct	241	320	373	303	106	143	466	250	387	206	279
Nov	181	181	289	93	96	156	166	67	213	430	187
Dec	295	283	409	233	671	510	376	276	523	256	383
Annual mean											3,084

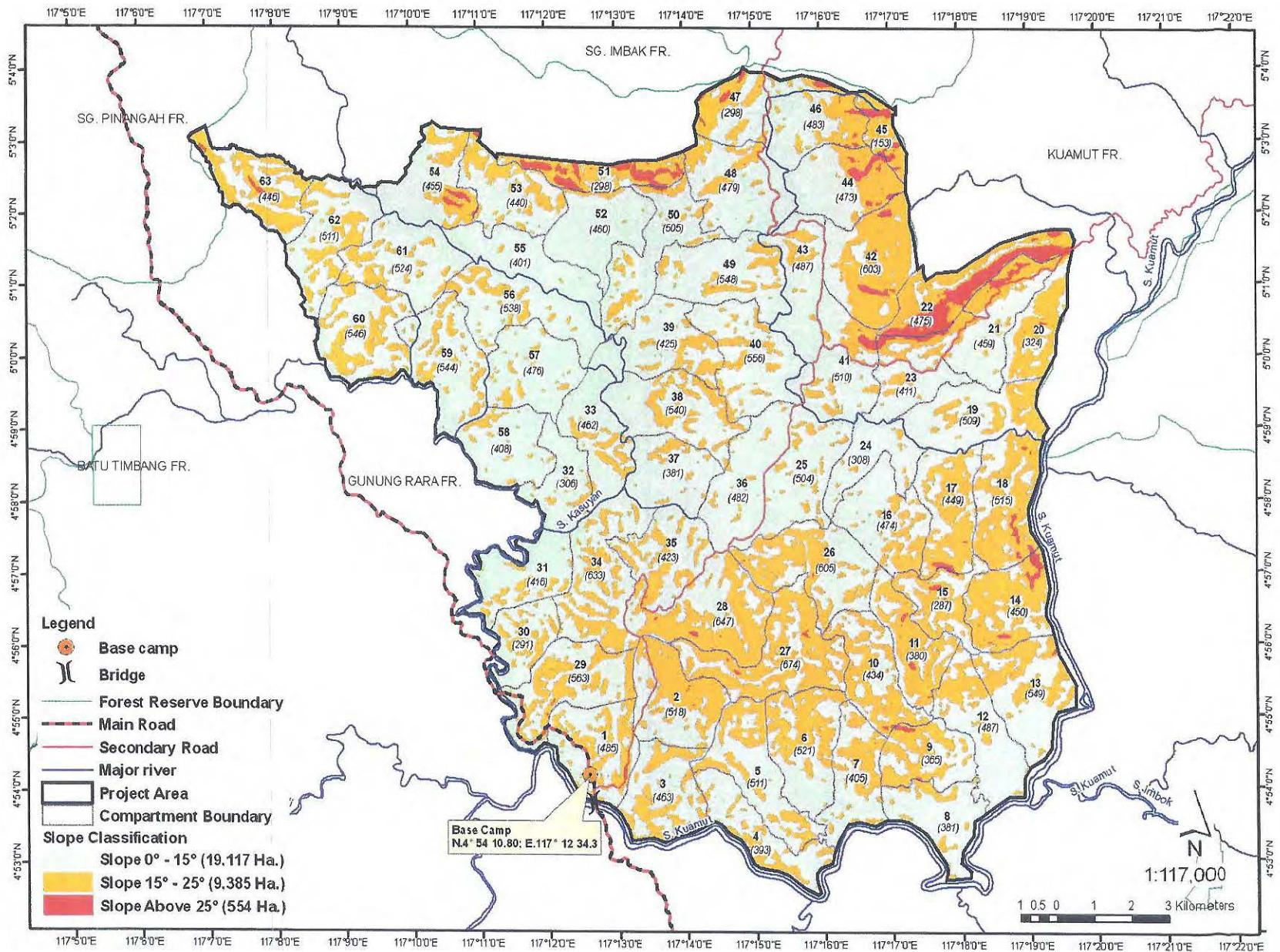
APPENDIX B

Major Roads & Topography map of the project area



APPENDIX C

Slope Classification of the Project Area



APPENDIX D

General wood properties and uses of selected candidate species

Species	Wood	Known uses	Remarks
<i>Neolamarkia cadamba</i> (laran) Family: Rubiaceae	Soft and very light, with air-dry densities generally ranging from 350 to 450 $kg\ m^{-3}$. Wood colour is a pale yellow, with no distinct heartwood. The grain of the wood is generally straight, and texture fine and even. Not durable and should be processed soon after felling in order to avoid blue staining. It can easily be impregnated with synthetic resins to increase density and compressive strength.	The principal use of laran in Sabah currently is for plywood manufacturing. Its uniform texture and colour makes it particularly suitable as face veneer. Tests have shown that it is also suitable for making good quality particle board. In India, it is commonly used for pulping, producing low to medium quality paper. Other known uses are, panels, matchsticks, disposable chopsticks, wood carvings, packing crates, and light temporary construction.	Local market price of logs ≥ 35 cm delivered to the mill in September 2006: RM 300–370 m^{-3}
<i>Octomeles sumatrana</i> (binuang) Family: Datiscaceae	Soft & light, average air-dry density is about 400 $kg\ m^{-3}$; colour is creamish to pale yellow. Wood can be easily bleached to a white colour. Interlocking grains with moderately coarse texture. Not durable and should be processed soon after felling in order to avoid blue staining.	Major use is for plywood, laminated veneer lumber, packing crates, temporary construction.	Local purchase price in Oct 2006, delivered to mill in Tawau: 46–59 cm RM 380 m^{-3} ≥ 60 cm RM 440 m^{-3}
<i>Paraserianthes falcataria</i> (batai) Family: Fabaceae	Soft and very light, with air-dry densities ranging from 300 to 350 $kg\ m^{-3}$. Colour is white to pale pink, with no clear difference between sapwood and heart wood. The wood is not durable and should be processed soon after felling in order to avoid blue staining.	In Sabah, batai wood is largely used as core material for blockboards. In plywood making, it is also used as face veneer. In the Philippines, batai is an important species for pulp and paper production. Due to its low density, it is not favoured for making particle board or medium density fibre board.	Local market price in Oct 2006, ex Sabah Softwoods Pengkalan in Brumas: 15–21 cm RM 125 m^{-3} 22–39 cm RM 180 m^{-3} ≥ 40 cm RM 225 m^{-3} Due to insufficient local supply, batai wood is also imported from Indonesia in the form of laminated boards.
<i>Terminalia copelandii</i> (Talisai Paya) Family: Combretaceae	Air-dry densities ranging from 380 to 440 $kg\ m^{-3}$. Colour is light brownish yellow. Very high recovery rates for rotary-peeled veneer (over 80 %).	General construction, core veneer for plywood, furniture, sawn timber	Local market price is more or less similar to laran

APPENDIX E

General silviculture of selected candidate species

Species	Growth & yield	Silviculture & management	Propagation
<i>Neolamarkia cadamba</i> (laran)	Early growth is remarkably rapid, particularly from year 3 to 5. 2.5 – 4 cm. Observations in Sabah of fertilized laran commonly show diameters of 25 to 30 cm in 5 years. Diameter increments of 7 cm/yr for the first 6 years is not unusual. From all observations and growth characteristics, laran can be expected to attain 50 cm in 12 years. A tree of 50 cm DBH would have a merchantable volume of about 2.5 m ³ . For veneer logs, a rotation of 10-12 years is considered realistic for laran plantations.	Very light demanding, and therefore requires open conditions for optimal growth. Due to its rapid early growth, laran is best planted at a final spacing of 5 x 6 m or 330 trees ha ⁻¹ . Canopy closure can be achieved by year 3	Mainly by seeds. Fruits annually, and fruits drop readily upon ripening. There are 5000-6000 seeds in a gram. Seeds should be stored in dry, airtight containers. In cool storage (16°C) seed can retain viability for up to 2 years, but under ambient temperature up to 6 months. The germination percentage of freshly collected seeds is around 25 %.
<i>Paraserianthes falcataria</i> (batai)	Growth rates on good sites over a 10-yr rotation can reach 50-70 m ³ ha ⁻¹ y ⁻¹ , while average sites yield about 35-40 m ³ ha ⁻¹ y ⁻¹ . Sabah Softwoods reported yields of 40-60 m ³ ha ⁻¹ y ⁻¹ over a 10 year period. Pulpwood is grown on a 6-7 yr rotation, while saw logs and peeler logs are usually grown on a 10-15 year rotation.	Recommended spacing for pulpwood production is 3 x 3 m, whereas for veneer and saw logs 4 x 5 m (500 trees ha ⁻¹).	Usually by seeds. <i>A. falcataria</i> begins to bear fruit at age 4-6 years. Seed pods are collected while still on the tree. The number of fresh seeds per kilogram is 38,000-45,000. If kept dry, seeds can be stored for up to 5 years. Untreated seeds germinate after 5-10 days, but sometimes it is delayed for up to 4 weeks from sowing. To hasten germination, seeds can be treated by soaking them in hot water (90°C) and allowing them to cool off for 24 hrs.
<i>Octomeles sumatrana</i> (binuang)	Growth characteristics quite similar to laran. Growth rates of 35-45 m ³ ha ⁻¹ over the first 6 years have been reported from the Philippines and Indonesia.	Pioneer tree. Best growth on moist, but well-drained alluvial sites. Recommended spacing for veneer and saw logs is 5 x 7 m (285 trees ha ⁻¹). Fertiliser application recommended in the first 3 years.	Propagation by seeds, but also amenable to vegetative propagation from stem cuttings. 10,000-15,000 seeds per gram. Germination of fresh seeds can vary from 5 to 35 %. Seeds can be stored for up to a year, but germination drops with time. Fruits annually, ripe fruits are usually collected when they begin to turn brown while still on the tree.
<i>Terminalia ccopelandii</i> (Talisai)	A small experimental plot in Sepilok planted at 4 x 5 m spacing showed average diameters of 40 cm in 12 years. However, the dominant trees show an average diameter of 55 cm. With wider spacing, careful selection of planting material, and fertilizer application better growth can be achieved. A tree of 45 cm DBH would have a usable volume of about 1.8 m ³ .	Needs moist well-drained sties. Light demanding. Recommended spacing for veneer logs is 5 x 6 m (330 trees ha ⁻¹).	Propagation by seeds. Trees begin fruiting as early as 4 years old. Fruits annually, and at different times of the year depending on location. 100-120 seeds per kg.

Appendix F

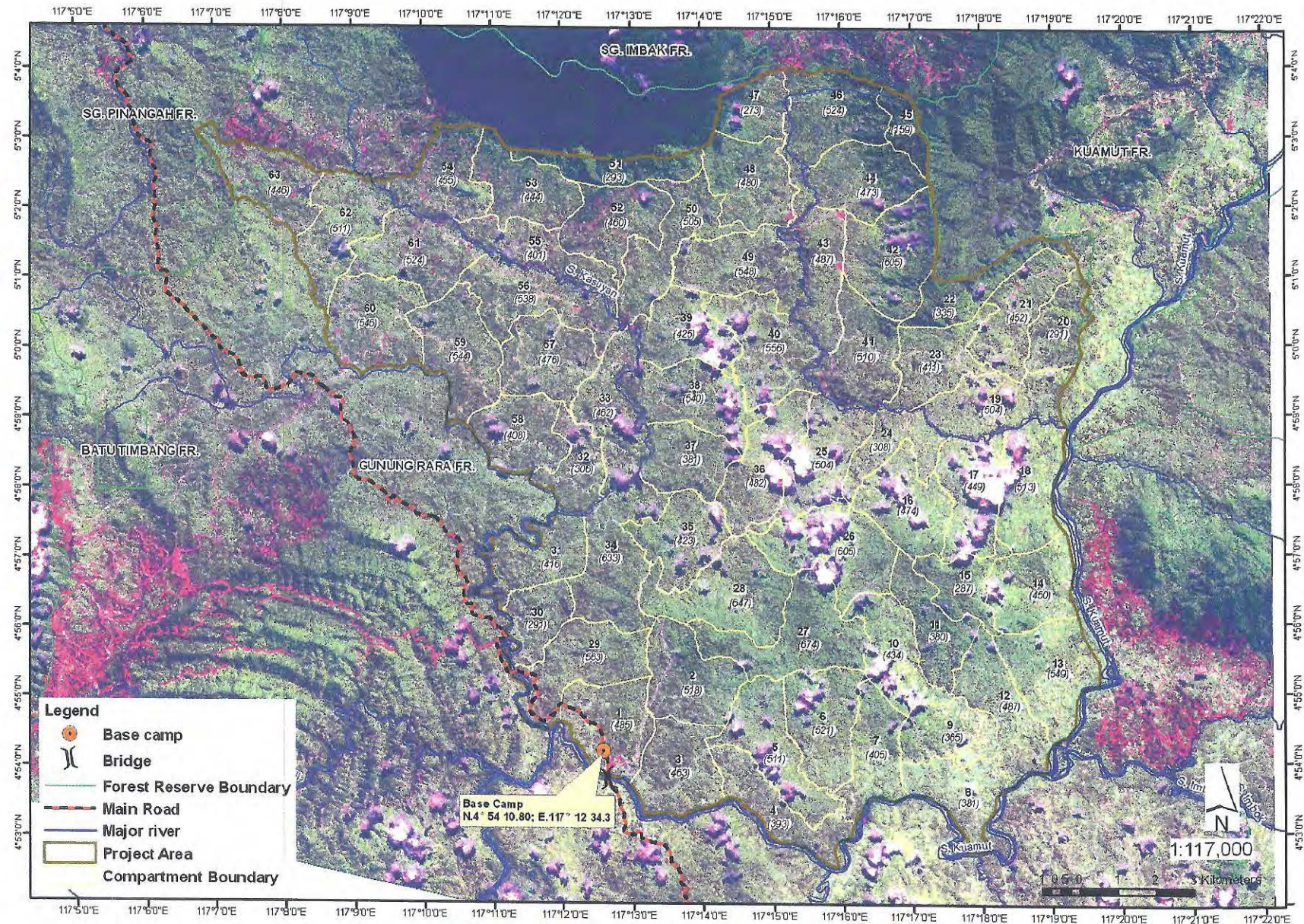
Projected cash flows from Yr 0 to 11 and associated present value (PV) using a discount rate of 15 % (in RM)

Cost component	Year												Total
	0	1	2	3	4	5	6	7	8	9	10	11	
Site preparation	450,000	1,017,000	1,017,000	1,017,000	1,017,000	1,017,000	1,017,000						6,552,000
Liberation thinning		845,000	845,000	845,000	845,000	845,000	845,000						5,070,000
Seedlings & planting	400,000	904,000	904,000	904,000	904,000	904,000	904,000						5,824,000
Tending	75,000	564,000	1,035,000	1,356,000	1,356,000	1,356,000	1,356,000	1,356,000	508,000				8,962,000
Road construction & maintenance	700,000	400,000	400,000	200,000	200,000	200,000	200,000	200,000	150,000	150,000	300,000	300,000	3,400,000
Management & administration	500,000	500,000	500,000	500,000	500,000	600,000	600,000	600,000	600,000	600,000	650,000	650,000	6,800,000
Transport & fuel	300,000	300,000	300,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	250,000	250,000	2,800,000
Miscellaneous costs (boundary survey, mgt planning, license fee, permits, etc)	2,000,000	80,000	80,000	80,000	80,000	80,000	85,000	85,000	85,000	85,000	85,000	85,000	2,910,000
Total yearly cost	4,425,000	4,610,000	5,081,000	5,102,000	5,102,000	5,202,000	5,207,000	2,441,000	1,543,000	1,782,000	1,658,500	1,285,000	42,318,000
PV @ 15 %	4,425,000	4,008,696	3,841,966	3,354,648	2,917,085	2,586,313	2,251,130	917,662	504,409	506,556	409,956	276,202	25,999,623
Revenue component													
Salvage logging	12,677,600	12,677,600	12,677,600										38,032,800
NFM logging	7,595,000	7,595,000	7,595,000										22,785,000
Revenue from planted trees											36,792,000	36,792,000	73,584,000
Total annual revenue	20,272,600	20,272,600	20,272,600								36,792,000	36,792,000	134,401,800
PV @ 15 %	20,272,600	17,628,348	15,328,998								9,094,420	7,908,191	70,232,557

Assumptions:

1. Planted area 7,315 ha; Natural forest 20,293 ha
2. Site preparation @ RM 900 ha⁻¹; natural forest treatment 3,380 ha⁻¹ yr⁻¹ from yr 1-6, @ RM 250 ha⁻¹
3. Seedling & planting cost @ RM 800 ha⁻¹
4. Salvage logging 6,095 ha per year in Yr 0, 1, 2, & 3. Estimated yield : 195,040 m³ per year
5. NFM logging: 3,100 ha net area per yr in Yr 0, 1, & 2. Estimated yield of 35 m³ ha⁻¹
5. Planting schedule: 650 ha in year 0, and 740 ha yr⁻¹ for the next 8 years
6. Tending cost @ RM 150 ha⁻¹ per round (3 rounds from Yr 1-2, 2 rounds in yr 3);
7. Yield from salvage logging is 32 m³ ha⁻¹, and a net profit of RM 65 m⁻³,
8. Harvest 730 ha in Yr 10 and 1000 ha in Yr 11. Revenue from harvest of planted trees calculated based on yield of 280 m³ ha⁻¹ and a profit of RM 180 m⁻³ (i.e. ex-pengkalan)

APPENDIX G **2.5 m SPOT Image of the project area captured in April 2010**



APPENDIX H

Organisation Chart

