

**PROJECT DESIGN DOCUMENT FORM  
FOR AFFORESTATION AND REFORESTATION PROJECT ACTIVITIES (CDM-AR-PDD)-Version  
01**

**CLEAN DEVELOPMENT MECHANISM  
PROJECT DESIGN DOCUMENT FORM FOR AFFORESTATION AND REFORESTATION  
PROJECT ACTIVITIES (CDM-AR-PDD)**

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**SECTION A. General description of the proposed A/R CDM project activity:**

**A.1. Title of the proposed A/R CDM project activity:**

The Mountain Pine Ridge Reforestation Project (MPR Project)

**A.2. Description of the proposed A/R CDM project activity:**

The proposed A/R CDM activity is the reforestation of a portion of the Mountain Pine Ridge Forest Reserve in Belize with native *Pinus caribaea* var. *hondurensis*. The purpose of the Mountain Pine Ridge Forest Project is to create a sustainable forest resource for carbon sequestration, timber production, habitat protection and socio-economic stability in Belize.

A vegetation survey was conducted in 1989 for purposes of management of the area (Sandom 1990). Discrete areas of canopy cover classes were identified and mapped – giving distinct areas that had canopy closure below the national standard of 30% for Belize. Recent surveys have identified those areas which still have crown closure below 30% in 2005. The pine bark beetle attack of 2000 did not affect the young trees (< 15 years old), and thus allows us to estimate today what the regeneration since 1989 has been. Where areas have not reached 30% crown closure during that period, including both the regeneration layer today, and the mature layer which was left as of 1989, and are clearly not on track meet that target, we can conclude that they do not meet the standard for expectation of regeneration, and are eligible for A/R CDM project activity. These discrete areas are spread throughout the Forest Reserve and total about 7,900 ha in a Forest Reserve of about 50,000ha.

Virtually the entire mature pine layer in the Mountain Pine Ridge area was destroyed by bark beetle attacks in the latter part of 2000. The pest (*Dentroctonus frontalis*) is common to pine forests throughout the region. However, attacks of this magnitude have not previously been known. The magnitude of this attack was probably caused by poor management, resulting in a distorted age mosaic with a preponderance of over-age trees. The attack has removed the seed source for natural pine regeneration from large areas of the MPR Forest Reserve.

Significant areas of the forest will not now return over the medium term through natural regeneration. Following the Beetle attack evidence of natural regeneration is confined to patches where remaining seed trees and favourable seed bed have coincided. (See Appendix 1) This is not unexpected as Gray (1995) commented “Problems have been encountered due to an almost total absence of regeneration on harvested and burned sites of *Pinus caribaea*. The lack of regeneration is thought to derive from a lack of seed rather than poor conditions for germination or early establishment. This species is a notorious infrequent and light seed bearer. Most years do not follow any pattern, and can be extremely variable within a stand. Limited seeding can be attributable to some degree to recent years being unfavourable for seed production, indeed following the past two years dry conditions, many trees have a reduced number of smaller than normal cones.”

The IPCC<sup>1</sup> predict increasing drought events: "**More El-Nino-like conditions may exist in the future leading to an increase in the incidence of floods and droughts in many parts of the tropics and sub-tropics.**" Such events, combined with high population density of the pine forest, could provide the conditions for a recurrence of the bark beetle infestation. Past management practices in the Mountain Pine Ridge Forest Reserve have proven non-sustainable in such conditions. The IPCC (and the COP) recognizes that adaptation is an issue: "**Developing countries are more vulnerable to climate change than developed countries:** There are a number of general conclusions that can be easily drawn: (i) human-induced climate change is an important new stress, particularly on ecological and socio-economic systems that are already affected by pollution, increasing resource demands, and non-sustainable management practices;..."

<sup>1</sup> Third Assessment Report, IPCC, 2001

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However, without drawing on limited UN adaptation funding, this project will apply CDM A/R CER funds to provide a sustainable management practice in the future forest. Through a process of pre-commercial and commercial thinnings with a mosaic of pre-mature to mature rotations, the predisposing conditions for a beetle infestation will be avoided. Despite these preventative measures, the forest protection plan will include a system for monitoring pine bark beetle populations to enable counter measures to be taken should beetle populations rise.

The Mountain Pine Ridge Forest Reserve natural pine forest provided a source of revenue to the Government of Belize, particularly through timber royalties. This revenue was sufficient to provide protection from fire to preserve the timber resource and to preserve the natural habitat of diverse wildlife. The Mountain Pine Ridge Forest Reserve was an important tourism attraction and a significant source of employment.

The loss of the forest industry in the Mountain Pine Ridge Forest has left the Government of Belize without a source of revenue with which the Reserve can be protected from fire. Without protection the occurrence of natural wildfires will return the region to a grassland savannah with riverine hardwood forest and most natural regeneration of pine will be lost.

In 2001 the Minister of Natural Resources for Belize, Deputy Prime Minister John Briceño, recognized the opportunity presented by the CDM as an incentive for financial investment in afforestation and reforestation. The Minister contracted Silviculture Belize Ltd. (a Belize registered company) to demonstrate the feasibility of reforestation in various parts of the Forest Reserve and awarded, to the company, the carbon rights to be fungible assets for financial investment to move beyond the demonstration phase. In 2002 almost 4,000ha were planted.

*Pinus caribaea* var. *hondurensis* (Mountain Pine Ridge provenance) seed for the planting was supplied by the Government of Queensland, Australia (see appendix 6). The Queensland forest industry was developed from seed collections made in the Mountain Pine Ridge Forest of Belize and the seed orchards have been maintained despite the state's progression to a *P.caribaea* x *P.elliottii* hybrid.

The Government of Belize is seeking sustainable development in the region through restoration of the forest industry, assurance for the tourism industry, and protection of the nation's water supply and wildlife biodiversity. To achieve this sustainable development and to apply Best Practices in silviculture and forest management, the simultaneous reforestation of the non CDM-eligible forest areas will be necessary. CDM CER funds from the eligible areas will subsidize the planting of the non-eligible areas.

The project activity continues beyond the establishment phase, which will be completed in three years. Forest management will be conducted by locally trained foresters and labour under the direction of an international forest management team. Silvicultural practices will be directed towards maintaining a healthy, vigorous *Pinus caribaea* forest through well-timed thinning regimes and harvest rotation ages. The risk of recurrence of bark beetle at an epidemic level will be significantly reduced with the planned management regime.

The management plan includes protection from wildfires using the existing extensive road complex and infrastructure, supplemented where required.

The Mountain Pine Ridge Forest project activity will be a key component for the sustainable development of the region and beyond: The loss of the forest industry in the Mountain Pine Ridge Forest has caused increased logging in the hardwood forests of Belize, and in softwood forests in neighboring countries. Alleviation of this deforestation pressure will be a positive side effect of the project.

The Mountain Pine Ridge project is also closely integrated with the Visitor Use Management Plan (VUMP) prepared for the Forest Department of the Ministry of Natural Resources, the Environment,

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and Industry for the Mountain Pine Ridge area in 2004. The VUMP identifies the wide range of ecotourism opportunities which are currently occurring or are possible within the Mountain Pine Ridge Area, and the infrastructure required to support them. The Mountain Pine Ridge Project is designed to both provide key services and resources identified in the VUMP, and minimize conflicts between timber and ecotourism uses through:

- Providing signage, infrastructure and road maintenance identified in the VUMP
- Assisting with inventory activities
- Maintaining buffers and enhancing viewlines along proposed trails.
- Re-establishing the pine ecosystem, and its associated wildlife, which are a key feature for visitors, across a significant portion of the MPR area.
- Establishing a nursery which will provide plant stock for amenity areas and ecological restoration activities.
- Assisting with the enhancement of the Douglas D’Silva station area as an educational resource center.
- Providing fire protection for the MPR area

Enhancing the ecotourism potential of the MPR area is a key part of the MPR project’s approach to sustainability. The A/R CDM project provides benefits to this complementary use of the area which would not be provided under alternate scenarios, including the baseline scenario.

**A.3. Project participants:**

The Government of Belize.

- D.N.A.

Silviculture Belize Ltd.

- Owner of the CER rights
- Authorization: DNA of Belize

Brinkman & Associates Reforestation Ltd.

- Contact for CDM activity
- Authorization: DNA of Canada

The Mountain Pine Ridge Forest Company Ltd.

- Project manager
- Authorization: DNA of Belize

**A.4. Technical description of the A/R CDM project activity:**

**A.4.1. Location of the proposed A/R CDM project activity:**

The Mountain Pine Ridge Forest Reserve, Belize, Central America

**A.4.1.1. Host Party(s):**

Belize CA

**A.4.1.2. Region/State/Province etc.:**

Cayo District

**A.4.1.3. City/Town/Community etc:**

The Mountain Pine Ridge Forest Reserve

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**A.4.1.4. Detail of geographical location and project boundary, including  
information allowing the unique identification(s) of the proposed A/R CDM project activity:**

The proposed A/R CDM project will take place on specified areas within the Mountain Pine Ridge Forest Reserve. The Mountain Pine Ridge Forest Reserve has been under the protection of forest legislation since 1944.

The reserve covers a total of 51976.8 ha. Of this approximately 10329.7 ha contains a pure broadleaved forest lying in a band 1-10 km wide east of the eastern Branch. The remaining 41647.1 ha is a mixture of pine forest, broadleaved gallery forests which in general follow watercourses, and grassland. The forest estate is divided into 522 compartments.

An intensive survey of the MPR reserve in 1989-90, (Sandom 1990) utilizing low level aerial photography and 300 ground samples identified the forest cover classes for most of the reserve. The inventory identified 6981 hectares of area with a canopy cover of 30% or less, and 1726 hectares of grassland. These areas meet the crown cover criteria for reforestation under CDM, and most of them do not exhibit sufficient regeneration in the subsequent 15 years to meet the definition of forest. These areas constitute the Assessment Area for the project, as defined in the baseline methodology.

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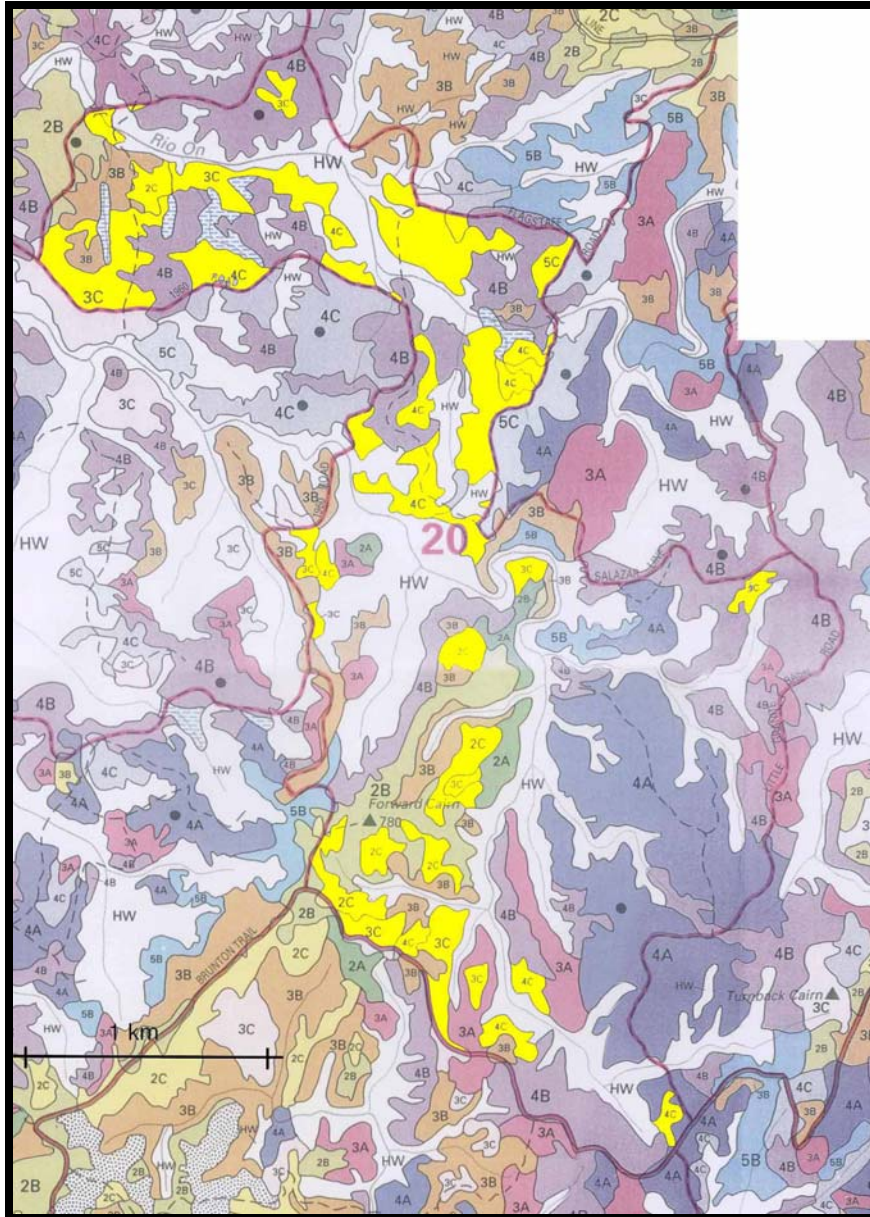


Figure 1: Typical compartment map, showing the dispersion of the areas meeting CDM criteria for reforestation (areas in yellow)

Preliminary work has identified approximately 7900 hectares of area which are likely to meet the CDM criteria for A/R, and are expected to be included in the project boundary. However, final mapping of the project boundary will require completion of surveys of each area, to ensure that levels of regeneration subsequent to 1989 demonstrate that regeneration would not have been reasonably expected to occur at that time. Definition of the final Project Boundary will occur once this work is complete.

**A.4.1.5. A description of the present environmental conditions of the area, including a description of climate, hydrology, soils, ecosystems, and the possible presence of rare or endangered species and their habitats:**

### **Geology**

Geologically MPRFR can be divided into four distinct phases of development. MPRFR lies to the north west of one of the major geological features of Belize, the Maya Mountain Massif. This has been derived from material laid down in the Pennsylvanian and Permian eras (280-300 million years ago). Within MPRFR this is manifested by the presence of mudstones, shales, slates and sandstones. These metasediments have been identified as part of the Santa Rosa Group.

In the early Triassic period (230 million years ago) the Santa Rosa Group was subjected to a series of granitic intrusions.

Following this in the Cretaceous period (100 million years ago) the area was submerged by a shallow warm sea – which permitted the deposition of a substantial layer of limestone. Subsequent uplifting of the area followed by erosion has meant that most of the limestone cap has been removed from within MPRFR except for the extreme west and north of the reserve where typical karst topography can be observed. Also individual hills where the limestone cap has not been fully removed remain as limestone outliers to the main area. Where the limestone has been removed the igneous granite and metasediments are exposed. Faulting, folding and further intrusions have added some additional features.

The geology of MPRFR can be divided into three main units. In the west lying as a continuous band flanking the Eastern Branch the limestone cap remains. This material is contiguous with the Vaca Plateau lying to the west of Eastern Branch. The central portion of the reserve consists of a heavily weathered and eroded granitic basin. Thirdly a crescent-shaped band of Santa Rosa Group metasediments lie to the northeast, east and south of the reserve bounded by the Macal River.

### **Topography**

The reserve contains a wide range of landforms and topographic features. Elevation within the reserve is at a maximum 1020 m (3336 feet) at Baldy Beacon and minimum of 120 m (394 feet) on the Macal River at Black Rock. The central granite basin lies at an average elevation of between 400-700 m (1312-2296 feet).

The limestone area in the west of the reserve displays typical karstic topography with moderately rough landforms and steep slopes. Sink-holes and cave systems are frequent. The central granite basin has in the west extremely flat level areas thought to result from the presence of a lake induced by poor drainage caused by the limestone mass to the west. From west to east the central granite basin displays increasingly broken and rough topography from these flat areas through rolling features to frequently dissected steep sided hills. The metasediments in the east contain rough to very rough topography. Valleys are very steep sided, often over 35°.

With the exception of a small number of streams in the north east of the reserve, which flow into the Upper Barton Creek, all rivers flow into the Macal River or Eastern Branch. All rivers eventually discharge into the Belize River.

### **Soils**

The soils of MPRFR have been surveyed on three occasions by; Wright *et al* (1959), Hartshorn *et al* (1984) and King *et al* (1992). A preliminary version of this latest analysis was used in the preparation of the 1990 inventory (Sandom 1990).

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The majority of the reserve consists of two soil suites - Stopper and Ossary. Much smaller areas are classified as belonging to the Melinda and Vaca suites. Spatially these suites are arranged as follows - the Melinda suite in river valleys on the Macal River or its tributaries, the Vaca suite is located on the limestone area in the west of the reserve, the Stopper suite overlying the granite basin in the central section of the reserve and the Ossory situated in the eastern part of the reserve overlying the metasediments.

Within these suites several subsuites exist. The Ossory includes all soils derived from the Santa Rosa Group of metasediments. Within the reserve four subsuites are present. Of greatest extent is the Cooma subsuite. Consisting of sandy to sandy clay soils these are relatively deep but suffer from base and nutrient deficiencies. Closely related is the shallower Chiquibul subsuite. These soils are vulnerable to erosion. King *et al* (1992) suggested these soils are best left under natural vegetation. The Baldy subsuite is represented in the reserve by the soils of the grassland around Baldy Beacon. These soils are extremely acid and leached resulting in marked nutrient deficiency.

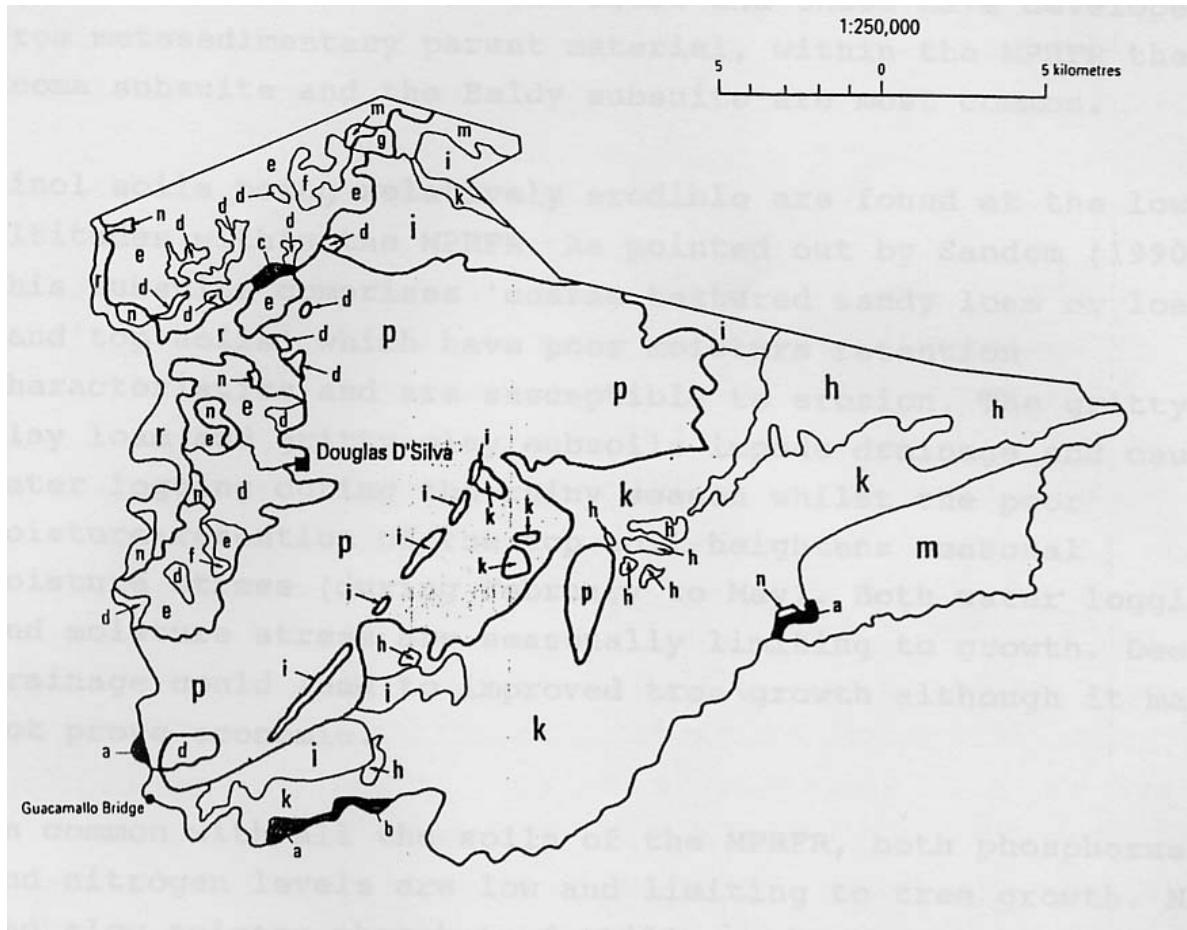
The Stopper suite includes all soils derived from granitic parent material. The largest subsuite is the Pinol subsuite and consists of sandy loams to sandy clay loams. These acid soils are well leached, are base deficient with very low phosphorus levels.

The third largest suite, the Vaca suite contains calcareous clays derived from limestone parent material. Only one subsuite exists - the Cuxu subsuite. Debate exists whether this subsuite should be incorporated into the Chacalte suite. Soils are frequently thin overlying hard fractured limestone, which is frequently exposed. Deeper Cuxu soils elsewhere in Belize have been used for agriculture; however problems have been encountered due to the soils extreme droughtiness.

The final Melinda suite covers a very small area within the reserve and consists of soils developed in riverine alluvium. These are differentiated by age and presence of siliceous and/or calcareous alluvium.

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Figure 2 : Soils Map & Legend



SOILS		
Type		Suite
a	Canquin	MELINDA
b	Monkey River > Canquin	
c	Canquin + Stony Canquin	
d	Cuxu	CHACALTE
e	Shallow Cuxu	
f	Grandoro + Cuxu	
g	Grandoro + Chacalte	
h	Baldy	OSSORY
i	Cooma	
k	Cooma + Chiquibul	
m	Cabbage Haul > Curassow	
n	Stopper	STOPPER
p	Pinol	
r	Powder Hill + Mayflower	

**Climate**

The general climate of Belize shows two distinct seasons. A dry season prevails between February and May and a wet season from June to January. The latter part of the dry season is often punctuated by electrical storms, which increase in severity and frequency until the beginning of the rains. This has a major impact on MPRFR through the incidence of wild fires.

Belize has been repeatedly affected by hurricanes. Within the last 200 years 18 have impacted on Belize, with severe damage being caused in 1961, by Hurricane Hattie (Friesner 1993).

Readings from DDFS and Cooma Cairn (in the north east of the reserve at 920 m elevation) meteorological stations have been incomplete over the past few years. However meteorological data taken from King *et al* (1992) is sufficient for forestry planning purposes.

Total rainfall at DDFS is 1559 mm (61 in) and at Cooma Caim 2101 mm (83 in). The distribution of this rainfall is markedly uneven through the year. During the dry season, February to May monthly rainfall can be less than 100 mm (4 in). From the beginning of the wet season in June rainfall increases to a monthly maximum in September/October of 250 mm (9.5 in), then declines slowly until the dry season commences in February.

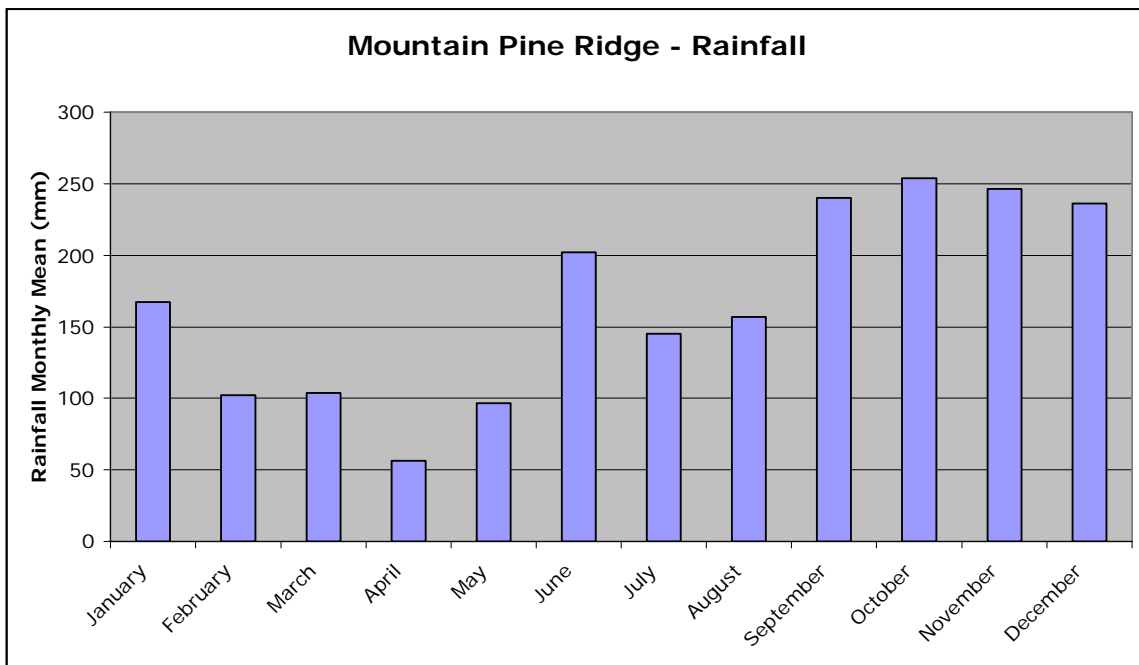


Chart 1 : Mean rainfall at Bull Run 1980 – 1994

Temperature readings have also been recorded at DDFS and Cooma Cairn giving mean annual maxima of 29°C and 25°C and mean annual minima of 19°C and 17°C for DDFS and Cooma Cairn respectively. Record extremes of temperature are 39°C and 6°C for DDFS and 36°C and 7°C for Cooma Cairn.

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Average monthly temperature figures show that January is the coolest month with a steady rise in temperature through the dry season until May and the advent of the wet season. Thereafter temperatures decrease until the January minimum.

### **Endangered Species**

No endangered species have been identified within the MPR area. Overall impacts for pine dependent species in the area should be positive, while maintaining more than adequate habitat for grassland and fire dependent species.

The current environmental conditions of the MPR area are far from ecological equilibrium. Fire protection, beginning in the 1950's, resulted in significant increases in the population density of pine in the area, resulting in a change from a fire dominated savannah to a dense pine forest. Failure to adequately manage this forest resulted in the oversupply of older age classes of trees, which combined with drought caused the epidemic outbreak of Southern Pine Bark Beetle at a much higher level of intensity and impact than would have occurred in the natural savannah ecosystem. This has eliminated *Pinus caribaea* from large portions of the MPR Forest Reserve.

MPR is an ecological island. An outcropping of ancient granitic bedrock, its soils support a unique ecosystem. Similar discontinuous areas are scattered in other areas of Central America. The dense forest conditions prevailing prior to the bark beetle outbreak had undoubtedly reduced or dramatically changed habitat conditions for a number of savannah-adapted species. However, these impacts were not documented.

The bark beetle infestation has moved the ecosystem to the other extreme. Eliminating the pine has eliminated food and habitat features for a significant number of species. Lodge operators within the reserve have noted reductions in bird population since 2000. Increases in soil loss have also been noted in some areas where grass cover response has been poor.

The proposed project activity will not restore the natural savannah ecosystem that existed prior to fire control. However, it will restore a critical ecosystem component to the area. Because only a portion of the area will be planted, the project will result in a mix of dense pine areas within a larger grass dominated ecosystem. This mix will be more similar to the natural savannah than either the uniform dense pine forest under fire control, or the dead pine forest since the bark beetle outbreak.

### **Hydrology**

Detailed hydrologic studies have not been undertaken in the area. However, anecdotally, there has been an increase in soil erosion since the bark beetle outbreak in 2000. No negative impacts on soil erosion or water quality are expected from the project. Typically, forests reduce run-off peaks, and improve water quality through filtration and reduction of erosion. The changes in the hydrograph from the area are expected to positively impact the hydroelectric project currently being undertaken on the river that forms the southern border of the area.

<b>A.4.2. Species and varieties selected:</b>
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The native species *Pinus caribaea* var. *hondurensis* is to be re-established with the original Mountain Pine Ridge provenance. Seed of this provenance is to be supplied by the Government of Queensland, Australia, where the provenance has been preserved as a source of seed for the Queensland forest industry. (See appendix 6).

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**A.4.3. Specification of the greenhouse gases (GHG) whose emissions will be part of the proposed A/R CDM project activity:**

Greenhouse gases accounted: CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O.

**A.4.4. Carbon pools selected:**

Above ground biomass, below ground biomass

As allowed in the baseline methodology, some carbon pools are not being accounted, since opting not to account for these pools is conservative in terms of carbon pool accounting.

Dead wood and litter are not included for the following reasons

- Rot rates and processes for the existing high levels of deadwood originating from the beetle kill of the previous pine trees in the ecosystem will not differ between the baseline and project scenarios.
- Levels of new deadwood and litter inputs and retention are expected to be higher under the project scenario than the baseline scenario due the establishment of the pine plantations, and to fire control. Thus not accounting for deadwood and litter represents a conservative approach

Soil organic carbon is not included for the following reasons:

- Current soil organic carbon content of the Mountain Pine Ridge area is low. The soils in this area are generally shallow, coarse soils sitting on impermeable compacted layers, with low SOC content.
- The native grasses are fire prone bunch grasses which contribute less SOC than would other grass species
- Conversion to pine forest is not expected to change SOC content significantly. Under the Project Activity some increase in SOC is anticipated over time with increased litter incorporation, therefore leaving SOC out of the methodology is a conservative approach.

**A.4.5. Compliance with the definition for afforestation or reforestation:**

The Government of Belize has indicated that they will select a minimum tree crown cover value of **30%**, a minimum land area value of **0.05** ha, and a minimum tree height of **5m**.

Sandom in the survey of 1989 classified the entire area of the MPR into cover classes, with cover class C corresponding to areas with less than 30% crown cover in 1989, and cover class G corresponding to Grass, with or without scattered pine.

Recent surveys are identifying those areas which still have crown closure below 30% in 2005, and are still not expected to exceed that level. The pine bark beetle attack of 2000 did not affect the young trees (< 15 years old), and thus allows us to estimate today what the regeneration since 1989 has been. Where areas have not reached 30% crown closure during that period, including both the regeneration layer today and the mature layer which was left as of 1989, and are clearly not on track meet that target, we can conclude that they do not meet the standard for expectation of regeneration, and are eligible for A/R CDM project activity.

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**A.4.6. A description of legal title to the land, current land tenure and land use and rights of access to the sequestered carbon:**

Mountain Pine Ridge Forest Reserve has been under the protection of forest legislation since 1944. The legal status is forest reserve as defined under the forest ordinance, chapter 115 of the laws of Belize. It was first so proclaimed under Statutory Instrument No. 56 of 1944 and amended by SI No. 65 of 1944. These two SI's were cancelled when new boundaries were proclaimed under SI No. 19 of 1959, which in turn was also cancelled when revised boundaries were proclaimed under SI No. 49 of 1977.

The Government of Belize has assigned the rights of access to the sequestered carbon to Silviculture Belize Ltd. (see appendix 9).

**A.4.7. Type(s) of A/R CDM project activity:**

Afforestation and Reforestation:

The establishment of forests on lands deforested as of Dec 31 1989, using application of either seed or seedlings, together with activities designed to increase the survival and/or growth of the trees.

**A.4.8. Technology to be employed by the proposed A/R CDM project activity:**

**Genetics**

The native species *Pinus caribaea var. hondurensis* is to be re-established with the original Mountain Pine Ridge provenance. Seed of this provenance is to be supplied by the Government of Queensland, where the provenance has been preserved as a source of seed for the Queensland forest industry.

The germplasm has not been genetically modified in any way. The species is not "alien invasive". Further details are given in Appendix 6.

**Nursery Practice**

Modern container nursery technology is to be transferred by Canadian specialists to Belizean technicians through 'hands on' training. Equipment has been sourced from Canada, USA, South Africa and Mexico.

Nursery construction utilizes local materials and labour. Nursery operation utilizes the local Mayan Indian stakeholders.

The nursery is located within the Mountain Pine Ridge Forest Reserve to provide suitable acclimatization for the seedlings. The growing seedlings are exposed fully to the environment; there are no protective greenhouses.

See Appendix 7 for photographs of the nursery system.

**Tree Planting**

The prime considerations for tree establishment are: watershed protection; wildlife habitat protection and avoidance of 'plantation' effects.

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The goal of the plantation plan is to simulate the natural conditions that would precipitate natural regeneration i.e. minimal soil disturbance (no mechanical cultivation).

The planting of seedlings will be manual, utilizing the local Mayan Indian stakeholders. The required seedling density will be achieved by training the planters to vary intertree spacing within limits to optimize the microsite selected and not by formal grid patterns as commonly applied in plantation establishment.

Gallery forests (i.e. riverine) will be preserved and where appropriate pine seedlings will be underplanted to restore the natural composition of these areas.

Planting tools have been manufactured locally with technology transferred from North America by professional foresters. Seedling transport containers have been sourced from neighbouring Guatemala.

**Silviculture Treatments**

There will be no applications of chemical herbicides to release seedlings from competing weeds. Manual slashing will be carried out where necessary.

There will be applications of inorganic fertilizers (DAP) to mitigate phosphorus deficient soils and ensure tree establishment.

Thinnings will yield merchantable timber. However, no additional roadworks will be required and thinning technology from South Africa will be applied to minimize site impact. Local operators will be trained in the use of modern plantation thinning technology.

**A.4.9. Approach for addressing non-permanence:**

Issuance of I-CERs

**A.4.10. Duration of the proposed A/R CDM project activity / Crediting period:**

**A.4.10.1. Starting date of the proposed A/R CDM project activity and of the (first) crediting period, including a justification:**

August 2002– planting began with a Government of Belize funded trial designed to yield initial fungible credits which would assist the reforestation of the remaining area. Planting was undertaken specifically to generate Kyoto eligible carbon sequestration, and certificates were issued by the Government of Belize at that time to allow the sale of the credits.

**A.4.10.2. Expected operational lifetime of the proposed A/R CDM project activity:**

30 years

**A.4.10.3. Choice of crediting period and related information:**

**A.4.10.3.1. Renewable crediting period, if selected:**

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**A.4.10.3.1.1. Starting date of the first crediting period:**

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**A.4.10.3.1.2. Length of the first crediting period:**

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**A.4.10.3.2 Fixed crediting period, if selected:**

**A.4.10.3.2 .1. Starting date:**

Aug 1 2002

**A.4.10.3.2.2. Length:**

30 years

**A.4.11. Brief explanation of how the net anthropogenic GHG removals by sinks are achieved by the proposed A/R CDM project activity, including why these would not occur in the absence of the proposed A/R CDM project activity, taking into account national and/or sectoral policies and circumstances:**

The project activity of reforestation will sequester carbon by the process of photosynthesis removal of carbon dioxide from the atmosphere. As the forest matures, sequestration in different pools (living biomass, dead biomass, soil carbon) will increase to a theoretical maximum. In practice, silvicultural interventions and timber harvesting – timed to achieve normality – will establish a sustained level of carbon sequestration in the forest as a whole below the theoretical maximum.

The silvicultural regimes needed to attain normality will be complex and will be modified as growth performance is recorded and re-projected. The expected sequestration is based on a combination of thinning regimes and harvest rotations on an initial planting density of 1334sph (540spa) thinned at 7 years or, on the 2002 initial planting density of 865sph (350spa) without an early thinning.

In the absence of the project activity the Government of Belize (GOB) would not have the resources to restore the Mountain Pine Ridge forest. This is apparent from the lack of planting in 2003, 2004 and 2005 following the GOB exhausting available funds on demonstrating the feasibility of the project in 2002.

Financial analyses demonstrate that in the absence of funding from CDM A/R CER sales, returns are too low to attract private finance. Thus funding will not be available from either the GOB or the private sector under these conditions.

In the absence of the project activity the GOB will not have the resources to protect the area from natural wildfires. Natural processes will result in a savannah ecosystem with scattered pine, and the carbon sequestration projected above will not occur.

The Government of Belize, acting within its forest policy (see Appendix 8) has assigned the carbon sequestration rights to Silviculture Belize Ltd. for the purposes of funding the project (see Appendix 9) and will assign the management of the Forest to The Mountain Pine Ridge Forest Company Ltd.

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**A.4.11.1. Estimated amount of net anthropogenic GHG removals by sinks over the chosen crediting period:**

At the expected project size of 8700 ha there would be approximately 1,340,000 tonnes CO<sub>2</sub>e of net anthropogenic GHG removals by sinks over the 30 year crediting period.

**A.4.12. Public funding of the proposed A/R CDM project activity:**

Public funding (\$60,000 CDN) has been received from the Government of Canada through their CDM/JI office. Funding from CDM/JI Canada is additional to the Government of Canada's ODA budget.

**SECTION B. Application of a baseline methodology**

**B.1. Title and reference of the approved baseline methodology applied to the proposed A/R CDM project activity:**

No approved baseline methodology is available at this time.

A proposed new baseline methodology is being submitted: (**Afforestation/Reforestation with baseline control area(s)**).

**B.1.1. Justification of the choice of the methodology and its applicability to the proposed A/R CDM project activity:**

In the absence of an existing baseline methodology applicable to the proposed A/R CDM project activity, a new methodology has been developed for the project. The proposed methodology is applicable under the following circumstances:

1. The carbon stocks of the baseline scenario must be measurable in control areas.  
This methodology requires that the management activities comprising the baseline scenario are applied to Baseline Control Area/s, and that the carbon pools within these areas are measured on an ongoing basis.

Within the MPR area large areas are available within which conditions are the same as those within the expected A/R Activity Strata. No issues have been identified which will prevent these areas from being managed under the management plan dictated by the Baseline Scenario. The scale of these areas will allow periodic sampling within these areas to meet the required statistical precision for the means of the variables measured.

2. It must be possible to establish Baseline Control Areas which are representative.  
This methodology is based on stratified systematic sampling in Baseline Control Area/s and in the Project Activity Area/s., both of which lie within the project boundary. The Baseline Control Area/s must be statistically representative of the Project Activity Area/s conditions.

As discussed above, large areas are available where conditions are the same as those expected within the A/R Activity Strata. Prior to commencement of management, sampling of both A/R Activity Strata and proposed Baseline Control Areas will be

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undertaken to ensure that the areas are part of the same population for all key variables at a 95% confidence level.

3. It must be possible to manage the Baseline Control Area/s with the techniques and intensity required by the baseline scenario throughout the crediting period.

The baseline scenario consists of natural ecosystem processes, with disturbance processes dominated by occasional fires, mostly of anthropogenic origins (originating from military training activities). Emulation of fire return intervals and intensity within the Baseline Control Areas can be undertaken using controlled burning.

4. It must be possible to ensure that management of the Baseline Control Area/s is not subject to the risk of management bias leading to apparent reduced carbon pools under the baseline scenario.

The second option proposed in the Baseline Methodology, appointment of an independent accredited auditor acceptable to the Designated Operational Entity responsible for Verification, will be used to ensure that the management of the Baseline Control Areas is not subject to management bias.

The Mountain Pine Ridge Forest is intensively mapped and all discrete project areas delineated. The Baseline Scenario can be measured on representative areas within the geographic boundary of the project. Management of these Baseline Control Areas to match the baseline scenario is possible.

**B.2. Description of how the methodology is applied to the proposed A/R CDM project activity:**

The methodology is applied in the following steps to determine the baseline scenario for the proposed A/R CDM activity:

The proposed new baseline methodology consists of the following steps, consistent with the chosen baseline approach:

- 0) Analyze the socio-economic and policy context

Method:

- a) Assess the existing and historical land use patterns in the region to identify the factors influencing the land use, including biophysical, socioeconomic and policy variables. Undertake this assessment in light of policy, tradition, market, infrastructure and other factors. This assessment may use multiple sources of data, e.g. government policy documents, primary data from field studies, socioeconomic surveys, interviews, participatory assessments, and secondary data from official records, archived information, aerial photographs and related evidence.
- b) Assess the significance of the existing land use for the local economy and evaluate the policy and market mechanisms that influence land use. Include assessment of both market and subsistence uses.

- 1) Delineate the Assessment Area

Method:

- a) Identify the Assessment Area in terms of legal property boundaries, geo-referenced points, natural features, or other means. The Assessment Area is that area within which steps 2 through 5 are undertaken. All areas included within the project boundary in step 6 must have been within the Assessment Area..

- 2) Determine the eligibility of the project area

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Method:

**Eligibility Tool**

- a. Determine the definition of a “forest” as selected by the national DNA.
- b. Determine whether some or all of the area/s within the Assessment Area were deforested as of December 31 1989, based on the above definition. The resources to be used to make this determination include:
  - Analysis of satellite or aerial photography. For satellite imagery, Landsat images should generally be available within the 6 month period preceding Dec 31 1989. If not, the most recent image preceding that period should be used. Analysis should where possible include use of control areas where image characteristics can be compared to known land conditions. Analysis should follow normal, widely accepted procedures for multi-spectral analysis. (See for example Barrett & Curtis 1992)
  - Existing records, including but not limited to tax and property records, land use mapping, and agricultural, forestry and other authoritative studies.
  - Interviews with local people regarding land use and history.

Wherever possible, two or more of the resources listed should be used in conjunction to make the determination.

If some or all of the area/s within the Assessment Area are found to be deforested as of December 31 1989, proceed to step c).

- c. Determine whether or not the area/s deforested in December 31 1989 are currently deforested.<sup>2</sup> Analysis of current status should generally be on the basis of field surveys. Surveys must meet standard forestry mensuration standards for unbiased sampling, and must determine both crown closure and tree height to a 95% confidence interval. In some cases, where access or other constraints make field surveys difficult, determination may be made using time series aerial or satellite imagery as per b) above.
- d. Determine, for area/s which were not forested as of Dec 31 1989 and are currently not forested, but were normally part of the forest area, whether those areas were temporarily unstocked due to harvesting or natural causes and are expected to revert to forest. The resources to be used to make this determination include those identified in b) above, as well as:
  - Surveys and studies of the area/s in the period between Dec 31 1989 and the present
  - Studies of vegetation succession or management on parallel sites.
  - Policy, socio-economic, and biological data.

In a reforestation context, the fact that some temporary reversion to forest has occurred in the period between 1989 and the present is not in and of itself sufficient evidence that a reasonable expectation of reversion to forest existed in 1989. However, where such a reversion has occurred, the proponent must identify specific causal changes in policy, socio-economic conditions, or environmental conditions which occurred subsequent to 1989 and which were significant drivers in the reversion.

If an area or areas were deforested as of December 31 1989 (step b), are currently not forested (step c), were not on their way to becoming a forest due to natural or artificial processes as of December 31 1989, and were not reasonably expected at that time to revert to forest (step d), they are eligible areas for A/R projects.

- 3) Determine the additionality of the proposed Project Activities within the strata of the Assessment Area.

Method: Additionality is determined using the CDM Additionality Tool detailed in E.3. below.  
Note that completion of this step may be simultaneous with steps 4 and 5 below, since these

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<sup>2</sup> This is a requirement of the ARWG and not a COP decision. To avoid the perverse incentive presented by this stipulation this tool seeks evidence of recent harvesting by analysis of recent time series aerial or satellite imagery.

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steps are closely interdependent. The additionality assessment should be undertaken on individual strata or groups of strata, rather than on the Assessment Area as a whole, in cases where step 1 of the Additionality Tool produces a different set of alternatives for different strata.

4) Define the baseline scenario/s

Method:

- a) Identify a the most probable land use that represents an economically attractive course of action, taking into account barriers to investment, in the absence of CDM CER credits, for each stratum within the Assessment Area. A project area may include more than one stratum, depending on factors including:
- Soils and site characteristics
  - Climate
  - Local infrastructure and common practice

Identifying strata is undertaken in step 5, below, and work undertaken in this stage may in turn influence step 5, consequently these two stages, as well as step 3, above, should be completed simultaneously. The Baseline Scenario shall be the most probable land use for each stratum.

Identification of the most probable land use shall be undertaken as follows:

**Baseline Scenario Tool**

- i. Complete steps 1 through 4 of the Additionality Tool..
  - ii. The most probable land use shall be that alternative to the project activity, consistent with current laws and regulations and national and sectoral policies, which is one of the possible land uses identified in step 1 of the Additionality Tools, and which meets the following criteria:
    - a. Is the course of action providing the highest financial return (step 2 of the Additionality Tool, using Investment Analysis), which also
    - b. Does not face barriers which would prevent its implementation (step 3 of the Additionality Tool) and
    - c. Is Common Practice to the extent that other activities implemented previously or currently underway are similar to the land use in question. Land uses are considered similar if they are in the same country/region and/or rely on a broadly similar technology, are of a similar scale, and take place in a comparable environment with respect to regulatory framework, investment climate, access to technology, access to financing, etc. (Step 4 of the Additionality Tool)
- b) For each stratum with a discrete Baseline Scenario, develop a Baseline Management Plan which defines the sequence, method, timing and intensity of the most likely management actions or natural events which would be undertaken or would occur on the area under the baseline scenario. This Plan must take into account
- Local standard practices and methods
  - Local resources
  - Impact of technological and other change on local practices and methods
  - Anticipated availability of capital for management under the Baseline Scenario

The Baseline Management Plans will be used to manage the Baseline Control Area/s. The Baseline Management Plan must detail the timing, intensity, frequency and methods for each action with sufficient specificity that an independent auditor can reasonably assess whether or not management of the Baseline Control Areas has conformed to the Baseline Management Plan. The Baseline Management plan represents the most reasonable plan for achieving the Baseline Scenario in the Baseline Control Areas.

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The work undertaken in step a), above, shall be reassessed every 5 years. Where the assessment reveals that a different land use is now the most probable use within a stratum or strata, and therefore that a new Baseline Scenario exists for those strata, a new Baseline Management Plan must be developed (step b), above) and put into action within the Baseline Control Area, ensuring that the measurements of the control area continue to be measurements of the most probable land use. This periodic re-assessment of the Baseline Scenario is a key strength of the methodology.

5) Stratify and sample the Assessment Area

Method:

a) Develop basic stratification of the Assessment Area from existing resources

i) Identify factors limiting land use

Method:

Within the Assessment Area

A) Identify and map current land uses

Resource/approach: Information may be drawn from:

- Paper and digital mapping of the land uses of the area/s
- Analysis of satellite or aerial photography
- Existing records and studies of land use and land capability
- Local knowledge and site surveys

B) Identify and map soil and topographic types

Resource/approach: Information may be drawn from:

- Paper and digital soil mapping
- Existing records and studies of soils
- Soil surveys undertaken by the proponent

C) Identify and map climatological zones

Resource/approach: Information may be drawn from:

- Paper and digital climate mapping
- Existing records and studies of climate
- Records from local climate stations

D) Identify and map areas with national and/or sectoral policy and circumstance, socio-cultural, and/or logistical limitations

Resource/approach: Information may be drawn from:

- Socio-economic studies of the area
- Maps of land status, protected areas, etc.
- Local, regional, national and international legislation and regulation
- Census data and regional and national economic data
- Local knowledge and site surveys

ii) Identify land use criteria

Method: For the full range of current land uses in the Assessment Area, and other land uses which might reasonably be considered for the area, given current practice and technical and capital capacity, identify the limiting factors for that land use in terms of soil, climate, sociocultural, policy and logistical factors.

Resource/approach: Information may be drawn from:

- Interviews with local people on local practice
- Published information on requirements for particular crops or management regimes
- Testimony of experts in specific land use systems

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- National and/or sectoral policy documents or studies
- Economic analyses of resource and logistical requirements

iii) Map the boundaries where limiting factors come into play for all land uses examined  
Method: Utilizing the data gathered in Steps 2 and 3, map the boundaries within which land is eligible for particular crops or management regimes.

iv) Map the stratum boundaries  
Method: Based on the land use boundaries determined in step iii, and the work undertaken in steps 3 and 4, determine initial stratum boundaries based on the most likely baseline scenarios. This process is completed iteratively with steps 3 and 4 until complete.

b) Confirm stratification with onsite sampling

Resource/approach: Based on the initial stratification, undertake systematic sampling to determine variability within the strata, and the need for further stratification. Sampling may be undertaken using line intersect methods combined with fixed area plots to identify boundaries and variability, or may use such other techniques as are considered suitable. This sampling is for the purpose of identifying stratum boundaries on the ground, rather than the determination of quantitative data, and is not subject to statistical analysis.

c) Develop final stratification map

Resource/approach: Utilize field sampling to determine whether or not strata based on existing information are discrete, and whether or not each existing stratum is sufficiently homogenous. The degree of homogeneity which is reasonably achievable will vary from project to project, and will be subject to qualitative rather than quantitative assessment, taking into account:

- Minimum practical stratum size in the context of the project
- The degree of natural variability in the area
- The significance of the variability to the project and baseline scenarios

Although factors such as soil, climate, etc., may be critical determining factors, final stratification will be based only on the factors contained in the following hierarchical list. The stratification process will begin with stratification according to differences in the Baseline Scenario, if any, and only once each stage is complete will stratification at the next level down commence. At each step in the hierarchy, stratification will only occur within the strata determined at the next level up, and will not cross strata boundaries determined at higher levels.

- i) Baseline Scenario – areas with different Baseline Scenarios, as determined in step 4 above.
- ii) Project Management Regime or Project Management Plan for a stratum – within an area with a common Baseline Scenario, areas with different management regimes under the Project Scenario, including substantially different species or species groups, different reforestation methods, and other factors
- iii) Projected carbon sequestration rates – within areas with the same Project Management Plan for a stratum where rates of carbon sequestration in measured carbon pools are expected to be significantly distinct due to soil, moisture, topography, or other factors.

Develop a final stratification based on the criteria above, and map these strata. These

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final strata will be the A/R Activity Strata for the project.

d) Identify and map Baseline Control Areas

Baseline Control Areas are managed in accordance with management plan under the baseline scenario, and are sampled to provide the data required to quantify the carbon pools under the baseline scenario. No net anthropogenic GHG removals by sinks can be accounted from these areas. However, management emissions may be generated within these areas.

Resource/approach:

- i) For each A/R Activity Stratum (or group of such stratum, where a single Baseline Control Area is applicable to more than one A/R Activity Stratum), determine the minimum area of the Baseline Control Area within which the sequence of management actions laid out in the Baseline Management Plan for the applicable Baseline Scenario can be practically undertaken.
- ii) Based on an analysis of expected variability within each Baseline Control Area under its Baseline Management Plan, calculate the minimum number and size of baseline samples for each Baseline Control Area which will be required to achieve an accuracy of +/- 5% in the mean value of the key variables to a 90% confidence level
- iii) Determine the minimum area of Baseline Control Areas for each stratum, which meet the limits identified in steps i and ii above allowing for appropriate buffer areas around and between plots. The size of these buffer areas will depend on the degree of boundary and other effects expected.
- iv) For each stratum, identify and map Baseline Control Area/s with an extent equal to or greater than the minimum Baseline Control Area identified in iv) above. Baseline Control Areas should be chosen to conform in characteristics as closely as possible to the mean characteristics of the stratum.

6) Delineate the project boundary

“The “project boundary” geographically delineates the A/R CDM project activity under the control of the project participants. An A/R CDM project activity may contain more than one discrete areas of land. If an A/R CDM project activity contains more than one discrete area of land:

- Each discrete area of land should have a unique geographical identification;
- The boundary should be defined for each discrete area and should not include the areas in between these discrete areas of land.”

The area within the project boundary shall consist only of those areas within the Assessment Area which meet the following criteria:

A/R Activity Strata:

- a) Are eligible, as determined in Step 2 and
- b) Meet the Additionality test, as determined in step 3 and
- c) For which a Baseline Scenario and Baseline Management Plan have been defined in step 4 and
- d) Will be reforested or afforested by the project

Baseline Control Area/s

- e) Will be used as Baseline Control Area/s for A/R Activity Strata meeting criteria a through d above.

7) Establish systematic Permanent Sample Plots in the Baseline Control Areas and A/R Activity Strata prior to commencement of management, and gather all required data from these plots. Resample these

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plots with the specified frequency there-after.

Method: Utilize sampling methods as defined in the Monitoring Methodology associated with this Baseline Methodology.

8) Establish a systematic program to allow fine tuning of variables to local conditions as required.

IPCC and other sources will be routinely monitored for updates in constants and variables produced from outside data. Ongoing research within the project boundary must be undertaken as outline below to allow fine tuning of specific IPCC variables. . This research will consist at minimum of the following:

- Collection of data on root to shoot ratios for tree species grown in the project area
- Collection of data on stem volumes for tree species grown in the project area
- Collection of data on biomass expansion factors
- Collection of data on wood density

Method:

A minimum of 3 trees of each species grown in the project will be randomly chosen and destructively sampled on each verification date until the trees are 8 years old, and optionally after that time. Sampling will consist of:

- Measurement of stem diameter at 1 m intervals from 0.3 m above ground to the top of the merchantable stem, defined as the point at which the stem is 7.5cm in diameter. Where a tree is forked all stems greater than 7.5 cm in diameter shall be measured individually.
- Measurement of stem length
- Measurement of the O.D. density in  $\text{kg/m}^3$  of a slice not less than 5 cm thick taken from the tree at breast height
- Measurement of the green mass of the top and branches of the tree.
- Measurement of the ratio of green to O.D. mass for the tops and branches, measured by taking a single major branch, and weighing it both green and O.D.
- When possible, excavation of the roots of the tree, and measurement of the green mass of the tree roots
- Measurement of the ratio of green to O.D. mass for the roots, measured by taking a sample from the roots, and weighing it both green and O.D.

This research will produce the information required to allow the values of these key variables to be fine tuned to local conditions. However, continuous updating of these variables has the potential to produce problems with time-series consistency. Although in general use of updated variables will have the likely effect of increasing the accuracy of carbon pool estimates, updating of the variables used in carbon pool calculations is optional. Where a choice is made to update the variables, updating may only be done under the following conditions:

- Where the quality and statistical precision of the gathered data has been reviewed by an independent assessor and been found to be consistent with generally accepted scientific standards
- Where the updated variables will not fall outside the minimum and maximum values found in the literature for the variable in question

Whether or not updating is undertaken, the methods and results of the research described above must be reported in the verification documentation, to allow future projects access to the data.

9) For each carbon pool in the Baseline Control Areas and A/R Activity Strata, calculate the total carbon stock per hectare.

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Method: Utilize formulae given below and in the associated Monitoring Methodology

10) Calculate the total increase in GHG emissions by sources that are increased due to the A/R activity.

Method: Utilize formulae given below and in the associated Monitoring Methodology

11) Calculate the actual net anthropogenic greenhouse gas removals by sinks

Method: Utilize formulae given below and in the associated Monitoring Methodology

12) Calculate leakage directly attributable to the project activity for each time period.

Method: Utilize the leakage tools and equations given in E.6.

13) Calculate the net anthropogenic GHG removals by sinks for each time period.

Method: Using the nested algorithms below.

The proposed methodology, using these steps, systematically quantifies accounted carbon pools, emissions and leakage associated with the project. The methodology includes a continuous quality improvement program based on monitoring and research plots which will continually fine tune the variables used in calculating the net anthropogenic GHG removals by sinks. The method relies on actual measurements of both the project and baseline scenarios to remove the requirement for extrapolative estimation of the baseline scenario.

**External Data Used:**

**Soil mapping**

Compiled by: Selva Maya Ecoregional Planning Process (The Nature Conservancy)

Base maps: 1959, 1:250,000 hardcopy map developed by Wright.

Base map creation: Base maps were created off aerial photography and extensive ground truthing.

Funding and photography provided by UK-ODA.

**Ecosystem mapping**

Compiled by: Jan Meerman and Wilber Sabido, Programme for Belize

Base maps: 1959 Wright vegetation map, 1994 Brokaw/Iremonger vegetation map, Bruce King's 1993 landuse maps, 1998, 1999, 2000 satellite imagery (composite).

Base map creation: Ground surveys and refinement of existing vegetation classes. In addition to use of 1994 Brokaw/Iremonger digital coverage whose vegetation classes were modified based on UNESCO classification system and vegetation boundaries based on existing ground data and available satellite imagery.

**Forest cover mapping 1989/90**

Compiled by: J Sandom

Base Maps: 1989/90 J Sandom, Johnson and Chaffey 1970 inventory

Base map creation: From photo interpretation of 1:12500 aerial photographs, ground checked with 300 – 40 by 50 m ground plots, systematically distributed

**Biomass expansion factors for the plantation species:**

IPCC GPG for LULUCF 3A.1.10

**GHG emissions from fuel use in power equipment:**

Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories

**Global warming potential conversion constants for CH<sub>4</sub> and N<sub>2</sub>O:**

IPCC

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Carbon Fraction of Dry Matter – Living biomass  
IPCC GPG for LULUCF Page 3.25

Carbon Fraction of Dry Matter – Litter  
IPCC GPG for LULUCF Page 3.35

Root to shoot ratio  
IPCC GPG for LULUCF 3A.1.8

Plantation species wood density  
Measured values for plantation *Pinus caribaea* of the MPR genome from PLUMPTRE, R.A. (1978).  
“Variation in wood density of *Pinus caribaea* var. *bondurensis* Barrett and Golfari grown in plantations”

**B.3. Description of how the actual net GHG removals by sinks are increased above those that would have occurred in the absence of the registered A/R CDM project activity:**

The Additionality Tool demonstrates how actual net GHG removals by sinks are increased above those that would have occurred in the absence of the registered A/R CDM project activity:

**Step 0. Preliminary screening based on the starting date of the project activity**

(a) The starting date of the project is August 1 2002

(b) The project was commenced using seed money from the Government of Belize, which was explicitly granted with the intention of providing a basis for funding the rest of the project with funds from CDM CER sales. This intention was demonstrated by the issuance of a carbon credit assignment certificate to Silviculture Belize Ltd. at that time. (see Appendix 9)

**Step 1. Identification of alternatives to the project activity consistent with current laws and regulations**

Define realistic and credible alternatives to the project activity(s) that can be (part of) the baseline scenario through the following sub-steps:

***Sub-step 1a. Define alternatives to the project activity:***

The realistic and credible alternative(s) available to the project participants or similar project developers that provide outputs or services comparable with the proposed CDM project activity are:

1. Replanting of areas in the MPR Forest reserve with *Pinus caribaea*, not undertaken as a CDM project activity
2. Continuation of the current situation (No management)

Other plantation options, such as hardwood or citrus plantations, are not an option for the Mountain Pine Ridge area, as the soils are not suitable for these activities (coarse, acidic, low in nutrients and organic matter, droughty) Likewise, the area has no potential for agricultural crops. Furthermore, as a designated Forest Reserve the land use is restricted to forestry.

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***Sub-step 1b. Enforcement of applicable laws and regulations:***

Both alternates are consistent with the current regulation and policy applying to the Mountain Pine Ridge Forest Reserve.

***Proceed to Step 2 (Investment analysis) or Step 3 (Barrier analysis). (Project participants may also select to complete both steps 2 and 3.)***

**Step 2. Investment analysis**

The proposed project activity without the revenue from the sale of certified emission reductions (CER's) is alternative 1, given above. This alternative gives very low returns, with negative NPV's at realistic return rates. Alternative 2 gives no returns, and an NPV of \$0.

***Sub-step 2a. Determine appropriate analysis method***

Benchmark analysis (Option III) is the appropriate analysis method for this project

***Sub-step 2b – Option III. Apply benchmark analysis***

Both IRR and NPV are appropriate financial indicators for this project. NPV has been chosen as the primary indicator.

The relevant benchmark value has been set at 15%, which represents the reasonable minimum required by a private equity partner for this type of project

***Sub-step 2c. Calculation and comparison of financial indicators (only applicable to options II and III):***

Analysis of the project without sales of CER's gives an NPV of -\$12.1 million. The second alternative, no management, gives no NPV. The project with CER sales shows an NPV of \$3.7 million

***Sub-step 2d. Sensitivity analysis (only applicable to options II and III):***

The only revenue stream for the alternate scenario is derived from sales of timber. Sensitivity analysis was undertaken with prices for timber from the MPR area as the variable tested. Even with the price of the timber doubled, the NPV of the alternate scenario is still -\$6.3 million.

***– If after the sensitivity analysis it is concluded that the proposed CDM project activity is unlikely to be the most financially attractive (as per step 2c para 8a) or is unlikely to be financially attractive (as per step 2c para 8b), then proceed to Step 3 (Barrier analysis) or Step 4 (Common practice analysis).***

Based on the analysis, the proposed CDM activity in the absence of revenue from CER sales would not be undertaken. Leaving the area unmanaged is the only realistic alternative to undertaking the project with revenue from CER sales. The unmanaged site therefore constitutes the baseline for this project.

***– Otherwise, unless barrier analysis below is undertaken and indicates that the proposed project activity faces barriers that do not prevent the baseline scenario(s) from occurring, the project activity is considered not additional.***

**Step 3. Barrier analysis**

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Barrier analysis was not undertaken for this proposed CDM activity, as the Investment Analysis step demonstrated that the project was not viable without Sales of CER's.

**Step 4. Common practice analysis**

*Sub-step 4a. Analyze other activities similar to the proposed project activity:*

The only activity of this type identified in Belize was the initial planting within the MPR area, which forms part of this project. Other plantation projects have fallen into one of two types clearly differentiated from this project:

- Commercial precious hardwood plantations. The economics of these plantations are not parallel to the proposed CDM project, due to the vastly higher value of the product produced
- Commercial fruit tree orchards. Orange and other citrus and tropical fruit orchards are common in Belize, but rely on revenues from fruit production, rather than timber.

The soils in the Mountain Pine Ridge area are not suitable for either of these alternate plantation types and the land use of the Forest Reserve is restricted by legislation.

*Sub-step 4b. Discuss any similar options that are occurring:*

No similar options are occurring

**Step 5. Impact of CDM registration**

As discussed above, the primary impact of CDM registration on the project is the financial benefit of the revenue obtained by selling CER's. Without these benefits the project would not be viable.

<b>B.4. Detailed <u>baseline</u> information, including the date of completion of the baseline study and the name of person(s)/entity(ies) determining the <u>baseline</u>:</b>
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Current baseline study: Version 3.4, completed Mar 30 2005. Lead Author: Robert Seaton, Brinkman & Associates Reforestation Ltd.

Note: The current baseline study is incomplete for two reasons

- 1) Further fieldwork is required to complete detailed stratification of the project area.
- 2) Further research is required on fire return intervals and other key variables

It should be noted that the proposed Baseline Methodology is based on actual sampling of the baseline scenario throughout the project crediting period. For this reason, the baseline study is indicative only, and does not form the baseline that will be used for crediting purposes.

The current baseline study projects the following net levels of CO<sub>2</sub>e, in t/ha under the baseline scenario:

Year	t/ha
2002	25.1
2003	25.2

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2004	25.3
2005	24.3
2006	23.5
2007	22.7
2008	21.8
2009	20.9
2010	20.1
2011	19.5
2012	19.6
2013	19.7
2014	19.7
2015	19.8
2016	19.9
2017	19.9
2018	20.0
2019	20.1
2020	20.2
2021	20.2
2022	20.3
2023	20.4
2024	20.4
2025	20.5
2026	20.6
2027	20.6
2028	20.7
2029	20.8
2030	20.8
2031	20.9
2032	21.0

The initial projected decline in carbon occurs as a result of fire, after which the ecosystem reaches a steady state, with slow increases as a result of the few trees able to survive the fires. The current model includes only the tree, brush and grass/herb carbon pools onsite, for the reasons discussed in A.4.4. above.

**SECTION C. Application of a monitoring methodology and of a monitoring plan**

**C.1. Title and reference of approved monitoring methodology applied to the project activity:**

No approved monitoring methodology applicable to this project exists.

The proposed new monitoring methodology **Afforestation/Reforestation with baseline control area/s** is currently submitted.

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**C.2. Justification of the choice of the methodology and its applicability to the proposed A/R CDM project activity:**

The proposed monitoring methodology is based on a standard mensurational procedure for plantation forestry. The MPR reforestation project activity follows silviculture procedures without strict adherence to spatial density uniformity. The proposed monitoring methodology will deliver statistically reliable data on tree, shrub and grass layers in a managed plantation, and on emissions within the project area caused by project activities.

The monitoring methodology is cost effective and serves the dual purpose of providing growth data to allow sustainable forest management, and accurately inventorying carbon stocks and other relevant GHG effects of the project.

The methodology is applicable under the conditions of this project:

1. The carbon stocks of the baseline scenario must be measurable in control areas.  
This methodology requires that it be possible to apply the Baseline Scenario to Baseline Control Areas where it can be measured, and that the measurements must be able to be made to the level of statistical precision specified for each variable.  
  
Within the MPR area large areas are available within which conditions are the same as those within the expected A/R Activity Strata. No issues have been identified which will prevent these areas from being managed under the management plan dictated by the Baseline Scenario. The scale of these areas will allow sampling to meet the required statistical precision.
2. It must be possible to establish Baseline Control Areas which are representative.  
This methodology is based on stratified systematic sampling in Baseline Control Area/s and in the Project Activity Area/s., both of which lie within the project boundary. The Baseline Control Area/s must be statistically representative of the Project Activity Area/s conditions.  
  
As discussed above, large areas are available where conditions are the same as those expected within the A/R Activity Strata. Prior to commencement of management, sampling of both A/R Activity Strata and proposed Baseline Control Areas will be undertaken to ensure that the areas are part of the same population for all key variables at a 95% confidence level.
3. It must be possible to manage the Baseline Control Area/s with the techniques and intensity required by the baseline scenario throughout the crediting period.  
  
The baseline scenario consists of natural ecosystem processes, with disturbance processes dominated by occasional fires, mostly of anthropogenic origins (originating from military training activities). Emulation of fire return intervals and intensity within the Baseline Control Areas can be undertaken using controlled burning.
4. It must be possible to ensure that management of the Baseline Control Area/s is not subject to the risk of management bias leading to apparent reduced carbon pools under the baseline scenario.  
  
The second option proposed in the Baseline Methodology, appointment of an independent accredited auditor acceptable to the Designated Operational Entity

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responsible for Verification, will be used to ensure that the management of the Baseline Control Areas is not subject to management bias.

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**C.3. Monitoring of the baseline net GHG removals by sinks and the actual net GHG removals by sinks:**

**C.3.1. Actual net GHG removals by sinks data:**

<b>C.3.1.1. Data to be collected or used in order to monitor the verifiable changes in carbon stock in the <u>carbon pools</u> within the <u>project boundary</u> resulting from the proposed <u>A/R CDM project activity</u>, and how this data will be archived:</b>								
<b>ID number (Please use numbers to ease cross-referencing to table D.3.)</b>	<b>Data variable</b>	<b>Source of data</b>	<b>Data unit</b>	<b>Measured (m), calculated (c) or estimated (e)</b>	<b>Recording frequency</b>	<b>Proportion of data to be monitored</b>	<b>How will the data be archived? (electronic/paper)</b>	<b>Comment</b>
<b>1.1.0</b>	Stratum #	Stratification Process	Alpha numeric	N/A	Once	100%	e	
<b>1.1.1</b>	Stratum Area	Project Maps	Ha	m	Once	100%	e	
<b>1.1.2</b>	Sample Plot #	Project maps	Alpha numeric	N/A	Once	100%	e	
<b>1.1.3</b>	Plot location	Field recording	Map coordinates	m	Once	100%	e	
<b>1.1.4</b>	Plot area	Field recording at plot location	ha	m	On verification dates	100%	e	
<b>1.2.0</b>	Stems	Sample plots	count	m	On verification dates to a minimum of every 5 years	100%	e	
<b>1.2.1</b>	Height	Sample Plots	m	m	On verification dates to a minimum of every 5 years	Minimum 10 trees per plot	e	

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<b>C.3.1.1. Data to be collected or used in order to monitor the verifiable changes in carbon stock in the <u>carbon pools</u> within the <u>project boundary</u> resulting from the proposed <u>A/R CDM project activity</u>, and how this data will be archived:</b>								
<b>ID number (Please use numbers to ease cross-referencing to table D.3.)</b>	<b>Data variable</b>	<b>Source of data</b>	<b>Data unit</b>	<b>Measured (m), calculated (c) or estimated (e)</b>	<b>Recording frequency</b>	<b>Proportion of data to be monitored</b>	<b>How will the data be archived? (electronic/paper)</b>	<b>Comment</b>
<b>1.2.2</b>	Diameter	Sample Plots	mm	m	On verification dates to a minimum of every 5 years	100%	e	
<b>1.2.3.1</b>	Brush aboveground O.D. biomass	Sample sub-plots	kg/m <sup>2</sup>	m	On verification dates to a minimum of every 5 years	Minimum 5 plots/stratum	e	
<b>1.2.4.1</b>	Grass/Herb aboveground O.D. biomass	Sample sub-Plots	kg/m <sup>2</sup>	m	On verification dates to a minimum of every 5 years	Minimum 5 plots/stratum	e	
<b>1.3.0</b>	Deadwood & litter plot location	Sample Plots	Distance (m) + Cardinal Direction	m	On verification dates to a minimum of every 5 years	Minimum 5 plots/stratum	e	The precise location of the Deadwood & litter plots are needed to avoid re-sampling at a later verification
<b>1.3.1</b>	Deadwood & litter >1cm	Deadwood & litter plots	kg	m	On verification dates to a minimum of every 5 years	Minimum 5 plots/stratum	e	
<b>1.3.2</b>	Deadwood & litter <1cm	Deadwood & litter plots	kg	m	On verification dates to a minimum of every 5 years	Minimum 5 plots/stratum	e	
<b>1.4.0</b>	Soil sample	Sample Plots	Alpha numeric	N/A	On verification	Minimum 5	e	

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<b>C.3.1.1. Data to be collected or used in order to monitor the verifiable changes in carbon stock in the <u>carbon pools</u> within the <u>project boundary</u> resulting from the proposed <u>A/R CDM project activity</u>, and how this data will be archived:</b>								
<b>ID number (Please use numbers to ease cross-referencing to table D.3.)</b>	<b>Data variable</b>	<b>Source of data</b>	<b>Data unit</b>	<b>Measured (m), calculated (c) or estimated (e)</b>	<b>Recording frequency</b>	<b>Proportion of data to be monitored</b>	<b>How will the data be archived? (electronic/paper)</b>	<b>Comment</b>
	spot location				dates to a minimum of every 5 years	plots/stratum		
<b>1.4.1</b>	Auger diameter	Instrument	mm	m	once	N/A	e	
<b>1.4.2</b>	Soil Sample mass	Soil sample	kg	m	On verification dates to a minimum of every 5 years	100%	e	
<b>1.4.3</b>	Soil Organic Carbon	Soil samples	mg/kg	m	On verification dates to a minimum of every 5 years	100%	e	From laboratory analysis
<b>1.4.3.1</b>	SOC Laboratory method	Initial laboratory used	N/A	N/A	Once	100%	e	This method is to be used hereafter
<b>1.5.0</b>	Root to Shoot Ratio	IPCC GPG for LULUCF 3A.1.8	Ratio	e	Once	100%	e	Selected based on merchantable volume of stand at time of sampling
<b>1.6.0</b>	BEF	IPCC GPG for LULUCF 3A.1.10 and others	Ratio	e	Once	100%	e	Selected based on age of stand at time of sampling
<b>1.7.0</b>	Carbon content	IPCC GPG for LULUCF	numeric	e	Once	100%	e	Constant value
<b>1.8.0</b>	Wood	IPCC GPG	t/m <sup>3</sup>	e, m	Once	100%	e	Initial values will be

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<b>C.3.1.1. Data to be collected or used in order to monitor the verifiable changes in carbon stock in the <u>carbon pools</u> within the <u>project boundary</u> resulting from the proposed <u>A/R CDM project activity</u>, and how this data will be archived:</b>								
<b>ID number</b> <i>(Please use numbers to ease cross-referencing to table D.3.)</i>	<b>Data variable</b>	<b>Source of data</b>	<b>Data unit</b>	<b>Measured (m), calculated (c) or estimated (e)</b>	<b>Recording frequency</b>	<b>Proportion of data to be monitored</b>	<b>How will the data be archived? (electronic/paper)</b>	<b>Comment</b>
	Density	for LULUCF-authoritative sources	(O.D.Mass/wet volume)					default values per species. Default values will be fine tuned with ongoing measurements

<b>C.3.1.2. Data to be collected or used in order to monitor the GHG emissions by the sources, measured in units of CO<sub>2</sub> equivalent, that are increased as a result of the implementation of the proposed <u>A/R CDM project activity</u> within the project boundary, and how this data will be archived:</b>								
<b>ID number</b> <i>(Please use numbers to ease cross-referencing to table D.3.)</i>	<b>Data variable</b>	<b>Source of data</b>	<b>Data unit</b>	<b>Measured (m), calculated (c) or estimated (e)</b>	<b>Recording frequency</b>	<b>Proportion of data to be monitored</b>	<b>How will the data be archived? (electronic/paper)</b>	<b>Comment</b>
<b>2.1.0</b>	Fuel	Equipment logs	Litres (l)	e	Monthly	100%	e	Measured by fuel type or estimated by fuel type based on equipment hours within project area
<b>2.1.0.1</b>	Baseline Fuel	Equipment logs	Litres (l)	e	Monthly	100%	e	Measured by fuel type or estimated by fuel type based on equipment hours within Baseline Control Area

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<b>C.3.1.2. Data to be collected or used in order to monitor the GHG emissions by the sources, measured in units of CO<sub>2</sub> equivalent, that are increased as a result of the implementation of the proposed <u>A/R_CDM_project_activity</u> within the project boundary, and how this data will be archived:</b>								
<b>ID number (Please use numbers to ease cross-referencing to table D.3.)</b>	<b>Data variable</b>	<b>Source of data</b>	<b>Data unit</b>	<b>Measured (m), calculated (c) or estimated (e)</b>	<b>Recording frequency</b>	<b>Proportion of data to be monitored</b>	<b>How will the data be archived? (electronic/paper)</b>	<b>Comment</b>
<b>2.1.1</b>	Fertilizer	Management records	tonnes	m	Annual	100%	e	Recorded by fertilizer formulation used in project area
<b>2.1.1.1</b>	Baseline Fertilizer	Management records	tonnes	m	Annual	100%	e	Recorded by fertilizer formulation used in Baseline Control Area
<b>2.1.2</b>	Lime	Management Records	Tonnes	M	Annual	100%	E	Recorded by lime type
<b>2.1.2.1</b>	Baseline Lime	Management Records	Tonnes	M	Annual	100%	E	Recorded by lime type
<b>2.2.0</b>	fertilizer N content	Technical source	%	e	Once	100%	e	
<b>2.3.0</b>	GHG fuel emission rates	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories	Kg/l	e	Once	100%	e	Constants : Emission rates by fuel and GHG type for power equipment
<b>2.4.0</b>	CO <sub>2</sub> conversions	IPCC	t/t	e	Once	100%	e	Constants : Global warming potential conversions for CH <sub>4</sub> and N <sub>2</sub> O to CO <sub>2</sub> e
<b>2.5.0</b>	Project controlled	Field recording	ha	m	Per planned event	100%	e	.

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<b>C.3.1.2. Data to be collected or used in order to monitor the GHG emissions by the sources, measured in units of CO<sub>2</sub> equivalent, that are increased as a result of the implementation of the proposed <u>A/R_CDM_project_activity</u> within the project boundary, and how this data will be archived:</b>								
<b>ID number (Please use numbers to ease cross-referencing to table D.3.)</b>	<b>Data variable</b>	<b>Source of data</b>	<b>Data unit</b>	<b>Measured (m), calculated (c) or estimated (e)</b>	<b>Recording frequency</b>	<b>Proportion of data to be monitored</b>	<b>How will the data be archived? (electronic/paper)</b>	<b>Comment</b>
	burning area							
<b>2.5.0.1</b>	Sample Plot #	Project maps	Alpha numeric	N/A	Per planned event	100%	e	
<b>2.5.0.2</b>	Plot location	Field recording	Map coordinates	m	Per planned event	100%	e	This will identify the stratum
<b>2.5.0.3</b>	Plot area	Field recording at plot location	ha	m	Per planned event	100%	e	
<b>2.5.0.4.1</b>	Grass/Herb aboveground O.D. biomass (before)	Sample Plots	kg/m <sup>2</sup>	m	Per planned event	Minimum 5 plots/stratum	e	Measured immediately before the planned event.
<b>2.5.0.4.1</b>	Grass/Herb aboveground O.D. biomass (after)	Sample Plots	kg/m <sup>2</sup>	m	Per planned event	Minimum 5 plots/stratum	e	Measured immediately after the planned event. (New plots)
<b>2.5.0.5</b>	Deadwood & litter plot location	Sample Plots	m <sup>0</sup> + Alpha numeric	m	Per planned event	Minimum 5 plots/stratum	e	The precise location of the Deadwood & litter plots are needed to avoid re-sampling after the burning event
<b>2.5.0.5.1</b>	Deadwood & litter (before) >1cm	Deadwood & litter plots	kg	m	Per planned event	Minimum 5 plots/stratum	e	Measured immediately before the planned event.
<b>2.5.0.5.2</b>	Deadwood &	Deadwood &	kg	m	Per planned	Minimum 5	e	Measured immediately

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<b>C.3.1.2. Data to be collected or used in order to monitor the GHG emissions by the sources, measured in units of CO<sub>2</sub> equivalent, that are increased as a result of the implementation of the proposed <u>A/R_CDM project activity</u> within the project boundary, and how this data will be archived:</b>								
<b>ID number (Please use numbers to ease cross-referencing to table D.3.)</b>	<b>Data variable</b>	<b>Source of data</b>	<b>Data unit</b>	<b>Measured (m), calculated (c) or estimated (e)</b>	<b>Recording frequency</b>	<b>Proportion of data to be monitored</b>	<b>How will the data be archived? (electronic/paper)</b>	<b>Comment</b>
	litter (before) <1cm	litter plots			event	plots/stratum		before the planned event.
<b>2.5.0.5.3</b>	Deadwood & litter (after) >1cm	Deadwood & litter plots	kg	m	Per planned event	Minimum 5 plots/stratum	e	Measured immediately after the planned event.
<b>2.5.0.5.4</b>	Deadwood & litter (after) <1cm	Deadwood & litter plots	kg	m	Per planned event	Minimum 5 plots/stratum	e	Measured immediately after the planned event.
<b>2.6.0 – 2.6.0.5.4</b>	Baseline Control Area Controlled Burning							Repeat all cells
<b>2.7.0</b>	Baseline Control Area Animal Years	Field recording	Years	m	Once	100%	e	Recorded annually by species and type..

**C.3.1.3. Description of formulae and/or models used to monitor the estimation of the actual net GHG removals by sinks:**

**C.3.1.3.1. Description of formulae and/or models used to monitor the estimation of the verifiable changes in carbon stock in the carbon pools within the project boundary (for each carbon pool in units of CO<sub>2</sub> equivalent):**

The model used to monitor the estimation is:

- 1) Determine the sum of the verifiable changes in carbon stocks in the carbon pools within the project boundary. The change in carbon stocks must be determined for the A/R activity from the start date to the verification date.

$$\text{Tot } C_{\text{sinks}} = \text{Tot } CS_t - \text{Tot } C_{t=0} \quad (\text{tC})$$

where

Tot CS<sub>t</sub> = total carbon stocks in the carbon pools within the project boundary at time t  
(tC)

Tot C<sub>t=0</sub> = total (baseline) carbon stocks in all pools at project start date (See E.4 algorithm #1).  
(tC)

- 2) Determine the total carbon stocks in the carbon pools within the project boundary at time t.

$$\text{Tot } CS_t = \sum(CS_{tA1} : CS_{tAx}) \quad (\text{tC})$$

where

$\sum(CS_{tA1} : CS_{tAx})$  = the sum of the carbon stocks in all pools at time t for strata 1 through x, consisting of all the strata within the A/R project boundary that have received A/R activity.  
(tC)

- 3) Determine the carbon stocks in all pools, at time t, for each stratum

$$C_{tAx} = (BcT_{tAx} + BcS_{tAx} + BcGH_{tAx} + BcL_{tAx} + OcS_{tAx}) * 10^{-3} * H_{Ax} \quad (\text{tC})$$

where

BcT<sub>tAx</sub> = total biomass carbon per ha. of the trees in stratum x at time t (kgC/ha)

BcS<sub>tAx</sub> = total biomass carbon per ha. of the shrub layer in stratum x at time t (kgC/ha)

BcGH<sub>tAx</sub> = total biomass carbon per ha. of the grass and herb layer in stratum x at time t  
(kgC/ha)

BcL<sub>tAx</sub> = total biomass carbon per ha. of the litter and deadwood layer in stratum x at time t  
(kgC/ha)

OcS<sub>tAx</sub> = total soil organic carbon per ha. in stratum x at time t (kgC/ha)

H<sub>Ax</sub> = the number of ha. in stratum x

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- 4) Determine the total biomass carbon per ha. of the trees in stratum x at time t

$$BcT_tAx = Mvol/ha * BEF * (1+RS) * D * Kc \quad (kgC/ha)$$

where

Mvol/ha = the total merchantable volume per hectare (m<sup>3</sup>/ha)

RS = the root to shoot ratio for the species and total above ground biomass

BEF = the biomass expansion factor for the species and age

D = the density of the wood (O.D.mass/Green volume) (kg/m<sup>3</sup>)

Kc = the carbon content constant = 0.5

- Determine the total merchantable vol. per hectare of the trees in stratum x at time t

$$Mvol/ha = \sum (trees_{ha} * Vol_{average}) \quad (m^3/ha)$$

where

trees<sub>ha</sub> = Average number of trees per hectare

Vol<sub>average</sub> = Average per tree volume of the sampled trees

Where

Vol<sub>average</sub> is calculated using authoritative allometric equations for the tree species. The number and selection of the measured trees is as per the associated monitoring methodology.

- 5) Determine the total biomass carbon per ha. of the shrub layer in stratum x at time t

$$BcS_tAx = SB_k * Kc \quad (kgC/ha)$$

where

SB<sub>k</sub> = Brush O.D.biomass (kg/ha)

Kc = the carbon content constant = 0.5

- Determine number samples required for accuracy ± 10% of the mean Brush O.D.biomass/ha @ 95% level of probability:

$$N^{\circ} \text{ samples reqd.} = ( \text{Standard Deviation} * (\text{Mean Brush O.D.biomass} * 0.05)^{-1} )^2$$

- 6) Determine the total biomass carbon per ha of the grass & herb layer in stratum x at time t

$$BcGH_tAx = GH_k * Kc \quad (kgC/ha)$$

where

GH<sub>k</sub> = Grass & herb O.D.biomass (kg/ha)

Kc = the carbon content constant = 0.5

- Determine number samples required for accuracy ± 10% of the mean Grass & herb O.D.biomass/ha @ 95% level of probability:

$$N^{\circ} \text{ samples reqd.} = ( \text{Standard Deviation} * (\text{Mean Grass/herb O.D.biomass} * 0.05)^{-1} )^2$$

7) Determine the total biomass carbon per ha. of the litter and deadwood layer in stratum x at time t

$$BcL_tAx = [(Dw_{>1} * a^{-1}) + (L_{<1} * b^{-1})] * 10^{-3} * Kc \quad (\text{kgC/ha})$$

where

$Dw_{>1}$  = deadwood (> 1cm) OD mass (kg)

$L_{<1}$  = litter (<1cm) OD mass (kg)

a = deadwood plot area ( $225 * 10^{-6}$ ha)

b = litter plot area ( $36 * 10^{-6}$ ha)

Kl = the carbon content constant for Litter = 0.370

- Determine number samples required for accuracy  $\pm 10\%$  of the mean Deadwood O.D.biomass/ha @ 95% level of probability:

$$N^{\circ} \text{ samples reqd.} = (\text{Standard Deviation} * (\text{Mean Deadwood O.D.biomass} * 0.05)^{-1})^2$$

- Determine number samples required for accuracy  $\pm 10\%$  of the mean Litter O.D.biomass/ha @ 95% level of probability:

$$N^{\circ} \text{ samples reqd.} = (\text{Standard Deviation} * (\text{Mean Litter O.D.biomass} * 0.05)^{-1})^2$$

8) Determine the total soil organic carbon per ha. in stratum x at time t

$$OcS_tAx = (\text{SOC} * \sum S_{\text{mass}}) * (n * (\pi * (0.5A_{\phi})^2))^{-1} * 10^{10} \quad (\text{kgC/ha})$$

where

SOC = mean Soil organic carbon % of dry mass of samples

$S_{\text{mass}}$  = dry mass of samples (kg)

n = number of soil samples

$A_{\phi}$  = auger diameter (mm)

- Determine number samples required for accuracy  $\pm 10\%$  of the mean soil organic carbon % @ 95% level of probability:

$$N^{\circ} \text{ samples reqd.} = (\text{Standard Deviation} * (\text{Mean soil organic carbon \%} * 0.05)^{-1})^2$$

**C.3.1.3.2. Description of formulae and/or models used to monitor the estimation of the GHG emissions by the sources, measured in units of CO<sub>2</sub> equivalent, that are increased as a result of the implementation of the proposed A/R CDM project activity within the project boundary (for each source and gas, in units of CO<sub>2</sub> equivalent):**

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- 1) To determine the increase in emissions by sources that are increased from time 0 to t: Calculate the increase in emissions above the level that would occur in the baseline scenario.

$$\text{TotC}_{\text{source}} = (\sum \text{GHG}_{\text{project sources}} - \sum \text{GHG}_{\text{baseline sources}}) * 12/44 \quad (\text{tC})$$

where

$\sum \text{GHG}_{\text{project sources}}$  = the sum of emissions by sources within the project boundary, including the baseline control areas, attributable to the A/R CDM activity. (tCO<sub>2</sub>)

$\sum \text{GHG}_{\text{baseline sources}}$  = the sum of emissions by sources within the project boundary, including the baseline control areas, that are determined from the baseline scenario in the Baseline Control Areas. (tCO<sub>2</sub>)

- 2) Determine the sum of emissions of the GHGs measured in CO<sub>2</sub> equivalents by the sources that result from the implementation of the afforestation or reforestation (A/R) project activity, including the management of the Baseline Control Area, within the project boundary, attributable to the A/R CDM project activity.

$$\sum \text{GHG}_{\text{project sources}} = \sum \text{GHG}_{\text{project management}} + \sum \text{GHG}_{\text{project silviculture}} + \sum \text{GHG}_{\text{project baseline controls}}^3 \quad (\text{tCO}_2)$$

where

$\text{GHG}_{\text{project management}}$  = Total GHG emissions from fuels consumed within the project boundary in management (transport) of the A/R activity to time t (tCO<sub>2</sub>)

$\text{GHG}_{\text{project silviculture}}$  = The sum of:

- a. Total GHG emissions from fuels consumed within the project boundary in operations (transport & equipment) of the A/R activity to time t (tCO<sub>2</sub>)
- b. Total non-CO<sub>2</sub> emissions (CH<sub>4</sub>, N<sub>2</sub>O) released from site preparation and controlled burning within the project boundary for the A/R activity to time t (tCO<sub>2</sub>)
- c. Total GHG emissions released from fertilizers applied within the project boundary for the A/R activity to time t (tCO<sub>2</sub>)
- d. Total GHG emissions released from lime applied within the project boundary for the A/R activity to time t (tCO<sub>2</sub>)

$\sum \text{GHG}_{\text{project baseline controls}}$  =

- e. Total GHG emissions (CH<sub>4</sub>) released from animal husbandry on baseline control areas within the project boundary for the A/R activity to time t (tCO<sub>2</sub>)

- 3) Determine the total GHG emissions from fuels consumed within the project boundary in management (transport) of the A/R activity to time t

$$\begin{aligned} \sum \text{GHG}_{\text{project management}} = & [\text{Gas}_t * (\text{CO}_2\text{Gas} + \text{CH}_4\text{Gas} * \text{GWP}_{\text{CH}_4} + \text{N}_2\text{OGas} * \text{GWP}_{\text{N}_2\text{O}}) * 10^{-3}] \\ & + [\text{Diesel}_t * (\text{CO}_2\text{Diesel} + \text{CH}_4\text{Diesel} * \text{GWP}_{\text{CH}_4} + \text{N}_2\text{ODiesel} * \text{GWP}_{\text{N}_2\text{O}}) * 10^{-3}] \quad (\text{tCO}_2) \end{aligned}$$

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<sup>3</sup> Baseline Control Areas constitute additional strata within the project boundary and all emission sources are recognised and measured. This parameter identifies a source that is unique to Baseline Control Areas.

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where

Gas<sub>t</sub> = total gas used for project management activities within the project boundary between time 0 and time t (litres)

CO<sub>2</sub>Gas = the CO<sub>2</sub> emissions per unit of gas burned (kg/l)

CH<sub>4</sub>Gas = the CH<sub>4</sub> emissions per unit of gas burned (kg/l)

N<sub>2</sub>OGas = the N<sub>2</sub>O emissions per unit of gas burned (kg/l)

Diesel<sub>t</sub> = total diesel used for project management activities within the project boundary between time 0 and time t (litres)

CO<sub>2</sub>Diesel = the CO<sub>2</sub> emissions per unit of diesel burned (kg/l)

CH<sub>4</sub>Diesel = the CH<sub>4</sub> emissions per unit of diesel burned (kg/l)

N<sub>2</sub>ODiesel = the N<sub>2</sub>O emissions per unit of diesel burned (kg/l)

GWP<sub>CH4</sub> = the global warming potential of CH<sub>4</sub>

GWP<sub>N2O</sub> = the global warming potential of N<sub>2</sub>O

*Note: Method for calculating constants for conversions from litres of fuels to kg of GHG are shown in B.5.*

- 4) Determine the total GHG emissions by sources from project silviculture within the project boundary, attributable to the A/R CDM project activity.

$$\sum \text{GHG}_{\text{project silviculture}} = \sum \text{GHG}_{\text{project fuels}} + \sum \text{GHG}_{\text{project burning}} + \sum \text{GHG}_{\text{project fertilizer}} + \sum \text{GHG}_{\text{lime}}$$

- a. Determine the total GHG emissions from fuels consumed within the project boundary in operations for the A/R activity to time t.

o  $\sum \text{GHG}_{\text{project fuels}} =$  Utilize the algorithm in (C.3.1.3.2 (3)) above. (tCO<sub>2</sub>)

- b. Determine the total Non-CO<sub>2</sub> GHG emissions released from site preparation burning and controlled burning within the project boundary for the A/R activity to time t. The loss in aboveground biomass due to each fire event will be determined by subtracting the remaining biomass from the value measured immediately before the planned event. Calculation of biomass before and after site preparation is completed using Equations 4 through 7, and the associated variables and mensuration methodologies.

$$\sum \text{GHG}_{\text{project burning}} = \sum (\text{Ha}_x * ((\text{AGCL}_x * \text{ER}_{\text{CH}_4} * 16/12 * \text{GWP}_{\text{CH}_4}) + (\text{AGCL}_x * \text{N/C} * \text{ER}_{\text{N}_2\text{O}} * 44/28 * \text{GWP}_{\text{N}_2\text{O}}))) \quad (\text{tCO}_2)$$

where

Ha<sub>x</sub> = area burned in event x (ha)

AGCL<sub>x</sub> = Loss of Carbon in Aboveground Biomass Due to Fire event x (tC/ha)

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ER<sub>CH4</sub> = emission ratio of methane (IPCC default = 0.012)  
 ER<sub>N2O</sub> = emission ratio of nitrous oxide (IPCC default = 0.007)  
 N/C = nitrogen to carbon ratio in burned biomass (IPCC default = 0.01)

$$\circ \text{ AGCL}_x = (\sum \text{O.D.Biomass}_{(\text{before event})} - \sum \text{O.D.Biomass}_{(\text{after event})}) * \text{CF} \quad (\text{tC/ha})$$

where

$\sum \text{O.D.Biomass}$  = sum above ground biomass (calculated individually for each category: litter & deadwood; above ground live biomass) in fire event location (t/ha)

CF = carbon fraction of biomass (IPCC default = 0.5 for living biomass, 0.37 for deadwood and litter) (dimensionless)

- c. Determine the total GHG emissions released from fertilizers applied within the project boundary for the A/R activity to time t

$$\sum \text{GHG}_{\text{project fertilizer}} = \sum \text{Fert } x_t * \text{NC}_x * (1 - \text{Frac}) * \text{EF} * \text{Mw} * \text{GWP}_{\text{N}_2\text{O}} \quad (\text{tCO}_2)$$

where

Fert  $x_t$  = total fertilizer of type x used for project activities within the project area between time 0 and time t (tonnes)

NC<sub>x</sub> = Nitrogen content of fertilizer of type x (%)

EF = Emission Factor = 0.0125 t N<sub>2</sub>O-N/t N applied (IPCC Guidelines 4.92ff)

Frac = factor for volatilisation as NH<sub>3</sub> and NO<sub>x</sub> = 0.1 for chemical fertilizers, 0.2 for organic fertilizers (IPCC Guidelines 4.92ff)

Mw = The molecular weight ratio of N<sub>2</sub>O to N<sub>2</sub>O as N = 44/28

GWP<sub>N<sub>2</sub>O</sub> = the global warming potential of N<sub>2</sub>O = 310

- d. Determine the total GHG emissions on the form of CO<sub>2</sub> released from lime applied within the project area between time 0 and time t

$$\sum \text{GHG}_{\text{lime}} = \text{Limestone} * \text{EF}_{\text{limestone}} + \text{Dolomite} * \text{EF}_{\text{dolomite}}$$

Where

Limestone = Limestone applied within the Project Boundary (tonnes)

Dolomite = Dolomite applied within the Project Boundary (tonnes)

EF<sub>limestone</sub> = 0.4404 (limestone Carbon content of 0.12 times the conversion constant from C to CO<sub>2</sub> of 3.67) (dimensionless)

EF<sub>dolomite</sub> = 0.44774 (dolomite Carbon content of 0.122 times the conversion constant from C to CO<sub>2</sub> of 3.67) (dimensionless)

- 5) Determine the total GHG emissions (CH<sub>4</sub>) released from animal husbandry (enteric fermentation and manure management) on baseline control areas within the project boundary for the A/R activity to time t

*Note: Since the Baseline Control Areas occupied by animals will be much smaller than the project activity strata, and therefore the total number of animals relatively small, as compared with the project as a whole, Tier 1 methods for calculating emissions are used in this*

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*methodology. Where animal husbandry emissions are projected to amount to more than 2% in CO<sub>2</sub>e of the Actual net GHG removals by sinks, Tier 2 methods should be used as per the Revised 1996 IPCC Guidelines for National GHG Inventories.*

$$\sum \text{GHG}_{\text{project baseline controls}} = \sum (\text{CH}_{4\text{enteric}(t)} + \text{CH}_{4\text{manure}(t)}) * \text{GWP}_{\text{CH}_4}$$

Where:

$\text{CH}_{4\text{enteric}(t)}$  = methane emissions from enteric fermentation by cattle on Baseline Control Areas to time t (tCH<sub>4</sub>)

$\text{CH}_{4\text{manure}(t)}$  = methane emissions from manure management by cattle on Baseline Control Areas to time t (tCH<sub>4</sub>)

- o Methane Emissions from Enteric Fermentation on Baseline Control Areas

$$\text{CH}_{4\text{enteric}(t)} = \text{AP}_{(t-0)} * \text{F}_{\text{CH}_4(\text{enteric})} * 10^{-3} \quad (\text{tCH}_4)$$

where

$\text{AP}_{(t-0)}$  = total animal years between year 0 and year t on Baseline Control Areas

$\text{F}_{\text{CH}_4(\text{enteric})}$  = emission factor for methane from enteric fermentation (kg CH<sub>4</sub>/animal year)

- o Methane Emissions from Manure Management on Baseline Control Areas

$$\text{CH}_{4\text{manure}(t)} = \text{AP}_{(t-0)} * \text{F}_{\text{CH}_4(\text{manure})} * 10^{-3} \quad (\text{tCH}_4)$$

where

$\text{F}_{\text{CH}_4(\text{manure})}$  = emission factor for methane from manure management (kgCH<sub>4</sub>//animal year)

*Note: Emission factors are sources from Revised 1996 IPCC Guidelines for National GHG Inventories Tables 4-3 through 4-6 N<sub>2</sub>O manure emissions should be dealt with using the methods for organic fertilizers- Equation 15c, above.*

- 6) Determine the sum of emissions of the GHGs measured in CO<sub>2</sub> equivalents by sources within the project boundary that would have occurred in the absence of the A/R CDM project activity.

$$\sum \text{GHG}_{\text{baseline sources}} = \sum \text{GHG}_{\text{baseline management}} + \sum \text{GHG}_{\text{baseline silvi/agriculture}} \quad (\text{tCO}_2)$$

where

$\sum \text{GHG}_{\text{baseline management}}$  = Total GHG emissions from fuels that would have been consumed within the project boundary in management (transport) of the baseline activity to time t (tCO<sub>2</sub>)

$\sum \text{GHG}_{\text{baseline silvi/agriculture}}$  = Total GHG emissions from fuels that would have been consumed within the project boundary in operations (transport & equipment) of the baseline activity to time t

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- 7) Determine total GHG emissions from fuels that would have been consumed within the project boundary in management (transport) of the baseline activity to time t

$$\sum_{(x)} \text{GHG}_{\text{baseline management}} = \sum_{(x)} (\text{algorithm C.3.1.3.2 (3)}) * \text{Ha}_{(x)} / \text{Hb}_{(x)}$$

(tCO<sub>2</sub>)

where

Gas<sub>t</sub> = total gas used for baseline management activities within the Baseline Control Areas between time 0 and time t for each stratum (x) (litres)

Diesel<sub>t</sub> = total diesel used for baseline management activities within the Baseline Control Areas between time 0 and time t for each stratum (x) (litres)

Ha<sub>(x)</sub> = area of the project stratum associated with the Baseline Control Area (x) (ha)

Hb<sub>(x)</sub> = area of the Baseline Control Area (x) (ha)

- 8) Determine the total GHG emissions from agriculture and silviculture operations sources that would have been emitted within the project boundary in conducting the baseline activity to time t

$$\sum_{(x)} \text{GHG}_{\text{baseline silvi/agriculture}} = \sum_{(x)} (\text{algorithm C.3.1.3.2 (4), (5)}) * \text{Ha}_{(x)} / \text{Hb}_{(x)}$$

(tCO<sub>2</sub>)

where

measured parameters refer to Baseline Control Areas

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<b>C.3.2.. As appropriate, relevant data necessary for determining the <u>baseline net GHG removals by sinks</u> and how such data will be collected and archived:</b>								
<b>ID number</b> <i>(Please use numbers to ease cross-referencing to table D.3.)</i>	<b>Data variable</b>	<b>Source of data</b>	<b>Data unit</b>	<b>Measured (m), calculated (c) or estimated (e)</b>	<b>Recording frequency</b>	<b>Proportion of data to be monitored</b>	<b>How will the data be archived? (electronic/paper)</b>	<b>Comment</b>
<b>3.1.0</b>	Baseline Stratum #	Project maps	Alpha numeric	N/A	Once	100%	e	Project area to be stratified at start date
<b>3.1.1</b>	Baseline Stratum Area	Project Maps	Ha	m	Once	100%	e	
<b>3.1.2</b>	Baseline Control Area #	Stratum maps	Alpha numeric	N/A	Once	100%	e	
<b>3.1.3</b>	Baseline Control Area location	Field recording	Map coordinates	m	Once	100%	e	
<b>3.1.4</b>	Baseline Sample Plot #	Stratum maps	Alpha numeric	N/A	Once	100%	e	
<b>3.1.5</b>	Plot location	Field recording	Map coordinates	m	Once	100%	e	
<b>3.1.6</b>	Plot area	Predetermined	m <sup>2</sup>	m	On verification dates to a minimum of every 5 years	100%	e	
<b>3.2.0</b>	Tree Stems per plot	Sample plots	count	m	On verification dates to a minimum of every 5 years	100%	e	

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<b>C.3.2.. As appropriate, relevant data necessary for determining the <u>baseline net GHG removals by sinks</u> and how such data will be collected and archived:</b>								
<b>ID number</b> <i>(Please use numbers to ease cross-referencing to table D.3.)</i>	<b>Data variable</b>	<b>Source of data</b>	<b>Data unit</b>	<b>Measured (m), calculated (c) or estimated (e)</b>	<b>Recording frequency</b>	<b>Proportion of data to be monitored</b>	<b>How will the data be archived? (electronic/paper)</b>	<b>Comment</b>
<b>3.2.1</b>	Tree Height	Sample Plots	m	m	On verification dates to a minimum of every 5 years	Up to 100% 10 trees/plot	e	
<b>3.2.2</b>	Tree diameter breast height	Sample Plots	mm	m	On verification dates to a minimum of every 5 years	100%	e	
<b>3.2.3.1</b>	Brush aboveground O.D. biomass	Sample plots	kg/m <sup>2</sup>	m	On verification dates to a minimum of every 5 years	100%	e	
<b>3.2.4.1</b>	Grass/Herb aboveground O.D. biomass	Sample Plots	kg/m <sup>2</sup>	m	On verification dates to a minimum of every 5 years	100%	e	
<b>3.3.0</b>	Deadwood & litter plot location	Sample Plots	Distance (m) + Cardinal direction	m	On verification dates to a minimum of every 5 years	5 plots/stratum	e	The Sample Plot selected and precise location of the Deadwood & litter plots are needed to avoid re-sampling at a later verification

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<b>C.3.2.. As appropriate, relevant data necessary for determining the <u>baseline net GHG removals by sinks</u> and how such data will be collected and archived:</b>								
<b>ID number</b> <i>(Please use numbers to ease cross-referencing to table D.3.)</i>	<b>Data variable</b>	<b>Source of data</b>	<b>Data unit</b>	<b>Measured (m), calculated (c) or estimated (e)</b>	<b>Recording frequency</b>	<b>Proportion of data to be monitored</b>	<b>How will the data be archived? (electronic/paper)</b>	<b>Comment</b>
<b>3.3.1</b>	Deadwood & litter >1cm	Deadwood & litter plots	kg	m	On verification dates to a minimum of every 5 years	100%	e	
<b>3.3.2</b>	Deadwood & litter <1cm	Deadwood & litter plots	kg	m	On verification dates to a minimum of every 5 years	100%	e	
<b>3.4.0</b>	Soil sample spot location	Sample Plots	Alpha numeric	N/A	On verification dates to a minimum of every 5 years	3 plots/stratum	e	
<b>3.4.1</b>	Auger diameter	Instrument	mm	m	once	N/A	e	
<b>3.4.2</b>	Soil Sample mass	Soil sample	kg	m	On verification dates to a minimum of every 5 years	100%	e	
<b>3.4.3</b>	Soil Organic Carbon	Soil samples	mg/kg	m	On verification dates to a minimum of every 5 years	100%	e	From laboratory analysis
<b>3.5.0</b>	Root to Shoot Ratio	IPCC GPG for LULUCF	Ratio	e	Once	100%	e	Selected based on merchantable volume of

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<b>C.3.2.. As appropriate, relevant data necessary for determining the <u>baseline net GHG removals by sinks</u> and how such data will be collected and archived:</b>								
<b>ID number</b> <i>(Please use numbers to ease cross-referencing to table D.3.)</i>	<b>Data variable</b>	<b>Source of data</b>	<b>Data unit</b>	<b>Measured (m), calculated (c) or estimated (e)</b>	<b>Recording frequency</b>	<b>Proportion of data to be monitored</b>	<b>How will the data be archived? (electronic/paper)</b>	<b>Comment</b>
		3A.1.8						stand at time of sampling
<b>3.6.0</b>	BEF	IPCC GPG for LULUCF 3A.1.10 and others	Ratio	e	Once	100%	e	Selected based on age of stand at time of sampling
<b>3.7.0</b>	Carbon content	IPCC GPG for LULUCF	numeric	e	Once	100%	e	Constant value
<b>3.8.0</b>	Wood Density	IPCC GPG for LULUCF and authoritative sources	t/m <sup>3</sup>	e	Once	100%	e	

**C.3.2.1. Description of formulae and/or models used to monitor the estimation of the baseline net GHG removals by sinks (for each carbon pool, in units of CO<sub>2</sub> equivalent):**

*“Baseline net greenhouse gas removals by sinks” is the sum of the changes in carbon stocks in the carbon pools within the project boundary that would have occurred in the absence of the afforestation or reforestation project activity under the clean development mechanism (CDM)”*

The nested model used to monitor the estimation is:

- 1) Determine the verifiable changes in the carbon stocks in the carbon pools within the project boundary at the verification date.

$$C_{\text{baseline}} = \text{Tot } C_{t=n} - \text{Tot } C_{t=0} \quad (\text{tC})$$

where

$$C_{\text{baseline}} = \text{Baseline net GHG removals by sinks} \quad (\text{tC})$$

$$\text{Tot } C_t = \text{total baseline carbon stocks in all pools at time } t \quad (\text{tC})$$

t=0 = the project start date

and t=n = verification date.

- 2) Determine the total carbon stock in all pools, in all strata, at time t

$$\text{Tot } C_t = \sum(C_t A_1 \dots C_t A_x) \quad (\text{tC})$$

where

$$\text{Tot } C_t = \text{total carbon stock in all pools at time } t \quad (\text{tC})$$

$\sum(C_t A_1 : C_t A_x)$  = the sum of the Baseline carbon stocks in all pools at time t for strata 1 through x, consisting of all the areas within the A/R project boundary.

(tC)

- 3) Determine the carbon stocks in all pools, at time t, for each stratum

$$C_t A_x = (BcT_t A_x + BcS_t A_x + BcGH_t A_x + BcL_t A_x + OcS_t A_x) * 10^{-3} * H_{ax} \quad (\text{tC})$$

where

BcT<sub>t</sub> A<sub>x</sub> = total biomass carbon per ha. of the trees in stratum x at time t (kgC/ha)

BcS<sub>t</sub> A<sub>x</sub> = total biomass carbon per ha. of the shrub layer in stratum x at time t (kgC/ha)

BcGH<sub>t</sub> A<sub>x</sub> = total biomass carbon per ha. of the grass and herb layer in stratum x at time t (kgC/ha)

BcL<sub>t</sub> A<sub>x</sub> = total biomass carbon per ha. of the litter and deadwood layer in stratum x at time t (kgC/ha)

OcS<sub>t</sub> A<sub>x</sub> = total soil organic carbon per ha. in stratum x at time t (kgC/ha)

H<sub>ax</sub> = the number of ha. in stratum x

- 4) Determine the total biomass carbon per ha. of the trees in stratum x at time t

$$BcT_t A_x = M_{\text{vol}}/\text{ha} * BEF * (1+RS) * D * K_c \quad (\text{kgC/ha})$$

where

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Mvol/ha = the total merchantable volume per hectare (m<sup>3</sup>/ha)  
 RS = the root to shoot ratio for the species and total above ground biomass  
 BEF = the biomass expansion factor for the species and age  
 D = the density of the wood (O.D.mass/green volume) (kg/m<sup>3</sup>)  
 Kc = the carbon content constant = 0.5

- Determine the total merchantable vol. per ha. of the trees in stratum x at time t

$$Mvol/ha = \sum (trees_{ha} * Vol_{average}) \quad (m^3/ha)$$

where

trees<sub>ha</sub> = Average number of trees per hectare

Vol<sub>average</sub> = Average per tree volume of the sampled trees

Where

Vol<sub>average</sub> is calculated using authoritative allometric equations for the tree species.

- 5) Determine the total biomass carbon per ha. of the shrub layer in stratum x at time t

$$BcS_tAx = SB_k * Kc \quad (kgC/ha)$$

where

SB<sub>k</sub> = Brush O.D.biomass (kg/ha)

Kc = the carbon content constant = 0.5

- Determine number samples required for accuracy ± 10% of the mean Brush O.D.biomass/ha @ 95% level of probability:

$$N^o \text{ samples reqd.} = ( \text{Standard Deviation} * (\text{Mean Brush O.D.biomass} * 0.05)^{-1} )^2$$

- 6) Determine the tot. biomass carbon per ha of the grass&herb layer in stratum x at time t

$$BcGH_tAx = GH_k * Kc \quad (kgC/ha)$$

where

GH<sub>k</sub> = Grass & herb O.D.biomass (kg/ha)

Kc = the carbon content constant = 0.5

- Determine number samples required for accuracy ± 10% of the mean Grass & herb O.D.biomass/ha @ 95% level of probability:

$$N^o \text{ samples reqd.} = ( \text{Std Dev.} * (\text{Mean Grass/herb O.D.biomass} * 0.05)^{-1} )^2$$

- 7) Determine the total biomass carbon per ha. of the litter and deadwood layer in stratum x at time t

$$BcL_tAx = [(Dw_{>1} * a^{-1}) + (L_{<1} * b^{-1})] * 10^{-3} * Kc \quad (kgC/ha)$$

where

Dw<sub>>1</sub> = deadwood (> 1cm) OD mass (kg)

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$L_{<1}$  = litter (<1cm) OD mass (kg)

a = deadwood plot area ( $225 * 10^{-6}$ ha)

b = litter plot area ( $36 * 10^{-6}$ ha)

Kl = the carbon content constant for Litter = 0.370

- Determine number samples required for accuracy  $\pm 10\%$  of the mean Deadwood O.D.biomass/ha @ 95% level of probability:

$$N^{\circ} \text{ samples reqd.} = (\text{Std Dev} * (\text{Mean Deadwood O.D.biomass} * 0.05)^{-1})^2$$

- Determine number samples required for accuracy  $\pm 10\%$  of the mean Litter O.D.biomass/ha @ 95% level of probability:

$$N^{\circ} \text{ samples reqd.} = (\text{Std Dev} * (\text{Mean Litter O.D.biomass} * 0.05)^{-1})^2$$

- 8) Determine the total soil organic carbon per ha. in stratum x at time t

$$O_c S_t A_x = (\text{SOC} * \sum S_{\text{mass}}) * (n * (\pi * (0.5 A_{\phi})^2))^{-1} * 10^{10} \quad (\text{kgC/ha})$$

where

SOC = mean soil organic carbon % of dry mass of samples

$S_{\text{mass}}$  = dry mass of samples (kg)

n = number of soil samples

$A_{\phi}$  = auger diameter (mm)

- Determine number samples required for accuracy  $\pm 10\%$  of the mean soil organic carbon % @ 95% level of probability:

$$N^{\circ} \text{ samples reqd.} = (\text{Std Dev} * (\text{Mean soil organic carbon \%} * 0.05)^{-1})^2$$

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**C.4. Treatment of leakage in the monitoring plan:**

<b>C.4.1.. If applicable, please describe the data and information that will be collected in order to monitor <u>leakage of the proposed A/R CDM project activity</u>:</b>								
<b>ID number (Please use numbers to ease cross-referencing to table D.3.)</b>	<b>Data variable</b>	<b>Source of data</b>	<b>Data unit</b>	<b>Measured (m), calculated (c) or estimated (e)</b>	<b>Recording frequency</b>	<b>Proportion of data to be monitored</b>	<b>How will the data be archived? (electronic/paper)</b>	<b>Comment</b>
<b>4.1.0</b>	Fuel Use	Equipment logs	Litres (l)	m/e	Monthly	100%	e	Measured by fuel type or estimated by fuel type based on equipment hours used for transport outside project areas
<b>4.2.0</b>	Land Management Area	GPS measurement	ha	m	When management occurs	100%	e	
<b>4.2.1</b>	Prior Carbon Pools	Sampling as per B.2.1. to B.2.6	tonnes	c	Prior to management activities	100%	e	
<b>4.2.2</b>	Post Carbon Pools	Sampling as per B.2.1. to B.2.6	tonnes	c	Subsequent to management activities	100%	e	
<b>4.3.0</b>	Quantity of displaced production	Various	variable	various	Once	100%	e	Data type and source will depend on the nature of the displaced production
<b>4.3.1</b>	Market Data	Various	variable	various	Once	100%	e	Market data on displaced production at various market scales

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<b>C.4.1.. If applicable, please describe the data and information that will be collected in order to monitor <u>leakage of the proposed A/R CDM project activity</u>:</b>								
<b>ID number (Please use numbers to ease cross-referencing to table D.3.)</b>	<b>Data variable</b>	<b>Source of data</b>	<b>Data unit</b>	<b>Measured (m), calculated (c) or estimated (e)</b>	<b>Recording frequency</b>	<b>Proportion of data to be monitored</b>	<b>How will the data be archived? (electronic/ paper)</b>	<b>Comment</b>
<b>4.4.0</b>	Historic A/R	various	various	various	once	100%	E	Data on volume of national A/R activities over the preceding 10 years
<b>4.4.1</b>	Implementation A/R	various	various	various	once	100%	E	Data on volume of national A/R activities during the project implementation period
<b>4.5.0</b>	Pre Implementation demographics	various	various	various	once	100%	e	Demographic and socio-economic data on the project areas prior to implementation
<b>4.5.1</b>	Displacement demographics	various	various	various	once	100%	e	Demographic and socio-economic data on the displaced families or groups
<b>4.5.2</b>	Displacement Carbon	various	Tonnes CO2e	various	On verification dates	100%	e	Amount of carbon release caused by activities of displaced families or groups

**C.4.2. Description of formulae and/or models used to estimate leakage (for each GHG, source, carbon pool, in units of CO<sub>2</sub> equivalent):**

Leakage is determined through the formula:

$$\text{TotC}_{\text{leakage}(t)} = \sum_x L_t * 12/44 \quad (\text{tC})$$

where

$L_t$  = GHG emissions and/or reduced sequestration outside of the project boundary attributable to the A/R project at time  $t$

Leakage is calculated in five broad classes: Energy Leakage, consisting of increases in GHG emissions from fossil fuels, which can be measured, occur outside the project boundary, and which are directly attributable to the project management activities; Land Management Leakage, consisting of GHG emissions, that can be estimated, arising from land management under the control of the project managers, outside of the project boundaries and directly attributable to the project activity; Market Leakage, consisting of GHG emissions, that can be estimated, resulting from displacement of production of products or services from the project area to other areas, resulting in changes in carbon pools in areas outside the project boundary, A/R Diversion, consisting of the diversion of pre-existing A/R activities as a consequence of the implementation of the A/R project, and Displacement Leakage, consisting of the displacement of people and their associated land management activities from within the Project Boundary to other locations.

Details of the calculation of each of these leakage classes is given in the associated Baseline Methodology, section E.6.

**C.4.3. Please specify the procedures for the periodic review of implementation of activities and measures to minimize leakage:**

As discussed in the baseline methodology, five broad categories of leakage are assessed in this project:

- 1) Energy Leakage – leakage arising from the use of fossil fuels for energy for activities under the direct control of the project management, but outside of the project area.

Minimization strategy: Minimization of leakage associated with fossil fuel powered equipment will take place as part of the routine cost minimization analyses carried out by the project management. Cost reduction incentives are the major driver of reductions in energy use and associated leakage.

- 2) Management Leakage – leakage arising from management activities on land outside of the project boundaries. The major source of this type of leakage will be fire control measures.

Minimization strategy:

- 1) Layout of planting areas to make maximal use of available natural fire breaks – roads and watercourses.

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- This portion of the fire protection methodology will be maximized during the project design phase, since it is the most effective approach, and contributes no leakage
- 2) Planting of areas between project area boundaries and natural fireguards.
    - Where cost effective this method will be used to meet natural firebreaks, and to reduce leakage.
  - 3) Clearing of fireguards of not less than 15m in width in areas where no natural fire break is available.
    - This approach will be used where neither of the two methods above is viable. Use of this method will produce leakage during the first clearing. Initial clearance will remove 100% of the living above ground biomass, and will be counted as having removed all of the below ground biomass.

Where management finds, subsequent to the establishment of the plantation, that further fire control measures are necessary, similar strategies will be used. All fire control measures will prioritize maximization of carbon pools for the project as a whole, which may mean increasing leakage in order to eliminate significant risk of much greater losses within the plantation area.

- 3) Market Leakage – leakage arising from shifting of economic activities from the project area to other areas.

Minimization strategy: Control of market leakage is only possible during the selection of the landbase for the project. In the case of the MPR project, there are currently no economic activities occurring within the project area that will be displaced. Therefore no market leakage is accounted.

- 4) A/R Diversion – leakage arising from the diversion of funds, market share, infrastructure availability, or other incentives and resources, from other A/R projects, resulting in a reduction of other A/R projects in the country.

Minimization strategy: Belize currently does not have an active A/R sector, with the exception of the occasional establishment of citrus plantations and investor driven precious hardwood plantations, and some reforestation associated with logging. The MPR project will generally have no impact on these small occasional A/R activities. However, the MPR project will minimize the potential for A/R diversion through:

- Development of new nursery infrastructure, rather than drawing on small existing nurseries.
- Completion of the project without further subsidies or funding from the Government of Belize, which might potentially be diverted from other projects.
- Production of products different from those provided by other A/R projects in Belize (softwood, versus hardwoods or fruit), so as not to create end market competition.

- 5) Displacement Leakage – leakage arising from the displacement of residents on or near the Project Area due to removal of their ownership or use of the landbase, or due to loss of livelihoods due to economic changes caused by the project

Minimization strategy: There are currently very few people resident in or economically dependent on the MPR area, apart from a few employees of the Government of Belize, and of some local ecotourism lodges. The project is designed to enhance ecotourism opportunities, and provide an economic base for the government's ongoing role in the management of the area, so no displacement leakage is anticipated

**C.5. Description of formulae and/or models used to estimate net anthropogenic GHG removals by sinks for the proposed A/R CDM project activity (for each GHG, carbon pool, in units of CO<sub>2</sub> equivalent):**

*“Net anthropogenic greenhouse gas removals by sinks” is the actual net greenhouse gas removals by sinks minus the baseline net greenhouse gas removals by sinks minus leakage.*

The model used to estimate the Net anthropogenic GHG removals by sinks for the proposed A/R CDM project activity is:

$$\text{Net GHG}_{\text{sinks}(t)} = (C_{\text{actual}(t)} - C_{\text{baseline}(t)} - C_{\text{leakage}(t)}) * 44/12 \quad (\text{tCO}_2)$$

where

Net GHG<sub>sinks(t)</sub> = Net anthropogenic GHG removals by sinks at time t

- $C_{\text{actual}(t)} = (\text{Tot CS}_{t(\text{actual})} - \text{TotC}_{\text{source}}) - \text{TotC}_{t=0(\text{baseline})} \quad (\text{tC})$

where

$C_{\text{actual}(t)}$  = actual net greenhouse gas (GHG) removals by sinks at time t

Tot CS<sub>t(actual)</sub> = actual GHG removals by sinks at time t

TotC<sub>source</sub> = increase in emissions by sources that are increased from time 0 to t

TotC<sub>t=0(baseline)</sub> = total baseline carbon stock in all pools at time t = 0 (from E.4)

- $C_{\text{baseline}(t)} = \text{TotC}_{t(\text{baseline})} - \text{TotC}_{t=0(\text{baseline})} \quad (\text{tC})$

where

$C_{\text{baseline}(t)}$  = baseline net GHG removals by sinks at time t

TotC<sub>t(baseline)</sub> = total baseline carbon stock in all pools at time t

TotC<sub>t=0(baseline)</sub> = total baseline carbon stock in all pools at time t = 0 (from E.4)

- $C_{\text{leakage}(t)} = \text{TotC}_{\text{leakage}(t)} \quad (\text{tC})$

where

$C_{\text{leakage}(t)}$  = increase in GHG emissions by sources (at time t) which occurs outside the boundary which is measurable and attributable to the A/R CDM project activity

TotC<sub>leakage(t)</sub> = sum of GHG emissions from (negative) leakage at time t

**C.6. Quality control (QC) and quality assurance (QA) procedures are being undertaken for data monitored:**

<b>Data (Indicate table and ID number e.g. 3.-1.; 3.2.)</b>	<b>Uncertainty level of data (High/Medium/Low)</b>	<b>Explain QA/QC procedures planned for these data, or why such procedures are not necessary.</b>
<b>1.2.0 to 1.2.4. 2.2.0 to 2.2.4</b>	Medium	All field data and basic collation of field data will be subject to a random check by a supervising employee of not less than 5% of the plots established and collations done.

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<b>C.6. Quality control (QC) and quality assurance (QA) procedures are being undertaken for data monitored:</b>		
<b>Data (Indicate table and ID number e.g. 3.-1.; 3.2.)</b>	<b>Uncertainty level of data (High/Medium/Low)</b>	<b>Explain QA/QC procedures planned for these data, or why such procedures are not necessary.</b>
<b>1.1.1, 3.1.1, 3.1.2., 4.1.0</b>	Low	All area measurements will be subject to standard assessments of GPS point location error
<b>2.1.0</b>	Low	Equipment logs will be audited monthly to ensure completeness and accuracy
<b>IPCC and other outside data</b>	Various	IPCC and other sources will be routinely monitored for updates in constants and variables produced from outside data. Key data will be validated with data collected from the project, as explained in the Monitoring Methodology.

<b>C.7. Please describe the operational and management structure(s) that the project operator will implement in order to monitor <u>actual GHG removals by sinks</u> and any <u>leakage</u> generated by the proposed <u>A/R CDM project activity</u>:</b>
--

The Mountain Pine Ridge Reforestation Project will be managed by a team of professional foresters and technicians. This team will be responsible for:

- Implementation of the baseline management regime.
- Implementation of fire control and plantation management measures
- Implementation of the plot measurements, both within the Project Area, and in the unplanted Baseline Control Areas
- Layout and implementation of thinning and harvest activities with a primary goal of maintaining forest health to protect the sequestered carbon.

Quality control on the work of this team will be undertaken by the senior forester and his designates, who will check not less than 5% of the plots on each verification, and audit the summarization of the data.

All data will be preserved, for 2 years beyond the crediting period, within a GIS system, maintaining the geographical integrity of the data, and allowing for ease of audit.

Because changes in the implementation of the Baseline Management Plan/s in the Baseline Control Area/s could result in systematic bias in the measured changes in carbon stocks in the carbon pools in these areas, this implementation must be subject to independent audit or control. In order to ensure against such bias, the project proponent must either:

1. Put the management of the Baseline Control Areas under the control of an independent arms length entity acceptable to the Operational Entity, who shall be responsible both for ensuring that the Baseline Management Plan represents the most reasonable plan for achieving the Baseline Scenario, and for enacting the Baseline Management Plan in the Baseline Control Areas, or
2. Appoint an independent accredited auditor acceptable to the Operational Entity who shall audit the management of the Baseline control areas not less frequently than once per crediting period to ensure that:
  - a. The Baseline Management Plan represents the most reasonable plan for achieving the Baseline Scenario, and

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- b. Management of the Baseline Control Areas has been consistent with the Baseline Management Plan as regards the nature, timing, frequency, intensity and method of any management action, and
- c. The auditor finds no evidence of intentional bias in any of the management actions undertaken.

<b>C.8. Name of person/entity determining the <u>monitoring methodology</u>:</b>
--

Jolyon Hodgson and Robert Seaton  
Brinkman & Associates Reforestation Ltd  
520 Sharpe St  
New Westminster B.C. Canada  
V3M 4R2

Tel (604) 521-7771 ext 122

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**SECTION D. Estimation of net anthropogenic GHG removals by sinks:**

**D.1. Estimate of the actual net GHG removals by sinks:**

The model shows the following flow of actual net GHG removals by sinks, in tCO<sub>2</sub>e, on a cumulative basis:

Actual Net Greenhouse Gas Removals by Sinks  
tonnes CO<sub>2</sub>e

Year	Carbon Pools				Onsite Emissions	Net
	Trees	Brush	Grass & Herb	Total		
2002	150,404	64,868	157,097	372,369	8	372,362
2003	339,713	64,868	140,561	545,142	8	545,134
2004	554,515	58,381	120,717	733,613	8	733,605
2005	795,777	48,651	99,219	943,647	20	943,628
2006	1,113,673	25,947	74,414	1,214,035	22	1,214,012
2007	1,156,553	16,217	57,878	1,230,648	25	1,230,623
2008	1,448,260	14,271	57,878	1,520,409	25	1,520,383
2009	1,751,678	12,974	57,878	1,822,530	35	1,822,494
2010	1,273,430	19,460	82,683	1,375,573	35	1,375,538
2011	1,443,093	14,271	66,146	1,523,510	35	1,523,475
2012	1,535,602	9,730	57,878	1,603,211	49	1,603,162
2013	1,520,147	8,433	57,878	1,586,457	49	1,586,408
2014	1,625,822	6,487	57,878	1,690,186	49	1,690,137
2015	1,828,270	6,487	57,878	1,892,634	49	1,892,585
2016	1,945,950	6,487	57,878	2,010,315	117	2,010,198
2017	1,942,472	6,487	57,878	2,006,836	186	2,006,651
2018	2,073,354	6,487	57,878	2,137,719	254	2,137,465
2019	2,096,572	6,487	57,878	2,160,936	322	2,160,614
2020	2,186,527	6,487	57,878	2,250,892	391	2,250,501
2021	2,115,721	6,487	57,878	2,180,086	459	2,179,627
2022	2,105,731	6,487	57,878	2,170,096	527	2,169,568
2023	2,129,203	6,487	57,878	2,193,568	596	2,192,972
2024	1,948,273	6,487	57,878	2,012,638	664	2,011,974
2025	1,975,422	6,487	57,878	2,039,786	732	2,039,054
2026	1,747,364	6,487	57,878	1,811,729	801	1,810,928
2027	1,650,166	6,487	57,878	1,714,531	869	1,713,661
2028	1,607,398	6,487	57,878	1,671,763	938	1,670,825
2029	1,458,681	6,487	57,878	1,523,046	1,006	1,522,040
2030	1,515,135	6,487	57,878	1,579,500	1,074	1,578,426
2031	1,501,634	6,487	57,878	1,565,998	1,143	1,564,856
2032	1,444,498	6,487	57,878	1,508,862	1,211	1,507,651
TOTAL	1,444,498	6,487	57,878	1,508,862	1,211	1,507,651

Notes:

1) Planting is modeled to occur in 2002 (3900 Ha) and 2006 (4800 ha), for a total of 8700 ha planted

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- 2) Losses in the carbon pool in the trees reflect thinnings.
- 3) Losses in the carbon pools in the Shrub and Grass/Herb layers reflect shading by the planted conifers.
- 4) Onsite emissions in the early years are for transportation of equipment and supplies within the project area. Once thinning begins, emissions represent the use of harvesting equipment.

**D.2. Estimated baseline net GHG removals by sinks:**

Year	Carbon Pools (tCO <sub>2</sub> e)			Total
	Trees	Brush	Grass & Herb	
2002	19,750	58,856	120,031	198,637
2003	20,301	58,856	120,031	199,187
2004	20,851	58,856	120,031	199,738
2005	21,402	55,023	115,621	192,045
2006	21,952	51,740	111,845	185,537
2007	22,503	48,527	108,148	179,177
2008	23,053	45,084	104,187	172,323
2009	23,604	41,640	100,226	165,470
2010	24,154	38,197	96,265	158,616
2011	24,705	35,902	93,624	154,231
2012	25,255	35,902	93,624	154,781
2013	25,806	35,902	93,624	155,332
2014	26,356	35,902	93,624	155,882
2015	26,907	35,902	93,624	156,433
2016	27,457	35,902	93,624	156,983
2017	28,008	35,902	93,624	157,534
2018	28,558	35,902	93,624	158,084
2019	29,109	35,902	93,624	158,635
2020	29,659	35,902	93,624	159,185
2021	30,210	35,902	93,624	159,736
2022	30,760	35,902	93,624	160,286
2023	31,311	35,902	93,624	160,837
2024	31,861	35,902	93,624	161,387
2025	32,412	35,902	93,624	161,938
2026	32,962	35,902	93,624	162,488
2027	33,513	35,902	93,624	163,039
2028	34,063	35,902	93,624	163,589
2029	34,614	35,902	93,624	164,140
2030	35,164	35,902	93,624	164,690
2031	35,715	35,902	93,624	165,241
2032	36,265	35,902	93,624	165,791
TOTAL	36,265	35,902	93,624	165,791

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Notes:

- 1) Reduction of Shrub and Grass/Herb pools reflect return to fire dominance in unmanaged ecosystem
- 2) Increase in tree biomass reflects the growth of scattered trees surviving the fires.

<b>D.3. Estimated leakage:</b>
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Year	Cumulative tCO <sub>2</sub> e		
	<u>Management</u>	<u>Energy Leakage</u>	
	<u>Leakage</u>	<u>Offsite Fossil Fuel</u>	<u>Net</u>
	Fireguard Clearance	Emissions	Leakage
2002	-260	-31	-291
2003	-260	-4	-264
2004	-260	-4	-264
2005	-850	-10	-859
2006	-850	-90	-939
2007	-850	-25	-875
2008	-850	-25	-875
2009	-850	-32	-881
2010	-850	-25	-874
2011	-850	-18	-867
2012	-850	-15	-864
2013	-850	-15	-864
2014	-850	-15	-864
2015	-850	-49	-899
2016	-850	-117	-967
2017	-850	-186	-1,035
2018	-850	-254	-1,104
2019	-850	-322	-1,172
2020	-850	-391	-1,240
2021	-850	-459	-1,309
2022	-850	-527	-1,377
2023	-850	-596	-1,445
2024	-850	-664	-1,514
2025	-850	-732	-1,582
2026	-850	-801	-1,650
2027	-850	-869	-1,719
2028	-850	-938	-1,787
2029	-850	-1,006	-1,855
2030	-850	-1,074	-1,924
2031	-850	-1,143	-1,992
2032	-850	-1,211	-2,060
<b>TOTAL</b>	<b>-24,850</b>	<b>-11,648</b>	<b>-36,228</b>

Notes:

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1) Offsite fossil fuel emissions are for delivery of supplies, and delivery of logs to milling facilities

**D.4. The sum of D.1 minus D.2 minus D.3 representing the net anthropogenic GHG removals by sinks of the proposed A/R CDM project activity:**

	Cumulative sinks in tonnes CO <sub>2</sub> e			
	Actual Net	Baseline net	Leakage	Project Net
2002	351,789	-198,637	-291	152,861
2003	526,094	-199,187	-555	326,352
2004	717,006	-199,738	-819	516,449
2005	929,923	-192,045	-1,679	736,198
2006	1,204,710	-185,537	-2,619	1,016,554
2007	1,223,756	-179,177	-3,494	1,041,085
2008	1,513,696	-172,323	-4,369	1,337,004
2009	1,815,928	-165,470	-5,251	1,645,207
2010	1,366,071	-158,616	-6,126	1,201,329
2011	1,516,021	-154,231	-6,994	1,354,796
2012	1,596,895	-154,781	-7,859	1,434,255
2013	1,580,262	-155,332	-8,724	1,416,207
2014	1,684,172	-155,882	-9,589	1,518,700
2015	1,886,620	-156,433	-10,488	1,719,699
2016	2,004,232	-156,983	-11,455	1,835,794
2017	2,000,685	-157,534	-12,491	1,830,661
2018	2,131,499	-158,084	-13,595	1,959,820
2019	2,154,648	-158,635	-14,767	1,981,247
2020	2,244,536	-159,185	-16,008	2,069,342
2021	2,173,661	-159,736	-17,317	1,996,609
2022	2,163,603	-160,286	-18,694	1,984,623
2023	2,187,007	-160,837	-20,140	2,006,030
2024	2,006,008	-161,387	-21,654	1,822,967
2025	2,033,088	-161,938	-23,236	1,847,914
2026	1,804,962	-162,488	-24,887	1,617,587
2027	1,707,696	-163,039	-26,606	1,518,051
2028	1,664,860	-163,589	-28,394	1,472,876
2029	1,516,075	-164,140	-30,250	1,321,685
2030	1,572,460	-164,690	-32,174	1,375,596
2031	1,558,890	-165,241	-34,167	1,359,483
2032	1,501,686	-165,791	-36,228	1,299,667
TOTAL	1,501,686	-165,791	-36,228	1,299,667

**D.5. Table providing values obtained when applying formulae above:**

Formulas used in calculating the values given in the tables above are given in C.5. above.

Proposed sales of ICER's from the project will not exceed the minimum cumulative net sinks over the 30 year period. The current model is based on rapidly moving the project toward a stable timber supply.

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However, it is possible to substantially increase the total available ICER's by delaying thinning. This potential increase in supplies provides an inherent buffer for the project.

**SECTION E. Environmental impacts of the proposed A/R CDM project activity:**

**E.1. Documentation on the analysis of the environmental impacts, including impacts on biodiversity and natural ecosystems, and impacts outside the project boundary of the proposed A/R CDM project activity:**

The Mountain Pine Ridge Reforestation project is a restoration activity designed to ameliorate the environmental impact of the Southern Pine Beetle infestation. The CDM A/R project will reforest approximately 8700 ha of the total 20,000 ha pine area.

The current environmental conditions of the MPR area are far from ecological equilibrium. Fire protection, beginning in the 1950's, resulted in significant increases in the population density of pine in the area, resulting in a change from a fire dominated savannah to a dense pine forest. Failure to adequately manage this forest resulted in the oversupply of older age classes of trees, which combined with drought caused the epidemic outbreak of Southern Pine Bark Beetle at a much higher level of intensity and impact than would have occurred in the natural savannah ecosystem. This has eliminated *Pinus caribaea* from large portions of the MPR Forest Reserve.

MPR is an ecological island. An outcropping of ancient granitic bedrock, its soils support a unique ecosystem. Similar discontinuous areas are scattered in other areas of Central America. The dense forest conditions prevailing prior to the bark beetle outbreak had undoubtedly reduced or dramatically changed habitat conditions for a number of savannah-adapted species. However, these impacts were not documented.

The bark beetle infestation has moved the ecosystem to the other extreme. Eliminating the pine has eliminated food and habitat features for a significant number of species. Reductions in bird populations since 2000 have been anecdotally noted by lodge operators within the reserve. Increases in soil loss have also been noted in some areas where grass cover response has been poor.

The proposed project activity will not restore the natural savannah ecosystem that existed prior to fire control. However, it will restore a critical ecosystem component to the area. Because only a portion of the area will be planted, the project will result in a mix of dense pine areas within a larger grass dominated ecosystem. This mix will be more similar to the natural savannah than either the uniform dense pine forest under fire control, or the dead pine forest since the bark beetle outbreak.

For this reason, negative ecological impacts are not expected from the project. Initial analysis suggests that the project should lead to increased habitat for a number of pine dependent species, without eliminating habitat for species requiring more open, ecosystems.

Impacts outside the project boundary will largely be positive. The MPR area traditionally is a refugium and connective feature for animal and bird populations migrating through Central America. The project will provide significant cover areas and improved connectivity for those species.

No negative impacts on soil erosion or water quality are expected from the project. Typically, forests reduce run-off peaks, and improve water quality through filtration and reduction of erosion. The changes

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in the hydrograph from the area are expected to positively impact the hydroelectric project currently being undertaken on the Macal River which forms the southern border of the area.

The planned activities are fully supported by the Government of Belize and will meet all national environmental regulations.

**E.2. If any negative impact is considered significant by the project participants or the host Party, a statement that project participants have undertaken an environmental impact assessment, in accordance with the procedures required by the host Party, including conclusions and all references to support documentation:**

There are no significant negative impacts anticipated

**E.3. Description of planned monitoring and remedial measures to address significant impacts referred to in section E.2. above:**

None required

**SECTION F. Socio-economic impacts of the proposed A/R CDM project activity:**

>>

This section will be expanded. Stakeholders' comments have all been positive.

**F.1. Documentation on the analysis of the socio-economic impacts, including impacts outside the project boundary of the proposed A/R CDM project activity:**

>>

**F.2. If any negative impact is considered significant by the project participants or the host Party, a statement that project participants have undertaken a socioeconomic impact assessment, in accordance with the procedures required by the host Party, including conclusions and all references to support documentation:**

>>

There are no significant negative impacts anticipated

**F.3. Description of planned monitoring and remedial measures to address significant impacts referred to in section F.2 above:**

>>

None required

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**SECTION G. Stakeholders' comments:**

>>

**G.1. Brief description of how comments by local stakeholders have been invited and compiled:**

>>

Stakeholders comments were solicited on interview.

**G.2. Summary of the comments received:**

>>

All comments were positive and supportive of the A/R project

**G.3. Report on how due account was taken of any comments received:**

>>

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Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROPOSED A/R\_CDM PROJECT  
ACTIVITY

Organization:	Brinkman & Associates, Reforestation Ltd.
Street/P.O.Box:	520 Sharpe Street
Building:	
City:	New Westminster
State/Region:	British Columbia
Postfix/ZIP:	V3M 4R2
Country:	Canada
Telephone:	(604) 521-7771
FAX:	(604) 520-1968
E-Mail:	Dirk_Brinkman@brinkman.ca
URL:	www.brinkman.ca
Represented by:	Dirk Brinkman
Title:	CEO
Salutation:	Mr.
Last Name:	Brinkman
Middle Name:	
First Name:	Dirk
Department:	
Mobile:	
Direct FAX:	(604) 520-1968
Direct tel:	(604) 521-771 ext 111
Personal E-Mail:	Dirk_Brinkman@brinkman.ca

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Organization:	Government of Belize
Street/P.O.Box:	
Building:	
City:	Belmopan
State/Region:	
Postfix/ZIP:	
Country:	Belize CA
Telephone:	(501) 822-1524
FAX:	
E-Mail:	cfo@mnrei.gov.bz
URL:	
Represented by:	Osmany Salas
Title:	Chief Forestry Officer
Salutation:	Mr.
Last Name:	Salas
Middle Name:	
First Name:	Osmany
Department:	Forestry
Mobile:	
Direct FAX:	
Direct tel:	
Personal E-Mail:	

Organization:	Silviculture Belize Ltd.
Street/P.O.Box:	
Building:	
City:	Belize City
State/Region:	Belize
Postfix/ZIP:	
Country:	Belize
Telephone:	
FAX:	
E-Mail:	
URL:	
Represented by:	Brinkman & Associates, Reforestation Ltd.
Title:	
Salutation:	
Last Name:	
Middle Name:	
First Name:	
Department:	
Mobile:	
Direct FAX:	
Direct tel:	
Personal E-Mail:	

**Annex 2**

**INFORMATION REGARDING PUBLIC FUNDING**

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**Annex 3**

**BASELINE INFORMATION**

Variables derived from onsite measurements are detailed in the Baseline and Monitoring methodologies. Variables given below are derived from offsite data. Variables 1 to 3, below will be subject to onsite verification and revision using methods shown in Section B.6. of the Monitoring Methodology.

1. *Pinus caribaea* volume equation: Selection based on Mountain Pine Ridge field study conducted by Dr.Bredenkamp in 2002.

$$\text{Ln}V = b_0 + b_1 \ln(\text{dbh}) + b_2 \ln H$$

where

ln = natural logarithm to the base *e*

*H* = mean height (m)

*dbh* = breast height mean diameter (cm, over-bark)

and for *P.caribaea*

$$b_0 = - 10.5647$$

$$b_1 = 1.7790$$

$$b_2 = 1.2654$$

Source: Bredenkamp B. 2000 : Volume and Mass of Logs and Standing Trees *in* Owen D.L. (Ed) South African Forestry Handbook 2000. Pub. South African Institute of Forestry 734pp.

2. Biomass expansion factors for the plantation species (*Pinus caribaea*)

<u>Age</u>	<u>BEF</u>
1	3.57
2	2.90
3	2.50
4	2.30
5	2.25
6	2.09
7	2.00
8	1.89
9	1.79
10	1.72
11	1.67
12	1.62
13	1.58
14	1.57
15	1.55
16	1.53
17	1.51
18	1.49
19	1.47
20	1.45
21	1.39
22	1.36
23	1.33
24+	1.30

Source: IPCC GPG for LULUCF 3A.1.10 and S.L.Brown and P.E. Schroeder. 1999: Spatial Patterns of

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**FOR AFFORESTATION AND REFORESTATION PROJECT ACTIVITIES (CDM-AR-PDD) - Version 01**  
 Aboveground Production and Mortality of Woody Biomass for Eastern U.S. Forests. *Ecological Applications*, 9(3).

3. Root to shoot ratio - IPCC GPG for LULUCF 3A.1.8

4. GHG emissions from fuel use in power equipment (Outputs: kg per litre)

Fuel	CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O
Gas	2.2690538	0.0006609	0.0000198
Diesel	2.6799175	0.0001826	0.0000219

Source: Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories

5. Global warming potential conversion constants for CH<sub>4</sub> and N<sub>2</sub>O

CH<sub>4</sub> – 21,  
 N<sub>2</sub>O - 310

Source: IPCC

6. Carbon Fraction of Dry Matter - 0.5 for living biomass, 0.37 for deadwood and litter

Source: IPCC GPG for LULUCF default values

7. Wood density *P.caribaea* = 586 kgO.D./m<sup>3</sup>

Source: Hughes, J.F. 1970. A preliminary investigation of some structural features and properties of the wood of *Pinus caribaea* from British Honduras. Commonwealth Forestry Review 49: 336-355.

Other References Used

Hawkes, Mike. 1991. Management Plan for Mountain Pine Ridge Forest Reserve 1<sup>st</sup> April 1992 to 31<sup>st</sup> March 1997. Ministry of Natural Resources, Belmopan, Belize.

Midtgaard, Fred and Karl H. Thunes. 2003. Pine bark beetles in the Mountain Pine Ridge Forest Reserve, Belize: Description of the species and advice on monitoring and combating the beetle infestations. Norwegian Forestry Group. Oslo, Norway.

Sandom, J.H. 1990. A Forest Inventory of the Mountain Pine Ridge Belize 1990. Forestry Department, Government of Belize. Belmopan, Belize.

**Annex 4**

**MONITORING PLAN**

<b>Overall summary description of the methodology:</b>
--

The project area is stratified according to the following stratification method and hierarchy:

The stratification process will begin with stratification according to differences in the Baseline Scenario, if any, and only once each stage is complete will stratification at the next level down commence. At each step in the hierarchy, stratification will only occur within the strata determined at the next level up, and will not cross strata boundaries determined at higher levels.

- i) Baseline Scenario – areas with different baseline scenarios, as determined in step 4 above.
- ii) Project Management Regime – within an area with a common baseline scenario, areas with different management regimes under the A/R project activity, including substantially different species or species groups, different reforestation methods, and other factors
- iii) Projected carbon sequestration rates – within areas with the same Project Management Regime, areas where rates of carbon sequestration in measured carbon pools are expected to be significantly distinct due to soil, moisture, topography, or other factors.

Baseline Control Areas are selected on a stratum by stratum basis within the project boundary and the Baseline Management Plan for each stratum is applied to these areas. These control areas are monitored from the project start date to the end of the project to provide the baseline scenario and the time zero estimation of carbon stocks for the project activity areas. Each demonstration area must be large enough to reliably apply the baseline approach selected and described.

Because changes in the implementation of the Baseline Management Plan/s in the Baseline Control Area/s could result in systematic bias in the measured changes in carbon stocks in the carbon pools in these areas, this implementation must be subject to independent audit or control. In order to ensure against such bias, the project proponent must either:

3. Put the management of the Baseline Control Areas under the control of an independent arms length entity acceptable to the Operational Entity, who shall be responsible both for ensuring that the Baseline Management Plan represents the most reasonable plan for achieving the Baseline Scenario, and for enacting the Baseline Management Plan in the Baseline Control Areas, or
4. Appoint an independent accredited auditor acceptable to the Operational Entity who shall audit the management of the Baseline control areas not less frequently than once per crediting period to ensure that:
  - a. The Baseline Management Plan represents the most reasonable plan for achieving the Baseline Scenario, and
  - b. Management of the Baseline Control Areas has been consistent with the Baseline Management Plan as regards the nature, timing, frequency, intensity and method of any management action, and
  - c. The auditor finds no evidence of intentional bias in any of the management actions undertaken.

Within the Baseline Control Areas and within the A/R Activity Strata common sampling procedures are applied to provide an estimate of the carbon stocks in each pool. Details of the sampling procedures are given in B.2 of the Monitoring Methodology.

The number of sample plots is determined to ensure that sample means, for any parameter, meet the specified level of precision.

For each parameter measured by sampling an acceptable margin of error at the 95% confidence level is

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stated for the sample mean :

<b>ID Number</b>	<b>Data variable</b>	<b>Accuracy</b>	<b>Error</b>
<b>1.2.0</b>	mean stems per plot	<i>1.0</i>	±5%
<b>1.2.1</b>	Stratum mean height	<i>0.1m</i>	±5%
<b>1.2.2</b>	Stratum mean diameter	<i>1.0mm</i>	±5%
<b>3.2.0</b>	mean stems per plot	<i>1.0</i>	±5%
<b>3.2.1</b>	Stratum mean height	<i>0.1m</i>	±5%
<b>3.2.2</b>	Stratum mean diameter	<i>1.0mm</i>	±5%

### **Data Archiving**

All primary data shall be electronically archived, subject to the following methods and procedures:

1. Geographically specific data sets shall be archived within a GIS database, with all data tied to defined points or areas.
2. Data collected from non-geographically specific sources shall be archived in a database format.
3. Each data element shall be identified by its standard ID number and variable name, as given above
4. Date of collection, and the person(s) collecting the data shall be included in the GIS or database for every data element.
5. Where laboratory or other procedures are required to extract the data, the date of the procedure and the name of the lab or person conducting the procedure shall be included in the GIS or database.
6. All electronic data shall be backed up in an offsite location not less than weekly
7. GIS and database formats shall be widely used standard formats, or directly translatable to such formats.
8. GIS and database formats shall be updated as required, to ensure that data is readable by the latest versions of the programs used. Updating shall be subject to quality control procedures, to ensure continued data integrity, and datasets in previous formats current to the date of updating shall be saved for the duration of the project.

### **Calculation Procedures and Documentation**

Calculation procedures shall be as per those laid out in the Baseline Methodology and the Monitoring Methodology. All calculations shall be undertaken using a spreadsheet type program. Each spreadsheet used to conduct the calculations at a given time shall be archived electronically, to the following standards:

1. The date of the calculation and the name of the person(s) conducting the calculation shall be indicated in the spreadsheet.
2. All calculation spreadsheets shall be backed up in an offsite location not less than weekly
3. Spreadsheet formats shall be widely used standard formats, or directly translatable to such formats.

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4. Spreadsheet formats shall be updated as required, to ensure that data is readable by the latest versions of the programs used. Updating shall be subject to quality control procedures, to ensure continued data integrity, and spreadsheets in previous formats current to the date of updating shall be saved for the duration of the project.

APPENDICES

Appendix 1: Regeneration

Appendix 2: Area map & forest classification

Appendix 3: Vegetation map & types

Appendix 4: Geology, topography & soils

Appendix 5: Climate

Appendix 6: Seed authenticity

Appendix 7: Nursery photographs

Appendix 8: Forest policy

Appendix 9: Assignment of Carbon Rights

**APPENDIX 1**  
**Regeneration**



*Ministry of Natural Resources, the Environment, Commerce and Industry*  
*Belmopan, Belize, C.A. ph: 501-822-2199; Fax: 501-822-2923*

23 August, 2002

**TO WHOM IT MAY CONCERN**

**NATURAL REGENERATION:**  
**MOUNTAIN PINE RIDGE FOREST RESERVE – BELIZE C.A.**

Following the widespread mortality of the *Pinus caribaea var. hondurensis* in the Mountain Pine Ridge Forest Reserve due to the attack of the Southern Pine Bark Beetle, officials of the Forestry Department have conducted a survey of forest health and regeneration.

We have found that an area totaling over 70,000 acres has suffered tree mortality exceeding 90% and minimal regeneration of the pine forest.

We conclude that regeneration with the same pine species can only be achieved through planting nursery-grown tree seedlings.

Signed:   
Oswaldo Sabido  
Chief Forest Officer

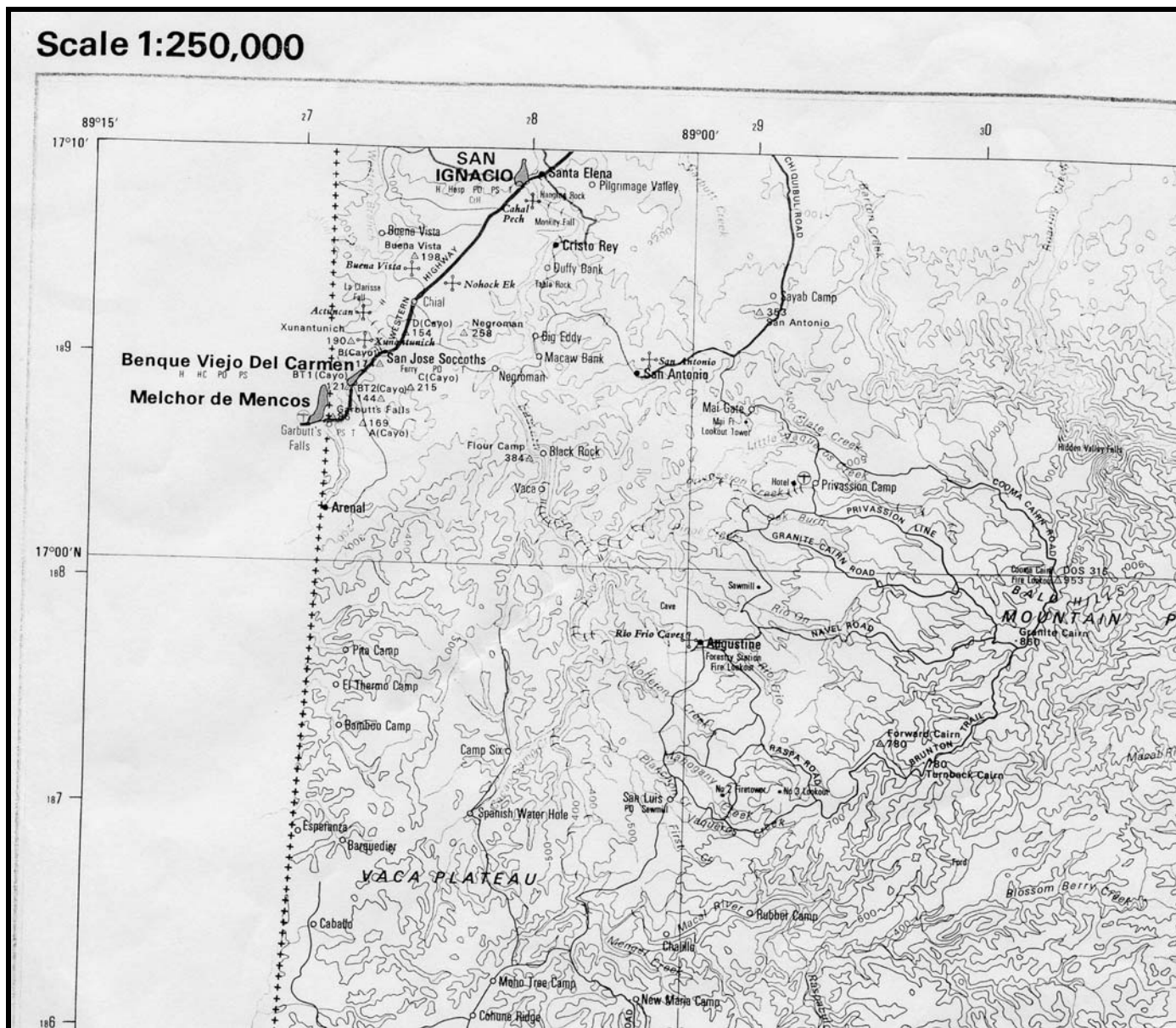
Signed:   
John Briceño  
Minister of Natural Resources, the Environment  
Commerce and Industry

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**APPENDIX 2 : AREA MAP AND FOREST TYPING**

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### **1990 Forest Type Classification**

The 1990 inventory (Sandom 1990) followed a similar design to that of the 1970 Inventory (Johnson and Chaffey 1970) restricted to pine dominated areas. Aerial photography was used to stratify the pine forest based on observed canopy densities. While the 1970 inventory divided the forest into three classes, the 1990 inventory identified eighteen strata.

Excluding the large block of pure broadleaves in the west of the reserve, the primary split was between vegetation. Non-pine vegetation was divided into three categories:

- (G) Grass - Areas of grass (pine absent or rare).
- (H) Hardwood - Gallery forests.
- (S) Swamp - Very limited in extent.

The pine dominated areas were divided into five maturity classes:

- Class 1 Sapling stage with the majority of stems below 5cm dbh or under 3m in height.
- Class 2 Small pole crop with the majority of stems between 5-15 cm dbh and over 3m in height.
- Class 3 Medium pole crop with the majority of stems between 15-25 cm dbh (approximately midway to maturity).
- Class 4 Old pole crop with the majority of stems between 25-35 cm dbh.
- Class 5 Mature crop with sufficient number of stems over 35 cm ready for harvesting.

Each maturity class was then further subdivided according to three canopy closure classes:

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- Class A                      Canopy cover 70% or greater (unspaced or unthinned).
- Class B                      Canopy cover between 30-70% (medium spacing).
- Class C                      Canopy covers 30% or less (wide/very wide spacing)

One additional stratification class was required to account for areas showing greater variability in stocking and crown closure. The M (matrix) modifier was therefore included.

Each resulting type is briefly described below:

- IA            Densely stocked young saplings as may result from successful natural regeneration after fire. None was recorded in the inventory.
- IB            As IA above but less well stocked. None recorded.
- IC            Sparsely stocked young generation which tends to occur as pines spread on open grassland which has not been recently burned or which is particularly susceptible to seasonal moisture stress.
- 2A           Densely stocked (typically 1500 sph) young pole crop. Canopy closure typically 70% or more. Majority of stems 5cm - 15cm DBH.
- 2B           Relatively moderately stocked (typically 1150 sph) young pole stage stand with canopy closure between 30% and 70%.
- 2C           Relatively wide spaced (typically 1000 sph) young pole stage crop with canopy closure 30% or less. Tend to occur on less fertile sites.
- 2BM        Matrix of 2B type cover , but with greater variability in density
- 3A           Densely stocked (typically 1100 sph) mid pole stage crop with most trees between 15cm and 25cm DBH and canopy closure in excess of 70%
- 3B           As 3A but less densely stocked (typically 850 sph).
- 3C           As 3B but less densely stocked (< 30% crown closure).
- 4A           Densely stocked (typically 810 sph) late pole stage crop.
- 4B           As, 4A but less densely stocked (typically 780 sph).
- 4C           As 4B but less well stocked (<30% crown closure).
- 5A           Densely stocked mature crop (none recorded)

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5B Densely stocked (approx. 480 sph) mature crop with canopy closure between 30% & 70%. Most stems with a DBH of 35cm or greater. Largely occupying more fertile sites.

5C Widely spaced mature trees commonly over sapling stage natural regeneration.

The remaining non-Pine categories were:

HW Areas dominated by hardwood trees, mostly gallery forests along water courses or occupying limestone outcrops. 8,800 Ha were recorded, representing 21% of the inventory area.

G Areas dominated by grasses and sedges mostly occurring on exposed ridges of the Baldy sub suite of metasediments in the North East and East of the reserve (Sandom 1990). Nearly 1800 Ha recorded and this classification accounts for 4% of the inventory area.

S Swamp areas which are limited to less than 300 Ha or approximately 1% of the inventory area.

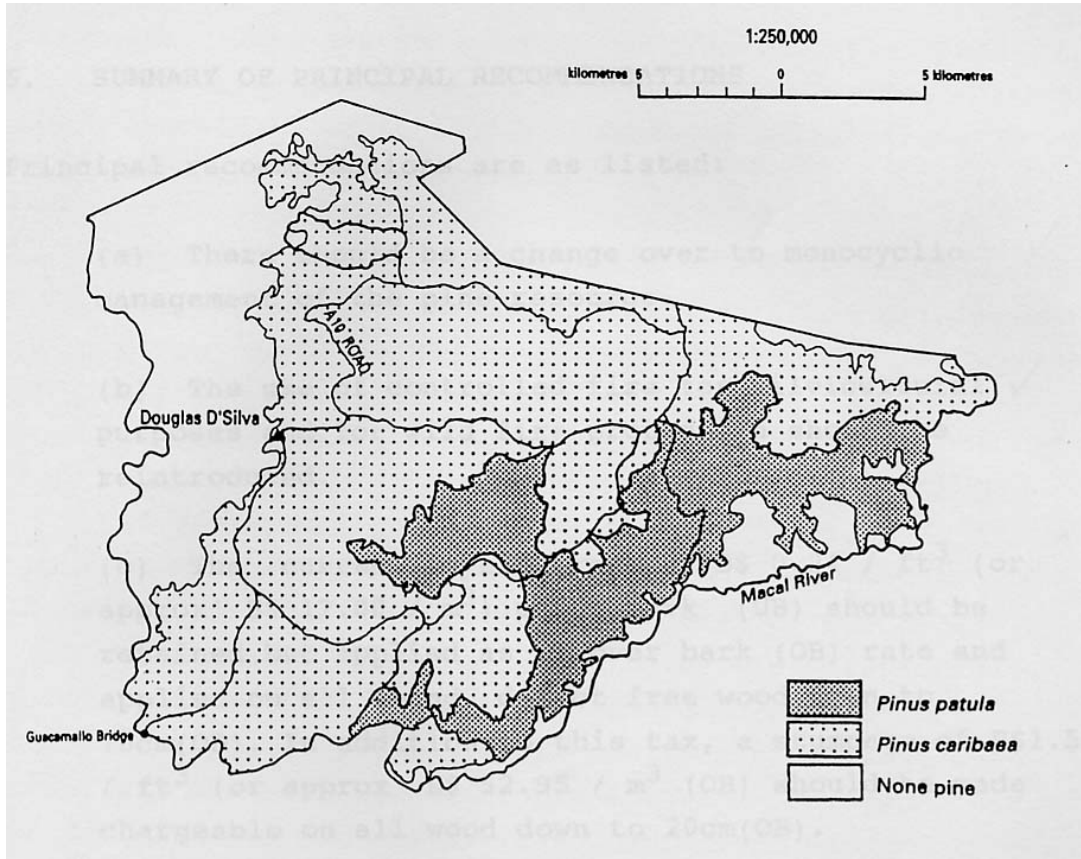
Other non-pine areas amount to 350 Ha.

**Table of Areas by Forest Type.**

Vegetation Type	Code	Area (ha)	% of Reserve
<b>Grass</b>	G	1777.4	3.4
<b>Hardwood</b>	H	8809.8	16.9
<b>Swamp</b>	S	292.4	0.5
<b>Western Hardwoods</b>	WH	10329.7	20.0
<b>Pine</b>	P	30416.9	58.5
Others (roads, non-prod)	0	350.6	0.7
<b>TOTAL</b>		51976.8	100.0

### APPENDIX 3

#### Vegetation Map and Types



Since 1947 several attempts have been made to classify vegetation types within the reserve using various international classification systems. Perhaps most useful for management of MPRFR are the five broad vegetation types outlined in the 1990 inventory (Sandom 1990) which provide easy understanding of the mosaic of vegetation types within the reserve:

1. Hardwood on Limestone - occurs in the west of the reserve on limestone parent material as a continuous block and on outlying hills with limestone caps. Composed of pure broadleaves with pine entirely absent. Within this vegetation type all ages of individuals are present. This vegetation type has been repeatedly impacted by harvesting operations over a long period. Species include mahogany (*Swietenia macrophylla*), santa maria (*Calophyllum brasiliense*), nargusta (*Terminalia amazonia*), cedar (*Cedrela odorata*) and sapote (*Manilkara zapota*).
2. Hardwood on Granite - occurs in blocks or strips of pure or nearly pure broadleaved species commonly a few tens to several hundred metres in width.

Frequently associated with streams and riversides and commonly termed gallery forest. Although these areas contain many of the broadleaved species found on limestone parent material in the west they are markedly different. In particular cedar (*Cedrela odorata*) and sapote (*Manilkara zapota*) are extremely infrequent and yemeri (*Vochysia hondurensis*) is present in high numbers. Another marked difference is the presence of pine within these stands. Large stands of this type of vegetation can be found flanking the Macal River on the eastern and southern boundaries of the reserve and as a network of corridors flanking streams and rivers within the reserve.

3. Pine Forest Dominated by *Pinus caribaea* - this vegetation type occurs over the majority of the reserve and displays a wide range of ages and densities of pine in either pure stands of pine or pine mixed with broadleaves. The amount and composition of broad leaves varies considerably, rarely as an overstorey most frequently as an understorey. In stands where pine constitutes a pure dense overstorey the understorey usually consists of a variety of grasses and sedges including *Axonopus* species, *Mesosetum filifolium*, *Paspalum plicatum* and *Trachypogon* species. Oak (*Quercus* species), craboo (*Byrsonima crassifolia*) and various *Melastomataceae* family shrubs can be found as individuals or in small groups. In moister areas two species can dominate the understorey in localised areas. Tiger bush (*Dicranopteris pectinata*) and dumb cane (*Tripsacum latifolium*) can exhibit prodigious growth totally excluding other species over small areas. Rarely, where the pine are very widely spaced the broadleaved component can be well developed. It rarely reaches a point where it competes with the pine component.
4. Pine Forest Dominated by *Pinus patula* (*P. tecunumannii*)-like *Pinus caribaea*, *Pinus patula* is present in a range of age classes and stand densities. However marked differences exist between these two vegetation types. *Pinus patula* is commonly found in pure stands of sufficient density to exclude most of the overstorey and understorey species found in association with *Pinus caribaea*.

Broadleaves can be found but as sporadic individuals or in small groups where the canopy of *Pinus patula* is broken. Extensive understoreys are generally absent from stands of *Pinus patula*, however tiger bush (*Dicranopteris pectinata*) and dumb cane (*Tripsacum latifolium*) frequently form a dense continuous layer over large areas.

5. Grass – this vegetation type is found in a restricted area on exposed ridges in the vicinity of Baldy Beacon. *Pinus caribaea*, *Pinus patula* and the associated broadleaved species are frequently absent from the ridgetops and restricted to lower valley slopes and bottoms. Grass species include *Axonopus purpusii*, *Mesosetum filifolium*, *Paspalum plicatum* and *Trachypogon plumosus* (Kellman 1985 and Sandom 1990).

## APPENDIX 4

### Geology, Topography & Soils

#### **Geologically MPRFR can be divided into four distinct phases of development.**

MPRFR lies to the north west of one of the major geological features of Belize, the Maya Mountain Massif. This has been found to be derived from material laid down in the Pennsylvanian and Permian eras (280-300 million years ago). Within MPRFR this is manifested by the presence of mudstones, shales, slates and sandstones. These metasediments have been identified as part of the Santa Rosa Group.

In the early Triassic period (230 million years ago) the Santa Rosa Group was subjected to a series of granitic intrusions.

Following this in the Cretaceous period (100 million years ago) the area was submerged by a shallow warm sea which permitted the deposition of a substantial layer of limestone. Subsequent uplifting of the area followed by erosion has meant that most of the limestone cap has been removed from within MPRFR except for the extreme west and north of the reserve where typical karst topography can be observed. Also individual hills where the limestone cap has not been fully removed remain as limestone outliers to the main area. Where the limestone has been removed the igneous granite and metasediments are exposed. Faulting, folding and further intrusions have added some additional features. The geology of MPRFR can be divided into three main units. In the west lying as a continuous band flanking the Eastern Branch the limestone cap remains. This material is contiguous with the Vaca Plateau which lies to the west of Eastern Branch. The central portion of the reserve consists of a heavily weathered and eroded granitic basin. Thirdly a crescent-shaped band of Santa Rosa Group metasediments lie to the northeast, east and south of the reserve bounded by the Macal River.

#### Topography

The reserve contains a wide range of landforms and topographic features. Elevation within the reserve is at a maximum 1020 m (3336 feet) at Baldy Beacon and minimum of 120 m (394 feet) on the Macal River at Black Rock. The central granite basin lies at an average elevation of between 400-700 m (1312-2296 feet).

The limestone area in the west of the reserve displays typical karstic topography with moderately rough landforms and steep slopes. Sink holes and cave systems are frequent. The central granite basin has in the west extremely flat level areas thought to result from the presence of a lake induced by poor drainage caused by the limestone mass to the west. From west to east the central granite basin displays increasingly broken and rough topography from these flat areas through rolling features to frequently dissected steep sided hills. The metasediments in the east contain rough to very rough topography. Valleys are very steep sided, often over 35°.

With the exception of a small number of streams in the north east of the reserve which flow into the Upper Barton Creek, all rivers flow into the Macal River or Eastern Branch. All rivers eventually discharge into the Belize River.

## Soils

The soils of MPRFR have been surveyed on three occasions by Wright *et al* (1959), Hartshorn *et al* (1984) and King *et al* (1992). This latest analysis was used in the preparation of the 1990 inventory (Sandom 1990).

The majority of the reserve consists of two soil suites - Stopper and Ossary. Much smaller areas are classified as belonging to the Melinda and Vaca suites. Spatially these suites are arranged as follows - the Melinda suite in river valleys on the Macal River or its tributaries, the Vaca suite is located on the limestone area in the west of the reserve, the Stopper suite overlying the granite basin in the central section of the reserve and the Ossary situated in the eastern part of the reserve overlying the metasediments.

Within these suites several subsuites exist. The Ossary includes all soils derived from the Santa Rosa Group of metasediments. Within the reserve four subsuites are present. Of greatest extent is the Cooma subsuite. Consisting of sandy to sandy clay soils these are relatively deep but suffer from base and nutrient deficiencies. Closely related is the shallower Chiquibul subsuite. These soils are vulnerable to erosion. King *et al* (1992) suggested these soils are best left under natural vegetation. The Baldy subsuite is represented in the reserve by the soils of the grassland around Baldy Beacon. These soils are extremely acid and leached resulting in marked nutrient deficiency.

The Stopper suite includes all soils derived from granitic parent material. The largest subsuite is the Pinol subsuite and consists of sandy loams to sandy clay loams. These acid soils are well leached, are base deficient with very low phosphorus levels. Two smaller subsuites exist - Stopper of very limited extent and Pinol + Mayflower flanking the Rio On Creek and Eastern Branch.

The third largest suite, the Vaca suite contains calcareous clays derived from limestone parent material. Only one subsuite exists - the Cuxu subsuite. Debate exists whether this subsuite should be incorporated into the Chacalte suite. Soils are frequently thin overlying hard fractured limestone which is frequently exposed. Deeper Cuxu soils elsewhere in Belize have been used for agriculture, however problems have been encountered due to the soils extreme droughtiness.

The final Melinda suite covers a very small area within the reserve and consists of soils developed in riverine alluvium. These are differentiated by age and presence of siliceous and/or calcareous alluvium.

## APPENDIX 5

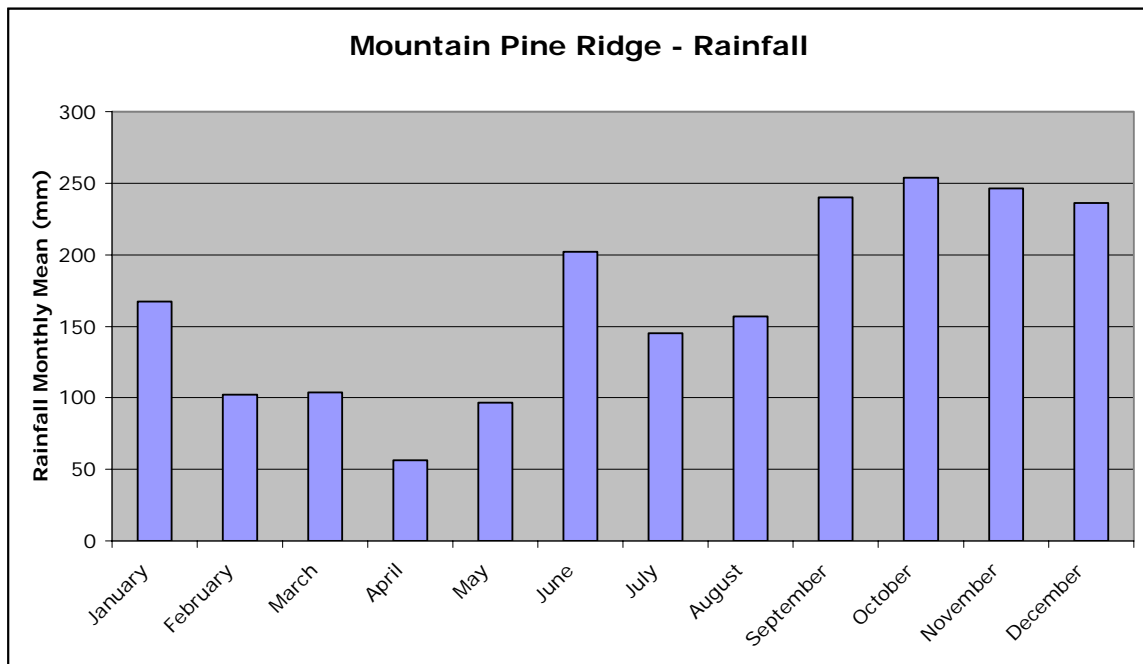
### Climate

The general climate of Belize shows two distinct seasons. A dry season prevails between February and May and a wet season from June to January. The latter part of the dry season is often punctuated by electrical storms which increase in severity and frequency until the beginning of the rains. This has a major impact on MPRFR through the incidence of wild fires.

Belize has been repeatedly affected by hurricanes. Within the last 200 years 18 have impacted on Belize, with severe damage being caused in 1961, by Hurricane Hattie (Friesner 1993).

Readings from DDFS and Cooma Cairn (in the north east of the reserve at 920 m elevation) meteorological stations have been incomplete over the past few years. However meteorological data taken from King et al (1992) is sufficient for forestry planning purposes.

Total rainfall at DDFS is 1559 mm (61 in) and at Cooma Cairn 2101 mm (83 in). The distribution of this rainfall is markedly uneven through the year. During the dry season, February to May monthly rainfall can be less than 100 mm (4 in). From the beginning of the wet season in June rainfall increases to a monthly maximum in September/October of 250 mm (9.5 in), then declines slowly until the dry season commences in February.



Mean rainfall at Bull Run 1980 – 1994

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Temperature readings have also been recorded at DDFS and Cooma Cairn giving mean annual maxima of 29°C and 25°C and mean annual minima of 19°C and 17°C for DDFS and Cooma Cairn respectively. Record extremes of temperature are 39°C and 6°C for DDFS and 36°C and 7°C for Cooma Cairn.

Average monthly temperature figures show that January is the coolest month with a steady rise in temperature through the dry season until May and the advent of the wet season. Thereafter temperatures decrease until the January minimum.

## APPENDIX 6

### Seed Authenticity



Department of  
Primary Industries

Enquiries: Daryl Goschnick  
Telephone: +61 7 54940362

12 April 2002

Chief Executive Officer  
Silviculture Belize Ltd  
**BELIZE CITY, BELIZE**

Dear Sir

*Pinus caribaea var hondurensis*

#### **Mountain Pine Ridge Reforestation Project.**

The seed material, identified as Seedlot 12360, 12073, 12074, 12075 are collected from Seed Orchards and Seed Stand whose original seed source was British Mountain Pine Ridge Belize. These seedlots will be supplied for use in the Mountain Pine Ridge Reforestation Project.

Yours faithfully

A handwritten signature in black ink, appearing to read "D. N. Goschnick".

D N Goschnick  
**Senior Seeds Officer**

#### **Forestry**

Forestry Tree Seed Centre  
201 Rye Road  
Beverly Qld 4519  
AUSTRALIA

Facsimile 61 7 54940068  
Email [Daryl.Goschnick@dpi.qld.gov.au](mailto:Daryl.Goschnick@dpi.qld.gov.au)  
Mobile  
Website [www.dpi.qld.gov.au](http://www.dpi.qld.gov.au)  
Call Centre 13 25 23  
DPI Fax File Ref 635 05 130



To whom it may concern,

The Queensland Department of Primary Industries Forestry has recently supplied 110 kilogrammes of seed of *Pinus caribaea* var *hondurensis* (PCH) to Silviculture Belize, 90 Barrack Road, Belize City, Belize, Central America. The seed was harvested in February 2002 in the Department's Kennedy Clonal Seed Orchard (CSO).

Seed from the Kennedy CSO is both high in viability and genetic quality. Seedlings grown from this seed should be of excellent form and vigorous growth. The use of this seed should contribute significantly to the re-establishment of a quality forest in the Mountain Pine Ridge Forest Reserve.

The following summary and references provide information in support of the expected performance of this seed.

#### **Improvement**

Kennedy CSO was established using grafts from trees selected for their excellent vigour, outstanding stem form and windfirmness in plantations in coastal Queensland. These plantations were established with seedlings grown from seed of the Mountain Pine Ridge (MPR) provenance of PCH purchased by this Department from the Forest Department of British Honduras (Belize). (See Nikles, D.G. 1996. The first 50 years of the evolution of Forest Tree Improvement in Queensland. in Dieters *et al.*(ed.) Tree Improvement for Sustainable Tropical Forestry. Proc. QFRI-IUFRO Conf., Caloundra, Queensland, 27 October - 1 November, 1996).

#### **Selection**

Nikles (1996) lists the selection criteria as: "good growth rate; good stem straightness; long, clear bole free of forking; light branching that is not sleep; freedom from high susceptibility to insect pests and freedom from disease; and, a range of basic densities of the wood around the current mean." Trees selected for inclusion in Kennedy CSO were selected at an intensity of about 1 tree in 40,000. Subsequently the clones were rogued to remove poor families and further improve the quality of the seed produced.

#### **Performance**

Genetic tests over the years have shown that seed from the Kennedy CSO yields trees of superior volume growth and stem form. When compared with trees grown from seed collected in Poptun, Guatemala, which has been used to represent the native provenance of Mountain Pine Ridge in our comparative growth studies, trees of Kennedy CSO origin yielded 29 to 36% better stem wood volume and three to five times better stem form. (See Research Report 1986 and 1987, Department of Forestry, Queensland, pp. 45-51)

International trials of PCH laid out and assessed by the Oxford Forestry Institute have shown that PCH selected in Queensland, from stands of MPR origin, has consistently maintained superiority in survival and growth over a wide range of sites (see Hodge, G.R. *et al.* 2000. Growth and Provenance Variation in *Pinus caribaea* var. *hondurensis* as an Exotic Species. in Forest Genetics for The Next Millennium. IUFRO Working Party 2.08.01 Conference, Durban, South Africa, p.36).

#### **Windfirmness**

Evidence to suggest that the windfirmness of PCH has been improved by selection is presented in Nikles, D.G., Spidy, T., Rider, E.J., Eisemann, R.L., Newton, R.S., and Matthews-Frederick, D. (1983). Genetic variation in windfirmness among provenances of *Pinus caribaea* Mor. var. *hondurensis* Barr. and Golf. in Queensland. *Silvicultura* 8:124-130.

An improvement of 16% in the windfirmness of trees derived from Kennedy CSO seed over unimproved stock is reported in a study by Dieters, M.J. (2000). Performance of *Pinus caribaea* hybrids in north and central Queensland, and on dry sites in south-east Queensland in "Hybrid Breeding and Genetics of Forest Trees" Proceedings of QFRI/CRC-SPF Symposium. 9-14 April 2000, Noosa, Queensland, Australia.

#### **Drought tolerance**

The trees in Kennedy CSO were not selected specifically and intensively for drought tolerance. However, selection automatically included adaptation to the growing environments all of which experience annual dry seasons of severity varying with latitude and distance from the coast, and all are subject to occasional, unusual drought.

The mean annual rainfall, mean number of rain days, highest and lowest annual rainfall for the major Queensland plantation sites are shown in Hawkins, P.J. and Muir, J.D. 1968, (Revised 1987). Aspects of management of plantations in tropical and subtropical Qld. Ninth Commonwealth Forestry Conference, 1968. The lowest annual rainfalls were 448 mm and 465 mm for Gregory and Tuan respectively, while the mean annual rainfall for these two centers was 1,090 and 1,337 mm.

PCH is regarded as a drought tolerant species in Queensland.

#### **Pest Resistance**

As an exotic species to Queensland, PCH has not been subject to naturally occurring pests and diseases present in Belize. Pests have periodically occurred in Queensland plantations, but these have subsided without intervention by management following the development of natural predators.

As a result there has been minimal selection pressure caused by pests and diseases in Queensland. Consequently the seed supplied should be of comparable pest resistance to Mountain Pine Ridge provenance of *P. caribaea* var. *hondurensis*.

**DPI Forestry, Queensland**  
**15<sup>th</sup> May 2002**

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#### **Disclaimer:**

This information is distributed by the Department of Primary Industries (Forestry), for and on behalf of the State of Queensland ("DPIF") as a background information source only.

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APPENDIX 7

Nursery Photos



## APPENDIX 8 : FOREST POLICY

M.P. 759/53.

Colonial Secretary's Office,  
Belize, 2nd September, 1954.

### FOREST POLICY OF BRITISH HONDURAS.

The following Forest Policy of the Government of British Honduras as approved by the Governor in Council is published for general information:—

The Forest Policy of the Government of British Honduras is:—

1. *To establish, preserve for all time and develop a Crown Lands Forest Estate* consisting of areas of Crown Land in any of the following categories:—

- (a) land unsuitable for permanent agriculture but supporting or capable of supporting forest.
- (b) land capable of producing a greater sustained financial return, if retained or developed as forest than if used for other purposes.
- (c) land which is best kept or put under forest for the better protection of watersheds, catchment areas, drainage basins, steep hill slopes and for the prevention of erosion, the control of run-off, the regulation of stream-flow and the stabilisation of the climate.
- (d) areas which are required for the production of fuelwood for use in the towns and villages or by local industries, or for the production of rough building and fencing materials for local use.
- (e) areas which from time to time may be set aside as nature reserves.

2. *In order to establish the Forest Estate*, to survey, demarcate, and constitute as Forest Reserves by proclamation, all Crown Land areas described in paragraph 1 above. Forest Reserves once constituted will only be dereserved wholly or in part by the Governor in Council as a result of some over-riding public necessity.

3. *In order to preserve the Forest Estate*, to maintain demarcated boundaries by clearing of traces and maintenance of boundary marks as may be necessary to afford protection to the forests from fire, animals, insect pests or diseases, trespass and illicit felling, removal of or damage to forest produce, by such measures including legislation as the Government may deem advisable and practicable; and to place all exploitable Forest Reserves under sustained yield management by enumeration surveys, and calculation of increment or other practicable methods of yield control; by control of exploitation, and by natural or artificial regeneration and tending operations, so that their yield of timber and other forest produce will be maintained in perpetuity.

4. *In order to develop the Forest Estate*, and thus ensure an adequate and increasing supply of timber and other forest produce at a reasonable price to the people, industries and timber trade of British Honduras, and for export; to establish intensive regeneration centres in selected forest reserves. At these regeneration centres, the aim will be to create fully stocked forests or plantations of mahogany, cedar, pine or other species including exotics by artificial or intensively-assisted natural regeneration over areas adequate to supply in perpetuity a sawmill or processing plant of economic size at or near each centre.

5. *To increase production from Forest Reserves* by ensuring full utilization of prime hardwoods and pine, and encouraging the use of secondary hardwoods and other forest produce; by developing local and export markets for small dimension stock of prime hardwoods and pine; for secondary hardwoods and other forest produce: by exploring the possibilities of other forms of Forest utilisation, for example for paper pulp.

6. *To raise the quality of sawn lumber exported to world markets* by the institution of Timber grading, the encouragement of seasoning and of accurate sawing and machining to specification, in order to achieve assured markets for British Honduras timber abroad.

7. *To promote the practice of forestry on freehold lands*, by the control of felling of mahogany, cedar and such other species as the Government may deem advisable, by the inspection and marking for felling of trees of these species to specified minimum girth limits; encouraging and assisting landowners to draw up and implement simple working plans for the sustained yield management on approved lines of their forest land in the categories described in 1 (a), (b), (c) and (d) above; and by encouraging and assisting afforestation on private lands.

8. *To control the exploitation of forests and forest produce growing outside Forest Reserves on Crown Land not yet taken up for agriculture* by the issue of Forest produce licences framed in such a way that these forests, which are a wasting asset on land allocated to agriculture, will continue to augment the yield from Forest Reserves for as long a time as possible during the period when Forest Reserves are being brought up to full production.

9. *To bring about an increased appreciation of the need for and aims of forest conservation amongst the general public* by propaganda over the British Honduras Broadcasting Station, and to the schools.

10. *To maintain a Forest Department of sufficient strength and supplied with sufficient funds to carry out the Forest Policy set forth in 1 to 9 above*; supported by an adequate research programme; and to staff the Forest Department with personnel recruited locally so far as possible and trained at established University Schools of Forestry, or at Forester training schools, or locally, as may be appropriate to the different grades.

Dated this 28th day of October, 1954.

P. M. RENISON,  
Governor

APPENDIX 9

Assignment of Carbon Rights

BELIZE

**DEED OF ASSIGNMENT**

THIS DEED OF ASSIGNMENT is made this 28<sup>th</sup> day of December 2011 between THE GOVERNMENT OF BELIZE (hereinafter referred to as the GOBL) of the ONE PART and SILVACULTURE BELIZE LTD a limited liability company duly registered under the Law of Belize with its registered office located at No. 65 Chiguan street, Belize City, Belize (hereinafter referred to as the Company) of the OTHER PART.

The purpose of this Assignment between the GOBL and the Company is to provide renewable sustainability and carbon storage in the 90,000 acres of the Mearns Pine Ridge Forest Reserve (hereinafter referred to as "MPFR") through a reforestation project that will re-establish the natural endemic forest ecosystem.

In view of this Assignment the company agrees to fulfill its potential funding for the MPFR, administrative services that will create, enhance and protect carbon sequestration within the MPFR.

By virtue of this Assignment, GOBL hereby assigns to the Company for a period of 25 years and all Carbon Credits existing and created within the 90,000 acres of the MPFR and the Company is permitted by GOBL to transfer and sell the value of these Carbon Credits.

The transfer or assignment of the carbon credit is subject to prior approval of the GOBL acting through its Ministry responsible for Forestry such approval not to be unreasonably withheld.

These Carbon Credits will be offered as an investment under offer for Greenhouse Gas Credits for a term of 10 to 15 years.

The participation of maintenance or management by any party other than the GOBL requires prior approval from the GOBL. The GOBL further agrees to ensure that the MPFR remains as a Forest Reserve for at least 25 years.

The GOBL, retains all rights to the MPFR and accepts the responsibility for the MPFR.

IN WITNESS WHEREOF the parties have hereunto set their hands and seals the day and year first before written.

SIGNATURE(S) AND DELIVERED BY:  
 The Honourable JILL BRISCO, Minister of Natural Resources for and on behalf of the Government of Belize

*[Signature]*  
 JOHN BRUCINO  
 (on behalf of SILVACULTURE BELIZE LTD)

*[Signature]*



COMMON SEAL OF SILVACULTURE BELIZE LTD was hereunto affixed in the presence of

CHALEMAN JURELSON  
 DIRECTOR  
*[Signature]*  
 WITNESS

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**CERTIFICATE OF ASSIGNMENT**

Certificate No. 001 Number of Acres: 9600

THIS IS TO CERTIFY that the benefit of this Certificate is entitled to the Carbon Offset to be derived from the MOUNTAIN PINE RIDGE FOREST RESERVE, Belize for a term of 55 years subject to the terms and conditions contained in the Annexes of this Certificate.

DATE: 12<sup>th</sup> Dec 2012 TO: 12<sup>th</sup> Dec 2012

 TO 

THE HON. JOHN DELPINO SILVICULTURE BELIZE  
Deputy Prime Minister and Minister of Natural Resources and Environment of the Government of Belize COMMONWEALTH OF BELIZE, C.A.

DATE: 12<sup>th</sup> Dec 2012 TO: 12<sup>th</sup> Dec 2012

SILVICULTURE BELIZE LTD TO: \_\_\_\_\_

**TERMS AND CONDITIONS**

1. This Certificate shall be valid for a term of 55 years from the date of transfer from SILVICULTURE BELIZE LIMITED.
2. At the end of the 55 year period, this Certificate shall become void and all mineral proceeds shall be determined and distributed if not in accordance with Annex 1.
3. The Government of Belize retains all rights to the forest and accepts this obligation to maintain the status of the MOUNTAIN PINE RIDGE FOREST RESERVE as forest.

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