

LOGGING OPERATIONS  
SOUTHERN FOREST INDUSTRY



PUBLIC ENVIRONMENTAL  
REPORT

JULY 2015

<b>TABLE OF CONTENT</b>	<b>2</b>
Executive Summary	5
Chapter 1: Introduction	7
1.1 Project proponent	7
1.2 Nature of project	7
1.3 Location of project	8
1.4 Need for project	8
1.5 Institutional and Legal Framework	8
1.6 Scope of report	10
1.7 Study Approach	10
Chapter 2: Description of Major Project Activities	12
2.1 Roading	12
2.2 Skid tracks	12
2.3 Gravel borrow pits	13
2.4 Log landings	13
2.5 Machinery	13
2.6 Workshop	14
2.7 Log pond and wharf	14
2.8 Housing/camp	15
2.9 Bridge	15
2.10 Timber harvesting	15
Chapter 3: Description of Environmental Setting	17
3.1 Physical Environment	17
3.1.1 Geology and soil	17
3.1.2 Topography and landform	17
3.1.3 Surface and groundwater hydrology	17
3.1.4 Climate	18
3.1.5 Land use	19
3.2 Biological Environment	19
3.2.1 Description of vegetation	19
3.2.2 Description of fauna	20
3.2.3 Description of fisheries	20
3.2.4 Ecologically sensitive areas	20

3.3	Socio-economic Environment	21
3.3.1	Education	21
3.3.2	Public health	21
3.3.3	Economic situation	21
3.3.4	Population and demography	22
3.3.5	Water and sanitation	22
3.3.6	Transportation & communication	23
3.3.7	Cultural/archeological sites	23
Chapter 4: Potential Significant Environmental Impacts		24
4.1	Negative Impacts	24
4.1.1	Coastal degradation	24
4.1.2	Siltation and sedimentation	24
4.1.3	Water quality impairment	25
4.1.4	Risk of accident	25
4.1.5	Redundant machinery	26
4.1.6	Oil spillage	26
4.1.7	Damage to non-timber products	26
4.1.8	Forest fragmentation	27
4.1.9	Accelerated soil erosion	27
4.1.10	Loss of garden sites	28
4.1.11	Soil compaction	28
4.2	Positive Impacts	28
4.2.1	Employment opportunities	28
4.2.2	Income generation through spin-offs	29
4.2.3	Improved livelihood	29
4.2.4	Access to market	29
Chapter 5: Environmental Management Plan		30
5.1	Mitigation Measures	30
5.1.1	Directed drainage	30
5.1.2	Buffer and protection strips	30
5.1.3	Bunding	30
5.1.4	Seasonal closure	31
5.1.5	Location and design of roads and bridges	31
5.1.6	Exclusion areas	32
5.1.7	Selective harvesting system	32
5.1.8	Limited and controlled earth clearance	32
5.2	Environment Monitoring Plan	35
5.2.1	Monitoring activity	35

5.2.2	Personnel	36
5.2.3	Follow up action	36

<b>References</b>	38
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<b>Appendix</b>	39
-----------------	----

Scoping matrix	39
----------------	----

Concession areas map	46
----------------------	----



## Executive Summary

This public environment report considers forestry operations that Southern Forest Industry has proposed to undertake in its timber concessions in West Are 'are, Malaita Province. The proponent will be conducting its operations in conjunction with landowning groups responsible for Hahonanihau, Hunanara and Horonaria customary lands.

The primary need for the proposed logging operations stems from the resource owners' aspiration to improve their basic needs and socio-economic wellbeing. It is the desire of the land owners to put their land into productive use by harvesting their forest resource and promote other development activities in land areas concerned. By allowing their land, resource owners are contributing to the national government's policy for economic diversification and help resource owners get maximum benefit from their resource. Logging contributes significantly to the economic growth of Solomon Islands by bringing in the much needed foreign earnings. Without logging the country's economy will have collapsed due to weak performances of other key sectors.

In developing this proposal the licensee and the contractor are aware of adverse effects associated with logging and, therefore will adopt a strategy that identifies and protects the special values of the forest, while simultaneously maintaining a sustainable level of human use.

The main purpose of this PER is to assess the environmental impacts of the planned forestry activities by Southern Forest in its concessions and to propose measures to mitigate adverse effects of the operations. It addresses the requirements of the Environment Act 1998, particularly Part III on Development Control, Environmental Impact Assessment, Review and Monitoring. Public consultations with resource owners and local communities are an important aspect of the planning process for this EIS. This statement helps to define areas for harvesting operations and assists with sustained yield activities.

Major project activities anticipated from the operations include site preparation involving road construction, construction of camps and land clearing. Forestry operations comprising mainly harvesting system and log transportation are integral to these activities. For road construction, use and maintenance the proponent will embark on opening up new access roads as operable areas become available for harvesting. However, old logging roads will be rehabilitated for use as part of the operations. Minor, temporary access roads will be required as part of harvesting operations. All existing roads will be maintained as necessary.

In conformity with good forest practices as set out in applicable regulatory frameworks, timber harvesting operations will be undertaken to ensure harvested stands contain adequate numbers of actively growing trees to maintain the log production potential of the forests. The concessions cover an estimated total forested area of 1,200 hectares. Log production, as anticipated, will yield approximately 50,000 cubic meters based on current estimates of the total operable productive area.

Sustainable timber yields are governed by a number of factors, including the area available for harvesting, distribution of tree sizes and quality in that area and growth rates of the trees. Annual allowable cut will be determined by data available from Ministry of Forestry and this will be complemented with information to be provided by the company. However, the licensee has been given an annual production quota of cubic meters by the authority.

Certain potential adverse effects are expected to occur during timber harvesting operations particularly on the soil, aquatic environment, flora, fauna, socio-economic and cultural environment. Three levels of measures will be pursued by the licensee and its contractor to manage the potential adverse significant impacts, including pre-emptive measures, mitigation measures and ameliorative measures. For the design and location of roads and bridges, pre-emptive measures will be applied to ensure any adverse significant impacts are avoided at the first place. Where impacts cannot be avoided, efforts will be made to mitigate and ameliorate the effects in terms of reduction and rehabilitation, as the next resorts.

An environmental management plan (EMP) has been developed to cater to this requirement, to make the operations ecologically sustainable. The EMP outlines the measures considered appropriate to deal with the identified potential impacts and levels of responsibility to ensure the measures are effectively implemented. This is identified as part of environmental monitoring plan, which is integral to the EMP. The EMP is based on the interaction matrix for components of the timber harvesting operations and selected environmental parameters.

With the mitigation measures defined in the EMP and considering the adverse effects of adopting a do nothing option to the economy, it is recommended for the operations to commence without further delays.



# Chapter 1

## Introduction

### 1.1 Project proponent

The project proponent is Southern Forest Industry, a locally-owned company with registration under the relevant law of Solomon Islands. Southern Forest Industry which owns the timber felling license has particular interest in the forest industry especially commercial logging but also has other development plans for the areas. It has always been the primary goal of this company, to assist resource owners derives maximum benefit from their forest resource.

The proponent intends to conduct its logging operations with the technical support of Global (SI) Limited. The license covers customary land areas which include Hahonanihau, Hunanara and Horonaria of ward 24, West Are'are, Malaita Province.

A technology agreement is being executed with its contractor Global (SI) Limited which Southern Forest will rely heavily on to undertake the operational aspect of the business. These include providing of equipment, machinery operators and other services such as round logs export for the operations. In any case Southern Forest and its contractor take full responsibility for managing the logging operations while resources owners' trustees will be responsible for the welfare of their own tribal members. The logging operations should be set in motion once the development consent is secured from the Ministry of Environment, Climate Change, Disaster Management and Meteorology.

### 1.2 Nature of project

The project involves mostly logging including timber harvesting for the forest resource in the timber concessions clearly identified above. Logging operation involves different components, activities and use of range of heavy machinery for these various activities. Major project activities anticipated include site preparation encompassing road construction, construction of camps and land clearing. The other major component is forestry operations that consist of mainly harvesting system and log transportation. These are described in adequate detail later in the report under description of project activities.

Other activities that the operations entail such as creation of log landings, log pond and wharf and construction of bridges or culverts, among others, are part and parcel of the major project components.

### **1.3 Location of project**

Timber concessions included in the license are for Hahonanihau, Hunanara and Horonaria of ward 24, West Are'are, Malaita Province. The total concession straddles an area in the region of 1,200 hectares excluding those areas not considered suitable, which is about 268.5 hectares in total. Log production, as anticipated, will yield approximately 50,000 cubic meters based on current estimates of the total operable productive area.

The total operable area has been estimated after the removal of potential exclusion areas such as streams and buffer strips as well as other environmental and conservation factors.

### **1.4 Need for the Project**

Solomon Islands is a country dominated by rural population, with approximately 86 per cent of the country's total population living in rural areas and, largely dependent on the subsistence sector. With very limited economic opportunity and, with meager and unreliable cash income from sale of agricultural products and marine resources it can be a major challenge to get basic household necessities and afford school fees for children. The increase in cost of living with rising price of basic food items has led resource owners to explore other alternative sources of income from their resources. As logging is rampant in the country community elders and landholding groups see this as the only viable alternative to generate income for their communities and respective families.

The primary need for the proposed logging operations stems from the resource owners' aspiration to improve their socio-economic wellbeing and put their land into productive uses by harvesting their forest resource and undertaking subsequent schemes such as human re-settlement. Harvesting of natural forest for log exports contributes significantly to the foreign earnings and revenue base of the government of Solomon Islands. This is through export duties and royalties to landowners. In recent years, the logging and timber industries have been the major source of income for the government and the country at large, in contrast to other sectors such as fisheries and agriculture.

The government at present heavily depends on the logging and timber industries to sustain the economy. All these major primary industries are subject to international market conditions which are largely unstable.

### **1.5 Institutional and Legal Framework**



### **1.5.1 Environment Act 1998**

All logging operations pursuant to the Second Schedule of the Environment Act are prescribed development. For any such operations to commence, a public environment report (PER) or an environmental impact statement (EIS) is a prerequisite. A development consent is required by the developer from the Environment and Conservation Division in order for logging operations to commence. Established mechanisms are in place for this.

The environmental report identifies all potential adverse consequences associated with the operations and defines appropriate mitigation measures to ameliorate the impacts. The Act requires a set of criteria to be used in the environmental impact assessment (EIA) process in assessing the impacts of logging on the environment. It is the responsibility of development proponent to prepare the environmental report, at its own expense.

### **1.5.2 Solomon Islands Environmental Impact Assessment Guidelines**

These guidelines provide useful checklists for undertaking preliminary environmental assessment of certain sectoral activities to realize the objectives of Environment Act. The Environment and Conservation Division administers this set of guidelines. The checklists and the environmental appraisal summary form clearly indicate the types of information that are required to accompany the development application, the initial stage in the process of acquiring the development consent. Different sectors covered under the checklists include coastal zone and marine, forest, construction, infrastructure, agriculture and mining projects due to their potentials to cause environmental degradation.

### **1.5.3 National Environmental Management Strategy**

The National Environmental Management Strategy (NEMS) provides the strategic approach and blueprint for sustainable environmental and natural resource management and conservation in Solomon Islands. A wide range of strategies and programmes has been identified in the NEMS to address the problem of environmental degradation in the country.

Integration of environmental considerations with policies and economic development projects was among the top priority areas identified to control and manage environmental issues faced by the country. The requirement to submit an environmental report as part of the logging operations to address the environmental and social dimensions of the project is consistent with this priority.

#### **1.5.4 Forest and Timber Utilisation Act 1990 (CAP 40, as amended)**

Section 5 of the Act on licensing, which deals with issues involving felling and removing of trees sets out the rights and conditions the company needs to adhere to in undertaking its harvesting operations. The standard logging agreement (*Forest and Timber (Prescribed forms) (Amendment) the Regulations*) has provisions and procedures relevant to environmental protection.

According to 1984 amendment, it is binding on the developer, for example, to ensure river catchment areas are conserved and soil erosion prevented, among other environmentally sound provisions. The 1990 amendment further emphasized the need for environmental protection, for example, by requiring developers to carry out such investigations to identify and describe any areas which should be excluded from the application on grounds of environment or social values.

#### **1.5.5 Solomon Islands Code of Logging Practice**

The code of logging practice complements and simplifies the complicated requirements in Schedule C and Form 4 of the *Forest and Timber Utilisation Act*. It provides guidelines for planning and monitoring of logging operations to improve logging practices in Solomon Islands thereby minimizing potential adverse environmental consequences associated with logging. The guidelines identify several key standards for purposes of environmental protection, among which, are Key Standard 1 on Protected and Exclusion Areas, Key Standard 2 for Location of Roads and Landings and Key Standard 7 on Temporary Crossings. Other important key standards are also available in these guidelines.

#### **1.5.6 National Forest Policy**

Four implementation strategies have been identified in this policy document, as crucial for sustainable utilization and management of the country's forest resource. Of these strategies, the two that have direct relevance to logging are the promotion of increased local level participation in forest management and provision of support for the protection of the environment and ecological sustainability.

The ecological services provided by forest as non consumptive forest uses are given due attention in the policy document. Protecting the forest as recognized in the policy document plays a greatly significant role in protecting the rivers, soil and other organisms whose livelihood depend on the forest ecosystem.

### **1.6 Scope of Report**

The main purpose of this environmental impact statement is to describe and assess the potential environmental impacts associated with the forestry activities of



Southern Forest in its timber concessions. Additionally the report helps to identify relevant measures to deal with the potential adverse environmental effects resulting from the operations. The report addresses the requirements of the Environment Act 1998, particularly Part III on Development Control, Environmental Impact Assessment, Review and Monitoring. Since logging operations is among the list of developments classified as prescribed development in the Second Schedule of the Environment, production of this report also fulfils that provision.

## **1.7 Study Approach**

Information contained in this document has been obtained during field assessment undertaken within the forest concession by the company's surveyor and representatives of the licensee. The field surveys covered specific areas of interest including the forest stands, topography, surface water systems, coastal zone and areas of cultural significance, among others. Identifying such environmental characteristics earlier is vital for the company due to the need for the log pond, logging camp, primary access road, river or stream crossings and timber harvesting areas.

Public consultations with key community elders and resource owners during the timber right process also yielded useful information about environmental characteristics such as land form, land use patterns, catchments and forest types of the timber concession area. Site visits were conducted prior to producing the report.



## Chapter 2

### Description of Major Project Activities

#### 2.1 Roothing

There will be creation of three main roads. Two will be constructed for the West part of the concession (Ward 24), with the remaining road to be constructed in Ward 20. For the proposed logging operations to be achieved the developer intends to build these new road networks within the concessions. Poor surface conditions of logging roads will be constructed for use as part of the operations by conducting necessary earthworks and land clearing to improve the drainage. They will be compacted to maintain proper drainage of the pavement. New primary access roads will only be built by the proponent as operable areas become available for harvesting. Minor, temporary access roads likewise will be required as part of the harvesting operations.

The proposed primary road and secondary or spur roads are important for the company's operations to enable activities to proceed unhindered. These access roads enable machinery and operators to gain easy access to the coupes demarcated within the concessions. The shorter, temporary harvesting spur roads will be drained and left to revegetate after harvesting and maintained as necessary.

Due to the different landform features within the concession, the main access roads (primary, secondary, and feeder) that require major earthworks will be surveyed and designed accordingly. Important factors to be taken into account in road design are location, cross sectional dimensions, and major drainage structures. However, most roads will be constructed on ridge tops, limiting the need for major cut and fill earthworks including side-cutting across slopes. Side cuts of steep hill slopes, unstable soil types and stream crossings will be avoided, where possible.

#### 2.2 Skid tracks

Several feeder roads will be constructed to service areas where skidding tracts are required and distance exceed five hundred meters. Skid tracks are a network of tracks along which skidding equipment (see Machinery for equipment) travels by pulling of logs from point of felling to the log landing. Main skid tracks will be established within the concession on ridges. The number of skid tracks to be established largely depends on the size of the coupe, its expected yield and environmental conditions. On average, two skid tracks will be required for each log landing.

Without skid tracks bringing felled logs directly to the log landings or to the spur roads before being transported to the landings will be very difficult. The company recognizes and emphasizes safe environmental procedures in skidding to avoid excessive damage to the soil, groundcover and soil erosion during skidding operations. All skidding works will be done uphill, where the terrain is deemed suitable environmentally. Skid tracks involve minor, temporary access roads which form part of harvesting operations.

### **2.3 Gravel borrow pits**

Quarries are planned to be established as close as possible to the road networks to reduce cost of haulage. Gravel borrow areas have been identified in various areas within the concession but close proximity to roads is an important consideration in their establishment. It is equally important to establish quarries clear of any stream or water body. The company intends to make the road weather proof and also provide adequate natural gravel for construction and maintenance of all roads. It is anticipated for an individual quarry to service specific section of roads up to several kilometers from the pit. Gravel pits will be rehabilitated in a way that minimizes adverse environmental impacts.

### **2.4 Log landings**

Major log landings will be established at convenient locations along designated sections of the primary roads. The company will be adhering to the recommended standard size for log landings. It is, however, anticipated for some landings to vary in sizes, although still within the recommended size limit. This is largely due to topographic features, where generally flat landform with broader ridges should have wider landings as opposed to narrow ridges. On narrow ridges with unstable slopes landings are designed to be compatible with the topography and will be relatively small.

The number of landings per coupe in many cases is dependent on the productivity of the coupe but as well as on topographic features. An important consideration in designing log landings is availability of enough space for loaders and operators to maneuver.

### **2.5 Machinery**

The table below provides insight into the types of equipment and machinery the company uses in its operations. Administratively, the operations have been divided into administration, workshop, production and roads department.



Equipment	Units
Bulldozer/ripper	15
Excavator	4
Log truck	8
Wheel loader	3
Fuel tanker	2
Chainsaw	10
Dump truck	2

## 2.6 Workshop

A workshop will be constructed onsite at the logging camp for defective machinery to be serviced. To be constructed of a mixture of locally extracted materials and roofing irons, the outside part of this temporary structure will have no walling. The outer part of the workshop will not be enclosed to allow easy passage of machinery for maintenance. Adequate open space for garaging of machinery should be available adjacent to the workshop. The workshop will be clear from any river, wet land or streams.

## 2.7 Log pond and wharf

A suitable area has been identified and will be cleared for the log pond and wharf, taking into consideration the need to have sufficient log storage capacity. This strip of land is covered predominantly with mangroves, grasses and newly established plants. Directed drainage will be provided to prevent inflow of surface water from the log pond during rainfall events to the coast, to reduce runoffs and sedimentation of the coastal ecosystem. Wharf and log pond location are selected in a sheltered location, with the aim for the company barge to easily come into berth for loading of processed logs.



The wharf will only be temporary and meant to load processed logs during the period of operations. The wharf will be constructed from wood decking and then filled with earth as a causeway. Appropriate measures will be introduced to reduce disturbance to mangrove species dominating the shoreline. Set of silt traps will be introduced to reduce the sediment flows into the marine environments. Platform for fuel storage tanks will also be accommodated at the log pond within easy reach of the coastline.

## **2.8 Housing/logging camp**

A camp is expected to be constructed not far from the coast within the log pond area. To minimize further interference with the environment, the logging camp is most likely to be constructed at an elevation of 40 meters that overlook the log pond site. Separate accommodations will be provided at the camp for local employees and several expatriate employees. More accommodations will be provided for the mostly local employees of 50 general labourers while only few will be constructed for the expatriates consisting of 8 personnel. The accommodations will be of decent standard with adequate lighting system and water supply.

Water supply at the camp will be relying on both rainwater catchment in tanks and piped water from nearby streams. The main source of water to supply and for sanitation for the camp will be collected from Tawapaina River. Ventilated improved pit toilet is expected to be constructed at the camp for all employees. Availability of water source is one important factor for selecting potential campsites. Household wastes such as kitchen remains are disposed of in pits as a means to manage wastes generated at the camp. The pits will be buried when they are no longer needed.

## **2.9 Bridges**

About 2 wooden bridges will be constructed within the entire concessions across the major surface water systems located at coupe 2 and 11. In addition, 4 culverts will be constructed in coupe 1, 4, 6, and 7. This is understandable since the major catchments and headwaters are found inland. With log decking and earth filling the structures should be strong enough to accommodate the passing of hauling trucks and heavy machinery during forest operations. Two appreciable river systems and many tributaries drain and traverse the coupe 2 and 11 concession that requires the 3 crossing structures.

Where bridges are necessary, the crossing structures will be so designed to meet specifications taking into consideration hydrological conditions and other environmental factors such as the river ecology. The location and design of bridges are important factors in selecting sites for the bridges to be erected. Generally

bridges are built at river sections with higher river banks to ensure they are not washed away during floods caused by prolonged wet weather events. Temporary crossing structures are also planned for certain streams, which are expected to be removed after operations cease.

## **2.10 Timber harvesting**

Harvesting is planned and undertaken using the compartment or coupe as the basic operating unit and conventional tractor logging. Compartments vary in size but the percentage of a compartment that is harvested depends on the forest types, stand conditions, slope conditions and access. All harvesting activities are to be undertaken in accordance with the harvesting plan for the compartment. The company heavily employs selective harvesting system for its operations through use of specific machinery during harvesting. Activities such as harvesting roads and access to log dumps are clearly identified in the plan.

In general topographic features, easy and quick access to coupes greatly influence site selection for new log dumps. Harvesting plan consists of information on area (location, size of coupe, area of different forest types, condition of the forest, physical features and predicted volumes of the products to be harvested; harvesting details (type of operation, product specification, tree marking procedures and tree retention requirements (e.g habitat trees); and operational procedures (order of working, location of log dumps, snig tracks, creek crossings, critical boundaries (flora reserves), exclusion areas and wet weather controls. The harvesting system employed recognizes the need to maintain ecological sustainability and log production in the longer term.



## Chapter 3

### Description of Environmental Setting

#### 3.1 Physical Environment

##### 3.1.1 Geology and soil

The geology of the forest concession is derived from some sort of volcanic gabbros, basalt lavas and diorites associated with serpentinites and andesite lavas. Riverine alluvium with organic accumulations are proof that the rock basement comprise a mixture of ultramafic and gabbros with serpentinitized matrix. The parent material gives rise to the composition of deep brown loams and clays for the moderate steep slopes. Towards the middle of the island are basaltic volcanics. These geologic processes are closely associated with the landform and land system identified within the timber concession. In terms of soil brown to red clay, dark brown clay, and loams dominate the soil textures identified within the concession. Clays and loams are commonly found across all these soil types.

These textural properties are influenced by the various dominant landforms within the concessions, which in turn are influenced by the parent materials of the soil types that occur therein. For example, adjacent to the coast in substantial section of the concession calcareous and non-calcareous sediments are widely distributed and this is directly influenced by short to long, gentle to moderate hill slopes landform, constituting the parent material consisted of brown loam and clays that can be found in the mid elevation below Matari towards Wa'ai River and give rise to the eastern end of Wairaha River system.

##### 3.1.2 Topography and landform

The landform within the concession consists of different topographic features and, this varies between areas within close proximity to the coast and areas upland. At the easterly end of the area, there is about 3,000 hectares of lowland, hill and coastal forest that is recommended for production. Adjacent to the coast with some distance inland short to long, gentle to moderate hill slopes are the dominant landform. Generally, the topography is quite flat in these areas. Freshwater swamps along river terraces and flood plains are also found there with pockets of steep rocky slopes and dry valleys. As this landform type occur further inland, the topographic characteristics displayed here are more of moderately steep slopes.

While within the coast the land is characteristically flat, topographic changes become apparent upland, with the physiographic features ranging progressively from zero to forty meters relief from the coastal areas to narrow ridges and unstable slopes in the interior.



### **3.1.3 Surface and groundwater hydrology**

Several catchments provide the water that drains the concession. A number of streams whose sources are in the foothills contribute to the river system within the concessions. There is about 4 major rivers, Wairaha, Wa'ai, Tarapaina, Oroa'ou and Roatai that flows through the concession area. The drainage system of these surface water systems including the streams is supplied through overland flow, interflow and groundwater flow. The catchments supplying the rivers are drained with water derived from the entire surface within the outer divide or ridge of the drainage basin.

During moderate to high rainfall events, overland flow provides most water to these water systems. The presence of ground cover heavily influences the downslope volume of overland flow that is likely to enter the natural drainage. In protracted periods of little or no rain interflow and groundwater flow tend to be the main sources of supply for the river system through water retained in the soil or ground water after rainfall. Because surplus water is always available in the catchments during high intensity rainfall, this contributes significantly to the flow regimes of the rivers and streams. Rainfall patterns and undisturbed areas where the vegetation acts as a filter strongly control overland flow and subsurface water flow.

### **3.1.4 Climate**

Rainfall for Solomon Islands varies year round from January to December. From January to April there is always a lot of rainfall whereas the months from May through October the rainfall tends to be lower. There are also some variations in the number of rainy days per month for the entire country. For example, the rainfall pattern for Honiara is such that the period between November and April always receives most rain and May to October shows less rainfall occurrences. This is influenced by prevailing trade winds. The northwest wind usually prevails towards the end and start of the year whereas the south easterlies occur throughout the year.

Unlike rainfall, the temperature for the entire country is almost consistent all year round. Unfortunately, records are not available for air quality not only in Honiara but the rest of the country. While industrial air pollution is not a concern for Solomon Islands, emissions from shifting cultivation and burning of wastes can be a problem in the rural communities.

The climate for the Are' Are area of concern experiences warm to hot humid oceanic climate, with rainfall in the range 3000 to 5000 mm annually. There is a variation with topography, latitude and the area orientation to the direction of prevailing wind.

### 3.1.5 Land use

Land use within the forest concessions obviously shows some distinctive pattern. The areas within the vicinity of the coast generally do appear to have major agricultural commercial crops such as coconut plantations. Several types of human settlements are found within and immediately outside the concessions. Large settlement, medium settlement and small settlement are all observed there, most of which are along the coast. Some of these small settlements mostly consist of coastal hamlets. In ward 24, the two main settlements within the concessions are Pipisu and Masihuro.

The logging operations will be carried out in secondary and virgin forest areas beyond sites commonly cultivated by the local communities. It is through the gardening areas that the log road line has been marked. Undisturbed primary forested areas will be cleared during the felling operations with new access roads anticipated to be constructed. The growing population is a phenomenon that contributes significantly to the changing landscape, with the trend in settlement creation tending to favour inland areas. Major road infrastructure provided by the province is not yet available to these areas.

## 3.2 Biological Environment

### 3.2.1 Flora and forest types

Several forest types occur and are distributed within the forest concession. Within the coastline are saline swamp forests dominated primarily by stranded vegetation which are subject to tidal and supra tidal influences. The concessions support freshwater swamp and riverine forest as well, where *terminalia brasii* and *metroxylon* species is abundantly available. With decreasing in water level, *Inocarpus* and *Eugenia therneyana* species predominate the area. Besides freshwater swamp forest, the company's timber extraction activities are expected to be heavily concentrated within lowland rainforest and hill forest. Freshwater swamp forest is associated with valley floor landform.

The timber inventory carried out by the company within the concession shows that *pometia piñata*, *Calopyllum kajweki*, *canaria sp*, *Burckella obovata* and other *terminalia* mostly dominant in lowland rainforest and hill forest. For the montane forest, *Pometia pinnata*, *Nauclea orientalis*, *parinarium salomonensis*, *canarium* species and *Celtis philippensis* dominates that this region.

### 3.2.2 Description of fauna

No detail studies have been conducted to determine the occurrence, abundance and distribution of the different animals within the concessions. Several parrot species in cardinal lorry and yellow-bibbed lorry have been sighted within the concessions. Cockatoos, fruit doves, pigeons and starlings are also quite common upland in the



concessions. The varied forests in the concessions provide good habitat for other forest-dependent birds and other animals. Some bird species which are endemic to Solomon Islands that are recorded from Malaita are hawks, eagles, rails, owls, kingfishers, monarchs and honey eaters.

### **3.2.3 Description of fisheries**

Are 'are is situated on the Southern part of Malaita that has valuable habitats and ecosystems that can provide home for important fisheries. The reef and mangrove ecosystems that are outside the region provide important habitats for different fisheries. Beyond the coast towards the outer edge of the reefs are important habitats for turtles and snappers, lobsters and other fisheries. Pelagic fisheries include tuna species and this provides important food source for the local people.

The important role of fisheries in the livelihood and socio-economic wellbeing of the coastal settlements within and outside the concessions makes it easier for them to be self reliant.

### **3.2.4 Ecologically sensitive areas**

Certain ecologically sensitive areas occur within and adjacent to the concession. Coastal zones, watercourses and primary rainforest support diverse life forms. In coastal areas, for example, these are important for spawning and breeding for certain aquatic animal species. Undisturbed forest likewise provides habitats and breeding places for diverse animal life including birds, reptiles, and various other organisms. Removal of forest can have adverse impacts on such ecologically fragile regions due to destruction of habitats, sediment deposition in swamps and smothering of coral reefs from silt runoffs. The mitigation measures proposed are intended to help minimize these potential impacts.

## **3.3 Socio-economic Environment**

### **3.3.1 Education**

Education institution such as primary schools is available within close proximity to the proposed logging area at Pipisu village. This coastal village school also serves the nearby settlements such as Masihuro and other small settlements. These two coastal settlements can be considered the largest within the timber concessions. This is a non-boarding school and school children always return home after school. The school is operated by Malaita province education authority.



### **3.3.2 Public health**

Pipisu community has somewhat proper health facility or Aid post available within the village. The facility while at times experiences shortages of medicines still serves the need of the locals in and around the area. Nearby settlements also use this facility when required. The aid post is provided and built by Malaita provincial government.

The proposed logging operations can also benefit from the services offered at this facility, which can be easily accessed by motorized canoes. A basic health centre will be made available at the proposed camp to ensure company employees have access to treatment of simple ailments such as malaria and others. Otherwise more serious health conditions will be referred to Afio clinic and Auki hospital for proper medical advice and attention.

### **3.3.3 Economic situation**

Major economic activities dominantly practiced in rural Solomon Islands from which people get some income are agricultural and fishing activities. Agricultural activities mostly involve cash crops such as copra, cocoa, and betel nuts. Sale of garden produce such as potato, yam and taro rarely happens, except occasionally in Honiara central market. With irregular and unreliable shipping services to these areas, easy access to markets is also quite difficult. The logging operations are expected to create wage employment opportunities for the local population but, as well as markets for their local produce.

The limited economic opportunities available in the rural areas make wage employment very difficult. Those who are able to find work are mostly self employed farmers in the informal sector. It is these economic hardships and limited employment opportunity that drives people to look for alternative income sources apart from farming and fishing. The decision by resource owners to harvest their forest resource for export can be attributed to this, given the huge cash income expected to be derived from log exports. Resource owners will receive their money by way of royalty payment.

### **3.3.4 Population and demography**

The total population of Malaita Province was 122,620 people according to the 1999 national Housing and Population census. Of this, 3,773 people were recorded for this region in which the forest concession occurs. This accounts for approximately 3 per cent of the total population of Malaita province. Accordingly, this population was predominantly rural based. In terms of the size of the productive age group, namely between 15 to 40 years, this dominates this population structure. There were 5891

households recorded for this area. For Pipisu and Masihuro communities, their combined population can be estimated at 600 people.

It can be concluded that a majority of the population of West Are Are is rural-based, with heavy dependence on subsistence farming and fishing activities. Where wage employment is scarce and hardly non-existent and, considering the active age group of the population and, given the large proportion of the population residing in rural setting, this is of concern as urban drift and social disorder in the communities are a likely problem. The logging operations will enable many of the young people to get some wage employment with the logging company.

### **3.3.5 Water and sanitation**

Both Pipisu and Masihuro settlements have to access to proper water supply with stand pipes. Except for Pipisu, Masihuro does not have school and/or clinic available within the village. These two settlements largely depends on their water supply to fetch water for its daily water uses such as washing, cooking and drinking.

Within the logging camp water supply will be provided to resident employees by the company. Where surface water of good quality exists closer to the camp, water supply is going to be extracted from the nearby stream. Water tank catchments are planned for all quarters, irrespective of whether water supply is made available for residents at the camp from nearby surface water system.

### **3.3.6 Transportation and Communication**

There is limited infrastructure such as proper roads and bridges currently available within the concessions. The provincial public road that connects the provincial capital of Malaita, Auki Town to southern region only ends at Hauhui village. This is still very far from the proposed logging areas, which are further south in Are Are lagoon. Therefore, land transportation by vehicles does not exist in this part of Malaita. The dominant mode of transport practiced is sea transportation by canoes, both motorized and dug outs.

Due to limited and irregular shipping service to this, this also significantly restricts the locals exploiting to their advantage market opportunities in Auki and even Honiara. M.V. Baruku and few other passenger and cargo ships occasionally travel to this region but their schedules are only conditional and irregular.

The proposed development site is fortunate to get connected to modern communication. B Mobile has a transmission tower erected at Afio and communities within the concessions relatively easily gain access to this modern convenience through cell phone technology.

### **3.3.7 Cultural/archeological sites**

There are known areas of cultural significance within the concessions. These cultural sites are remains from old villages, sacrificial sites to worship ancestors and graves of ancestors. All these areas have been identified and special marking has been placed around the sites, at least thirty meters on all sites. The markings on the trees indicate that these are exclusion areas.



## Chapter 4

# Potential Significant Environmental Impacts

### 4.1 Negative Impacts

#### 4.1.1 Coastal degradation

The area in which the log pond and wharf have established is adjacent to the coast in a bay. Removal of vegetative cover by heavy machinery can have detrimental impacts on the coastal zone. Such habitats or ecosystems tend to support a range of ecological services, for example, spawning grounds for certain fish species and provisioning services such as food supplies.

Land clearing and associated earthworks for the log pond and wharf can be harmful to the organisms that exclusively depend on this type of land form and ecosystems for their survival and livelihood. This is likely due to increased surface runoffs and subsequent siltation of the beach with sediments created during earthworks. In situations where sediment runoffs are not properly controlled, this can result in decreased productivity of the ecosystems.

#### 4.1.2 Siltation and sedimentation

Siltation and sedimentation are caused by the delivery and deposition of sediment or silt runoffs from disturbed soils. The loose soil particles are transported into the surface water system via surface runoffs or overland flow, which depends on various factors. This is more evident at the approaches to the stream crossing sites as sediments are generated next to the stream bank and enter the stream relatively easily. Road usage certainly affects sediment production whose mobilization and transportation to varying degrees downslope is a function of particle size and volume, velocity of overland flow due to high intensity rainfall events and existence of roadside table drains.

The fate of sediments derived from road construction is largely determined by overland flow characteristics following rainfall. While a large proportion of coarser fractions of the sediment are expected to be retained within the forest floor in depressions and drainage lines close to the sites of erosion along the new road alignment, the finer fractions will be more mobilized and transported downslope. This appears to be the general observation at the valley side slope along a section of the road alignment as a result of the buffer rendered by the undisturbed forest

cover, which helps to disperse surface runoff carrying the sediments and also acts as a filter to entrap sediments.

Surface runoffs or overland flow in which loose soil particles are transported into the surface water system are likely to cause water turbidity and impairment of water quality. Siltation and sedimentation are caused by the delivery and deposition of sediment or silt runoffs from disturbed soils, which can be heavy at the approaches to the stream crossing sites as sediments are generated next to the stream bank and enter the stream relatively easily. In the streams, the coarse sediments usually form part of the bed load which are transported downstream in suspension, causing water turbidity and water pollution. Sediment production from road construction varies with catchment geology, microclimate, vegetation, soil stability and slope. Siltation is also caused by unconsolidated soils from freshly exposed cut and fill batters.

#### **4.1.3 Water quality impairment**

Sediments that do reach forest streams are expected to enter in an episodic manner, being transported in surface runoff associated with moderate to high rainfall events, with bulk of sediments transported during storm events. In the streams, the coarse sediments are expected to form part of the bed load and be transported downstream in suspension. However, where the sediment carrying capacity of streams draining the disturbed forest catchment is exceeded, sediment deposits are expected to develop in the short term.

It is these suspended sediment loads and silts derived from in-stream sedimentation and stream bank that are responsible for water pollution of the surface water system. Catchment areas with higher rainfall frequency tend to experience greater degree of water turbidity from suspended sediments in the water column. In events that sedimentation occurs, this will be highly localized with sedimentation impacts expected in the short term, only at the site scale.

#### **4.1.4 Risk of accident**

Use of heavy machinery at the log pond to move logs between log stockpiles and the fact that log trucks are allowed to transport logs through the camp pose serious safety risks for the employees but more so to their younger children. Within the log pond the risks are quite high for the children of local employees whose accommodations are within easy reach of the log pond area. While there is no local community within immediate vicinity of the logging camp, the safety of locals visiting the camp to sale their agricultural produce also is at risk, if appropriate measures are not in place.



#### **4.1.5 Redundant machinery**

Logging companies heavily depend on machinery for almost every activity inherent in the operations. Machinery are serviceable and defective ones can be maintained but their working conditions cannot always be guaranteed. Heavy equipment like bulldozers and others are not always easy to handle when repair works are beyond ones' ability. There is therefore a high possibility that such malfunctioned equipment can be discarded on site because of the difficulties in maintaining them. This is a form of environmental pollution but redundant machinery also poses safety risks for curious rural village children who may take advantage of the situation to climb up and down on the abandoned equipment. Such actions create opportunities for accidental risks to occur.

#### **4.1.6 Oil spillage**

There is a general inclination for logging companies to establish fuel storage tanks within the immediate vicinity of the coastline as it is convenient to refuel them when the tanks are empty or low in fuel. In many cases, these tanks are firmly established and cannot easily be relocated. This practice is acceptable only if appropriate management plan is in place to deal with accidental spills from the tanks. Spills can easily reach the sea because of the location of the tanks if proper bunding is not provided for the tanks to sit on. The importance of the bunding structure is to contain any accidental spills that may occur while refueling or during the supply of fuels to the machinery.

#### **4.1.7 Damage to non-timber products**

Timber harvesting operations generally involve removal of identified trees by felling them with chainsaws. During felling operations other unwanted trees such as undergrowths can be affected and this is particularly true for rainforest with complex canopy structures. Use of heavy machinery commonly identified with logging in skidding and road construction involves a lot of soil disturbance in localized areas. Not only that skidding and road construction destroys the soil but, soil compaction and erosion can lead to the loss of good gardening sites rendering it unproductive. Soil texture, structure, profile depth and profile drainage all contribute to soil fertility and are most relevant to determining susceptibility to erosion and compaction processes.

Land clearing for roads and associated earthworks are activities inherent in logging that can result in loss of building materials and properties. In most rural village settings, construction materials for housing are supplied almost entirely by the rainforest. Forest not only provides necessary building materials but further enriches the soil through soil nutrients supplied by the forest. Traditional building



materials supplied from the forest, for example, for housing are exposed during felling operations.

#### **4.1.8 Forest fragmentation**

The opening up of the forest due to felling operations is a concern as felling leaves the forest dissected. In areas with highly dense commercial tree stands this is especially noticeable. The concentration of timber harvesting in such areas with more timber trees, as opposed to other areas with low timber yield, obviously can make the forest highly fragmented. With clearance for road construction and log landings, this only adds to the problem. Negative impacts associated with dissection of a viable forest into fragments are in many cases related to the ecological and hydrological processes of the forest as habitats and water retention capability of the exposed soils are threatened. Forest fragmentation also affects the regeneration dynamics of forest stands due to altered soil conditions and light regimes created by harvesting.

#### **4.1.9 Accelerated soil erosion**

Soil erosion through water agent is unavoidable where the ground has been denuded of vegetation cover and the greatest potential impact from soil erosion is directly related to water quality and stream ecosystems. Soil physical properties that affect the susceptibility of the soil to erosion are texture, structure and profile depth including climate, slope and land use factors. Although soil erosion is a natural process and occurs in undisturbed terrestrial ecosystems, it is more pronounced when land is disturbed and vegetative cover removed and the amount of exposed forest soils and amount of bare compacted soils exposed to rainfall and runoff.

In undisturbed forest ecosystem, surface erosion is generally very low as a result of vegetation and litter layers protecting the soil surface. Taking into consideration the limited scale of the access road and the undisturbed nature of the forest cover providing the buffer for the stream, soil erosion impacts including loss of soil fertility can be considered as localized and minimal. High intensity rainfall events are expected to present critical periods of high erosion risk, with accelerated rates of surface erosion anticipated to prevail during and after road construction.

#### **4.1.10 Loss of garden sites**

Earthworks and land clearing associated with road construction, timber harvesting and soil compaction due to trampling of machinery can result in destruction to arable land and productive garden sites. Primary access roads aligned through potential agricultural land due to environmental conditions can be destructive to the land. Not only that this leads to decreased productivity of the soil through removal

of the productive layer of the soil but, changes in soil structure through compaction, changes in soil texture and changes in stability of slopes are likely consequences.

This poses serious concern for women whose routine outdoor activity involves cultivating the land for gardens to feed the family. As fertile land is destroyed and becomes scarce, new gardens will certainly be cultivated further inland. Women as a result will have to bear the cost of this loss by walking long distances to get to the garden site.

#### **4.1.11 Soil compaction**

Soil physical properties most relevant to forest management are texture, structure, profile depth and profile drainage. All these contribute to soil fertility and are most relevant to determining susceptibility to erosion and compaction processes. Soils with high silt plus clay content, low organic matter, poor structure and poor drainage are the most susceptible to compaction impacts. Sandy soils have also been reported as having a high compaction risk. Poor drainage will also predispose soil to compaction and disturbance since soil strength is lowest at high moisture contents. Use of heavy machinery in logging creates compaction and loss of organic matter thereby altering soil structure and reducing infiltration, water holding capacity, aeration and root penetration.

## **4.2 Positive Impacts**

### **4.2.1 Employment opportunities**

Lack of employment opportunities in most rural areas of Solomon Islands is a huge challenge not only for government but, for rural people, as well. Logging offers rural people with limited opportunities to be engaged in wage employment to support their families by providing for basic needs and school fees. Although the security of tenure of the employment may be temporary, access to steady income from being employed provides rural people with something to look forward to.

### **4.2.2 Income generation through spin-offs**

Apart from wage employment provided by the company, other income opportunities are also available to the local communities to exploit. It is a common practice for local communities to take advantage of the operations by selling to company employees' garden produce and marine products. Such spin-offs contribute in many ways to the livelihood of families in meeting their basic household needs. This is an additional income source for family if member(s) of the same family is working for the company. For some logging operations, even a proper market house has been built to enable local communities to sell their produce and products.



### **4.2.3 Improved livelihood**

The economic difficulties often severely experienced in rural communities, due to limited opportunities, undermines efforts by local communities to improve their lifestyle. Cash income from wage employment and spin-off effects of logging operations can be a benefit to the communities. As basic household items are always not available on a daily basis to some families, wise use of money obtained through sale of labour and cash crops should help in improving rural livelihood.

### **4.2.4 Access to market**

Sale of cash crops such as root crops and marine products in rural communities can be difficult due to inaccessibility to markets. In almost all logging operations markets are provided by the company for local residents to sell their produce. The market can be in the open or in a proper market house built by the members of the communities themselves. Easy access to markets plays an important part in improving rural economy and rural livelihood.



## Chapter 5

# Environmental Management Plan

### 5.1 Mitigation Measures

The mitigation measures developed by the proponent for the logging operations are complementary to the key standards identified in the Solomon Islands Code of Logging Practice. This guidance document has been developed with the view to ensuring logging in the country heeds the important ecological and cultural functions of the forest and its wider implications for associated ecosystem services or the environment. The Code emphasizes the importance of reduced impact logging (RIL).

#### 5.1.1 Directed drainage

Appropriate measures will be applied to address adverse impacts of timber harvesting. Proper drainage engineering is part of the company's planning policies to reduce the amount of sediments transported and discharged to the marine environment or river system. Instead of drains channeled directly into the water course, drain turnouts are important to divert sediment-laden water from direct deposition into the water course.

Since sediments are more likely to enter the stream channel at approaches to bridge crossings and through harvesting closer to the stream banks proper drainage and sediment traps are important measures to minimize siltation of the water course and eventual deposition in vulnerable marine ecosystems. The post-harvesting construction of water diversion bars across snig tracks is always emphasized in the company's operation to control erosion prior to re-vegetation.

#### 5.1.2 Buffer and protection strips

To minimize the amount of sediments entering the stream channels via surface runoffs establishment of buffer strips is essential. It is vital to comply with necessary specifications in forestry regulations, not to operate in buffer strips, except where roads are expected to cross streams. Roads intended to be constructed in buffer strips and cross streams should be in a perpendicular position to the watercourse, rather than run parallel to the watercourse.

This is a form of a sediment trap to reduce sediment-laden water directly transported into the stream. The forest floor acts as a filter for the sediments that only fine sediments can be able to enter the channel during prolonged wet weather events or high intensity rainfall events.

### **5.1.3 Bunding**

Bunding is an important measure to control oil spills on land regardless of whether the tanks are situated on the coast or inland. Bunding involves building structures impermeable to either water or oil and it serves the purpose of containing any accidental spillage from escaping into the soil. Oil can easily infiltrate the soil in incidents of spillage and bunding provides an effective way of containing the spills for easy collection. Without appropriate structures or management plan to address oil spill incidents, it is not an easy task to control oils when they infiltrate the soil.

### **5.1.4 Seasonal closure**

Operations during periods of prolonged wet condition are not encouraged and will be prohibited. It is during wet conditions when excess or surplus water is available on the ground surface that surface runoffs tend to be higher. Water erosion is responsible for most sediments going into the surface water systems.

In denuded forested areas water erosion can be a huge problem and this can be compounded if heavy machinery are allowed to trample on the wet ground surface. Not only that soil erosion will be accelerated but the ground surface becomes hardened leading to other environmental concerns such as loss of the productive capacity of the soil through soil compaction including loss of soil nutrients.

### **5.1.5 Location and design of roads and bridges**

Pre-emptive measures will applied in the design and location of roads and bridges within the concessions. This is to prevent the impact by identifying and isolating specific areas from exposure to adverse impacts. The company will be using planning techniques to identify the most suitable road alignments and impose maximum slope constraints to address erosion hazard. Erosion hazard is the key factor in determining the need for the specified measures. Siting of roads should not be a cause of deep concern since soils in the area consist of a mixture of clay, organic matter and coral fragments.

As alternative mitigation measures, all major primary roads will aligned and built on ridge tops where topographic conditions permit. Side cutting of hilly slopes is an option and this can only be entertained if its creation does not affect any streams within the vicinity. At least there should be sufficient buffer for deposition of sediment runoffs during wet conditions. The location of bridges is to be restricted to sections of the river that will allow only minimal sediments into the water course. In any case all bridges are to be established in areas where the terrain is generally flat or gently sloping towards the streams or rivers.



### 5.1.6 Exclusion areas

Specific areas or exclusion areas within the timber concession will be reserved for either their cultural or ecological or environmental significance or values as one of its pre-emptive measures. This is to deal with loss of old cultural sites and reduce adverse environmental impacts on environmental sensitive areas and ecological fragile ecosystems. While it is unlawful to harvest mangrove forest, destroy traditional building materials and operate in steeper terrains, the company will ensure chain and machinery operators strictly keep clear from such areas.

Such exclusion areas are important to maintain the quality of these ecosystems and environmental values. Where important ecological habitats exist, every effort will be made to ensure reduction in damage to the ecological functioning of these habitats in developing the roading network.

### 5.1.6 Selective harvesting system

In efforts to minimize impacts on forest ecosystem through fragmentation and destruction of non-forest products, the company has a strict policy to conduct selective and directional felling in its harvesting operations. This means that only identified, selected trees will be felled so that the forest structure is not unnecessarily tampered with. Selective harvesting system will be practiced and emphasized but it is also important to ensure trees felled do not interfere with the functioning of surrounding environs. Selective and directional felling practices are necessary to keep important habitats and ensure important ecosystem services are maintained.

### 5.1.8 Limited and controlled earth clearance

Road and log dump clearance and associated earthworks will be undertaken as specified in the Code of Logging Practice. Machinery operators are already made aware of the specifications and their activities will be given close attention by the company's operations manager. This is necessary to reduce impacts on habitats and ensure important ecosystem services are maintained and soil erosion controlled. Efforts in this endeavour will also see the company adopting planning techniques to identify the most suitable road alignments and impose maximum slope constraints to address erosion hazard.

## Summary of Potential Environmental Impacts and Mitigation

Actions affecting environmental components	Potential Impacts Identified	Magnitude (high, moderate, low, uncertain)	Long/short term	Significance (high, medium, low, uncertain)	Mitigation measures
Clearance of existing land, vegetation	1) Forest fragmentation	Moderate	Short term	Medium	1) Selective felling 2) Directional felling

	<ul style="list-style-type: none"> <li>2) Loss of crown cover</li> <li>3) Disturbance to forest structure</li> <li>4) Displacement of certain plants or animals</li> <li>5) Increased surface runoffs</li> <li>6) Loss of property</li> </ul>				<ul style="list-style-type: none"> <li>3) Setting aside and reserving representative areas or habitats within the forest</li> <li>4) Identifying and setting aside unique occurrences of plants and animals</li> <li>5) Directed and controlled earth clearance</li> <li>6) Remove vegetation only in designated areas identified during planning phase</li> <li>7) Directed drainage</li> </ul>
Creation of new land uses	<ul style="list-style-type: none"> <li>1) Influx of people to the area either temporarily or permanently</li> <li>2) Displacement of certain plants or animals</li> <li>3) Ecological disruptions</li> </ul>	Moderate	Short term	Medium	<ul style="list-style-type: none"> <li>1) Setting aside and reserving representative areas or habitats within the forest</li> <li>2) Identifying and setting aside unique occurrences of plants and animals</li> <li>3) Use of existing infrastructures</li> </ul>
Construction works associated with housing of construction workers	<ul style="list-style-type: none"> <li>1) Displacement of certain plants or animals</li> <li>2) Ecological disruptions</li> </ul>	Moderate	Short term	Low	<ul style="list-style-type: none"> <li>1) Setting aside and reserving representative areas or habitats within the forest</li> <li>2) Identifying and setting aside unique occurrences of plants and animals</li> <li>3) Limited and controlled forest clearance</li> </ul>
Earthworks including cut and fill or excavations for roads	<ul style="list-style-type: none"> <li>1) Changes to the hydrology of watercourses</li> <li>2) Changes in water bodies or land surface affecting drainage or runoff</li> <li>3) Soil erosion</li> <li>4) Water pollution</li> </ul>	Moderate	Short term	Medium	<ul style="list-style-type: none"> <li>1) Avoid site cutting of hills</li> <li>2) Roads aligned on ridge tops</li> <li>3) Sediment traps</li> <li>4) Remove vegetation only in designated areas</li> </ul>
Dredging	NA	NA	NA	NA	No dredging required
Facilities for storage of	1) Displacement				8) Setting aside and



goods or materials	<ul style="list-style-type: none"> <li>of certain plants or animals</li> <li>2) Ecological disruptions</li> <li>3) Oil spillage</li> </ul>	Moderate	Short term	Medium	<ul style="list-style-type: none"> <li>reserving representative areas or habitats within the forest</li> <li>9) Use of concrete bunding for refilling platform</li> <li>10) Limited and controlled earth clearance</li> </ul>
Log pond and wharf	<ul style="list-style-type: none"> <li>1) Sediment runoffs and sedimentation</li> <li>2) Coastal erosion</li> <li>3) Loss of fisheries reproductive potentials</li> </ul>	Low	Short term	Low	<ul style="list-style-type: none"> <li>1) Limited and controlled earth clearance</li> <li>2) Directed drainage</li> </ul>
Machinery	<ul style="list-style-type: none"> <li>1) Soil compaction</li> <li>2) Limited water infiltration</li> </ul>	Moderate	Short term	Medium	<ul style="list-style-type: none"> <li>1) Use of right type of equipment</li> </ul>
Stream crossings	<ul style="list-style-type: none"> <li>1) Sedimentation</li> <li>2) Sediment load</li> <li>3) Water quality impacts</li> </ul>	Moderate	Short term	Medium	<ul style="list-style-type: none"> <li>1) Proper culverts used</li> <li>2) Restricted to designated crossing sites</li> <li>3) Directed drainage</li> </ul>
Gravel borrow pits	<ul style="list-style-type: none"> <li>1) Increase vector borne disease</li> <li>2) Displacement of certain plants or animals</li> <li>3) Water pollution</li> </ul>	Moderate	Short term	Medium	<ul style="list-style-type: none"> <li>1) Back filling of pits</li> <li>2) Setting aside and reserving representative areas or habitats within the forest</li> <li>3) Limited and controlled earth clearance</li> <li>4) Restricted to areas far from water bodies</li> <li>5) Restricted to designated sites</li> </ul>
Municipal wastes (household wastes)	<ul style="list-style-type: none"> <li>1) Increase in solid waste</li> <li>2) Coastal pollution</li> </ul>	Medium	Short term	Low	<ul style="list-style-type: none"> <li>1) Limited burning of paper or plastic materials</li> <li>2) Use of composting for biodegradable items</li> <li>3) Collection of metal wastes for reuse</li> <li>4) Burying of certain metal wastes at designated sites</li> </ul>
Timber felling	<ul style="list-style-type: none"> <li>1) Forest fragmentation</li> <li>2) Loss of crown cover</li> <li>3) Disturbance to forest structure</li> </ul>	Moderate	Long term	Medium	<ul style="list-style-type: none"> <li>1) Selective felling</li> <li>2) Directional felling</li> <li>3) Setting aside and reserving representative areas or habitats</li> </ul>

	4) Displacement of certain plants or animals				4) within the forest Setting aside unique occurrences of plants and animals
Haulage and transport	1) Noise impacts 2) Effects on animals 3) Soil compaction 4) Safety	Moderate	Short term	Low	1) Roads not to be aligned within ecologically sensitive areas 2) Setting aside and reserving representative areas or habitats 3) Roads to avoid passing through villages
Oil spills	1) Effects on coral reefs 2) Effects on coastal dwelling organisms 3) Effects on artisanal fishing areas	Low	Short term	Low	1) Use of bunding for refilling platform 2) Directed drainage for collection
Infrastructure	1) Noise impacts 2) Safety 3) Ecological Perturbations 4) Increased surface runoffs	Moderate	Short term	Medium	1) Roads to avoid passing through villages 2) Restricted to designated sites from ecologically sensitive areas 3) Security measures (personnel) 4) Directed drainage

## 5.2 Environment Monitoring Plan

### 5.2.1 Monitoring activity

Monitoring of company's operations will be conducted using different forms. Compliance and impacts monitoring will be undertaken to ensure the company complies with its environmental management plan and determine the extent of impacts on the socio-economic and bio-physical environments. Specific variables to be monitored and environmental indicators to be monitored for are identified here. This involves using some environmental auditing procedures. The monitoring plan is implemented at the company's expense.



### 5.2.2 Personnel

To be effective, monitoring systems need to identify the different people to be involved and what they should be monitoring. It is particularly important that those to be involved are designated including members of the community, company representatives and relevant government agencies.

### 5.2.3 Follow up action

Reporting plays a significant part in ensuring company complies with what has been indicated in the environmental management plan in terms of the identified mitigation measures. The follow up action is the second level of checks on the company's operations as opposed to the first level of checks to be conducted by resource owners and company representatives.

Monitoring activity	Environmental impact/indicator	Person responsible (company, representative of licensee)	Follow up action and person responsible (relevant government agencies)
Check sediment control structures	Seawater quality for sediment runoffs; water quality	Operation Manager/licensee rep	Environment officer(s)
Check oil control structures	Discharge of oils into the soil and marine environment	Camp manager/licensee rep	Environment officer(s)
Check felling operations	Desiccated forest; disturbance to forest structure	Operations manager/licensee rep	Forest/Environment officer(s)
Check equipment types used for specific tasks	Unnecessary disturbance to soil and forest stand	Operations manager/licensee rep	Forest officer(s)
Check clearance of existing land, vegetation	Unnecessary disturbance to soil and forest stand; disturbance to forest structure	Operations manager/licensee rep	Forest officer(s)
Check gravel borrow pits extraction	Unnecessary disturbance to soil and forest stand	Operations manager/licensee rep	Forest officer(s)
Check earthworks including	Unnecessary	Operations	Forest officer(s)

cut and fill or excavations for roads	disturbance to soil and forest stand; disturbance to forest structure	manager/licensee rep	
Check designated exclusion areas	Disturbance to forest structure; designated sites intact	Operations manager/licensee rep	Forest officer(s); Environment officer(s)
Check waste management practices	Increase in solid waste	Camp manager/licensee rep	Environment officer(s)
Check stockpiles and material storage	Oil spillage	Camp manager/licensee rep	Environment/forest officer(s)



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## Appendix

### Matrix of interactions between project activities and environment

Project Activities	Roading	Skid tracks	Land clearing	Workshop	Log pond	Logging camp	Wharf construction	Log landings	Harvesting	Fuel storage	Haulage
<b>Environmental Parameters</b>											
<b>A. General</b>											
i. General climate	--	--	---	-	-	-	-	--	---	-	-
ii Landform and topography	--	--	---	-	-	-	-	-	--	-	
<b>B. Biological environment</b>											
<b>Flora</b>											
Terrestrial habitats	--	--	--	--	--	--	--	--	--	--	--
Forest understorey	--	--	---	--	--	--	--	---	---	--	--
Forest overstorey	--	--	---	--	--	--	--	---	---	--	--
Rare/threatened plants	--	--	--	--	--	--	--	--	--	--	--
<b>Fauna</b>											
Ground mammals	--	--	--	--	--	--	--	--	--	--	--
Arboreal mammals	--	--	---	--	--	--	--	--	---	--	--
Ambhians	--	--	---	--	--	--	--	--	--	--	--
Reptiles	---	--	---	--	--	--	--	--	--	--	--
Birds	--	--	---	--	--	--	--	--	---	--	--
Bats	--	--	---	--	--	--	--	--	---	--	--
Rare/threatened fauna	--	--	--	--	--	--	--	--	--	--	--
<b>Aquatic</b>											
In-stream habitats	--	--	--		--	--	--	--	--	--	
Riparian habitats	---	---	--	--	--	--	--	--	---	--	--
Swamp habitats	--	---	---	--	--	--	--	--	--	---	--
Coastal wetlands	--	--	---	--	--	--	--	--	--	--	--
Fish	--	--	--	--	--	--	--	--	--	--	--
Aquatic flora	--	--	--	--	--	--	--	--	--	--	--
Threatened aquatic wildlife											
<b>Physical environment</b>											
<b>Water</b>											
Water yield	--	--	---	--	--	--	--	--	---	--	--
Stream flow	---	--	---	--	--	--	--	--	---	--	--

Sediment load (suspended)	---	--	---	--	--	--	--	--	---	--	--
Sedimentation (bed load)	---	--	---	--	--	--	--	--	---	--	--
Water quality	---	---	---	--	--	--	--	--	--	---	--
Ground water	--	--	---	--	--	--	--	--	---	--	--
<b>Land</b>											
Slope stability	---	--	---	--	--	--	--	--	---	--	--
Soil erosion	---	---	---	--	--	--	--	--	---	--	--
Soil compaction	---	---	---	--	--	--	--	--	---	--	--
Land sediment deposition	--	--	---	--	--	--	--	--	---	--	--
Soil nutrients	---	---	---	--	--	--	--	--	---	--	--
<b>Social/economic</b>											
Employment	++		++	++		++			++		
Income	++		++	++		++			++		
Tourism & recreation			++			++					
Community services	++		++	++		++			++		
Regional economy	++		++	++		++			++		
Archaeology sites	--	--	--	--	--	--	--	--	--	--	--

**Legend**

++	Potential minor positive impact	Localized, temporal, seasonal
+++	Potential major positive impact	Localized, temporal, seasonal
--	Potential minor negative impact	Localized, temporal, seasonal
---	Potential major negative impact	Localized, temporal, seasonal





**Plate:** Existing logging operations within the vicinity



**Plate:** Local settlements and human habitation next to existing logging operations



**Plate:** The type coastal vegetation and topography predominant within this region



**Plate:** The region is dominated by coastal settlements such as this settlement within the vicinity