ENVIRONMENTAL MANAGEMENT PLAN FOR MURAMBA RIVER LODGE

COMPILED BY

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- Environmental Impact Assessments (EIA)
- Environmental Management Plan (EMP)
- Environmental Monitoring

Stakeholders Consultation

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1 INTRODUCTION

1.1 PROJECT BACKGROUND

This Environmental Management Plan (EMP) contains practical measures that must be taken to ensure that potentially negative impacts upon the environment (ecological and social) are minimized or completely avoided.

Namibia's Environmental Assessment Policy requires that an EMP be put in place before a project is implemented. This is usually prepared after an Environmental Impact Assessment (EIA). According to the Environmental Management Act (2007), a lodge is one of the listed activities for which an EIA has to be conducted and which needs an Environmental Clearance (EC) from the Ministry of Environment and Tourism (MET) before implementation of the project. Since the lodge has already been constructed and in operation, the MET indicated that an Environmental Clearance of the lodge will be considered upon the submission of an EMP **(Appendix A)**.

Ultimate Geological and Environmental Servicescc(UGES) has been appointed to compile an Environmental Management Plan for the Muramba River Lodge. This EMP is an environmental management tool to be used to ensure that unwarranted or reasonably avoidable negative impacts associated with the operations and services of lodge are minimized, avoided or mitigated, and that the positive benefits emanating from the lodge are enhanced. The management plan includes the following:

- Information on proposed management, mitigation, protection or remedial measures to be undertaken to address the identified environmental impacts associated with the proposed project including objectives in respect of the rehabilitation of the environment and closure:

- A description of the manner in which the applicant intends to modify, remedy, control or stop any action, activity or process which causes pollution or environmental degradation remedy the cause of pollution or degradation and migration of pollutants.
- As far as is reasonably practicable, measures to rehabilitate the affected environment its natural or predetermined state or to a land use which conforms to the generally accepted principle of sustainable development;

The environmental management plan includes both the biophysical and the socio-economic elements of the environment. This EMP contains practical measures that should be taken and maintained by Muramba River Lodge in order to prevent potentially negative impacts on the environment, both from the ecological and social perspective. The EMP assigns rules, regulations and responsibilities and can be used by the MET and other relevant authorities as checklist to monitor compliance at the site.

The EMP was prepared from information gathered from the owner, knowledge of the site (based upon site visit) and Kavango Region, as well as from experience with EIA's and EMP's conducted for other similar lodging operations

1.2 LOCALITY OF SITE

The Muramba River Lodge is located at Muramba in the Ndonga-Linena Village onthe Southern Bank of the Kavango River, about 76km East of Rundu

(Figure1).

Figure 1.Locality of Muramba River Lodge and Muramba Matako.

1.3 THE PROPONENT

Muramba River Lodge is registered as a Sole Proprietor with Mr Moses Thame Mpareke as the sole member of the sole proprietorthus the operator or proponent.The principle business description of the lodge includes the following: Tourism related ventures including provision of accommodation, conference facility, wildlife conservation and all matters related hereto.

The Ndonga-Linena Village in which the Muramba River Lodge is located is governed by the Gciriku Traditional Authority. The Proponent was granted Permission to Occupy (PTO) a portion of the land for 15 years by the governing traditional authority. The PTO was granted under the following conditions:

- The land remains the property of Gciriku Traditional Authority.
- Agreement expires in 15 years on a renewable basis.
- An amount of N$ 400-00 is payable at the completion of the construction monthly
- Agreement lapses if no development takes place within one year.

- The leaseholder (Mr Moses ThameMpareke) is expected to assist the nearby schools with developmental issues and employ the community as far as possible.
- The leaseholder is also allowed to develop the extend area of the lodge for the same purpose at that particular village.

See **Appendix B** for a copy of the PTO agreement signed and consent letter between the Gciriku Traditional Authority and The Proponent.

1.4 EMP SCOPE

It is essential to implement the EMP right from the planning stage and then continuing it throughout the construction and operation and even decommissioning stage. Given, the lodge has already been constructed and is in operation, this EMP provides a description of the management actions to be undertakenduring operational phases and any future planning and construction activities at the lodge. The scope of this EMP is all current operational activities and services carried-out by the lodge.The overall aim of this EMP is to demonstrate to the Ministry of Environment and Tourism, through its designated authority, the Directorate of Environment Affairs (DEA), that The Proponent has management safeguard plan in place to be implemented to reduce potential environmental impacts associated with the lodge to as low as reasonably practicable (ALARP).

This EMP has been prepared for submission to DEA, in accordance with the Environmental Assessment Policy for Sustainable Development and Environmental Conservation of 1995as well as the Environmental Management Act No. 7 of 2007 and it's Environmental Impact Assessment Regulations No. 30 of 2012.

1.5 EMP OBJECTIVES

The main objective during the operation phase is to manage the lodge with minimal disturbance to the surrounding natural environment, and to ensure that operational activities and services do not impact negatively on the environment, wildlife and local communities. The purpose of the this EMP document is

- To outline how The Proponent" Mr Mpareke, proposes to avoid, minimise, mitigate and, if necessary, offset the identified negative biophysical and socio-economic

impacts associated with the operational activities and services, while at the same time still being able to achieve the benefits associated with the lodge's operational activities.

- To outline mitigation measures and environmental specifications which are required to be implemented in order to manage and minimise the extent of potential negative environmental impacts.
- To identify entities responsible for the implementation of the measures and outline functions and responsibilities.
- To propose mechanisms and frequency for monitoring compliance, and preventing long-term or permanent environmental degradation.

1.5.1 STRUCTURE OF THE EMP REPORT

This EMP report has been compiled in accordance with Section 8 of the EIA Regulations. The EMP report has the following structure:

- **Chapter 1:** Introduction
- **Chapter 2:**Relevant statutory requirements.
- **Chapter 3:**Description of operational activities and services.
- **Chapter 4:**Description of the baseline environment in the area
- **Chapter 5:**Description of the potential environmental impacts arising from the project, on the physical, biophysical, biological and socio-economic components associated with the proposed project and their mitigation and management measures.
- **Chapter 6:** Project Cycle Environmental Management Plan: A description of the management measures and strategies to be used in implementing the best practice requirements and commitments made in this EMP.
- **Chapter 7:**EMP Implementation Strategy: Includes the identification of environmental performance objectives, standards and criteria practicable for the proposed seismic acquisition activity. It will also serve as a practicable environmental management tool that can be used throughout the survey by operators to implement targeted environmental control measures.
- **Chapter 8:**Project cycle environmental Management Plan: A description of the management measures and strategies to be used in implementing the best practice requirements and commitments made in this EMP.

- **Chapter 9:** References
- **Chapter 10:** Appendices

2

2 RELEVANT STATUTORY REQUIREMENT

It is the responsibility of The Proponent to have a comprehensive inventory and understanding of all relevant legislations and determine the relevance of these legislations. The interpretation and understanding of legislation provides the background for management and mitigation of all environmental impacts.

This section identifies statutory requirements which are relevant to the lodge establishment with respect to the managing of environmental impacts associated with the operational activities and services offered by the lodge. The following legislation and guidelines have informed the scope and content of this EMP.

2.1 ENVIRONMENTAL LEGISLATION

2.1.1 Environmental Management Act No. 7 of 2007

The Environmental Management Act No. 7 of 2007 is an important tool in terms of environmental protection. The Act requires adherence to the principle of optimal sustainable yield in the exploitation of all natural resources. The Act gives effect to Article 95 (l) of the Namibian Constitution by establishing general principles for the management of the environment and natural resources. It promotes the coordinated and integrated management

of the environment The Act promotes inter-generational equity in the utilisation of all natural resources. Environmental impact assessments and consultations with communities and relevant regional and local authorities are provided for, to monitor the development of projects that potentially have an impact on the environment. According to the Act, Namibia's cultural and natural heritage is required to be protected and respected for the benefit of present and future generations. In order to promote the sustainable management of the environment and the use of natural resources, the Act has established a bundle of principles for decision-making on matters affecting the environment. The objective of the Act is laid down in its Section 2, which is to prevent and mitigate, on the basis of the principles set out in section 3, the significant effects of activities on the environment.

2.1.2 Environmental Impact Assessment Regulations No. 30 of 2012 of the Environmental Management of 2007

Environmental Impact Assessment Regulations No. 30 of 2012 of the Environmental Management Act No. 7 of 2007 lists activities which may not be undertaken without environmental clearance certificate and hence are subject to an environmental assessment process. It is for these reasons that an environmental assessment should be undertaken to identify the fatal flaws associated with the various activities to be undertaken.

2.1.3 Environmental Management Bill of (2004)

The draft Environmental Management Bill of (2004), administered by the Directorate of Environmental Affairs, Ministry of Environment and Tourism is aimed at giving statutory effect to the Environmental Assessment Policy for Sustainable Development and Environmental Conservation (1995). The purpose of this bill is to give effect to Articles 95(c) and 95(1) of the Namibian Constitution by establishing general principles for the management of the environment and natural resources. It further promotes the coordination and integrated management of the environment. Schedule 1 of the bill lists activities that require a full environmental assessment to be conducted and include exploration and mining related.

2.1.4 Environmental Assessment Policy for Sustainable Development and Environmental Conservation of 1995

Currently, the Environmental Assessment process in Namibia is governed by the cabinet approved Environmental Assessment Policy published by the Ministry of Environment and Tourism in 1995. **Figure 2** shows all the relevant stages that are required in an

environmental assessment process. The Environmental Assessment policy for Sustainable Development and Environmental Conservation (1995) provides that all policies, projects and programmes should be subjected to an Environmental Assessment, regardless of where these originate. The assessment must aim for a high degree of public participation, and consider the environmental costs and benefits of projects proposed. In order to allow for identification and avoidance of adverse impacts in line with best practice, Environmental Assessmentsshould be conducted at an early phase of project development. The Directorate of Environmental Affairs (DEA) provides guidelines for environmental assessments for all mining related projects. The guidelines address obvious environmental aspects such as pollution and waste management as well as operational procedures and rehabilitation measures.

2.1.5 Nature Conservation Ordinance 4 of 1975 (as amended 1996)

The Nature Conservation Ordinance deals with conservation by providing for the declaration of protected habitats as national parks and reserves, and for the protection of scheduled species wherever they occur. Chapter 5 and 6 of the ordinance is relevant to the proposed project in that the chapters deal with protection of fish and flora in inland waters. Inland waters are defined as all waters which do not permanently or at any time during the year form part of the sea. Section 48 of Chapter 5 stipulates that no pollution of inland waters either by depositing or causing or allowing to be deposited pollutants in any inland waters or in any place from where it is likely to percolate into or in any other manner enter any inland waters. The pollutants can be anything, whether solid, liquid or gaseous, which is or is likely to be harmful to any fish or fish food or which, if was deposited in large quantities would be harmful. Killing, injuring and wilfully disturbance or destroying the spawn of any fish in the inland waters is also prohibited. Chapter 6 of the ordinance deals with the protection of flora by prohibiting unpermitted possession of endangered flora species and picking or sale of protected flora species.

- **Soil Conservation Act No. 76 of 1969**
- **Parks and Wildlife Management Bill of 2006;**
- **Forest Act No. 12 of 2001**
- **Namibia Wildlife Resorts Company Act No. 3 of 1998**
- **National Heritage Act No. 27 of 2004**

2.1.6 The National Environmental Health Policy

The operational activities and services offered by the lodge must be guided by the aim of this policy, which includes the following:

- Facilitate the improvement of the living and working environments of all Namibians, through pro-active preventative means, health education and promotion and control of environmental health standards and risks that could result in ill-health; and
- Ensure provision of a pro-active and accessible integrated and co-ordinated environmental health services at national, regional, district and local levels.

2.1.7 Namibia's Green Plan

Namibia's Green Plan aims at securing - for present and future generations - a safe and healthy environment and a prosperous economy. The Green Plan recognises that "the health of individuals, society and the economy are inextricably linked to the health of the environment. Accordingly, the objective is to manage its natural resources for present use without jeopardising the future accessibility of these resources. Namibia's Green Plan cautions that environmental policies must be based on the precautionary principle and that all major construction projects, especially in the water sector, should always be preceded by an Environmental Impact Assessment (EIA) in order to prevent or minimise the potential negative effects on the environment. Further to this, the plan makes provision for the protection of the country's genetic resources; also its rich biodiversity must be maintained.

2.2 WATER RESOURCE LEGISLATION

2.2.1 Water Resources Management Act, (No. 24 of 2004)

The Water Resources Management Act, (No. 24 of 2004)came into operation on 8 December 2004, makes provision for a number of functions pertaining to the management, control and use of water resources, water supply and protection of water resources.The

objective of the Act is to ensure that Namibia's water resources are managed, developed, protected, conserved and used in ways which are consistent with or conducive to fundamental principles set out in section 3 of the Act.In accordance with the Water Resources Management Act, 2004, (Act No. 24 of 2004) and in view of the arid nature of the Namibian environment, the disposal of waste-water as well as all other type of waste is strictly controlled. In most cases and in particular wastewater is disposed of in evaporation ponds because no effluent may be discharged into the ephemeral, dry riverbeds in the interior of Namibia. The reclamation, re-use and recycling of waste is encouraged whenever an industry applies for a waste water disposal permit.

Other sections of the Act relevant to operational of the lodge deal with the following:

- No discharge of effluent without permit; and
- Standards of effluent quality.

2.3 POLLUTION HEALTH AND SAFETY LEGISLATION

A number of regulations have been gazetted since 1992, dealing with various aspects related to employer and employees rights, including the regulations relating to the health and safety of employees at work, promulgated in terms of the Labour Act (Government Gazette 1617 of 1 August 1997) and the amendments of 2004.

2.3.1 Draft Pollution Control and Waste Management Bill of 1999

A draft version of the Pollution Control and Waste Management Bill of 1999 has amalgamated a variety of Acts and Ordinances that provide protection for particular species, resources or components of the environment. This Bill deals mainly with the protection of particular species, resources of components of the environment. All disturbance, effluent and pollution resulting from operational activities of the lodge block will be required to be in strict accordance with the regulations outlined in the Pollution Control and Waste Management Bill. Various sections, of relevance for the lodge, are described below.

- *Water Pollution*
  - Water quality monitoring will be co-ordinated by an Agency, in terms of water quality objectives and activities liable to cause water pollution.
  - Regulations under this pending law will include limits for discharges of pollutants to water and land from fixed and mobile sources, water quality objectives, standards for the pre-treatment or purification of pollutants, and

procedures required for compliance with any standards. It will also prescribe offences and water quality action areas and the restriction of polluting activities in these areas, as well as require application for water pollution licences to be accompanied by an environmental assessment report, and offences.

- *Air Pollution*
  - Co-ordination and monitoring of Namibia's air quality, through reference to air quality objectives that will be drawn up once the Bill is promulgated.
  - An air pollution licence will be required for the discharge of pollutants to the air, subject to air pollution objectives that are set, standards, treatment processes, the contents of an environmental assessment, and an air pollution action plan that stipulates the best possible means for reducing and preventing the discharge of pollutants to the air.

- *Integrated Pollution Control*
  - Processes creating a risk of pollution to more than one environmental medium, e.g. Air and water, may be subject to specific regulations that adopt an integrated approach to pollution and licencing. These prescribed processes shall be subject to an Integrated Pollution Control Licence.

- *Noise, Dust and Odour Pollution*
  - Local authorities or a separate agency created to deal with dust, noise and odour will have the power to issue an abatement notice for activities causing a nuisance. The activity may be stopped, or conditions determined for migratory or other measures to reduce the nuisance to acceptable levels.
  - Regulations may come into force under this Act that set standards for noise, dust and odour emissions, and product or process standards that have a bearing on noise, dust and odour pollution.

- *Waste Management*
  - The production, collection, sorting, recovering, treatment, storage, disposal andgeneral management of waste shall be covered under this Act.

- *Hazardous substances*

- The Bill further makes provision for regulations that establish standards and otherrequirements in relation to hazardous substances.

- *Accident Prevention Policies*
  - The Bill makes provision for the enforcement of regulations that require a person in possession of specified hazardous substances or products containing hazardous substances or any person carrying on an activity involving significant risk of harm to human health or the environment, to take measures to limit the risk of accidents occurring as a result of those substances or activities.

2.3.2 Atmospheric Pollution Prevention Act (No. 45 of 1965)

The Atmospheric Pollution Prevention Act (No. 45 of 1965) has parts that are relevant to the health and safety associated with operational activities of the lodge. The following parts of the Act, and its related regulations, are relevant:

- Part II - Control of noxious or offensive gases;
- Part III - Atmospheric pollution by smoke;

2.3.3 Regulations for the Health and Safety of Employees at Work of the Labour Act of 2007 (amended 2011)

The Regulations relating to Health and Safety at the Workplace in terms of the Labour Act No. 11 of 2007 came into force on 31 July 1997. These regulations prescribe conditions at the workplace, and *inter alia* deal with the following:

- Welfare and facilities at work-places, including lighting, floor space, ventilation, sanitary and washing facilities, usage and storage of volatile flammable substances, fire precautions, etc.
- Safety of machinery.
- Hazardous Substances including precautionary measures related to their transport, labelling, storage, and handling. Exposure limits, monitoring requirements, and record keeping are also covered.
- Physical hazards including noise, vibration, ionising radiation, non-ionizing radiation, thermal requirements, illumination, windows and ventilation.
- Requirements for protective equipment.
- Emergency arrangements.

- Electrical safety.

2.3.4 Hazardous Substances Ordinance 14 of 1974;

2.4 OTHER LEGISLATION

Other relevant legislation and policy strategies with respect to the lodge which are also worth noting are as follows:

- The Regional Councils Act, 1992, (Act 22 of 1992)
- The Local Authorities Act, 1992, (Act 23 of 1992)
- The Labour Act 2004, (Act 15 of 2004)
- Liquor Act, 1998

3 DESCRIPTION OF THE OPERATIONALACTIVITIES AND SERVICES

An application has been submitted to the Ministry of Lands, Resettlement and Rehabilitation for the formalization of the leasehold. The leasehold can only be formalizedonce Environmental Clearance has been obtained.The lodge has been granted conditional registration for 6months until the leasehold is formalized with the Ministry of Land and ResettlementNamibian Tourism Board *(See Appendix E for a copy of the Conditional Registration Letter)*. Moreover, as per the Liquor Act of 1998, Muramba River Lodge also will apply for a liquor license granting them permission to sell alcoholic beverage on the lodge premises to tourists, guests and visiting and residing at the lodge, but not to the community. Currently, the lodge has also been granted a temporary operation license by the Liquor Board. This temporary license will be reviewed upon the approval of the leasehold.

3.1 LAYOUT

Muramba River Lodge has been constructed as a Thatched Lodge to fit with the natural (bush) character of the environment. Brickworks and thatch grass were included as part of the construction of the lodge to form rooms in order to maintain a natural earthy overall

appearance and feel. The lodge has been constructed with the least impact on the environment as practically possible. Existing roads had been upgraded and trees and plants were retained wherever possible in the construction of the thatched lodge. The flow of the river has not been altered and plants are left unharmed and disturbed. The owner and staff members strive to sustain and improve the natural environmental to the best of their abilities.

The portion agreed upon between The Proponent and theGciriku Traditional Authoritywas surveyed by Ministry of Land and Resettlement **(APPENDIX B)** and found to include a lodge area of 0.73 hectares and further area of which is 2.27 hectares. The total area granted to the lodge operations is 3 hectares. See Appendix B for the survey diagrams of the portions which the Traditional Council made available to the lodge.

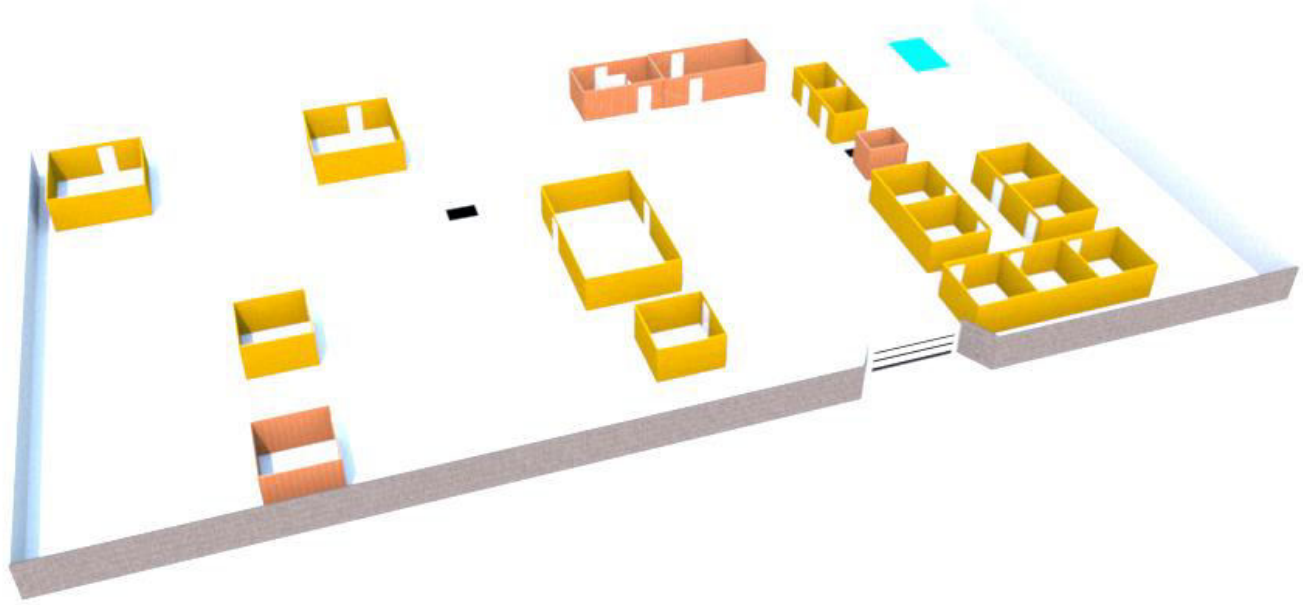

Figure 2.Map or plan showing layout of the lodge.

3.2 LODGE INFRASTRUCTURE

The Muramba River Lodge has the following infrastructures access roads, water, electricity, sewerage, conference and accommodation facilities. The lodge has been constructed with the least impact on the environment as practically possible. These infrastructures were constructed without the guidance of an EMP as no EIA was conducted prior to construction. The lodge and associated facilities were constructed using cement bricks, rockwork, and thatched grass, creosoted pined wood poles and painted walls to fit the natural colour of environment (See **Appendix D** for drawing of the thatched rooms). From the site report and observations on site, it is clear that the access roads, bulk services and rooms were positioned to fit- in with the natural environment and the indigenous trees thus utilizing their natural shade and consequently minimize the damage to the natural receiving environment. This happened mainly because of close supervision from the owner who has great appreciation for the receiving environment and the sustaining thereof. The impacts associated with the construction of the lodge were thus limited to the absolute minimum. The bulk services at the lodge operate as follows:

3.2.1 Water Supply

Bulk water supply for the gardens, operation of the accommodation facilities is directly pumped from the Kavango River into storage tanks from where it is gravitated to various accommodation rooms and facilities via an underground water reticulating system. Due to the fact that, the river water at the site is not purified, workers and residents at the site are notified through various notice boards on site and in the rooms where theriver water is not purified,hence not suitable for human consumption. Purified commercially bottled water is provided to staff and customers for human consumption.

Figure 3.Location of underground water reticulating system relative to the river and lodge

3.2.2 Electrical and Wood Supply

Electricity is supplied by Northern Region Electricity Distributing company (NORED) to a central point from where it is distributed to various areas such as accommodation rooms,reception, conference, kitchen and restaurant via an underground reticulation system. Firewood utilized for fire places and barbecues is purchased from commercial fire wood and charcoal suppliers from local business outlets in Rundu. This firewood is generated from bush clearing operationsof intruder bushes. No fire wood is sourced from the community as the type and origin of the wood would be difficult to confirm and as such this activity can led to further loss of natural vegetation in this area and potentially contribute towards deforestation.

3.2.3 Roads

The Muramba RiverLodge is accessible off the B8 main tarred road from Rundu to Divundu. Existing roads on the site have been upgraded.Trees and plants were retained wherever possible in the construction of the thatched lodge and roads.

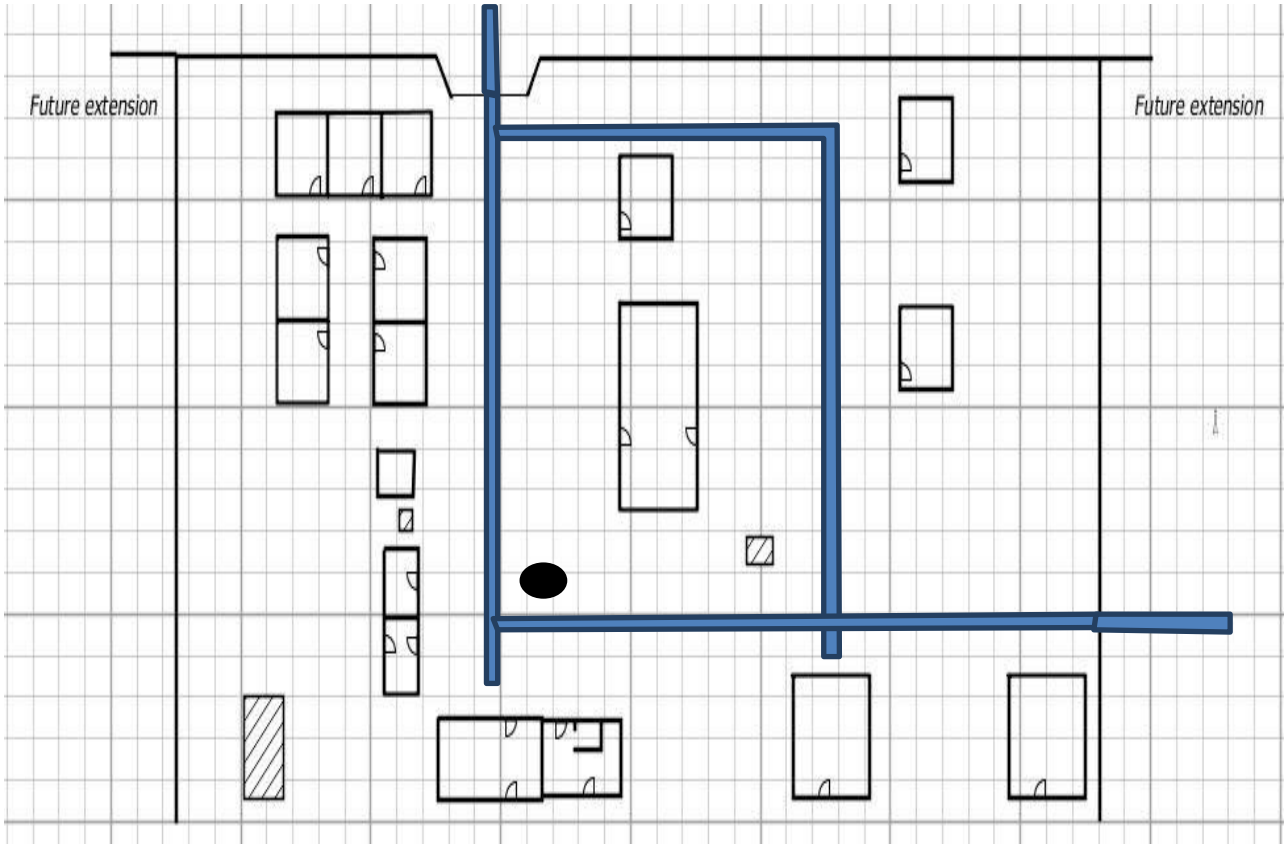

Figure 4.Map or plan showing roads within the lodge.

3.2.4 Sewerage System

The on-site ablution facilities as well as the public ablution facilities are connected to properly constructed and sealed-off French Drains. These drains have main receiving septic tanks made-up of bricks and cement which collect the sewerage waste. These drains/septic tanks are located some distance from theMuramba River and therefore will not be subjected to flooding to result into contamination of the river system. The tanks are also positioned in such a way as to prevent any effluent from washing or flowing back into the river or into the surrounding area. Thesewerage waste from the septic tanks is collected by a contractor and dumped at a designated dumping site far-off from the lodge and river system.

Figure5.Location of septic tanks relative to the river and lodge.

3.3 SERVICES

The principle business description of the lodge includes the following: Tourism related ventures including provision of accommodation facilities and restaurant, conference facility, wildlife conservation and all matters related hereto.Muramba River Lodge provides job opportunities and employment to local citizens in the Kavango Region.

The solid waste generated from these facilities is sorted and gathered at a dedicated waste site in dedicated containers on-site from where it is transported by a contractor and dumped at the designated dump site also situated way-off from the lodge and river system. No hazardous waste is currently generated at the lodge.

4 DESCRIPTION OF THE CURRENT ENVIRONMENT

An understanding of the baseline environment within the project area is vital in identifying positive and negative impacts associated with the operational activities at Muramba Lodge. The purpose of this environmental description is to provide the baseline environmental context within which the lodge activities will take place. A detailed description of the natural environment within the project area is therefore highlighted in this section in terms of the physical, biological and other aspects of the environment. The summaries presented below are based on information gleaned from several authors.

4.1 PHYSICAL ENVIRONMENT

4.1.1 Topography

The Muramba lodge area falls within the extensive Kalahari sand basin, along the stretch of the Kavango River, in an area comprising of characteristic Aeolian sands deposited ca. 30 000 years ago as longitudinal, east-west oriented dunes (Hegenberger, 1986).Through erosion, the topography around the study area was flattened to less than 10m relative differences in relief, with areas close to the river annually being subjected to annual floods which seasonally inundate large area of land.

4.1.2 The Kavango River

Theriver originates in the rainy Bié Plateau in Angola, touches the north-western part of Namibia with its savannah woodlands and terminates in a delta situated in the Kalahari Desert in Botswana.The riverflows along the northern border of the Kavango Region of Namibia and forms the boundary between Kavango and Zambezi Region.The river which forms the border between Angola and Namibia meandersthrough a 2-6 km wide valley, at 30-70 m below the surroundingbush savannah and dry woodlands. Floodwaters inundate large areas withinthe valley each summer but seldom reach thecultivated alluvial terraces alongside.The floods in the Kavango River supply the resources for a vast complex of waterways, reedbeds, floodplain, and islands that makes up the Kavango Delta in Botswana.

4.1.3 Hydrology

The hydrological cycle is, the predominant feature the predominant feature determining the ecology and productivity of the Kavango floodplains. The annual hydrological cycle of the area shows two extremes: seasonal floodingalternates with dry periods influencing water levels of the Okavango River in downstream regions. According to Bethune, (1990), central

and southern Angola receives summer rains between September and April usually peaking in January. The resultingflood waters reach Rundu in January or February and continue to rise until April. High flood is usually 3 to 4 or 5 times higher than levels in November but floods as high as 6 m above low waterhave been recorded (Fisch 1987). At high-flood the river carries40-60 times more water than in the winter months (Bethune, 1990).

4.1.4 Soil

Kavango soils are generally infertile,aeolian sand and water-depositedgravel with a low organic content. The soils ofthe floodplain and river terraces, however, are enriched byalluvial silt (Schneider 1987). Although the latter no longerreceive alluvial deposits they are intensively cultivated byfarmers. Soil erosion is evident along most of the southern bankof the Kavango River and is particularly serious 50 km eithersideofRundu and between Andara and Papa. This erosion is due to human use, trampling by stock and indiscriminate clearing ofriverine vegetation.

Water quality

The quality of the water of the Kavango River in Namibia is well documented by Bethune (1990). According to Bethune (1990), the waters are clear, wellmixed and well oxygenated. Watertemperatures are relativelyhigh in summer 23 - 30°C and decrease sharply in winter to 17-19°C and are usually within a degree of the air temperature (Bethune 1990).Temperature remains fairly constant with depth and distance along the river but vary with the time of day. This diurnal cycle is commonly marked in shallow waters (Bethune 1990).

Dissolved oxygen concentrations in the mainstream vary from5.3 to 9.4 ppm during the year. Oxygen levels in floodplain pools aremarkedly higher by day than at night due to photosynthesis andtend to decrease with depth in isolated backwaters due todecomposition, particularly in late summer.The nutrient levels are generally low, indicating an enrichedsystem but slightly higher phosphate concentrations were recordedat human access points where cattle wastes and detergentsmay cause a degree of pollution.

4.1.5 Climatic Conditions

Climatic conditions include meteorological conditions such as temperature, rainfall, wind and fog. The climate around the Muramba Lodge locality is typical of the Kavango region, with rainy summers and comparatively dry winters. Temperatures around Rundu range from a

high of +40°C in August to a low of +12°C in the winter season which runs from late April to late August.

Humidity is low to moderate, while the average annual rainfall is highly variable and ranges between 500mm - 560 mm around the Rundu district. The rainfall distribution is extremely seasonal with a vast percentage of the precipitation occurring in summer - from October to May with a peak rainfall during January and February

(Figure 4).

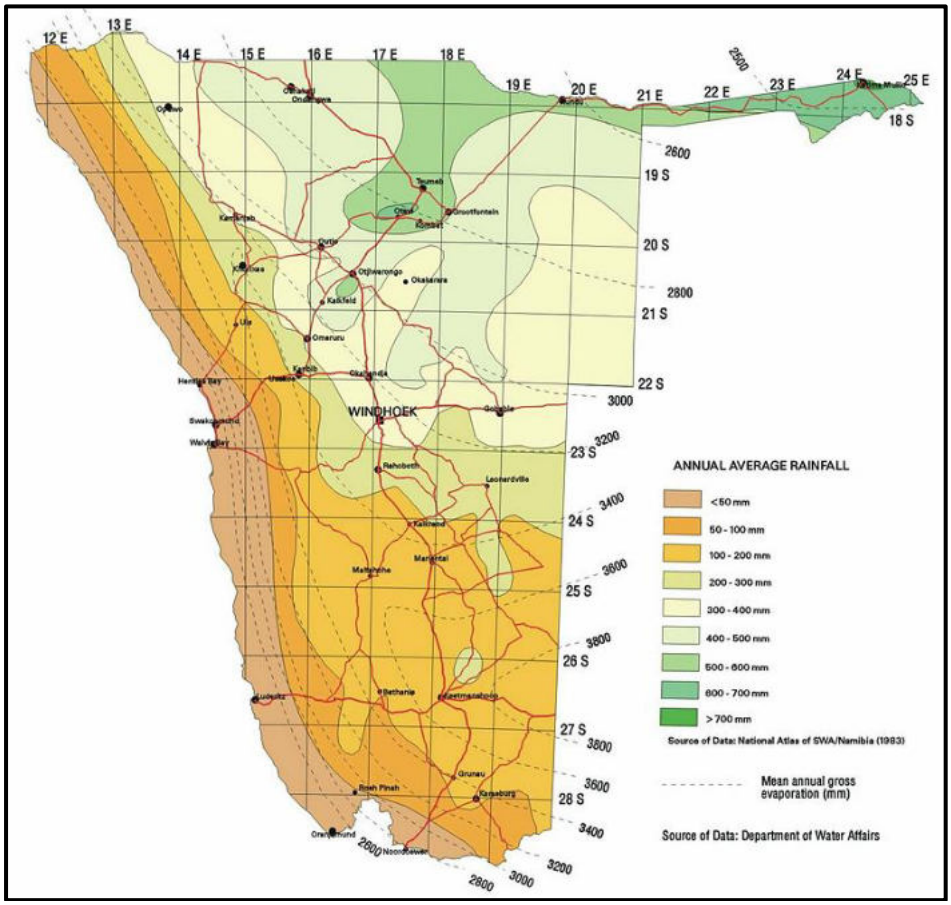

Figure 6.Regional climatic patterns of Namibia showing the location of the study area (Directorate of Environmental Affairs, 2002).

4.1.6 Vegetation

The Kavango Region supports a rich and diverseflora. There are 869 species from 88 families listed and19 algal species(Page 1980; Coates Palgrave 1983; Muller 1984;

Correira&Bredenkarnp 1987; Hines 1987). This includes 5 ferns, 334 monocotyledons ofwhich 185 are grasses; and 530dicotyledon (Buthene, 1990).

Classifications used to describe the vegetation in the Kavangoregion differ. Page (1980) defines 10 main vegetation types' and19 subunits within these. Correira&Bredenkarnp(1987) differentiatebetween 5 major and 15 land use units of which four occur alongside the Kavango River, whilst Hines (1987) describes3 major habitat types, of which "River" includes openwater, the riverine fringe, back swamps and flood plains and For thisreport five main vegetation zones arc distinguished: open water, river margin, floodplain, permanent marsh, and alluvial terraces.There are no clear-cut boundaries between these habitats but agradual change from the wetter to the drier types occurs Withdistance from the river and time since flooding. A schematic vegetation profile is given in Figure 4.

4.2 BIOLOGICAL ENVIRONMENT

This section summarizes biological environment within and around Muramba Lodge, and is predominantly compiled from the Journal article "Kavango Rover Wetlands", dated July1990, prepared by Shirley Bethune. The Kavango region and its associated Kavango river in general is deemed as one of the productive systems supporting a diversity of plants and animals in Namibia. Hence similar to Bethune (1990)'s journal article, for thisreport five main vegetation zones are distinguished: open water,river margin, floodplain, permanent marsh, and alluvial terraces.Other reports on the historical work include Reeve (1967, 1968, 1970) and Sanguinetti (1996).

4.2.1 FLORA

The Kavango falls within the ZambesianBaikiaea woodlands as delimited by the World Wild Fund (WWF) (Vetter, 2001). It is therefore characterised by dominant open woodlands with numerous hardwood species.

4.2.1.1 Open water

The mainstream, which is 50 m-200 m wide, and the narrowerside channels areclearand swift-flowing. The substrate is sandy or rocky with exposed sandbanks and rocks in places. Depthsvary from 0, 5 m to 8 m .Submerged macrophyte beds ofpond weeds, *Potamogetonspp*spp. *Vallisneriaaethiopica*andoxygen weed,*Lagarosiphonilicifolius,*occur in

beds along themainstream at low water levels. The free-floating water ferns, *Azollanilorica*and A. *pinnata var. Africana, water* lilies,*Nymphaea*sppand the water chestnut, *Trapanatans,* aresometimes found floating in the open water of bays and backwaters.

In the rapids, water flow is swift, cascading and turbulent overa substrate of bedrock, potholes, loose stones and sand pockets.Here algae and a small moss-like seedplant grow. The latter iscommon in the Andara-Bagani region where it completelycovers rocks and offers a habitat to many.Inthe more sheltered marginal cascadessome ferns. *Thelypterisinterruptus*invertebratesand the insectivoroussundew plant.*Droseramadagascariensis*are found.

Insert pictures

4.2.1.2 River Margins

The natural vegetation of the river margins is either reed fringesor riparian forest, but in the vicinity of settlements large tractsof land have been cleared for agriculture and access to the water.In contrast, the margins on the northern hank in Angola arevirtually undisturbed. This is expected to change as the area isresettled.

4.2.1.3 Reed Fringes

Along the middle reaches of the Kavango Riverdensereedbanksoccur. These typically include two reed species, *Phragmitesmauritianus*and*P. astralis* , tall grasses such as *Pennisetumglaucocladum*and*Echinochloastagnina,*creepers including*Mikaniacordata*and*Koslte*lelzkyabuelttneri,* rooted emergent *Polyganumpulchrum,*knotweed, and *P. senegalense*andseveral aquatic legumes such as the river beans, *Sesbaniacinerascens,*S. *sesban, Aeschynomenenilotica*and*Mimosapigra*(Smith 1976). In the lower reaches, south of Andara, thiscommunity is replaced largely by a dense fringe of papyrus.

At high water sheltered bay lets or channels are formed behinddense reedbeds and sandbanks. These barriers are 1-4 m wideand isolate shallow pools less than a metre in depth, the substrateis sandy or muddy and covered by a light organic sediment orflooded terrestrial grass; a slow current or counter current ispresent. These sheltered waters support abundant temporaryaquatic macrophyte communities. Submerged aquatic plantsinclude the pondweeds,*Potamogetonoctandrus*and*P. schweinfurthii,* sawweed, *Najaspetinata, Vallisneriaaethiopica*and*Otteliakunenesis.*

4.2.1.4 Riparian forests and thickets

Large stretches of river bank support dense riverine forests andthickets. Many of the trees and shrubs bear edible fruit. Theseinclude the bastard dwaba-berry,*Friesodielsaobovata;* theZambezi raisin,*Grewiaschinzii;* of the custard apple family, *Annonastenophylla;* the africanmangosteen, *Garcinialivingstone;* the marula, *Sclerocarahirrea;* the koobooberry,*Cassineaethiopica;* the Transvaal ebony, *Diospyrosmespiliformis*and the monkey orange,*Strychnosspinosa.*

Trees typical of the thickets are the ordeal tree, *Erythrophleunafricanum; the knobbly* bushwillow,*Combretummmossambicense; and the birdplum, Berchemiadiscolor.*

The riverine forest in the north and west is dominated by Rhodesian teak*, Baikiaeaplurijuga.* whilst further east, red syringa*, Burkeaafricana*dominates *(Fisch 1987).* Forest trees include

the well-known kiaat,*Pterocarpusangolensis,* the large false Mopane*, Guibourtiacoleosperma,* the manketti*, Ricinodendronrautanenii,* the terminalias*, Terminaliapruniodes*(purple-pod terminalia) *and T. sericea (*silver terminalia), several bushwillows*, Combretumimberbe*(leadwood), *C. psidioidesvar, psidioides*(Silver bushwillow)and *C. zeyheri*(large-fruited bushwillow) and the *buffalo thorn, Ziziphusmucronata.* (Smith 1976; Coates Palgrave 1983).

The best examples of riparian forests are downstream of Mukwe.Typical trees are the bi-coloured waterberry*, Syzygiumguineensesubsp. barotsense;* several acacias*, Acacia erubescens*(Blue thorn),*A. hebeclada subsp. chobiensis,* (candle acacia)*,* and*A.nigrescens*(knob-thorn)*;* the sausage tree*, Kigeliaafricana;*Rhodesianebony,*Diospyrosmespiliformis;* and two varieties of the rough leafed raisin*, Grewiaflavescens.*

4.2.1.5 Cleared river banks

The large cleared areas on the low slopes next to the river areaptlydescribed as a "mosaic of agricultural fields, old fallow lands, bush thickets and parklands" by Correira&Bredenkamp

(1987). These support dense thickets of secondary vegetationwhich include *Acacia* species thickets of *Baphiamassaiensis, Bauhinia petersiana*and*Terminaliasericea.*


4.2.1.6 Floodplain

The annual floodwaters spill into several braided side channels, back up into the omuramba and inundate the surrounding valley,forming a marshy environment intersected by several deepchannels.

The side channels have a steady current, clear water, sandy orclay substrate and varying water depths. The islands and shallowareas are covered in terrestrial grasses, *Eragrostis rotifer,Chlorisvirgata*(feather-top chloris), *Cymbopogoncaesius*(broad-leaved turpentine grass) and the lawn-like *Cynodondactylon*and a few trees adapted to the seasonal floods, such asthe paper-bark acacia, *Acacia sieberana.* The river rhus, *Rhusquartiana*and the forest waterberry, *Syzygiumgerrardi.*Themargins support reeds, sedges including bull rushes *(Typhacapensis)* and thick-stemmed grasses. Floating vegetation includes dense stands of floating-leaved plants such as waterlilies*(Nymphaea*spp.) and floating hearts *(Nymphoidesindica*subsp. *occidentalis),* floating-stemmed plants such as willow herb *(Ludwigiastolonifera),* the legume *Aeschynomefluitans*and water spinach *(Ipomoea aquatica).* Submerged macrophytes include C*eratophylllumdemersum,* sawweed*(Najaspectinata)*, fine oxygenweed*(Lagarosiphonilicifolius), Vallisneriaaethiopica*and*Otteliakunenensis.*

The receding flood waters isolate pools of various sizes in the floodplain. These are usually turbid, show some degree of thermal stratification, have an organic substrate and support a dense aquatic vegetation until they dry out. The tall grass *Vetiverianigritana*often indicates the high-water mark.

4.2.2 Permanent Marsh

At the confluence of the Kavango River there are areas of permanent marsh. These resemble the flooded zones at high water. In the dry season the water is shallow and stagnant, dissolved oxygen levels are fairly low and the substrate consists of silt and organic debris. The marshes support dense stands of *Phragmites*spp. some*Cyperus papyrus,* aquatic macrophytes similar to those in the flood channels, a variety of sedges and trees typical of marshes such as the forest waterberry, *Syzygiumgerrardi.*

Insert pictures

4.2.2.1 Alluvial terraces and inland

The alluvial terraces are on either side of the river above the general flooding area. These terraces have been successfully farmed for the past 150 years. The main crops are sorghum, *Sorghum bicolor*and pearl millet, *Pennisetumamericanum*(Schneider 1987). The terrace soil was once enriched by silt deposits. Trees which characterize these terraces are the baobab; *Adansoniadigitata,* the palms: *Phoenix reclinata*(wild date palm), *Hyphaenebenguellensis*(real fan palm) and *H. petersiana*the edible mobolo plum; *Parinaricuratellifolia*and the corky-bark monkey orange *Strychnoscocculoides.* Several climax grasses grow on the terraces, they include, Kalahari buffalo grass; *Panicumkalaharense,* guinea grass; *P. maximum,* silky Bushmen grass; *Stipagrostisuniplumis,* gonya grass; *Urochloaoligotrich,* buffalo grass; *Cenchrusciliaris,* black

footed brachiaria; *Brachiarianigropedata,* woolgrass, *Anthephorapubescens*and*Schmidtiapappophoroides.*

The middle reaches of the Kavango River flow through thenorthern Kalahari sand zone. The vegetation on either side of theriver valley is tree savannah and dry woodland. Trees typical ofthis region are the silverterminalia; *Terminaliasericea,* severaltypes of combretum and acacia, good timber trees such as thecrystal bark; *Crossopteryxfebrifuga,* the horn-pod tree;*Diplorhynchuscondylocarpon,* and the snake-bean: *Swartziamadagascariensis,* and several species of *Grewia*and*Commiphora.* Grasses which thrive on the aeolianKalaharisands are *Eragrostisjeffreysii, E. lehmanniana, E. paliens*andthe curly-leaved love grass, *E. rigidior.* As in the floodplainssecondary vegetation has become established on areas previouslycleared for agriculture (Correira&Bredenkamp 1987).

Insert pictures

4.2.2.2 Endemics and protected plants

Only oneendernic plant occurs in the Kavango valley, this is thering wood tree, *Maeruaschinzii*which grows along riverbanksand water courses. This is probably a geographical variant andit is likely that closer investigation will show the tree to be asubspecies of *Maeruaangolensis*which is found in similarhabitats in Angola (Coates Palgrave 1983).

Protected plants arc the African protea, *Proteagaguedi,* theorchid, *Eulophiahereroensis,* the two aloes found particularlyin the vicinity of Andara, *Aloe esculenta*and A. *zehrina*arIdtheamaryllid*Crinumcarolo-schmidtii*(State Herbarium list 1982).*Proteagaguedi*is threatened and possibly rare or extinct alongthe river as a result of over-use by local herbalists. The aloes areprotectedin a small reserve near Andara.The lead wood tree, C*ombretumimberbe*is protected in Namibiaand several other trees which are protected in South Africa maywarrant protection. They are, the woolly caper bush: *Capparistomentosa,* the ana-tree; *Acacia albida.* the baobab; *Adansoniadigitata,* the apple-leaf; *Lochocarpuscapassa*andthemarula;*Sclerocaryabirrea*(Cnates Palgrave 1983).

4.2.3 FAUNA

4.2.3.1 Aquatic Invertebrates

Although several collectors (S. Bethune, C. Appleton, B.A. Curtis this volume, M. & M-L. Penrith) have collected aquaticinvertebrates from the Kavango River in Namibia, generallyonly the more conspicuous and medically important ones havebeen identified to species level. Thirty mollusc species from 10families have been found in the Kavango River and its associatedfloodplain; none are considered endemic nor endangered(B.A. Curtis this volume). Only the larger crustacea have beenidentified. They are two freshwater shrimps, *Caridinanilotica*and C. *African* and two subspecies of the crab, *Potamonhayonianus.* These crustacea and some snails, *Pilawernei,Lanistes ovum* and *Muteladubia*(Curtis & Appleton 1987) areeaten by people living along the river. Eight orders of aquaticinsects are found in the river.

Insert pictures

4.2.3.2 Amphibians

Twenty-nine species of frogs and toads from six families areexpected to occur in the Kavango wet lands. Although none are endemic or endangered, all aredependent on water to complete their life-cycles. Of the 22species listed for the Kavango Delta (Forrester et al. 1989), 16occur both in Namibia and Botswana.

4.2.3.3 Fishes

Much of the recent research on the river has concentrated on thefish fauna. Of the 83 species and subspecies which occur in theOkavango drainage system 71 are found in Namibia (Skelton etal. 1985; Merron&Bruton 1988; Skelwn&Merron 1984,1985, 1987; Van del' Waal this volume) and 32 in the Delta(Forresteret al. 1989). Of these, 31 are common to both regions.Two species, the ocellaledspinyeel.*AefhiomaslGcembelusvallderwaali,* and the broad head catfish, *Clariallabesplaryprosopos,* are listed as red data species (Skelton 1987).Both favour rocky rapids and are considered rare in Namibia.

The fishes of the Kavango River are well adapted to the seasonalfluctuations in water-level and the resultant habitat changes.During the annual floods, the fish migrate from the river into thenewly inundated floodplain. The subsequent input ofallochthonous material and nutrients creates an ideal habitat forthem to breed and feed, away from predators. Fishes whichremain in the mainstream are well adapted to the fast flowingwaters. This population includes the silver robber. *Micralestesacutidens, the longbeard barb, Barbusunitaeniatus,* the orangefin barb. *B. eutaenia,* upper Zambezi yellow fish, *B. codringtonii,*the broad-barredcitharine, *Nannocharaxmacropterus,*the barred minnow,*Opsaridiumzambezense and two strictly*rheophilic species, the redeye labeo,*Labeocylindricus*and the mountain catfish, *Amphiliusuranoscopus.*

The population in the floodplain habitats and marginal waterstypically include small species such as the Zambezi parrotfish,*Hippopotamyrusdiscorhynchus*and other mormyrids,

thestripped robber, *Brycinuslateralis,* the Okavango robber, *Rhahdaiestesmaunensis,* the African pike, *Hepsetusodoe,* several cyprinid *Barbusu s*pp., small cichlids such as the Zambezihappy, *Pharyngochromisdarlingi,* the southemmouthbrooder, *Pseudocrenilabrus philander,* the Okavango tilapia,*Tilapiaruweti,*the snake catfish, *Clariastheodorae*andthemany-spined climbing perch, *Ctenopomamulitispinis.*

As the flood waters recede some of the fishes migrate back to themainstream whilst others are trapped in backwaters. As thesedry out the remaining fishes are concentrated and there is a highmonality from predation and desiccation. The mainstreambecomes shallower (I - 3 m) and slower flowing, exposingsandbanks and rocks. The rheophilic community is limited tothe rapids or may migrate upstream.

Species found in rocky habitats include the rare broad headcatfish, *Clariallabesplatyprosopos,* the rock catlet, *Chiloglanisfasciatus,* the stargazer mountain catfish, *Amphiliusuranoscopus,* and the spiny eels, *Aethiomastacembelusfrenatus*and*A. vanderwaali.*

Mainstream residents include the rigerfish, *Hydroccynusvittatus,*which is the top fish predator in the river, the silver catfish*Schilbemystus,* and the dashtail barb, *Barbuspoechii.* Marginalrocky areas abound with squeakers, *Synodontis*spp .Cichlidstendto keep to the vegetated marginal areas by day.Theseinclude the threespottilapia,*Oreochromisandersonii,*the green-headed tilapia, *Oreochromismacrochir,*the pink happy, *Serranochromis (Sargochromis) giardi,* the purple-face large-mouth,*Serranochromis*(*Serranochromis) macrocephalus,*thenorthem redbreast bream,*Tilapiarendallirendalli,* and thebanded tilapia, *Tilapia sparrmanii.* Fishes found in the middlereaches of the Kavango River but not in the Delta region include*Clariasliocephalus,* the Okavango catfish, *Opsaridumzambezense,* the redspot barb, *Barbustangandensis*and the upperZambezi yellow fish. *B. cordringtonii*.

The fish populations of the few permanent floodplain pools suchas those in the swamp at the confluence of the Kavango River are similar to those found in the Delta region.They include the species found in the floodplain at high waterlseveral cyprinids, the snake catfish, *Clariastheodorae,*the topminnow *Aplocheilichtyshutereaui*and*Coptostomabarbuswittei.* In the Delta region catfish, *Clariasgariepinus*andtigerfish, *Hydrocynusvittatus,* migrate upstream prior to eachflood. It is not known whether similar migrations occur in theNamibian section.

Insert pictures

4.2.3.4 Reptiles

Branch (1988) mentions 63 reptiles found in Kavango. Theseinclude three tortoises, three turtles, 32 snakes, 24 lizardsandthe Nile crocodile. Of the 51 reptiles listed for the Delta(Forrester *el al.* 1989), 43 are common to both regions. Allcrocodiles and monitors are protected. The South African Red Data list classifies all monitors as endangered and the Africanrock python as vulnerable (Branch 1988). Protected species in the Kavango wet land area are the Nile crocodile *Crocodylusniloticus,* two tortoises, *Psammobatesoculifer*(Kalahari tent tortoise) and *Geochelonepardalis*(leopard tortoise) both lequaan species, *Varanusexanthematicus (*rock monitor*)*and*V.niloticus*(water monitor) and the African rock python, *Python sebae*(The Nature Conservation Ordinance NoA of 1975).

4.2.3.5 Birds

The Kavango River and its, associated floodplain support a widevariety of birds. A checklist by Hines (1987) lists 390 species for the Kavango region east of Rundu , of these 80% (310) are found in riverine habitats. This compares well with the 350 species listed for the Delta of which 60% are wet land associated (Forrester et al. 1989).

Eighteen species associated with the Kavango wet lands are listed in the Namibian red-data list (Brown and Williams. in prep.) Two of these are included in the African red-data list (Collar & Swan 1985). They are the wattled crane, *Gruscarunculata*and the slaty egret, *Egrettavinaceigula.* Both are considered endangered.

Other endangered species are the African skimmer. *Rhynchopsflavirostris,*the pink backed pelican,*Pelicannsrufescens,*theAfricanfinfoot,*Podicasenegalensis,* the rock pratincole,*Glarcolanuchalus,*the western-banded snake eagle,*Circaetuscinerascens,*andPel's fishing owl *Scotopeliapeli.*

The white pelican,*Pelecanusonocrotalus,*the white-backednight heron, *Gorsachiusleuconotus,* the saddlebilledstork,*Ephippiorhynchussenegalensis,*thespurwinggoose.*Plectropterusgambensis and*the broad-billed roller,*Eurystomusglaucurus*are considered vulnerable.

Also included are several species which are vulnerable toriverine forest clearing such as the Cape parrot, *Poicephalusrobustus,*the emerald cuckoo, *Chrysococcyxcupreus,* the wood*owl,Strixwoodfordii,* the African broadbill,*Smilthorniscapensis*andSousa'sshrike,*Laniussouzae (AJ.* Williams and CJ. Brown pers. comm.).

By law all birds, with the exception of certain "agricultural pests" and gamebirds, are protected (The Nature Conservation ordinance No. 4 of 1975). Unfortunately this does little toalleviate the four main threats to the birds of the Kavango area. These are: the ever increasing destruction of their habitats as theriver margins and floodplains are cleared for settlement andagriculture: local hunting, particularly of spurwing geese, crowned cranes and various ducks; pesticides such as DDT andDieldrin which are sprayed to control malaria and tsetse flies;and human disturbance at nesting sites particularly of colonialbreeders such as the African skimmer and carmine bee-eater,*Meropsnubicoides.*

Insert Picture

4.2.3.6 Mammals

Unfortunately much of the wildlife along the river has disappeareddue to hunting loss of habitat and other disturbancescaused by the dense human population. Most of the largermammals are now limited to the Mahango Game Reserve in thenortheastern corner of Kavango and the West Caprivi GameReserve on the opposite bank of the Kavango River.

Smither (1983) includes 99 mammals from 32 familiesfoundalong the Kavango River in Namibia. Forresteret al. (1989) lists54 species for the Delta in Botswana. Only one of these, thebushpig, *Potamochoerusporcus,* does not occur in the Kavango,but neither shrews nor bats are included in the Deltachecklist.

The species closely associated with a wet land environmentinclude four shrew species, *Crociduramariquensis(swampmusk*shrew), C. *bicolor*(tiny musk shrew), *C.flavescens*(greater muskshrew), and C. *hirta*(lesser red musk shrew), the greater canerat. *Thryonomysswinderianus, the* water rat, *Dasymysincomtus,*Shorrtridge's mouse *Praomys (Mastomys) shortridgei,* whichhas only been found at the confluence of the Kavango and theCuito Rivers and at Shakawe in Botswana, the water mongoose,*Atilaspaludinosus,* both protected other species, *Aonyxcapensis*(the Cape clawless otter) and *Lutramaculicollis*(the spotted-neckedotter), the specially protected impala,*Aepycerosmetamus*which occurs in riverine woodlands and is dependenton open water, the red lechwe, *Kobuslechee*and the sitatunga*Tragelophusspekei.* The latter two are protected.

The riverine woodland provides an ideal habitat for three batspecies; *Taphozousmauritianus*(tomb bat),*Pipistrellusnanus*(banana bat),*Chalinolobusvariegatus*(burterfly bat).Severalother bat species associated with the Kavango River in Angolaand Botswana probably also occur but have not been recordedfrom Namibia.

The common molerat, *Cryptomyshottentotus,* prefers riverinealluvial sand for burrowing, as does the fat mouse, *Slealomyspratensis.* Other inhabitants of sandy alluvial terraces are thetiny fat mouse,S. *parvus*and two gerbils. *Tateraleucogaster*(the bushveld gerbil) and *T. hrantii*(the highveld gerbil). Brandt'sclimbing mouse, *Dendromusmesomelas,*is found in the tallgrass associated with the floodplains.

Several carnivores, other than the otters and the water mongoosefavour a riverine or swamp habitat. These include theserval,*Felisserval,*often found in the reeds near water, the side-stripedjackal, Canis*adustus,* found in riverine woods, and fourviverrids found only in the north-east of Namibia. They are thelarge spotted genet,*Genettagenetta,*found in riverine associations in Kavango and Caprivi,Selousmongoose,*Paracynictisselousi, found* only along the Cuito and Kavango Rivers. Thelarge grey mongoose, *Herpelrtes ichneumon,* found along theKavango and possibly the white-tailed mongoose, *Ichneumiaalbicauda,*associated with wetlands in Caprivi.

Five ungulates which are dependent on wetland habitat are thebuffalo,*Synceruscaffer,*and four protected species; the bush-buck,*Tragelaphusscriptus,*thesitatunga, *T. spekei,* the reedbuck, *Reduncaarudinum*and the oribi,*Ourebiaourebi*which are found only in the Mahango and West Caprivi Game Reserves.

The five specially protected mammal species found along theriver are the elephant, *Loxodontaafricana,* Burchell's zebra, *Equusburchelli,* the hippopotamus, *Hippopotamusamphibius.*thegiraffe,*Giraffacamelopardalis,* and the impala, *Aepycerosmelampus.* (Nature Conservation Ordinance No. 4 of 1975.amended 1976 & 1987).

Protected species not yet mentioned are; the bushbaby, *Galagosenegalensis,*the leopard, *Pantheraleo,*the bat-eared fox, *Otocyonmegalotis,* the honey badger, *Mellivoracapensis,* theantbear, *Orycteropusafer,* the blue wildebeest, *Connochaetestaurinus,* the tsessebe,*Damaliscuslunatus,* the common duiker,*Sylvicapragrimmi,* the steenbok, *Rhaphiceruscampestris,* theeland. *Taurotragusoryx*as well as roan,*Hippotragusequinus,*andsable,*H. niger,*which were translocated from the Caprivi to the Mahango Game Reserve in 1984. Altogether there are 18protected mammal species in this region.

4.3 SOCIO ECONOMIC ENVIRONMENT

A literature review conducted to collate the various socio-economic environmental components within the study area. This section therefore highlights information gleaned from various sources. As indicated earlier, the Kavango Region and its associated Kavango River in general is deemed as one of the productive systems supporting a diversity of plants and animals in Namibia.The region caters for various secondary economic industries such as the fishing and farming. Given the characteristic high biodiversity associated with the Region, multiple siteshave been identified as a major conservation area.

The human population in the study area is dominantly rural and thepopulations are very remote relative to the capital and the main centres of economic activity. From west to east five tribes, the Kwangali, the Mbunza,the Shambyu, the Gciriku and the Mbukushulive along

theNamibian section of the Kavango River. These tribes practice amixed economy which includes subsistence agriculture, cattleraising, artisanal fishing, gathering and some hunting, as discussed below. All theseactivities use natural wetland resources to some extent. Floodplain grasses provide good grazing for cattle during the dry season. Reeds are used for thatching, fencing, baskets and traps. Many wild fruits and animals are eaten or used as medicines

Farming

Farming in Kavango, especially within the vicinity of the study areaconsists very largely of a mix of small-scale dryland crop and livestock farming. Almost all ruralhouseholds practice this kind of agriculture, the main purpose of which is to provide food for domesticconsumption. The alluvial terraces and in some areas omiramba and dry floodplains are used for cultivating crops particularly millet (mahangu). Floodplain grasses provide good grazing for cattle during the dry season.Mahangu is much the dominant crop, being planted on about 95 % of all cultivated land.The remaining 5% is cultivated with maize, sorghum and vegetables such as melon, groundnuts, beans,spinach and pumpkins..

Fishing

There is an abundance of fish resources mainly along the Okavango river and floodplains. Fish are harvested by a variety of traditional methods largely for local consumption.Fish is an important source of protein and is eaten fresh or dried (mainly for subsistence) or is sold locally.

Tourism

The other significant natural resource contributor to thelivelihoods of households in the study area is tourism. Here, local households derivesignificant amounts of cash income from employment and rentals. Tourism involves largescale lodge investments, which are relatively complex, capital intensive, and owned as arule by formal sector businesses. The livelihoods they provide to local households arecomplemented by further income in the form of salaries and wages to other employees,profits accruing to owners, payments to lenders of capital, and taxes accruing togovernments.

5 PROJECT CYCLE ENVIRONMENTAL MANAGEMENT PLANS

In this section the EMP provides a description of the management actions to be undertaken throughout the project life cycle of the lodge. This EMP is valid for the future planning and construction phases as well as operational and closure phases of the lodge **(Figure 7)**. It is essential to implement the EMP right from the planning stage and then continuing it throughout the construction and operation and even decommissioning stage. Each phase has a number of sub-activities, which need to be managed in a specific way to minimize or mitigate and potential impacts associated with the various phases.

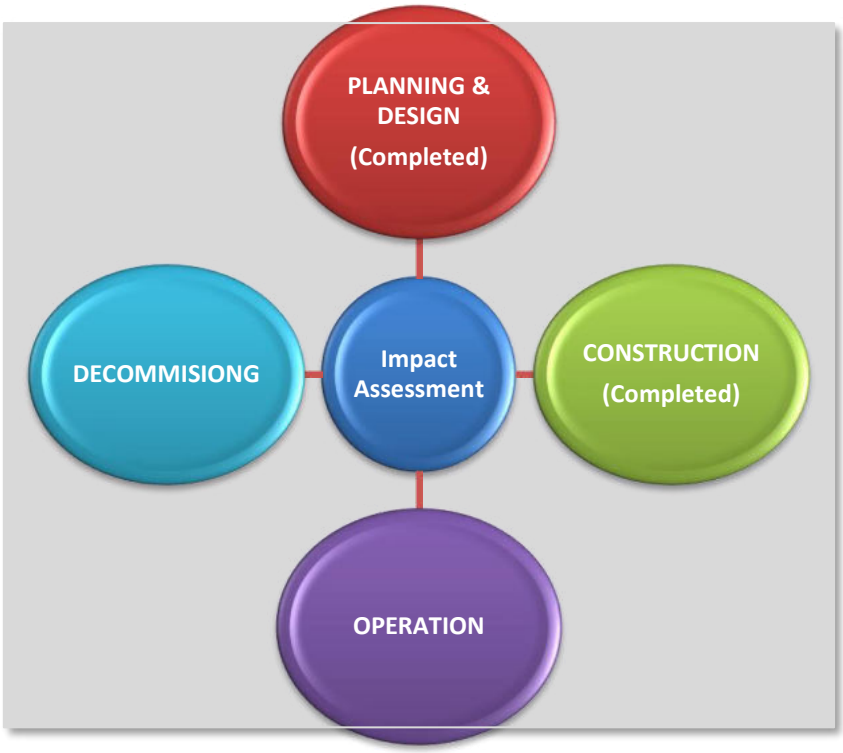

Figure 7.The structure of this Environmental Management Plan showing the various phases of the project.

5.1 PLANNING AND DESIGN ENVIRONMENTAL MANAGEMENT PLAN

The main purpose of the planning stage EMP is to plan and design any additional or future lodge constructions in such a way that impacts on the natural environment are minimized during the construction and operation stage.The actions required to minimize negative impacts during the planning and design stage are as follows:

5.1.1 Degradation of the environment with respect to visual aesthetics, loss of indigenous flora, and erosion.

Planning of future extension must ensure that:

- The location and design of any extensions and infrastructure fits into the natural environment. The manager of the lodge and the leaseholder must ensure that the sense of place is kept in accordance with the surrounding area and lodges.
- Environmental sensitivities are taken into consideration and avoided as far as possible, thereby mitigating potential impacts.

  - Buildings must be aesthetically pleasing, of a style that presents an “African” feel
  - Use shapes that do not contrast too much with the surroundings and orientate roof pitches so that they are in parallel with rather than at 90% to the horizon
  - Use colours that are sympathetic with the environment
  - Use natural materials as much as possible, especially rocks from the area, poles and thatch
  - If corrugated iron is used for the roof, paint it an earthy colour
- Any new buildings or tents on the lodge should be visually pleasing namely it should be in concordance with a certain African/Natural style as per the surrounding natural environment.
- The building shapes should not contrast too much of the area namely high rising buildings in future should rather be avoided.
- The use of certain African or earthy colours (paint) on the buildings or tents, which are in harmony with the environment, are strongly advised.
- If any further construction on the lodge is carried out, it should make use to a large extent of the natural materials namely rocks from area, wooden poles either from already non-living trees or commercially produce poles and thatch in order not to destroy the environment.
- Should there be any further development regarding communication masts, solar panels, water tanks and other prominent features, it should be placed or constructed at spots that prohibits visual destruction or minimized visual impact.
- Tourists or any persons driving past the lodge should not be able to notice visually unpleasing objects on the lodge
- Avoid any neon or non-earthy signs that will reduce the sense of place, rather use rustic metal or wood to construct signs.
- Any further construction of walkways leading to campsites or guest rooms should take the environment into concern namely by building walkways around trees, large rocks and other natural features not removing or disturbing the natural setting.
- All additional or new pipes and cables should be buried underground and not be visible to the tourists or any other person.

Planning of future alignment of additional linear infrastructure such as power lines and access roads infrastructure must ensure that:

- The best environmental option for alignment of linear infrastructuresuch as power lines, water supply pipelines and access roads should be selection. Select an alignment that curtails environmental impacts and enhances environmental benefits.
- Plan new access roads according to contour lines to minimise cutting and filling operations.
- The design of the facility responds to the identified environmental constraints and opportunities.
- External access point and internal access road to be carefully planned to maximise road user safety.

Performance Indicator

- Power line and road alignments meet environmental objectives
- The design meets the objectives and does not degrade the environment.
- Selected linear alignments that minimise any negative environmental impacts and maximise any benefits.

Monitoring

Review of the design by the Project Manager and the Environmental Control Officer (ECO) prior to the commencement of construction.

5.1.2 Poor storm water management and alteration of the hydrological regime (i.e. drainage lines).

- Compile a comprehensive storm water management plan for hard surfaces as part of the final design of the project. This must include appropriate means for the handling of storm water within the site, e.g. separate clean and dirty water streams around the plant, install stilling basins to capture large volumes of run-off, trapping sediments, and reduce flow velocities (i.e. water used when washing the panels).
- Appropriately plan hard-engineered bank erosion protection structures.

Performance Indicator

- Sound water quality and quantity management.

Monitoring

- Surface water quality monitoring plan.

5.1.3 Ensuring water consumption efficiency

- The cultivation or enhancement of locally adapted grasses which can survive the natural conditions should be preferred in the planning phase.
- Ensure that all toilets are of the flush type, and that they all drain into a properly designed, two-chamber septic tank that is located at least 20 metres from any building.
- Grey water from newly created showers and basins should be drained into a soak away area and this could be developed as a reed-bed.
- It should be communicated to guests to make use of showers rather than baths since showers uses less water than baths do. This should save water to a large extent.
- The river and drainage systems bordering the lodge should be maintained and channels should be kept open during the design stage to conserve the environment and flow of water.
- Water efficient systems/equipment which limits the use of water or recycling of water possible should be introduced, such as:
    - Specify showers only in the chalets (no baths) in order to save as much water as possible.
    - Specify low-flow shower-heads for the showers.
    - Specify appropriate flushing devices in the toilets, so that flushing stops as soon as pressure on the handle is released.

5.1.4 Ensuring energy consumption efficiency

- Preference should be given to the implementation of energy conserving and efficient systems if and when the existing facilities is extended or placed.
- Renewable energy sources like firewood or solar should be considered to replace the current commercially supplied electricity.
- Device or equipment which conserves energy and wastages should be considered during planning and designing stages of the lodge.

5.1.5 Pest Control

- Given that the lodge is situated in a Malaria prime area, it is vital to specify fly-screens during the design stage on open-able windows in the chalets, lodge area,

kitchen area etc., so that there is less need to use insect repellents most particularly mosquitoes.

Responsible

- Architect:The architect must appreciate the need for sensitivity with regards to sense of place, water and energy efficiency in the design and planning stage.

- Project Manager: The plans must be approved (in writing) by the Project Manager before future expansions or development at the lodge are built.

5.2 CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN

Muramba River Lodge has been constructed as a thatched lodge to fit with the natural (bush) character of the environment. Brickworks and thatch grass were included as part of the construction of the lodge to form rooms in order to maintain a natural earthy overall appearance and feel. The lodge has been constructed with the least impact on the environment as practically possible. Existing roads were upgraded and trees and plants retained wherever possible in the construction of phase of the lodge. The flow of the river was not altered during the construction and plants were left unharmed and undisturbed. A visual assessment was conducted on the lodge revealed that the lodge as constructed and operated will not pose any long term or irreversible threats to the receiving and surrounding environment if the operations are conducted along the guidelines of the proposed EMP.

During future constructions local site-specific impacts may occur because of physical disturbance to the site. The overall goal is to undertake any future construction activities in a way that ensures that construction activities are properly managed in respect of environmental aspects and impacts.

5.2.1 Minimize Impact on the Natural Environment

5.2.1.1 Impacts Description

Future construction should minimise the impact on the indigenous natural vegetation, protected tree species, and habitats of ecological value as well as fauna within the NdongaLinena area. In order to minimise impacts on flora, fauna, and ecological processes, the development footprint should be limited.

5.2.1.2 Mitigation Actions

Construction activities should aim to minimise impacts on and loss of indigenous vegetation and faunal habitat.

- Natural vegetation must be preserved where possible by minimising the footprint of disturbance of vegetation/habitats within the lease area.
- The extent of vegetation clearing, construction of additional roads within the lease area and disturbance to the native vegetation must be kept to a minimum so that impact on flora and fauna and their habitats is restricted to the lease area.
- Operation activities and services must be restricted to demarcated areas so that impact on flora and fauna is restricted. Areas to be cleared must be clearly marked in the field to eliminate unnecessary clearing.
- Unnecessary impacts on surrounding natural vegetation such as driving around in the veld should be limited and existing access roads utilised instead. Do not scrape any other areas other than the road itself (i.e. the earthmoving equipment should only work in the road area, and not venture into the veld).
- If the road is to be surfaced, use natural materials (rocks with concrete) as far as possible so that the colour of the road is similar to the surrounding area.
- Do not demarcate the road with any artificial or unnatural barriers that are visually prominent – e.g. sign posts, whitewashed stones, metal railings or lights of any kind.
- Veld fires should be totally avoided as they have detrimental effects on the natural and environment in the area.
- Excavate the road as little as possible in order to reduce the scar effect (though it is accepted that excavation will be necessary).
- Road overburden that is dumped on the down-slope of the road should not only consist of rocks, but should also include enough soil to allow vegetation to become established. This is the best way to reduce the visual impact of the scar. The overburden should also not be stabilized with concrete, since this will make it impossible for vegetation to become established. The main aim is to hide the scar with natural vegetation

Performance Indicator:

- Minimal disturbance outside of designated work areas.
- Minimise clearing of existing vegetation.
- Limited impacts on areas of identified and demarcated sensitive habitats/vegetation.

Monitoring:

- Observation of vegetation clearing and soil management activities by ECO.
- Supervision of all clearing and earthworks.
- An incident reporting system will be used to record non-conformances to the EMP.

5.2.2 Minimize Soil Degradation and Erosion

5.2.2.1 Impacts Description

The construction of any additional electrical power lines, water supply pipelines, buildings and access roads will result in degradation of the natural soil profile due to removal of vegetation excavation, compaction, pollution and other activities will affect soil forming processes and associated ecosystems. Construction of these infrastructures also results in water and wind erosion of disturbed areas within the lease area. Uncontrolled run-off relating to construction activity (excessive wetting, uncontrolled discharge, etc.) will also lead to accelerated erosion and possible sedimentation of the drainage lines.

5.2.2.2 Mitigation Actions

The following mitigation measures will be carried-out to minimize degradation and erosion of the soil within the construction site or area:

- Identify disturbed areas and restrict construction to these areas.
- Rehabilitate unused disturbed areas using indigenous vegetation to minimize soil erosion.
- Minimise extent of disturbed areas.
- Access roads on the lodge premises should be carefully constructed to and prevent unnecessary excavation, placement, and compaction of soil.
- Dust control measures such as wetting of denuded areas should be carried-out on the construction site to minimize soil erosion.
- Minimise removal of vegetation as it adds stability to soil and thus minimizes soil erosion.
- Stockpile topsoil for re-use in rehabilitation phase, protect stockpile from erosion.

- Erosion control measures (i.e. run-off attenuation on slopes (sand bags, logs), silt fences, storm water catch-pits, shade nets, or temporary mulching over denuded area as required).
- Control depth of excavations and stability of cut faces/sidewalls.

Performance Indicator

- No activity outside demarcated disturbance areas.
- Acceptable level of activity within disturbance areas, as determined by the ECO.
- Acceptable level of soil erosion around site, as determined by the ECO.
- Acceptable level of increased siltation in drainage lines, as determined by the ECO. Acceptable state of excavations, as determined by the ECO.
- No activity in restricted areas.

Monitoring

- Monthly inspections of the site by the ECO.
- Monthly inspections of sediment control devices.
- Monthly inspections of surroundings, including drainage lines. Immediate reporting of ineffective sediment control systems.
- An incident reporting system will record non-conformances.

5.2.3 Minimize Establishment and Spread of Weeds or invasive alien species

5.2.3.1 Impact Description

Weeds or invasive alien speciescaninvade the natural vegetation especially riverbeds and the drainage. There is therefore the potential for alien plants to spread or invade following disturbance on site hence it is vital to minimize this impact.

5.2.3.2 Mitigation Actions

The following management actions should be carried-out to minimise the establishment and spread of alien invasive plantswithin the lodge area:

- Avoid creating conditions in which alien plants may become established.
- Keep disturbance of indigenous vegetation to a minimum.
- Rehabilitate disturbed areas as quickly as possible.
- Do not import soil from areas with alien plants.

- Establish an on-going monitoring programme to detect and quantify any alien species that may become established and identify the problem species.
- Immediately control any alien plants that become established using registered control methods.

Performance Indicator:

For each alien species: number of plants and aerial cover of plants within project area and immediate surroundings

Monitoring:

- On-going monitoring of area by ECO.
- Annual audit of lodge area and immediate surroundings by qualified botanist.

5.2.4 Minimize Impact on Heritage Resources

5.2.4.1 Impact Description

The main cause of impacts to archaeological sites is physical disturbance of the material itself and its context.Large-scale excavations as well as road construction activities for future foundations may damage archaeological sites.This means that even though, for example a deep excavation may expose archaeological artefacts, the artefacts are relatively meaningless once removed from the area in which they were found. Archaeological or other heritage materials occurring in the path of any surface or sub-surface disturbances associated with any aspect of the development in future are highly likely to be subject to destruction, damage, excavation, alteration, or removal. The objective should be to limit such impacts to the primary activities associated with the construction.

5.2.4.2 Mitigation Actions

The following management actions are mandatory in order to minimize impacts on the heritage resources during any additional future construction activities:

- Areas required to be cleared during construction must be clearly marked in the field to avoid unnecessary disturbance of adjacent areas (which will not be surveyed in detail by a heritage specialist).
- Project employees and any contract staff will maintain, at all times, a high level of awareness of the possibility of discovering heritage sites.

- If a heritage object is found, work in that area should be stopped immediately, and appropriate specialists brought in to assess the site, notify the administering authority of the item/site, and followthe required processes.
- Any heritage objects found on site are treated appropriately and in accordance with the relevant legislation.
- Heritage objects or artefacts found on site are inappropriately managed or destroyed.
- Familiarise all staff and contractors with procedures for dealing with heritage objects/sites.

Performance Indicator

- Zero disturbance outside of designated work areas.
- All heritage items located are dealt with as per the legislative guidelines.

Monitoring

- Observation of excavation activities by ECO throughout construction phase. Supervision of all clearing and earthworks.
- Due care taken during earthworks and disturbance of land by all staff and any heritage objects found reported.
- An incident reporting system will be used to record non-conformances to the EMP.

5.2.5 Minimize Visual Impacts

5.2.5.1 Impact Description

General construction activities and construction accommodation, has the potential of scarring the landscape due to vegetation clearing. During the construction phase heavy vehicles, components, equipment and construction crews will frequent the area and may cause, at the very least, a cumulative visual nuisance to landowners and residents in the area.

5.2.5.2 Mitigation Action

The following management actions should be carried-out in order to minimize visual impacts during any additional construction activities:

- Minimal visual intrusion by construction activities and construction accommodation and intact vegetation cover outside of immediate works areas.

- Plan the placement of lay-down areas and temporary construction accommodation in order to minimise vegetation clearing.
- Restrict the activities and movement of construction workers and vehicles to the immediate construction site and existing access roads.
- Ensure that all infrastructure and the site and general surrounds are maintained in a neat a manner.
- Reduce and control construction dust using approved dust suppression techniques.
- Rehabilitate all disturbed areas, construction areas, roads, and servitudes to acceptable visual standards.

Performance Indicator

- Vegetation cover on and near the site is intact with no evidence of degradation or erosion.
- Construction site is kept in a neat and tidy state.

Monitoring

- Monitoring of vegetation clearing during construction.
- Monitoring of rehabilitated areas post construction.

5.2.6 Inference with Other Land Users

5.2.6.1 Impact Description

The NdongaLinenaVillage is major agricultural area. Temporary interference might therefore occur if lodge activities take place at the same time as the other activities in the community.

5.2.6.2 Impact Mitigation

Prior to the commencement of any activities, the lodge owner must notify the Gciriku Traditional Authority and the neighbouring community in the NdongaLinenaVillage. Communication should be maintained to reduce the risk of interaction between the proposed seismic surveys their activities.Construction activities to be undertaken without significant disruption to other land uses and activities in the area, in particular concerning noise impacts, farming practices, traffic and road use, and effects on local residents.

5.3 OPERATION ENVIRONMENTAL MANAGEMENT PLAN

During project execution, the contractor and The Proponent will carry-out their responsibilities and progress information will be continuously monitored and appropriate adjustments are made and recorded as variances from the original plan. The reported and recorded information will be utilized to maintain control over the direction of the project by measuring the environmental performance of the lodge activities comparing the results with the EMP and taking corrective action as needed. The first course of action should always be to come back to the course as stipulated by the EMP. If that cannot happen the team should record variations from the original plan and record and publish modifications to the EMP.

The components of lodge that could result in significant environmental effects have been determined through an evaluation of the various operational activities and services offered by the lodge. The owner and staff members strive to sustain and improve the natural environmental to the best of their abilities. Theoperational activities with potential to have an effect on the environment include

- Infrastructure such as electrical pipelines and wood supply, water supply and sewerage system as well as the local road network.
- Routine waste discharges from the various facilities
- Accidental fuel and oil spills from the vehicles and other machinery
- Cumulative impacts from a combination of any of these impacts

Each of these activities has the potential to result in detrimental impacts on the physical, biological and socio-economic environment of the surrounding area. To either eliminate potential environmental negative impacts or to reduce them to as low as reasonably practicable, a number of key control and mitigation measures must be implemented. Mitigation measures for each of the impacts identified should be implemented as indicated by the EMP. The identified impacts along with strategies for control of the environmental impacts associated with the lodge are described in the sub-sections that follow.

5.3.1 Minimize Disturbance of the Forest Area or Natural Vegetation

5.3.1.1 Impacts Description

Current operations and infrastructure of the lodge such as aerial infrastructure (i.e. power line water supply pipelines and access roads) and linear infrastructure (i.e.ancillary buildings,

septic tanks etc.) within the leased lodge area should aim to minimize disturbance of the forest area or natural vegetation within the NdongaLinena area and surroundings.

5.3.1.2 Mitigation Actions

- Operation activities and services must be restricted to demarcated areas so that impact on flora and fauna is restricted.
- Unnecessary impacts on surrounding natural vegetation such as driving around in the veld should be limited and access roads utilised instead.
- Veld fires should be totally avoided as they have detrimental effects on the natural and environment in the area.

Performance Indicator:

- Minimal disturbance outside of lodge areas.
- No additional clearing of existing vegetation.

Monitoring:

- Observation of vegetation clearing and soil management activities by ECO.
- An incident reporting system will be used to record non-conformances to the EMP.

5.3.2 Minimize Soil Degradation and Erosion

5.3.2.1 Impacts Description

The presence of electrical power lines, water supply pipelines, buildings and access roadsresult in water and wind erosion of disturbed areas within the lodge.

5.3.2.2 Impacts Mitigation

The following mitigation measures will be carried-out to minimize further degradation and erosion of the soil within the lodge area:

- Identify disturbed areas and restrict operations to these areas.
- Rehabilitate unused areas within the lodge premises using indigenous vegetation to minimize soil erosion.
- Dust control measures such as wetting of area within the lodge premises should be carried-outon site to minimize soil erosion.
- Avoid furtherremoval of natural vegetation as it which adds stability to soil and minimizes soil erosion.

Performance Indicator

- No activity outside demarcated disturbance areas.
- Acceptable level of soil erosion around within the lodge, as determined by the ECO.
- No activity in restricted areas.

Monitoring

- Monthly inspections of the site by the ECO.
- Monthly inspections of sediment control devices.
- Monthly inspections of surroundings, including drainage lines. Immediate reporting of ineffective sediment control systems.
- An incident reporting system will record non-conformances.

5.3.3 Impacts on Water Quality

The lodge is situated close to the Muramba River from where bulk water supply is sourced. Potential sources of water pollution are solid wastes hazardous waste and sewage waste.Potential pollutants include ablution facilities, sewerage system, fuel from vehicles, oil leakage from pump station solid and hazardous waste from the. At the moment no hazardous waste generated at the lodge.

5.3.3.1 Water Pollutiondue to Sewage Waste

5.3.3.1.1 Impact Description

Leakage of sewage wastes into the river may directly cause damage to fishery resources and aquatic biota.Biodegradation of oil also generates polymerizedoil particles and toxic aromatic fractions using the dissolved fairly low oxygen content in the water, which cause damages to bottom biota and habitat.

Water pollution can harm important habitats by encouraging excess algae growth. Pollution can include eutrophication from sewage and sewage based pathogens like faecal coliform bacteria.The discharge of biodegradable wastes may result in localised increases in nutrient levels, which may stimulate microbial activity and therefore act as a food source for scavenging birds and/or marine animals.

5.3.3.1.2 Impact Mitigation

- Regularly serviced chemical toilets facilities will be used to ensure appropriate control of sewage.

- All toilets must be of the flush-type and all must drain into the septic tank
- Notices must be placed at each toilet to remind guests not to flush foreign objects down the toilet
- The overflow from the septic tank should be into a reed-bed soak-away
- Use bio-degradable toilet cleaners that do not kill the bacteria in the septic tank.
- Documentation (waste manifest) must be maintained detailing the quantity, nature, and fate of any regulated waste. Waste disposal records must be available for review at any time.

5.3.3.2 Water Pollution due toSolid and Hazardous Waste

5.3.3.2.1 Impact Description

Operation activities will typically result in the generation of solid wastes from the kitchen, shower, laundry area and normal operation such as operational garbage (bottles, plastic metals and cardboards) as well as hazardous wastes such as cleaning products, acids, solvents, toxic waste and medical waste.Litter or contamination of the site or water through poor waste management practices.Similarly water pollutionis such as heavy metals (e.g. copper and zinc) which can aquatic life in the river system by encouraging excess algae growth.Dumping of solid waste into the river may directly cause damage to fishery resources and aquatic biota.

5.3.3.2.2 Mitigation Action

In order to manage the wastes effectively, guidelines for the assessment, classification, and management of solid and hazardous wastes must be implemented.To comply with waste management legislation and to avoid environmental harm from solid and hazardous waste disposal. To manage various wastes produced at the site, waste management plans to deal with all waste streams will be put into place.

- Solid waste production will be kept to a minimum.
- Various solid (i.e. plastic, bottles, paperand metal etc.) and hazardous wastes should be separated on site.
- Specific areas must be designated on-site for the temporary management of various waste streams. Location of such areas must seek to minimise the potential for impact on the surrounding environment, including prevention of contaminated runoff, and seepage.

- No plastics or plastic products of any kind, domestic waste (i.e. cans, glass, paper or other waste) are to be discarded into the river or surrounding area. Waste will either be stored for recycling; stored for disposal. Solid wastes and all hazardous wastes will be stored for disposal at an appropriate disposal facility.
- Where practically possible, general wastes on-site must be reused or recycled. Bins and skips must be available on-site for collection, separation, and storage of waste streams (such as wood, metals, general refuse etc.).
- All storage facilities and handling equipment must be segregated in properly secured and clearly marked containers, designed in such a way as to prevent and contain any spillages as far as practicable prior to disposal.
- Disposal of waste must be in accordance with relevant legislative requirements, including the use of licensed contractors.
- Uncontaminated waste will be removed at least weekly for disposal; other wastes will be removed for recycling/ disposal at an appropriate frequency.
- Hydrocarbon waste must be contained and stored in sealed containers within an appropriately bounded area.
- No waste of any kind may be burnt at the lodge site.
- All chemicals used to clean surfaces (e.g. basins, floors, tables, kitchen worktops, etc.) must be of the biodegradable.
- Waste must be transported by approved waste transporters to sites designated for their disposal.
- When transporting the waste to the dump site, ensure that there is NO possibility of waste blowing or falling off the vehicle.
- Documentation (waste manifest) must be maintained detailing the quantity, nature, and fate of any regulated waste. Waste disposal records must be available for review at any time.

Performance Indicator

- No complaints received regarding waste on site or indiscriminate dumping.
- No incidents related to spills of chemicals and hazardous materials.

- Internal site audits ensuring that waste segregation, recycling and reuse is occurring appropriately.
- Provision of all appropriate waste manifests for all waste streams.

Monitoring

- Observation and supervision of waste management practices.
- Waste collection will be monitored on a regular basis by ECO.
- Waste documentation completed.
- A complaints register will be maintained, in which any complaints from the community will be logged. Complaints will be investigated and, if appropriate, acted upon.
- An incident reporting system will be used to record non-conformances to the EMP.

5.3.3.3 Cumulative Impacts on Water quality

5.3.3.3.1 Impact Description

Combined effects from individual impacts resulting from various oil discharges, biodegradable and non-biodegradable waste discharges on the water quality as well as from other marine users namely the fishing, diamond mining and petroleum vessels are anticipated.When the various impacts raising from theses discharges as well as other marine users are combined there could be considerable impacts on the water quality.Collectively, discharges and spills of these wastes result in water pollution, floating garbage, unsanitary conditions, odour and other degradation of the already low oxygen content and sulphur eruption susceptible water quality.

5.3.3.3.2 Impact Mitigation

Mitigation measures pertaining to each waste discharge are discussed above for each discharge (i.e. oil discharges, biodegradable and non-biodegradable wastes), and these should be implemented as such.

5.3.4 Impacts on Air Quality

5.3.4.1 Dust and Air Emissions

5.3.4.1.1 Impact Description

Gaseous or particulate emissions are anticipated from exhaust emissions from fuel burning vehiclesand equipment on-site, as well as firewood combustion facilities. Vehicle entrained

dust from the movement of vehicles on the main and internal access roads as well asroad maintenance activities is also another source of impact.The types of pollutant emissions to the air are exhaust gases from the vessel engines such as sulphur dioxide (SO_2) nitrogen dioxide (NO_2), carbon monoxide (CO), and hydrocarbons (HC). These pollutant gases may affect air quality in the vicinity as well as the surrounding area. Wind erosion from topsoil and unsealed roads and surfaces is also another impact on the air quality.

5.3.4.1.2 Impact Mitigation

Ensure that emissions from all vehicles and nuisance to the community arising from dust emissionsare minimised, where possible by adhering to the following.Compliance with workplace health and safety requirements is essential throughout all operation activities.

- Roads must be maintained in a manner that will ensure that nuisance from dust emissions from road or vehicle sources are not visibly excessive.
- Appropriate dust suppressant must be applied on all exposed areas as required to minimise/control airborne dust.
- Speed of vehicles along the access roads must be restricted, as defined by the ECO.
- Disturbed areas which are not utilised must be re-vegetated to minimize the effects of wind erosion.
- Where possible, emissions from engines and power generators will be minimised by means of optimising fuel efficiency and conducting regular maintenance and checks. The Proponent should ensure adequate maintenance of diesel motors and generators to minimise the volume of soot and un-burnt diesel released to the atmosphere. Prohibition of the use of heavy diesel oil as fuel could be a possible means to reduce pollutants.

Performance Indicator

- No complaints from affected residents or community regarding dust or vehicle emissions.
- Dust suppression measures implemented for all heavy vehicles that require such measures during the construction phase commences.
- Drivers made aware of the potential safety issues and enforcement of strict speed limits when they are employed.

Monitoring

Monitoring must be undertaken to ensure emissions are not exceeding the prescribed levels via the following methods:

- Immediate reporting by personnel of any potential or actual issues with nuisance dust or emissions to the Site Manager.
- A complaints register must be maintained, in which any complaints from residents/the community will be logged, and thereafter complaints will be investigated and, where appropriate, acted upon.
- An incident reporting system must be used to record non-conformances to the EMP.

5.3.4.2 Cumulative Impacts on Air Quality

5.3.4.2.1 Impact Description

Combined impacts on the air quality resulting from gaseous and particulate emissions as well as dust from other land users are anticipated on the air quality in the area.These emissions similarly include exhaust gases from the vessel engines, air compressor generators and firewood combustion. Vehicle entrained dust from the movement of vehicles on the main and internal access roads in the surrounding area will also result in cumulative impacts on the air quality.

5.3.4.2.2 Impact Mitigation

All land users to ensure adequate maintenance of diesel motors and generators to minimise the volume of soot and un-burnt diesel released to the atmosphere. In order to reduce the emission of pollutants, all land users should avoid using heavy diesel oil as fuel.Engines on all the vehicles and generators operational in the area to be maintained at peak efficiency. In order to minimise dust production all land users should ensure that the following:

- Roads must be maintained in a manner that will ensure that nuisance from dust emissions from road or vehicle sources are not visibly excessive.
- Appropriate dust suppressant must be applied on all exposed areas as required to minimise/control airborne dust.
- Speed of vehicles along the access roads must be restricted.
- Disturbed areas which are not utilised must be re-vegetated to minimize the effects of wind erosion.

5.3.5 Water Management

Keep water consumption to below 100 liters of water per day per person (divide total daily consumption by the number of people at the lodge – guests and staff), by adopting the following strategies:

- Place a prominent notice in each chalet (and the staff quarters), informing guests about the importance of saving water.
- Do not have any lawns or gardens that need to be watered (a small vegetable garden is permitted, but it must be placed under a reed structure to reduce evaporation)
- Ensure that the pool is covered when not in use
- Wash vehicles with a bucket, not a hose
- Clean driveways and parking areas with a broom, not with water
- Wash laundry off-site
- Ensure that all pipes are well maintained and leaks are repaired immediately
- Ensure that all taps are turned off after use
- Floors must be cleaned with a mop, not hosed down
- Install a water meter, and check this daily if possible, or once a month as a minimum. Keep a register of water consumption so that trends can be monitored.

5.3.6 Energy Management

Use as much renewable energy as possible, and limit the use of fossil fuels in the generation of energy. This can be achieved by:

- Combining both diesel generated power and solar power (this is both a design and a management issue, requiring planning in the early stages and committed management for the life of the lodge)
- If solar systems are in place, make sure that they are well maintained so that they remain efficient
- If the same generator is used for pumping water and for powering the lodge, try to combine both tasks at the same time, so that the generator runs at maximum load, and so that is does not run unnecessarily.

Where fires are used for creating ambiance in the lodge, or for warmth (during winter), try to burn alien-invasive wood that is readily available (e.g. *Prosopis*) or wood that comes from

bush encroaching species (e.g. *Acacia melifera*). Avoid using mopane, leadwood (*Combretumimberbe*) or other species that might be harvested unsustainably. Whatever the case, ensure that there are no significant negative environmental impacts associated with the supply of wood.

5.3.7 Negative Socio-Economic Impacts

Socio-economic impacts include impacts imposed on the social and economic components of the environment within the area. These include potential impacts on economic aspects of other land users as well as other social aspects of the environment. Potential negative and positive socio-economic impacts are discussed in the sub-sections that follow.

5.3.8 Positive Socio-Economic Impacts

Though the lodge has potential adverse impacts on the biological and socio-economic environments, its potential counter positive impacts particularly on the socio-economic environment are quiet lucrative hence noteworthy. These include employment opportunities, promotion of secondary industries within the community and neighbouring town, stimulation of investment and economic growth. These socio-economic benefits are geared towards meeting Namibia's Vision 2030 and thus are of national importance.

5.3.8.1 Job Creation

5.3.8.1.1 Impact Description

The lodge employs local people within the area, thus positively contributing to Namibia's Vision 2030 of job creation and poverty reduction.

5.3.8.1.2 Impact Enhancement

The leaseholder or proponent should employ the community or local skill and contractors as far as possible as per the condition of the PTO.

5.3.8.2 Promotion of Secondary Industries

5.3.8.2.1 Impact Description

The lodge has a direct benefit to the local economy in the Rundu town, due to the fact that other secondary industries such as wood suppliers, waste removal contractorsare utilized.

5.3.8.2.2 Impact Enhancement

The leaseholder or proponent should continue or expand the usage of local goods and services providers in Rundu and local area whenever possible to help enhance the promotion of secondary industries.

The leaseholder should assist the nearby schools and community at large with developmental issues as far as possible as per the condition of the PTO.

5.3.8.3 Stimulation of Investment & Economic Growth

5.3.8.3.1 Impact Description

Tourism is the major contributor to the country's Global Domestic Product. The lodge is therefore an important direct source of revenue to the Republic of Namibia.

5.3.8.3.2 Impact Enhancement

More tourism attraction mechanisms such as boat cruises, game drives, bird watching and tours should be implemented to attract moretourists' to the area.

5.4 DECOMMISSIONING AND CLOSURE MANAGEMENT PLAN

During the final phase of the project, the emphasis will be on releasing the final deliverables (survey data) to The Proponent, re-instating the marine environment to its pre-determined state, handing over relevant environmental project documentation to the relevant authorities and communicating the closure of the project to all stakeholders and other land users. During this phase, the project team will evaluate the success of the project by reviewing how well environmental objectives were met. This is accomplished primarily through soliciting and evaluating feedback fromother land users and other stakeholders. The primary purpose of this assessment is to document best practices and lessons learned for use on future projects and these should be compiled into a close-out report to be submitted to the relevant ministries, particularly the Ministry of Environment and Tourism, through the Directorate of Environmental Affairs.Post-project support should still be provided after project closure if required and where necessary. The EMP for the operational phase of the project is shown in **Table 13**.

Table 1. Decommissioning and Closure phase environmental management plan.

ASPECT	ENVIRONMENTAL OBJECTIVES	MANAGEMENT ACTION	RESPONSIBILITY	CONTRO
REHABILITATION	Re-instate the environment to its pre-determined state.	All equipment utilized in the survey operation such as surveying vessel any support or chase vessel, towed hydrophones, temporary facilities at the operational base and waste materials must be removed from the site. Disturbed area must be rehabilitated if possible as per the rehabilitation plan	PROPONENTIN CONSULTATION WITH REHABILITATION SPECIALIST	Records
CLOSURE REPORT	To compile a closure report.	Document best practices and lessons into a closure report	PROPONENT	Record of c

6 EMP IMPLEMNETATION STRATEGY

6.1 INTRODUCTION

This section details the environmental management strategies and procedures that will be put in place. These include responsibilities, training, reporting frameworks, mitigation and response activities and monitoring and auditing procedures which are intended to reduce environmental impacts to As Low as Relatively Possible and to ensure that environmental performance objectives are met. The Proponent will ensure that its personnel and contractors comply with all regulatory controls under relevant legislation and guidelines, and with the commitments within this EMP.

6.2 ROLES AND RESPONSIBILITIES

6.2.1 The Proponent

The Proponent intends to manage the lodge operations in such a way that the environment and the health and safety for the workers, and other land users are protected. The Proponent will adopt this EMP as an integral part of the lodge from the planning phase to the end of the decommissioning and closure phase. In particular, The Proponent will:

- Acquire the necessary clearance, permits, licences and approvals from the relevant authorities prior to the beginning of the operations; and
- Provide the EMP to all the contractors, the sub-contractors, the supervisors and the workers in general and ensure that appropriate training on its requirements is provided;
- Take general responsibility for implementation of the EMP, ensuring that it is in agreement with all legislative and contractual requirements;
- Ensure that staff members are trained in environmental and safety procedures.
- Assign internal resources or hire experienced personnel to fill the role of Environmental Control Officer;
- Inform managers, contractors, supervisors and workers of safety, health and environmental requirements, and hold them responsible for carrying them out.

- Monitor, evaluate and report performance of the contractors in the areas of safety, health and environmental protection.
- Take general responsibility for warranting that any issues not in conformity with the EMP are entirely corrected through the implementation of corrective measures;

6.2.2 Environmental Control Officer

Environmental Control Officer (ECO) is responsible for the following:

- Carry-out an environmental management review. This review will include a inspection and an assessment of the environmental components of the Lodge's Health Safety and Environment Management System. This review will particularly focus on aspects of practical environmental management, such as waste management, effluent and emission control, transport and materials supply, project management, contingency planning and preparedness and operations effects and control.
- Responsible for ensuring that, all sub-contractors perform operations in a manner consistent with the performance objectives and environmental management procedures detailed in this EMP.
- Responsible for keeping himself fully appraised of on-going operations, particularly for environmentally critical activities.
- Responsible for immediately reporting any reportable incidents to the lodge owner.
- Filling of the Waste Transport Manifest, checking information on wastes to be manifested and for requiring purchase of material, necessary for the wastes management (containers, bags, etc.).
- Ensuring that all wastes are handled, segregated and disposed of in accordance with this EMP. All personnel shall be made aware of waste management best practices (waste identification, segregation, reduction, reuse, recycle, storage and disposal) through the safety briefing and / or specific training.

6.2.3 Contractors

The Proponent shall provide contractors the EMP and ensure they are in compliance with the environmental directives approved in the EMP. Contractors shall be bound to the following obligations:

- Overall responsibility for HSE management on-board the vessel, and for ensuring that appropriate control and mitigation measures are implemented to minimise potential environmental effects resulting from vessel operations (e.g. waste management/disposal, and fuel/oil spill response).
- The contractor will, in general, minimize environmental damage, control litter, avoid pollution, prevent the loss of or damage to natural resources, and minimize interference with other activities present in the area, such as fishing; diamond mining and prospecting, petroleum prospecting activities.

6.2.4 Lodge Manager

Lodge Manager is responsible for the following:

- Ensures that the Proponentenvironmental objectives and Health, Safety and Environmental Policy are followed.
- Has overall accountability for all aspects of waste management and is responsible for the effective implementation of this EMP. It is his responsibility to allocate duties to individuals, related to waste management at the lodge.
- Responsible for the safe execution of all operations of the survey vessel.
- Overall responsibility for HSE management and for ensuring that appropriate control and mitigation measures are implemented to minimise potential environmental effects resulting from operations (e.g. waste management/disposal).
- Establish liaison with, and answer to, the representatives of the proponent in all matters relevant to the implementation of the EMP;
- Observe the environmental mitigations measures defined in the present EMP and apply techniques, practices and operation methods that will ensure the fulfilment of the EMP.
- Be open to compliance with environmental audits by theowner and by the relevant government bodies or local authority and provide the information necessary so that monitoring occurs in the best possible way.
- Inspecting the adequate storage of wastes on the decks, keeping the storage area clean and safe and to verify the necessity of resources (containers, plastic bags, big bags, drums).

- Ensuring that all waste is appropriately assessed, segregated/packed, marked/labelled and accompanied by the appropriate paperwork (e.g. waste manifest) before off-loading the waste for disposal.
- Responsible for ensuring compliance with all aspects of Health, Safety and Environment reporting and for investigations of all incidents and near misses.
- Responsible for immediately notifying the owner of any incidents/activities arising from lodge operations that are likely to have a negative impact on the performance objectives detailed in this EMP.
- If the authorities consider that the operational activities performed by the lodge are causing unacceptable environmental damage, the manager of the lodge should immediately consult the competent authorities and The proponent to agree on appropriate mitigation measures. The agreed measures should be implemented as soon as possible, in order to avoid subsequent damage and to repair any damage that might have occurred.

6.2.5 Personnel

Personnel or staffs are responsible for the following:

- Ensuring that all wastes are appropriately segregated, identified, packed and stored prior to off- loading for disposal.
- Ensuring that all garbage and hazardous wastes are appropriately segregated/packed and identified.

6.3 TRAINING, AWARENESS AND COMPETENCE

All staff and contractors will receive appropriate training on their responsibilities. Key environmental performance objectives and commitments, as detailed in this EMP should be reviewed as well.

6.4 MONITORING

In partial fulfilment of this EMP, the following monitoring program is proposed to determine the effectiveness of mitigation measures applied.

6.5 AUDITING

6.5.1 Audits and Inspections

Technical compliance audits should be supplemented by a program of regular compliance inspections and tracking of progress towards rectification of non-compliance items.Internal compliance inspections will be undertaken on a weekly basis or as determined by the Proponent's Environmental Coordinator or Lodge Manager. A system of informal audit mechanisms will also be put in place including, but not limited to adhoc inspections by the Proponent's Environmental Coordinator, Lodge Manager and personnel self-audits. All compliance inspection and audit reports are to be reviewed by the Lodge Manager.

6.5.2 Non-conformance, corrective and preventative action

An environmental non-conformance can surface through:

- environmental incidents;
- environmental monitoring;
- compliance audits; and
- deviations from the Environmental Policy and objectives and performance criteria.

When environmental non-conformances are identified, the following will be undertaken:

- actions will be taken immediately towards re-compliance;
- investigations will be carried out to identify and analyse the root cause;
- preventative actions will be implemented, these may include:
    - new objectives and performance criteria;
    - identification and implementation of specific training.

6.6 REPORTING

All incidents that have the potential to cause significant effects on the environment must be reported and investigated according to legislative requirements and the Proponent'sEnvironmental Policy. Incident reporting and investigation provides the mechanism to prevent a recurrence. All personnel are encouraged to proactively report all incidents, near-misses and hazards.An incident form will be initiated by any person present within the operational boundaries of the lodgein the event of an incident,non-compliance, accident or unplanned occurrence in relation to other land users.

All environmental incidents or deviations from this EMP will be reported to The Proponent. A reportable incident is defined as an incident mentioned in the EMP that has caused, or has the potential to result in, moderate to catastrophic environmental consequences, as per the significance rating criteria.

7 CONCLUSIONS

This EMP provides a management tool that will be utilized to ensure that unwarranted or reasonable avoidable negative impacts associated with the lodge are avoided and mitigated. The Proponent should therefore ensure that its personnel and contractors comply with all regulatory controls under relevant legislations and guidelines, and with the commitments within this EMP.

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