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ENVIRONMENTAL IMPACT ASSESSMENT FOR MUNSHIWEMBA INTERMEDIATE DAM PROJECT

Prepared For:
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BACKGROUND

This report is an Environmental Impact Assessment (EIA) report for the proposed Munshiwemba Intermediate Dam project to be sited on Munshiwemba River. The dam embankment will be located on farm no. 2380 belonging to Chobe Agrivision Company Limited (Chobe), the proponent of the dam project. However, part of the land that is expected to be inundated belongs to Masebe Ranch and Mkushi Country Club (See annex 12 and 13 for no objection). Chobe is a Zambian registered company incorporated in 2008 and has its offices in Mkushi.

The proposed earth dam, estimated to cost US$306,900, will have a catchment area of around 513 Km^2 with an average capacity of 3.5million m^3 at Full Supply Level (FSL). The height of crest above river will be 11.485m and a throwback of about 2.52Km is expected with a surface area of 0.793km^2. The dam wall length will be 300m. However, being aware of the effects of a dam project regardless of its size, Chobe engaged Envsol Consult to undertake an environmental impact assessment for the proposed dam project.

The Environmental Impact Assessment (EIA) was undertaken to determine, analyse and present the environmental impacts of proposed earth Dam Project, formulate remedial measures to mitigate the negative impacts and plan in such a way that a rational decision can be made about its implementation. The EIA multi disciplinary team studied the project sites and their conditions, assessing the needs for design adjustments taking into account existing infrastructure. The methodology used involved six basic steps:

- Review of the literature on environmental baseline conditions of the project area and its immediate environs relating to past studies
- Scoping exercise aimed establishing issues of relevance to the study
- Consultative meetings with stakeholders at various levels in order to determine the potentially significant issues of the project and to exclude any issues unlikely to be of significance;
- Identification and analysis of the magnitude and significance of the principal impacts;
- Determination of appropriate mitigation measures and/or design changes to eliminate or reduce the identified impacts; and
- Formulation of an environmental management plan and monitoring plan, the emergency response Plan as well as dam decommissioning plan.

In undertaking the EIA, relevant legal instruments were reviewed focusing on provisions relevant to the proposed dam project. The principal Act governing and regulating environment issues in Zambia is the Environmental Management Act passed in 2011, replacing the EPPCA of 1990. Besides the Environmental Management Act, due consideration was given to protocols and international conventions of which Zambia is a party.

PROJECT JUSTIFICATION AND OBJECTIVE

Mkushi district has high temperatures and evapotranspiration is equally high such that it exceeds precipitation making rain fed farming unsustainable. On the other hand, Zambia ranks quite low in the region regarding overall water storage capacity and number of dams in existence hindering full exploitation of the country's irrigation potential. Unreliable rain patterns as witnessed in recent years coupled with rains being scantly prolonged causes crop stress, resulting into poor crop yield hence the need for irrigated agriculture.

PROJECT ALTERNATIVES

With regard to the overall project development, three options were considered namely;

1) Avoid construction of the earth dam at the proposed site and continue to depend on rains with the view of increasing agricultural productivity without irrigation
2) Construct a single large dam on another site on Munshiwemba River within the project area
3) Construct a number of smaller earth dams at a number of identified sites including the proposed site for Munshiwemba Intermediate Dam.

Choosing the first option would entail perpetual losses on the part of Chobe resulting in low productivity as witnessed in recent years by other farmers. This would further undermine the championing of agriculture as an engine for economic growth in the country. Further no additional employment opportunities are envisaged under this option.

The second option involving construction of a large dam will entail far reaching environmental effects most of which are irreversible. Therefore this option was found to be inappropriate and environmentally challenging. The third option not only provides a technical solution but also in many ways it's environmentally sound. Choosing this option cumulatively guarantees availability of adequate water throughout to meet current and future water demand for Chobe for meaningful irrigation. This option would mean creating a number of smaller earth dams with minimum flooded areas. In which case, the environmental effects will be localised to small portions of land thus minimising the extent of impacts within the project area.

IMPACTS AND MITIGATION MEASURES

Displacement of people: No households are expected to be relocated due to inundation resulting from dam and spillway construction. Therefore no mitigation measure is required.

Loss of productive land, historical and cultural sites: No mitigation is required for loss of historical and cultural sites since none are located within the impoundment area. However, the developer will take a precautionary measure i.e. should any effect of historical nature be discovered during construction, relevant authorities will be notified immediately.

Loss of wildlife habitat, flora and fauna: limit clearance of vegetation only to critical areas, Conduct awareness campaigns among staff and community on the need to conserve nature and Adopt strict good practices in conservation

Erosion of the top soil and reservoir sedimentation: Carryout reforestation of the disturbed area after construction activities using guidelines given in annex 10, Limit movement of heavy machinery only to designated access routes and operational areas

Skills Transfer to local people: Ensure there is skill transfer through an elaborate programme, Categorise staff and each group to be supervised by dedicated skilled

personnel to ensure on job training and encourage job on training through observation and trial under supervision

Pollution due to increased usage of pesticides and fertilisers: Stick to recommended dosage and frequency of application of agro chemicals, ensure recommended types of agro-chemicals are used and conduct awareness campaign among communities on dangers of agro chemicals.

Deterioration in water quality: Stick to good practices of dam operation rules of ensuring minimum flows in times of low flow and Ensure prior clearance of all deadwood/vegetation prior to dam filling

Change in water quantity in downstream: Ensure that the design has adequate design provisions to allow flow downstream even in times of dry months, Apply standard dam operational rules and Observe water right permit regulations and requirements for the sake of downstream water right holders

Encroachment of aquatic weeds: Create a buffer zone between the waterfront and settlement area, avoid discharge of any waste effluent into the dam and conduct awareness on invasive aliens aquatic weeds

Deterioration of public health: Encourage natural aquatic life that takes care of mosquito larva as part of the food chain

To dust pollution: Undertake watering of the area and surroundings regularly during construction stage

Loss of wildlife habitat, indigenous flora and fauna: encourage natural restocking of the area by educating the locals on the benefits of conserving nature; discourage cutting of trees and unnecessary clearing of vegetation within the area.

Erosion of the top soil: limit use of heavy machinery to designated areas, avoid unnecessary clearing of the vegetation and rehabilitate heavily disturbed areas

Reservoir sedimentation: Ensure a buffer zone is created between the water front and occupied areas of human settlement and agricultural activities, avoid unnecessary clearing of the vegetation

Soil and water pollution due to oil spills: Ensure all machinery and equipment is regularly maintained, limit servicing and repair of machinery and equipment to designated areas and dispose any used oil at in accordance with the law

Skills transfer to locals: Adopt a deliberate policy of giving employment priority to locals, design on job training programmes and ensure skilled manpower is employed

Erosion of the top soil and reservoir sedimentation: Restrict movement of vehicles and equipment to designated areas and Restrict clearance of vegetation to critical areas

Deterioration in water quality in downstream reaches of the stream: Observe standard dam operation rules and ensure minimum flows downstream at all times

Change in water quantity in downstream reaches of the stream: Ensure that excess flow during summer season is harnessed and Observe Water Right regulatory requirements

Encroachment of aquatic weeds and water quality of the reservoirs: Conduct awareness campaigns among the staff and community on the dangers of invasive aquatic weeds, Promote sustainable fishing methods and Minimise nutrient loading through effective usage of agro chemicals

Increase in groundwater Level: Impound Munshiwemba River to promoting percolation of water to deeper levels and ensure that the dam is constructed to standard design ensuring that there is no dam wall seepage thus minimizing losses while increasing retention time for percolation

Deterioration in groundwater quality: Remove most of the vegetation from the area prior to dam filling to reduce decaying of organic matter and regulate use of agro chemicals to maintain water quality in the reservoir

Pollution due to solid waste: Collect waste at selected points for proper disposal at a designated area and some of the rubble will be used for compaction in the construction of the dam wall

Deterioration in water quality due to liquid waste: Provide portable sanitation facilities for construction workers

Employment opportunities: Give local people priority for employment as a deliberate company policy.

Increase in local population: Adopt selective employment opportunities targeting locals and Ensure adequate facilities are provided for staff such as sanitation facilities

Increase in local economic activities: Ensue that the irrigation scheme is operated in a professional manner.

Loss of social & cultural infrastructure: No social or cultural infrastructure will be inundated and therefore no mitigation is required.

Economic growth: Ensured effective management of the irrigation scheme

Increase in local population: Give priority for employment to local people

Increase in local economic activities: Ensure that the irrigation scheme is operated in a professional manner.

ENVIRONMENTAL MONITORING AND MANAGEMENT PLAN

A monitoring and environmental management plan (EMP) has been elaborated for purposes of addressing identified adverse/positive impacts. Under the EMP, various mitigation measures have been organised into well-formulated plan, which will serve as a guide for construction and operation phases of the proposed project.

EMERGENCY RESPONSE ACTION PLAN

The purpose of this ERAP is primarily to safeguard lives and secondarily to reduce property damage of local communities who live within Munshiwemba Catchment and beyond in an event of flooding caused by a large volume of runoff from or failure of Munshiwemba Intermediate Dam. It provides contact information and describes actions to be taken in an event of flooding.

CONCLUSION

Any meaningful developmental project of magnitude such as Munshiwemba Earth Dam Project comes at a cost either economically or socially and can hardly ever be without either positive or negative impacts. However, what is important is to systematically identify all potential impacts and put measures in place aimed at either enhancing benefits or minimising impacts through an elaborated Environmental Management Plan. It is for this reason that as developers of this project we believe that natural resources such as water can sustainably be utilised to optimise on the benefits for the good of all. Construction of water retaining structures such as dams, is one such initiative aimed at attaining these benefits and thus require support from all especially in light of scanty rains and unreliable rainfall pattern.

SIGN:……

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ABBREVIATIONS AND ACRONOMYNS

CAP	– Chapter
CHOBE Ltd	- Chobe Agrivision Company Limited
CBD	– Convention on Biological Diversity
CITES	– Convention on International Trade in Endangered Species of the wild fauna and flora.
Cu M	– Cubic metre
CSO	– Central Statistics office
ZEMA	– Zambia Environmental Management Agency
EIA	– Environmental Impact Assessment
EIS	– Environmental Impact Statement
EMP	– Environmental Management Plan
EMA	– Environmental Management Act
ERAP	- Emergency Response Action Plan
FF	– Chaote's formula factor
FSL	– Full Supply Level
GPS	– Global Positioning System
JICA	- Japanese International Corporation Agency
LHPC	– Lunsemfwa Hydro Power Company
m/s	– metre per second
NHCC	– National Heritage Conservation Commission
Sq Km	– Square Kilometre
STIs	- Sexually Transmitted Diseases
TORs	– Terms of Reference
WHO	- World Health Organisation

CHAPTER 1 INTRODUCTION

1.1 BACKGROUND

Zambia has four months of effective rain annually while the remaining months are dry. With this kind of rain pattern it is necessary that excess water during the wet months is harnessed to sustainably support agriculture production. This strategic approach would ensure maximum utilisation of water resources for increased livestock and crop production.

In the past, Zambia highly depended on rain fed agriculture with very little arable land under irrigation. The National Irrigation Policy states that of the 58% of land suited for arable use, only 14% is currently being utilised and less than 5% is under irrigation in Zambia. This means that 5% of arable land is under irrigation at most during the eight months of dry season making agricultural productivity unsustainable.

Central province and Mkushi area in particular is one of the areas in Zambia with very good soils and generally receives good rains on average. Statistics show that the average total annual rainfall is about 1100 mm most which falls between October and April. However, high temperatures in the area have made evapotranspiration to be very high exceeding precipitation. This further affects agriculture production that is dependent on rain.

Apart from high evapotranspiration, perpetual drought occurrences witnessed in recent years has further made rain fed farming in the area unsustainable. This has prompted many farmers dependent on rain fed agriculture to change their strategy in order to overcome the effects of these droughts. Most farmers have resorted to constructing water retaining structures such as dams and weirs aimed at harnessing excess runoff water for irrigation during the dry periods of the year. This is not a new phenomenon as dams have been built for years world over to manage flood waters, for hydropower, to supply water for domestic, industry or indeed primarily for irrigation .What is certain is that dams enhance productivity and contribute effectively to the growth of the country's economy. Besides, statistics show that Zambia has only about 1500dams (WWAR, 2009). This is far less compared to other neighbouring states such as

Zimbabwe which has in excess of 4000 dams. Therefore building of dams in Mkushi should be promoted to increase the national water storage capacity.

Chobe would like to be part of the efforts being made to increase the national water storage capacity through the construction of dams. Chobe owns two adjoining farms holdings on the right (north) bank of the Munshiwemba River. These are Parklands Farm (783.874 ha), a recent sub-division of Wheatlands Farm and Whispering Hope Farm (1,720.000 ha). Chobe is in the process of extending its existing irrigated crop area by 380 ha from 660 ha to a total of 1,040 ha (less than 50% of the total area of the two farms combined). Munshiwemba River and the Masebe Dam form the southern boundary to Whispering Hope Farm while Parklands Farm does not have a riparian location. The expansion of irrigated area project will be implemented in two stages. Initially, two centre pivot irrigation systems on Whispering Hope Farm (1x80ha and 1x70 ha respectively) will be established and later on four centre pivots (2x60 ha and 2 x 50 ha) on Whispering Hope and 1 x 30 ha pivot on Parklands will be set up marking the end of the project.

An environmental impact assessment for the extension of irrigated area was carried out by Whydah Consulting Limited and approved by the Zambia Environmental Management Agency. To sustain this expansion in area under irrigation, additional water reservoir storage is required. Considering that large dams have significant impacts on the environment most of which may be irreversible, Chobe has as a matter of company environmental policy opted to develop a number of small dams whose impacts scale and magnitude can easily be managed. The proposed Munshiwemba Intermediate Dam is one of the dams that Chobe intends to construct. However, being aware of the effects of a dam project regardless of its size, Chobe engaged Envsol Consult to undertake an environmental impact assessment for the proposed Munshiwemba Intermediate Dam.

The embankment for the proposed earth dam will be located on Chobe farm no. 2380. The earth dam will have a catchment area of around 513 Km^2 with an average capacity of 3.5million m^3 at Full Supply Level (FSL). The height of crest above river will be 11.485m and a throwback of about 2.52Km is expected with a surface area of 0.793km^2. The dam wall length will be 300m. The cost of the dam is estimated to be US$306,900.

This Environmental Impact Statement (EIS) has therefore been prepared in compliance with Zambian legislation elaborated by the EMA Act of 2011 and in accordance with international environmental principles. The EIS report is structured in accordance with ZEMA guidelines and as elaborated in the TORs. Below is the report structure:-

i) Executive Summary

ii) Introduction of the Project and the Developer

iii) Policy Legal and Administrative framework

iv) Project Description

iv) Existing Biophysical and Social Economic Environment

v) Potential Environmental and Social Impacts;

vi) Proposed Enhancement and Mitigation measures

vi) Environmental Management Plan

vii) Environmental Monitoring Plan

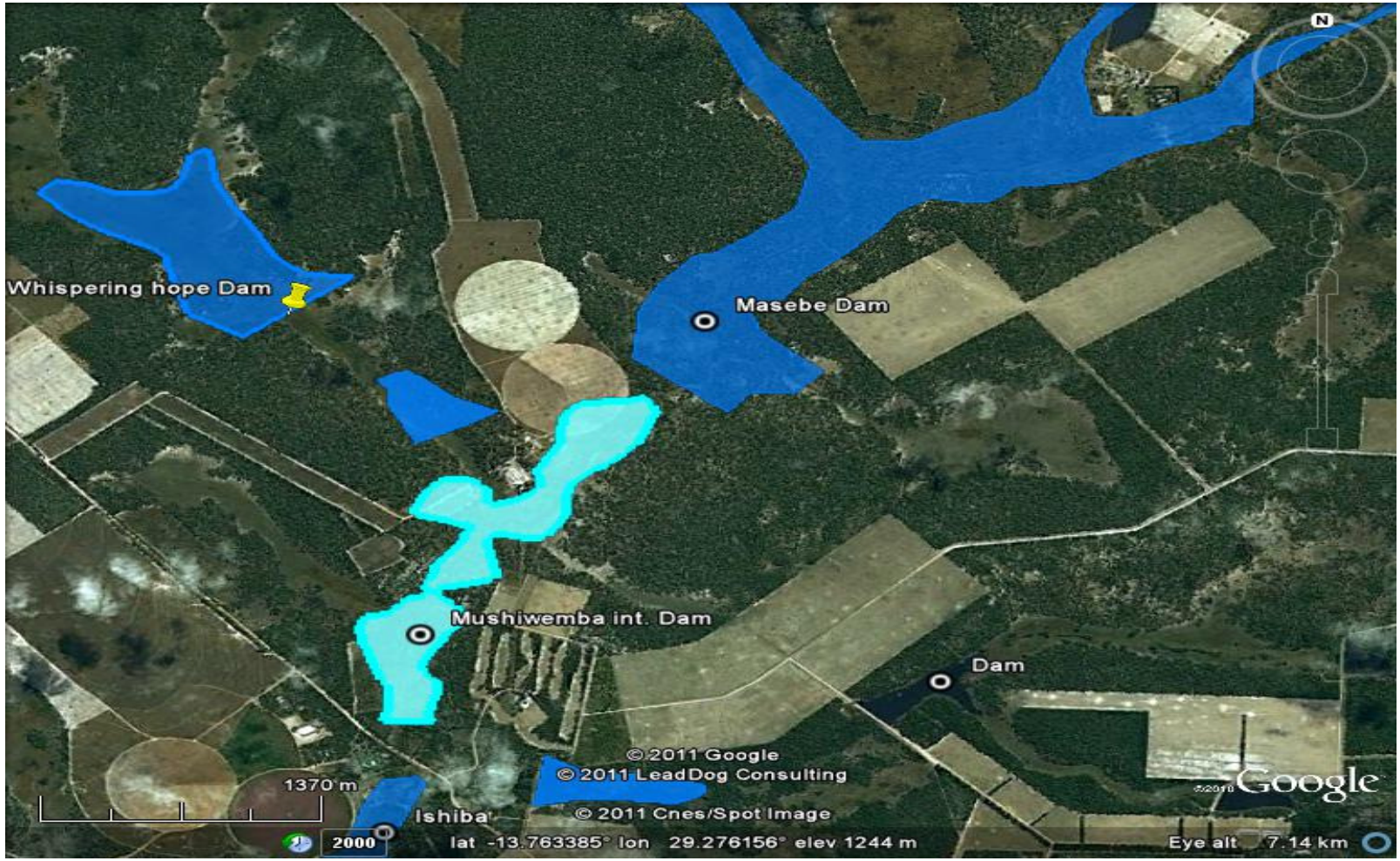
viii) Environmental Emergency Response Plan

ix) Decommissioning Plan

x) Review of Engineering Designs

xi) Annexes

Figure 1.1.: Map showing Munshiwemba Catchment Areas



1.2 PROJECT DEVELOPER

Chobe , the proponent of the proposed Munshiwemba Intermediate Earth Dam project, is a Zambian registered company incorporated in 2008 and has its offices in Mkushi. Chobe owns Parklands (Farm 3283) and Whispering Hope (Farm 2380). Chobe forms part of an investment company whose vision is to create world-class farming operations and integrated businesses across the agricultural value chain, and to leave a legacy of responsible commercial agricultural practices in the region.

The Company seeks to make pioneering investments in agriculture, agribusiness and related infrastructure; and intends to unlock the potential of agricultural land and assets by expanding land under cultivation as well as optimising production and operational efficiency across the agricultural value chain. The Company is managed by an experienced operational and investment team with an investment philosophy which has been developed and applied extensively in emerging markets. The management team combines a strong investment track record and best-in-class reporting and transparency with significant large-scale commercial agriculture experience in sub-Saharan Africa.

The company's goals are to:

1. Develop infrastructure throughout the region and improve exports of food cross-border within Africa;
2. Acquire brown field sites for purposes of increasing productivity by using a combination of farming techniques that improve soil quality and irrigation;
3. Achieve economies of scale through the creation of service businesses along the value chain;
4. Improve conditions for the farming workforce and their families and create more jobs;
5. Provide skills transfer at the local level, by offering a source of training within communities through outreach programmes, on the job training and formal education, thereby cultivating the next generation of farm management from within the local communities;

Details about the shareholding of the company are summarized in Table 1.1 below.

Table 1.1: CHOBE Ltd Shareholders Details

NAME	CONTACT DETAILS	SHAREHOLDING %
Chayton Atlas Investments Limited	Les Cascades, Edith Cavell Street, Port-Louis, Mauritius	100%

1.3 PURPOSE OF THE EIA

The EIA was undertaken to determine, analyse and present the environmental impacts of proposed earth dam project, formulate remedial measures to mitigate the negative impacts and plan in such a way that a rational decision can be made about its implementation. In addition, the EIA aimed at contributing to the reduction or mitigation of adverse impacts by generating a number of project alternatives. In this regard, Chobe is committed to enhancing positive biophysical and social environmental impacts of the Project while mitigating negative impacts of the project.

The proposed dam project falls under the Second Schedule of the Statutory Instrument No. 28 (EIA regulations). Dam construction projects are subject to an EIA. The Environmental Impact Statement (EIS) has therefore been prepared with a view to complying with EIA regulations that require that an Environmental Impact Assessment (EIA) study be carried out following the guidelines and requirements of the Zambia Environmental Management Agency (ZEMA).

1.4 SCOPE OF THE EIA STUDY

The EIA study comprised, but not limited to a scoping meeting, stakeholder consultations and detailed specialised field investigations as outlined below;

- **Undertake a Scoping Exercise**

The scoping exercise was intended to identify and screen all relevant issues related to the proposed project as well as to identify at the earliest possible time whether any detrimental effects existed that could render the dam project environmentally

unacceptable. Arising out of the scoping exercise was a number of issues. See table 1.2 given below;

Table 1.2: Scoping Issues

	Project Phase		
Issue	***Preparation***	***Construction***	***Operation***
Change in Water quantity in downstream reaches			✓
Loss of wildlife habitat, flora and fauna	✓		✓
Skills Transfer to Locals	✓	✓	✓
Loss of farmland	✓	✓	
Water Quality		✓	✓
Increase in Local Economic Activities	✓	✓	✓
Lack of Mobility of Community Members			✓
Employment Opportunities	✓	✓	✓

- **Existing Baseline Environmental Conditions**

Primary data on environmental and socio-economic baseline conditions for the project within farm lot No: 3373 and surrounding areas was collected during field surveys and analysed. Further an analysis of available secondary data from past studies on biological, zoological, botanical and aquatic for Mkushi area in particular was undertaken.

- **Description of Project Activities**

Construction of a dam involves use of various construction materials and equipment. Thus project inputs, activities and outputs during project preparation, construction and operational life stages are described. This section also include description of project alternatives

- **Environmental Impacts Analysis**

An assessment of environmental effects and benefits of the project regarding biophysical and socio-economic environment has been elaborated including an analysis of the impacts including their extent, duration, intensity and significance.

- **Possible Mitigating Measures Formulation**

A number of measures and plans for mitigating the identified possible adverse environmental impacts of the earth dam project have been proposed including measures and plans for enhancing positive environmental impacts. And wherever possible, the costs and benefits of these environmental measures are quantified.

- **Environmental Management and Monitoring Plan Elaboration**

A management and monitoring plan for implementing cited mitigation measures during preparation and construction phases as well as operational life of the Munshiwemba Intermediate Dam Project is elaborated. The plan further indicates management responsibilities and time frames.

- **Emergency Response Plan**

An emergency response plan outlining measures and actions to be undertaken in an event of an emergency situation that includes possible dam failure due either man induced or natural circumstances beyond man control has been elaborated.

- ***Elaboration of a Decommissioning Plan***

A decommissioning plan elaborates measures to be taken in an event of decommissioning the dam. This is aimed at ensuring that the environmental conditions are managed and if possible restored for sustainability of the ecosystem.

1.5 METHODOLOGICAL A ND APROACH

The EIA multi-disciplinary team studied the project sites and their conditions, assessing the needs for design adjustments taking into account existing infrastructure. The team also studied and reviewed existing literature. A list of references is included in Annexes.

Several field surveys couple with consultative meetings in the area were undertaken to assess the different aspects of the project and the environment. The methodology used for this assessment was standard and involved six basic steps:

- Review of the literature on environmental baseline conditions of the project area and its immediate environs
- Scoping exercise aimed establishing issues of relevance to the study
- Consultative meetings with stakeholders at various levels in order to determine the potentially significant issues of the project and to exclude any issues unlikely to be of significance;
- Identification and analysis of the magnitude and significance of the principal impacts;
- Determination of appropriate mitigation measures and/or design changes to eliminate or reduce the identified impacts; and
- Formulation of an environmental management plan and monitoring plan, the emergency response Plan as well as dam decommissioning plan.

1.6 STAKEHOLDER CONSULTATIONS

Transparency and open consultative process are an important element of any EIA process that ensures that public views are taken into account in determining the scope of the EIA study. In recognition of this important aspect, a public consultative meeting was held at Parklands farm premises on 13th August, 2011. The meeting was attended by relevant stakeholders including government departments as well as other interested and affected parties.[1] Details of the proceedings for the consultative meeting are elaborated below.

[1] See a full attendance list in annex

1.6.1 Approach and Methodology

The stakeholder consultation process involved stakeholder meetings, open discussions and interviews. The aim was to get views from stakeholders in terms of how they understood the dynamics of the environment in which the proposed project will be located and any possible underlying causes that could lead to changes over time as a result of implementing the project.

Consultations with stakeholders having either experience or expert knowledge on the study area were also conducted to validate existing data as well as get their advice on any additional sources of information that was not readily available. The objective was to obtain their interpretation with regard to the underlying factors of the trends already observed. Those located within or around the project area were visited as well where it was deemed that they are likely to shed very useful pieces of information.

Responses from the stakeholder meetings and interviews provided the relevant background information and helped identify major environmental concerns of the stakeholders within the project area.

1.6.2 Outcome of the consultative process

Below is a concretised list of pertinent issues that were raised during the consultative process;

- Generally most stakeholders welcomed the idea of constructing a dam on Munshiwemba River. However, the Ishiba Dam downstream expressed reservation.
- Any road and bridge that will be submerged should be reconstructed at alternative sites for accessibility by general public.
- The need to take into account future water requirements of other stakeholders with reference to existing water rights downstream.
- The possibility of Chobe partnering up with stakeholders in the area in the utilisation of the water from the proposed dams

- The need to recognise priority of existence for downstream dams to fill up
- The need for relevant authorities to set up gauging stations on Munshiwemba to enable proper water planning for the catchment.

1.6.3 EIA TEAM OF EXPERTS

Names and signatures of persons involved in the compilation of the environmental impact statement for the Munshiwemba Intermediate Dam Project are given below.

Table 1.3: EIA Team Members

ITEM	NAME OF TEAM MEMBER
1	Mr. Kenneth Nyundu *(Team leader)*
2	Mr. Frank Sikana *(Civil Engineer)*
3	Mr. Joseph Simfukwe *(Socio-economist)*
4	Mr. Patrick Kunga *(Ecologist)*
5	Mr. Chisanga Siwale *(Hydrologist)*

CHAPTER 2 POLICY, LEGAL AND INSTITUTIONAL FRAMEWORK

2.1 INTRODUCTION

The need for any socio-economic development to be undertaken in such a manner that avoids environmental degradation is one of the important elements enshrined in Zambia's Environmental Policy. Promotion of awareness at all levels of society and its relationship to socio-economic development and the necessity for rational resource use among all sectors is a vital part of the overall policy objective. Another important aspect provided for in the Policy is public participation in the environmental decision-making process.

Under Zambia's legislative requirements, a project of this nature and magnitude requires to be subjected to an EIA for purposes of ascertaining effects and how these can either be mitigated or enhanced. In doing so, relevant legal instruments are reviewed focusing on provisions relevant to the proposed dam project.

2.2 Chobe Company Policy on Environment

There is urgent need in Zambia to increase arable land under irrigation from the current 5% to at least 50% or more. This will significantly reduce the high levels of poverty currently estimated at 70%. The levels of poverty and associated food insecurity are worse in rural areas where over 60% of the population live. Chobe Agrivision wishes to contribute to the reduction of poverty among Zambians especially the rural population. To achieve this rain fed agriculture should be complimented by irrigated farming. As such enough water should be stored for irrigation during the dry season. This would lead to optimal crop yields and livestock production hence contributing effectively to the overall national economic growth.

However, Chobe recognises the fact that any meaningful developmental project of magnitude such as the proposed Munshiwemba Intermediate Dam Project comes at a cost either economically or socially and can hardly ever be without either positive or negative impacts., Therefore, the company fully embraces the principle of sustainable

development that ensures that any development meets the needs of the present generation without compromising those of future generations.

Chobe believes that what is cardinal in promoting sustainable development is to systematically identify all potential impacts and put measures in place aimed at either enhancing or minimising impacts through an elaborated Environmental Management Plan that covers all stages of project development. Specifically, Chobe will ensure that it abides by the following principles in line with its company policy on environment:-

- Engage and dialogue with authorities and institutions including the local communities;
- Undertake a professional approach in assessing environmental as well as socio-economic issues prior to project development;
- Undertake regular evaluations of the environmental and socio-economic potential risks of ongoing operations;
- observe locally and internationally acceptable environmental standards in all its undertakings;
- comply fully with all relevant applicable environmental laws and regulations;
- Conduct awareness campaigns not only to its workers but any contractor on site on the importance of observing environmental regulations;
- Conduct training seminars for relevant staff on environmental management issues;
- Be transparent in all its dealings relating to the proposed project.

2.3 ADMINISTRATIVE FRAMEWORK

The legislative responsibility for environmental impact assessment is vested in the Zambia Environmental Management Agency (ZEMA) which administers the Environmental Management Act (EMA) of 2011. It's responsible for enforcing environmental regulations and coordinating sectoral government agencies involved in environmental management in their sectors.

The Water Act, which establishes the Water Board, administers the allocation of surface water through issuance of water rights. Under this Act, abstraction of water from a surface water body through direct pumping or impoundment using a weir or dam requires a water right. As a pre-condition a water right is only issued among other conditions when the EIA of the proposed dam project is approved by ZEMA. A new Water Act, the Water Resources Management Act was passed by Parliament and assented to by the executive in 2011. This Act once actualized through a statutory Instrument will bring about formation of the National Water Resources Authority replacing the current Water Board

2.4 THE ENVIRONMENTAL MANAGEMENT ACT (EMA)

This is the principal Act governing and regulating environment issues in Zambia. Passed in 2011, to replace the EPPCA of 1990, this Act is the principal environmental law in Zambia and provides for the management, protection of the environment and the prevention of pollution. This law is the primary legal basis for undertaking environmental assessment for the proposed project due to its nature. This Act is therefore relevant to the project as it offers legal guidance to the implementation of the project to ensure environmental sustainability.

Besides the Environmental Management Act, Zambia has signed a number of protocols and international conventions, which contain environmental aspects important to this study.

2.5 THE WATER ACT OF 1949 (CAP 312)

The Water Act has recently been revised into the Water Resources Management Act of 2011. The Water Resources Management Act, enacted in 2011 provides for the establishment of the National Water Resources Management Authority to replace the current Water Board. However, the new Act is yet to be actualized through a Statutory Instrument (S.I). The Water Board established under the old Water Act has continued to administer the allocation of surface water through issuance of water rights until the new Act comes into force. Under the old Act, abstraction of water from a surface water body through direct pumping or impoundment using a weir or dam requires a water right. As

a pre-condition a water right is only issued among other conditions when the EIA of the proposed project is approved by the ZEMA.

The proposed project involves damming a river and that requires obtaining a permit from Water Board which was established by the Act of parliament i.e. The Water Act. Thus this Act is very relevant to the proposed project since the project involves impounding a river which requires a water permit issued by Water Board.

2.6 THE NATIONAL HERITAGE CONSERVATION ACT (CAP 173)

Enacted in 1989, the Act provides for the Conservation of Ancient, Cultural and Natural heritage, relics and objects of aesthetic, historical, pre-historical, archaeological or scientific interest. It establishes the Commission and sets out its functions.

The Act is the implementing legal framework in Zambia for the World Heritage Convention of 1972, under which the heritage sites are included in the World Heritage List as World Heritage sites.

This Act is relevant to the proposed project since the construction of the dam will result in inundation of land which may be host to either a heritage site or objects of heritage significance and as such measures are required to ensure preservation of such sites.

2.7 THE ZAMBIA WILDLIFE ACT

Enacted in 1998, the Act provides for the conservation and management of ecosystems to preserve them from the impacts of modern man's socio-economic activities. The Acts also regulates the type and extent of tourism activities that may be permitted in a National Park or Game Management area setting. Although the proposed development does not lie within a national park, the area is habitat to some animal and bird life. Besides, once the dam is constructed a number of small animals and birds will be attracted to the area. As such measures in accordance with the Act will be required to conserve wildlife.

2.8 THE FORESTRY ACT

Enacted in 1974, the Forestry Act vests ownership of the forests and forest produce in the President and provides for among other things the following;

- The establishment of the Zambia Forestry Commission to replace the Forestry Department as the administrative body for the Act.
- The Participation of Local communities, traditional institutions, non-governmental organizations and other stakeholders in a sustainable forest management
- The conservation and sustainable use of forest and trees for the management of forest ecosystems and biological diversity.
- The implementation of the Conservation on Biological Diversity

Although the proposed project does not lie in a gazetted forest area, significant amount of vegetation will be lost due to inundation and as such this Act is very relevant. Besides, the provisions of this Act provide for protection of head waters to ensure sustained flow in the stream and as such CHOBE Ltd will ensure headwaters are protected through conservation of trees.

2.9 THE LAND AND LAND ACQUISITION ACT

Enacted in 1995, the Department of Lands administers the Lands Act for alienation of land under statutory leaseholds. Under the Land Act, land has been divided into the following categories: State, Local Authority and Traditional land. The proposed development will affect land that is under Local Authority and as such due consideration will be given to the provisions of this Act in managing land issues.

2.10 THE LOCAL GOVERNMENT ACT

Enacted and implemented in 1991, the Act provides for the establishment of Councils or Districts, the functions of local authorities and the local government system. Some of

these functions relate to pollution control and the protection of the environment in general. The proposed project will be within the jurisdiction of Mkushi district Council and will affect the environment. Managing these impacts requires due consideration to the provisions of this Act.

2.11 THE TOWN AND COUNTRY PLANNING ACT 1962

Enacted in 1962, the Act provides for the appointment of planning authorities whose main responsibilities are the preparation, approval and revocation of development plans. It also provides for the control of development and subdivision of land. The Act however does not apply to Trust Land and Land in Reserve and Mining Areas. The proposed project neither lies in Trust nor Reserve/ Mining areas and as such the Act is very relevant since its provisions apply to the proposed developmental project.

2.12 THE FISHERIES ACT (CAP 314)

The Fisheries department administers the Fisheries Act (CAP 314). The Act regulates commercial fishing through registration of fishermen and boats, and prohibition of certain fishing methods and equipment. The proposed project involves a dam. It is anticipated that as a result of damming the fish population will increase consequently more local communities will engage into fishing in which case such an activity is supposed to be regulated by this Act. Thus this Act is very relevant to the project since CHOBE ltd will have to ensure that those engaging in fishing in the dam abide by the provisions of this Act.

2.13 THE INVESTMENT ACT

Enacted in 1993, the Act provides a legal framework for investment in Zambia. The Act relates to the environment indirectly by providing incentives for tree planting, soil and water conservation activities. The Act further recognizes the role of other agencies including those responsible for environmental protection in authorities' specific projects. The proposed project will constitute a very important investment in the agriculture sector and hence it's subject to the provisions of the Investment Act.

2.14 THE NATURAL RESOURCES CONSERVATION ACT

The act provides for the establishment of the Natural Resources Advisory Board whose main functions are to ensure the proper use, conservation and improvement of natural resources. Some of the provisions of the Act have since been repealed with the coming into force of the then EPPCA which has since been replaced by EMA of 2011. This includes the abolition of the Natural Resources Advisory Board. Given that the proposed project site will be surrounded by natural resources, CHOBE ltd will ensure that these resources are protected.

2.15 NOXIOUS WEEDS ACT

Enacted in 1953, it provides for the declaration and eradication of noxious weeds. This is relevant to the project since the presence of a reservoir and agricultural activities may lead to high nutrient loading resulting into proliferation of weeds if not checked. CHOBE ltd will abide by the provisions of this Act by ensuring that application of fertilisers is regulated.

2.16 PLUMAGE BIRDS PROTECTION ACT

Enacted in 1915, it provides for the prohibition of dealing in plumage of wild birds except for scientific or education purposes. The project area is home to many bird species and therefore this Act is very relevant.

2.17 INTERNATIONAL CONVENTIONS AND PROTOCOLS

Zambia is a signatory and party to more than thirty International Conventions and Protocols. Among the most relevant environmental conventions are; Convention dealing with the Protection of the World Cultural and Heritage (1972) and ratified by Zambia in 1982, Statutes of the International Union for the Conservation of Nature and Natural Resources (IUCN). Others include Convention on Biological Diversity (1992) ratified in 1993 and the RAMSAR Convention. This entails that national developments should be done with due consideration to these conventions and protocols and as such CHOBE ltd is obliged to abide by these national commitments.

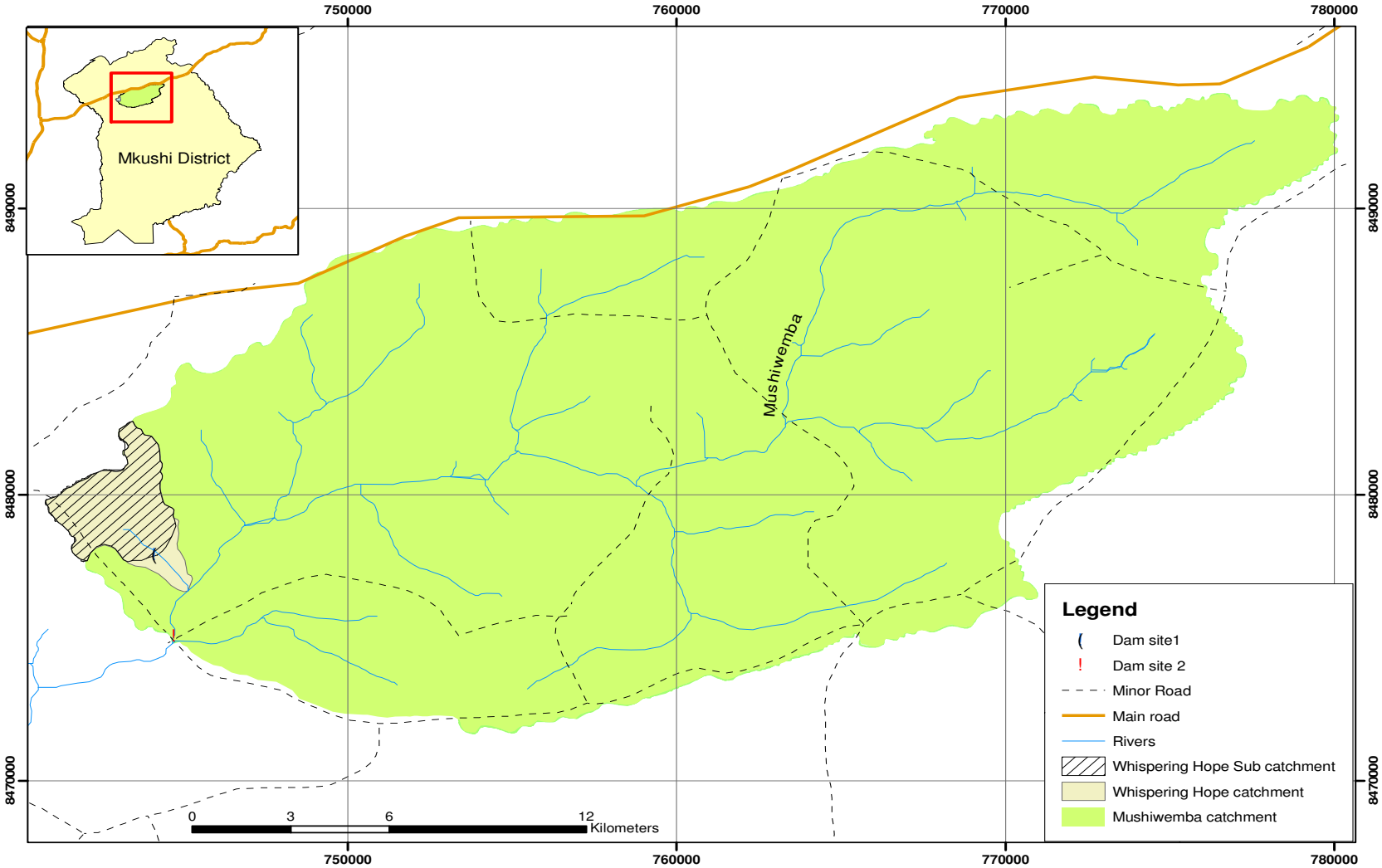
CHAPTER 3 PROJECT DESCRIPTION

3.1 PROJECT DETAILS

Chobe Agrivision proposes to construct an earth dam on Munshiwemba River within Mkushi Farm Block. The stored water in the earth dam amounting to 3,500,000 million cubic meters at full capacity will be used mainly for irrigation and to a lesser extent animal watering. Munshiwemba River is a tributary of the Lunsemfwa River. The rationale behind construction of this dam is that runoff resulting from the summer flow (i.e. rain season) which is currently lost due to inadequate storage infrastructure will be targeted for capturing.

The catchment area of the proposed dam will be around 531 sq Km. The average yield of this earth dam once constructed is expected to be 3,500,000m^3 at Full Supply Level (FSL) while the height of crest above river will be 11.7m. A throw back of about 2.52Km is expected and mainly arable land will be submerged. However, part of the land that is expected to be inundated belongs to Masebe Ranch and Mkushi Country Club (See annex 12 and 13 for no objection). The dam wall length will be 300m. This size of a dam is classified as a small dam. No households (HHs) are expected to be relocated. The dam rock consists of granite, granite greiss and sandstone. The total cost of constructing the dam is estimated to be US$306,900.

Figure 3.1: Location sketch map of the proposed earth dam.



3.2 NATURE OF PROJECT

The nature of the project will in the course of development involve three stages namely Site Preparation, Construction and Operation Phases. The envisaged implementation time frame for the proposed project is estimated to be two hydrological years depending on rainfall pattern. The project is expected to begin in 2011, however, actual commencement date of the project will depend on when the approvals from ZEMA, Water Board and other relevant authorities will be obtained. During Site Preparation phase the project area was investigated for dam construction suitability through a number of tests. The concept was to determine the nature of the soil and geology critical in dam construction. In addition, hydrological investigations were conducted using secondary data.

In addition, a number of alternative sites were investigated. However, all the sites except for the site where the earth dam is proposed to be located were found to be lacking in one way or another. Reasons for not choosing the other sites included unsuitable topography, soils and underlying geology for constructing the earth dam wall, spillway and foundation. The construction phase will mainly involve excavations, earth movements and development of embankment. The Operation phase will involve filing the dam and abstraction of water for irrigation.

3.3 INPUT RAW MATERIALS

To implement the proposed dam project, it will require various raw materials as an input. For outlet works, rubber lined pipes and fittings of various diameters will be used. The embankment and spillway will be cleared of vegetation and top soil. The core will be excavated to bedrock and spread and compacted with suitable impervious material. The rest of the embankment will be constructed using suitably conditioned material.

The material to be used for the embankment will mainly be excavated from the spillway area, outlet works and borrow pits to be sited during construction. Bull dozers and other related equipment that Chobe already possesses within its investment portfolio will be used.

The borrow areas will be cleared of vegetation and top soil (spillway excavation also regarded as borrow pit). All vegetation will be disposed off if not required by making compost manure for soil conditioning, surplus soil will be retained either for embankment cladding or borrow area rehabilitation. The borrow area will be in close proximity to the main embankment thereby reducing hauling distances. In addition, removing of the soil from the outflow area down to rock will limit siltation for the downstream portion of the stream. Detailed management plan for borrow pits are given in the annexes.

EMBANKMENT

The embankment will be a zoned type. The hearting shall overlie the cut off trench and extend up to full supply level with the crests of about 4m. The downstream and upstream slopes will be 1:2.5 and 1:2 respectively. Sand clay loams laid in layers will be used to construct the hearting and upstream zone. However, for upstream zones, sand clay loam containing gravel within it will be placed on the water face to aid in resisting wave action erosion. The downstream zones will be made of gravel, coarse grained sand and medium grained sand layered at optimum moisture and compacted. Dry stone toe and foundations will be incorporated in these zones. The selection of materials will take into account the hydraulic stability of the materials in the dam.

3.4 PROJECT RATIONALE AND OBJECTIVE

Chobe recognises recent changes in rain pattern in the Mkushi area. Recurrent droughts have become a norm in the area. In order to mitigate against these droughts, Chobe plans to construct the proposed Munshiwemba Intermediate Dam Project. The project will involve construction of an earth dam of capacity 3,500,000m3 at full scale. The water stored in the dam will be used for irrigation of crops that include wheat, soya beans and maize. Once completed, the Chobe will manage and maintain the dam.

With the construction of the dam, Chobe envisages a reliable water supply throughout the year leading to increased agricultural production thus contributing effectively to national economic growth.

3.5 PROJECT JUSTIFICATION

From literature, Mkushi district is said to have high temperatures and evapotranspiration is equally high such that it exceeds precipitation. Given such an area, depending entirely on rain fed farming may not be appropriate if the desire is to sustain agricultural productivity. Field surveys indicated that Munshiwemba River is a perennial river and has excess runoff during summer flows if the hydrological year is normal. Under such circumstances it's imperative that the excess runoff water is harnessed by constructing water retaining infrastructure such as an earth dam. This is runoff that cannot be harvested due to inadequate storage capacity. This would greatly mitigate the effects of unreliable rain pattern.

On the other hand, Zambia ranks quite low in the region regarding overall water storage capacity and number of dams in existence. It's no wonder that current statistics show that of the 58% of land suited for arable use, only 14% is being utilized and less than 5% is under irrigation. The inadequate national total water storage capacity has hindered full exploitation of the country's irrigation potential. Chobe intends to construct an earth dam to be able to store enough water for irrigation during the dry season to enhance agricultural productivity. This would in turn contribute to increasing the country's national water storage capacity as well as the area under irrigation. This would in turn contribute to reduction in poverty and enhance the overall national economic growth

Besides, commercial farming requires heavy capital investment. To realise meaningful returns on such an investment, it would be unwise to entirely depend on rain fed farming. Rain fed farming has its own short comings that include unreliable rain patterns as witnessed in recent years. Many times, rains are adequate but the period may be too short or scantly prolonged leading to crop stress, resulting into poor crop yield.

3.6 PROJECT ALTERNATIVES

Project alternatives may comprise alternative sites, alternative processes or alternative implementation schedules. The EIA process contributes to generation of a number of project alternatives. Seeking project alternatives for Munshiwemba Intermediate Dam Project focused on investigating a number of sites along the Munshiwemba River.

A variety of project alternatives presented themselves from the design and management of dam project. Due consideration was given to topographical characteristics- narrowest section of the valley is preferred, catchment area of the dam- the wider the Catchment area of the dam the higher discharge available, Distance to beneficiary areas- the shorter the conveyance the more economical, and Accessibility of the site- the easy accessibility of the site the cheaper it is to construct. In addition, the geology and soil type are the other critical factors that were taken into account.

With regard to the overall project development, three options were considered namely;

4) Avoid construction of the earth dam at the proposed site and continue to depend on rains with the view of increasing agricultural productivity without irrigation
5) Construct a single large dam on another site on Munshiwemba River within the project area
6) Construct a number of smaller earth dams at a number of identified sites including the proposed site for Munshiwemba Intermediate Dam.

The first option which is a do nothing option is retrogressive for an existing enterprise such as Chobe whose vision is to create world-class farming operations and integrated businesses across the agricultural value chain, and to leave a legacy of responsible commercial agricultural practices in the region. Choosing this option would entail perpetual losses on the part of Chobe resulting in low productivity as witnessed in recent years by other farmers. This would further undermine the

championing of agriculture as an engine for economic growth in the country. Further no additional employment opportunities are envisaged under this option.

The second option appears to be the most attractive and a onetime investment whose returns can be huge. This option would certainly be a solution to the projected water demand for Chobe current and future undertakings. However, considering the fact that large dams have far reaching environmental effects most of which are irreversible, choosing this option would be invariance with the company's policy on environment. The company embraces the principle of sustainable development that ensures that any development meets the needs of the present generation without compromising those of future generations. Therefore this option was found to be inappropriate and environmentally challenging.

The third option not only provides a technical solution but also in many ways it's environmentally sound. Choosing this option cumulatively guarantees availability of adequate water throughout to meet current and future water demand for Chobe for meaningful irrigation. This option would mean creating a number of small earth dams with minimum flooded areas. In which case, the environmental effects will be localised to small portions of land thus minimising the extent of impacts within the project area. Besides, the environmental effects resulting from small dams can easily be minimised and managed. However, cumulatively the benefits will be huge. Employment for the local people would be guaranteed due to increased agricultural productivity. As such, Chobe Limited settled for the third option as the best option under the circumstance.

3.7 WATER RIGHT

Information obtained from the Water Board indicated that there are a number of existing water right holders on both upstream and downstream of the dam site on Munshiwemba River. However, despite these existing structures the river is ungauged and reliable consistent hydrological data is unavailable. Nonetheless the developer takes full recognition of existing water rights and is convinced that priority of use will be applied in granting the water right to ensure water availability to downstream users as prescribed in the Water Act. In this regard, the developer has

made a preliminary application for a Water Right permit subject to the EIA report for the proposed dam being approved by ZEMA.

CHAPTER 4 DESCRIPTION OF EXISTING ENVIRONMENT

4.1 INTRODUCTION

The prevailing environment baseline conditions in the area were assessed using appropriate standard methodologies. The approach involved undertaking inventory of physical and biological environments, conducting interviews with citizens and reviewing of relevant literature. Sources of literature that was reviewed included public and private offices, libraries and reports on past studies relevant to the area. The subject matter of interviews included but not limited to forest products and services obtained, the natural resource management practices in the area with reference to what used to obtain decades ago.Mapping of the project area was equally done using a hand held GPS receiver. Information on names of streams and rivers was checked from the maps and confirmed by interviewing local community members who were conversant with the area.

In order to determine the location of the proposed dam wall in relation to any existing critical installations and developments, Munshiwemba Catchment was mapped. In doing so, the existing environment was categorised into physical, socio-economic and biological environments.

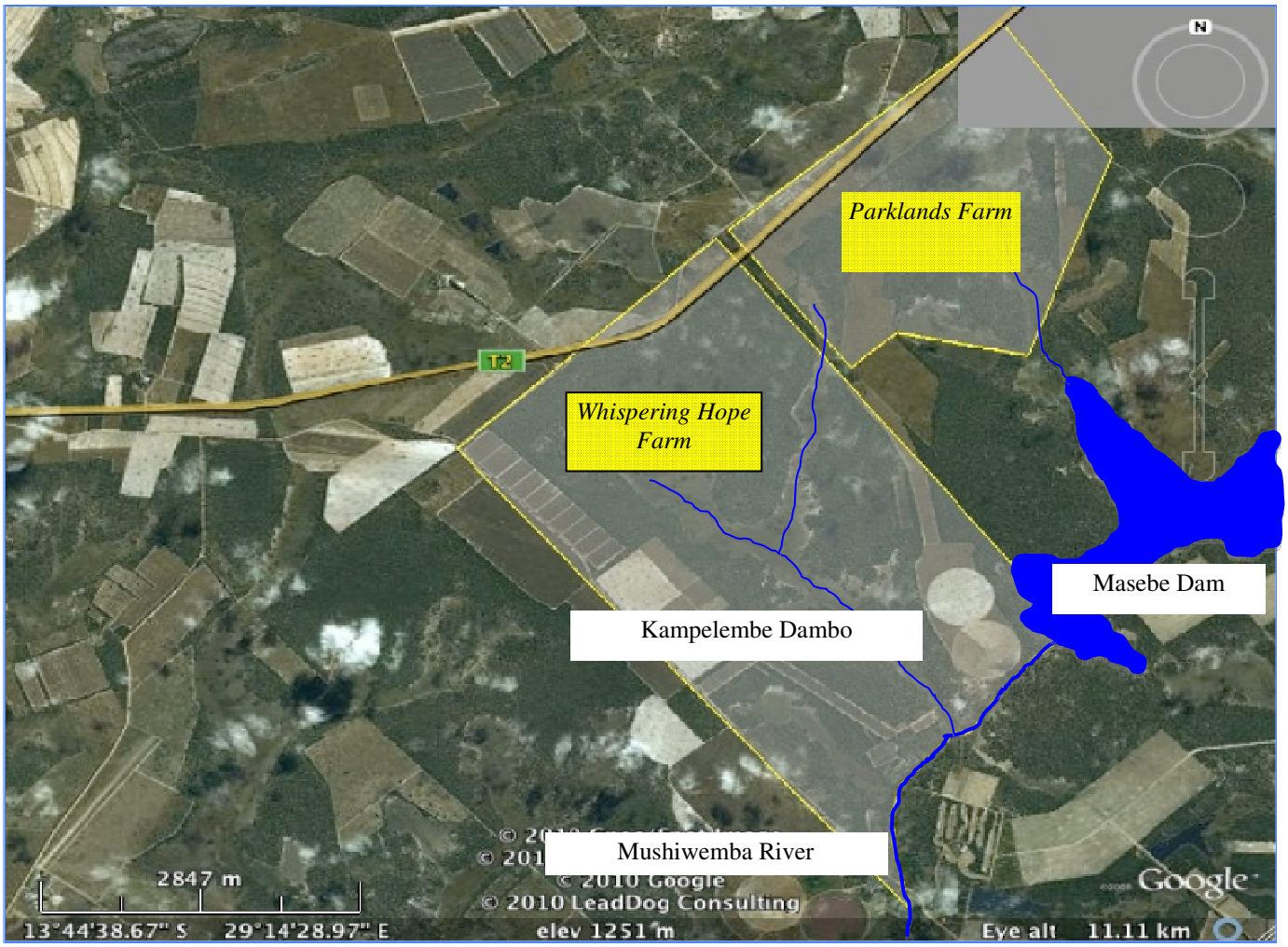
4.2 PHYSICAL ENVIRONMENT

LOCATION

The location of the proposed dam project is in Mkushi farm block in Mkushi district Central Province of Zambia. Mkushi district is about 293 km away from the capital city Lusaka. The dam site is on the Munshiwemba River one of the numerous tributaries of the Lunsemfwa River.

The location map given in figure 4.1 show the location of the project site in relation to other features in the area. These include bridges, roads, farms as well as the mines . From the figure it can be observed that the existing main road and bridge that leads to other farms and Mkushi Country Club will not be affected by the construction of the dam.

Figure4.1: Location of Whispering Hope Farm and Parklands Farm



CLIMATE

Munshiwemba Catchment lies in agro ecological region IIa where annual rainfall ranges from 800-100mm. Munshiwemba and surrounding areas, receives 1105mm as annual rainfall which slightly exceeds the range for the agro ecological region IIa. This amount is received over an average period of 103 days. Rainfall pattern in this area is similar to rest of the country in that the wettest months are December and January. The average monthly rainfall in these months is 260 and 270mm respectively (JICA, 1995).

TEMPERATURE

Temperatures in this area do not deviate significantly from the national average. Minimum temperature is 7.5ºC experienced in the month of July and maximum

being 30.3ºC in October. Annual evapotranspiration is estimated as 818mm in comparison to the potential of 1538mm. Considering annual rainfall received in this area, potential evapotranspiration is high. Therefore as is the case with many parts of the country, Munshiwemba is in a hydrological condition of precipitation deficit (JICA, 1995).

WIND

Field surveys revealed that prevailing winds are predominantly towards South – west in the area. The average annual speed in Mkushi is around 1.7 m/s reaching its maximum of 2.1 – 2.2 m/s during the month of August to October. The monthly minimum wind speed measured from January to February ranges between 1.1 and 1.2m/s.

TOPOGRAPHY

The topography of the area surrounding the Mkushi farming block is characterized by an eroded mountain chain forming long ridges mountain east to west and some flat land mostly used for farming with depressions and banks along the Munshiwemba River. This undulating plateau has an altitude of about 1300m above sea level.

The terrain for the project site was observed to be mainly gently undulating and flat plateau with isolated hills and low ranges forming gently sloping valleys. Valley slopes average 2° to 5°. The area is drained by small seasonal or semi-perennial streamlines and headwater dambos. The plateau is abruptly broken by a steep linear escarpment running in a North East to South West direction. The area has an average elevation of about 1300m above sea level.

AIR QUALITY

An assessment of the baseline air quality status in the project area and surroundings is essential and primary requirement for assessing the impacts on the air particularly for projects which might release pollutants to the ambient air. In case of Munshiwemba Catchment grassland and forest fires during dry season and

charcoal burning generate smoke and dust. This air pollution hangs over the area and forms a distinctive haze especially during coolest months when temperature inversions tend to trap the smoke near the ground. Based on visual assessment, the air quality in the area was generally found to be good. This can be attributed to nature of economic activities in the area mainly agricultural activities.

GEOLOGY

The geology of Central Province comprises various rocks dating from thousands years ago. These rock formations consist of igneous, sedimentary and metamorphic rocks. With regard to Mkushi area, the geological setting comprises of Precambrian Pre-Katanga and Basement Complex rocks (gneiss, migmatite, and granite).

Red white quartzite is found north of the great North Road together with intrusion of dolerite and gabbro white gneisses and granites are found in the South. In terms of Agriculture, the gneisses and granites are important because the light sandy soils derived from them are ideal for tobacco growing. It was observed during field surveys that these are the dominant soils utilised by commercial farmers in the Mkushi Block. Schist's is found in an extensive area north of the Central Province with a red heavy soil suitable for maize and the dolerites very fertile red soil on which peasant farmers depend. For details see figure 4.2 showing the geological map of Zambia.

The regional geology of Mkushi Farming Block is dominated by a sequence of granite gneiss and highly metamorphosed schist's and quartzite of the pre – Katanga formation. Some other granites of unknown age can also be found. The basement gneisses and schist are over lain by quartzite's – pelite – schist sequences. Around this area of Mkushi basement domes are restricting the meta-sediment sequence.

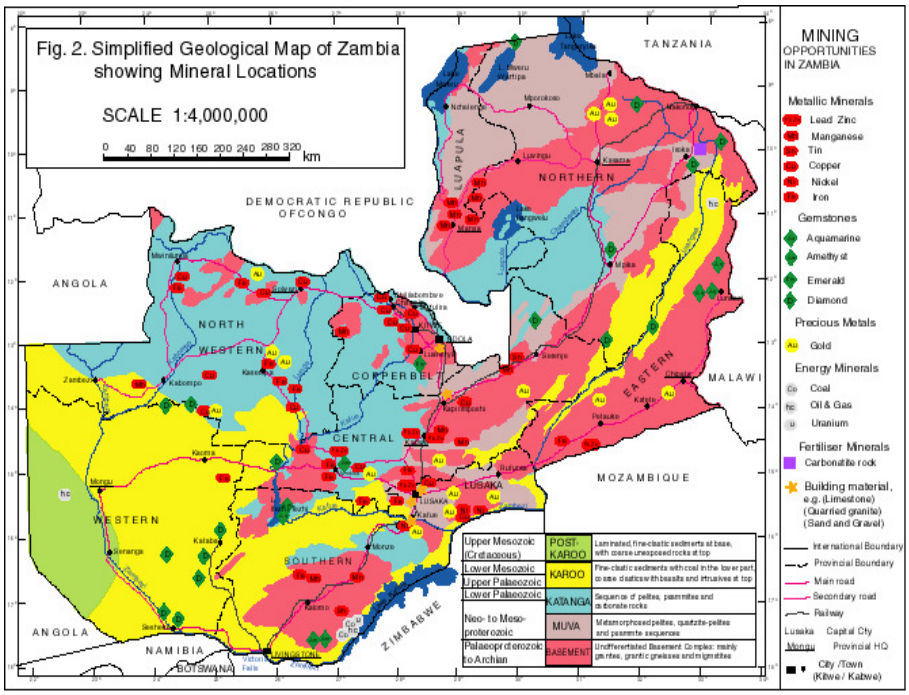


Figure 4.2: Map showing the general geological layout of Zambia.

The meta-sediment dips steeply towards the south and southeast. The sediment sequence is stapled along east - north - east to west – south – west striking thrusts. Younger faults strike north to south and North West to south – east. The gneisses and schist's are deeply weathered whereas the quartzites are more resistant against chemical weathering and thus forming the dominant relief for example the Masebe and Mwansa Chawa Hills.

SOILS

Soil forming factors and processes operating in Zambia are quite varied and complex. Correspondingly, the resulting soils types and their distribution in the country are equally very varied. The major trends in soil properties across the country roughly follow the three main rainfall belts, also referred to as the agro-ecological zones of Zambia. These are;

AGRO-ECOLOGICAL ZONE THREE

This is often referred to as the high rainfall region of Zambia. This zone covers the northern part of the country, including the whole of the North Western, Copperbelt, and Luapula, most of the Northern and parts of the Central Provinces. This zone,

therefore, experiences the highest moisture availability in the country. Relatively high temperatures and high rainfalls have produced an environment conducive for intensive chemical weathering of parent materials.

Soils in this zone therefore tend to be highly weathered and very strongly leached of basic cations such as calcium, magnesium, potassium and sodium. A combination of the fact that this zone is dominated by acidic rocks that are inherently low in plant nutrient, and the leaching of basic cations has produced soils that are generally very strongly acidic and low in nutrient content and nutrient retention capacities. Furthermore, the acidic soils conditions include solubilization of aluminium, from various soil compounds and complexes. The solubilized aluminium remains in the soil solution and is toxic to many plants. In this state, the aluminium also complexes other plant nutrients such as phosphorous (p) and make them unavailable for plant uptake.

Due to a relatively high moisture availability and conducive temperature, rates of organic matter decomposition are also high. Thus under cultivation, these soils have relatively high risks of biological soil degradation and if not replenished, organic matter content quickly declines.

AGRO-ECOLOGICAL ZONE TWO

Also known as the medium rainfall region of Zambia, this zone covers the middle parts of the country, including most of the Western, Central, Luapula, Eastern and the plateau parts of Southern province. This zone is characterized by annual rainfalls of 800-1000mm.

As in agro-ecological zone three, this zone is dominated by acidic rocks that are inherently low in basic cations. Although temperatures are high, soils are generally only moderately weathered due to relatively less rainfall and somewhat more limited moisture availability compared to the northern parts of the country, these soils have a high risk of biological degradation.

Agro-Ecological Zone One

This zone is often referred to as the low rainfall region of Zambia. This is mostly in the southern parts of the country, covering the Zambezi, Luano-Lusemfwa and Luangwa rift valleys. In these valleys, annual rainfall is less than 800mm. This zone is dominated by the Karoo-sedimentary deposits, particularly the calcareous madumambisa mudstones.

Due to limited moisture availability, soils in this zone are generally less weathered, neutral to alkaline or sometimes even strongly alkaline. The content of basic cation is generally high. However, because of the commonly high contents of exchangeable sodium a significant proportion of soils in these valleys are sodic.

An analysis of the three ecological zones of Zambia shows that the project site shares characteristics of agro-ecological zones two and three. Therefore soils in this area are generally, highly weathered, strongly acidic commonly with high aluminium content. These soils are often with toxic levels of exchangeable aluminium. The high amounts of exchangeable aluminium may act as firm barrier to deep rooting of the plants, leading to physiological drought of crops at dry spells within the rainy season. Under this circumstance there is a high fixation rate of phosphorus such that lime has to be added for crop production. In other instances, soils are acid (average pH of 4.7, but still moderately fertile (average cation exchange capacity of 5.4, ranging between 3.3 and 7.3emol/kg), but there are high levels of Iron on localised areas in the upper soils profile.

Furthermore, the soils are generally very low in organic matter. However, in other instances, soils are generally only moderately weathered. During field surveys, soils in the area were observed to include gravel clays, sandy clay and clay loam particularly towards the river bed.

HYDROLOGY AND WATER RESOURCES POTENTIAL

Munshiwemba River is 66km in length from the source to the confluence with Lunsemfwa River and it drains a catchment area of 996 km^2

The average elevation of the catchment is 1300m amsl (figure 2). The headwaters of the river are on the hills, 1400m amsl on the south eastern part of Mkushi town.

From the headwaters to the mouth the river falls to 1125m amsl. Therefore the slope of Munshiwemba River is 4.2m/km. This is a relatively a gentle slope considering the length of the entire Munshiwemba River.

Munshiwemba River is a perennial tributary to the Lunsemfwa. Flow records on Munshiwemba are not available. Lunsemfwa on the other hand is gauged and has an estimated catchment yield of 5,240Mm^3. Based on catchment characteristics, rainfall and runoff, Munshiwemba catchment whose catchment is 996 km^2 contributes 200Mm^3 as its catchment yield. See figure 4.3 below.

The proposed site for the construction of the intermediate dam is located within the Chobe property . It is about 20m upstream of the bridge on the road to Mkushi Country Club (Figure4.3). Upstream of the site is Masebe Dam and on the downstream reach is the Ishiba Dam. The embankment of the proposed dam shall be 11.5m and is estimated to hold 3.5Mm^3 of water. The intended use of the water is primarily crop irrigation.

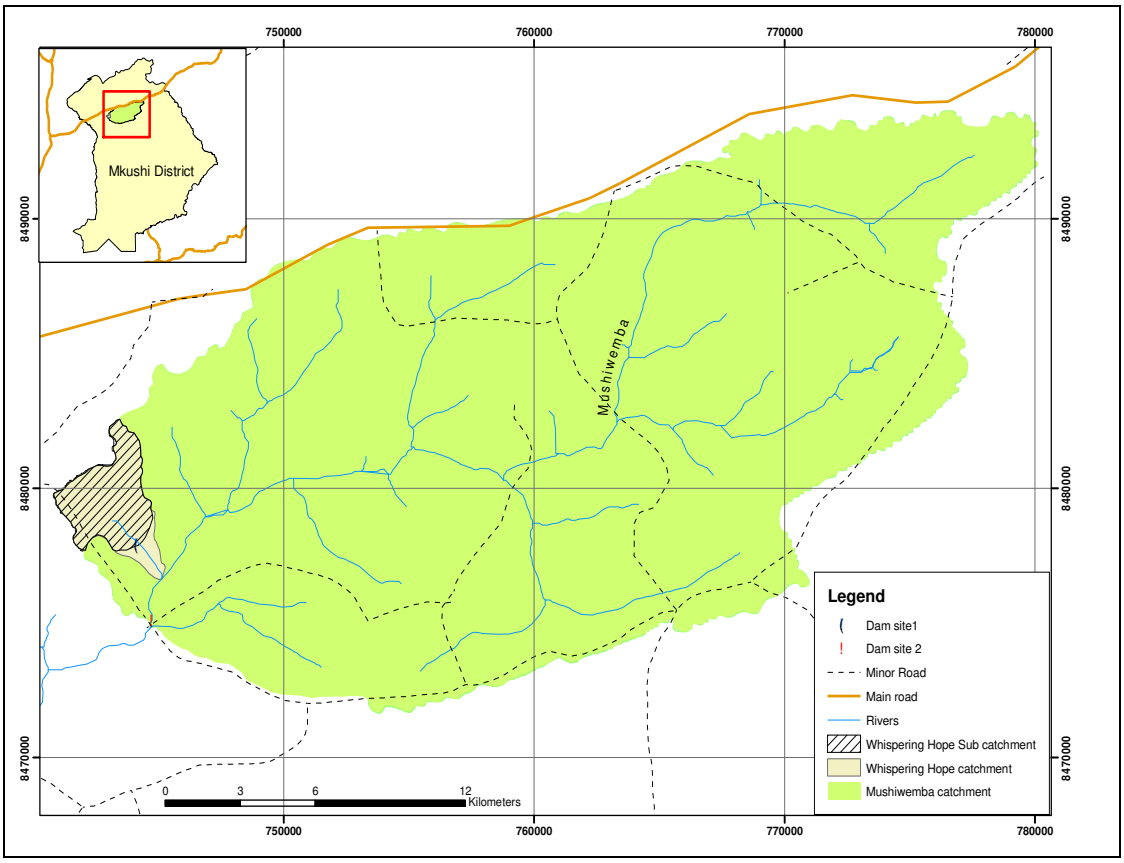


Figure 4.3: Location of dam sites and extent of Munshiwemba River catchment

WATER POTENTIAL AND CATCHMENT YIELD OF MUNSHIWEMBA CATCHMENT

Munshiwemba River is a perennial tributary to the Lunsemfwa River. Its main tributary joining from the eastern side is Tembwe River. Both Munshiwemba and Tembwe Rivers do have flow records. Lunsemfwa River, which is the main catchment, is gauged and has an estimated catchment yield of 5,240Mm^3. Since Munshiwemba is a sub-catchment of Lunsemfwa, its catchment characteristics are similar in terms of geomorphology, climatic conditions and land use. In this case the estimation of catchment yield for Munshiwemba relative to the main catchment is based on the Hot-Deck infilling gap method. This method has been widely used in estimating flows in ungauged basins as shown in equation below.

Estimated Flow (X) = (Measured Flow)(Drainage Area (A)/Drainage Area (B)*

Where X= Estimated flow (m^3/sec) of the ungauged stream

A= Area (km^2) of the ungauged stream

B= Area (km^2) of the gauged stream

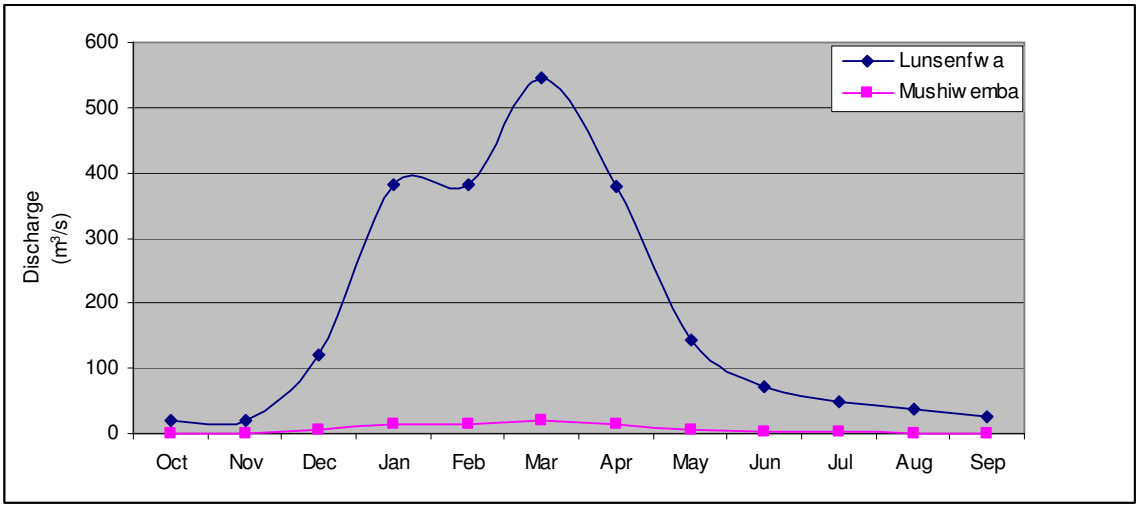


Figure 4.4: Comparative annual flow on Lunsemfwa and Munshiwemba

Figure 4.4 indicates the monthly mean discharge pattern of the Munshiwemba relative to the gauged Lunsemfwa Catchment using the infilling method. This is based on a 30 year period data (JICA, 1995). The mean monthly discharge on Munshiwemba is therefore 0.73m^3/s and this occurs in the months of September and October while the highest is during the month of March in the order of 20m^3/s.

With regards to the annual mean minimum discharge, the derived flow duration curve shows that the minimum flow on Munshiwemba is 0.51 m^3/s. In comparison to the measure discharge in the month of September 2011, this can be as low as 0.22m^3/s.

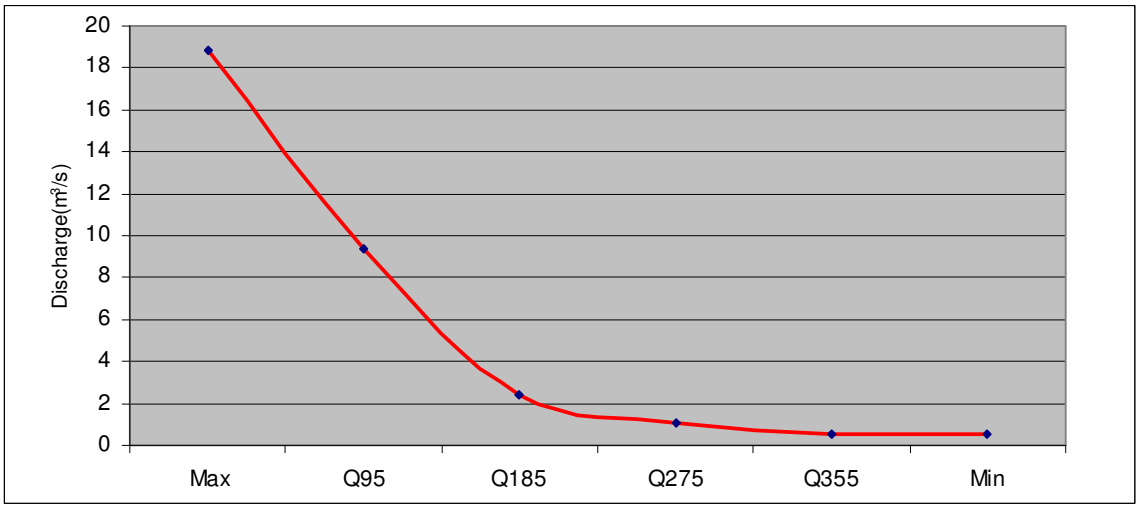


Figure 4.5: Flow regime showing the highest and minimum discharge on Munshiwemba(JICA,1995)

Based on the known catchment yield of the Lunsemfwa, Munshiwemba catchment whose catchment is 996 km^2 contributes 200Mm^3 as its catchment yield. Up to the proposed dam site, the catchment area from the source of Munshiwemba is 513 km^2. This is 51.5% of the entire Munshiwemba catchment. In terms of catchment yield, this translates to 103.2Mm^3. Figure 4.3 shows the extent of the Munshiwemba Sub-catchment and location of the dam site.

EXISTING AND PROPOSED DAM SITES

There are 12 existing dams (See Annex 14). All these are upstream of the proposed dam sites for Chobe Farm. The total storage at full supply is 55.73Mm^3 (table 1). All the dams thus receive 54% of the estimated 103Mm^3 yield. The two proposed dam sites Whispering Hope (0.897Mm^3) and Intermediate (3.5Mm^3) have a total storage of 4.4Mm^3 are therefore expected to receive 47.3Mm^3 of the entire catchment yield.

Downstream of the proposed sites there are 8 dams whose total storage at full supply is 24.66Mm^3. The construction of the two dams is therefore expected to take up only 9 percent of the 47.3Mm^3. Therefore 42.9Mm^3 is meant for the downstream

storage and demand of 24.66 Mm^3. Considering the prevailing rainfall pattern in the catchment it is expected that the proposed construction of the two dams will not have significant impact on the existing dams downstream.

GROUNDWATER POTENTIAL

According to the Water Resources Master Plan (JICA, 1995), annual groundwater potential is estimated as 8% of annual rainfall. Groundwater recharge is therefore 73mm per annum. This estimate is for the entire Mkushi District. Therefore based on the extent of Mkushi District (22,395km^2) groundwater potential is 1.6 x 10^9m^3/annum. Furthermore annual base flow in the rainy season is equivalent to 0.294 x 10^9m^3 (JICA, 1995). Overall, the Munshiwemba Sub-catchment has a reasonably high potential for groundwater which contributes to the overall potential of surface water.

RIVER FLOW CHARACTERISTICS AT PROPOSED DAM SITE

Consistent historical Hydrological data for Munshiwemba River is scanty due to the absence of a gauging station on the river. According to records obtained from Department of Water Affairs, there is no gauging station is located on Munshiwemba River except those in proximity on Lunsemfwa River. However, discharge measurements were conducted on 10th September 2011 at two points about 100m upstream and 120m downstream of the dam site respectively during the study to establish the base flow. A summary of the results after analysis are shown in table 4.1 below.

Table 4.1: Discharge Measurement Results

Point A		**Point B**	
Total Discharge per second	Total Discharge per Day	Total Discharge per second	Total Discharge per Day
0.218m^3/s	**18,835.74m^3/d**	**0.220m^3/s**	**19.037.71m^3/d**

An analysis of the results above shows that discharge at point B upstream was less by 0.002m^3/s compared to discharge at point A.

MUNSHIWEMBA CATCHMENT CHARACTERISTICS

Munshiwemba River catchment lies between latitudes -13.58864E and -13.95627E and longitudes 29.1233 S and 29.59029 S on the upper part of the Lunsemfwa main catchment. Munshiwemba River is 66km in length from the source to the confluence with Lunsemfwa River and it drains a catchment area of 996 km^2.

The average elevation of the catchment is 1300m asl (figure 1). The headwaters of the river are on the hills, 1400m asl on the northern part of Mkushi district. From the headwaters to the mouth the river falls to 1125m asl. Therefore the slope of Munshiwemba River is 4.2m/km. This is a relatively a gentle slope considering the length of the entire Munshiwemba River (See figure 4.6).

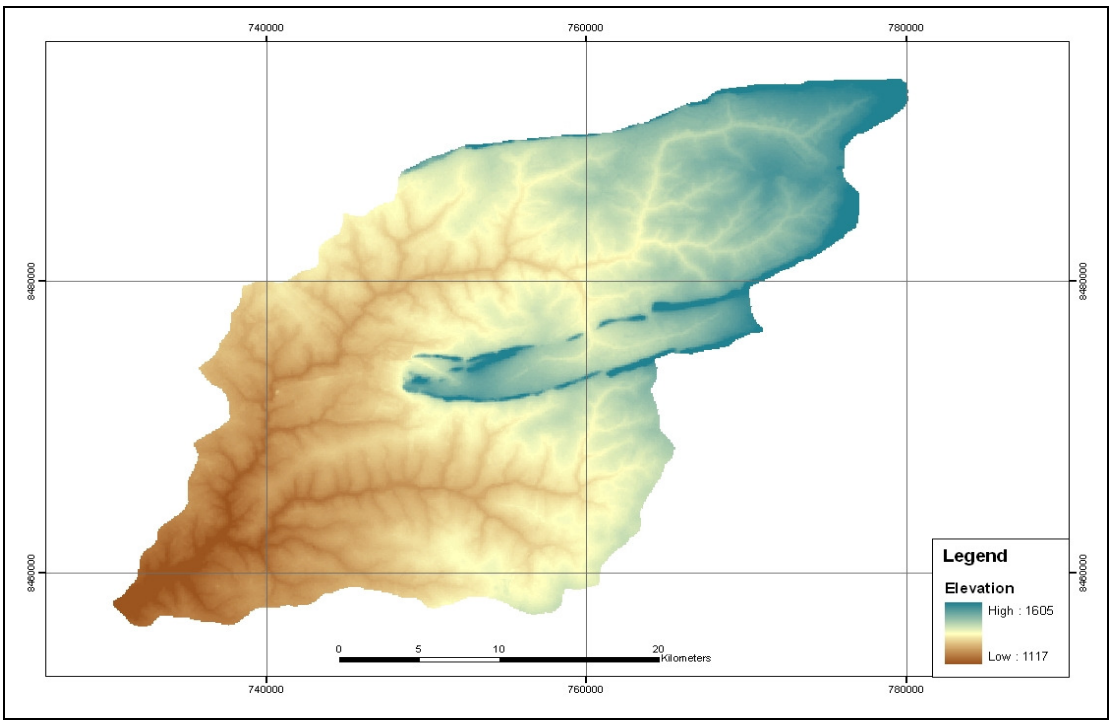


Fig 4.6: Elevation of the Munshiwemba catchment (derived from Digital Elevation Model)

WATER RESOURCES QUALITY

Like hydrological data, no reliable consistent water quality data is available for Munshiwemba River. Field surveys indicated that no significant pollutant sources are known in the area except from agricultural activities. The use of chemical fertilizers, herbicides and pesticides is likely to have an impact on the water resources in Mkushi Farming Block.

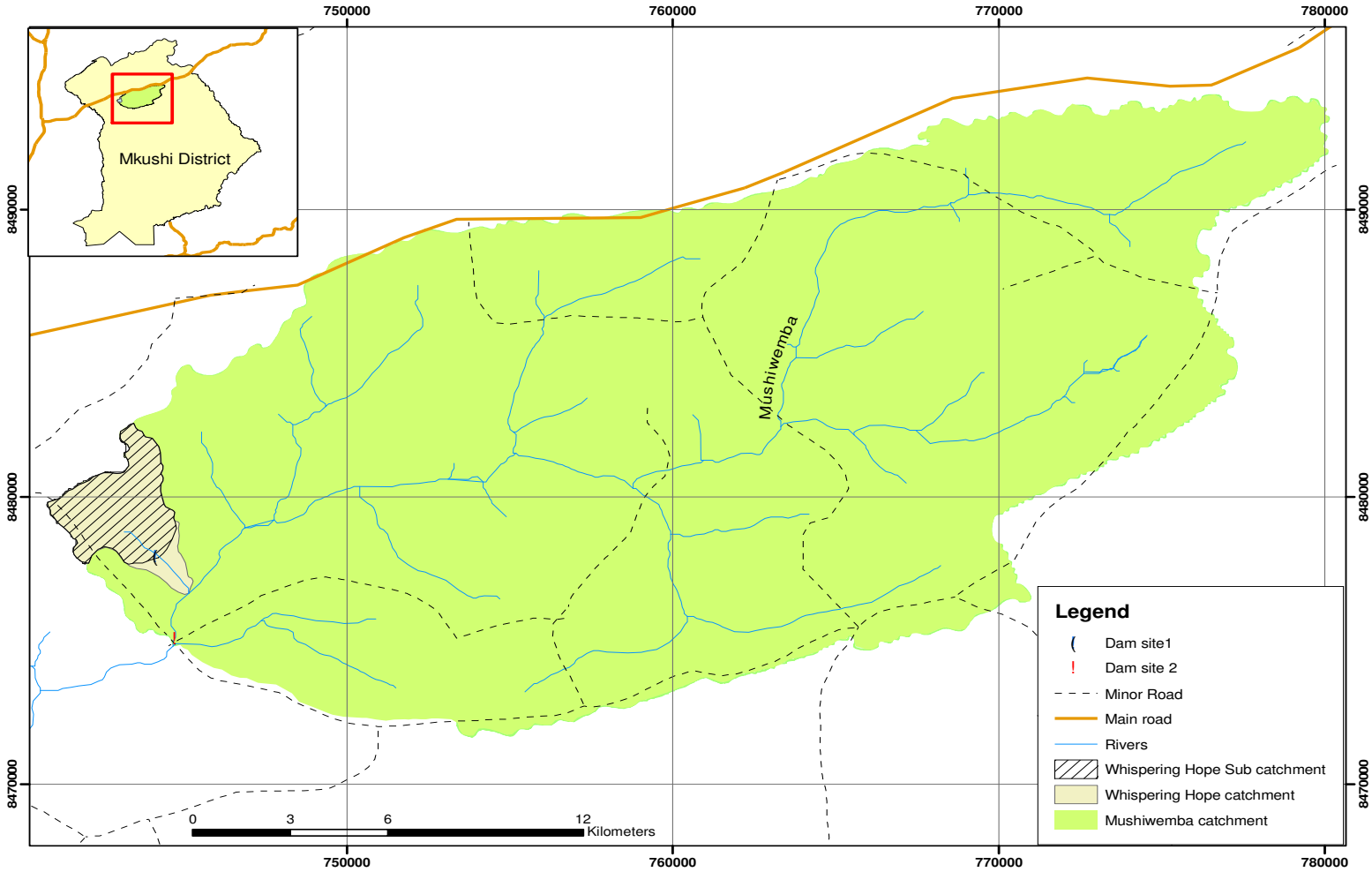
For baseline surface water quality, water samples were collected by the technicians during site visits to establish the surface water quality. The aim was to have baseline information on the quality data of water prior to project development. Sampling was carried out in accordance with WHO accepted procedures for the collection of surface water quality samples Full suite chemical and physical analyses were performed on samples and analysed by Department of Water Affairs Laboratory in Lusaka. Parameters analysed included; pH, Conductivity and Total dissolved Solids (TDS), etc.

According to Zambian and WHO drinking water standards the results obtained showed that the surface water in Munshiwemba River is of good quality for parameters analysed. This is also in agreement with other studies done in the area during other feasibility studies. This can be attributed to dilution effect considering that the catchment has on average good annual rainfall. For a summary of results see Table 4.4 below.

Table 4.2: Surface Water Quality Results

Parameter	Unit (Mg/l)	WHO Max. Permissible Value
Calcium	4	-
Magnesium	5.8	0.05
Total Dissolved Solids	10	1000
pH	7.1	6.5-8.5
Sodium	5.1	200
Potassium	2.5	200
Total Hardness	34	500
Chloride	15	-
Sulphate	4.5	250

Figure 4.7: Map showing Munshiwemba Catchment areas



4.3 BIOLOGICAL ENVIRONMENT

Zambia's forest resources are habitat to various types of flora and fauna species estimated at 228 mammals, 740 birds, 156 fresh water fish, 152 reptiles and 83 amphibians. Plant genetic diversity is about 600 – 700 species. About 5000 species are flowering plants, 88 mosses, 130 ferns, 390 orchids, 630 grasses, 2000 herbs and 2300 trees and shrubs. More are still to be discovered and described.

Flora and fauna on the Munshiwemba River catchment and its immediate surrounding environment was surveyed. A total of 11 Count Quadrant plots each of approximately 100m^2 were systematically established on site. Four quadrants were established on either side of the stream and another one about 40m downstream the proposed dam wall. The dam location (S13^0 46' 59.8'', E029^0 15' 51.4'') and the end of the estimated throw back distance about 2.7km from the dam location were also sampled. These quadrants were approximately equidistant apart and alternated in arrangement between those near the stream and those about 30m away from the stream. A combination of the quadrants and belt transects enabled the team to capture the necessary information and adequately cover the site. Data collected was used to estimate frequencies and abundance of tree species within the proposed dam development area. Information about the activities in the study area was obtained through observations, interviewing of both locals and key informants. Secondary data was obtained through the use of appropriate maps and relevant literature. Materials used included geographic positioning system (GPS), digital camera, and data sheets.

FLORA

The vegetation on the proposed dam development site area and its vicinity is typically miombo woodland. Large and older trees and relatively medium sized and slightly, the dominant trees were relatively young. There were also large patches of grassland ecosystem on the dam site.

(i) MIOMBO WOODLANDS

Miombo Woodland on Plateau

This is the characteristic vegetation of the Mkushi block. This vegetation type covers some 80% of the country. The term 'Miombo' is derived from the plural of 'Muombo' the Bemba name *for Brachystegia longifolia* one of the common dormant species in these woodlands. This plateau Miombo Woodland has an open and semi-evergreen canopy of about 15– 20m.

The storey is covered by dormant Miombo species of *brachystegia, Isoberlina, Julbernadia, Albizia, Syzygium, Baphia, Vitex, Uapaka, pericorpsis, combretum* and with a few relics of *Pterocarpus angolensis.* The sparse, under storey is dominated by *Anisophyllea, Baphia*, Monotes species and uapaka. Common shrubs found in the area included *Dichrostachys cinera, Diploryhnchus condoylocarpon, Flucourtia indica, Bauchina Pefersiana* and *odina pulchra*.

Miombo Woodland on Hills.

Hill Miombo woodland was found to occur on steep slopes of the Mwansa Chawa and Masebe hills within the vicinity of the project area. Others occur on small unnamed hills. Miombo woodland merges into hill Miombo as the soils get shallower or rockier.

The role miombo woodlands play cannot be under estimated. Some of the benefits gotten from the rich diverse Miombo woodlands are outlined below:

- Cattle And Wildlife Browsing In The Miombo

Although cattle and wildlife animals can eat fallen leaves, especially during the dry season when grazing is poor, they prefer to eat fresh leaves directly from trees. Such dry season browsing can to some extent, be found in Miombo forests. The Miombo, which is one of the most extensive vegetation communities in Zambia, is dominated by leguminous *Brachystegia* and *Julbernadias* as earlier alluded too. The trees are mainly deciduous and form a light canopy averaging 10-15m high, and as a result this type of woodland is not ideal in its natural state for browsing.

However, Miombo does come into leaf about 2 months before the beginning of the rains and because most of the trees are legumes, the young leaves tend to have a fairly high crude protein content. Miombo is a source of readily made natural cattle and wildlife feed, and could be of great value to farmers, especially when stocking feed is in short supply. Considering the lifestyle of the local community, these characteristics of Miombo eco-region could have offered immerse benefits to the people particularly that a good number of people are in animal husbandly. However, deforestation has limited this benefit.

- Caterpillar Collections in the Miombo

Several different types of caterpillars, some of which are yet to be identified, are of increasing socio-economic importance among local people in the Miombo woodland. The common edible caterpillars in Zambia and central province in particular are *the saturinidae Gonimbrasia belina* (Westwood), *Gonimbrasia zambesiana Walker, Gynanisa maja strand, Imbrasia epimethea Druly and Cirina forda*. In Zambia, the caterpillars feed on over 20 tree species of the Miombo, but their preferred hosts include the *Julbernadia paniculata*. Some of the Miombo species on which edible caterpillars breed on are *Anisophyllea boehmii, Parinari curatellifolia, Syzygium guineense, Uapaka kirkiana, Brachystegia floribunda, Brachystegia utilis, Albizia antunesiana, Isoberlina angolensis and Erythrophloem africanum*. Nonetheless collection of caterpillars in the project area has diminished over the years due to deforestation. As such this activity is of little significance.

- Fruit Collection in the Miombo

The Miombo woodland produces a variety of edible fruits, and they contribute enormously to the nutrition and economic well-being of many people. These fruits can be collected or gathered either for domestic or commercial use. At certain times of the year, particularly towards the end of the dry season, many Miombo tree species are covered with fruits. Some of these fruits are in the form of small hard nuts and a large number of trees bear dry fibrous pods.

There is also quite good variety of juicy, edible fruit. Unfortunately people, except those who live in the rural areas, do not take full advantage of the wealth of fruits available in the Miombo forest. A few local fruits like Mupundu and Musuku are sold

seasonally in the markets or the big towns but preference is ever growing for exotic fruits expensive to buy. Besides, there is possibility of danger to health due to wide usage of insecticides and growth promoters for exotic fruits.

The fruits of the Miombo forests are safe as regards artificial poisons though some contain natural toxic ingredients and therefore must be avoided. Many fruits, though edible are not particularly palatable; some don't look very appetizing, and others are too small to be worthwhile gathering. But despite all these there are many trees bearing tasty, edible and nutritious fruits, which are perfectly safe. Not only can they be picked and eaten raw, but most can be made into jams or dried for future use. Like the issue of caterpillar collection, there is not much wild fruit collection due to deforestation and agriculture activities in this area.

➢ Beekeeping in the Miombo

Beekeeping is the practice of rearing bees for the purpose of honey and beeswax production or for pollination of crops. This practice thrives well in the Miombo woodland around Mkushi and Kapiri Mposhi. The Miombo woodland species that enhances or promotes beekeeping are *Brachystegia, Julbernadia, Cryptosepalum, Mrquesia, Erthrina, Syzygium* and many more flowering plants. These provide foliage for honey bee called *Apis melifolia*. In 1992 national level production potential of honey was estimated at 5000 metric tons per year. During the field surveys, it was observed that two households within the project area were involved in bee keeping for supply to urban markets.

Some other benefits of beekeeping include:

- Bees seek flowers from where they collect nectar and pollen. In so doing, the bees pollinate plants resulting in good fruit and seed production.
- In collecting pollen and nectar, bees utilize a natural resource, which would otherwise remain unexploited. The pollen and nectar are converted into products that are useful to human beings.
- Beekeeping does not take up valuable land. Hives are placed in trees and on wasteland rendering the activity attractive and feasible even for landless people.
- The sale of beekeeping products (beeswax, honey and honey beer) provides additional income for both men and women in rural and peri urban areas.

- Honey is consumed at times as medicine or tonic. Honey has been found to have some anti-biotic activity due to its high sugar concentration which prevents growth of micro-organisms, the enzymes present in honey produce bactericidal hydrogen peroxide and it is highly acidic. There is high demand for honey by those suffering from hypertension.
- In industrialized countries, honey is regarded as a health-giving, luxury food whose consumption increases with the rise in standard of living. There is therefore a good export market for locally produced honey.
- Once harvested, honey does not require further processing. It is a stable commodity with a long shelf life.

➢ Medicinal and Cosmetic

Due to the immense biological diversity of the Miombo species, a lot of different species have been found to have some medicinal properties and have been used in local communities since time immemorial. About 25% of all prescription drugs in the world with an estimated value of US 43 billion dollars per year come from plants. The World Health Organisation (WHO) defines medicines as "the sum total of all knowledge and practices used in the diagnosis, prevention and elimination of physical or social imbalances' and relying exclusively on practical experience and observation handed down from generation to generation whether verbally or in writing".

The reliance of people on the Miombo forests that have medicinal and cosmetic usage in Zambia cannot be over emphasized. The role of traditional practitioners and dealers in herbal medications is central in prescribing and dispensing herbal medications. In rural and peri-urban Zambia, modern medical facilities are limited and even when available; medicines are usually out of stock or expensive. So the local people mainly depend on forest plants and traditional medicines for most of their medical problems.

It has been documented in Zambia that many people who seek modern medical care also consult and apply traditional medicines before, during or after modern consultation. Modern medical services do not reach many rural and peri-urban areas. Even in places where some form of medical care reaches the population; there has been disappointment with the poor quality of care offered. These factors

put traditional medical practice at an advantage; it is practically accessible and cheap.

Examples of plants with medicinal purposes are: *Phytolacca dodecandra* plant growing near sources of streams, rivers, lakes is effective in controlling malaria, Rosy periwinkle, which is used to treat Leukemia and increases a child's chance of survival up to 80% and others include *Albizia antunesiana, Combretum molle, Dichrostachys cinerea, Diploryhnchus condylocarpon, Pterocarpus angolensis, Strychnos species, Syzygium cordatum* and many more Miombo species.

- Mushrooms in the Miombo

Most Miombo woodland has abundant and diverse mushroom populations. During the rains, the Miombo woodlands in Zambia yield between 15 and 25 species of edible mushrooms. These are an important source of food in rural areas particularly before the first crops mature. One of the species is *Chanterelle (Chantharellus*), which has export potential, especially in Europe, due to its seasonal availability. Field surveys revealed that in the past prior to deforestation in the area, mushroom contributed significantly to people's livelihood. However this is no longer the case.

- Watershed Management

Forests play a protective role to watersheds by ensuring a sustained flow of water from catchments throughout the year and preventing soil erosion and drift-sand formation in coastal and inland areas. Rivers originate from mountains areas covered by forest vegetation. The presence of vegetation enables the falling precipitation to be absorbed, infiltrated and stored in the soil. The water is subsequently released slowly. Loss of vegetation cover, on the other hand, exposes the soil to raindrop impact and excessive runoff, causing erosion and flooding and consequently, loss of land and water resources.

From the sampling procedure, 41 tree species were recorded as shown in Table below. The focus was on the frequency and abundance/density of the trees on the site. According to Shukla and Chandel (2000), frequency refers to the degree of dispersion in terms of percentage occurrence. Therefore, poorly dispersed species will occur only in a few quadrants and their frequency will be low and conversely, the higher the frequency value of a species in the area the greater will be the

uniformity in the spread. The abundance (density of population in those quadrants in which a given species occurs) of the species was calculated and assigned to abundance classes such as Rare (1 – 4); Occasional (5 – 14); Frequent (15 – 29); Abundant (30 – 90) and Very Abundant (100+) per square meter quadrant.

Data gathered from 11 quadrants of approximately 100m^2 in area revealed that the most dominant tree species on site were the *Julbernadia, Brachystegia* and *Parinari curatelifolia* with over 80% frequency. Other species with frequencies of between 50% and 80% were *Bauhinia petersiana, Diplorynchus condylocarpon and Syzygium spp.* A total of 41 different species were recorded from the established quadrants as listed in Table below. However, it should also be mentioned that these are not the only tree species on site as some species may not have been captured with the established quadrants.

Figure4.5: Vegetation Type on the Munshiwemba Project Site. Top left: Cross-section for location of proposed dam wall. Top right: Portion of dam site showing the young trees that were dominant on site. Bottom left: Portion of dam site showing grass as the dominant species. Bottom right: Approximate end of dam site.

Nonetheless, from the calculated abundance and classes of species, it can be concluded that the abundance of species on the site is low as only of rare and 4

occasional abundance classes were recorded on an area of approximately 0.16Km^2 that was being considered. The grasses included *Hyparrhenia spp. Eleusine indica*, *Andropogon spp* and *Phragmites* and there were few herbaceous plants. See table 4.3.

Table 4.3: Sampled Tree Species on Study Site Showing Frequency, Abundance and Abundance Class.

No.	Species	Frequency	Abundance/ Density	Abundance Class
1	*Accacia polyacantha*	27%	2.33	Rare
2	*Accacia tortilis*	18%	1.00	Rare
3	*Afzelia quanzensis*	18%	1.00	Rare
4	*Aloe spp.*	9%	13.00	Occasional
5	*Anisophyllea pomifera*	9%	1.00	Rare
6	*Azanza garckeana*	27%	1.67	Rare
7	*Bauhinia petersiana*	55%	3.50	Rare
8	*Bobgunia (Swartzia) madagascariensis*	45%	4.20	Occasional
9	*Brachystegia boemhii*	82%	3.11	Rare
10	*Brachystegia bussei*	45%	3.40	Rare
11	*Brachystegia longifolia*	45%	2.80	Rare
12	*Brachystegia microphylla*	18%	1.00	Rare
13	*Brachystegia stipulate*	9%	1.00	Rare
14	*Brachystegia utillis*	18%	1.50	Rare
15	*Cassia abbreviate*	9%	1.00	Rare
16	*Combretum zeyheri*	18%	1.50	Rare
17	*Cryptosepalum maraviense*	18%	1.00	Rare
18	*Dalbergiella nyasae*	18%	1.00	Rare
19	*Diplorynchus condylocarpon*	55%	1.00	Rare
20	*Erythrophleum africanun*	18%	1.50	Rare
21	*Julbernadia globiflora*	82%	4.00	Rare
22	*Julbernadia paniculata*	91%	4.30	Occasional
23	*Parinari curatelifolia*	82%	4.56	Occasional
24	*Pericopsis angolensis*	36%	2.00	Rare
25	*Piliostigma thonningii*	27%	2.33	Rare
26	*Protea gaguedi*	27%	1.00	Rare
27	*Protea welwitschii*	18%	1.00	Rare

No.	Species	Frequency	Abundance/ Density	Abundance Class
28	*Pseudolachnostylis maprouneifolia*	18%	1.50	Rare
29	*Pterocarpus angolensis*	36%	3.00	Rare
30	*Schrebera trichoclada*	9%	1.00	Rare
31	*Securidaca longepedunculata*	27%	1.33	Rare
32	*Strychnos cocculoides*	9%	1.00	Rare
33	*Strychnos innocua*	18%	1.00	Rare
34	*Strychnos potatorum*	9%	1.00	Rare
35	*Strychnos spinosa*	18%	1.00	Rare
36	*Syzygium cordatum*	55%	3.33	Rare
37	*Syzygium guinense*	45%	1.20	Rare
38	*Terminalia sericea*	18%	1.00	Rare
39	*Uappaca kirkiana*	27%	1.00	Rare
40	*Uappaca nitida*	27%	1.67	Rare
41	*Uappaca sansibarica*	9%	1.00	Rare

FAUNA

No big mammals were reported or observed within Munshiwemba Catchment area. Clearing of woodlands in the area to create farmland and settlements has over the years affected the project area and surrounding areas. These activities coupled with increased human presence in the past led to increased poaching activities within the area, loss of breeding sites, disruption of wildlife corridors, and destruction of woodland habitats late fires for hunting and shifting cultivation by local people. Illegal hunting using wire and log traps and hunting dogs was reported to be the main cause of wildlife depletion in the area. Overall, the field surveys reviewed that there are no endangered species at site and all the reported species are of least concern according to IUCN list for endangered species.

According to Harrison Tomato, the field guide who had lived in the project area for 8 years, some of the mammals on site and surrounding areas included *Otolemur crassicaudatus* (Bushbaby), *Crocuta* (Spotted hyena), *Potamochoerus porcus* (Bushpig), *Cricetomys gambianus* (Giant rat), *Paraxerus cepapi* (Bush squirrel), *Lepus victoriae* (Hare), and *Sylvicapra grimmia* (Common duiker). Reptiles included *Agama aculeate armata*, *Hemidactylus mabouia*, *Gerrhosaurus nigrolineatus*, *Python sebae*

natalensis, *Natriciteres olivacea*, *Psammophis phillipsii* and *Philothamnus hopplogaster* and *Bitis arietans* while amphibians included *Phrynobatrachus natalensis and Xenopus laevis pertersii.*

FISHERIES

When collecting data on fisheries the team focused on critical variables which included among others; fish species, stream conditions and fishing activities in the area. The methodology used included Interviews with local inhabitants and Fish trapping using fishing baskets. The rapid assessment of Aquatic biota for small streams was also applied.

Fish species from Munshiwemba River included *Tilapia rendallii, Clarias ngamensis,* Luciolates stappersii and Ctenopoma multispinis. Crabs and earthworms were a representation of the lower invertebrates while spiders and other arachnids were present. Generally, insects of the following broad categories; grasshoppers, bugs, beetles, dragon flies, wasps, bees, butterflies, moths and ants were represented. However, the faunal and fish numbers and diversity were low. The following birds were spotted on site during the survey and included; *Kaupifalco monogrammicus*, *Streptopelia semitorquata, Pycnonotus barbatus, Batis molitor, Parus griseiventris, Oriolus larvatus, Tchagra senegala, Dicrurus adsimilis, Emberiza flaviventris, Anhinga rufa*, *Milvus migrans*, *Gallinula chloropus*, and *Uraeginthus angolensis.*

RARE OR ENDANGERED SPECIES ON SITE

No threatened, rare or endangered species of fauna or flora was registered on the study site with respect to national or international conservation status.

SENSITIVE HABITATS

There were no sensitive or fragile habitats on the study area with respect to the magnitude and extent of the project being proposed that could cause a serious environmental upset in the stability of the existing ecosystem.

SPECIES OF COMMERCIAL IMPORTANCE

The study site had no significant species of fauna or flora that could be exploited for commercial purposes.

SPECIES WITH POTENTIAL TO BECOME NUISANCES, VECTORS OR DANGEROUS

No species with potential to become nuisances, vectors or dangerous were noted on the study site at time of survey.

PROTECTED AREAS (FOREST RESERVE)

There proposed project site is not located or near a government gazetted protected area.

4.4 SOCIO-ECONOMIC ENVIRONMENT

POPULATION PATTERN

According to Central Statistics Office (CSO) population census of 2010 preliminary report, Central province population stands at 1,267,803 and annual growth rate was put at 2.3% recording a decline from 2.7% in the period between the 1990 and 2000 census. However, population of Mkushi recorded the highest annual population growth rate in the province of 3.5%. The population of Mkushi is now at 151,803 (CSO, 2010). The population distribution in Mkushi district households by constituency and wards are shown in the table 4.5 below:

HUMAN SETTLEMENT

The majority of the population in Mkushi District lives in rural area. This accounts for about 76% while the urban areas have the remaining 24% (CSO, 2010).

The project area is mainly surrounded by commercial farms. There are no settlements within the project area except for dwellings for farm workers. There are a total of 136 houses situated in the three compounds. At Parklands, there are six managers' houses currently being constructed, 21 newly constructed brick and tin roofed houses for permanent employees and 38 temporary houses. In addition, there are 36 traditional mud and thatch houses at Whispering Hope and 41 at Beckett.

Table 4.4: Demography of Mkushi district

MKUSHI NORTH CONSTITUENCY	2000 POPULATION	
	HOUSEHOLD	TOTAL POPULATION
CHALATA	1462	7597
CHIBETWE	2499	13151
CHIKANDA	1647	9864
KAWA	244	1283
MUSHIBEMBA	1293	6270
MUSOFU	830	4861
NKUMBI	1505	8325
NSHINSO	2693	16050
TEMBWE	1536	7283
UPPER LUNSEMFWA	1784	9709
MKUSHI SOUTH CONSTITUENCY	-	-
CHING'OMBE	702	4086
CHIPABA	152	834
KAMIMBYA	915	5998
MUNDA	1807	10475
MWALALA	288	1652

Source: CSO (2003)

LAND USE

The main land use in the area under consideration is agriculture. The main crops cultivated are wheat, maize and soya beans. Livestock being kept include cattle,

goats, chickens, pigs and sheep. Besides, a number of people rely on being employed by surrounding commercial farmers.

HUMAN SETTLEMENT

Mkushi Commercial Farming Block has very few traditional rural settlements. None of these traditional settlements will either be affected or relocated by the proposed dam project. The local population are dependent on commercial farms for employment. According to a snap survey, a total of 136 houses are situated in the three farm compounds within the project area.

Chobe has embarked on building permanent housing to its workers. At Parklands, there are six managers' houses currently being constructed, 21 newly constructed brick and tin roofed houses for permanent employees and 38 temporary houses. There are 36 traditional mud and thatch houses at Whispering Hope and 41 at Beckett. Temporary workers and casual workers are housed in temporary accommodation consisting of traditional mud and thatch houses. A few structures made of plastic were also observed.

SOCIAL SERVICES

At both Parklands and Whispering Hope farms, the source of domestic water supply is groundwater through boreholes. The water is pumped into water tanks before distribution. On site sanitation using pit latrines are in use in all three compounds. With regard to education services, Katuba Primary School and Kasakota Primary School 15 km and 9 km from Parklands farm, respectively are the nearest schools serving the project area. Apart from first aid service at the farms, the project area is only serviced by an under 5 and Maternity clinic is in Mkushi district about 25 km away.

ARCHEOLOGICAL AND CULTURAL SITES

The proposed site for dam construction has no archeological and cultural sites. However, outside the farm in question within Mkushi are the Mpumbu Caves. Other sites identified as Mkushi Heritage Sites are listed below;

Ass. Magistrate Guest House	- Historical
Lunsemfwa Bell Point	– Natural
Chipawa Boma	– Historical
Fort Elwes	– Historical
Fort Elwes Surface	– Archaeological
Lunsemfwa Bridge	– Archaeological
Lunsemfwa Mine	- Archaeological
Mkushi Rest House	– Archaeological
Mufulwe Hills	– Archaeological
Mukowe	– Archaeological
Kapiri Kabundi	– Archaeological
K177 locality 65	– Geological

CHAPTER 5 POTENTIAL ENVIRONMENTAL AND SOCIO-ECONOMIC IMPACTS

5.1 GENERAL CONSIDERATIONS

Construction of dams and associated reservoirs are usually planned for single or multipurpose use that include hydropower generation, domestic and industrial water supply, flood control and irrigation. The proposed Munshiwemba Intermediate Dam will primarily be used for irrigation of agricultural commercial crops that include wheat, soya beans and maize.

Although adequate bulk water storage is desired world over for sustainable agricultural production, large scale dam projects if not properly planned and managed may cause irreversible environmental changes over a wide geographical area and thus have the potential for significant impacts. Criticism of such projects has grown in the last decade. Such severe critics claim that benefits from large dams are outweighed by their Social, Environmental and Economic costs and therefore, the construction of large dams is unjustifiable. Others contend that in some cases environmental and social costs can be avoided or reduced to an acceptable level by carefully assessing potential problems and implementing cost-effective corrective measures. The proposed dam can be classified as a small earth dam with barely 3.5million capacity which may not significantly impact on the environment since the geographical area affected is minimal. However, the developer is keen on addressing any adverse impacts so long as they are identified.

The main objective in assessing the potential effects of this project was essentially to permit planning of actions to avoid or reduce undesirable effects. Actions to enhance secondary benefits of the project were also identified. A project may exert a suite of effects during construction that largely end when the project comes into operation. It is therefore common practice to discuss the effects of the project construction (including preparatory phase if any) separately from those of project operation.

Creating a dam or reservoir fundamentally alters the hydrological regime upstream and downstream of the designed obstruction. This can have far reaching consequences, which may not be localised to the project area. These should be

taken into consideration during the environmental impact assessment and incorporated into the design development. In many cases the area of influence of a dam project extends from the upper limits of the Catchment of the reservoir to as far downstream as the estuary and off-shore zone. It includes the watershed and river valley below the dam.

There are direct environmental impacts associated with the construction of the dam (e.g. dust, erosion, borrow and disposal problems), the greatest impacts are expected from the impoundment of the water flow downstream. These effects will have direct impacts on soil, vegetation, wildlife and wild habitat, fisheries and more especially human population within the project area.

On the other hand, indirect effects are expected, these include those associated with the construction or buildings, maintenance and functioning of the dam (e.g. access roads, irrigation facilities made possible by the dam). However, it should be noted that major environmental factors affecting the functioning and life span of a dam are those caused by land, water and other resource use in the Catchment upstream the dam (e.g. agriculture, settlement, forest clearing) which may result in increased siltation and changes in water quality in the reservoir and river downstream.

Nonetheless, in spite of the above, the benefits of a dam project are immerse, e.g. flood control and the provision of more reliable water supply throughout the year for irrigation, domestic and industrial use as well as environmental flows for aquatic ecosystem. Dams are also said to provide an alternative to activities with greater potential for greater adverse impacts. For instance, intensification of agriculture locally through irrigation can reduce pressure on uncleared forest lands, intact wildlife habitat and areas unsuitable for agriculture elsewhere. In addition, dams create a reservoir for fishery and possibilities of agricultural production on the reservoir drawdown area, which in some cases can be more than compensating for losses in these sectors due to dam construction.

Therefore, this section of the environmental report addresses the interactions of the project with the natural and socio-economic resources around it. These interactions are normally known as 'impacts'. Many of the effects of the proposed project may

be secondary benefits though not part of the objective of the project. It is worthwhile separating project effects into direct (or primary) effects resulting from direct interaction of some components of the project with one or more environmental resources, and indirect (or secondary) effects which arise from the primary effects. Note that a classification of negative effect does not necessarily imply a long-term adverse effect on the environment. It may as well indicate an irreversible change to the physical environment from original conditions. In some cases, these irreversible changes can result in favourable long-term effects.

5.2 PREDICTION OF IMPACTS

The proposed Munshiwemba Intermediate Dam Project is expected to have both negative and positive impacts. Considering that the throw back is barely 2.7km with an inundated area of 0.793km^2 the effects of this project will largely be localised. The negative impacts will mainly be related to the construction of the dam and irrigable area. As earlier stated, primary impacts may be followed by secondary and tertiary ones e.g. sedimentation and eutrophication of reservoir water reduces the oxygen content of the water downstream and results in secondary effects like the spread of aquatic weeds and eventually in tertiary effects like disease vectors and fish mortality. The following broad division into impact zones was made;

(i) *Areas influenced by hydrological changes in the river system*: Reservoir area where the reservoirs will be created following the closure of the dam and area immediately below the dam

(ii) *Areas influenced by activities associated with dam construction*: Dam construction impact zone, Access roads and local communities within radius of 5km.

Mapping of these ecological zones were done with the help of hand held GPS receiver and field surveys with the aid of topographical maps. Prediction of impacts of the proposed project was mainly carried out with the aid of appropriate analytical techniques. However, certain ecological aspects do not lend themselves to straight forward quantification e.g. the impact of water resources development on human health or cultural heritage. In such instances, expert judgement by members of the multi-disciplinary EIA team was used.

Learning from the construction of large reservoirs, the oxygen budget of a new manmade lake is one of the most critical factors in water quality and moreover a determining factor for the aquatic ecosystem of the reservoirs and downstream river system, especially during filling of a new reservoir and the first years of operation. The decaying of inundated terrestrial vegetation is expected to cause a high demand for oxygen. Other ecological problems are expected to occur due to the nutrient supply from the decay of the original vegetation include excessive algae bloom.

Malaria and hookworm are the most prevalent diseases that may be promoted by permanent humidity in the irrigated area and reservoir. The proposed development may influence vegetation and wildlife through inundation of the reservoir area. The aquatic ecosystem may also be influenced by changing water quality.

5.3 IMPACT CLASSIFICATION AND CRITERION

With the understanding derived from general considerations and prediction of impacts highlighted earlier, a number of impacts (positive and negative) were identified. These impacts are based on the design of the dam, project details, environmental and socio-economic baseline study as well as expert judgment. In order to be thorough with the manner in which impacts were classified, the water course was segmented into four sections and under each section associated impacts identified (See Table 5.1 below);

Table 5.1: General Impacts Associated with Dam Construction

Category	General	Above dam	Below dam	Barrier effect
General Impacts	Loss of terrestrial habitats/farmland/settlements	Loss of river section	Reduced flows	Blocking of Migration of fish
	Local rise in water table	Changes in flow regime	Reduced oxygen levels	Blocking of Migration of invertebrates
	Visual impacts of retaining walls	Siltation	floodplain siltation	
	Water borne pathogens			
	failure risks			

5.4 POSSIBLE ENVIRONMENTAL AND SOCIO-ECONOMIC IMPACTS

For purposes of this report, possible impacts have been categorized based on classification and criterion outlined in table 5.2 below;

Table 5.2: Criterion and Classification of Impacts

Item	Impact Criterion	Effect Consideration on Environment	Classification of Effect	
			Expression	Effect Description
I	Positive or Negative	Will impact be positive or negative	Positive	**A positive impact**
			Negative	**A Negative impact**
Ii	Likelihood of occurring	What certainty of occurrence is associated with impact	Certain	**Will occur**
			Unlikely	**May not occur**
			Possible	**May occur**
Iii	Duration	What timeframe or period is effect to be felt or last	Permanent	**Will last a lifetime**
			Short term	**Will last up to end of construction activities**
			Medium Term	**Will last as long as operation activities**
			Long Term	**Will last beyond project operation life**
Iv	Timing	At what stage will impact occur or felt	Immediately	**Will occur upon starting project activities**
			Near Future	**Will occur during project operation activities**
			Distance future	**Will occur beyond project operation activities**
V	Significance	How severe will the impact be	Low	**Little impact**
			Medium	**Moderate impact**
			High	**High impact**

Item	Impact Criterion	Effect Consideration on Environment	Classification of Effect	
			Expression	Effect Description
Vi	Extent	Areal extent or coverage of impact	Project Area	**Effect confined to project area**
			Surrounding Environs	**Effect to be felt by surrounding areas**
			Beyond Surrounding Environs	**Effect to be felt within, surroundings and beyond environs**
Vii	Overall Rating	How important is Impact in project design	Insignificant	**Impact not substantial needs no mitigation/ enhancement**
			Low	**Impact of little importance needs limited mitigation / enhancement**
			Moderate	**Impact has influence and requires mitigating/ enhancing**
			High	**Impact of great importance mitigation/ enhancement a must**

The proposed dam development can be classified into eight development components. Possible impacts due to construction of the dams have been discussed for each development component listed below;

- Dam wall and spillway construction
- Equipment mobilisation, Storage and Operation
- Borrow pit operation, materials handling and rehabilitation
- Inundation productive
- Change in stream flow regime, morphological features and water quality
- Change in groundwater level and quality
- Waste management,
- Socio-economic and cultural

5.4.1 Dam wall and spillway construction

This will involve site clearing and stripping of subsoil i.e. removal of tree stumps and roots from the site foundation as well as removal of anthills. In addition river bed foundation preparations including removal of inferior material, core trench excavation and rock surface preparation under the earth wall core, spillway area and in the tail water section will be undertaken. Note that excavation and exploration of any joint fissures on faults in the rock, and their treatment will also be carried out.

The cross-section of the embankment shall comprise a height of 11.485m up to settled level, a crest width of 6m, upstream and downstream slopes of 1:2.5 and 1:2 respectively. The crest will be raised to a level of 0.57m from settled crest level to allow for a 5% settlement. A spillway length will be 60m.

Construction Stage

Impact: Displacement of people:
The number of people actually living in the Catchment area of the proposed reservoir was derived from census data and field surveys. It was established during field surveys that the project area particularly impoundment areas are part of commercial fields meant for agricultural activities. As such no households are expected to be relocated due to inundation.

Impact: loss of productive land, historical and cultural sites:
No historical and cultural sites are located within the impoundment area. However, loss of agricultural land due to impoundment will be there though relatively small compared to the available arable land.

Impact: Loss of wildlife habitat, indigenous flora and fauna:
The project site will not interfere directly with any existing wildlife reserves or national parks. Wildlife is in fact expected to resurface in the area due to improved water supply. However, limited loss of some wildlife habitat and flora is expected while aquatic life will be enhanced.

Impact: Erosion of the top soil and reservoir sedimentation:

The nature of the project demands use of heavy machinery during construction mainly for earth movement and levelling. This may lead to instability of the soil in the area and as a result cause soil erosion mainly of top soil. Consequently this may lead to siltation and sedimentation of rivers/ reservoirs in the Catchment if not controlled.

Impact: Skills transfer to locals:

When the local people are employed during dam wall construction, they will acquire skills in construction which they can use later in future. By employing as many local people as possible there will be skills transfer thus building human capacity in the area.

Operation Stage

Impact: Pollution due to increased usage of pesticides and fertilisers:

Increased availability of water supply throughout the year for irrigation may lead to higher usage of agro chemicals. The contamination levels of the drainage water and the toxicity of the residue will depend on the dosage and frequency of use as well as on the types of agro chemicals used. Human health, fish and wildlife may be threatened due to high usage of agro-chemicals if done in unregulated manner.

Impact: Deterioration in water quality in downstream reaches of the stream:

Water quantity measures affect water quality in several ways. Impoundment may increase or decrease (dilution) the pollutant load of receiving waters while withdraws may indirectly lead to an increase of the pollutant loads, when water returns polluted to the source after use. Therefore, construction of a reservoir implies creation of a new environment, developing its own typical water quality problems that may affect the downstream areas to some extent.

Impact: Change in water quantity in downstream reaches of the stream:

Munshiwemba River will not be completely impounded but will allow environmental flows for both the ecosystem and any other activity that may be undertaken downstream at any given time. Besides, excess flow during summer season is

targeted for filling of the dams. It is also worth noting that filling of a dam is normally gradual and may take a number of rain seasons.

Impact: Encroachment of aquatic weeds and water quality of the reservoirs:
The aquatic ecosystem in newly constructed reservoirs is very unstable and water is often eutrophic as a result of the inundation of fertile land. Explosive growth of certain plant species may seriously threaten the effective use of such reservoirs. In eutrophic circumstances, reservoirs can suffer a fast growth of unicellular algae, mostly of a blue green nature. Since these algae do not enter common food chains, these blooms are unfavourable to fish production.

Impact: Threat to public health:
Development of reservoirs in tropic countries usually leads to change in incidence of water-borne diseases. In Zambia, this may imply the spread of mosquitoes and vectors of malaria. This may threaten public health if no special attention and mitigation measures are put in place.

Impact: Dust pollution:
The project will take place in the dry season which is well known for dust circulation. Dust pollution is expected to pose a negative impact that can affect human health.

5.4.2 EQUIPMENT MOBILISATION AND OPERATION

The nature of the project requires use of heavy trucks and earth moving machinery. Taking these to site would require making access roads as well as a camp site with storage facilities for materials and lubricants. This will result in the disturbance of soil and vegetation and the likelihood of oil spillages. During operation, the dust will be generated and noise may disturb wildlife.

Construction Stage

Impact: Loss of wildlife habitat, indigenous flora and fauna
The activities at the project site will not interfere directly with any existing wildlife reserves or national parks. In fact Wildlife may resurface in the area due to improved

water supply. However, the exercise of mobilisation of equipment and machinery will lead to limited loss of some wildlife habitat and flora.

Impact: Erosion of the top soil and reservoir sedimentation

Mobilisation of heavy machinery to site for earth movement and levelling will cause instability of the soil in the area and as a result cause soil erosion mainly of top soil. Consequently this may lead to siltation and sedimentation of rivers/ reservoirs in the Catchment if not controlled.

Operation Stage

Impact: Erosion of the top soil and reservoir sedimentation

During operation of heavy machinery for earth movement and levelling, soil in the area will be disturbed and as a result cause soil erosion mainly of top soil. Consequently this may lead to siltation and sedimentation of rivers/ reservoirs in the Catchment if not controlled.

Impact: Soil and water pollution due to oil spills

Use of machinery which is not well maintained or serviced may lead to leakages thus polluting soils and consequently water resources.

Impact: Skills transfer to locals

When the local people are employed for operation of heavy machinery and equipment, they will acquire skills in operation and maintenance of the equipment and machinery which they can use later in future. By employing as many local people as possible skill transfer will be enhanced thus building human capacity in the area.

Impact: Dust pollution

The mobilisation of machinery and equipment will be done during dry season which is well known for dust circulation. Dust pollution is the expected negative impact that will pose a danger to human health.

5.4.3 BORROW PIT OPERATION, MATERIALS HANDLING AND REHABILITATION

Since the dam to be constructed will be an earth dam, gravel for the embankment would be obtained within the project area. However, this will be some distance from the stream as the suitability of gravel from the site was confirmed by laboratory tests on the material. As a result, loss of vegetation due to land clearance, land degradation due to excavation works and dust are expected.

Construction Stage

Impact: loss of productive land, historical and cultural sites:

No historical and cultural sites are located within the impoundment area. However, loss of agricultural land due to creation of borrow pit will be there though relatively small compared to the available arable land.

Impact: Loss of wildlife habitat, indigenous flora and fauna

The project site will not interfere directly with any existing wildlife reserves or national parks. Wildlife is in fact may resurface in the area due to with improved water supply. However, formation of borrow pit will lead to limited loss of some wildlife habitat and flora.

Impact: Erosion of the top soil and reservoir sedimentation

Heavy machinery will be required during construction of the borrow pit. This would lead to instability of the soil in the area and as a result cause soil erosion mainly of top soil. Consequently this may lead to siltation and sedimentation of rivers/ reservoirs in the Catchment if not controlled.

Impact: Dust pollution

Dust pollution is the most expected negative impact that will pose a health hazard. The project construction works will take place in the dry season known for dust circulation thus posing a danger to human health.

Impact: Loss of Cultural Sites

No cultural site is reported at the proposed site and as such none is likely to be affected. Should any site be discovered during operation the matter will be brought to the attention of the relevant authorities.

Operation Stage

Impact: Erosion of the top soil and reservoir sedimentation

Owing to the nature of the operation of a borrow pit, heavy machinery will be required for earth movement and excavation. This would lead to instability of the soil in the area and as a result cause soil erosion mainly of top soil. Consequently this may lead to siltation and sedimentation of rivers/ reservoirs in the Catchment if not controlled.

Impact: Dust Pollution

Dust pollution is expected during excavation and earth movement posing a health hazard especially that the project will take place in the dry season which is well known for dust circulation thus posing a danger to human health.

5.4.4 INUNDATION OF PRODUCTIVE LAND

The proposed dam will result into loss of agricultural land belonging to Chobe. However, this will be minimal compared to the available total land.

Construction Stage

Impact: Displacement of people:

The number of people actually living in the catchment areas of the proposed reservoirs was derived from census data and field surveys. It was established during field surveys that the project area particularly impoundment areas are part of fields meant for agricultural activities. As such no households are expected to be affected due to inundation.

Impact: loss of productive land, historical and cultural sites:

No historical and cultural sites are located within the impoundment area. However, loss of agricultural land due to impoundment will be there though relatively small compared to the available arable land.

Impact: Loss of wildlife habitat, indigenous flora and fauna

The project site will not interfere directly with any existing wildlife reserves or national parks. Instead, wildlife may resurface in the area due to improved water supply. However, impoundment of the reservoir will lead to limited loss of some wildlife habitat and flora.

5.4.5 CHANGE IN STREAM FLOW REGIME, MORPHOLOGICAL FEATURES AND WATER QUALITY

Construction of a dam affects variations in discharges and water levels. The discharge regime becomes more regular compared to the conditions without dam and both low and high discharges occur less frequently. Hydrological changes in the river system may lead to greater area of influenced both upstream and downstream. The stream morphological features may also change with time.

Construction Stage

Impact: Deterioration in water quality in downstream reaches of the stream:

During construction, waste in form of rubble and other forms may cause pollution to water quality that can affect downstream users

Operation Stage

Impact: Deterioration in water quality in downstream reaches of the stream

Impoundment may increase or decrease (dilution) the pollutant load of receiving waters while withdraws may indirectly lead to an increase of pollutant loads. Therefore, construction of a dam (reservoir) implies creation of a new environment, developing its own typical water quality problems that may affect the downstream section to some extent.

5.4.6 CHANGE IN GROUNDWATER LEVEL AND QUALITY

Groundwater levels are liable to be impacted by the creation of an impoundment. Raised water levels upstream may result in a localized change to the water table. These changes to water levels may impact on groundwater upstream and downstream, resulting in water logging of soils or wells, and changes to catchments Infiltration.

Operation Stage

Impact: Increase in groundwater level

Impoundment of a stream may lead to increased percolation of water to deeper levels resulting in localized increase in groundwater level and consequently overall quantity. If this is not checked this may lead to water logging of soils. However, this is mainly the case where the water table is too near to the surface which is not the case in Munshiwemba Catchment. Instead recharge to groundwater will be enhanced and is desired since the area has generally poor groundwater yields.

Impact: Deterioration in groundwater quality

Since impoundment of a stream may lead to increased percolation of water to deeper levels, the percolating water if contaminated may lead to groundwater quality deterioration depending on soil type and condition.

5.4.7 WASTE MANAGEMENT

During the construction and operation stage solid waste is expected resulting from land clearance and levelling, excavation and rock blasting. However much of the earth and rubble will still be used in the erection of the dam wall. In addition, human activity involving workers will also result into waste being generated.

Construction Stage

Impact: Pollution due to solid waste

Due to construction works solid waste in form rubble and litter is expected. If not properly disposed this may pollute soil and water resources.

Impact: Deterioration in Water quality due liquid waste

Water quality can be affected by receiving untreated human waste. Absence of proper sanitation facilities for construction workers may result in human waste finding itself in stream water thus polluting it and posing a health risk to people who depend on river water for domestic use.

Operation Stage

Impact: Threat to human health

Water pollution due to indiscriminate disposal of waste may lead to water borne diseases especially that the majority of the local community depend on Munshiwemba River.

5.4.7 SOCIO-ECONOMIC AND CULTURAL

The construction of the proposed dam will result into inundation of a portion of productive land. However, there are no settlements that will be affected since the land in question is part of the agricultural land for commercial farming. From the situational analysis of the existing baseline socio-economic conditions, issues of concern will include Loss of productive agricultural land and Loss of livelihood (from wild fruit trees) among others.

Construction Stage

Impact: Displacement of people:

The number of people actually living in the Catchment areas of the proposed reservoirs was derived from census data and field surveys. It was established during field surveys that the project area particularly impoundment areas are part of fields meant for agricultural activities. As such no households are expected to be relocated due to inundation.

Impact: Loss of productive land, historical and cultural sites:

No historical and cultural sites are located within the impoundment area. However, loss of agricultural land due to impoundment will be there though relatively small compared to the available arable land.

Impact: Increased employment opportunities

Construction and operation of a dam will create opportunities for jobs mainly for the local communities. At preparatory and construction stage, local people will be engaged and consequently livelihood for family members will be guaranteed.

Impact: Increase in Local Population

The construction of the dam will have an influence on the population size of the area. During the construction, skilled personnel will add on to the local population. After the construction of the dam is over, more skilled manpower may come to the area to seek jobs thus putting pressure on the available natural resources.

Impact: Increase in local economic activities

Dam construction will provide trading opportunities to the local people. Farm produce and food stuffs will be sold to construction workers. It is also expected that the dam once operational will result in more fish production thereby providing a

long term positive addition to the livelihood of the community due to increase in income.

Impact: Loss of social and cultural infrastructure

No social or cultural infrastructure is likely to be flooded. In particular there are no grave yards expected to be submerged.

Operation Stage

Impact: Increase in employment opportunities

Construction and operation of dams create opportunities for jobs mainly for the local communities. At operation stage, local people will be engaged and consequently livelihood for family members will be guaranteed. In a long term, increased productivity in the area as a result of irrigation will equally further create job opportunities.

Impact: Boost to economic growth

Reliable water supply throughout the year will effectively enable Chobe to increase its production levels. This entails enough production to satisfy local demand while at the same time export. As a result, earn the country the much needed foreign exchange thus contribute to overall economic growth.

Impact: Increase in local population

The operation of the dam will have an influence on the population size of the area. The dam is anticipated to temporary attract additional people who are interested in working for Chobe thus putting pressure on the available natural resources.

Impact: Increase in local economic activities

The irrigation scheme will provide both permanent and temporal employment to the local people. This means more income for the community in the area resulting into increased economic activities. Further, increase in fishing and other supporting trading activities will all contribute to increase in economic activity.

Impact: Skills transfer to locals

Operation of the dam and the irrigation scheme will result into skills being transferred to the local people which they can use later in future. Thus human capacity will be built in the area.

Impact: Threat to human health

The operation of the dam and irrigation scheme will result in increased economic activity in the area consequently more people will be attracted to the area. This will expose the community to the foreign people who may lead to the spread of HIV/AIDS and other STIs.

Impact: Weakening of social cohesion

Since no displacement of households is expected no weakening of the social cohesion will take place for surrounding farm communities that may lead to loss of livelihood.

Impact: Loss of immovable assets

No immovable assets of different value which include houses, pit latrines, gardens, wells and shops will be lost since no relocation of people is expected.

Impact: Enhanced Livelihood

There will be more fish that could make more people to adopt fishing as an additional source of livelihood. Employment and new trading activities will equally support livelihood for the locals.

For a summary and evaluation of potential impacts see Table 5.3 during Construction Stage and Table 5.3 during Operation Stage.

TABLE 5.3: EVALUATION MATRIX FOR POTENTIAL ENVIRONMENTAL IMPACTS: - CONSTRUCTION STAGE

ITEM	POTENTIAL ENVIRONMENTAL IMPACT	IMPACT CRITERION						OVERALL IMPACT RATING
		POSITIVE(+VE) OR NEGATIVE (-EV) IMPACT	LIKELIHOOD OF OCCURING	DURATION	TIMING	SIGNIFICANCE	EXTENT	
ENVIRONMENTAL ISSUE: DAM WALL AND SPILLWAY CONSTRUCTION								
1	**Displacement of people:**	-VE	UNLIKELY	N/A	N/A	N/A	N/A	**INSIGNIFICANT**
2	**loss of productive land**	-VE	CERTAIN/	PERMANENT	IMMEDIATE	Medium	PROJECT AREA	**MODERATE/**
3	**historical and cultural sites**:	-VE	UNLIKELY	N/A	N/A	N/A	N/A	**INSIGNIFICANT**
4	**Loss of wildlife habitat, flora and fauna**:	-VE	CERTAIN	SHORT TERM	IMMEDIATE	LOW	PROJECT AREA	**LOW**
5	**Erosion of the top soil and reservoir sedimentation:**	-VE	POSSIBLE	SHORT TERM	IMMEDIATE	LOW	SURROUNDING ENVIRONS	**HIGH**
6	**Skills Transfer to Locals**:	+VE	CERTAIN	MEDIUM TERM	IMMEDIATE	HIGH	PROJECT AREA	**HIGH**
7	**Dust Pollution:**	-VE	POSSIBLE	SHORT TERM	IMMEDIATE	LOW	SURROUNDING ENVIRONS	**MODERATE**

ITEM	POTENTIAL ENVIRONMENTAL IMPACT	IMPACT CRITERION						OVERALL IMPACT RATING
		POSITIVE OR NEGATIVE IMPACT	LIKELIHOOD OF OCCURING	DURATION	TIMING	SIGNIFICANCE	EXTENT	
ENVIRONMENTAL ISSUE: EQUIPMENT MOBILISATION AND OPERATION								
8	**Loss of wildlife habitat, flora and fauna:**	-VE	CERTAIN	SHORT TERM	IMMEDIATE	LOW	PROJECT AREA	**LOW**
9	**Erosion of the top soil and reservoir sedimentation:**	-VE	CERTAIN	SHORT TERM	IMMEDIATE	MEDIUM	PROJECT AREA	**MODERATE**
ENVIRONMENTAL ISSUE: PRODUCTIVE AND SETTLEMENT LAND								
10	**Displacement of people:**	-VE	UNLIKELY	N/A	N/A	N/A	N/A	**INSIGNIFICANT**
11	**loss of productive land/**	-VE	CERTAIN/	PERMANENT	IMMEDIATE	HIGH	SURROUNDING ENVIRONS	**HIGH**
12	**historical and cultural sites:**	-VE	UNLIKELY	N/A	N/A	N/A	N/A	**INSIGNIFICANT**
13	**Loss of wildlife habitat, flora and fauna:**	-VE	CERTAIN	MEDIUM TERM	IMMEDIATE	MEDIUM	PROJECT AREA	**MODERATE**

ITEM	POTENTIAL ENVIRONMENTAL IMPACT	IMPACT CRITERION						OVERALL IMPACT RATING
		POSITIVE OR NEGATIVE IMPACT	LIKELIHOOD OF OCCURING	DURATION	TIMING	SIGNIFICANCE	EXTENT	
ENVIRONMENTAL ISSUE: BORROW PIT OPERATION AND MATERIAL HANDLING								
14	**loss of productive land, historical and cultural sites:**	-VE	POSSIBLE	SHORT TERM	IMMEDIATE	LOW	PROJECT AREA	**INSIGNIFICANT**
15	**Loss of wildlife habitat, flora and fauna:**	-VE	POSSIBLE	SHORT TERM	IMMEDIATE	LOW	PROJECT AREA	**LOW**
16	**Erosion of the top soil**	-VE	POSSIBLE	SHORT TERM	IMMEDIATE	HIGH	PROJECT AREA	**HIGH**
17	**Dust Pollution:**	-VE	POSSIBLE	SHORT TERM	IMMEDIATE	MEDIUM	SURROUNDING ENVIRONS	**MODERATE**
18	**Loss of Cultural Sites:**	-VE	UNLIKELY	N/A	N/A	N/A	N/A	**INSIGNIFICANT**

ITEM	POTENTIAL ENVIRONMENTAL IMPACT	IMPACT CRITERION						OVERALL IMPACT RATING
		POSITIVE OR NEGATIVE IMPACT	LIKELIHOOD OF OCCURING	DURATION	TIMING	SIGNIFICANCE	EXTENT	
ENVIRONMENTAL ISSUE: WASTE MANAGEMENT								
19	**Water Quality:**	-VE	POSSIBLE	SHORT TERM	NEAR FUTURE	MEDIUM	SURROUNDING ENVIRONS	**MODERATE**
20	**Human Health:**	-VE	POSSIBLE	SHORT TERM	NEAR FUTURE	MEDIUM		**MODERATE**
ENVIRONMENTAL ISSUE: SOCIO-ECONOMIC AND CULTURAL								
21	**Displacement of People:**	-VE	UNLIKELY	N/A	N/A	N/A	N/A	**INSIGNIFICANT**
22	**Loss of Historical and Cultural Sites:**	-VE	UNLIKELY	N/A	N/A	N/A	N/A	**INSIGNIFICANT**
23	**Employment Opportunities:**	+VE	CERTAIN	MEDIUM TERM	IMMEDIATE	HIGH	PROJECT AREA	**HIGH**
24	**Increase in Local Population:**	**+VE**	**POSSIBLE**	**LONG TERM**	**NEAR FUTURE**	**MEDIUM**	**PROJECT AREA**	**MODERATE**

ITEM	POTENTIAL ENVIRONMENTAL IMPACT	IMPACT CRITERION						OVERALL IMPACT RATING
		POSITIVE OR NEGATIVE IMPACT	LIKELIHOOD OF OCCURING	DURATION	TIMING	SIGNIFICANCE	EXTENT	
ENVIRONMENTAL ISSUE: SOCIO-ECONOMIC AND CULTURAL								
25	**Increase in Local Economic Activities:**	+VE	CERTAIN	MEDIUM TERM	IMMEDIATE	HIGH	SURROUNDING ENVIRONS	**HIGH**
26	**Loss of Social & Cultural Infrastructure:**	-VE	UNLIKELY	N/A	N/A	N/A	N/A	**INSIGNIFICANT**
27	**Boost to Local Industry**	+VE	CERTAIN	SHORT TERM	IMMEDIATE	HIGH	SURROUNDING ENVIRONS	**HIGH**
28	**Skills Transfer to Locals:**	+VE	CERTAIN	MEDIUM TERM	IMMEDIATE	HIGH	PROJECT AREA	**HIGH**
29	**Threat to Human Health:**	-VE	POSSIBLE	SHORT TERM	NEAR FUTURE	MEDIUM	SURROUNDING ENVIRONS	**MODERATE**

TABLE 5.3: EVALUATION OF POTENTIAL ENVIRONMENTAL IMPACTS: OPERATION STAGE

ITEM	POTENTIAL ENVIRONMENTAL IMPACT	IMPACT CRITERION						OVERALL IMPACT RATING
		POSITIVE OR NEGATIVE IMPACT	LIKELIHOOD OF OCCURING	DURATION	TIMING	SIGNIFICANCE	EXTENT	
ENVIRONMENTAL ISSUE: DAM WALL AND SPILLWAY CONSTRUCTION								
1	**Pollution due to increased usage of pesticides and fertilisers:**	-VE	POSSIBLE	MEDIUM TERM	NEAR FUTURE	LOW	PROJECT AREA & SURROUNDING ENVIRONS	**LOW**
2	**Deterioration in Water quality in downstream reaches of the stream:**	-VE	CERTAIN	SHORT TERM	IMMEDIATE	MEDIUM	SURROUNDING ENVIRONS	**MODERATE**
3	**Encroachment of aquatic weeds and water quality of the reservoirs:**	-VE	POSSIBLE	MEDIUM TERM	NEAR FUTURE	LOW	PROJECT AREA	**LOW**
4	**Public health:**	-VE	POSSIBLE	MEDIUM TERM	IMMEDIATE	MEDIUM	PROJECT AREA	**MODERATE**
5	**Dust Pollution:**	-VE	POSSIBLE	SHORT TERM	IMMEDIATE	MEDIUM	SURROUNDING ENVIRONS	**MODERATE**

ITEM	POTENTIAL ENVIRONMENTAL IMPACT	IMPACT CRITERION						OVERALL IMPACT RATING
		POSITIVE OR NEGATIVE IMPACT	LIKELIHOOD OF OCCURING	DURATION	TIMING	SIGNIFICANCE	EXTENT	
ENVIRONMENTAL ISSUE: EQUIPMENT MOBILISATION AND OPERATION								
7	**Erosion of the top soil and reservoir sedimentation:**	-VE	CERTAIN	SHORT TERM	IMMEDIATE	MEDIUM	PROJECT AREA	**HIGH**
8	**Soil and Water Pollution due to oil spills:**	-VE	POSSIBLE	SHORT TERM	IMMEDIATE	LOW	SURROUNDING ENVIRONS	**LOW**
9	**Skills Transfer to Locals:**	+VE	CERTAIN	MEDIUM TERM	IMMEDIATE	HIGH	PROJECT AREA	**HIGH**
10	**Dust Pollution:**	-VE	POSSIBLE	SHORT TERM	IMMEDIATE	MEDIUM	SURROUNDING ENVIRONS	**MODERATE**

ITEM	POTENTIAL ENVIRONMENTAL IMPACT	IMPACT CRITERION						OVERALL IMPACT RATING
		POSITIVE OR NEGATIVE IMPACT	LIKELIHOOD OF OCCURING	DURATION	TIMING	SIGNIFICANCE	EXTENT	
ENVIRONMENTAL ISSUE: BORROW PIT OPERATION AND MATERIAL HANDLING								
11	**Reservoir sedimentation:**	-VE	UNLIKELY	N/A	N/A	N/A		**INSIGNIFICANT**
12	**Human Health:**	-VE	POSSIBLE	SHORT TERM	IMMEDIATE	LOW	PROJECT AREA	**LOW**
ENVIRONMENTAL ISSUE: PRODUCTIVE AND SETTLEMENT LAND								
13	**Increased Fish Production:**	+VE	CERTAIN	MEDIUM TERM	NEAR FUTURE	HIGH	PROJECT AREA	**HIGH**
14	**Dust Pollution**	-VE	POSSIBLE	MEDIUM TERM	IMMDIATE	MEDIUM	PROJECT AREA	**MODERATE**
15	**Loss of Immovable Assets**:	-VE	UNLIKELY	N/A	N/A	N/A	N/A	**INSIGNIFICANT**

ITEM	POTENTIAL ENVIRONMENTAL IMPACT	IMPACT CRITERION						OVERALL IMPACT RATING
		POSITIVE OR NEGATIVE IMPACT	LIKELIHOOD OF OCCURING	DURATION	TIMING	SIGNIFICANCE	EXTENT	
ENVIRONMENTAL ISSUE: DAM FILLING								
16	**Deterioration in Water quality:**	-VE	CERTAIN	SHORT TERM	IMMEDIATE	HIGH	BEYOND SURROUNDING ENVIRONS	**HIGH**
17	**Change in Water quantity in downstream reaches:**	+VE	CERTAIN	SHORT TERM	IMMEDIATE	HIGH	SURROUNDING ENVIRONS	**HIGH**
18	**Encroachment of aquatic weeds:**	-VE	POSSIBLE	MEDIUM TERM	NEAR FUTURE	LOW	PROJECT AREA	**LOW**
ENVIRONMENTAL ISSUE: CHANGE IN GROUNDWATER LEVEL AND QUALITY								
17	**Increase in Groundwater level**	+VE	CERTAIN	MEDIUM TERM	NEAR FUTURE	MEDIUM	PROJECT AREA	**MODERATE**
18	**Deteriorating Groundwater quality**	-VE	POSSIBLE	SHORT TERM	NEAR FUTURE	LOW	PROJECT AREA	**LOW**
ENVIRONMENTAL ISSUE: WASTE MANAGEMENT								
19	**Threat to Human Health:**	-VE	POSSIBLE	SHORT TERM	IMMEDIATE	LOW	SURROUNDING ENVIRONS	**LOW**

ITEM	POTENTIAL ENVIRONMENTAL IMPACT	IMPACT CRITERION						OVERALL IMPACT RATING
		POSITIVE OR NEGATIVE IMPACT	LIKELIHOOD OF OCCURING	DURATION	TIMING	SIGNIFICANCE	EXTENT	
ENVIRONMENTAL ISSUE: SOCIO-ECONOMIC AND CULTURAL								
21	**Employment Opportunities:**	+VE	CERTAIN	MEDIUM TERM	IMMEDIATE	HIGH	BEYOND SURROUNDING ENVIRONS	**HIGH**
23	**Boost to Economic Growth:**	+VE	CERTAIN	LONG TERM	DISTANT FUTURE	MEDIUM	BEYOND SURROUNDING ENVIRONS	**MODERATE**
24	**Increase in Local Population:**	-VE	POSSIBLE	LONG TERM	NEAR FUTURE	MEDIUM	PROJECT AREA	**MODERATE**
25	**Increase in Local Economic Activities**:	+VE	CERTAIN	MEDIUM TERM	IMMEDIATE	HIGH	PROJECT AREA	**HIGH**

ITEM	POTENTIAL ENVIRONMENTAL IMPACT	IMPACT CRITERION						OVERALL IMPACT RATING
		POSITIVE OR NEGATIVE IMPACT	LIKELIHOOD OF OCCURING	DURATION	TIMING	SIGNIFICANCE	EXTENT	
ENVIRONMENTAL ISSUE: SOCIO-ECONOMIC AND CULTURAL								
26	**Threat to Human Health:**	-VE	POSSIBLE	MEDIUM TERM	NEAR FUTURE	MEDIUM	SURROUNDING ENVIRONS	**MODERATE**
28	**Break down in Social Cohesion:**	-VE	UNLIKELY	N/A	N/A	N/A	N/A	**INSIGNIFICANT**
29	**Loss of Immovable Assets:**	-VE	UNLIKELY	N/A	N/A	N/A	N/A	**INSIGNIFICANT**
30	**Disruption of Livelihood:**	-VE	UNLIKELY	N/A	N/A	N/A	N/A	**INSIGNIFICANT**

CHAPTER 6 MITIGATION AND ENHANCEMENT MEASURES

6.1 IMPACT MITIGATION AND ENHANCEMENT MEASURES DURING CONSTRUCTION AND OPERATION STAGES

The proposed mitigation and enhancement measures to be carried out during all development stages of the project are elaborated in this section. These mitigation and enhancement measures have been arranged according to sequence of identified potential impacts under Chapter 5 of this report.

6.1.1 DAM WALL AND SPILLWAY CONSTRUCTION

Construction Stage

Mitigation: To prevent displacement of people:

No households are expected to be relocated due to inundation resulting from dam and spillway construction. Therefore no mitigation measure is required.

Mitigation: To prevent loss of productive land, historical and cultural sites:

No mitigation is required for loss of historical and cultural sites since none are located within the impoundment area. However, loss of agricultural land is expected. This impact is moderate considering that only 0.793km^2 out of the total 1,720,000ha will be inundated. Nonetheless the developer will take the following measures;

i) Take a precautionary measure i.e. should any effect of historical nature be discovered during construction, relevant authorities will be notified immediately.

Mitigation: To prevent Loss of wildlife habitat, flora and fauna

The project area has been subjected to years of human activities mainly agriculture and as such not much wildlife habitat, flora and fauna is left. Therefore this impact will be low. However, the following mitigation measures are proposed;

i) limit clearance of vegetation only to critical areas

ii) Conduct awareness campaigns among staff and community on the need to conserve nature based on a well-developed overall awareness and sensitisation company programme.

iii) Adopt strict good practices in conservation

Mitigation: To prevent erosion of the top soil and reservoir sedimentation:

Disturbed top soil in the area due to use of heavy machinery may lead soil erosion consequently silting the stream and if not checked can be the impact can be significant. To minimise soil erosion the following measures will be undertaken;

i) Carry out reforestation of the disturbed area after construction activities (See Annex 9 for reforestation guidelines).

ii) Limit movement of heavy machinery only to designated access routes and operational areas

Enhancement: skills transfer to local people:

Dam wall construction works will require skilled manpower to ensure dam safety. Since it is company policy to give priority to local people when employing, skills will be imparted in them. This impact is high and of great importance and therefore it will be enhanced by;

i) ensuring there is skill transfer through an elaborate programme

ii) Categorise staff and each group to be supervised by a dedicated skilled personnel to ensure on job training

iii) Encourage job on training through observation and trial under supervision

Operation Stage

Mitigation: To prevent pollution due to increased usage of pesticides and fertilisers:

The presence of a dam wall will entail increased storage of water and therefore increased agriculture usage throughout the year. Consequently more agro chemicals are likely to be used posing a risk of pollution. This impact will be low. To minimise this impact the following measures will be put in place;

i) stick to recommended dosage and frequency of application of agro chemicals (See annex 10 for general pesticides guidelines)

ii) ensure recommended types of agro-chemicals are used

iii) Conduct awareness campaign among communities on dangers of agro chemicals.

Mitigation: To prevent deterioration in water quality:

Pollutant load can be influenced by increase or decrease in water quantity through dilution of the pollutant load. This impact is expected to be moderate and measures to minimise deterioration in water quality will include;

i) Stick to good practices of dam operation rules of ensuring minimum flows in times of low flow

ii) Ensure prior clearance of all deadwood/vegetation prior to dam filling

Mitigation: To prevent change in water quantity in downstream:

The damming of the river is expected to initially lead to decrease in flow downstream causing a significant impact during wet months. Since excess flow during summer season is targeted for filling of the dams this impact is of low significance in the long term. However, the following measures are proposed;

i) Ensure that the design has adequate design provisions to allow flow downstream even in times of dry months.

ii) Apply standard dam operational rules

iii) Observe water right permit regulations and requirements for the sake of downstream water right holders

Mitigation: Encroachment of aquatic weeds:

The encroachment of weeds may result due to increase nutrient load in the reservoir and is not likely to take place immediately. This impact will be of low significance in the short term. However, the developer will from the onset ensure that;

i) a buffer zone between the waterfront and settlement area is created

ii) avoid discharge of any waste effluent into the dam

iii) conduct awareness on invasive aliens aquatic weeds

Mitigation: Deterioration of public health:

Spread of mosquitoes and vectors of malaria are prone to reservoirs and immediate environs. This may threaten public health if no special attention and mitigation measures are put in place.

i) Employ disease vectors disruption techniques such as regulated reservoir operation to curb vectors for malaria and water borne diseases.

ii) Encourage natural aquatic life that takes care of mosquito larva as part of the food chain

Mitigation: TDust Pollution:

Dam construction normally takes place in the dry season which is well known for dust circulation thus posing a danger to human health. Proposed mitigation measure will include

i) Undertake watering of the area and surroundings regularly during construction stage

6.1.2 EQUIPMENT MOBILISATION AND OPERATION

Construction Stage

Mitigation: Loss of wildlife habitat, indigenous flora and fauna

There is not much wildlife habitat or indigenous fauna and flora left in the area. Instead, impoundment of the reservoir is expected to promote aquatic life as well as other small animals. The developer proposes to

i) encourage natural restocking of the area by educating the locals on the benefits of conserving nature

ii) Discourage cutting of trees and unnecessary clearing of vegetation within the area.

Mitigation: Erosion of the top soil

Disturbed top due construction activities may cause soil erosion mainly of top soil leading to siltation of the stream if not controlled. This impact is high. The following measures are proposed

i) limit use of heavy machinery to designated areas

ii) avoid unnecessary clearing of the vegetation

iii) rehabilitate heavily disturbed areas

Operation Stage

Mitigation: Reservoir sedimentation

Soil erosion mainly of top soil may lead to sedimentation of reservoir if not checked. To avoid this developer proposes to;

i) Ensure a buffer zone is created between the water front and occupied areas of human settlement and agricultural activities.

ii) avoid unnecessary clearing of the vegetation

Mitigation: Soil and water pollution due to oil spills

Not well maintained or serviced machinery usage may lead to leakages thus polluting soils and consequently water resources. To minimise this;

i) ensure all machinery and equipment is regularly maintained

ii) limit servicing and repair of machinery and equipment to designated areas

iii) dispose any used oil at a designated place in accordance with the law

Enhancement: Skills transfer to locals

Employing as many local people as possible will enhance skill transfer thus building human capacity in the area. This impact will be high and to enhance it the following measures will be taken

i) adopt a deliberate policy of giving employment priority to locals

ii) design on job training programmes

iii) ensure skilled manpower is employed

Mitigation: Dust Pollution

Dust pollution is expected since the project implementation will take place during the dry season, well known for dust circulation. Measures to minimise this impact will include;

i) The project site will regularly be watered using an interval of two to three hours interval depending on intensity of sunshine.

6.1.3 BORROW PIT OPERATION, MATERIALS HANDLING AND REHABILITATION

Construction Stage

Mitigation: TLoss of productive land, historical and cultural sites:

No historical or cultural sites are expected to be lost. However, agricultural land will be affected though relatively of low significance. Mitigation Measures will include;

i) rehabilitation of affected areas through reforestation

Mitigation: Loss of wildlife habitat, indigenous flora and fauna

No direct interference with any existing wildlife reserves or national parks is expected. However, limited loss of wildlife habitat and flora is expected.

i) Undertake reforestation of affected areas by planting plant species carefully selected to avoid introducing invasive alien species. Both exotic and indigenous plants will be considered for planting in consultation with experts from the forestry department.

Mitigation: Loss of Cultural Sites

No cultural site is reported at the proposed site and as such none is likely to be affected. Should any site be discovered during operation the matter will be brought to the attention of the relevant authorities.

Operation Stage

Mitigation: Erosion of the top soil and reservoir sedimentation

Use of heavy machinery may cause soil erosion causing siltation and sedimentation of rivers/ reservoirs in the Catchment if not controlled. The following measures are proposed;

I) Restrict movement of vehicles and equipment to designated areas

II) Restrict clearance of vegetation to critical areas

Mitigation: Dust Pollution

The project will take place in the dry season and dust pollution is expected. To minimise this following is proposed

i) Regularly water the area during construction works.

6.1.4 INUNDATION OF PRODUCTIVE LAND

Construction Stage

Mitigation: Loss of productive land, historical and cultural sites:

No historical and cultural sites were reported to be located within the project area. However, loss of agricultural land belonging to the project proponent though relatively small is expected.

Mitigation: Loss of wildlife habitat, indigenous flora and fauna

Years of human activity in the area has depleted wildlife habitat, flora and fauna. Nonetheless, the developer will

i) restrict unnecessary cutting of trees and clearing of vegetation to areas

ii) conduct awareness campaigns on the benefit of conserving nature

6.1.5 CHANGE IN STREAM FLOW REGIME AND WATER QUALITY

Operation Stage

Mitigation: To avoid deterioration in water quality in downstream reaches of the stream

Impoundment may increase or decrease (dilution) the pollutant load of receiving waters while withdraws may indirectly lead to an increase of the pollutant loads affecting water quality. Measures will include;

i) Observe standard dam operation rules

ii) Ensure minimum flows downstream at all times

Mitigation: To prevent change in Water quantity in downstream reaches of the stream

Munshiwemba River will not be completely impounded but will allow environmental flows for both the ecosystem and any other activity that may be undertaken downstream at any given time. Measures will include;

i) Ensure that excess flow during summer season is harnessed

ii) Observe Water Right regulatory requirements

Mitigation: To prevent encroachment of aquatic weeds and water quality of the reservoirs

The aquatic ecosystem in newly constructed reservoirs is very unstable and water is often eutrophic as a result of the inundation of fertile land. To minimise this, the developer will;

i) conduct awareness campaigns among the staff and community on the dangers of invasive aquatic weeds

ii) Promote sustainable fishing methods

iii) Minimise nutrient loading through effective usage of agro chemicals

6.1.6 CHANGE IN GROUNDWATER LEVEL AND QUALITY

Operation Stage

Enhancement: To increase in groundwater level

Generally, the project area has poor groundwater yield. The developer will enhance increase in groundwater level by

i) Impound Munshiwemba River to promoting percolation of water to deeper levels.

ii) ensure that the dam is constructed to standard design ensuring that there is no dam wall seepage thus minimizing losses while increasing retention time for percolation

Mitigation: Deterioration in groundwater quality

Decay of organic matter mainly from vegetation can impact on the water quality in the reservoir and in turn lead to contamination of groundwater. The developer will ensure that

i) most of the vegetation is removed from the area prior to dam filling to reduce decaying of organic matter

ii) regulate use of agro chemicals to maintain water quality in the reservoir

6.1.7 WASTE MANAGEMENT

Construction Stage

Mitigation: To prevent pollution due to solid waste

Solid waste in form of rubble and litter is expected during construction. The developer will ensure that

i) waste is collected at selected points for proper disposal

ii) Some of the rubble will be used for compaction in the construction of the dam wall

Mitigation: Deterioration in water quality due to liquid waste

Water quality can be affected by receiving untreated human waste. The developer will

i) provide portable sanitation facilities for construction workers

Operation Stage

Mitigation: Threat to human health

Water pollution due to indiscriminate disposal of waste may lead to water borne diseases. To minimise this

i) encourage the community to have their own household pit latrines

ii) Conduct awareness campaigns among the staff and the community.

6.1.8 SOCIO-ECONOMIC AND CULTURAL

Construction Stage

Mitigation: Displacement of people:

No mitigation measure is required since no single household is expected to be affected due to inundation resulting from dam and spillway construction.

Mitigation: To loss of productive land, historical and cultural sites:

No mitigation is required for loss of historical and cultural sites since none are located within the impoundment area. However, loss of agricultural land belonging to the project proponent is expected. Nonetheless the developer will take the following measures;

i) Take a precautionary measure i.e. should any effect of historical nature be discovered during construction, relevant authorities will be notified immediately.

Mitigation: Loss of wildlife habitat, flora and fauna

The project area has been subjected to years of human activities such as agriculture and charcoal burning and as such not much wildlife habitat, flora and fauna is left. Therefore this impact will be low. However, the following mitigation measures are proposed

i) Limit clearance of vegetation only to critical areas

ii) Conduct awareness campaigns among staff and community on the need to conserve nature

iii) Adopt strict good practices in conservation

Enhancement: Employment Opportunities

Construction of a dam creates opportunities for jobs mainly for the local communities. To enhance this

i) Local people will be given priority for employment as a deliberate company policy.

Mitigation: Increase in local population

During the construction, skilled personnel will add on to the population of the local community. There is also a possibility that the community will receive an influx of labourers looking for employment which will further add on to the local population. Measures will include;

i) Adopt selective employment opportunities targeting locals.

ii) Ensure adequate facilities are provided for staff such as sanitation facilities

Enhancement: Increase in local economic activities

It is also expected that the presence of a dam will result in more fish production and other trading activities in the area. To enhance this developer will;

i) Ensue that the irrigation scheme is operated in a professional manner.

Mitigation: Loss of social and cultural infrastructure

No social or cultural infrastructure will be inundated and therefore no mitigation is required.

Operation Stage

Enhancement: Employment Opportunities

Construction of a dam creates opportunities for jobs mainly for the local communities. To enhance this, the developer will

i) Ensure that the irrigation scheme is operated in a professional manner.

ii) Promote formation of small holder schemes to run by small scale farmers within the community

Enhancement: Economic growth

Reliable water supply throughout the year will effectively enable farmers to increase their production levels to satisfy local demand while at the same time export thus earn the country the much needed foreign exchange thus contribute to overall economic growth. To enhance this, the developer will

i) Ensured effective management of the irrigation scheme

Mitigation: Increase in local population

During the construction, skilled personnel will add on to the population of the local community as well as an influx of labourers looking for employment. Measures will include;

i) Give priority for employment to local people

Enhancement: Increase in local economic activities

Dam construction will provide temporal employment to the local people as well as fishing and other trading activities. To enhance this, the developer proposes to;

i) Ensure that the irrigation scheme is operated in a professional manner.

Enhancement: Skills transfer to locals

Skills transfer through employment of local people will enhance human capacity building in the area. To enhance this, the developer will;

i) Develop a programme for job on training

Mitigation: Threat to human health

Dam construction will also expose the community to the foreign people who may lead to the spread of HIV/AIDS and other STIs. Measures to minimise this will include;

i) sensitise staff and community on the dangers of HIV/AIDs and STIs

ii) support local programmes by Ministry of Health regarding HIV/AIDs

A summary of mitigation and enhancement measures are outlined in Table 6.1 below.

Table 6.1: Summary of Mitigation and Enhancement measures

Potential Impact	Proposed Mitigation and Enhancement Measures
Increase in local population	Local people will be given priority in employment.
Loss of cultural and historical assets	No cultural and historical site is present at the site and therefore no loss is expected
Loss of productive land	No mitigation required since the land belongs to the project proponent
Noise pollution	Noise pollution will be limited to construction phase.
public health	Operation of the dam will be done in a manner that will disrupt disease vectors such malaria
Soil Erosion	Designate buffer zones between settlement and water front
Erosion at construction site	Reforestation will be adopted to rehabilitate exposed areas after construction. Limit heavy machinery to designated routes
Distortion of flow patterns and sediment loads of river	Use of recommended devices to be taken care of during design of the dam. Recommended operating regimes will be adopted.
Distortion in landscape	Minimum access roads will be constructed and borrow pits will be rehabilitated using excess earth and applying reforestation
Air pollution (dust),	Dust will be minimised by regularly watering of construction area.
Destruction of vegetation	Unnecessary vegetation clearing will be prohibited. Reforestate disturbed

	areas
Loss of vegetation, wildlife habitat	Prohibit unnecessary cutting of trees and vegetation clearing
Spread of aquatic weeds in reservoir	Controlled usage of agro-chemicals to limit nutrient loading to the reservoir thus limiting proliferation of weeds
Fish mortality	Clear vegetation prior to dam filling Allow natural fish restocking
Spread of disease vectors in impoundment area	Disrupt disease vectors through controlled operations of reservoirs
Employment Opportunity	Give priority to local people
Economic growth	Effectively manage the irrigation scheme
Capacity Building	Conduct job on training
Change in river discharge	Observe Water Right regulatory requirements for downstream users and environment
Deterioration in water quality due to fertilizer use	control usage of agro-chemicals to standard
Increase in Sedimentation of reservoir	Buffer zones will be created and unnecessary tree cutting will not be permitted as this may lead to erosion enhancing sedimentation

CHAPTER 7 ENVIRONMENTAL MONITORING AND MANAGEMENT PLAN

A monitoring and environmental management plan (EMP) has been elaborated under this section for purposes of addressing identified adverse/positive impacts. Due consideration has been given to various factors that include increased pressure on upland areas above the dam, on-site environmental deterioration as well as decrease in water quality and increase in sedimentation rates in the reservoir resulting from clearing of forest land for agriculture, grazing pressures, use of agricultural chemicals, and tree cutting for timber or fuel wood.

Under the EMP, various mitigation measures have been organised into well-formulated plan, which will serve as a guide for construction and operation phases of the proposed project. Refer to table 7.1.

Table 7.1 BRIEF ENVIRONMENTAL MANAGEMENT PLAN

POTENTIAL IMPACT	MITIGATION MEASURE	OBJECTIVE	BY WHO	BY WHEN
Air and Noise Pollution from Construction and Waste Disposal	continuous watering of construction site to suppress dust, especially in areas were dust emitted is high Noise pollution will be limited to construction phase and confined to day time only	To minimized dust and noise disturbance	Site Engineer and Construction team "	- At Commencement of dam Construction - "
Immigration to Construction Site	- Immigration to construction site would be limited to temporary workers involved in the work. No permanent structures would be allowed at the site,	To reduce the pressure on local resources	- Recruitment Officer in conjunction with Project Manager	- At start of construction works
Loss of Cultural Sites and Historical Assets	- No cultural and historical site is present at the site and therefore, once any are discovered, ZEMA and NHCC will immediately be informed	To preserve cultural sites and articles of historical value	- Construction Team - Project Management	- At the start of sitting, construction and operation of the dam- on going

Table 7.1 Cont. BRIEF ENVIRONMENTAL MANAGEMENT PLAN

POTENTIAL IMPACT	MITIGATION MEASURE	OBJECTIVE	BY WHO	BY WHEN
Conflicting demand for water use, distortion of flow patterns and sediment loads of river	- use of recommended devices to be taken care of during design of dam - Planning and management of dams will be in context of existing laws and regulations	To maintain the minimum flow requirements Ensure equitable allocation of water among water users	- Permits from Water Board	- After completion and approval of EIA by ZEMA
Changes in water quality and sediment load	- Minimum flows will be maintained through dam design and control of usage of agro-chemicals - Sampling and testing of water in the dam for nutrients will be done at least biannually	Ensure acceptable good water quality	- Operations Manager	- Six months after commissioning
Deterioration of Water Quality in Reservoir	- Clearance of woody vegetation from inundation zone prior to flooding - Control of land uses, wastewater discharges- though very limited or none at all - Controlled and effective agricultural chemical use in watershed	To Maintain the water quality in the reservoir	- Construction team	- Prior to filling of the dam

Table 7.1 Cont. BRIEF ENVIRONMENTAL MANAGEMENT PLAN

POTENTIAL IMPACT	MITIGATION MEASURE	OBJECTIVE	BY WHO	BY WHEN
Decrease in flood plain (recession) agriculture	- Regulate releases from dam	to partially mimic natural flooding pattern	- Operation Manager	- On going during operation phase of project
Disruption of riverine fisheries due to changes in flow, blocking of fish migration	- Though not significant, the project will envisage provide fish ladders once identified fish passage and will provide spawning grounds protection - allow natural fish restocking in the reservoirs to compensate for fish loss	to maintain at least a minimum flow for fisheries. to maintain natural fish stocks	- Project proponents - Operation Manager	- Once such fish has been identified
Increase in water related diseases	- Use standard designs and observe operational rules of the dams	To decrease habitat for vector Disease prophylaxis and treatment	- Sanitation Health Education Officer - Project Manager	-On going during operation of dams
Increase in humidity and fog locally, creating favorable habitat for insect disease vectors (e.g. mosquitoes, tsetse)	- Employ disease vector control mechanism	To avoid proliferation of diseases	- Sanitation Health Education Officer	-After completion and commissioning of the dam

Table 7.1 Cont. BRIEF ENVIRONMENTAL MANAGEMENT PLAN

POTENTIAL IMPACT	MITIGATION MEASURE	OBJECTIVE	BY WHO	BY WHEN
Poor land use practices in Catchment areas above reservoir resulting in increased siltation and changes in water quality.	- -Buffer zone created to limit the distance of fields, e.g. Adhering to the Agricultural Act of last 50m away from the water body.	To avoid siltation and sedimentation of water bodies	- Project Manager	- before dam construction and after.
Environmental problems arising from development mode possible by dam.	-Apply basin –wide integrated planning.	to avoid overuse, misuse, and Conflicting uses of water	-operation Manager.	-Commencement of dam of dam.
Proliferation of aquatic weeds in reservoir and downstream Impairing dam discharge, Irrigation Systems, fisheries and Increasing water loss through transpiration.	-Clearance of woody vegetation from inundation Zone prior to flooding, provide need control measure, harvest for Compost, fodder or biogas. -regulation of water discharge and manipulation of water levels.	Minimise (nutrient loading to minimise weed growth	-Operation manager. - Irrigation officer.	- during operation of the dam.
Soil Erosion	- Buffers would be developed and terracing will be implored were appropriate - Apply restoration, revegetation and reforestation to exposed areas	to avoid soil erosion	- Construction team - Project manager	- During construction and operation stage

Table 7.1 Cont. BRIEF ENVIRONMENTAL MANAGEMENT PLAN

POTENTIAL IMPACT	MITIGATION MEASURE	OBJECTIVE	BY WHO	BY WHEN
Formation of sediment deposits at reservoir entrance creating backwaters effects, flooding and water logging up stream	- Sediment flushing and sluicing	To minimise sediment deposits	- Operation Manager	- On going during operation phase of project
Loss of vegetation due to road Construction and Borrow Pits	- Minimum access roads and borrow pits will be constructed. Many roads will be confined to existing cattle and farm paths	To minimize loss of vegetation	- Project Manager	- During dam construction
Sedimentation of reservoirs and loss of storage capacity	- Control land use in watershed, prescribed distances of fields in relation to the dam - Hydraulic removal of sediment (flushing, sluicing, release of density currents)	To avoid loss of dam storage capacity	- Operation Manager	- On going during the operation of the dams
Loss of wildlife and wildlife habitat	- Undertake to revegetate disturbed areas	To Minimise loss of wildlife habitat	- Construction team - Project Manager	- Upon commencement of dam filling

CHAPTER 8 EMERGENCY RESPONSE ACTION PLAN

8.1 INTRODUCTION

This section describes the purpose of this Emergency Response Action Plan (ERAP). It describes the extent of dam hazard area, identifies those responsible for dam operation and implementation of the ERAP as well as describing the procedures for training staff, reviewing, testing and updating the plan. It provides contact information and describes actions to be taken in an event of such flooding.

The purpose of this ERAP is primarily to safeguard lives and secondarily to reduce property damage of local communities who live within Munshiwemba catchment and beyond in an event of flooding caused by a large volume of runoff from or failure of Munshiwemba Intermediate Dam.

8.2 DAM HAZARD AREA

For purposes of this report, dam hazard area is that area that would suddenly get inundated in an event of Munshiwemba Intermediate Dam failure. Munshiwemba Intermediate Dam will be located on farm No. 2380 on Munshiwemba River in Mkushi district. Within the surrounding area are Mkushi Country Club and other commercial Farms with associated infrastructure. No settlements within the catchment will be affected by the proposed dam project. The earth dam will have a catchment area of around 513 Km^2 with an average capacity of 3.5million m^3 at Full Supply Level (FSL). The height of crest above river will be 11.485m and a throwback of about 2.5Km is expected with a surface area of 0.793 km^2.

Filed surveys coupled with pre-failure analysis were performed to determine the extent of inundation in an event that the dam fails. This exercise revealed that no settlements downstream of the dam or within the stream basin would be inundated. It was also noted that the main road used by other farmers would be inundated thus rendering it impassable. Further analysis indicated that, the other dam downstream is positioned

within the potentially hazard area. In conclusion, a main road and downstream dam are located within the dam hazard area.

8.3 RESPONSIBILITY AND AUTHORITY

Chobe will be responsible for maintaining Munshiwemba Intermediate Dam and the operation manager assisted by a team of engineers and craftsmen will be responsible for the operation of the dam. The operation manager will be the ERAP Coordinator and will have an overall responsibility for implementing the ERAP plans for all dams, including training staff and periodic reviewing, testing and updating of the plan. A designated mobile telephone number for the operation manager will be provided as an emergency contact telephone number and circulated to all staff and the public by displaying at strategic places including notice boards. The operation manager will regularly observe the dam. Inspections and routine maintenance would be done three times a year. During high water level conditions, the operation manager will be on 24hrs call. Specifically, the operation manager will be responsible for the following;

- Ensure the ERAP is reviewed and updated annually and copies of the revised ERAP are distributed to all concern.
- Serving as the primary contact person responsible for coordination of all emergency actions
- Preparing emergency management personnel for possible evacuations when required.
- determining the emergency level as soon as an emergency event is observed or reported.
- Notifying staff, Ishiba Dam Syndicate and Mkushi District Disaster management and Mitigation Committee
- Providing updates of the situation to the relevant authorities in making timely and accurate decisions regarding warnings and evacuations.

- Initiating warnings and order evacuation of people at risk downstream of the dam.
- Decide when to terminate the emergency.

8.4 IDENTIFICATION OF EMERGENCY

Identification of an emergency involves events or conditions that indicate an emergency. This is followed by defining the levels of emergency and deciding how staff and the general public will be notified in the event of an emergency.

When dam failure has occurred or when dam failure is imminent the situation is described an emergency. Floods are a major cause of dam failure and therefore monitoring the dam during high water level conditions is critical. However, failure may also occur during normal conditions, and this failure tends to be the most dangerous because the resulting flood would be sudden. The operation manager and his team shall pay particular attention to; indicators of a potential dam failure which include;

- New sinkhole in reservoir area or on embankment
- Sudden or rapidly proceeding slides of the embankment slope
- Damage to dam or appurtenances that has resulted in uncontrolled water release
- Excessive seepage or cloudy seepage through the abutments or embankments
- Settlement or cracking in the embankment
- Large cracks in the spillway
- Noticeable movement of the spillway
- Spillway flowing with active gully erosion
- Overtopping flow eroding the embankment slope
- Slumping or sloughing of the embankment
- Excessive erosion on the embankment, below the spillway, or at the abutments

8.5 NOTIFICATION GUIDELINES

The responsibility for notification of staff, the public and relevant authorities will lay with the operation manager. Two critical steps will define the notification process. The first step will be the detection of an unusual or emergency event. The second step will be the classifying of the event into one of the following three emergency levels.

Emergency level 1:–

It's a non-emergency but, unusual event and slowly developing. This situation would not be normal but not yet a threat to the operation or structural integrity of the dam. However, it may continue to deteriorate. The operation manager and his team will investigate the situation and recommend actions to be taken.

Emergency level 2:–

It's a potential dam failure situation, rapidly developing. This situation may eventually lead to dam failure and flash flooding downstream, but there is not an immediate threat of dam failure. Should this occur, the project manager will closely monitor the condition of the dam and periodically report the status of the situation to the relevant authorities. If the dam condition worsens and failure becomes imminent, Mkushi Disaster Management and Mitigation Committee and Ishiba Dam Syndicate membership will be notified immediately of the change in the emergency level to ensure people at risk downstream are evacuated. Chobe working in conjunction with relevant authorities will facilitate the process. Meanwhile, the operation manager and engineers will evaluate and recommend remedial actions to prevent failure of the dam. This emergency level will also be applicable when flow through the earth spillway has or is expected to result in flooding of downstream areas and people near the channel could be endangered.

Emergency level 3: –

It's urgent and dam failure is imminent or in progress. This is an extremely urgent situation when a dam failure is occurring or obviously is about to occur and cannot be prevented. Flash flooding will occur downstream of the dam. This situation will also be applicable when flow through the earth spillway is causing downstream flooding of people and roads. The operation manager will inform relevant authorities including

Mkushi District Disaster management and Mitigation Committee while at the same time make arrangement for immediate emergency services to evacuate all the people at-risk.

8.6 PERIODIC TRAINING, REVIEW, UPDATING AND TESTING

The ERAP will from time to time be reviewed, updated and tested. Training of members of staff to handle an emergency situation at Munshiwemba Intermediate Dam will be a continuous process. Annually the operation manager will verbally review the plan with members of staff to explain the procedures to follow in the event of an emergency, address any changes that need to be made in the plan, answer questions regarding the procedures, and test their understanding of the plan by stimulating a dam failure.

8.7 TERMINATION

Whenever the ERAP has been activated, an emergency level has been declared, all ERAP actions have been completed, and the emergency is over, the ERAP operations will eventually have to be terminated. The operation manager, in liaison with Mkushi Disaster Management and Mitigation Committee will be responsible for terminating ERAP operations and relaying this decision to Chobe Agrivision Limited. It is then the responsibility of project manager to inform others (team of engineers and dam operators) to notify others that the event has been terminated.

In an event of an Emergency of Level 3 event that has not caused actual dam failure, the engineers will inspect the dam to determine whether any damage has occurred that could potentially result in loss of life, injury, or property damage. If it is determined that conditions do not pose a threat to people or property, the engineers may advise the project manager to terminate EAP operations as described above.

Chobe through the operation manager shall ensure that the Dam Safety Emergency Situation Report is completed documenting the emergency event and all actions that were taken then avail copies to relevant authorities including the Water Board.

A summary of emergency events, suggested remedial action and responsible person is elaborated in Tables 8.1a to 8.1c.

Table 8.1a: EMERGENCY LEVEL 2: Potential dam failure situation, rapidly developing

Emergency Event	Emergency remedial actions	Responsibility
Seepage and sinkholes	1. Open principal spillway gate to lower the reservoir level as rapidly as possible to a non-erosive velocity. If the gate is damaged or blocked, pumping or siphoning will be employed instead. 2. If the entrance to the seepage origination point is observed in the reservoir (possible whirlpool) and is accessible, plug the entrance with readily available materials, such as hay bales, bentonite, soil or rock fill, or plastic sheeting to reduce flow. 3. Cover the seepage exit area(s) with several feet of sand/gravel to hold fine-grained embankment or foundation materials in place. Alternatively, Construct sandbag or other types of ring dikes around the seepage exit areas to retain a pool of water, providing backpressure and reducing the erosive nature of the seepage. 4. Prevent vehicles and equipment from driving between the seepage exit points and the embankment to avoid potential loss from the collapse of an underground void.	Operation Manager Team Of Engineers Dam Operators
EMERGENCY LEVEL 1: Non-*emergency , unusual event and slowly developing*		
Suspected Dam Failure	1. Mobilise technical staff to investigate the event 2. Continue monitoring the situation 3. Open the gates to allow more flow and avoid bleaching	

Table 8.1b: EMERGENCY LEVEL 2: Potential dam failure situation, rapidly developing

Emergency Event	Emergency remedial actions	Responsibility
embankment overtopping	1. Place sandbags along the low areas of the top of the dam to reduce the likelihood of overtopping and to safely direct more water through the spillway. 2. Cover the weak areas of the top of the dam and downstream slope with riprap, sandbags, plastic sheets, or other materials to provide erosion resistant protection.	Operation Manager Team Of Engineers Dam Operators
Embankment movement	1. Open outlet(s) to lower the reservoir to a safe level at a rate proportionate with the urgency and severity of the condition of the slide or slump. If the gate is damaged or blocked, pumping or siphoning will be employed instead. 2. Repair settlement of the crest by placing sandbags or earth and rock fill material in the damaged area to restore freeboard. 3. Stabilise slides on the downstream slope by placing a soil or rock fill buttress against the toe area of the slide.	Operation Manager Team Of Engineers Dam Operators

Table 8.1c: EMERGENCY LEVEL 3: Urgent, dam failure imminent or in progress

Emergency Event	Emergency remedial actions	Responsibility
Potentially Disastrous Event of Dam Failure	1. Contact emergency services that include fire brigade, disaster management Unit and others. 2. Issue warnings, close roads, and evacuated people at risk downstream from the dam. 3. Alert the general public and immediately evacuate at-risk people and close roads as necessary. 4. Maintain continuous communication and provide the relevant authorities with updates of the situation to assist him in making timely decisions concerning warning and evacuations. 5. Record all contacts that are made, all information, observations, and actions taken on the Event. 6. Ensure everyone follows procedure by stay away from any of the failing structures or slopes and out of potential breach inundation areas.	Operation Manager Team Of Engineers Dam Operators

CHAPTER 9 REVIEW OF ENGINEERING DESIGNS AND CONSTRUCTION

During the design phase many factors were considered within the EIA context. These included consideration of optimum dam height, optimisation of dam operation and fine tuning of the reservoir operation curve, alternative dam locations (for minimisation of impacts to all environmental factors) as well as optimisation and management of the development for maximum benefit. The following sections below highlight a review of the engineering designs and construction;

9.1 DESIGN DATA FOR THE PROPOSED UPPER DAM

The design data for the proposed earth dam is summarised in the box given below.

Design Details

Dam wall length	300m
Total Spillway width	6m
Maximum probable flood 10000yr	825 cu m/s
Design flood 1 in 50yr	590 cu m/s
Mean Annual Precipitation (Map)	1100mm
Coefficient of Variation	80%
Capacity at F.S.L	3500000m3
Surface area at FSL	79.3ha
Throwback	2.52m
Annual Yield at 20% risk	145640m3

9.2 DAM DIMENSIONS

The dam dimensions shown in Table 9.1 were obtained using the Catchment Area Map, Provisional Basin Survey and Storage Volume Curve. In addition information on proximity of dam to major roads and other infrastructure was obtained. The findings

revealed that no major road installation or any other infrastructure will be affected by the proposed dam.

Table 9.1 Dam Dimensions

Catchment Area	**513km2**
Volume at depth of 11.485m	3500000m3
Surface Area at depth of 11.485m	0.793km^2
Length of dam at Full Supply Level	2.52km

9.3 CONSTRUCTION PROCEDURES

All material properties, construction procedures and testing will be described in the dam design report. The site engineer will inspect works at all critical stages, notably;

- River bed foundation preparations including removal of inferior material
- Core trench excavation
- Rock surface preparation under the earth wall core, spillway area and in the tail water section
- site clearing and stripping of subsoil
- Removal of tree stumps and roots from the site foundation
- Removal of anthills and workings
- Excavation and exploration of any joint fissures on faults in the rock, and their treatment

Soils tests will be carried out on borrow areas and embankments and moisture conditions of the soil. The embankment will be a zoned type earth embankment. Positioning of the material within the embankment will be directed by the site engineer following detailed soil testing of borrow material.

REVIEW OF PROCEDURES

Prior to commencement of work on the embankment, the centre line will be marked by pegs, curves will properly laid out, top and bottom edges of the excavations and toe of all embankments and spoil banks will clearly be lock-spitted. The seat of the embankment will be prepared to receive the new earth and for which the whole site

will be cleared of trees, roots, shrubs and grass which might decay and form dangerous pockets. All loose surface or soft soil will be removed and surface roughened by ploughing or digging all over. Small trenches will be dug out in the bed to unite the body of the new embankment to the subsoil. For embankment stability, its foundation will be strong enough to withstand the enormous weight of the dam. To achieve this, slopes will be made as flat as practicable so that the shear stress produced in the foundation is less than the shear strength of the foundation material. Furthermore, for embankment stability, it will be made watertight and non-slipping.

Soils to be used in the embankment will be tested for cohesion, liquid limit, moisture content, permeability, shear and compression. Side slopes will be carried up simultaneously with the rest of the work and not filled in afterwards. Each layer of the embankment will be rolled well until all clods are flattened. Any roots or grass will be buried in the banks along with the earth. Compaction using water will be used to speed up the process.

The embankment will be constructed with a core wall of impervious material to provide a barrier to the passage of seepage water from the waterside to the rear of the dam and also to the passage of the burrowing animals that may cause dangerous breaches in the embankment. The material used in core wall will require proper conditioning and consolidation.

All drainage works will be done according to specifications. This will be ensured by the supervising site engineer. Proper drainage is necessary to remove water which may get into the heart of the dam due to percolation, leakage or rains.

Dam and Water Management

Bulk Water

The Bulk Water delivery system to irrigated fields will be put in place with due consideration to pipe type, length, diameter and pump size.

Irrigation Areas

Commercial farming irrigation areas will be under centre pivot irrigation. The centre pivot has been chosen among other reasons due to;

- Low capital cost per hectare irrigated
- Low labour and energy requirements
- Ease of operation
- High application and distribution efficiencies
- Prospect of increasing or maintaining yields while using less water

Preliminary Cost of Works

Table 9.2 below provides preliminary cost estimates for the construction of the proposed dam. Note that capital equipment costs are not included since Chobe already has in possession all the required earth moving equipment and trucks within its investment portfolio.

Table 9.2: Preliminary Cost Estimates

CATEGORY	UNITS	COST US$	Contingency 5%	Total Cost	Comments
Clearing	Ha	25,000	1,300	26,300	
Excavations	M^3	40,000	2,500	42,500	
Backfill	M^3	85,000	6,000	91,000	
Concrete Work	-	95,000	5,500	100,500	
Outlet Works	-	30,000	2,000	32,000	
Labour @ 5%	-	-		14,600	**Partially Contractor**
TOTAL (estimate)		**275,000**	**17,300**	**US$306,900**	

9.4 DAM DECOMMISSIONING

A number of reasons exist for decommissioning a dam and these include; obsolescence, environmental concerns, economics, safety criteria, risk reduction, and operation and maintenance costs. Note that many dam failures occur either

during construction or during or shortly after reservoir filling. However, the unique nature of each dam entails that every structure is expected to age at a different rate in a different way. Some dams may remain safe for a thousand years, others may start to crack and leak after less than a decade.

The proposed process of decommissioning will involve the study of all alternatives including repair and upgrade and decommissioning. If decommissioning is the selected alternative, activities associated with the process will include;

- Undertaking of feasibility study for decommissioning
- Reviewing of alternatives
- Build consensus with other stakeholders
- Undertake impact assessment for decommissioning
- Commence decommissioning and Restoration
- Undertake continuous operation and maintenance

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ANNEXES

Annex 1: Borrow Pits

Since the dam to be constructed will be an earth dam, gravel for the embankment would be obtained within the project area 500m meters away supplemented by spillway excavation. However, this will be some distance from the stream as the suitability of gravel from this site was confirmed by laboratory tests on the material and approved by the project design consultant Engineer Muzumara in accordance with project specifications which meet the requirements of standard specifications for dam construction.

The project is obliged to present details of how it intends to undertake the works on the borrow pit site with due regard to environmental concerns which are bound to arise thereof.

Description of activities

The main objective of the intended activities at the potential borrow pit site is to provide gravel for the dam embankment and the outlined activities would be carried out at the borrow pit.

a) Removal of Top Soil

Top soil thickness in the area would range between 0.3 – 0.4 m. The topsoil will be removed and stockpiled besides the pit for later use in the final stages of rehabilitation of the borrow pit. An excavator machine would do the cutting and stock piling of the topsoil.

b) A sizeable area would be excavated for gravel to a depth of 1.5 meters during the project period using a heavy – duty excavator. Then gravel would be loaded onto tipper trucks using the same excavator and transported to site.

Expected Environmental Impacts

Vegetation

There are patchy trees on the proposed borrow pit apart from the elephant grass that has grown on site. In terms of vegetation, the area carries very limited ecological and commercial value. Excavation of gravel shall prevent the growth of grass during the

extraction period. But it is anticipated that growing will resume after restoration of the landscape.

Dust

Dust is expected to be generated from the excavation, loading, transportation and tipping operations. The construction would be done far away from settled areas and machine operators will be provided with safety wear by the contractor.

Land degradation

This is being considered as the most significant impact which would require more attention as it is well understood that the activities would degrade the land leading to severe environmental and social impacts.

MITIGATION MEASURES

Vegetation

There would be natural revegetation occurring after restoration because the topsoil material that was stockpiled will be used to spread over the bp. This would allow the natural revegetation since the soil acts as a seed bank.

Dust

During excavation, the contractor shall employ all wet production were possible and supply of safety wear to reduce the emission of dust during excavation and loading. This also assist reduce the dust during transportation. In addition the loaded material on the tipper trucks shall be restricted to designated routes only.

Land degradation

The mitigation measures are well explained under the rehabilitation plan below.

BORROW PIT REHABILITATION

(a) Topsoil, which has been established at 0.3 -0.4m thick, shall be removed and stockpiled for final stages rehabilitation of borrow pit.

(b) Excavation for gravel shall be limited to 1.5m deep.

(c) The grass and any twigs shall be cut and composted and used later for site rehabilitation.

(d) Only one access route to the pit shall be maintained and this shall be kept as small as possible. At the end of the material removal, the topsoil shall be replaced.

(e) The gradient of the borrow pit slopes shall be kept as low as possible (Sloppy).

(f) The borrow pit shall be clearly marked and signaled to ensure safety of humans who may wander near the pit during the construction phase. Otherwise the site shall be restricted to any other person.

(g) At the end of material removal, the borrow pit shall – fill with stockpiled sub and topsoil and leveling of the soil forming a gentle slope and allowing natural revegetation occurring.

Annex 2: List of Participants for the Scoping Meeting

Absentees but Invited:

1. Department of Agriculture – Mkushi
2. Lunsemfwa Hydropower Company
3. Zambia Environmental Agency.

NO	NAME	CONTACT NO	ORGANISATION	Signature
1.	Garryingtone Mukupa	0967 898 738	Mkushi District Council	
2.	Innocent Mwenya	0977 898 287	M Mkushi District Council	
3.	Don Stacey	0966 683 306	Masebe Ranch	
4.	Mupenda Victor	0966 285 626	Envsol	
5.	Patricia Mupenda	0975 096 484	Envsol	
6.	R. Street	0977 352 139	Broywel Farms	
7.	M. Thorne	0966 861 172	Cema Farms Ltd	
8.	Peter Micheal Goetsch	0966 661 133	Cameo Estates	
9.	Malama Felix	0976 450 200	Tazara	
10.	Mwiza Muzumara	0977 405 352	-	
11.	Bill Nicolson	0974 772 340	Chobe Agrivision	
12.	Fred Wallis	0974 056 131	Chobe Agrivision	
13.	Paul Francis	0974 683 445	Francis Farms/ Ishiba	
14	Nico de kock	0966 362 000	Fisanga Ltd/ Ishiba	
15	Simon Hunt	0966 689 271	Friston/ Ishiba	

Annex 3 – Minutes of the Scoping Meeting

MINUTES OF THE SCOPING MEETING FOR TEMBWE RIVER DAM PROJECT

HELD ON 13TH AUGUST, 2011

AT THE PARKLANDS FARM PREMISES, MKUSHI

1. INTRODUCTION

The proposed development involves construction of two earth dams, one on Munshiwemba River while the other within a dambo area. The principal overall objective of the project is to capture runoff water for irrigation, enhance and develop sustainable agriculture through appropriate sound farming practices of benefit to the host communities and the country at large.

As part of the transparent consultative process, and in order to take public views into inclusive account in determining the scope of the Environmental Impact Assessment (EIA), a public consultation meeting was held at Parklands Farm Premises in Mkushi Farming Block on 13th August, 2011. This meeting was attended by relevant stakeholders as well as other interested and affected parties. (See a full attendance list attached).

2. MEETING PROCEEDINGS

The Meeting chaired by Mr Fred Wallis, was called to order at 11 15hrs hrs. He welcomed all participants and thanked them for finding time to attend the meeting. He gave a brief historical background of the project and then called upon Mr Nyundu (Consultant) to make a presentation.

Mr Nyundu, a member of the EIA team of Consultants from Envsol Consult, outlined the Agenda for the Meeting. He went on to highlight the objectives of the meeting stating that it was twofold. One objective was (a) to inform stakeholders about the proposed project and its proposed activities and the other was, (b) to give all stakeholders a first-hand opportunity to objectively raise issues of concern. This was further followed by presentations by Mr Nyundu on the Scope of the proposed

project and Key Specific Issues to be considered during the Environmental Impact Assessment (EIA). After the presentation, participants were then called upon to verbally give their comments, concerns or indeed ask questions.

Besides, Mr Nyundu outlined the Environmental Impact Assessment (EIA) process. He defined EIA in simple terms as being a study which attempted to determine the potential impacts (both positive and negative) of proposed activities and to suggest mitigating measures as well as to monitor the implementation of these measures. He pointed out that an EIA was an opportunity for interested parties to comment on the proposed activities and to raise valid concerns that may need particular attention.

Plenary Session

After the presentation, the Chair called upon the participants to seek clarification, ask questions or voice their concerns pertaining to the presentations and the project in general.

Questions/ Discussions

1. Mr Don Stacey wanted to seek clarification as which Act was in force between the newly enacted Water Resources Management Act and the Old Water Act with regard to provisions relating to water rights.

   In response, Mr Nyundu stated that the old Water Act was still in force until such a time when the newly enacted Water Resources Act is actualised by the Minister. Once the Water Resources Management Act is actualised, it will provide for the establishment of the National Water Resources Management Authority replacing the Water Board. At the moment the Water Board established under the old Water Act was still functional and still administering relevant provisions of the Water Act.

2. Mr Simon Hunt expressed concern over his existing water right for his dam downstream of the proposed Munshiwemba Intermediate Dam. He wanted to

know whether the proposed dam will negatively affect his water right to his existing dam which he hoped would not be the case.

In response, Mr Nyundu stated that according to the provisions of the Water Act, before any dam is constructed the Water Board will review the designs to ensure that the dam once constructed does not completely stop flow downstream. He further informed Mr Hunt that the issue of water right will adequately be addressed by Water Board once the study is completed and the report submitted to Zambia Environmental Management Agency who will in turn consult the Water Board before any decision is made.

3. Mr Peter Micheal expressed concern that some of the dams constructed in the past within Mkushi farming block did not involve stakeholder consultations before being constructed. He further wondered whether it was mandatory that a scoping meeting is held as a first step before implementing a project such as a dam project.

   In response, Mr Nyundu explained that it was a requirement by law that a scoping meeting be held as an initial step to undertaking an environmental impact assessment. Further he informed the audience that the minutes of the meeting will be recorded and presented together with the terms of reference to ZEMA for approval. Besides, each stakeholder in attendance will have a copy of the same minutes sent to him or her for record.

4. Mr Peter Michael wondered whether the developer of the proposed two dams will invite other interested farmers to be part of the development and benefit in the use of the water in the dams once constructed.

   In response, Mr Nyundu stated that the issue of who directly benefits from the dam is open for discussion with the developer. He further said it required evaluating the cost of investment and establishing input of each potential participant in terms of proportion of water to be abstracted from the dam once it's constructed based on level of investment.

5. Mr Mwiza Muzumara wanted to know who determines which person should participate in abstracting water from a dam once it's constructed or whether the developer has a right to prevent other farmers from using water in a dam.

   In response, Mr Nyundu said that construction of a dam is just like any other development project and can involve one entity or more coming together prior to implementation to establish costs involved. Then decide proportions of contributions towards the cost that will consequently relate to how much benefit each investor gets. As such he said that the issue is one which should be discussed with the developer for those interested to be partners.

6. Mr Nico de Kock wanted to know whether one of the dam named as Whispering Hope is the one already in existence.

   In response Mr Nyundu clarified by stating that the proposed two dams are yet to be constructed and currently there is no existing structure at any of the two proposed project sites.

7. Mr Mwiza Muzumara wanted to know how the study will rank importance of certain impacts in relation to others before a decision is made as to whether the project could go ahead or not, particularly he cited the issue of what is more important the wellbeing of insects or human beings.

   In response, Mr Nyundu stated that in undertaking the study particularly in rating impacts certain criteria is used relating to significance, magnitude and extent of a given impact. This would help in ranking the impacts on whose basis decisions can be made. He further said that every element is an important factor in environment as it constitutes part of the ecosystem.

8. Mr Simon Hunt stated that he received the invitation late and expressed worry that this may have applied to other stakeholders who may not have made it to attend the meeting.

In response, Mr Fred (Developer) regretted that the invitation reached Mr Hunt late. He reiterated the fact that invitation letters were sent a week before and those who received the letters on delivery signed for them. In addition, Mr Nyundu said that the meeting was just the beginning of the many consultations that will be done during the cause of the study. Besides, stakeholders were still free to make further submissions in writing and send them to the study steam any time in the course of the study.

9. Mr Nico de Kock requested that the minutes of the meeting be circulated to everyone for record.

   In response, Mr Nyundu agreed to the requested and promised to send the minutes to the developer who will in turn circulate them to all stakeholders in attendance.

3. CONCLUDING REMARKS

After a lengthy discussion, Mr Fred thanked the participants for freely expressing themselves and indicated that, the team of consultants from Envsol Consult will ensure that all issues raised would be taken into consideration when carrying out the study. He went on to state that this Scoping Meeting was therefore the beginning of the recommended consultations and as such, he would like to ask for the full co-operation of the participants in the follow-up consultations.

The meeting then closed at 12 50 hrs.

Annex 4 –Sample of Invitation Letter for Scoping Meeting

CHOBE AGRIVISION
MKUSHI
Telephone: 0974 772 340

TO:

Dear Sir / Madam

RE: INVITATION TO A SCOPING MEETING FOR THE PROPOSED DAM PROJECT ON MUNSHIWEMBA RIVER

Chobe Agrivision Limited intends to construct an earth dam on Munshiwemba River a tributary of Lunsemfwa River at its farm within Mkushi Farming Block.

Envsol Consult has been engaged as consultants to undertake an Environmental Impact Assessment (EIA). An important part of this assessment is stakeholder consultations. A scoping meeting will be held prior to commencing the environmental studies in line with the Environmental Impact Assessment Regulation of 1997. The purpose of this meeting is to get views and concerns of stakeholders, interested and affected parties so that they can be taken into account within the EIA.

As one of the key stakeholders your views over this project and support would be valuable to the successful implementation of this dam project. In this regard, you are cordially invited to attend a scoping meeting on **13th August**, **2011** at **1030hrs, venue is Parklands Farm Premises within Mkushi farm block in Mkushi district**. Your presence at this meeting is highly valued. However, if you are unable to attend in person kindly send your representative. For clarification and further information kindly contact Mr Nyundu on mobile 0966 780 120, email: kapalu69@yahoo.com.

Bill Nicolson
Director- Chobe Agrivision Limited

SCOPING MEETING AGENDA 13TH AUGUST 2011

AGENDA

- Registration of participants
- Welcoming Remarks
- Introductions of participants
- Presentation on the Project and EIA process
- Plenary discussions
- Remarks by Distinguished guests
- Way Forward
- Closing Remarks

Annex 5: Minutes of Further Consultative Meeting with Ishiba Dam Syndicate

MINUTES OF THE CONSULTATIVE MEETING WITH ISHIBA DAM SYNDICATE FOR THE PROPOSED DAM PROJECTS BY CHOBE AGRIVISION

HELD ON 20th OCTOBER, 2011

AT THE FOREST INN, MKUSHI

1. IN ATENDANCE

- Mr Angus Campell of Kurima Investment
- Mr Por Gotsch of Cameo Estates
- Mr N.E. de Kock of Fisanga Ltd
- Mr DCJ Strea of Brodawell Farms
- Mr Alex Holding of Cenis Farms Ltd
- Mr Simon Hunt of Friston Farm
- Mr K. Nyundu - Consultant

2. INTRODUCTION

These minutes are as a result of a follow up consultative meeting with Ishiba Dam Syndicate regarding the proposed development involving construction of two earth dams, one on Munshiwemba River while the other within a dambo area. Resulting from the scoping meeting, it was felt that Ishiba Dam Syndicate were not fully represented and therefore the Consulting team arranged for a further consultative meeting.

2. MEETING PROCEEDINGS

The Meeting was called to order by Mr Kenneth Nyundu, the Consultant at 0915hrs. He welcomed members of Ishiba Dam Syndicate and thanked them for finding time to attend the meeting. He reminded members of Ishiba Dam Syndicate that the meeting was called in order for them to make submission regarding the proposed dams being one of the stakeholders in the catchment.

Mr Nyundu briefly outlined the details of the proposed project and requested members in attendance to make their submission. The Chairperson of the Syndicate made a submission on behalf of other members. In addition individual members further gave oral submissions. In summary, the following were the issues raised;

- The Syndicate felt that with all the existing dam development in the catchment, Munshiwemba Catchment was fully subscribed and can no longer accommodate additional reservoirs
- The Syndicate felt that the notice given to them to attend the scoping meeting for the proposed dam was inadequate and requested for another scoping meeting
- The syndicate felt that the data provided in the dam design reports was not accurate specific reference was given to mean annual precipitation which was stated as being 1100mm in the dam design report. The syndicate felt that this was too high and as far as the syndicate was concern the figure should be below 1000mm.
- The Syndicated doubted if the proposed Munshiwemba Intermediate Dam can hold 3.5million cubic meters of water without over topping the upstream Masebe dam
- The syndicate felt that the data provided during the scoping meeting was not accurate particular reference was given to the farm plot number the location for the proposed dam projects
- The Syndicate further felt that the proposed dams will affect their dam downstream since it was yet to fill up
- The Syndicate further felt that Chobe Agrivision the proponents of the project should allow other farmers in the area to abstract water in the proposed dams on agreed upon terms

4. RESPONSE FROM MR NYUNDU

In responding to the issues raised by the Syndicate, Mr Nyundu noted that most of the issues raised by the Syndicate hinged on granting of water right permit by Water Board and had little to do with environmental concerns the scope of the environmental Impact study. He however, noted that as downstream stakeholder,

Ishiba Dam was likely to be temporarily affected in terms of reduced flow and as such mitigation measures will be proposed.

With regard to the demand for another scoping meeting, Mr Nyundu said that that would not be necessary since another consultative meeting was being arranged specifically for the syndicate. Since the purpose of the scoping meeting is merely to get views and opinions of stakeholders regarding the proposed development, the consultative meeting would still achieve the same purpose.

In reference to the farm plot number, he informed members of the syndicate that the farm plot number was corrected during the same scoping meeting to reflect the true location and the developer apologised for the typo error.

With regard to the alleged inaccurate dam design data, Mr Nyundu said that he believed that the data was correct. However, he promised to consult the dam design engineer to establish if there was any misrepresentation of figures and make changes if necessary.

Concerning the catchment being fully subscribed, Mr Nyundu said that this issue remained debatable particularly that the catchment is ungauged. He advised the Syndicate to work together with all stakeholders in the catchment and commission a detailed water balance study for the whole catchment to establish the true accurate status of water availability. As the situation currently was and based on available limited data there was still room for further development in the catchment

Regarding the issue of partnering up with Chobe Agrivision in the utilisation of the water from the proposed dam, Mr Nyundu said that it was an investment issue that can only be resolved by engaging into discussions with concern parties on how best this can be done since it hinged on cost of investment.

He further, informed the members of the syndicate that it was not intentional that the invitation for the scoping meeting delayed to reach the syndicate. Nonetheless, the consultative meeting that was being deliberated was an opportunity for them to

make submissions as a group of which all issues raised would be given serious consideration during the EIA study.

3. CONCLUDING REMARKS

After a lengthy discussion, the meeting closed by resolving that the consultant will take on board all points raised in the EIA study. The meeting closed at 1020hrs.

Annex 6: CVs of EIA TEAM

CURRICULUM VITAE (CV) 1

PERSONAL DATA

Name:	Kenneth Nyundu
Date of Birth:	12/01/69
Marital Status:	Married
Current Address:	P.O. Box FW 238, Lusaka. Zambia
Permanent Address:	Plot 13844, Hillview Park, Lusaka. Zambia
Contact Tel. Numbers:	260-966-780 120 (mobile)
Email Address:	kapalu69@yahoo.com
Work Expérience:	18 Years
Profession:	Water/ Environmental Ressources Engineer

ACADEMIC QUALIFICATION

Education

1988-1994 BACHELOR OF ENGINEERING DEGREE (B.Eng -University of Zambia, Lusaka. Zambia)

1998-2000 MASTER OF SCIENCE IN WATER AND ENVIRONMENTAL RESOURCES MANAGEMENT (MSc - International Institute for Hydraulic, Water and Environmental Resources management. Delft. The Netherlands)

SPECIALISED TRAINING

August 2002 Zambia Institute of Advanced Legal Education/ IWLRI Dundee
Certificate- International & National Water Resources Law

Nov 2002 Swedish International Development Cooperation /Tanzania
Certificate - Environmental monitoring and management

August 2002 Zambia Institute of Advanced Legal Education/ IWLRI Dundee
Certificate- Advanced Negotiation Skills

Sept 2004 University of Zambia/ Danish B Laboratories Denmark
Certificate- Applied GIS for Public Health Surveillance

Nov 2004 University of Science and Technology, Suzhou, China
Certificate- Environmental Quality Management and Impact Assessment

WORK EXPERIENCE

1999-2000- Assistant Researcher

- Worked for six months as Research Assistant at Swiss Federal Institute of Environmental Science and Technology on an exchange programme with IHE Delft in Netherlands. Research Project area of focus was Danube delta.

2004-2005 Policy Development

- I have been involved in the development of policy paper development. For the formulation of the SADC Regional Water Policy.

- I was part of the team of experts working on the revising of the National Water Policy with assistance from GTZ

2002- Team member

- I have been involved in the study for mapping of the Miombo Eco-region coordinated by Wild Wide Fund for Nature (WWF)

2003- Water Quality Expert

- I have been part of the technical team for Assessment of Pollution to African Cities Aquifers (Lusaka) project supported by UNEP and co-ordinated by UNZA

2000- 2005 – Principal Consultant

- Team leader Environmental Impact Study for the construction of two dams covering 210 and 610 ha respectively on Mushiwemba River in the Mkushi farm block

- Team leader Environmental Impact Assessment study for Mean wood Housing Project for the construction of more than 3000 housing units in Lusaka near Chainda area

- Team leader Environmental Impact Assessment study for Ndeke Housing project for the construction of more than 4000 housing units near the International airport

- Team leader Environmental impact study for setting up of a Quarry for Stones in Lusaka West under Trishu Investments

- Team member Environmental impact study for Cage fish farming in Siavonga on the Zambezi River Banana Island for Lake Harvest ltd.

- Team leader Environmental impact assessment brief for Overland Missions in Livingstone for setting up of a logistical centre for regional relief supplies near Batoka Gorge

- Team leader Environmental impact assessment brief for setting up of Vineyard lodge in Livingstone along the Zambezi river Chief Mukuni area

- Team leader Enviornmental impact assessment for the construction of Munda dam in Mkushi farming block

- Environmentalist for implementation of Resettlement Programme for the construction of Munshimbili Dam in Kapiri Mposhi funded by AfDB.

- Team leader Environmental impact assessment for the construction Mwomboshi dam in chisamba

- Team leader Environmental impact assessment for the construction Tembwe dam in Mkushi farming block.

- Team leader for Environmental Impact Assessment for Masasa dam project for Syringa Entreprises Mazabuka Zambia
- Team member Environmental Impact Assessment for the Construction of the Spinal Road in the Kafue National Park by Roads Development Agency.
- National Consultant for African Development Bank for Post Evaluational of the Central Province of Zambia Rural Water and Sanitation project
- Consultant for Food and Agricultural Organisation for preparation of the National Investment Profile for Zambia for Water for Energy projects.
- Consultant for Zambia Environmental Management Agency for preparation of the Water Resources Chapter for Zambia's Environmental Outlook.

2000-2001 **National Co-ordinator** – RITS Project funded by DFID (Research Study into Rural Community Water Sources)

- Responsible for overall management of the project- preparing quarterly plans, budgets and supervision of staff.
- Responsible for design, collection of field data and analysis regarding water supply sources including sanitary conditions and hygiene practices
- Responsible for documentation and dissemination of research findings.
- Responsible for organising and conducting sensitisation and training workshops at district and national level. In addition, arranged collaborative workshops with other agencies involved in the water sector such UNICEF and Water Aid
- Responsible for assisting district staff develop work plans, budgets and project proposals for possible funding by other donor agencies

1997-'98 **Water/ Sanitation Site Engineer** (Attachment to Ireland Aid Water/Sanitation Project of Northern Province)

- Responsible for supervision of water and sanitation projects
- Supervised rehabilitation of Water/sanitation plants, drilling of boreholes, construction of Ventilated Improved Latrines
- Served as site engineer for the rehabilitation and expansion of Isoka, Mporokoso and Kaputa districts water supply plants

Part-Time Employer

University of Zambia, School of Civil and Environmental Engineering, Box 32379, Lusaka.

Job Title: **Part-Time Lecturer**

Responsibilities

- 2001- to date Conduct lectures and tutorials in Environmental Engineering II

For fifth year students

- " Conduct lectures, tutorials and laboratories in Hydrology course for fourth year students

- " Conduct lectures and tutorials in Water Resources Management And Hydraulic Structures for fifth year students

- " Prepare and conduct mid and final examinations in Water Resources Management and Hydraulic Structures, Hydrology, Environmental Engineering II courses

Computer Literacy: Excellent. Conversant with Windows, Microsoft Word, Data management, analysis and presentation, MS Excel, MS Power point, GIS Arc VIEW3.2 and Microsoft Project 2000

Languages English: Speaking- *Excellent* Reading- *Excellent* Writing *Excellent*
Mbunda Speaking- *Excellent* Reading- *Excellent* Writing *Excellent*
Bemba Speaking- *Good* Reading- *Good* Writing *Good*
Nyanja Speaking- *Good* Reading- *Poor* Writing *Poor*

Referees

1. Mr Isaac Mbewe
   Water Aid Zambia
   Lusaka. Zambia.

2. Dr. Henk Lubberding,
   International Institute for Infrastructural, Hydraulic and Environmental Engineering,
   Box 3015, 2601 DA Delft, Netherlands. Tel: 31(0) 15 2151715. E-mail: Lub@ihe.nl

3. Mr L Handia
   University of Zambia
   Faculty of Civil and Environmental Engineering
   P.O. Box 32379, Lusaka. Zambia. Tel: 260-1-290962

CURRICULUM VITAE 2

SURNAME: Khunga
FIRST NAME: Patrick
SEX: Male

RELIGION: Christianity

PHONE: 291532 (Biological Sciences Department)

Email: pkhunga@natsci.unza.zm or Khungapat@yahoo.co.uk

ADDRESS: Biological Sciences Department University of Zambia, P. O. Box 32379,

LUSAKA.

EDUCATIONAL AND PROFESSIONAL QUALIFICATIONS

2000 to 2004 Bachelor of Science in Biology/UNZA.

1989 – 1991 Advanced Certificate in Science Laboratory Technology – Evelyn Hone College.

COMPUTER LITERACY

24 - 28 June 2000

Certificate in Hardware Maintenance Course –Computer Consultancy and Training Unit / University of Zambia.

1997 – 1998

Certificate in MS-DOS, WINDOWS 98, MS- WORD, MS-Excel and MS-POWER POINT/Modern Computer Techniques Ltd. – Lusaka.

July 1994 - Sept., 1994

Certificate of Attendance/Data Management Course - School of Veterinary Medicine, University of Zambia (Course sponsored by NORAD).

Dec., 1993 - Jan., 1994

Certificate of Attendance/Statistics Course –School of Veterinary Medicine, University of Zambia (Course sponsored by NORAD).

WORK EXPERIENCE

1992 – 2000 Senior Technicians, Biological Sciences Department/UNZA (Technical and Administrative work).

RESEARCH EXPERIENCE

November 2002 – February 2003

Co–Consultant– An assessment of HIV/AIDS Multisectoral Task Forces for Livingstone, Gwembe and Siavonga districts for POLICY PROJECT/USAID/ZAMBIA.

The study was part of a process of clarifying how USAID/Zambia Mission would implement its HIV/AIDS multisectoral response in its Country Program.

2001 – 2002

- Worked as Research Assistant on the study tilted – Mainstreaming Gender Issues in Environment and Natural Resources Management, Policies and Programmes. The study was under the support of Pilot Environmental Fund under the Environmental Support Programme.

The goal of the study was to enhance the crucial role of women in environmental and natural resources management. It sought to understand salient but critical experiences, concerns, interests and perceptions of women and men that could be input into environmental and natural resources policies and programmes. The study further sought to understand the structural linkages between gender, environment/natural resources and development in Zambia.

Quantitative data was obtained from interviewer-administered questionnaires and for qualitative data, information was obtained from focused group discussions (FGDs), key informants and through observations.

The study was carried out in Chongwe district.

2002- 2003

- Worked as Research Assistant on the study tilted – An assessment of Information, Education and Communication (IEC) strategies in Forest and Wildlife conservation in Zambia: a participatory approach. The study was under the support of Pilot Environmental Fund under the Environmental Support Programme.

  The study sought to identify and bridge existing and potential gaps in current IEC strategies in forest and wildlife conservation in Zambia. The study aimed at making recommendations eventually to relevant stakeholders on effective and appropriate IEC strategies in order to promote and enhance community participation in conservation activities.

  Information was obtained using relevant unstructured questionnaires. Key informants were interviewed and information from the community was obtained through focused group discussions (FGDs).

  The study was carried out in Mumbwa district.

2003- 2005

- Data Entry on a Swedish International Development Agency – Area Development Project (Sida ADP study) on behalf of the Overseas Development Institute with MANO Consultancy Services Limited, Lusaka, Zambia.

2001

Member of the 8-man Organising Committee (5 at national level and 3 at international level) on the International Workshop on 'Human Helminth Infections – Future Research Foci' held at Taj Pamodzi Hotel, Lusaka, Zambia from 5 – 9 March, 2001, in conjunction with the Danish Bilhaziasis Laboratory (DBL) and the University of Zambia (UNZA). Workshop attracted 36 participants from various countries in Europe and Africa.

2000

Worked on the Service for the Environmental Conservation of Biodiversity and Sustainable Development Project (SECOSUD) based in Biological Sciences Department, UNZA. Project

sponsored by the Italian Government and operating in SADC countries with its headquarters in Lilongwe, Malawi. Work involved field collection trips and data entry on computer.

1998

- 'Large Herbivore Census' in Hluhluwe-Umfolozi Park (HUP), Natal, South Africa – Earthwatch Europe sponsored project.

  October, 1998 - Highly recommended by the African Fellowships Officer – Earthwatch Europe, for producing the best Earthwatch Project Report on 'Monitoring South African Wildlife'. Report incorporated into the main 'Project Briefing' so that it could be distributed to future participants to save as a perfect example of what is expected of them.

1997

- Worked as Research Assistant on the study entitled - Impacts of Loss of Aquatic Plant Life on a Wetland Ecosystem (On the Kafue River of Zambia) with the financial and logistical support and facilitation of the Zambia Electricity Supply Corporation (ZESCO), The Environmental Council of Zambia (ECZ), The Ministry of Environment and Natural Resources (MENR), and other Kafue River Stakeholders (KRS).

1997

- Worked as Research Assistant on the study entitled - Specialist Environmental Impact Assessment of the Ecology at the Konkola Mining Licence Area in Chililabombwe-Zambia, for the Anglo- American Corporation of South Africa.

For referees, contact the following:-

1. Dr. C. Munyati
   Geography Department
   University of Zambia
   P. O. Box 32379
   Lusaka.

2. Professor K. J. Mbata
   Biological Sciences Department
   University of Zambia
   P. O. Box 32379
   Lusaka.
   Email: KMbata@natsci.unza.zm

3. Ms. F. C. Lumbwe
   Biological Sciences Department
   University of Zambia
   P. O. Box 32379
   Lusaka.
   Email: flumbwe@natsci.unza.zm

CURRICULUM VITAE 3

Name of Staff	:	**Frank Sikana**
Date of Birth	:	28th February 1968
Profession/Specialisation	:	**CIVIL ENGINEER**
Marital Status	:	Married
Nationality	:	**Zambian**
Experience	:	12
Institutional Membership	:	

- **Registered Engineer,** Member of the Engineering Institute of Zambia (EIZ)
- Member of the Water and Sanitation Association of Zambia (WASAZA)

KEY QUALIFICATIONS

Mr. Frank Sikana has over 10 years experience in Design, Supervision and Management of Civil Engineering Projects. He is currently employed as a Senior Engineer. For 5 years he practiced in CAD Design/Water and Sewerage Network Modelling, Geometrical Computer Design of Roads. From 1993 to date, Mr Sikana has successfully held positions ranging from Junior Water Engineer to Senior Engineer. He designs, coordinates and manages all aspects of civil engineering contracts.

To illustrate Mr. Sikana's relevant experience for the proposed position below are some projects that he has worked on:
Design and supervision of the construction of Mpongwe Water Supply Scheme
Water Supply for Chirundu border town in Zambia funded by Government of the Republic of Zambia.
Kanyama Community Based Aquifer Management Project in Zambia, this was a Water and Sanitation Community based programme, funded by UN-HABITAT
Design of Water and Sanitation Services to Unserviced areas of Lusaka in Zambia
The design of the car park, drainage, water and sanitation facilities to the proposed Eye Clinic in Kitwe.
Rehabilitation and refurbishment of 15 Rural Health Clinics in Southern and Eastern Provinces of Zambia for the Ministry of Health funded by World Bank.

EDUCATIONAL QUALIFICATIONS

B.Eng. (Civil and Environmental Engineering) – The University of Zambia
Diploma in Water Engineering - Natural Resources Development College (NRDC) – Zambia
Certificate in Data Surveys and Application In Rural Energy and Environmental Management

EXPERIENCE

2003 – Date Brian Colquhoun Hugh O'Donnell and Partners Senior Engineer

Responsible for:

Design and supervision of the construction of Mpongwe Water Supply Scheme
Supervision of the renovations to the executive building Bank of Zambia
Field assessment, condition survey, design, tender documentation of Improvement of Selected Core District and Feeder Roads in Mumbwa, Kaoma, and Mongu

Supervision of construction of roadworks, parking areas, cycle tracks and footpaths and related civil works at Chirundu boarder post.
Design of access roads, car park, drainage facilitate to the proposed Eye Clinic in Kitwe, Zambia – financed by LIONS CLUB
Day to day management of contracts
Attending site meetings and progress reporting
Preparation of Tender and contract documents
Preparation of Technical and Financial Proposals
Carrying out Tender Evaluation

1993 - 2003 Zulu Burrow Zambia Limited, Integrated Engineering and Development Consultants (formerly known as Burrow Binnie Zambia Limited)

2002 – 2003 Engineer

Responsible for:

Proposed Rehabilitation of Sewerage Facilities for Kafue Gorge Power Station – Zambia Electricity Supply Corporation (ZESCO). Engineer responsible for Investigations, report, and design of works to rectify problems with sewerage and sewage treatment ponds for a housing area for ZESCO employees in Kafue Gorge. Financed by ZESCO.
Design of Chirundu Water Supply in Zambia, funded by the Government of the Republic of Zambia.
Rehabilitation and refurbishment of Agricultural Training Centres in Eastern Province of Zambia, ADB/ASIP Support Programme
Kanyama Community Based Aquifer Management Project in Zambia, Engineer responsible for evaluation of water points and on-site disposal systems, conducting household and community education on sanitation. Funded by UN-HABITAT
Design of dams for clients such Mkushi farmer in Mkushi
Emergency Drought Recovery Programme (EDRP); community based feeder road rehabilitation responsible for contractual and technical issues related to the daily management of contracts. Finance-IDA Credit Facility to the Government of the Republic of Zambia.
Stallholder Enterprise and Marketing Programme (SHEMP) – Access Road Improvement Component financed by IFAD; responsible for supervision of contractors.
Engaged in design of Road Layouts for Meanwood Housing Scheme.

1997 – 2002 Engineer

Responsible for:

Design of Water and Sanitation Services to Unserviced areas of Lusaka in Zambia
Rehabilitation and refurbishment of 15 Rural Health Centres in Southern and Eastern Provinces of Zambia
Rehabilitation and refurbishment of teacher's training colleges in Zambia

1996 – 1997 Design Engineer

Responsible for:

Designed Water/Sewerage facilities for Proposed Tropical Diseases Research Centre in Ndola Zambia, funded by ADB
Rehabilitation of a 236km road from Chipata to Lusaka in Zambia, funded by ADB
Upgrade of a 6km Pipeline for Nakambala Sugar Estate in Zambia
Rehabilitation of the Pumping Station and Construction of a 1km sewer line for the University of Zambia

1993 – 1995 Junior Water Engineer
Responsible for:
Diversion of a sewer line for sable Butchery in Zambia
Planned and designed water/sewerage facilities for Proposed Petauke Barclays Bank Limited in Zambia
Involved in the Feasibility Study of Urban Water Supply and Sanitation in southern and North Western Provinces of Zambia, funded by ADB/EDF.
Designed the concrete pavement for the Proposed Office Block for Zambia National Provident Fund
Designed Water and Sewerage as well as drainage facilities for 20 primary schools under the Zambia Education Rehabilitation Project (ZERP) for the Ministry of Education funded by World Bank.

LANGUAGES

	Reading	Writing	Speaking
English	Excellent	Excellent	Excellent
Bemba	Excellent	Excellent	Excellent
Namwanga	Excellent	Excellent	Excellent

CURRICULUM VITAE 4

JOSEPH SIMFUKWE CURRICULUM VITAE

PERSONAL DETAILS

Date of Birth: 20 October 1978
Contact Phone: + 26097 708733
E-mail Address: j_simfukwe@yahoo.co.uk
Postal Address: C/O Pastor Teddy Theu, Dunamis Christian Centre, P.O. Box 50480, LUSAKA

EDUCATION

- Bachelors Degree in Social Work (Bsw), University of Zambia, 2004
- Diploma in HIV/AIDS Leadership, Dynamic of Faith College, 2006

PERSONAL PROFILE

- Results-driven, logical and methodical approach to achieving tasks and objectives
- Good strategic appreciation and vision; able to design and implement sophisticated projects
- Strong planning, organising and monitoring abilities - an efficient time-manager
- Critical thinker - strong analytical skills; accurate and probing
- Good researcher - creative and methodical - probing and resourceful
- Excellent interpersonal, computer and communication skills
- High integrity, diligent and conscientious - reliable and dependable

EXPERIENCE

- Two-and-half years proven post-qualification expertise and interest in social research / surveys, health surveys, environmental impact assessments, social impact assessments and resettlements (See profile of assignments undertaken)

COMPUTER LITERACY

- Microsoft Access (Database Creation and Management), Word processing, Microsoft Excel, Microsoft PowerPoint, Statistical Package for Social Sciences and Internet

LANGAUGES

- Bemba, Nyanja, Tonga, Lenje, Lamba and English

PROFILE OF ASSIGNMENTS UNDERTAKEN

No	Position/ Client	Project	Key Achievements
1	Socio-economist/ BCHOD	Designing Resettlement Action Programme (RAP) of Munshimbili Community	Participated in sensitizing Munshimbili community on African Development Bank Policy and Zambian Legislation on Involuntary Resettlement; participated in negotiating with Munshimbili community on compensation and with Chief NKole for relocation land; participated in facilitating formation of 2 Resettlement Committees, development of their TOR and training of committee members; participated in designing livelihood restoration activities for the resettled community and conflict resolution

No	Position/ Client	Project	Key Achievements
			mechanism; participated in designing monitoring and evaluation plans for implementing Resettlement Programme; and writing progress reports and final RAP reports
2	Socio-economist/ Kaizen Consulting International	Environmental Impact Assessment for rehabilitating Chingola-Solwezi-Mwinilunga Road	Facilitating FGD with communities and interviews with high profile stakeholders along the road on potential negative socio-economic impacts of rehabilitating the road and their best mitigation measures; and wrote the socio-economic chapter of the Environmental Impact Assessment Report
3	Socio-economist/ Kaizen Consulting International	Review and Verification of Environmental Impact Statement for constructing Mongu-Kalabo Road	Assessed integration of socio-economic issues in project design and implementation; assessed adequacy and accuracy of baseline socio-economic data of project area, socio-economic impacts and mitigation measures; and wrote report
4	Socio-economist/ Kaizen Consulting International	Environmental Project Brief for rehabilitating Pedicle Road	Facilitated FGDs with communities and interviews with key stakeholders along the road on their concerns in the rehabilitation of the road and wrote the socio-economic chapter of the Environmental Impact Statement
5	Socio-economist/ Kaizen Consulting International	Environmental Profile of the City of Kitwe under UN Habitat Sustainable City Programme	Participated in developing questionnaires, collecting and analyzing data on development sectors and their use of, competition over and impacts on environmental resources of Kitwe and strategies for improving the urban environmental management capacity of Kitwe City Council
6	Socio-economist/ Kaizen Consulting International	Environmental Project Brief for constructing canal at Mulungushi Hydro-power station	Facilitated FGD with communities around the dam on their concerns in the construction of the canal at Mulungushi Hydropower station and wrote the socio-economic chapter of the Environmental Project Brief
7	Lead Consultant/ Parent Partnership Association for Children With Special Needs(PPACWSN)	Data Analysis, validation and report writing of Baseline Survey on Children with Special Needs in Lusaka District	Led identification of pertinent variables for cross- tabulation, triangulation of data through FGD and report writing on Children with Special Needs in Lusaka District
8	Facilitator// Parent Partnership Association for Children With Special Needs(PPACWSN)	Stakeholders' Consultative Workshop on Children with Special Needs in Lusaka District	Presented report, facilitated workshop and wrote report on outcome of workshop
9	Research Assistant/ Nzelu Consultancy	Capacity Assessment of Training Institutions Servicing the of Councils	Administered questionnaires in training institutions and entered data in Database of Training institutions with potential to train Local Authority personnel using Microsoft Access
10	Research Assistant/ Care Zambia	Evaluation of Care PROSPECT	Participated in facilitating FGDs in Peri-urban areas of Lusaka on the impact of CARE PROSPECT and it sustainability
11	Socio-economic Research Assistant/ Swedish Geological AB	ZCCM Consolidated Environmental Management Plan II(CEMP II)	Planned, coordinated and monitored office and field socio-economic data collection, analysis, validation and participated in report writing on negative socio-economic impacts of mining;

No	Position/ Client	Project	Key Achievements
			participated in facilitating FGDs with 75 RDCs on community inputs in the Corporate Social Responsibility, Environmental Management, Mine Closure and Exit Plans of mine investors; participated in sensitizing mine communities against encroaching mine caving areas; and participated in facilitating Stakeholders' Consultative Workshops on negative socio-economic impacts of mining, Corporate Social Responsibility, Environmental Management, Mine Closure and Exit Plans of mine investors
12	Research Assistant/ Dr. Kapungwe	HIV/AIDS Testing Treatment and the Youths in Zambia	Administered questionnaires in schools, entered, cleaned, validated and analyzed data using SPSS
13	Volunteer/ Reformed Church National HIV/AIDS Desk	Proposal for conducting a Situational Analysis of Response of the Reformed Churches in Zambia to HIV/AIDS	Wrote a Technical and Financial Proposal
14	Intern /Tiyanjane Development Project, CCF	Research on Extent, Distribution and Background Characteristic of TB cases in project area	Developed questionnaires, collected and analyzed data, wrote report and co-presented report at the Strategic Planning Workshop
15	Intern/ Tiyanjane Development Project, CCF	Evaluation of Education Programme of Tiyanjane Development Project	Developed questionnaires, collected and analyzed data, wrote report and co-presented report at the Strategic Planning Workshop
16	Intern/ YMCA	Proposal for conducting a survey on Youth Headed Households arising from HIV/AIDS in Kabwata, Kamwala and Chilenje	Participated in writing proposal, developing questionnaires and training Research Assistants
17	Intern/ Chivuna Area Development Programme, Word Vision	Research on Development Problems of women of the project area	Conducted FGDs with women and wrote a report

REFEREES

Prof. Thomson Sinkala, Mr. Moses Nkhata
Lecture, School Of Mines Partner
University of Zambia
P/Bag E 835,
Lusaka, ZAMBIA
tsinkala@thomro-zambia.zm nkhatam@microlink.zm
+26097851976 / 26096750545 +26097610983

Dr. Augustus Kapungwe
Lecture, SDS Department
University of Zambia
P. O Box 32379
Lusaka, Zambia
akapungwe@zamnet.zm
+26097821399 / 095885838

Brian Colquhoun Hugh O' Donnell
and Partners Consulting Engineers
P. O Box 3194, Lusaka, Zambia

CURRICULUM VITAE 5
CV for Chisanga Siwale

PERSONAL DETAILS

NAME AND ADDRESS	:	Chisanga Siwale P. O Box 30530 Lusaka Email: siwalechisanga@yahoo.com Phone: +260 977674413 (Mobile), +260 211 241577 (Home)
DATE OF BIRTH	:	30th June 1973
NATIONALITY	:	Zambian
MARITAL STATUS	:	Married

1. PERSONAL PROFILE

- Holder of Bachelor of Science Degree in Natural Resources (School of Natural Sciences)- University of Zambia
- Holder of Master of Science in Integrated Water Resources Management (Faculty of Engineering)- University of Zimbabwe
- Have attended short courses in Environmental Impact Assessment, Project Management, Groundwater Management, GIS and Data base management, Tracer Techniques in Groundwater
- Five(5) years of working experience in surface and groundwater management at technical level, planning and implementation of surface water monitoring activities

2. EDUCATIONAL QUALIFICATIONS

QUALIFICATION	AREA OF STUDY	INSTITUTION	PERIOD
Master of Science *(Integrated Water Resources Management)*	- Integrated Water Resources Management - Water Quality and Aquatic Ecology - Hydrology & Hydrogeology - Water Resources Planning and Modelling - Water and Environmental Law	University of Zimbabwe (Faculty of Engineering)	2007-2008
Bachelor of Science (*Natural Resources*)	- Remote Sensing and Geographic Information System & Geomorphology - Natural Resources management - Environment and Development	University of Zambia (School of Natural Sciences)	1995-2002

	- Aerial Photography and Photo Interpretation - Land Resources Survey & Climatology - Research Projects		

3. PROFESSIONAL/SHORT TRAINING

Course	Skills/Knowledge Acquired	Institution	Period
ArcGIS and Map Projections	-Production of thematic - Georeferencing and georectification of images -On screen Digitizing of maps	Kelly and Kelly, LusakaZambia	March-April 2005
Groundwater Management	-Groundwater Monitoring and management - Rainfall-Runoff analysis	University of Witwatersrand, South Africa	July 2009
Hydrogeological Mapping	-Application of Geographic Information System in Hydrogeological Mapping - Production of cross sections of groundwater maps	Council of Geosciences and SADC, South Africa	October 2009 and April 2010
Tracer Techniques in Groundwater	- Use of tracer in investigation of groundwater flow and aquifer characteristics -	Rhur University, Germany	August 2009

Career History and Experience

Senior Hydrologist – Department of Water Affairs (November 2009 to date)

Roles and Responsibilities

- Compilation and analysis of surface water data
- Coordination of establishment and maintenance of Hydrological observation network
- Provision of technical information for surface water projects
- Supervision of surface water projects

Other Roles

- Attached to Groundwater Project in the department and responsible for Hydrology and GIS application in the project
- Participation in assessment of potential dam sites and survey as well as determining reservoir capacities
- Assessment of surface water resources availability for issuance of water rights

Hydrologist - Department of Water Affairs (April 2005 to October 2009)

- Collection of surface water data
- Preparation of technical reports
- Monitoring of surface water projects

Specialized Skills

- Competent in use of Arc GIS/ Remote Sensing in compilation of thematic maps for water resources management
- Analysis of hydrological data for the preparation of technical reports for water resources management

Current Project(s)

- Currently developing a Hydrological Map for Lusaka Province

Institutional Affiliation

- Member of the International Association of Hydrological Sciences (IAHS) since 2004

Referees

1. Mr G. Hampwaye (Lecturer) ,The University of Zambia, School of Natural Sciences P.O Box 32379, Lusaka. Cell: +260 977 806063

3. Mr. F. N Ngoma, Provincial Water Officer, P.O Box 30530, Lusaka., Office: +260 211 240917

Annex 7: EIA Study TORs

Introduction

Chobe Agrivision Company Limited would like to construct two earth dams one on Munshiwemba River while the other within a dambo area. The dams will be used mainly for irrigation. The earth dam within the dambo together with its inundated area will entirely be located on Chobe Farm Lot 3373 while the other dam on Munshiwemba River will have its inundated area occupying land that belonging to Masebe Farms Limited.

The Terms of Reference have been drawn up from discussions within the EIA study team taking into consideration the issues contained in the Third Schedule of the EIA guidelines and results of the public consultations.

The consultant shall provide information on all matters as specified in the content requirements of the Terms of Reference together with other such matters judged to be necessary by Zambia Management Agency (ZEMA).

Scope of Study

The Environmental Impact Assessment will be done for each of the proposed dams. It is proposed that two separate studies will be done for each of the proposed two dams. Specifically the studies will address the following issues:

Legal framework

An outline of environmental policy and institutional framework including statutory regulations that should be complied with and requirements for environmental approval that should be issued by ZEMA for the construction of the two dam projects.

Project Description

A description of each of the proposed dam projects including:

- The objective and nature of the project
- Outline of proposed project design including planning, infrastructure (dam) design and development, technologies and processes that shall be used.
- Description of project activities during the planning, construction and operational / maintenance phases
- Raw material inputs to the project e.g. water, sand, cement.
- Expected product and by-products of the project (e.g. sewage for construction workers, construction rubble)

Analysis of Alternatives

An analysis of reasonable alternatives for each of the dam project, the no – action alternative, and reasons for adopting the respective proposed sites.

Description of the Environment

A baseline description of the present environment of the proposed two sites and surroundings including the following:

The Bio - physical Environment:

- Location of the two sites
- Geology
- Soils
- Topography
- Hydrology (surface water features and drainage)
- Climate
- Fauna and flora
- Protected areas (Forest Reserves)
- Existing physical structures and infrastructure

The Social – Economic Environment:

- Population and settlement
- Land tenure (and zoning)
- Land and natural resources use
- Economic activities within the catchment area. (e.g. agriculture, goods and services, domestic property market)
- Cultural / historical / archaeological sites

Assessment of Environmental Impacts

Potential impacts, both positive and negative, will be identified and assessed in respect of the issues below with the help of the following criteria:

- Magnitude
- Extent (spatial area to be affected)
- Sensitivity of affected area
- Significance of impact

Potential impacts will be divided into those occurring during the construction phase (direct impacts) and those occurring during the operational phase (long term or induced impacts) of the project as follows:

Impacts Occurring During Construction Phase in Respect of:

- Water flow (ground and surface water)
- Building of the dam (e.g. dam wall, access roads, construction camps)
- Local eco-system (removal of vegetation / endangered species / bird life)
- Traffic safety (people/construction traffic on and off-site)
- Public health (construction workers/HIV/malaria/dust/solid waste and sewage)
- Raw materials (source of materials/demand on local supply)
- Settlement (displacement of persons/communities)
- Cultural / historical / archaeological sites
- Employment
- Local / National Economy
- Capacity building

Impacts Occurring During Operational Phase in Respect of:

- Water quality, quantity and use of water, aquatic biota, and sedimentation in the river basin.
- Hydrologic and Limnological effects.
- Decomposition of organic matter (e.g. trees).
- Aquatic weeds, such as water hyacinth and *Salvinia molesta*
- Flora and fauna (vegetation, fisheries, wildlife).
- Settlement (migration of large number of people/unemployment)
- Public health (HIV/water borne diseases, pest, vermin)
- Land and natural resources use (loss of agricultural land/source of fuel, natural+ medicines)
- Landscape (effect on aesthetic quality of landscape / compatibility with surrounding area)
- Community life (community relationships/recreation/security)
- Capacity building

Mitigation Measures

All necessary environmental mitigation measures will be identified in the environmental impact assessment of the construction and operational phases of the two dam projects. The EIA will contain a description of proposed measures for preventing, minimising or compensating for any adverse impacts of the project as well as for enhancing beneficial effects.

The consultant will advise project proponents on environmental aspects that will be required to be included in the overall design for each of the proposed dam project, for the mitigation of identified environmental impacts and in particular;

- Each report will propose measures and plans for mitigating the adverse environmental impacts of the project;

- Wherever possible, the costs and benefits of these environmental measures will be quantified in monetary value.

Environmental Management Plan

The Environmental Management Plan (EMP) will seek to give a comprehensive plan on how proposed mitigation measures will be implemented during the construction and operational phases of each of dam project and as such will serve as a useful management tool to ensure implementation of these measures.

Environmental Monitoring Plan

The Environmental Monitoring Plan (EMP) will seek to give a comprehensive plan on how and what is to be monitored in either case to ensure that proposed mitigation measures are implemented according to the management plan during construction and operational phases of each of the project. In this regard, it will outline the duties and responsibilities of the developer, and other relevant parties with respect to environmental monitoring to ensure successful monitoring and subsequent audits during all project phases.

Emergency Response Plan

The emergency response plan for each dam project will primarily seek to safeguard lives and secondarily to reduce property damage of local communities who live within Munshiwemba catchment and beyond in an event of flooding caused by a large volume of runoff from or failure of either Munshiwemba Intermediate Dam or Whispering Hope Dam.

Decommissioning Plan

The decommissioning plan for each dam project will outline the approach and action to be taken in an event that the proponents decide decommission either of the dam by a large volume of runoff from or failure of either Munshiwemba Intermediate Dam or Whispering Hope Dam.

Proposed Environmental Impact Assessment Team

The Environmental Impact Assessment team comprises of:

NAME	POSITION
Kenneth Nyundu	Environmental Expert- Team Leader
Joseph Simfukwe	Socio-Economist
Patrick Kunga	Biologist/Ecologist
Frank Sikana	Civil Engineer/ Surveyor
Chisanga Siwale	Hydrologist

CVs of the individual EIA team members are attached as annexes.

Report format for each report

The EIA will be concise and the discussion limited to significant environmental issues. The main text will focus on findings, conclusions and recommended actions. The conclusions and recommendations will be substantiated by relevant data.

The format of the EIA will be in accordance with the following outline for the table of contents:

Executive Summary

Chapter 1 - Introduction

- Background
- Purpose of the EIA study
  - Objectives
  - Scope of the study
  - Methodology

Chapter 2 - Policy, legal and administrative framework

- Legislative and institutional framework in Zambia
- Environmental Legislation in Zambia
- Requirements for EIA
- Institutional framework for environmental management

Chapter 3 – Project Description

- Nature of the Project
- Project Rationale and Objectives
- Project Alternatives and Justification
- Project Activities (preparatory, construction and Operation stage)

Chapter 4 - Characteristics of Project Area

- Location
- Biophysical conditions
- Wildlife (including distribution of species, breeding areas, transit routes, etc.)
- Vegetation (including types of vegetation and distribution),
- Tourism and socio-economic conditions

Chapter 5 - Environmental impacts of proposed activities

- Impacts on soils
- Impacts on vegetation
- Impacts on wildlife and fauna
- Impacts on water quality and water flow and quantity
- Impacts on air quality
- Impact of noise
- Impacts on landscape / land-use
- Impacts on socio-economy
  - Impacts on tourism
  - Impacts on the local economy
- Significance of selected environmental impacts

Chapter 6 – Mitigation and Enhancement Measures

- Impact assessment and mitigation

Chapter 7- Environmental Management & Monitoring Plan

Chapter 8- Review of Engineering design and Construction

Chapter 9- Emergency Response Plan

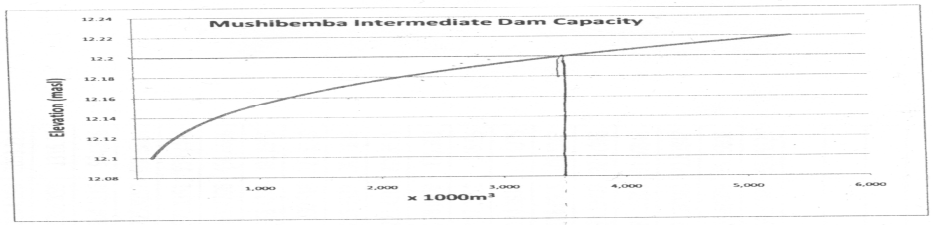
Chapter 10- Decommissioning Plan

Chapter 10- Conclusion

List of References

Annexes

Annex 8: Storage Volumes for the Dam



Capaity (m^3)	Elev (masl)	Fill Area (sq km)
5,371,692	1222	1.04
4,383,640	1221	0.924
3,524,031	1220	0.793
2,795,364	1219	0.669
2,179,580	1218	0.565
1,665,271	1217	0.465
1,248,434	1216	0.373
911,199	1215	0.296
654,450	1214	0.221
460,682	1213	0.167
315,064	1212	0.126
205,489	1211	0.093
125,440	1210	

Annex 9: Reforestation Guidelines

Introduction

Reforestation is important because it preserves soil productivity, creates wildlife habitat, enhances stream protection, protects water quality and creates recreational opportunities. Reforestation activities not only aim to mitigate soil erosion but also help in offsetting CO_2 emissions which is of global concern in view of climate change. However, these activities should be carryout in a systematic and well planned manner to avoid negative potential impacts on forest biological diversity and other ecosystems. These guidelines will provide guidance to Chobe Agrivision Ltd in the implementation of its planned reforestation programme for disturbed areas at the project site in such a manner that it will be economically viable, environmentally sound, and socially equitable and culturally acceptable.

Guidelines

1. Ensure to always apply the precautionary principle when planning for reforestation to avoid negative impacts on targeted areas
2. Adopt only reforestation activities that will benefit biodiversity conservation
3. Ensure that reforestation activities take into account relevant traditional knowledge.
4. Ensure to raise workers awareness on environmental issues related to reforestation and the potential economic and social benefits of reforestation.
5. Promote reforestation with native tree species that are well adapted to site conditions now and in the future whenever appropriate.
6. Use only species and varieties outside their natural range where their introduction would not endanger important and/or valuable indigenous ecosystems, flora and fauna.
7. Discourage the use of genetically modified trees and apply the precautionary principle in this regard

8. Promote species composition and structural diversity in reforestation to reflect the natural diversity at the landscape level.

9. Aim to maintain and protect all ground and surface water resources in terms of quantity and quality.

10. Ensure that decisions regarding reforestation are developed in consultation with relevant stakeholders such as Forestry Department.

Annex 10: Pesticide Use Guidelines

Personal Protective Equipment (PPE)

- Ensure to store PPE separately from pesticides.
- Always read the label for proper PPE and clothing to be worn.
- Always follow the direction on the label for PPE, clothing, and handling procedures.

Preparation for Application

- Designate one area specifically to be used only for weighing and mixing pesticides.
- Ensure soap, water and equipment storage are located near this area.

Application

- Mix only enough pesticide for the particular job.
- If an excess amount is mixed then store it for future use, if stable, in a well-labeled container, or bottled.
- Always follow directions on the label for disposing of empty pesticide containers in consultation with relevant authorities.
- Always wash and clean reusable protective equipment after each use.
- Ensure availability of proper disposal containers labeled for discarding contaminated equipment

Storage of Pesticides

- Ensure to store pesticides in the original intact container.
- All pesticide containers should be dated upon receipt and checked periodically for leakage and container integrity.
- Materials that have passed the useful shelf life should be discarded through a hazardous waste pickup by relevant authorities.
- Waterproof signs must identify pesticide storage areas.
- Always keep storage areas locked and ensure to post name(s) and telephone number(s) of the person(s) responsible for access.
- Telephone numbers for Emergencies should conspicuously be posted on the pesticide storage facility.

- Ensure to have an inventory list inside or close to the storage area.
- Ensure to update the inventory at least twice annually.

Records

- A record of all pesticide applications be kept and produced on demand.

Annex 11: Copy of no objection letter from Mkushi Country Club

MKUSHI COUNTRY CLUB
PO BOX 840085
MKUSHI
TEL 0215 352598
CELL 0966 610814

17th October 2011

To Chobe Agvision

Re : Proposed dam on the Munshiwemba River

To whom it may concern

The committee of Mkushi country club has no problem or interest, with the building of a dam and gauging weir by Chobe Agvision on the Munshiwemba River on the boundary with Mkushi Country club. This dam will flood approx 25ha of club property. There are some provisions that MCC will require and these are listed below.

1) The resiting of the pump station that has been installed to irrigate the golf course and club surroundings. This includes all civils to ensure that the pump can remain in viable service with different water levels within the dam.
2) A small abstraction right from this dam of 500m3 per day for the irrigation of the community golf course.
3) That minimal damage is done to the natural surroundings of the dam on MCC bank during the construction process. (the majority of heavy construction must take place on the opposite bank Beckett farm side) This includes refraining from damage to vegetation that will not be flooded by the dam.
4) The spillway of the dam (if constructed on the MCC bank) will be constructed in such a way that there will be minimal erosion and destruction of natural surroundings.
5) Any works that are constructed that can be viewed from the main road or access road are built from natural available resources so as not to destroy the natural beauty at the club entrance.

If in agreement with the above provisions please respond in writing.

.

Yours Sincerely

Mark Hazelden
Chairman - M.C.C.

Annex 12: Copy of no objection letter from Masebe Ranch Farm

MASEBE RANCH

P.O. Box 840055
Mkushi
Zambia
masebe@iwayafrica.com
Phone:- +260215-352144

To Whom It May Concern

This is to confirm that I have no objection to the construction of the Intermediate Dam on the Munshiwemba River between the Masebe and Ishiba Dams and the consequent inundation of a portion of my Farm No.4053.

Construction of the dam will flood a section of the Masebe Ranch game fence. The planned pump station will have to be modified as it will no longer be possible to pump from a fixed level.

My agreement is subject to the following conditions:-

1. **That the game fence currently following the course of the river be moved at my expense to the Chobe Agrivision side of the new dam. The exact position of the fence to be determined by the two parties.**
2. **That I secure a moderate percentage of the new Intermediate Dam Water Right – the specific percentage to be arrived at by negotiation.**

I consider this new dam a positive development for the area provided it is well planned and executed.

DON STACEY

Annex 13: Existing Dams

Table 1: Existing dam upstream of the proposed dam site

Dam name	Capacity (Mm3)	Area (km2)
Moffat	1.75	0.54
Matila	2.5	0.58
Mushi	11.1	5.4
Wakawaka	1.1	0.44
Raubie	2.5	0.58
Misenga	0.7	0.21
Carlyn	0.4	0.12
Masebe	18	6
Ishiba	14	5.22
Nsulu	1.2	0.4
Cocker	1.18	0.41
Whispering Hope	1.3	0.43
Total	**55.73**	**20.33**

Source: Water Board

Table 2: Existing dams downstream of the proposed dam site

Dam name	Capacity (Mm3)	Area (km2)
Tembwe	6.96	1.98
Papagiogio	0.9	0.31
Mwasachawa	2	0.44
Kabolwe	1	0.59
Kruso	7	4
Shigu	1.7	0.54
Fortwood	3.3	
Hugo	1.8	
Total	**24.66**	**7.86**

Source: Water Board.

Annex 14: Maps and Design Drawings