ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

REPORT VOLUME II
FOR THE PROPOSED

IRRIGATION SCHEME IN MUSAKASHI IN MUFULIRA DISTRICT

SUBMITTED TO ZEMA
SEPTEMBER 2015
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<tbody>
<tr>
<td>AFLEG</td>
<td>African Forest Law Enforcement and Governance</td>
</tr>
<tr>
<td>BOQ</td>
<td>Bill of Quantities</td>
</tr>
<tr>
<td>CBD</td>
<td>Convention on Biological Diversity</td>
</tr>
<tr>
<td>CCD</td>
<td>Convention to Combat Desertification</td>
</tr>
<tr>
<td>CP&amp;CB</td>
<td>Community Participation and Capacity Building</td>
</tr>
<tr>
<td>DACO</td>
<td>District Agriculture Coordinator</td>
</tr>
<tr>
<td>EIA</td>
<td>Environmental Impact Assessment</td>
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<tr>
<td>EMA</td>
<td>Environmental Management Act</td>
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<tr>
<td>EMP</td>
<td>Environmental Management Plan</td>
</tr>
<tr>
<td>ESIA</td>
<td>Environmental and Social Impact Assessment</td>
</tr>
<tr>
<td>FAO</td>
<td>Food and Agriculture Organisation</td>
</tr>
<tr>
<td>GDP</td>
<td>Gross Domestic Product</td>
</tr>
<tr>
<td>GI</td>
<td>Galvanised Steel</td>
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<tr>
<td>GIS</td>
<td>Geographical Information System</td>
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<tr>
<td>GRP</td>
<td>Glass Reinforced Plastic</td>
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<td>GRZ</td>
<td>Government of the Republic of Zambia</td>
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<tr>
<td>HDPE</td>
<td>High Density Polyéthylène</td>
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<tr>
<td>HH</td>
<td>Household</td>
</tr>
<tr>
<td>HIV/AIDS</td>
<td>Human Immunodeficiency Virus/Acquired Immune Deficiency Syndrome</td>
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<tr>
<td>IBRD</td>
<td>International Bank for Reconstruction and Development</td>
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<tr>
<td>ICBP</td>
<td>International Council for Bird Preservation</td>
</tr>
<tr>
<td>IDA</td>
<td>International Development Association</td>
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<td>IDSP</td>
<td>Irrigation Development Support Project</td>
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<td>IFC</td>
<td>International Finance Corporation</td>
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<tr>
<td>IPMP</td>
<td>Integrated Pest Management Plan</td>
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<tr>
<td>IPS</td>
<td>Irrigation Policy and Strategy</td>
</tr>
<tr>
<td>ISF</td>
<td>Investment Support Fund</td>
</tr>
<tr>
<td>IUCN</td>
<td>International Union for the Conservation of Nature</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Full Form</td>
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<td>--------------</td>
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<tr>
<td>LDPE</td>
<td>Low Density Polyéthylène</td>
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<tr>
<td>MAL</td>
<td>Ministry of Agriculture and Livestock</td>
</tr>
<tr>
<td>MIGA</td>
<td>Multilateral Investment Guarantee Agency</td>
</tr>
<tr>
<td>NAP</td>
<td>National Agricultural Policy</td>
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<tr>
<td>NIP</td>
<td>National Irrigation Plan</td>
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<tr>
<td>NWP</td>
<td>National Water Policy</td>
</tr>
<tr>
<td>O&amp;M</td>
<td>Operation and Maintenance</td>
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<td>PAPs</td>
<td>Project Affected Persons</td>
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<td>PPP</td>
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<td>RAP</td>
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<td>SAR</td>
<td>Sodium Absorption Ratio</td>
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<td>SCAFE</td>
<td>Soil Conservation and Agro-Forestry Extension</td>
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<td>SCCI</td>
<td>Seed Control and Certification Institute</td>
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<td>SNDP</td>
<td>Sixth National Development Plan</td>
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<td>SOFRECO</td>
<td>Société Française de Réalisation, d’Etudes et de Conseil</td>
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<tr>
<td>ToR</td>
<td>Terms of Reference</td>
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<tr>
<td>WARMA</td>
<td>Water Resources Management Authority</td>
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<td>WCHN</td>
<td>World Cultural and Natural Heritage</td>
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<tr>
<td>WUG</td>
<td>Water User Groups</td>
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<td>ZEMA</td>
<td>Zambia Environmental Management Agency</td>
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PROJECT BRIEF NOTES

Proponent:
Ministry of Agriculture and Livestock (MAL), Zambia Ministry Of Agriculture and Livestock (Mal) Mulungushi House, Independence Rd, 3rd Floor, Box 50291 Lusaka.

Developer’s Contact Person:
Ms Deborah Phiri, Safeguard Specialist, +260-211-251629, +260-211-252029 +260 977988114

Project Location:
Mufilira District, Copperbelt Province, Zambia.

Project Summary:
The central concept of IDSP involves re-allocation of land and water resources for irrigated agriculture under a partnership arrangement between the Government, private operators and communities. Under this project different types of farms (i.e. Tier 1 to 3) are envisaged;

Tier 1 will be for smallholder farmers who wish to take up irrigated agriculture using mainly family labour, with individually farmed plots of 1 ha or less, using surface irrigation to grow vegetables and other high value crops;

Tier 2 will consist of larger plots of between one and five hectares each, for cultivation by emerging small-scale commercial farmers or small groups of neighbouring farmers, using sprinkler irrigation systems and hired labour to profitably grow mainly field crops; and

Tier 3 will consist of large plots of at least 60 ha each under centre-pivot irrigation operated by a private company that will eventually be wholly owned by the community but initially will be jointly owned with a private sector investor.

Estimated Capital investment and Project Commencement Date:
Approximate project cost is US$ 10 million. Project commencement date is 2014.

ESIA Study Consultant:
SOFRECO (Société Française de Réalisation, d’Etudes et de Conseil)
EXECUTIVE SUMMARY

GENERAL
Agriculture is one of the priority sectors in Zambia due to its contribution to national socio-economic development. With over 80 percent of the population dependent on agriculture and about 70% of the country’s labour force being employed in the sector, agriculture plays a critical role in the Zambia’s economy. However, the sector is vulnerable to seasonal rainfall variability, recurrences of drought making rainfed agriculture unviable in Zambia. Given that 70% of food crops are produced by peasant farmers, the above scenario has created food insecurity thereby threatening 80% of the population. In response, the Government has sourced funds to undertake an irrigation scheme project at three selected sites across the country (i.e. Lusitu in Southern province, Mwomboshi in Central province and Musakashi on the Copperbelt). The thrust behind the proposed Irrigation Scheme project is pro-poor economic growth through increased yields per hectare and value of diverse products marketed by smallholders benefitting from investments in irrigation.

THE PROJECT
Project Objectives
The objectives of the proposed project are:

- To increase yields per hectare and value of diverse products from investments served by the project
- To sustain the increase of agricultural incomes of smallholder farmers in Musakashi, thus, making the goal of the project to be pro-poor economic growth

Project Details
The ‘proponent for Irrigation Development Support Project’ is Ministry of Agriculture and Livestock. The operationalization of the proposed project will be facilitated by government through MAL, while ownership of the project at operation will be shared among the local communities, private sector and government. The project site is located on the right-bank of the Kafue River, in Mufulira District, between latitude 12°32’ and 12°35’ south and between longitude 28°06’ and 28°09’ east, and at an elevation of 1,220 to 1,260 masl. It will constitute three land divisions known as tiers:

Tier 1 being for smallholder farmers who wish to take up irrigated agriculture using mainly family labour, with individually farmed plots of 1 ha or less, using surface irrigation to grow vegetables and other high value crops;
Tier 2 consisting of larger plots of between one and five hectares each, for cultivation by emerging small-scale commercial farmers or small groups of neighbouring farmers, using sprinkler irrigation systems and hired labor to profitably grow mainly field crops; and

Tier 3 consisting of large plots of at least 60 ha each under center-pivot irrigation operated by a private company that will eventually be wholly owned by the community.

Key features of the project will include: Pumping stations, reservoirs as well as irrigation fields. Musakashi Irrigation Scheme, will have an estimated investment cost of US$ 10 million and is expected to commence by the end of 2014. The implementation of the project will take over seven years. However, the project lifespan is expected to exceed the implementation phase, as the project is conceived as a sustainable solution for smallholder farmers access to irrigation water for generations to come.

THE EIA AND STAKEHOLDER OUTCOME

A scoping exercise that included review of the project literature, targeted consultations with the relevant authorities and stakeholders and public consultation in form of general meetings was undertaken. Identification of potential environmental (socio-economic and biophysical) impacts, contemplation of environmentally options for the design detail, and identification of issues of concern for Interested and Affected Parties (IAPs) and stakeholders. The concern of most stakeholders was related to the resettlement and land re-organization that will accompany the irrigation development. Concern was also raised about the safety of people from crocodile attacks in the Kafue River, re-organization of common rights to fuel wood, grazing land and other common resources. Impact on vulnerable groups, social services and capacity building were other areas of concern expressed by stakeholders.

PROJECT ALTERNATIVES

“Without Project” and “With project” Option were analyzed: The “NO” project Option or the “do nothing” alternative, is the current state of affairs and entails the irrigation potential for the land not being fully utilized maintaining the status quo of continued less income for the communities and poverty, With Project Option generation of sustainable income for beneficiaries that include substantial numbers of female headed households, female farmers and female micro-entrepreneurs, youth, HIV/AIDS affected households and other vulnerable groups would be enhanced. Therefore this option is preferred.

Project Site Alternatives

Musakashi site offers suitable soils, climate and terrain for irrigation, cost effectiveness, adequate water, minimum disturbance to biophysical and socio-economic environments. These factors makes the site the best option. Constructing the IDSP irrigation scheme elsewhere was found to be economically and socially unviable as it fail short of providing a comparable site that meets standard criteria for construction or irrigation and associated infrastructure.

Alternative Processes

Direct abstraction using a pump as an option was found to be ideal because of adequacy of minimum flows in the Kafue River. Abstraction from groundwater was
found to be inappropriate for purposes of the project which seeks to expand irrigated land due to relative poor groundwater yield in the area. Rainwater harvesting was found to be inappropriate for commercial agricultural purposes even though it’s good for domestic purposes.

**Technological Alternatives**

Centre pivot as an option has a high initial capital investment cost but its high in water application efficiency and can cover a large area of land while conserving water for other users that include the environment. Flood irrigation has the lowest capital investment cost and water utilization efficiency and environmentally unsound as it deprives other users much needed water resources. Sprinkler irrigation has a moderate capital investment requirement and can equally be applied to sizeable large areas of land can have high water application efficiency. This option will equally be applied at all the three project sites for a particular category of farmers that will be involved in irrigating.

Pumps can be submerged with motors and controls on the platform (vertical axis centrifugal pumps). One drawback with the shore-based option is the use of submersible pumps and motors which are more expensive to purchase and maintain than standard centrifugal pumps. Submersible motors tend to burn-out more frequently, and often need to be replaced rather than re-wound.

**Irrigation Field System Alternatives:**

Small center pivots (for Tier 2): Centre pivots have a higher efficiency (85%) than normal sprinkler layouts and cause less soil damage, labor requirement is very low, allowing one operator to control several pivots. Centre Pivots (proposed for Tier 3 and 4): Centre-pivots, have ease of operation, high efficiency and low labour requirement make them the first choice if water availability is more limiting than land but have high initial cost. Hose-furrow (proposed for Tier 1): provides better control of water application and improved efficiency than traditional flood irrigation and has low-tech and easy to maintain thus justified as best solution for Tier 1. Hose-move sprinkler: The system is easy to operate as the laterals do not require moving, only the sprinklers which are mounted on tripods, every 6 hours and one worker can irrigate up to 5.4 ha (48 sprinklers).

**MAIN FINDINGS OF BASELINE STUDIES**

The continuity of flow on Kafue River is evidenced by the flow duration curve at Kafironda Hydrometric Station which is located downstream of the project site. The study established that 6.98m³/s is available as the lowest flow and is used as a basis for planning. This flow exceeds the daily water abstraction of 169,000m³ and 30,000m³ per day for Nkana and Mulonga Water Companies requirements. Since the total abstraction for domestic supply is only 33% of the available flow, it further implies that Kafue River is capable of meeting the cropwater requirements for the irrigation project.

The study further established that groundwater potential in the area is limited due to the rock types of Musakashi that do not form high yielding aquifers. The average borehole depths in Mjsaka was found to range from 50 to 60m. Results for heavy metals analysis were found to be below detection limit for all parameters analyzed, that is, aluminium (Al), cadmium (Cd), Copper (Cu), lead (Pb) and zinc (Zn).
Musakashi was observed to be within the savannah woodland biome characterised by a grassy ground layer and a distinct upper layer of woody plants with interspaced trees that are adapted to frequent fires. Main vegetation types observed included woodlands, scrublands, grasslands and some dambos (some kind of shallow “wetlands” mainly used as a source of clay) in transitional areas of wetlands and terrestrial forests.

The major vegetation type in Musakashi is Miombo woodlands with very few open grasslands and dambos almost confined to riverine areas. Bamboo was found to be the dominant grass species established. It was further established that much of the Miombo woodland in the project area have vegetation that is in the secondary stage of maturity. The riparian vegetation in Musakashi was found to be well preserved.

Further the study revealed that the remaining faunal species mostly comprised of small mammals and some carnivores. Fauna habitats in the area also are largely disturbed and much of it is still remain unspoiled.

The study also established that the land ear-marked for the proposed irrigation scheme will result in people and social infrastructure as well as cultural sites being affected and people will have to be relocated and infrastructure replaced elsewhere.

**IMPACTS / MITIGATIONS MEASURES**

**Major Impacts – Construction Stage**

Employment Opportunities; MAL should ensure good agricultural practices and adopt an efficient as well as effective management system are adopted to sustain productivity.

Economic Growth at local and national level; MAL should adopt a robust and profit oriented marketing system for agricultural yields to ensure high returns in order to contribute to the national treasury.

Skills Transfer to Local People; MAL should ensure there is skill transfer through an elaborate training programme which is a dedicated overall project component.

Displacement of Households, Loss of community assets such houses, meeting shelters and some burial sites: Relocation and compensation of affected persons should be carried out through an elaborated RAP

Loss of livelihood for vulnerable groups in the short term: Alleviating negative impacts on vulnerable groups should be done through training, land reorganization and entitlement to resources.

Disturbance of cultural and archaeological sites: MAL should take a precautionary measure i.e. should any effect of historical nature be discovered during construction, relevant authorities (National Heritage Conservation Commission) should be notified immediately.

Increased HIV/AIDS and other STDs: MAL should ensure that the contractor (as part of the contract) sensitize workers and the communities on the dangers of HIV/AIDS and other STDs.

Disturbance to ecological processes: Contract signed by MAL for construction should include provisions that limit clearance of vegetation to critical areas;
awareness campaigns among staff and community on the need to conserve nature and adopt strict good practices in conservation are conducted.

Groundwater Pollution: MAL should ensure all machinery and equipment at site are regularly maintained by contractor, limit servicing and repair of machinery and equipment to designated areas and dispose any used oil at a designated place.

Disturbance to fauna habitat especially insects, reptiles such as lizards and small mammals: MAL should ensure contractor limit clearance of vegetation only to critical areas, Conduct awareness campaigns among staff and community on the need to conserve nature.

Loss of agricultural and grazing fields: MAL should implement recommendations made in the RAP that include replacement of land through reorganization and compensation for relocation.

**Major Impacts – Operation Stage**

Economic multiplier effects at the national level: MAL should embark on an expansion and replication of the initiative that will resulting in demand for more inputs such as seed, chemicals, farm equipment and associated services. This will result in a chain effect by creating demand for inputs from other firms who in turn be made to increase their production levels by acquiring more equipment and employing more staff. This will have an economic multiplier effect on the general economy of the country.

Employment, skills transfer and human resource capacity development: Development of human resource capacity through establishment of a robust human resources development plan and incorporate systems to ensure that human resource development is carried out correctly must be top on the agenda for MAL. This should be done in a manner that will boost efficiency and effectiveness of crop production processes in the scheme.

Increased household incomes and food security: Expand crop production levels by increasing the number of agricultural fields under irrigation and purposefully MAL should employ more women where appropriate. Employing more women will have a direct positive impact on the income of the household and improve the welfare of children.

Disturbance to Biodiversity: Ensure that appropriate land management practices including preservation of strips of undisturbed vegetation are fully embraced. This will provide an environment for restoring woodland belts and interconnectivities critical for sustaining wildlife, creating positive biodiversity consequently enhancing sustainable agricultural production through soil improvement and natural controls on pests and diseases.

Technology impacts to soil structure, MAL should ensure good agricultural practices that include limited tillage and strict nutrient management are applied. As a result, there will be fewer impacts on the soil structure. Embrace new technology on the market and invest in best practices in managing water resources for efficient and effective utilization of water resources.

Soil erosion and siltation: In consultation and guidance from Forestry Dept., MAL should carry out reforestation of the disturbed area after construction activities, Limit movement of heavy machinery only to designated access routes and operational areas.
Inappropriate use of pesticide and herbicide: Working with relevant authorities, MAL should ensure that recommended dosage and frequency of application of agro chemicals are observed. Ensure recommended types of agro-chemicals are used and conduct awareness campaign among communities on dangers of agro chemicals. Avoid use of highly toxic pesticides found on the and instead encourage use of botanical pesticides particularly for Tier 1 and 2.

Over Application of fertilizers: MAL should encourage practice conservation and green farming, encourage organic farming, careful choice of crops which replenish soil fertility as well as use organic fertilizers. This would be more practical for Tier 1 and 2.

Soil degradation: MAL through its extension services should ensure that use of inappropriate methods of farming by communities in surrounding areas is avoided as it poses a risk of erosion and river siltation that may affect ecological biodiversity. Conduct sensitization programmes and training in good agricultural practices.

Loss of biodiversity: Ecological surveys showed no serious loss of species of special concern, and other species important to ecosystem functioning that may have resulted in loss of biodiversity. However, the scheme will limit clearance of vegetation to critical areas designated for development.

Impact on faunal diversity loss: To avoid loss of faunal diversity MAL should ensure that the EMP is implemented fully.

CONCLUSION

It is the opinion of the ESIA study team that social economic and environmental impacts from the proposed project can effectively be managed and reduced to acceptable levels as long as proposed measures are implemented. Consequently, the benefits arising from operations of Musakashi Irrigation Scheme as a developmental project outweigh environmental costs.

SIGN:……………………………
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1 INTRODUCTION

1.1 Background
1.1.1 Policy Context and Development Strategy

Contribution of Agriculture to the Economy

Agriculture employs about 70% of the labour force in Zambia and supplies raw materials to agro-industries accounting for about 84% of the manufacturing value-added in the country. Given these labour force figures, this means that 80 percent of the population is dependent on agriculture contributing about 40% of Gross Domestic Product (GDP) and 12% of export earnings. The sector however, has over the years recorded slower growth compared to other sectors such as mining, construction, and services. As a result economic development has been hampered in the process further compounding poverty levels. In a country where about 60% of the population are based on smallholder farms cultivating two ha or less of dry land farming and dependant on agriculture or agriculture-related activities for their livelihoods, reducing poverty and accelerating economic growth should focus on improving the agriculture sector particularly the smallholder agriculture and infrastructure development.

1.1.2 Characteristics of the Agriculture Sector

Zambia’s agricultural sector is characterized by a long history of expensive input, price controls, subsidy programmes and periodic export bans thus undermining efforts to invest in productive agriculture. Furthermore, the geography of land tenure, land resources and population distribution hinders efforts to achieve equitable agricultural development. With a total land area of 75.3 million ha, Zambia has 43.7 million ha that is said to have potential for agricultural production. Despite this huge potential that exist for agriculture in Zambia, limited access to affordable credit, especially for small and medium-scale farmers; High dependence on rain fed agriculture/limited utilization of irrigation; Limited access to markets for small-scale farmers; and Low productivity remain challenging factors to productive agriculture in Zambia. Despite numerous efforts made in the past to improve agricultural production; Institutional constraints and poor incentives at scheme level that resulted in poor operation and maintenance (O&M) and therefore poor sustainability; Lack of skills in irrigated production; Poor market...
access owing to weak organization of value chains, which negatively affected profitability; Problems of contract enforcement for the growing practice of contract farming; and Limited access to affordable short and long-term credit has constrained positive performance in the sector.

1.1.3 Policy Responses

With the challenges facing the agricultural sector highlighted earlier, Government responded by putting in place policies, plans and strategies such as the National Water Policy, National Irrigation Plan, the Sixth National Plan just to mention a few.

The National Water Policy (NWP) of 2011 promotes a holistic approach to management of the water sector by signaling the economic value and costs of water. It focuses on: water resources management; rural water supply and sanitation; and urban water supply and sanitation.

The National Irrigation Plan (NIP) (2005) is a sub set of the National Agricultural Policy (NAP) 2004-15 and part of a broader water resources action plan to develop and manage more sustainably the country’s water resources. The NIP advocates for interventions that include all categories of producers in areas with development potential, and focus on PPP for leverage of public investment if the high investment and management costs of irrigation could be managed. It calls for capacity-building through knowledge share and training and further recommends a package of economic instruments, including a reduction in energy costs and taxes for irrigation in order for Zambia to attain comparative advantage for import substitution or for export promotion. With these interventions, it is estimated that irrigated land in Zambia would increase by 70,000 ha.

The Revised Sixth National Development Plan 2011-15 (SNDP) is a strategic framework for “sustained economic growth and poverty reduction” focusing on Water Resources Management and Development and Water Supply and Sanitation. For the agriculture sector, its goal is to “increase and diversify agriculture production and productivity so as to raise the share of its contribution to 30% of GDP by end-2015.” And irrigation is seen as a strategy for achieving a number of objectives outlined in the SNDP, including:

- Achieving sustainable water resource development for socio-economic development;
- Providing water for productive use;
- Increasing productivity and export of non-traditional export crops;
- Increasing quality livestock numbers; and
- Increasing crop productivity.

As part of the SNDP, the Government of the Republic of Zambia (GRZ) aims to construct 30 irrigation schemes through the Sustainable Land and Water Management Programme across the whole country with the aim of increasing the irrigable area from 173,000 ha in 2011 to 187,500 ha by 2015.

1.1.4 The Proposed Project in the National Context

Musakashi irrigation scheme will encompass all the features designed specifically to conform to national policy documents in which these features are rooted. These include:

- Developing the natural resource to exploit Zambia’s irrigation potential;
- Developing PPP to improve the leverage of government investment in irrigation development;
- Improve implementation efficiency, realize benefits of scale in production and therefore accelerate economic growth by involving the private sector;
- Promoting irrigation schemes (and farm blocks) with a mix of commercial and smallholder farms to exploit the advantages of both production systems;
- Promoting irrigation investment for smallholders on customary land by adjusting tenure arrangements (on a site-by-site basis) to a form of leasehold (e.g. community or cooperative trusts) which will improve the security of land users; and
- Supporting water charging for irrigation to encourage users to pay the full costs of water supply.

In compliance with the above, Musakashi irrigation scheme will be innovative and inclusive in design and will be financed through a PPP arrangement with a provision for both commercial and smallholder farmers. Irrigation management entities will *ipsa facto* allow the State to charge for the use of water used on the irrigation scheme at its full supply cost, though there may be some initial cross-subsidy between commercial and smallholder farmers to allow the latter to accumulate operational capital.

### 1.1.5 The Proposed Project in the Local Context

The proposed project is well supported at local level even though it took a bit of time to win the support currently being demonstrated. This is because the project was designed and sponsored at Ministerial level. Project areas were identified through a national screening process in which Provincial and District authorities were consulted but did not participate in final decision making. As a result, the proposed project is not reflected in developmental budgets of targeted district. Nevertheless, the (District Agriculture Coordinator) DACO’s office is privy to MAL’s project planning as it affects the DACO’s District. In an effort to seek support and involvement of the districts, Ministry of Agriculture and Livestock (MAL) organized a national level workshop in November 2012 attended by the District Commissioner, District technical officers and the affected Chief to discuss project implementation with MAL and the Consultants charged with furthering project design. Support for the project was unanimous and District Council technical staff have been participating in project activities.

### 1.2 Project Design Concept

#### 1.2.1 Principles

The overall project design concept is based on four principles:

- First, smallholder irrigated agriculture can only be sustainable if the users pay for irrigation water and real Operation and Maintenance (O&M) costs and still make sufficient profit to provide an incentive to irrigate. This implies a need for improved support services, increased productivity, improved access to markets, better prices through value addition, realistically priced water and more cost effective O&M than hitherto;
- Second, successful smallholder irrigation demands professional irrigation services which can best be provided by a commercial private sector operator rather than by the public sector, although economy of scale is required;
Third, results are enhanced by inclusiveness involving all farming sectors, both men and women and by exploiting synergies between smallholders, emergent and large-scale commercial farmers;

Fourth, development can only be successful if the communities concerned feel a sense of ownership. This requires that they be empowered to take informed decisions on matters (including land and water allocation) that affect their livelihoods and that these decisions are respected in the planning process.

1.2.2 Beneficiaries and Target Groups

Direct beneficiaries of the project will include:

- 42,500 people who belong to smallholder farmer households with direct access to irrigated land;
- 26,500 people who belong to households with employees engaged as workers on the irrigated land; and
- A further 1,000 people who belong to households that are not involved in farming, but who will be able to establish micro-enterprises with project support.

At the Musakashi site, a total of 1,826 people in 362 households were recorded in the RAP Census concluded on 7th September 2013. All of these will have project beneficiaries with access to irrigation allocations in Tier 1. In addition there will be good opportunities for farm labour on Tier 2 and 3: about 12,400 labour days per year are expected to be required, compared with 35,000 labour days on Tier 1. The number of future micro-enterprises has not yet been established but opportunities are expected to be significantly increased through IDSP’s Irrigation Investment Trust.

The direct beneficiaries will include substantial numbers of female headed households, female farmers and female micro-entrepreneurs, youth, HIV/AIDS affected households and other vulnerable groups. The project will mainstream these groups as direct beneficiaries by providing equal opportunities in general (for example access to irrigated land) and special attention and support where appropriate.

Indirect beneficiaries of the project will include:

- Supply and value chain stakeholders who will benefit from increased supplies and business opportunities generated by the irrigation schemes and the supporting infrastructure; and
- Consumers (particularly in urban areas) who will benefit from improved supplies of agricultural products.

1.3 Agriculture and Irrigation Potential

Statistics show that 80% of the population is dependent on agriculture with about 70 percent of the country’s labour force being employed in the sector. However, seasonal rainfall variability makes agricultural production in Zambia vulnerable especially that almost 70 per cent of food crops are produced by traditional farmers who depend on dry land farming. This is evidenced by the limited number of irrigation schemes across the country shown in Figure 1-1. Coupled to this are re-occurrences droughts over the past decades resulting in food insecurity thereby threatening 80 percent of the population.
Even though these statistics may have improved slightly due to increased agricultural activities in recent years, there is still an opportune time for more investment in the sector taking advantage of the enabling environment and maximize the irrigation potential to expand on current agricultural production levels. Zambia ranks quite low in the region regarding overall water storage capacity and number of dams in existence. Statistics show that of the 58% of land suited for arable use, only 14% is being utilized and less than 5% is under irrigation. This goes to show that the irrigation potential in Zambia remains underdeveloped (See figure 1-1)\(^1\).

In order to improve the situation, the Government of the Republic of Zambia has put in place policies and legislation that have created an enabling environment for boosting irrigated agriculture. The intervention now enables farmers to partner with financial institutions for purposes of accessing funds to invest in agriculture development especially infrastructure such as water storage reservoirs to minimize dependence on rain fed agriculture. This has created an investment opportunity in the agricultural sector.

### 1.4 Location and Layout

The proposed Irrigation Development Support Project (IDSP) will be done in phases. Phase one being the three sites identified as being suitable for the proposed irrigation schemes located in Lusaka, Central and Copperbelt Provinces of Zambia. This report focuses on Musakashi project site located in Mufulira District on the Copperbelt Province encompassing the right bank of Kafue River. Refer to figure 1-2 for the location map for all three project sites\(^2\).

The Musakashi project site will constitute three land divisions known as tiers. The project site is located on the right-bank of the Kafue River, in Mufulira District, between latitude 12°32’ and 12°35’ south and between longitude 28°06’ and 28°09’ east, and at an elevation of 1,220 to 1,260masl. The proposed irrigation areas are split between North and South zones, taking advantage of the suitable soils. The site is accessible from the Kitwe-Mufulira road, and is about 35km NW of Kitwe. See Figure 1-3: Sketch Map of the Location of Musakashi Group 1 Site\(^3\).

### 1.5 Spatial Extent of the Study

The spatial extent of the study area will be Kafue River sub-catchment including Musakashi and surrounding areas in Mufulira district in Copperbelt province.

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\(^1\) See Figure 1 1: Map 1- Irrigation schemes in Zambia (Source National Irrigation policy) in Annex 1: Maps folder.

\(^2\) See Figure 1 2: Location of IDSP Group 1 Sites in Annex 1: Maps folder.

\(^3\) See Figure 1-3: Sketch Map of the Location of Musakashi Group 1 Site in Annex 1: Maps folder.
1.6 ESIA Study Objectives

The objectives of the ESIA study were to:

- Take environmental factors into consideration from the outset in order to optimize the functions of the project in the landscape;
- Prevent polluting and nuisance impacts before they are realized;
- Review the project from an independent environmental and socio-economic viewpoint so as to identify and assess its potential positive and negative impacts and to recommend mechanisms to remove, or mitigate negative impacts;
- Minimize these impacts where they are unavoidable;
- Provide management tools for identified environmental risks and hazards;
- Develop monitoring tools to optimize project operations that also minimize environmental, social, environmental extreme event and hazards;
- Provide baseline data and anticipate project outcomes in a manner that permits a full assessment of the acceptability of the project to Zambia Environmental Management Agency (ZEMA), other regulatory agencies and to the general public;
- Characterize the social set up of communities from within and the surrounding the areas;
- Establish the cultural dynamism of the communities from within and the surrounding areas.

1.7 Project Justification

Irrigated farming demands heavy capital investment and many times beyond affordability of many household level farmers as well as small scale farmers. This being the case, these groups of farmers lack necessary technical know-how, inputs, equipment and irrigation infrastructure to necessitate sustainable agriculture. As a result, these farmers most often attain crop yields below optimum. In order to address these challenges, Government has sourced funds to undertake an irrigation scheme project at three selected sites across the country, of which Musakashi Irrigation Scheme is one. The thrust behind the proposed project is pro-poor economic growth through increased yields per hectare and value of diverse products marketed by smallholders benefitting from investments in irrigation in selected sites served by the project.

According to the National Irrigation Policy 58% of land suited for arable use, only 14% is currently being utilized 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. This is against the backdrop of Zambia’s irrigation potential estimated at over 423,000 hectares. Most of the irrigated land is under large scale commercial operation while most small scale farmers are generally constrained to growing only one crop cycle annually of generally low-value crops with yields mainly affected by variation in rain pattern. Thus, making farming for small scale farmers unprofitable. Therefore, implementing the proposed project will contribute to an increase in land under irrigation and wealth creation among targeted beneficiaries.
1.8 EIA Scope and Approach

1.8.1 Scoping Studies

The Scoping exercise was conducted for purposes of identifying potential environmental (socio-economic and biophysical) impacts, contemplate environmentally considerate options for the design detail, and identify issues of concern for Interested and Affected Parties (IAPs) and stakeholders. The scoping exercise included review of the project literature, targeted consultations with the relevant authorities and stakeholders and public consultation in form of general meetings.

The environmental scoping process provided an opportunity for stakeholders to get clear, accurate and understandable information about the expected environmental issues or impacts of the proposed project; voice their concerns and to raise questions regarding the project; suggest ways for reducing or mitigating any negative impacts, and for enhancing its positive impacts. At the same time it provided an opportunity for MAL to incorporate the needs, preferences and values of IAPs into its planning and design decisions. This process is vital for ensuring transparency and accountability in decision-making.

1.8.2 Approach

The approach to the scoping exercise was done step-wise starting with a reconnaissance survey for appreciating the project area, followed by initial meetings with public officials and local leadership in the project area and lastly general consultative public meetings.

The reconnaissance survey served as the stepping stone for the team to understand the socio-economic context of the project sites, determine the existing governance regimes and structures in the area as well as to engage the leadership in the process of consultations for their support and cooperation. Besides, engaging the local leadership afforded the team to appreciate community structures and the acceptable way of engaging the general public into consultations.

During the consultative public meetings, the ESIA Scooping team gave presentations on the project detailing the project details and expected effects. The participants were there after accorded a chance to seek clarification, ask questions or give their concerns on any issue regarding the proposed IDSP project. The discussions were conducted in a participatory manner with every individual having an equal opportunity to take up the floor and address the audience. For the minutes of the consultative meetings held at Musakashi project site refer to the Annex 15. In general the discussions focused on:

- Explaining the nature of the proposed IDSP project;
- Determining major environmental impacts likely to arise as a result of the project activities;
- Determining level of acceptance of the project among the community;
- Establish existing infrastructure such as schools, clinics and churches that may be affected by the project;
- Determine employment opportunities;
- Determine benefits and liabilities that may arise from the project.
Baseline studies were then conducted using the Terms of Reference approved by the ZEMA. These studies entailed making field visits in order to describe and evaluate identified impacts focusing on:

- Aesthetics and culture;
- Hydrology, Water Quality and soils and;
- Ecological functioning of the project areas;
- Socio-economics;
- Legal and administrative.

### 1.8.3 Outcome of Stakeholder Consultations

The concern expressed by most participants were related to the resettlement and land re-organization that will accompany the irrigation development, re-organisation of common rights to fuel wood, grazing land and other common resources, safety of people from crocodile attacks, impact on vulnerable groups, social services and need for capacity building.

Concerns about resettlement and land reorganization will be addressed during the implementation of a Resettlement Action Plan (RAP), the procedures for which are not part of these terms of reference, though an assessment of the measures included in the RAP taken to alleviate negative social impacts (including those on the provision of social services) and their adequacy is clearly part of the ESIA. Alleviating negative impacts on vulnerable groups is a cross cutting issue which involves training, land reorganization and entitlement to resources. The ESIA will evaluate the efficacy of measures included in the IDSP. Capacity building is the responsibility of the IDSP CP&CB Provider.

Very little direct concern was raised in affected communities about direct and indirect environmental impact of the proposed projects. See Table 1-1 hereafter
<table>
<thead>
<tr>
<th>Issue</th>
<th>Issue Raised By</th>
<th>Response by ESIA Team</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LUSITU PROJECT SITE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Land tenure and ownership</td>
<td>Mr. J. Simpopenda</td>
<td>The RAP will recommend options based on mutual consultations with the concern</td>
</tr>
<tr>
<td>2. Need for capacity building for local people</td>
<td>Mr. Chikondi</td>
<td>Capacity building for the local community is one of the IDSP components to be done</td>
</tr>
<tr>
<td>3. Lack of free land for resettlement in the area</td>
<td>Mr. Simuno</td>
<td>Land will be found in consultation with the community and their traditional leadership</td>
</tr>
<tr>
<td>4. Need for special consideration for venerable groups such as the aged</td>
<td>Mr. Mukandela</td>
<td>The ESIA study will pay particular attention to these groups and make recommendations</td>
</tr>
<tr>
<td>5. Need to leave room livestock grazing land</td>
<td>Mr. Gidion</td>
<td>The issue was noted and due consideration will be given to this aspect</td>
</tr>
<tr>
<td>6. The need to ensure project design does not result into human animal conflict</td>
<td>Mr. Banda</td>
<td>The ESIA study will make recommendations to avoid such conflicts</td>
</tr>
<tr>
<td><strong>MUSAKASHI PROJECT SITE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Need to address the land tenure and ownership</td>
<td>Ms. C. Chipanta</td>
<td>The RAP will recommend options based on mutual consultations with the concern</td>
</tr>
<tr>
<td>8. Need to rebuild affected schools</td>
<td>Mr. G. Muhango</td>
<td>The project will take care of all affected infrastructure including schools based on recommendation made by the RAP team</td>
</tr>
<tr>
<td>9. Need for clarity on resettlement terms</td>
<td>Ms. G. Mumba</td>
<td>The resettlement terms will be defined based on a consultative process with all affected stakeholders</td>
</tr>
<tr>
<td>10. Need to leave provision for grazing land</td>
<td>Ms. E. Pande</td>
<td>The ESIA study will make recommendations based on prevailing conditions and outcome of consultations with local people</td>
</tr>
<tr>
<td>11. The need to minimise disturbance to flora and fauna</td>
<td>Mr. Nyendwa</td>
<td>The issue will be addressed through the ESIA study</td>
</tr>
<tr>
<td>12. Need for host communities to benefit</td>
<td>Ms. G. Mulenga</td>
<td>The RAP will make recommendations based on their findings and consultations with affected persons.</td>
</tr>
<tr>
<td><strong>MWOMBOSHI PROJECT SITE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Need to rebuild affected schools</td>
<td>Mr. Kalimina</td>
<td>The project will take care of all affected infrastructure including schools based on recommendation made by the RAP team</td>
</tr>
<tr>
<td>14. Need for clear resettlement terms</td>
<td>Mr. Chilanga</td>
<td>The RAP process will tackle the issue in detail and make recommendations</td>
</tr>
<tr>
<td>15. Lack of free land to resettle the affected persons</td>
<td>Mr. Kalimina</td>
<td>Land for resettlement will be found in consultations with all stakeholders including local leadership</td>
</tr>
<tr>
<td>16. Need for special attention for vulnerable groups</td>
<td>Ms. Kalombe</td>
<td>The ESIA study will take care of the issue and recommendations will be made</td>
</tr>
</tbody>
</table>
1.8.4 Outcome of Disclosure Meeting

The ESIA disclosure meeting, an important step in the consultative process of the ESIA development. The disclosure was necessary as a means to make the findings of the ESIA study and recommendations contained therein public to interested and affected parties. This was aimed at ensuring that the findings and recommendations of the ESIA study are based on factual information and representative of the aspirations of the stakeholders as part of the transparent consultative process. Key issues raised during the disclosure meeting were:

- Human – Animal conflict: Kafue is known for crocodiles and Hippos and the need to ensure attacks from crocodiles are avoided;
- Water Quality: The need to ensure that water in the Kafue River remain of good quality to ensure that the health of people is sustained;
- The need for all stakeholders that include the MAL, ZEMA and Mining companies to work together to manage threats of water pollution due to accidental spills and emissions from the mines.

1.9 Limitations to the ESIA

The ESIA had its own limitations that included inadequate hydrological data for the project area. Very little secondary data was available and generating primary data requires field work for a number of hydrological years which was not possible under this project. The other was relating to ecological aspects. The field surveys only covered flora and fauna species encountered during the survey period. Although flowering had finished for many plant species, there were few flowering plants observed. Therefore, there was high possibility that some plants and animal species were missed as the survey was done just in one season. The ideal situation is to sample in all the seasons of the year so as to cater for those species that are visible in a particular season. This is because no season specific survey can be expected to encounter all the fauna or flora occurring within a project area.

1.10 Project Proponent

The proponent for the proposed IDSP project is the Ministry of Agriculture and livestock whose contact details are given in Table 1-2 below. Over the years, the ministry has with support from cooperating partners developed a number of earth dams across the country to support irrigation and animal husbandry. The Ministry of Agriculture and Livestock (MAL) comprises of ten departments each headed by a Director who reports to the Permanent Secretary.
Table 1-2  Contact Details of the Applicant

<table>
<thead>
<tr>
<th>Name of Facility</th>
<th>Irrigation Development Support Project for Group 1 Sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>MUSAKASHI IN MUFULIRA DISTRICT</td>
</tr>
<tr>
<td>Province</td>
<td>SOUTHERN, CENTRAL AND COPPERBELT PROVINCES</td>
</tr>
<tr>
<td>Project Proponent</td>
<td>MINISTRY OF AGRICULTURE AND LIVESTOCK</td>
</tr>
<tr>
<td>Address</td>
<td>MULUNGUSHI HOUSE, INDEPENDENCE RD, 3RD FLOOR BOX 50291 LUSAKA.</td>
</tr>
<tr>
<td>Contact Person</td>
<td>Dr BARNABAS MULENGA</td>
</tr>
<tr>
<td>Designation</td>
<td>NATIONAL COORDINATOR -IDSP</td>
</tr>
<tr>
<td>Telephone Office</td>
<td></td>
</tr>
<tr>
<td>Fax:</td>
<td></td>
</tr>
<tr>
<td>Mobile:</td>
<td></td>
</tr>
<tr>
<td>Email</td>
<td></td>
</tr>
<tr>
<td></td>
<td>+260-211-251629</td>
</tr>
<tr>
<td></td>
<td>+260-211-252029</td>
</tr>
<tr>
<td></td>
<td>0977988114</td>
</tr>
</tbody>
</table>
2 PROJECT RATIONALE

2.1 Scope of the project

Musakashi project site will have a tier arrangement with the 1st tier being smallholders on plots up to 1 ha growing mainly subsistence crops but also cash crops for sale; the 2nd tier being emergent farmers or farmer-groups growing mainly cash crops for sale, possibly as out-growers for Tier 3; and a 3rd tier being a commercial operation with professional management, able to justify the investment in the scheme, cover the majority of operating costs, and provide services to both Tier 1 and 2. The proposed area of the each tier is shown in table 2-1 below.

Table 2-1 Proposed tier areas, Musakashi Total Covering all project Phases)

<table>
<thead>
<tr>
<th>Tier</th>
<th>Gross area, ha</th>
<th>Net irrigated area, ha</th>
<th>of which</th>
<th>North</th>
<th>South</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tier 1</td>
<td>196.0</td>
<td>185.0</td>
<td>97.5</td>
<td>87.5</td>
<td></td>
</tr>
<tr>
<td>Tier 2</td>
<td>97.1</td>
<td>93.5</td>
<td>50.8</td>
<td></td>
<td>42.7</td>
</tr>
<tr>
<td>Tier 3</td>
<td>728.0</td>
<td>728.0</td>
<td>312.0</td>
<td>416.0</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1,021</td>
<td>1,006.5</td>
<td>460.3</td>
<td>546.2</td>
<td></td>
</tr>
</tbody>
</table>

2.2 Overall Project Objective

The objective of the Irrigation Development and Support Project (IDSP) is to increase yields per hectare and value of diverse products marketed by smallholders benefitting from investments in irrigation at Musakashi Irrigation Scheme to be served by the project. It also aims at sustaining the increase of agricultural incomes of smallholder farmers, thus, making the goal of the project to be pro-poor economic growth.
2.3 **Project Ownership and Cost**

2.3.1 **Ownership and Implementation Date**

The project will be implemented by Ministry of Agriculture and Livestock under the project ‘Irrigation Development Support Project’. While the operationalization of the proposed project will be facilitated by government through MAL, ownership of the project at operation will be shared among the local communities, Private Sector i.e. commercial farmers as well as government.

The project preparation phase and construction phase is expected to start as soon as all relevant procedures and approvals are obtained from relevant authorities and other stakeholders. Thus, it is envisaged that commencement of the project will be before end of the year 2014.

2.3.2 **Project Costs**

The basic investment cost of the Musakashi Irrigation Scheme is estimated to be US$ 10 million. Costs have been calculated based on a Bill of Quantities (BOQ) which accumulates all the material and labour costs of the different systems of the irrigation scheme. Cost summaries are given in the table 2-2 below:

<table>
<thead>
<tr>
<th>Description</th>
<th>Costs US$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conveyance system</td>
<td>4,599,581</td>
</tr>
<tr>
<td>Irrigation System</td>
<td>5,372,028</td>
</tr>
<tr>
<td>Total</td>
<td>9,971,609</td>
</tr>
</tbody>
</table>
3 DETAILED DESCRIPTION OF THE PROJECT

3.1 The Project

The Irrigation Policy and Strategy and National Irrigation Plan (NIP) gives clear guidance on the development of the irrigation sector in Zambia. The NIP advocates for inclusive interventions that target all types of farmers living in areas of high potential for irrigated agriculture, whether smallholders, emerging commercial or large scale commercial. It also encourages Public-Private partnerships and small-large scale farmer cooperative arrangements. In order to successfully implement the NIP, Government has sourced funds to undertake the IDSP project. The proposed project consists of three components namely i) Irrigation Development, b) Smallholder Commercialization, and iii) Project Management.

The project concept is based on two principles:

- Smallholder irrigation schemes can only be sustainable if there is a firm commercial basis that enable beneficiaries to effectively pay for irrigation water and related services; and
- The successful long-term management, operation and maintenance of smallholder irrigation schemes depends on clearly defined roles and responsibilities of the different stakeholders, laid down in signed public private partnerships (PPP) type agreements between the government, smallholder farmers organized in water user organizations and professional service delivering entities.

The central concept of IDSP is the re-allocation of land and water resources for irrigated agriculture under a partnership arrangement between the Government, private operators and communities. To achieve this, the establishment of three categories of farms (i.e. Tier 1 to 3) for Musakashi site.

Tier 1 will be for smallholder farmers who wish to take up irrigated agriculture using mainly family labour, with individually farmed plots of 1 ha or less, using surface irrigation to grow vegetables and other high value crops.
Tier 2 will consist of larger plots of between one and five hectares each, for cultivation by emerging small-scale commercial farmers or small groups of neighbouring farmers, using sprinkler irrigation systems and hired labour to profitably grow mainly field crops.

Tier 3 will consist of large plots of at least 60 ha each under centre-pivot irrigation operated by a private company that will eventually be wholly owned by the community but initially will be jointly owned with a private sector investor. Apart from operating the Tier 3 farm as a commercial entity the company will also provide support services, such as input supply, extension, credit and marketing to the other two Tiers on a commercial (i.e. profit-making) basis.

A private operator (the Concessionaire) will be contracted to construct and operate the bulk water supply and associated infrastructure. Bulk water assets will be owned by a special purpose vehicle in the form of a public utility company (UtilityCo) established to act as an interface between MAL and the Concessionaire. A farming company (FarmCo) will be responsible for the operation of Tier 3 farms and the provision of farming services to farmers on Tiers 1 and 2. It is expected that the Concessionaire and FarmCo would generally be the same entity in order to achieve economies of scale.
3.2 Principal Components of the Project

The overall project design will include the following components:

(a) Irrigated agricultural support services

The objective of this component is to provide knowledge and skills resources, and to strengthen beneficiary capacities to prepare and operate medium to large size smallholder irrigation schemes on a sustainable commercial basis through the use of PPPs. The component will specifically provide funding for:

- Planning and preparation of the irrigation scheme, including: pre-feasibility studies, cadastral surveys, participatory planning; environmental and social management planning, resettlement planning/land consolidation and reallocation processes and PPP transaction advisory services;
- Professional scheme operation and marketing services using a PPP approach, including irrigation scheme development and O&M as well as the provision of support services (extension, credit and marketing) through strengthened market linkages; and

Capacity building and empowerment for smallholder farmers, including:

- Training for Transformation (T4T), formation of, and capacity building for, Community Trusts, Water User Groups (WUGs), producer organizations and micro-enterprises.

(b) Public infrastructure

The objective of this component is to provide public infrastructure required for the establishment of medium to large-scale smallholder irrigation schemes using PPPs. The component will provide funding for:

- Irrigation infrastructure development, such as bulk water storage and supply infrastructure; and roads within the scheme;
- Supporting infrastructure, such as irrigation site access roads; electrification; storage facilities, drinking water points; and
- Implementation of site specific Environmental Management Plans (EMPs) and Resettlement Action Plans (RAPs).

(c) Private and cooperative investment

The objective of private and cooperative investment is to facilitate private and cooperative investment in productive equipment and assets in and around irrigation schemes, and to stimulate the establishment of small agri-enterprises. The component will provide funding for:

- Facilitating access to long and short term finance, including the following: access to credit; networking and linking access to investment support; and
- Investment Support Fund (ISF), including conditional partial grants for: on-farm irrigation equipment; other on-farm equipment and assets; highly specialized production inputs; post-harvest and value adding equipment and assets; highly specialized essential inputs for production and marketing grant for non-traditional activities; and seed capital for small enterprise development. The fund includes a specialized window for women, youth and other vulnerable groups (previously resettled people).
(d) Management and Coordination

The objective of this component is to ensure efficient and timely project resources management and use in accordance with the project objectives and Bank and Government procedures to deliver expected results and outcome. It will also support the policy and institutional framework. The component will provide funding for:

- Management of the project;
- Supporting refining of the policy and institutional framework;
- Safeguards issues, management and oversight; and
- Monitoring and evaluation.

3.3 Planned Project Components

(a) Irrigation system

The layout of the scheme can be seen in Figure 3-2 below. The two zones (north and south) will be supplied by separate main pump-stations (PSK-N and PSK-S), drawing water from the Kafue River. The water will be pumped to reservoirs (R1-N and R1-S) before being pumped again to Tiers 1 and 2, and to secondary reservoirs for Tier 3 (R2-N and R2-S). All but one of the 14 centre-pivots in Tier 3 will be supplied by tertiary pump stations (PS3A-N and PS3A-S) located downstream of R2-N and R2-S, while one pivot in T3-S will be fed by a gravity line. It is proposed that a low-pressure hose-furrow system is used in Tier 1, and a combination of hose-move sprinklers and small centre pivots in Tier 2. Table 3-1 summarises the water conveyance and different irrigation areas.

Table 3-1 Stages of water conveyance and irrigation systems by tier and area

<table>
<thead>
<tr>
<th>Main pump station</th>
<th>Main reservoir</th>
<th>Secondary pump stations / reservoirs</th>
<th>Tier &amp; section</th>
<th>Irrigation system &amp; area (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSK-N</td>
<td>R1-N</td>
<td>PS1-N</td>
<td>T1-N</td>
<td>97.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PS2-N</td>
<td>T2-N</td>
<td>32.0 18.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PS3-N &gt; R2-N &gt; PS3A-N</td>
<td>T3-N</td>
<td>312.0</td>
</tr>
<tr>
<td>PSK-S</td>
<td>R1-S</td>
<td>PS1.S</td>
<td>T1-S</td>
<td>87.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PS2-S</td>
<td>T2-S</td>
<td>23.9 18.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PS3-S &gt; R2-S &gt; PS3A-S</td>
<td>T3-S</td>
<td>416.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>185.0 55.8 765.7</td>
</tr>
</tbody>
</table>

All the Tier 3 center-pivots are proposed to be fitted with auxiliary pumps at the pivot center to boost the pressure to overcome elevation differences in the fields. This means that for most of Tier 3, the water will be pumped four times before reaching the field, which increases operation and maintenance (O&M) costs, and the risks of stoppages due to breakdown. The lift to the main reservoirs from the river is about 30m, which is substantial but not excessive.
(b) Cropping patterns and Production Capacities

According to the social and agro-economic baseline survey that was conducted at the project site by Z&A in 2012/13, the average land holding is 16ha per household, ranging widely from 0.5 to 150ha. Many of the larger plots are owned by absentee landlords and are unutilized. The active farmers only cultivate 40% of their land due to a shortage of labour, draught power and finance.

The main rain-fed crops grown include maize, groundnuts, sweet potatoes and beans. Irrigated vegetables are grown by 40% of households on small plots of 0.25-0.5ha, using water from shallow wells and streams. The main crops are cabbage, okra and tomato. Overall, crop yields are low due to the lack of inputs, weed infestation, and inherently infertile soils.

The selected area has the soil and climate capable of producing high yields of arable and vegetable crops, under good management. The relatively high rainfall from November to March may pose a disease challenge to vegetables and beans, and sulphur dioxide pollution from nearby smelters could reach the area if these facilities are not regulated.

The proposed cropping patterns with target yields for each of the three tiers are given in the table below;

Table 3-2 Proposed cropping pattern, Tier 1

<table>
<thead>
<tr>
<th>Crop</th>
<th>Yield assumption</th>
<th>Unit</th>
<th>Yr 1</th>
<th>Yr 2</th>
<th>Yr 3</th>
<th>Yr 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize</td>
<td>130 t/ha</td>
<td></td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Rape</td>
<td>37 '000 bundles</td>
<td></td>
<td>25</td>
<td>30</td>
<td>35</td>
<td>35</td>
</tr>
<tr>
<td>Okra</td>
<td>19 t/ha</td>
<td></td>
<td>1.4</td>
<td>1.6</td>
<td>1.8</td>
<td>2</td>
</tr>
<tr>
<td>Cabbage</td>
<td>56 '000 hds</td>
<td></td>
<td>20</td>
<td>25</td>
<td>30</td>
<td>35</td>
</tr>
<tr>
<td>Tomato</td>
<td>37 t/ha</td>
<td></td>
<td>20</td>
<td>30</td>
<td>40</td>
<td>50</td>
</tr>
<tr>
<td>Total</td>
<td>278</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3-3 Proposed cropping patterns Tier 2

<table>
<thead>
<tr>
<th>Crop</th>
<th>Yield assumption</th>
<th>Unit</th>
<th>Yr 1</th>
<th>Yr 2</th>
<th>Yr 3</th>
<th>Yr 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grain maize</td>
<td>37 t/ha</td>
<td></td>
<td>4.2</td>
<td>5</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Soya</td>
<td>37 t/ha</td>
<td></td>
<td>1.5</td>
<td>2</td>
<td>3</td>
<td>3.5</td>
</tr>
<tr>
<td>Cabbage</td>
<td>28 '000 hds/ha</td>
<td></td>
<td>20</td>
<td>25</td>
<td>30</td>
<td>35</td>
</tr>
<tr>
<td>Sugarbeans</td>
<td>9 t/ha</td>
<td></td>
<td>1</td>
<td>1.5</td>
<td>2.5</td>
<td>3</td>
</tr>
<tr>
<td>Green maize</td>
<td>19 '000 cobs/ha</td>
<td></td>
<td>10</td>
<td>15</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Onion</td>
<td>9 t/ha</td>
<td></td>
<td>1.5</td>
<td>2.5</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>140</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 3-4  Proposed cropping pattern, Tier 3

<table>
<thead>
<tr>
<th>Crop</th>
<th>Ha p.a.</th>
<th>Unit</th>
<th>Yr 1</th>
<th>Yr 2</th>
<th>Yr 3</th>
<th>Yr 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>728</td>
<td>t/ha</td>
<td>4.2</td>
<td>5.5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>Soya</td>
<td>728</td>
<td>t/ha</td>
<td>1.5</td>
<td>2</td>
<td>3</td>
<td>3.5</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>1,456</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(c) Water supply and Conveyance system

The annual water requirement of Musakashi Irrigation scheme is estimated to be 7.8 million m³ at full scale i.e. 0.1% of the average flow of 280m³/s recorded at Itezi-itezi downstream (MEWD, 2010). Water analysis results for the period 2008-12 obtained by the engineer indicated an electric conductivity (EC) level of 422 μS/cm with a maximum value of 559 μS/cm, which poses a moderate risk of salination, while sodium levels were low enough to pose a low danger to soils under irrigation. The phosphate levels were not above WHO’s safe limits for potable water. Being downstream of a mining area, the pollution levels are likely to fluctuate, and regular monitoring is recommended.

The conveyance system will involve several stages due to the need to supply three tiers with differing requirements and operating hours. The primary reservoirs are necessary as the primary pumps will have to operate up to 20 hrs/day at peak, while Tier 1 will operate 10 hrs/day, and Tier 2 for 12hrs/day. Tier 3 is planned to operate 20hrs/day at peak, pumping from secondary reservoirs with two centralized pump-stations. The Tier 3 area in the north has been divided into two pressure zones – east (3 pivots) and north (3 pivots). The distance from the R1-N to the furthest pivot is 3km, and from R1-S it is 4km, this justifies the need to have secondary reservoirs and pump-stations to supply the more remote pivots. However, there are several Tier 3 pivots (3 of 6 in N, and 3 of 8 in S) which could be easily supplied directly from the primary reservoirs.

(d) Primary pump stations

Pumping Station PSK-N & PSK-S will be located on the river bank above the maximum expected flood level, with approach canals that will lead to wet-wells extending 8m below the pump-house floors. Submerged vertical axis line-shaft pumps with motors in the pump-house are proposed, with two pumps for normal operation and one extra standby pump. The pump-stations will be constructed with reinforced concrete below ground and a brick or concrete block superstructure above-ground. They will be fully enclosed and each contains the transformer, all electrical switchgear and a back-up generator. The pumps will be high volume units with relatively low pressure.
3.4 Water impoundment and storage elements

Two reservoirs in the northern zone are proposed, and two for the southern zone (see table 3-6), which serve to balance the water supply to the various tiers and sections, and provide a limited amount of storage in the case of breakdown at an upstream pump station. The capacities of the reservoirs have been calculated to balance the different supplies and demands of the pump stations as they have different operating regimes. For example Pump Station PS1-N supplying Tier 1 (north) will only operate 10 hrs/day, whereas Pump Station PSK-N will operate up to 20 hrs/day.

Table 3-6 Proposed reservoirs

<table>
<thead>
<tr>
<th>Reservoir</th>
<th>Capacity, m³</th>
<th>Supplied from</th>
<th>Lift, m</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1_N</td>
<td>6,300</td>
<td>PSK-N</td>
<td>35</td>
</tr>
<tr>
<td>R2_N</td>
<td>1,000</td>
<td>PS3-N</td>
<td>27</td>
</tr>
<tr>
<td>R1_S</td>
<td>6,300</td>
<td>PSK-S</td>
<td>33</td>
</tr>
<tr>
<td>R2_S</td>
<td>1,000</td>
<td>PS3-S</td>
<td>23</td>
</tr>
</tbody>
</table>

The reservoirs to be managed by the operators will be relatively small and excavated from the ground, with the excavated material used to form embankments. They will be lined with a HDPE membrane, backed by geotextile. An outlet pit will supply downstream pipes and pumps, and a drain. The depth of water will be up to 3 m. It is proposed that reservoir levels be controlled automatically and fenced for safety and security purposes. The proposed design of HDPE-lined reservoirs eliminates losses through seepage, and keeps the water clean and reservoir banks free of weeds. Unlined reservoirs, although cheaper, are not practical for the smaller reservoirs in the north, as there is a scarcity of heavy clays in the area to construct reservoirs entirely from earth, and the dirty water will eventually lead to wear and blockages in the downstream network. The membrane, however, can get brittle and damaged over time, especially above the waterline, which would require repairs or even replacement.

3.5 Electrical infrastructure

To support the irrigation infrastructure, an 11 kV overhead power lines to the pump-stations with appropriate transformers will be constructed, including graveled access roads to all tiers. The transformers to be installed will be PCB-
free and power lines will run along access roads to avoid acquiring lands for wayleaves.

3.6 Housing and social infrastructure

Construction of 115 houses and amenities for the community is planned and will be detailed under the resettlement action plan. A total area of 4,806.24 square meters will be used to build the houses. The development of Tier 3 will involve staff housing, offices, a workshop, general stores and grain silos for approximately 8,000 T. For Tier 2 some permanent structures such as a chemical store, office and an equipment store are planned to be constructed.

3.7 Water delivery and irrigation infrastructure

3.7.1 Booster pumps on center pivots

All of the center pivots in Tier 3 will be designed with auxiliary booster pumps to raise the pressure to the required 2.5 bar at the centers to overcome elevation differences within the fields. There would then be no need for auxiliary pumps at pivot centers, with the increased capacity of power cables and step-up and step-down transformers that this entails.

3.7.2 Pipe distribution network

The force mains from the river-side pump stations will be un-plasticized poly vinyl chloride (uPVC) rated at 10 bar operating pressure (PN10). The nominal diameters will be 560mm and 630mm for north and south respectively. The pipes will be manufactured in South Africa where the nearest equivalent is Class 9 (maximum pressure 9 bar). This is still adequate as the operating pressure will be about 4 bars. A diameter of 630 mm is the maximum available in PVC from South Africa.

The pipelines from R1 to R2 (for Tier 3) will be 500 and 560 mm PN10 uPVC for north and south respectively. Class 9 will also be adequate here. All the other pipelines supplying the fields from reservoirs will be PN6 (class 6) uPVC. The pipes will be permanently buried to protect them from damage imposed by traffic, vandalism, UV light and excessive temperatures, and will be encased with at least 15 cm of excavated material free of stones.

3.7.3 Valves & fittings

The main and secondary pipelines will be fitted with various valves:

- Check valves will be located immediately after pumps to prevent back-flow when switched off.
- Control valves will be located after the check valves to control the flow & pressure in pipelines.
- Air-release valves will be located on pump-discharge manifolds and at high points on pipelines where air may get trapped.
- Wash-out valves will be located at low points to drain pipelines for maintenance or cleaning.

The selection of valves will take into consideration ease of replacement or repair, safety and ease of operation, and durability.
3.8 Main Project Activities

3.8.1 Site preparation phase

3.8.1.1 Feasibility studies
For purposes of designing the entire irrigation scheme, surveys included technical surveys for the irrigation infrastructure and supporting facilities.

3.8.1.2 Planning and consultative meetings
These aimed at increasing stakeholder involvement and participation to ensure ownership from the very initial project stage.

3.8.1.3 Sensitization and training
Given the magnitude, scope and complexity of the proposed scheme, the beneficiary community will be sensitized and trained in order to maximize the benefits.

3.8.1.4 Socio-economic surveys
The scheme will require land that currently may be either under use by the local communities, occupied by existing infrastructure and or providing grazing land for animals. These will be assessed, quantified and people affected established through a socio-economic survey leading to development of a resettlement action plan.

3.8.2 Construction phase

3.8.2.1 Land clearing and level
Although the tree cover in the proposed irrigation areas is sparse, all cover will have to be cleared. It is estimated that 50ha under trees which will require clearing with bulldozers and manual labour. The requirement for levelling will be minimal and it is expected that primary tillage involving ripping and ploughing will be sufficient. Lime will not be required as the soils are generally neutral or weakly acid (A Hungwe, 2012).

3.8.2.2 Excavation of trenches
Laying of pipe network for irrigation will require digging of trenches.

3.8.2.3 Irrigation infrastructure
The main works will be construction of pump-stations, pipelines and reservoirs. The construction impacts are noted above, and the permanent impacts are minimal as the pipelines are buried and the pump-stations are small and secure. The reservoirs can pose a safety hazard but will be fully fenced and locked. As they are lined there will be no seepage into the ground.

The installation of in-field irrigation systems will be relatively quick as it involves laying pipes and installing fittings. It will have minimal impact on the environment, and the socio-economic impacts will be strongly positive.

The only negative environmental impact of the irrigation system will be noise of the electric motors. However, all pump-stations will be enclosed and all but PSz will have their motors in the basement. As the pressure requirements are
not high, slow speed motors (1,250 rpm) can be used in the Musakashi scheme.

3.8.2.4 Installation of irrigation equipment
Irrigation equipment to be installed will include pumps, electric transformers, sprinklers and center pivots.

3.8.2.5 Construction of power lines
To run the irrigation scheme electricity power supply will be required. These will be constructed to supply of electricity to all facilities at the scheme.

3.8.2.6 Construction of water storage facilities
Rain fed agriculture is unreliable due to climate change and weather variability. As such, to optimize the potential for the proposed irrigation scheme, water storage reservoirs will be constructed.

3.8.2.7 Construction of supporting infrastructure
The irrigation scheme will be supported by social infrastructure that include houses, offices among others for provision of social services to both the work force and the community at large.

3.8.2.8 Access Roads
The project will include construction and upgrading of access roads within the scheme.

3.8.3 Operation phase
During the operation phase activities will mainly be maintenance of irrigation infrastructure, and marketing of crops. Training of farmers will also be an ongoing exercise.

3.9 Equipment and Raw Materials Use
Excavators, bulldozers, large tipper trucks and loaders, scrapers, a crane, rock-drills for blasting, and a concrete production plant are some of the equipment that will be used.

A large tracked excavator and bulldozer will be used for the constructing the reservoirs, the canals feeding PSK-N and PSK-S on the south bank, and the pump-stations. The pipeline routes will to be cleared by bulldozer. Trenches for main and secondary pipelines will be dug with a wheeled backhoe digger, while minor trenches for tertiary pipes may be dug by hand. Road-making equipment including bulldozers, graders, loaders, tipper trucks, water bowsers and compactors will be required for the new access roads and upgrading of the main access road. Equipment and pipes will be transported to project site by large trucks of 28T capacity or more.

3.10 Chemical Use and Storage
3.10.1 Expected Agro-Chemical Usage
Due to the intensive nature of irrigated production, most crops will receive pesticides, but their use will be minimized through the use of Integrated Pest
Environmental and Social Impact Assessment Musakashi IDSP Group 1 sites

Management (IPM -see annex 1). Table 3-7 below presents the expected usage in pesticides when the scheme is in full production, although the range of products used in practice may be a lot wider, even if the quantities are similar.

Of the 14,990 units (kg or lt) expected to be used each year, 25% are WHO class II (moderately hazardous), the rest being slightly hazardous (WHO class III) or better. The average quantity of pesticides applied is expected to be about 12 units (kg or lt) of product per ha p.a.

Table 3-7  Expected usage of agro-chemicals at full-scale

<table>
<thead>
<tr>
<th>Tier</th>
<th>Crop</th>
<th>Area Ha</th>
<th>Type</th>
<th>Product (suggested)</th>
<th>WHO class</th>
<th>Rate/ha (kg or lt)</th>
<th>Total qty (kg or lt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tier 1&amp;2 Vegetables 355</td>
<td>Herbicide</td>
<td>Metolachlor</td>
<td>III</td>
<td>0.8</td>
<td>284</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Seed dress.</td>
<td>Thiram</td>
<td>III</td>
<td>0.1</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fungicide</td>
<td>Copper</td>
<td>III</td>
<td>4.0</td>
<td>1,418</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Mancozeb</td>
<td>U</td>
<td>3.0</td>
<td>1,064</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Insecticide</td>
<td>Acephate</td>
<td>III</td>
<td>2.0</td>
<td>709</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Chlorpyrifos</td>
<td>II</td>
<td>2.0</td>
<td>709</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nematicide</td>
<td>Bacillus &amp; Psuedomonas sp*</td>
<td>2.0</td>
<td>709</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beans 10</td>
<td>Herbicide</td>
<td>Metolachlor</td>
<td>III</td>
<td>0.8</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fungicide</td>
<td>Azoxystrobin</td>
<td>III</td>
<td>1.0</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Maize 110</td>
<td>Herbicide</td>
<td>Metolachlor</td>
<td>III</td>
<td>0.8</td>
<td>88</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Seed dress.</td>
<td>Imidachloprid</td>
<td>II</td>
<td>0.1</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fungicide</td>
<td>Azoxystrobin</td>
<td>III</td>
<td>1.0</td>
<td>110</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Insecticide</td>
<td>Chlorpyrifos</td>
<td>II</td>
<td>1.0</td>
<td>110</td>
<td></td>
</tr>
<tr>
<td>Tier 2 &amp; 3 Wheat 766</td>
<td>Herbicide</td>
<td>MCPA</td>
<td>III</td>
<td>1.5</td>
<td>1,149</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Glyphosate</td>
<td>U</td>
<td>2.0</td>
<td>1,531</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bromoxynil</td>
<td>II</td>
<td>2.0</td>
<td>1,531</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fungicide</td>
<td>Azoxystrobin</td>
<td>III</td>
<td>1.6</td>
<td>1,225</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Insecticide</td>
<td>Fenvalerate</td>
<td>II</td>
<td>0.2</td>
<td>153</td>
<td></td>
</tr>
<tr>
<td>Soya 766</td>
<td>Herbicide</td>
<td>Metolachlor</td>
<td>III</td>
<td>0.8</td>
<td>613</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Glyphosate</td>
<td>U</td>
<td>2.0</td>
<td>1,531</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Propaquizafop</td>
<td>U</td>
<td>0.5</td>
<td>383</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fungicide</td>
<td>Tebuconazole</td>
<td>III</td>
<td>1.5</td>
<td>1,149</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Captan</td>
<td>U</td>
<td>0.5</td>
<td>383</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Insecticide</td>
<td>l-cyhalothrin</td>
<td>II</td>
<td>0.1</td>
<td>77</td>
<td></td>
</tr>
<tr>
<td>TOTAL 1,240</td>
<td></td>
<td></td>
<td></td>
<td>Avg: 12.1</td>
<td>14,990</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Bacterial suppressant for nematodes

3.10.2 Storage

The following will be done for proper storage of agriculture chemicals:

- Storage facilities will be built to keep pesticides and fertilizers secure and isolated from the surrounding environment. These storage facilities will be...
located down slope away from the boreholes, wells and streams on the farm.

- Herbicides, insecticides, fungicides and fertilizers will be segregated and their respective labels kept during storage to prevent cross-contamination and minimize the potential for misapplication.
- All agriculture chemicals (pesticides and fertilizers) will be kept out of the way of activities that might rip open a bag or puncture a liquid storage container.
- All chemicals will be maintained in their original well labeled containers, securely closed and regular inspections will be carried out for splits, tears, breaks, or leaks.

Apart from handling chemicals, employees will also be trained on the BMPs of storing agriculture chemicals.

3.10.3 Residues & pollutants

If the quantities estimated are applied, the IPM plan followed, and soil run-off into the reservoir prevented, harmful residues or pollution from pesticides are not expected. All the chemicals listed in table above have low persistence in the environment. Only in the event of spillage or incorrect application shall pollution be an issue, but it would be very localized.

3.10.4 Expected usage of Fertilizer

Almost all crops are expected to receive some fertilizer, with the possible exception of sugar beans and soya beans, although even these crops will benefit from fertilizer due to the low fertility levels. Table 3-8 below gives the estimated usage at full scale, which amounts to about 1,100T p.a. The basal fertilizers will be NPK compounds with relatively high P concentration, as this nutrient cannot normally be applied as a top-dressing. Most of the top-dressing (70%) will be nitrogen-based, especially urea, the rest being potassium and phosphate dressings for vegetables and beans. All soya bean seed will be treated with inoculants to improve nitrogen-fixation.

Table 3-8  Expected fertilizer usage at full-scale

<table>
<thead>
<tr>
<th>Tier</th>
<th>Crops</th>
<th>Area</th>
<th>Rate kg per ha</th>
<th>Qty p.a. T</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Ha</td>
<td>Basal Top-dress</td>
<td>Basal Top-dress</td>
</tr>
<tr>
<td>Tier 1</td>
<td>Vegetables</td>
<td>290</td>
<td>400 300</td>
<td>116 87</td>
</tr>
<tr>
<td></td>
<td>Maize</td>
<td>80</td>
<td>250 200</td>
<td>20 16</td>
</tr>
<tr>
<td>Tier 2</td>
<td>Maize</td>
<td>30</td>
<td>300 200</td>
<td>9 6</td>
</tr>
<tr>
<td></td>
<td>Wheat</td>
<td>38</td>
<td>400 250</td>
<td>15 9</td>
</tr>
<tr>
<td></td>
<td>Beans</td>
<td>48</td>
<td>280 100</td>
<td>13 5</td>
</tr>
<tr>
<td></td>
<td>Vegetables</td>
<td>65</td>
<td>400 300</td>
<td>26 19</td>
</tr>
<tr>
<td>Tier 3</td>
<td>Wheat</td>
<td>728</td>
<td>400 250</td>
<td>291 182</td>
</tr>
<tr>
<td></td>
<td>Soya</td>
<td>728</td>
<td>280 100</td>
<td>204 73</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>2,006</td>
<td>346 198</td>
<td>694 397</td>
</tr>
</tbody>
</table>
3.10.5 Residues and pollutants

It is expected that in the light of well-drained soils of Musakashi, there will be some leaching of nitrogen from the irrigated areas into groundwater and streams during the rainy season. The risk of phosphorus pollution is lower as it is relatively immobile in the soil and would only be lost through soil erosion. Potassium, although applied in large quantities to vegetables, is not a major risk because if it is leached from the topsoil it is bound up by clay particles in the subsoil and can still be extracted plant roots.

The level of nitrogen pollution is dependent on the rates of nitrogen applied to the soil, the irrigation and rainfall pattern, and soil and crop management. At full scale, it is estimated that 270 T of urea (46% N) will be applied. Urea is preferred because it is the cheaper source of nitrogen in Zambia. This equates to 125 T of nitrogen per year. However, only about 20T of N is expected to be applied during the rainy season, the rest being used on wheat and vegetables in the dry season. It can be expected that 15% of the summer nitrogen and 5% of the winter nitrogen will be leached (T Addiscot, 1992, and UoM, 2005).

Table 3-9  Expected annual leaching losses of nitrogen

<table>
<thead>
<tr>
<th>Season</th>
<th>Applied N, T</th>
<th>Leaching %</th>
<th>Leached N, T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer</td>
<td>20</td>
<td>15%</td>
<td>3</td>
</tr>
<tr>
<td>Winter</td>
<td>105</td>
<td>5%</td>
<td>5</td>
</tr>
<tr>
<td>Total/avg.</td>
<td>125</td>
<td>6%</td>
<td>8</td>
</tr>
</tbody>
</table>

The leached nitrogen is not expected to have any significant effect on the water in the Kafue River due to the high river flows. This amount of nitrogen is also not expected to have a noticeable effect on groundwater resources, as 8 T of N spread over 1,000 ha is equal to only 8kg/ha.

3.11 Products and By-products

Among the products expected from Tier 3 are maize, wheat, soya beans, tobacco among other crops while from Tier 1 and 2 agro products will include both cash crops and none cash crops. The main rain-fed crops are maize, groundnuts, sweet potatoes and cotton. A high proportion (73%) of farming households practice irrigation on a small scale, producing vegetables and fruit, including cabbage, tomato, watermelon, onions, okra, rape and impwa. No processing plant is planned to be constructed within the project site. Consequently no by products are expected to be produced.
4  PROJECT ALTERNATIVES

4.1  Without and With Project Alternatives

4.1.1  Without Project Alternatives

The “NO” project Option or the “do nothing” alternative, is the current state of affairs which is associated with negative economic and social impacts. The irrigation potential for the land is not fully utilized thus there are less economic activities in the area. As a result, the well-being of most communities in the area is below poverty level datum line. Given high poverty level in the area, communities have resorted to unsustainable ways of harvesting natural resources in order to make a living. In view of the above, a ‘NO’ Project Option is not beneficial to both the environment and socio-economy. Choosing this option would entail continued less income for the communities, no opportunities for innovation and entrepreneurship. In addition, a do nothing approach is in variance with Government policy that aims at uplifting the standard of living for the Zambian people. Also doing nothing means limiting Government’s source of revenue for effective management of the environment itself. This option was therefore no preferred.

4.1.2  With Project Alternatives

Farming in general requires heavy capital investment and many times beyond affordability of many household level farmers as well as small scale farmers. Musakashi farmers are mostly small scale who lack necessary technical know-how, inputs, equipment and irrigation infrastructure to necessitate sustainable agriculture. As a result, these farmers most often attain crop yields below optimum. With this realization, Government has sourced funds to undertake an irrigation scheme project at three selected sites across the country, of which Musakashi Irrigation Scheme is one. The thrust behind the proposed project is pro-poor economic growth through increased yields per hectare and value of diverse products marketed by smallholders benefitting from investments in irrigation in selected sites served by the project.

The National Irrigation Policy further states that of the 58% of land suited for arable use, only 14% is currently being utilized and less than 5% is under irrigation in Zambia. This means that 5% of arable land is under irrigation at
During the eight months of the dry season. Therefore, the proposed project if implemented will contribute to an increase in land under irrigation and wealth creation among targeted beneficiaries. Therefore this option is preferred.

The main impact of the Musakashi irrigation scheme will be the generation of sustainable income for beneficiaries (PPP participants). The allocation of irrigation resources will bring wealth to each part of the community, including disadvantaged groups. This will result in incremental income expected from the proposed project and its distribution between socio-economic groups.

Finally, choosing this option would result in several beneficiaries i.e. direct and indirect beneficiaries. The direct beneficiaries will include substantial numbers of female headed households, female farmers and female micro-entrepreneurs, youth, HIV/AIDS affected households and other vulnerable groups.

4.2 Site Alternatives

4.2.1 Overall Project Site

Construct the IDSP irrigation scheme at Musakashi site

Musakashi offers adequate availability of water, minimum disturbance to biophysical and socio-economic environments, availability of suitable soils and climate and terrain for irrigation. From the socio-economic point of view, it was found to be economical and as well as low costs of implementation. Hence this option is preferred.

Construct the IDSP irrigation scheme elsewhere

Finding another comparable site that meets standard criteria for construction of an irrigation scheme and associated infrastructure may not be easy. Most sites that were investigated were found to be inappropriate due to unsuitable topographical characteristics, long water conveyance distance, economically and unsuitable soil type for farming. Besides, in many instances, those that were equally suitable meant that the number of settlements or infrastructure that would be affected was too large to manage from both environment and socio-economic point of view. Therefore this option was not preferred.

4.3 Alternative Processes

Three water harnessing processes were considered:

- Direct Abstraction using a pump;
- Abstraction of Groundwater;
- Rainwater Harvesting.

4.3.1 Direct abstraction using a pump

Direct abstraction using a pump involves pumping water directly from Kafue River for purposes of irrigation. Due to adequate flows in river flow and strict crop watering schedules, this type of harnessing is ideal. Choosing this alternative would mean irrigation will be possible during the dry season when flow in the river is at its minimum. Therefore this alternative was chosen.
4.3.2 Abstraction from groundwater

Groundwater Abstraction as an alternative still requires a reservoir for storage. Musakashi project site is known to have relative poor groundwater yield to sustain commercial agriculture. Given the scale of the proposed irrigation scheme, this alternative was found to be inappropriate for purposes of the project which seeks to expand irrigated land by more than 100ha.

4.3.3 Rainwater harvesting

Rainwater harvesting is environmentally sound. However, it depends on rainfall intensity and availability of infrastructure to harvest the rain water and store it in reservoirs. But, considering the amount of water that can be harvested at any given time, this process of harnessing water would be good for domestic purposes but inappropriate for commercial agricultural purposes. Therefore this option was not chosen.

4.3.4 Alternative Methods of Chemical Application

Three methods of chemical application were considered for each of the Tier. These are elaborated below:

- Knapsack sprayers will be the main method of application in small plots. This main method of application for farmers in Tier 1 was chosen because it is economical, readily available and easy to handle unlike other methods. All farmers under tier 1 will be trained to for this purpose,
- For Tier 3 and Tier 2 for out-growers farmers the method of application chosen is spraying by tractor and boom-sprayer. This method is ideal for medium size pieces of land where mechanization is in place.
- For Tier 4, where large center pivots will be the main method of irrigation mainly with standing crops, aerial spraying method for chemical application was chosen due to the large land size involved.

4.4 Technological Alternatives

4.4.1 Irrigation Systems

Centre pivot system offers a high initial capital investment cost but its high in water application efficiency. This means a large area of land can be irrigated with high crop water requirement efficiency hence conserving water for other users that include the environment. For all the sites, this option will be applied for certain categories of farmers (mainly in Tier 3) were 50ha or more land will be under irrigation as a single scheme.

Flood irrigation has the lowest capital investment cost among the three options. It is appropriate for small scale farming. However, it is equally the lowest in terms of water utilization efficiency. In most cases depending on the type of soil, three quarters of the water applied under flood irrigation is lost due evaporation and seepage. As such it is environmentally unsound as it deprives other users including the environment of the much needed water resources. In view of this, this option will not be applied at any of the project sites. Note that at household, this option may be used for gardening purposes that involves quite small pieces of land such that overall water losses are deemed minimal.
Sprinkler irrigation has a moderate capital investment requirement and can equally be applied to sizeable large areas of land. Depending on the types nozzles being used water application efficiency can be quite high as well as long as there is proper management in terms of irrigation schedules and timings. This option will equally be applied at all the three project sites for a particular category of farmers (mainly Tier 1 and 2) that will be involved in irrigating more than 1ha to 5ha of land.

4.4.2 Water Pumps

Pumps can be submerged with motors and controls on the platform (vertical axis centrifugal pumps). One drawback with the shore-based option is the use of submersible pumps and motors which are more expensive to purchase and maintain than standard centrifugal pumps. Submersible motors tend to burn-out more frequently, and often need to be replaced rather than re-wound.

Submerged vertical-axis centrifugal pumps with motors mounted above the surface are a preferred option as primary pumps over centrifugal pumps. For secondary pumps, there are no practical alternatives for the type of pump proposed in the design. Centrifugal pumps are simple to operate and maintain when under negative suction head, and are cost-effective.

4.4.3 Irrigation Field Application System

The alternative irrigation field application systems considered included Hose furrow, Hose mover Sprinklers and Small Center Pivots.

4.4.3.1 Hose-furrow (proposed for Tier 1)

Hose-furrow system involves hand-moved 30m-long plastic garden hoses with 32mm nominal diameter connected to a low-pressure main. The hoses are used to supply 25m-long furrows between crop rows or beds at 1.0m spacing, moved from furrow to furrow as required (see Figure 5-2). Each 0.5ha plot is able to operate four hoses simultaneously, and only one fifth of the entire scheme can be supplied at any one time (i.e. only 20% of the plots on any one secondary pipeline). The hoses are connected to above ground hydrants fitted with ball-type shut-off valves, and deliver a substantial flow of 5.3m³/hr at about 1 bar.

The irrigation schedule will be designed to apply 32.4mm net every 5 days (6.4mm net/day). The peak crop water requirement would be 9.9mm/day for tomatoes in October, so the system will only supply 64% of this. However, even if the entire area was fully planted, the crops would be at different stages of development and the average crop water requirement will be around 6mm/day, as long as the plots are relatively free of weeds. A preferred operating regime which requires no change to the design would be that only two hoses are used simultaneously per plot (fewer hoses and labourers required per plot) and each plot is allowed to irrigate more frequently e.g. 4 hours every 2 days.
Consideration was also given to other furrow-irrigation systems for Tier 1 which uses unpressurised water in field channels extracted by siphon pipes: lined field channels, and earthen field channels. The former was discarded due to the high capital cost of concrete lined channels, and the latter was discarded due to the low application efficiency for a similar cost to pressurized hose-furrow. The hose-furrow system is a closed system, mainly buried and has much lower maintenance costs than open field channels.
Table 4-1  Alternative irrigation systems for Tier 1

<table>
<thead>
<tr>
<th>System</th>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Flood irrigation (from hydrants or field channels)</strong></td>
<td>Lower capital cost (if earth channels); lower energy costs</td>
<td>Low efficiency; not suited to light soils; requires flat and graded land.</td>
</tr>
<tr>
<td><strong>Hose-basin</strong></td>
<td>Can be used to leach soils of salts; better control of irrigation;</td>
<td>Higher labour requirement; requires medium-textured soils that don’t cap; needs longer hoses than hose-furrow, and more hydrants.</td>
</tr>
<tr>
<td><strong>Sprinklers (hose move)</strong></td>
<td>Lower labour requirement, higher field efficiency; can irrigate uneven land</td>
<td>Higher energy costs (needs 3.5 bar); higher capital &amp; maintenance costs; Unsuitable to small plots of under 1ha;</td>
</tr>
<tr>
<td><strong>Sprinklers (solid-set)</strong></td>
<td>Very low labour requirement; higher field efficiency; can irrigate uneven land</td>
<td>Higher energy costs (needs 3.5 bar); much higher capital costs</td>
</tr>
<tr>
<td><strong>Drip</strong></td>
<td>Low labour requirement; very high field efficiency</td>
<td>High capital cost, difficult to germinate small-seeded crops; needs filtered water; high maintenance</td>
</tr>
<tr>
<td><strong>Micro-jet</strong></td>
<td>Low labour requirement; higher field efficiency</td>
<td>High capital cost; high maintenance, not suited to all smallholder crops.</td>
</tr>
<tr>
<td><strong>Moving rain-gun (e.g. Rotrix)</strong></td>
<td>Very low labour requirement;</td>
<td>Unsuitable to small plots of under 1ha;</td>
</tr>
<tr>
<td><strong>Centre-pivot</strong></td>
<td>Very low labour requirement</td>
<td>Unsuitable to plots of under 15ha</td>
</tr>
</tbody>
</table>

The selected hose-furrow system is a significant improvement on traditional flood irrigation as it will provide better control of water application and improved efficiency. At the same time, it is low-tech and easy to maintain, which is essential as smallholders will not have the capacity to repair or replace complex in-field systems. It is easier to install and maintain, and less wasteful of water than open systems which require carefully graded field channels. Although it will require some experience, planning and discipline to operate, it is justified in being the best solution for Tier 1. It also has the ability to be easily converted to drip (if filters are fitted after the hydrant) or even a portable low-pressure sprinkler system, should farmers wish to do so in the future.

### 4.4.3.2 Hose-move sprinkler

The layout will be divided into 2.7ha plots (180 x 150m) and standard sprinklers at a spacing of 15 x 15m and a pressure of 3bar. Each 2.7 ha plot will have two surface-laid 75mm HDPE laterals, which will simultaneously feed 12 sprinklers each, on 33m draglines of 25mm PE hose. Each sprinkler will have 5 positions and will be moved manually (see Figure 5-2). The system is easy to operate as the laterals do not require moving, only the sprinklers which are mounted on tripods, every 6 hours. One worker can irrigate 5.4 ha (48 sprinklers).
Figure 4-2  Hose move sprinkler system for Tier 2

The system has been designed to apply 8.8mm gross/day, which will give 6.6mm net/day as the application efficiency of sprinklers is only 75% due to non-uniform coverage and losses. The scheme will operate for 12 hours/day, so each sprinkler covers 2 positions. The peak crop water requirement would be 9.9mm/day for a crop like tomatoes in October, so the scheme can supply only 66% of this, however not all the area will be covered by fully-grown tomatoes or similar vegetables, so 6.6mm day is considered adequate as long as the plots are relatively free of weeds. If there was a need to apply more, the operating hours could be extended.

4.4.3.3 Small centre pivots (for Tier 2)

Centre pivots have a higher efficiency (85%) than normal sprinkler layouts due to more uniform application and less room for human error. They also cause less soil damage due to a lighter application of water from low pressure emitters. The labour requirement is very low, allowing one operator to control several pivots, or do other tasks during irrigation. The pivots can be utilised by groups of farmers growing a single crop like wheat or soya beans, or divided into several “slices” for different crops. The application rate can be varied by adjusting the speed of the pivot. Soluble fertilisers and some soil-acting chemicals and biological treatments can be easily applied through centre-pivots.

The flow requirement of each pivot is specified as 27 l/sec at 2 bar pressure, operating for 16hrs/day, which will give 8.2mm gross/day or 7.0mm net/day. If
planted to wheat, the peak demand will be 7.3mm net/day, and 3.5mm net/day if planted to early maize in October. Therefore, with a small increase in operating hours (to 17hrs), the scheme will be capable of being fully planted with wheat. The precise operating pressure and type of emitter will be determined in the final design in consultation with an experienced pivot supplier.

Table 4-2 Alternative irrigation systems for field crops and vegetables on Tier 2

<table>
<thead>
<tr>
<th>System</th>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flood irrigation (from hydrants or field channels)</td>
<td>Lower capital cost; lower energy costs</td>
<td>Low efficiency; not suited to light soils; requires flat and graded land.</td>
</tr>
<tr>
<td>Sprinklers (portable laterals)</td>
<td>Lower capital cost</td>
<td>High labour requirement, higher risk of damage and losses of equip't</td>
</tr>
<tr>
<td>Sprinklers (solid-set)</td>
<td>Very low labour requirement; higher field efficiency;</td>
<td>Higher capital costs; obstructs machinery access;</td>
</tr>
<tr>
<td>Moving rain-gun (e.g. Rotrix)</td>
<td>Low labour requirement; low capital cost per ha, easily moved &amp; shared.</td>
<td>Requires good management and maintenance; can cause damage to bare soil.</td>
</tr>
<tr>
<td>Drip</td>
<td>More efficient water use; less weed growth</td>
<td>Higher capital cost; needs filtered water; difficult to germinate small seeds; requires that all top-dressings are soluble technical grade fertilisers</td>
</tr>
</tbody>
</table>

4.4.3.4 Centre Pivots (proposed for Tier 3)

The most popular form of large-scale irrigation in Zambia today is center-pivots. These have been selected for Tier 3. The ease of operation, high efficiency and low labour requirement make them the first choice if water availability is more limiting than land. The main drawback with pivots is the large amount of land that cannot be irrigated due to the circular pattern (min 35% of a square field), and the high initial cost. The initial design specifies 52ha pivots in all sections of Tier 3, which is a 7-tower pivot with 25m overhang on the last tower. Larger pivots have a higher rate of discharge at the end, which can exceed the infiltration rate of the soil to a point where soil damage or erosion can occur, and the pressure difference on a sloping field can be too high. The selection of 52ha is a good compromise between cost per ha and the hydraulic considerations.

Pivots will be ideal for the Tier 3 areas with shallow soils as they allow frequent, light doses of irrigation where the soil water holding capacity is low. They also allow soluble fertilizers and some soil-acting chemicals and biological treatments to be easily applied through the irrigation water with a tank and injection system at the center.

The designed irrigation duty for Tier 3 pivots is 6.5mm net/day (8mm gross) on a 20hr pumping day, which is only just adequate for wheat where the peak requirement will be 7.3mm net/day (Aug), which requires pumping for 23hrs/day. This should be re-considered in the final design, as there is little safety margin with the shallow soils in this area.
### Table 4-3  Alternative systems for Tier 3

<table>
<thead>
<tr>
<th>System</th>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flood irrigation (from hydrants or field channels)</td>
<td>Lower capital cost; lower energy costs</td>
<td>Low water efficiency; not suited to light soils; requires flat and graded land, which is not possible in T3.</td>
</tr>
<tr>
<td>Sprinklers (portable laterals)</td>
<td>Can irrigate uneven and irregular blocks</td>
<td>High labour requirement, lower efficiency; higher risk of damage and losses.</td>
</tr>
<tr>
<td>Sprinklers (solid-set)</td>
<td>Low labour requirement; can irrigate uneven and irregular blocks.</td>
<td>Higher capital cost/ha; obstructs machinery access.</td>
</tr>
<tr>
<td>Lateral-movers</td>
<td>Better utilization of land</td>
<td>Requires canal or flexible pipe for water supply, limited regional experience/support.</td>
</tr>
</tbody>
</table>

#### 4.5 Materials Options

Surface-laid HDPE laterals and PE dragline hoses are used in hose-move sprinkler system. Sprinkler and tripod construction is not specified, but the more durable brass sprinklers on galvanized steel tripods is recommended. Plastic sprinklers are much cheaper but are easily broken. Tripods can be made from normal steel bar, which is cheaper and can be easily made or repaired on-farm, and rusting is not a major concern. However, these would be better suited to the scheme if workshop facilities will be available. The laterals could be made from uPVC but this would need to be buried to protect it from damage and light. This would prevent tractor operations near the laterals, and make repairs to leaking outlets more difficult. The HDPE pipes can be moved to allow access to tractors. Alternatively, metal pipes with quick-connectors could be used for the laterals, which would be more durable, but the cost and risk of theft are higher. Therefore, HDPE is the best solution.

Commercially available reinforced PVC “dragline” hose, made specifically for irrigation, is the best option for the hoses. It is durable enough to withstand the frequent moving of sprinklers, and has a lifespan of 5 to 10 years, depending on grade. An internal diameter of 20 mm, and length of 36m is standard. 25mm PE pipes are not generally used for hose-move systems in Southern Africa.

Alternative pipeline materials evaluated included:

- **m PVC**: Its 10-15% cheaper, and lighter than uPVC and tougher due to the high compression (18 MPa v 12.5 MPa) of the construction. This is the preferred for the main pipeline material;
- **Asbestos cement**: Heavy, liable to fracture, dangerous to cut (dust), requires couplings;
- **Steel**: Very strong, can be made in large diameters (max for uPVC is 630mm), but much more expensive than uPVC, difficult to move, and requires special joints and concrete supports;
- **Glass reinforced plastic (GRP)**: Good flow characteristics, can be made in large diameters (max for uPVC is 630mm), more difficult to install and repair than uPVC, and more expensive.

The distribution (or tertiary) network will use high density polyethylene (HDPE), which has been selected because it easier to install and has less joints than uPVC. HDPE comes in 50m or 100m rolls, while uPVC comes in 6m lengths.
HDPE can be surface laid as it is not damaged by UV light and is more resilient to impact and traffic than uPVC. Apart from uPVC, galvanized steel (GI) would be an alternative but the cost is much higher, and it is much more complicated to join and install. Low density polyethylene (LDPE) is a cheaper alternative to HDPE but will only withstand 3 bar pressure, and the joints are liable to leak, unlike the compression fittings used for HDPE. Thus it's not a preferred option.

4.6 Water Management Options

The concept behind the IDSP project is that a commercial operator of the irrigation system at all sites. In the case of Musakashi the operator is expected to be the Tier 3 farmer, as the scheme is too small to justify an independent operator. Including a commercial operator is for purpose of ensuring sustainability through timely maintenance, professional management, efficiency and the collection and proper application of water user fees. Water distribution will be controlled by the operator according to agreed pumping hours and irrigation schedules. In the event of a shortage of water, priority is to be given to Tier 1, followed by Tier 2, and then Tier 3. The water users are expected to form a committee to oversee the allocation of water, setting of schedules, and address operational problems. The water fees for Tier 1, and to a lesser extent Tier 2, will be subsidized by the project in the early years to ensure affordability (CEPA, 2013).
5 POLICY, LEGAL AND INSTITUTIONAL FRAMEWORKS

5.1 General Legal Framework

Zambia’s attainment of the middle income country status is partly depended on accelerated economic growth through efficient implementation of various developmental projects outlined in the Sixth National Development Plan (SNDP). However, such socio-economic development should be undertaken in such a manner that avoids environmental degradation in accordance with the legislative requirement.

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 is responsible for enforcing environmental regulations and coordinating sectoral government agencies involved in environmental management in their sectors. The legal framework of environmental management is described briefly below. Italics indicate the measures that MAL as the project implementing agency are responsible for ensuring compliance with all relevant Acts.

5.2 Legislation Framework

5.2.1 The Environmental Management Act (EMA), No. 12 of 2011

This Act is the principal environmental law in Zambia and provides for integrated environmental management and the protection and conservation of the environment and the sustainable management and use of natural resources. This law is the primary legal basis for undertaking environmental and social impact assessment for the proposed IDSP project.

Ministry of Agriculture and Livestock has commissioned ESIA process by engaging a consultant SOFRECO to undertake environmental and social impact assessment in compliance with requirements of this national regulation during implementation of the project at the three site.
5.2.2 The National Heritage and Conservation Commission Act

The objectives of the National Heritage and Conservation Commission Act apply to development activities in game parks as augmented by section 22 of the Zambia Wildlife Act that prohibits removal or damage of any objects of prehistoric, historic or archaeological interest that exist in these protected areas.

During the construction phase of the IDSP project at Musakashi site there will be excavation and earth movement activities for the preparation of agricultural fields and installation of water pipeline network for irrigation.

Therefore Ministry of Agriculture and Livestock shall ensure that any artefacts or objects of archaeological significance discovered in the process are preserved and reported to the National Heritage Conservation Commission.

5.2.3 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 irrigation development project at Musakashi site will affect land under state land.

Ministry of Agriculture and Livestock will give due consideration to the provisions of this Act in managing land issues since resettlement of affected households is expected.

5.2.4 The Water Resources Management Act

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. 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. The IDSP project when implemented will involve abstraction of directly from Kafue River and that requires a water right governed by this Act.

Ministry of Agriculture and Livestock will ensure that necessary documentation regarding the water right is obtained.

5.2.5 The Plant Pests and Diseases Act, CAP 233

The Plant Pests and Diseases Act is the enabling framework for the eradication and prevention of the introduction and spread of plant pests in Zambia. The Plant Quarantine and Phytosanitary Service implement this act. As in the case of eradication of noxious weeds under the Noxious Weeds Act, Section 7 of the Plant Pests and Diseases Act requires an owner of land or premises to take all measures prescribed and any additional or alternative measures as are reasonably necessary for the eradication, reduction or prevention of the spread of a pest which an inspector may by notice in writing order him to take.

Ministry of Agriculture and Livestock will be required to abide by the provisions of this Act.
5.2.6 The Plant Variety and Seeds Act, CAP 236

This Act was enacted in 1997 to provide for the regulation and control of the production, sale, import and export of seed and to provide for testing and for minimum standards of germination and purity. It also provides for the certification of seed. The Act is implemented by the Director of the Seed Control and Certification Institute (SCCI), the designated Authority, on behalf of the Minister of the Ministry of Agriculture and Cooperatives. The Cotton Act, Coffee Act and Plant Pests and Diseases Act also control the seed sub-sector. The Act prohibits any person from operating as a seed importer or cleaner without registration with the Authority. The Authority may register an applicant if satisfied that the applicant complies with the prescribed requirements. The Act empowers the Minister to exempt any class of seed importer or cleaner from application of the Act. The Certifying Authority may license any seed company or institution as a certifying agency in any kind of seed or plant variety.

Ministry of Agriculture and Livestock will abide by the provisions of these Acts given that the IDSP project will at operation stage involve planting of various crop seed.

5.2.7 The Cooperative Act Cap. 397 of 1972

The Act provides the registration, inspection, examination and supervision of cooperative societies which belong to the people who use their services, the control of which rests with their members in proportion to the use they make, and the gains from which are distributed among members in proportion to the use they make of these services or their interest in their society.

Ministry of Agriculture and Livestock will abide by the provisions of this Act particularly that the implementation of the IDSP project will involve some individual farmers forming groups to manage given portions of land ranging from 1 to 5ha in extent under tier 2.

5.2.8 The Local Government Act of 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 IDSP project will be implemented at Musakashi site falling under Mufulira District.

Ministry of Agriculture and Livestock will ensure that provisions of this Act are adhered to during the implementation of the IDSP project in order to avoid or minimize degradation of the environment.

5.2.9 The Fisheries Act

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 setting up irrigation schemes. To achieve this some hydraulic structures will be constructed that may affect the fish in the given rivers.

Thus this Act is very relevant to the project since the Ministry of Agriculture and Livestock will have to ensure that measures are put in place to avoid
disturbance to migratory and breeding pattern of fish in Kafue River where abstraction will be done.

5.2.10 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, The Ministry of Agriculture and Livestock will ensure that these resources are protected.

5.2.11 The Plumage Birds Protection Act

It provides for the prohibition of dealing in plumage of wild birds except for scientific or education purposes. The three project sites and their surrounding area are home to many bird species.

Therefore the Ministry of Agriculture and Livestock will ensure that provisions of this Act are observed at all the three sites.

5.2.12 The Town and Country Planning Act, Cap 285

This 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, use and change of land use zones and reservations for various purposes e.g. siting of work sites as well as compensation of those affected by planning decisions and regulated development subdivisions. The land being targeted is state land.

Ministry of Agriculture and Livestock will ensure it obtains relevant planning documentation from the relevant Planning Authorities.

5.2.13 The Tourism Act, CAP 155

This Act provides for the preservation of the country’s natural endowments e.g. National Heritage sites and waterfalls etc., as assets of tourist attraction.

Ministry of Agriculture and Livestock will therefore ensure that measures are put in place to promote and enhance the conservation of natural endowment during implementation of the proposed IDSP project.

5.2.14 The Zambia Wildlife Act, CAP. 12 of 1998

Provides for the establishment, control and management of Game Management Areas; to provide for the sustainable use of wildlife and the effective management of wildlife habitat in Game Management Areas; to enhance the benefits of Game Management Areas both to local communities and to wildlife; to involve local communities in the management of Game Management Areas; to provide for the development and implementation of management plans.

Ministry of Agriculture and Livestock will ensure that it adheres to principles highlighted in this law during implementation of the proposed project.
5.2.15 The Forest Act, CAP 199 of 1999

This act provides for, among others, the participation of local communities, traditional institutions, non-governmental organizations and other stakeholders in sustainable forest management including conservation and use of forests and trees for the sustainable management of forest ecosystems and biological diversity.

Ministry of Agriculture and Livestock will ensure that implementation of the proposed project is carried out in a manner which will conserve sensitive ecosystems at the project site in compliance with the provisions of this Act.

5.2.16 The National HIV/AIDS/STI/TB Council Act of 2002

The Act provides for the establishment of the HIV/AIDS/STI/TB Council whose functions include the coordination and provision of support to development, monitoring and evaluation of multi-sectoral response for the prevention and combating of the spread of HIV/AIDS/STI and TB in order to reduce the personal, social and economic impacts of HIV/AIDS/STIs and TB.

Ministry of Agriculture and Livestock will ensure that the contractors promote STDs & HIV/AIDS awareness as well as distributing condoms among construction workers during project implementation.

5.2.17 The Biosafety Act No. 10 of 2007

The Biosafety Act established Zambia’s position on ‘regulating the research, development, application, import, export, transit, contained use, release or placing on the market of any genetically modified organism whether intended for use as a pharmaceutical, food, feed or processing, or a product of a genetically modified organism’. The Act amplifies the provisions of the Plant Variety and Seeds Act.

Ministry of Agricultural and Livestock will comply with this Act in the purchase and use of seeds and the use and sale of its crops at Musakashi Irrigation Scheme.

5.2.18 The Noxious Weeds Act of 1953 Cap 231

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. The Noxious Weeds Act is the main legislative framework dealing with IAS, generally referred to as 'noxious weeds'. The Act provides for the eradication of noxious weeds. The Act places a duty on every occupier of land within any specified area to report the occurrence of and to eradicate noxious weeds. An occupier of land is further obligated to take reasonable steps to eradicate any noxious weed occurring within the boundaries of the land.

Ministry of Agricultural and Livestock will ensure that farmers within the scheme do not knowingly introduce noxious weeds onto their properties. Should such weed occur, measures will be taken to eradicate such weeds wherever they occur on land or impoundments.
5.3 Natural Resources Policies

5.3.1 National Agriculture Policy

National Agricultural Policy (NAP), 2004-2015 guides the development of agriculture in Zambia up to the year 2015. The main thrust behind this policy is to ensure sustainable development of land and water resources for both rain-fed and irrigated agriculture for food security and income generation especially for rural populations where people depend on agriculture for their livelihood. In this regard, the development and use of wells, boreholes, dams and springs for irrigation throughout the country is highly emphasized by the policy. It is the policy of the Zambian Government to increase the national water reservoir capacity and consequently increase land utilization for agricultural purposes.

5.3.2 Irrigation Policy

The Irrigation Policy and Strategy (IPS), 2004-2015 was developed with the aim of guiding the development of the irrigation subsector in Zambia. Specifically, to put 70,000 ha of new land under irrigated agriculture by 2011. Whether this has been achieved is yet to be established. Out of this plan, 10,000 ha is intended to be large scale commercial and 30,000 ha for each emerging commercial and small scale farmers respectively. The IPS was supported by the National Irrigation Plan (NIP) that established the Irrigation Development Fund to compliment the implementation. It’s the policy of the Zambia Government to deliberately create an enabling environment to ensure that the total land under irrigation is increased in order to reduce dependence on rain fed agriculture through initiatives such as the proposed IDSP project.

5.3.3 National Water Policy

This is the revised version of the 1994 edition. The earlier edition was promulgated primarily to guide the restructuring of the water sector with a strong bias to water supply and sanitation. The 2010 Policy has re-examined the role of water resources in an integrated manner and has provided guidance on the institutional and legal framework taking into account modern principles of water resources management (e.g. efficient and equitable water allocation to all users) and best international practices to promote sustainable national socio-economic development. One of the new measures advantageous to the farming community provided for by the National Water Policy of 2010 is the exclusion of traditional and small scale farmers with irrigation plots not to acquire water permits for their agricultural activities. Irrigation plots of less than 0.5ha will be exempted from water permits by the new water legislation.

5.3.4 The National Policy on Environment 2007

Provides environment and natural resources management policies to address current and future threats to environment and to human livelihoods and provides policy guidelines for sustainable development.
5.4 Multilateral Agreements and Biodiversity Protocols

Zambia is a signatory to a number of international and regional agreements and conventions, which are related to the environment. Those of relevance to the project are described below.

5.4.1 Biodiversity Protocols

The Convention on Biological Diversity (CBD), the associated Cartagena Protocol on bio piracy, and the African Forest Law Enforcement and Governance Agreement (AFLEG), are associated regulatory frameworks that have domesticated application through the Lusaka Agreement on Cooperative Enforcement Operations Directed at Illegal Trade in Wild Fauna and Flora (1994).

Application: MAL is required to be compliant with the provisions of the Convention on Biological Diversity as they are incorporated into domesticated documentation (including the EMA), and these provisions are now incorporated in principle into the MAL Conservation Application Policy Manual.

5.4.2 Convention on Biological Diversity

The Convention on Biological Diversity was adopted in 1992 and aims to encourage and enable all countries to conserve biodiversity and use its components sustainably in support of National Development. A number of plans falling under the Department of Agriculture, Forestry, Fisheries and National Parks and Wildlife Service’s integrate the philosophy of this Convention and the National Environmental Action Plan addresses many of the issues raised.

5.4.3 The Convention on Biological Diversity (Nairobi, 1992)

The Convention was adopted on 5th June 1992 and came into force on 29th December 1993. It was ratified by Zambia in 1993. The Ministry of Lands and Environment implemented the Convention in Zambia.

The objectives are the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising from the use of genetic resources. State parties to the Convention have committed themselves to identifying components of biological diversity of importance for conservation and sustainable use and that the policies and practices within individual jurisdictions should not cause damage to the environment of other states or to areas beyond their jurisdictions.

The Convention is the only globally applicable, legally binding instrument to address alien species introduction, control and eradication across all biological taxa and ecosystems. Parties are required as part of a suite of insitu conservation measures and as far as possible and appropriate, “to prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species”
5.4.4 United Nations Convention to Combat Desertification

The United Nations Convention to Combat Desertification (CCD) established in 1994 emphasizes desertification and mitigation of drought, but also aims to encourage long-term integrated strategies for improved production of land and rehabilitation, conservation and sustainable management of land and water resources. The CCD emphasizes the need for local participation in strategic programme implementation.

Zambia is a signatory to the CCD but has yet to ratify it. Among the obligations of the CCD relevant to Zambia and the project is the “encouragement of decentralization and local resource tenure to strengthen local participation” the Soil Conservation and Agro-Forestry Extension Project (SCAFE) is an example of an extension program in place which addresses the issues raised in the Convention and a number of other international conventions. Central to SCAF, which is established through the agriculture extension services, is the promoting of community awareness of land management and conservation in order to prevent land degradation and establish rehabilitation of degraded land.

**Application:** The CCD will have implications for climatic and micro climate change around the project site through the promotion of climate adaptation measures that may impact on future land clearing and land and water management. The CCD also has relevance to the mechanisms of land development and land use management. The objectives of both Conventions are incorporated in the MA corporate social responsibility charter. There is increasing evidence that application of resources to these objectives and to the principles of biodiversity conservation contribute measurably to overall operating efficiency and profitability in the medium term.

5.4.5 Pesticide and Hazardous Chemical Protocols


The Convention provides norms, rules and procedures governing movements and disposal of hazardous waste at international as well as national levels. The overall objective of the Convention is to protect, by strict control, human health and the environment against the adverse effects, which may result from the generation and management of hazardous wastes and other forms of waste.

Zambia acceded to the Convention on 15th November 1994. The Convention is implemented by ZEMA. Waste disposal, especially into water changes the nutrient load. In some cases this creates a favorable environment for the proliferation of certain invasive plant species.

5.4.5.2 Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade.

The Convention provides for promotion of shared responsibility and cooperative efforts among Parties in the international trade of certain hazardous chemicals in order to protect human health and the environment from potential harm and to contribute to their environmentally sound use, by facilitating information exchange about their characteristics, by providing for a national decision-making process on their import and export and by disseminating these decisions to Parties. This Convention applies to banned or
severely restricted chemicals and severely hazardous pesticide formulations. Zambia acceded to the Convention in 2000. The Convention is implemented by ZEMA.

**Application:** many of the chemicals listed under the Rotterdam Convention are still in circulation in Zambia and MAL’s attention is drawn to the requirements of this Convention and to periodic additions and changes to the list.

### 5.4.5.3 Stockholm Convention on Persistent Organic Pollutants

The Convention provides for norms, rules and procedure governing accessibility and usage of persistent organic pollutants. It aims at protecting human health and the environment from persistent organic pollutants. Any party to the convention is expected to prohibit and/or take the legal and administrative measures necessary to eliminate its production and use of the chemicals listed in Annex 2 subject to the provisions of that Annex; and its import and export of the chemicals listed in Annex 2 in accordance with the provisions and restrict its production and use of the chemicals listed in Annex 2 in accordance with the provisions of that Annex. Further each Party is expected to take measures to ensure that a chemical listed in Annex 2 is imported only for the purpose of environmentally sound disposal as set forth in paragraph or for a use or purpose which is permitted for that Party under Annex 2. Zambia is a party to the convention and ZEMA is the implementing agency.

**Application:** all three of these global conventions have been ratified by Zambia and are now largely domesticated into Zambian legislation, including the requirement to comply with utilization frameworks established by these conventions and the periodic changes made to them. MAL’s required by law to abide by the restrictions of the Rotterdam and Stockholm Conventions and to attempt to attenuate or, if possible, remove traces of persistent chemicals from their properties.

### 5.4.5.4 Convention on the Protection of World Cultural and Natural Heritage

The Convention on the Protection of World Cultural and Natural Heritage (WCNH) signed in 1973 aims to protect areas of universal value to science, conservation or natural and cultural heritage. It contains two legal principles, one of which states “There is a legal duty on the part of all states to conserve and take responsibility for all natural and cultural heritage.” Zambia acceded to the Convention in 1984.

**Application:** This policy will not directly affect the project, but cognizance should be taken of the context of the Convention.

### 5.5 Relevant International Finance Corporation Policy Guidelines

#### 5.5.1 Relevant World Bank and IFC Guidelines

The World Bank Group through its members such as the International Finance Corporation (IFC), the International Bank for Reconstruction and Development (IBRD), the International Development Association (IDA), and the Multilateral Investment Guarantee Agency (MIGA) has a policy that all its operations and
investment are carried out in an environmentally and socially responsible manner.

In this regard, IDSP project must comply with applicable World Bank and IFC environmental, social and disclosure policies. By nature of the proposed IDSP project Seven (7) safeguard policies out of the listed Ten were found to be relevant and fundamental to the project appraisal, approval and supervision process.

In carrying out the environmental and social impact assessment for the IDSP project for group one sites, consideration was given to applicable World Bank and IFC Safeguard policies: Environmental Assessment; Natural Habitats; Pest Management; Forest; Involuntary Resettlement, and Cultural property. Like the World Bank Safeguard policies, Zambia’s environmental policy and resettlement demands that adverse environmental and social impacts of any proposed developmental project must undertake a process to identify all relevant potential impacts and recommend means of avoiding or minimizing such impacts. Besides the mitigation measures it’s expected that their implementation would be monitored. In either case, World Bank policy or Zambia’s policy, the objective is the similar; ensuring that identified issues are integrated into decision making process so that only environmentally and socially sustainable projects are supported.

5.5.2 Policy Guidelines

World Bank/IFC EHS Guidelines and Pollution Management Sourcebook

The World Bank/IFC EHS Guidelines and Pollution Management Sourcebook (Getting to Green – A Sourcebook of Pollution Management Policy Tools for Growth and Competitiveness) apply to all projects directly financed by IFC. However, taking into account country legislation and local conditions, the Environment assessment may recommend alternative emission levels and approaches to pollution prevention and abatement for the project.

5.6 Institutional Responsibilities

5.6.1 The Zambia Environmental Management Agency (ZEMA)

The Zambia Environmental Management Agency (ZEMA) formerly (Environmental Council of Zambia - ECZ), is established by the Act of Parliament of 2011. It reports to the Ministry of Lands, Environment and Natural Resources. It is responsible for environmental management and the protection and conservation of the environment and the sustainable management and use of natural resources. It has legislative responsibility for environmental impact assessment. It’s responsible for enforcing environmental regulations and coordinating sectoral government agencies involved in environmental management in their sectors. It is empowered to among others to establish water quality and pollution controls standards and determine conditions for the discharge of effluents into the aquatic environment.

Under the Act ZEMA is responsible for preparation of the State of the Environment Report, environmental management strategies and other plans for environmental management and sustainable development; facilitation of
strategic environmental assessments of proposed policies, plans and programmes likely to have an impact on environmental management; responsible for ensuring public participation in environmental decision-making and access to environmental information as well as facilitate the implementation of international environmental agreements and conventions to which Zambia is a party.

5.6.2 The Water Resources Management Authority (WARMA)

Water Resources Management Authority was established under the Water Resources Management Act of 2011. The Authority is responsible for promoting and adopting a dynamic, gender-sensitive, integrated, interactive, and participatory and multi-sectoral approach to water resources management and development that includes human, land, environmental and socioeconomic considerations. The Authority is responsible for identifying and protecting potential sources of freshwater supply; conserve, preserve and protect the environment, in particular, wetlands, quarries, dambos (some kind of shallow “wetlands” mainly used as a source of clay), marshlands and headwaters and take into account climate change and the challenges posed by climate change, plan for and ensure the sustainable and rational utilization, management and development of water resources based on community and public needs and priorities, within the framework of national economic developmental policies.

The Authority has a Board of Directors appointed by the Ministry. The Board appoints a Director General to run the affairs of the Authority. The Authority is made up of Catchment Councils, Sub-Catchment Council and Water Users Associations.
6 BASELINE INFORMATION ON THE PROJECT

6.1 Physical Environmental Setting

6.1.1 Climate

The site falls within Agro-Ecological Zone III which is characterized by rainfall over 1,000 mm and highly leached soils. The chart below (figure 6-1) displays average data from Kafironda, and illustrates that the monthly evapo-transpiration (ETo) exceeds rainfall in all but 5 months (Nov-Mar) of the year.

The mean daily evapo-transpiration is 4.3 mm/day for the year, peaking at 5.7 mm/day in October.

![Figure 6-1  Climate for Kafironda](image)
Wind direction changes greatly in the rainy season and on average, Northerly winds prevail ranging from north-west to easterly winds. The average wind speed in the rainy season is between 3 to 4 knots during daytime and 2 knots as 24 hour winds. Winds generally increase in speed from 1 knot in June to 2 knots in October as 24 hour mean winds. From October to March winds are 2 knots 24 hours on average and then from April to May decrease to 1 knot 24 hour average speed. During the dry season, winds are mostly South-Easters ranging from North-East, South-East to Southerly winds.

Relative Humidity is more in the rainy season and is at its peak around February with the daily average of 82 % and becomes low around September to October with the daily average of 41 % in the atmosphere.

### 6.1.2 Rainfall

Historically, average rainfall for Musakashi area is 1124 mm per annum and is received over a period of 106 days. The Maximum Probable Annual Rainfall at Kafironda meteorological station is 2109 mm based on 5 year return period. With the same return period, the corresponding Minimum Probable Annual Rainfall is 959 mm (JICA, 1995).

For the past 20 years (1991 to 2012), the average annual rainfall has been 1291 mm (figure 6-2). During this period the maximum annual rainfall was 1620 mm in 1990/91 rain season. The lowest was recorded in 2006/07 season with 879 mm. According to the annual pattern, the wettest months during the rainy season are December, January and February with January receiving the maximum monthly average of about 350 mm (JICA, 1995).

![Figure 6-2 Annual rainfall trend at Kafironda Raingauge near Musakashi](image)

Temperature variations in the project area are typical the subtropical climate. The variations are therefore similar to national temperature trends. Figure 6-3 shows that maximum temperature range from 29°C to about 33°C. The maximum temperature occur in October while the minimum is experienced in June and July and can be as low as 4°C.
6.1.3 Hydrology

Kafue River rises from Kipushi area at an altitude of 1350m above mean sea level. From its source up to the Kitwe-Mufilira Road Bridge, the river is 250 km and it drains a catchment area of 7,058 km² (figure 1-6). The main tributaries that contribute to this catchment extent are Mushishima, Luansobe, Konkola and Mushindamu and are all upstream on the project area.

At the outlet of this catchment, Kafue River discharges an average runoff of 1,874 mm³ per annum (JICA, 1995). According to the monthly hydrograph based on historical monthly discharge, the flow regime of the river is perennial and it carries 140 m³/s as peak discharge between February and April (figure 6-5). The minimum flows are recorded in the months of September, October and November and range from 7 to 12 m³ per second (approximately 345,600 mm³ per day). The minimum flow can however be as low as 4 m³ per second in drier hydrological years. This is confirmed by the discharge measured during filed assessments in the month of November which was 4.74 m³/s (409,536 m³ per day).

The continuity of flow on Kafue River is evidenced by the flow duration curve at Kafironda Hydrometric Station which is located downstream of the project site (figure 6-6). The Q95 flow index for the Kafue River at Kafironda Hydrometric Station indicates that 6.98m³ per second is equaled or exceeded 95% of the time. This implies that 6.98 m³/s (603,072 m³ per day) is available as the lowest flow and is used as a basis for planning. This flow exceeds the daily water abstraction of 169,000 m³ and 30,000 m³ per day for Nkana and Mulonga Water Companies respectively (figure 6-7). Since the total abstraction for domestic supply is only 33% of the available flow, it further implies that the river is capable of meeting the cropwater requirements for the irrigation project.

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In Annex 1: Maps folder.
While there are no set standards for environmental flows, there is need to have environmental flow standards for not only the Kafue River, but other major systems in Zambia.

Figure 6-4   Historical hydrograph of Kafue River at Kafironda (Kitwe-Mufunira Road Bridge)-DWA Data
Figure 6-5  Schematic water use from the Kafue River in Musakashi area & downstream
Figure 6-6  Flow duration curve at Kafironda Hydrometric Station based on daily flows

Figure 6-7  Sections of the Kafue River at Musakashi showing the minimum flows (Nov, 2013)
6.1.4 Geology and Hydrogeology

Musakashi site is mainly underlain by two rock types namely; schist and granites. These rock types cover an extensive area of the project area extending from the north down to the southern part of the site where Quartzite rocks lies in a banded extent (figure 1-7). The rock types of Musakashi do not form high yielding aquifers and it is for this reason that groundwater potential in the area is limited. Borehole yields range from 0 to 2 litres per second (Hydrogeological Map of Zambia, 1978). The borehole depths in this formation range from 50 to 60 m.

6.1.5 Water Quality

6.1.5.1 Irrigation Water Quality

The basis for irrigation water quality is salinity hazard, sodium hazard, magnesium hazard and chloride hazard. The indices calculated in the dataset point to water for agricultural use (irrigation). These indices refer to the effect on soil and plant growth due to long term use of the water for irrigation.

6.1.5.2 Salinity hazard

Table 6-1 shows the guidelines for assessing salinity hazard (Bauder et al, 2008). Based on the results, none of the samples presented any salinity hazard problem although sample T2 (Kafue River at Kafironda) is close to causing a moderate salinity hazard.

<table>
<thead>
<tr>
<th>Limitation</th>
<th>None</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>EC (µS/cm)</td>
<td>&lt;750</td>
<td>750-3000</td>
<td>&gt;3000</td>
</tr>
<tr>
<td>TDS (mg/L)</td>
<td>&lt;450</td>
<td>450-2000</td>
<td>&gt;2000</td>
</tr>
</tbody>
</table>


6.1.5.3 Sodium hazard

The sodium hazard is estimated by the sodium adsorption ratio (SAR). SAR is the ratio of sodium concentration to the concentration of the square root of the average calcium plus magnesium concentration in either irrigation water or the soil solution (Miller and Gardiner, 2007). Table 6-1 shows the guidelines for assessing sodium hazard based on SAR and EC.

Irrigation water with low salt content and high SAR can contribute to poor soil permeability. Based on the results, all the samples have SAR below 3. Only T2 sample (Kafue River at Kafironda) gives a low degree of the sodium hazard while T3 (Kafue River at Musakashi) present the moderate sodium hazard. However, the relatively low SAR in all the samples and bicarbonate may reduce the risk of sodium hazard overall. In order to remedy the sodium

5 See Figure 1-7: Geological map of Musakashi Site and surrounding areas in Appendix 1: Maps folder.
hazard, such water requires to have its pH and bicarbonate reduced using, for instance, sulphuric acid or adding soluble calcium.

### 6.1.5.4 Potential bicarbonate hazard

According to table 6-3, T2 and T3 (Kafue River Samples) have a high potential of bicarbonate hazard. High bicarbonate content tends to reduce the dissolved calcium or magnesium thus increasing the relative proportion of sodium which directly raises the sodium hazard rating. The Residual Sodium Carbonate (RSC) for the samples shows a negative value which indicates little risk of sodium accumulation due to offsetting levels of calcium and magnesium.

**Table 6-2  Guidelines for assessing sodium hazard**

<table>
<thead>
<tr>
<th>Limitation</th>
<th>None</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>EC, µS/cm</td>
<td>&gt;700</td>
<td>200 - 700</td>
<td>&lt;200</td>
</tr>
<tr>
<td>When SAR = 0-3 and EC</td>
<td>&gt;1200</td>
<td>300 - 1200</td>
<td>&lt;300</td>
</tr>
<tr>
<td>When SAR = 6-12 and EC</td>
<td>&gt;1900</td>
<td>500 - 1900</td>
<td>&lt;500</td>
</tr>
<tr>
<td>When SAR = 12-20 and EC</td>
<td>&gt;2900</td>
<td>1300 - 2900</td>
<td>&lt;1300</td>
</tr>
<tr>
<td>When SAR = 20-40 and EC</td>
<td>&gt;5000</td>
<td>2900 - 5000</td>
<td>&lt;2900</td>
</tr>
</tbody>
</table>

Modified from Bauder et al (2008)

**Table 6-3  Guidelines for assessing potential bicarbonate hazard**

<table>
<thead>
<tr>
<th>Bicarbonate (HCO3), ppm</th>
<th>0 -120</th>
<th>120 – 180</th>
<th>180 - 600</th>
<th>600+</th>
</tr>
</thead>
</table>

### 6.1.5.5 Heavy metals

The heavy metals results were below detection limit for all the heavy metals analyzed, that is, aluminium (Al), cadmium (Cd), Copper (Cu), lead (Pb) and zinc (Zn). There is a possibility that heavy metal presence in the river samples, particularly in Kafue River, is best presented in sediment rather than water samples, considering that the pH was above 7. Above pH 7 heavy metals tend to precipitate out solution increasing the chance of not being detected in the water column.

### 6.1.5.6 Other Parameters

The results for sodium, calcium, magnesium, bi-carbonate, chloride and sulphate were within the recommended limits for drinking water as indicated in the Annex 2 substantial amount of total dissolved solids for the Kafue River samples is not accounted for.

The low mineralization of the groundwater at Musakashi indicates fresh recharge from rainfall and a perched aquifer with significant atmospheric influence. The groundwater tends to be aggressive owing to its low pH and mineralization. Being close to the surface, the water point might be easily vulnerable to pollution.
6.1.5.7 Water Quality for Musakashi River

Water sampling at four points; Point 1 close to river source before project site up to Point 4 after project site along the Musakashi River was conducted and analysis of the samples done at the Environmental Laboratory at the University of Zambia on 30th March 2015. Original results are annexed in Annex 3.

The results indicated that all parameters are within allowable limits according to WHO guidelines accept for sulphates which was found to be 264 mg/l slightly above the permissible limit of 250 mg/l. This result can be attributed to mining activities in the area.

6.1.6 Topography and Soil

To present a map of soils in the project area, 10 soil pits were dug following a general survey using an auger penetrating down to 1.20 meters (Hungwe, 2012, p.6). Information about the soil trenches is available (see Hungwe, 2012, appendix 1, pp.22-27). No evidence of ancient human occupations were found in the soil pits nor in the auger drillings.

6.1.6.1 Five soil types were determined.

- Sandy loam (15 cm) overlying quartz and shale gravels (30 cm), underlain by the weathering soil extending over 150 cm;
- Soil extending for 90 to 150 cm depth, made up of sandy loams, and as one goes deeper in the profile they change to a sandy clay loam. Below these sandy clay loams, there is a horizon of densely packed laterite coated quartz gravels. The surface soil has a pale whitish colour, and is associated to voluminous pale whitish coloured termite mounds;
- Loamy sand with quartz gravels, underlain by a densely packed horizon of subrounded quartz stones and gravels, which in turn overlie a densely packed horizon of laterite gravels. The gravels thus extend for a minimum of 100 cm;
- Rocky soils, with cemented laterite on the surface as large boulders or as a bench.
- Permanently wet land.

Soil types 1 and 2 are suitable for agriculture. They are associated with soil type 3 in figure 1-8 to form blocks of possible to be irrigated lands.

6.1.6.2 Topography

The Musakashi Project Area landscape is dissected by non-perennial tributaries of the Kafue River on the Southern bank. The proposed irrigation areas (Tiers) lie in between the streams at an average elevation of about 1200 m above mean sea level (figure 6-8). However some tiers lie on lower elevations close to the Kafue River. The surrounding parts of the project are higher with ground elevations ranging from 126 6m to 1300 m above sea level. Generally the landscape of the area slopes in the north-easterly direction towards the banks of the Kafue River. Figure 6-9 below shows the profile of the project area from the south westerly end towards the river.

See Figure 1-8: Soil types inside the project site area; mauve colour for soils type 3 and 4 in Annex 1: Maps folder.
Figure 6-8   Topography for Musakashi Project Area.

Figure 6-9   Longitudinal Profile (A-A) from the south western part towards the Kafue River

Most of the soil types are suitable to traditional agriculture and could have attracted people during the Iron Age, especially along the Kafue river which is a year round source of water.

6.1.6.3 Nutrient Cycling

Soil suitability

The soils at the general project area, covering 4,400 ha, were surveyed by Dr Hungwe in 2011 (Hungwe 2012), and revealed two soil types (Type 1 and 2, total 1,170 ha) which were classified as “suitable” for irrigation, and one which is marginally suitable (Type 1a: 261 ha). Figure 7 shows the distribution of these soils in relation to the proposed irrigation areas.
There is a shortage of suitable soils in the project area, so the irrigable area is unable to make full use of the availability of water. Furthermore, the suitable soils are in two different areas, so the project actually becomes two schemes, with the loss of efficiency and value for money which this entails. In the final design the Tier 3 pivots will be sited and sized more accurately to ensure optimum use of the available suitable soils and avoid the steepest areas.

Soil types 1 and 2 are sandy loams at the surface (11-17% clay) with a good depth (100-140 cm) of sandy clay-loams below (20-27% clay), which gives them good water holding capacity. The marginally suitable soil has a very gravelly layer below 45cm, and has been excluded from the proposed irrigation areas.

See Figure 1-9: Soil suitability map of Musakashi and proposed irrigation areas in Annex 1: Maps folder.

6.1.6.4 Nutrient Cycling

The levels of macro nutrients in the top-soils of all the selected soil types are generally very low, exacerbated further by the acidity:

- Nitrogen: 0.7 – 0.9 ppm (low);
- Phosphate: 5 (acutely deficient) - 24ppm (marginally adequate);
- Potassium: 0.03 (very low) – 0.13 me% (moderate);
- pH: 3.4 – 4.3 (strongly to moderately acid).

The soils are highly leached, which leads to their acidic and infertile condition. The acidity will be corrected to make nutrients available, so an initial application of 3T/ha of lime will be required. Annual applications of lower rates of lime will jeopardize the early crops, and small-holders cannot be expected to apply them.

The production systems will be very intensive in order make an economic return on investment and labour, so it is expected that all crops planted will receive artificial fertilizer. Practical methods that can be used to reduce the quantity of artificial fertilizer will include:

- Retaining crop residues where it does not pose a pest risk, i.e. where the following crop is of a different species to the preceding crop. Crop rotation will facilitate this. Minimum tillage in wheat/soya rotation is recommended;
- Mulching – creates an environment conducive to soil fauna and flora which are active in cycling nutrients, and introduces organic matter;
- Use of leguminous crops such as beans and groundnuts, together with inoculants;
- Maintaining the plots under crop at all times so they remain moist;
- Planting green manures and/or mulch crops when the land is not required for cash crops;
- Use of livestock manure;
- Regular soil analysis so that fertilizer application is tailored to crop requirements – this measure is only practical for Tier 3 and 2, unless Tier 1 gets external support.

6.1.6.5 Soil Deterioration Risks

Soils can be affected both chemically and physically. The risks of chemical deterioration are considered moderate as the quality of the water in the Kafue
River is relatively high in salts and there is a moderate danger of salination (Z&A 2013c). Levels of sodium in the most of the soils are low (1.7 – 2.5 %ESP), although one sample of soil type 1 had 15% ESP, which is sodic. Although heavy metal levels from the limited data available are within safe limits, there is a danger of levels rising due to discharge from the expanding mineral processing activities upstream.

The risks of physical damage are considered moderate, as the top-soils are light and friable, In Tier 1 there will be frequent cultivation and the possibility of erosion or capping caused by heavy application of water with hosepipes. The hosepipes discharge 1.5lt/sec, which equates to a velocity of 3 m/sec. In the relatively light soils, this could wash away beds or ridges in if not carefully directed or softened with a baffle. Tillage practices can damage soils by over-cultivating (pulverizing) the top-soil, and creating a plough-pan through continued shallow cultivation. Where the fields lie on steeper slopes, such as in parts of Tier 3 they are at risk of erosion. These areas will require contour ridges, and must adopt minimum tillage to stabilize the soil.

6.1.7 Water Supply, Demand And Allocation

Between Chambeshi and Kitwe town, there are five bulk water abstraction stations. Four of these stations (Chambeshi, Germaton, Bulangililo and Nkana) are operated by Nkana Water and Sewerage Company for the supply of domestic water to townships in Kitwe. The same company supplies water to Kalulushi town from the Mwambashi River. On a daily basis, Nkana water abstracts a total of 169,000m$^3$ of water from its five stations, inclusive of Mwambashi station (NWSC data, 2013).

Mulonga Water and Sewerage Company on the other hand operate one station (located between Musakashi site and Mufulira-Kitwe Road Bridge) for the supply of water to Mufulira town. The estimated volume abstracted from this station is about 30,000m$^3$ per day (MWSC data, 2013).

The two companies are the major water users of the Kafue River upstream and downstream of the project site. However, there are other users along the river that are not on record officially but abstract significant quantities of water for various uses.

Currently, as earlier stated, Kitwe and Mufulira abstracts 169,000 m$^3$ and 30,000 m$^3$ per day respectively. As of 2004, the water demand for Kitwe was 161,987 m$^3$ per day while that of Mufulira was 13,796 m$^3$ per day (Norconsult, 2004). The projections for the year 2015, according to the Water Resources master Plan (JICA-WRMP, 1995), for Kitwe and Mufulira are 181,079 m$^3$ per day and 62,227 m$^3$ per day respectively. These projections show a significant rise in water demand for domestic and industrial use. With the development of the irrigation project as well as the projected expansion capacities for the two towns, abstractions from Kafue River will certainly increase from the current water. It’s worth noting that there is still potential for increased abstraction from the Kafue River to meet requirements of the planned irrigation expansion and increase in demand for domestic needs without affecting flows in the river. This is mainly attributed to the fact that Kafue River continues to enjoy recharge from dewatering of deep cast mining on the Copperbelt province of Zambia.
6.1.8 Air Quality

No air quality data is available for the project site. Field observations indicated that the general air quality in the area is good. However, seasonal variation as well as localized and temporal deterioration in air quality does occur due to grassland and forest fires during the dry season that generate smoke and dust. Localized and temporal air quality deterioration is also associated with open air burning and domestic fire.

For baseline data, existing information was used. From literature review, a study conducted by Consolidated Advisory Services Ltd within the area yielded the following results:

Table 6-4 Guidelines for assessing potential bicarbonate hazard

<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
<th>TSP(^7) (µg/m(^3))</th>
<th>PM(_{10}) (^8) (µg/m(^3))</th>
<th>SO(_2) (µg/m(^3))</th>
<th>NO(_2) (µg/m(^3))</th>
<th>CO (mg/m(^3))</th>
</tr>
</thead>
<tbody>
<tr>
<td>17/05/2011</td>
<td>Mine Area</td>
<td>22.6</td>
<td>9.4</td>
<td>38.5</td>
<td>20.8</td>
<td>14</td>
</tr>
<tr>
<td>17/05/2011</td>
<td>Church area</td>
<td>36.2</td>
<td>15.2</td>
<td>26.9</td>
<td>30.3</td>
<td>9</td>
</tr>
<tr>
<td>17/05/2011</td>
<td>Local School</td>
<td>25.4</td>
<td>11.5</td>
<td>20.7</td>
<td>26.4</td>
<td>10</td>
</tr>
<tr>
<td>17/05/2011</td>
<td>Minsenga Market</td>
<td>40.7</td>
<td>15.5</td>
<td>36.2</td>
<td>27.3</td>
<td>13</td>
</tr>
</tbody>
</table>

The results for air particulate matter are expressed as mass concentration in microgram (µg) per cubic meter (m\(^3\)) of air sampled while the results for absorbed gases are gas mass concentration in microgram (µg) per cubic meter (m\(^3\)) of the absorbing solution.

It is seen from the air quality results that all the concentration levels of pollutants were within the prescribed Zambian guideline. The observed pollution load of Total Suspended Particles (TSP) and the Respirable Particles (PM\(_{10}\)) was attributed to the vehicular movement on the dirt roads.

6.2 General description of the vegetation

6.2.1 Vegetation Types

Musakashi is within the savannah woodland biome which is characterized by a grassy ground layer and a distinct upper layer of woody plants with interspaced trees that are adapted to frequent fires. Vegetation types include; woodlands, scrublands, grasslands and some dambos in transitional areas of wetlands and terrestrial forests.

The major vegetation type in Musakashi is Miombo woodlands with very few open grasslands and dambos almost confined to riverine areas. Bamboo was found to be the dominant grass species established. Much of the miombo

\(^7\) TSP = Total Suspended Particles, particles with diameter less than 45 micrometres(µm).
\(^8\) PM\(_{10}\) = Respirable Suspended Particulate Matter, particles with less than 10 micrometres(µm)
woodland in the project area have vegetation that is in the secondary stage of maturity.

![Vegetation Classification](image)

6.2.2 Vegetation Classification

Five vegetation types: Terminalia woodland, Miombo woodland, Mixed woodland and Riverine vegetation (Riparian) along streams and the Kafue
River characterise the project area. In addition, Grasslands/semi-dambos was observed.

6.2.2.1 RIPARIAN VEGETATION

Typical tree species observed included; Diospyros sp, Tamarindus indica, Acacia nigrescens, Ficus niloticus, Lonchocarpasa capasa, Syzygium cordatum. Palms were observed mainly along Kafue system while papyrus was abundant along the banks of Kafue and Musakashi rivers.

6.2.2.2 GRASS SPECIES IN THE DAMBO AREAS

Dambos were characterised by continuous patches of hydrophilic grass species like Echinochloa pyramidalis and Echinochloa colona. Other grass species observed were; panicum deustum, Brachiaria deflexa, Panicum deustum, Sporobolus panicoides, and Digitaria longiflora, (couch grass). Also common to the area was Arundinella nepalensis.

6.2.2.3 GRASSLANDS

Predominant grass species observed included; Dactyloctenium spp., Piptostachya inamoena, Rhynchelytrum spp., Diectomis fastigiata, Aristrida spp., Tristachia spp., Heteropogon spp., Setaria spp., Eragrostis spp., Hyperhienia spp., and Cynodon dactyl. Open grasslands characterize the area with Sporobolus ioclados, Brachiria spp., Tragus raeomocus, Pogonarthria flexii, as dominant grass species. The dambo area is dominated by Andropogon spp., Diplachle biflora, Sporobolus cordofanus, sporobolus
rhodesiansis. Other species included Cyperus spp., Gladiolus spp., and Pyreus macranthus. Notably bamboo is very common in the area and is used for construction and gardening. Some areas, especially hills, have pure stands of Bamboo.

6.2.2.4 TERMINALIA WOODLANDS

The dominant woodland species observed in the area was *Terminalia mollis* with most trees at about 7m high, and average Diameter at Breast Height (DBH), 0.55m. Other tree species included *Dickrostachys cineria*, *Anisophyllea boehmii*, *Ximenia caffra*, *Alchonea laxiflora* *Albizia antunesiana*, *Balanites aegyptiaca*, *Bosica matabelensis*, *Combretum elaeagnoides*, *Combretum mossambicense*, *Commiphora pyracanthoides*, *Croton megalobotrys*, *Croton polytriachias*, *Diospyros lycioides*, *Dulanta ripens*, *Friesodielsia obovata*, *Gardenia cornuta*, *Lannea schweinfurthi*, *Markhamia zanzibarica*, *Strychnos potatorum*, *Xylopia odoratissima*.

6.2.2.5 MIOMBO WOODLANDS

Miombo woodlands was observed to be a two storeyed woodland with an open or partially closed canopy of semi-evergreen trees 4 to 10 m high characterized by species of *Brachystegia, Isoberlinia, Jubernadia and Marquesia macraoura with Erythrophleum africanum, Parinari curatellifolia and Pericopsis lucenes* as frequent associates. The forest floor was covered by more or less dense grass cover.

6.2.3 Ecologically Important Areas

The project site is surrounded by forest reserves; Luano, Mufulira, Nsato,Nkana North A & B Ichimpe and Mwekera. Ichimpe and Mwekera are exotic tree plantations meant to provide timber and logs for construction and other aspects of the industry. See Figure 6-10: Protected Areas around the Project in Annex 1: Maps folder.

6.2.3.1 SENSITIVE HABITATS

Bamboos stands

Bamboos are a significant structural component of many forest ecosystems and play a major role in ecosystem dynamics. Bamboos play a critical role in stabilization of soils, especially those on steep slopes and river banks like owing to its extensive rhizome root systems of bamboos.

Ecologically, Bamboos are often associated with threatened plants, and there are many specialized animal species, birds, rodents, invertebrates that depend upon them.

However, bamboos groves are freely-growing and widespread through the Copperbelt region and continue to support biodiversity, and available for livelihoods. The impact of clearing of bamboos for the proposed irrigation area remains negligible due to its expanse.
Bamboos are multipurpose plants that have a lot of traditional uses that include housing, gardening, food and material for handicrafts. The many uses and the economic importance of bamboo means that it plays a considerable role in improving the livelihoods of rural people. As a show of its economic importance, a Zambian company (Zambikes) manufactures bicycles from bamboo since 2007. The environmental, economic and social importance of bamboos calls for strategies to be developed for their sustainable management.

6.2.3.2 Riparian Vegetation

Unlike Lusitu and Mwomboshi project sites, the riparian vegetation in Musakashi is well preserved. It was observed that gardening was being done 50 meters away from the river frontage except for a few exceptions. However, the situation may change with time due to population growth particularly with the proposed project when implemented. The increase in population may induce amorphous settlements, which may result in unorganized land use.

6.3 Fauna

Literature shows that Musakashi area was once rich in fauna especially mammalian species. However, due to anthropogenic factors such as poaching, habitat fragmentation, unplanned fires, and deforestation, most of the mammalian life has been disturbed. Ansell (Mammals of Zambia, 1978) documented small and large mammal species existing in the Copperbelt Province where Musakashi is located. There were more than 45 mammal species reported by Ansell in the late 1970’s, with the more significant species including Sable Antelope, African Wild Dog, Elephant, Lion, Waterbuck, Common Reedbuck, and Impala. Most of the large mammal populations have been decimated mainly due to uncontrolled use. As a result, the remaining faunal species mostly comprise small mammals and some carnivores.

According to documented evidence there is rich bird life in the project area, especially terrestrial birds. Much of the vegetation required to support birds has not been affected. The field study confirms the existence of these documented
species and identified the possible threats to their survival in view of the envisaged Agriculture development.

6.3.1 Mammals

Historically Musakashi area used to have most of commercially attractive mammals which are not present today. People sited the following animals as having been present in the past:

Table 6-5  Animals that existed before current

<table>
<thead>
<tr>
<th>No.</th>
<th>Common Name</th>
<th>Scientific Name</th>
<th>Local Status</th>
<th>IUCN status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Buffalo</td>
<td>Syncerus caffer</td>
<td></td>
<td>Least Concern</td>
</tr>
<tr>
<td>2</td>
<td>Eland</td>
<td>Taurotragus oryx</td>
<td></td>
<td>Least Concern</td>
</tr>
<tr>
<td>3</td>
<td>Elephant</td>
<td>Loxodonta africana</td>
<td></td>
<td>Least Concern</td>
</tr>
<tr>
<td>4</td>
<td>Hartebeest</td>
<td>Sigmoceros lichtensteinii</td>
<td></td>
<td>Least Concern</td>
</tr>
<tr>
<td>5</td>
<td>Kudu</td>
<td>Tragelaphus strepsiceros</td>
<td></td>
<td>Least Concern</td>
</tr>
<tr>
<td>6</td>
<td>Lion</td>
<td>Panthera leo</td>
<td></td>
<td>Least Concern</td>
</tr>
<tr>
<td>7</td>
<td>Rhinoceros</td>
<td>Diceros bicornis</td>
<td></td>
<td>Least Concern</td>
</tr>
<tr>
<td>8</td>
<td>Sable antelope</td>
<td>Hippotragus niger</td>
<td></td>
<td>Least Concern</td>
</tr>
<tr>
<td>9</td>
<td>Waterbuck</td>
<td>Kobus ellipsiprymnus</td>
<td></td>
<td>Least Concern</td>
</tr>
<tr>
<td>10</td>
<td>Wild Dog</td>
<td>Lycaon pictus</td>
<td></td>
<td>Least Concern</td>
</tr>
</tbody>
</table>

Almost all of the above species are now locally extinct. The most common reason cited to have caused extinction of these animal species is hunting using dogs, handmade guns, dug-pits armed with sharp sticks and wire snares.

6.3.2 Current Status Of Mammals

Not all small mammals have gone into local extinction in the project area. A number of small mammal species still exist in the Musakashi area; although poaching continues to be the major threat to their survival and existence. Fauna habitats in the area has largely not been disturbed and much of it is still remain unspoiled. The following animals were reported to exist in the area:

Table 6-6  Animals existing in Musakashi

<table>
<thead>
<tr>
<th>No.</th>
<th>Common Name</th>
<th>Scientific Name</th>
<th>Local Status</th>
<th>IUCN status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>African Civet</td>
<td>Civettictis civetta</td>
<td>Common</td>
<td>Least Concern</td>
</tr>
<tr>
<td>2</td>
<td>Bush baby</td>
<td>Galago crassicaudatus</td>
<td>Abundant</td>
<td>Least Concern</td>
</tr>
<tr>
<td>3</td>
<td>Bush Squirel</td>
<td>Paraxerus cepapi</td>
<td>Abundant</td>
<td>Least Concern</td>
</tr>
<tr>
<td>4</td>
<td>Bushbuck</td>
<td>Tragelaphus scriptus</td>
<td>Rare; locally threatened</td>
<td>Least Concern</td>
</tr>
<tr>
<td>5</td>
<td>Bushpig</td>
<td>Potamochoerus porcus</td>
<td>Rare</td>
<td>Least Concern</td>
</tr>
<tr>
<td>6</td>
<td>Duikers Common</td>
<td>Sylvicapra grimmia</td>
<td>Rare</td>
<td>Least Concern</td>
</tr>
<tr>
<td>7</td>
<td>Monkey vervet</td>
<td>Cercopithecus pygerythus</td>
<td>Common</td>
<td>Least Concern</td>
</tr>
<tr>
<td>8</td>
<td>Spring hares</td>
<td>Pedetes capensis</td>
<td>Common</td>
<td>Least Concern</td>
</tr>
<tr>
<td>9</td>
<td>Warthog</td>
<td>Phacochoerus aethiopicus</td>
<td>Rare</td>
<td>Least Concern</td>
</tr>
</tbody>
</table>

The map below shows locations where some of the animals stated in the table above were sighted and or where their spoor was observed. Animals physically observed during the field surveys included, spring hare, Scrub hare, Bush
Environmental and Social Impact Assessment Musakashi IDSP Group 1 sites

CP&CB Provider IDSP


Figure 6-13   Birds and Animals observed

Local people revealed that common duikers, bush pigs and hippopotamus (along the Kafue River) are common. Crocodiles are also common in Kafue and crocodile eggs are normally collected by locals along the Kafue River.

It is worth noting that human threats to mammalian life continue to increase with continued growth of human population which seeks more land for food production, more space for settlement and even greater development. The fundamental threat is on the modification of the ecosystem by removal of certain habitats which are perceived to be of lower value compared to the envisaged developments. These threats are eminent for all natural resources - inclusive of the above listed mammal species. Most of the mammal species listed above are still under the threat of poaching and habitat modification.

6.3.3 Birdlife

Abundant woodland coupled with availability of water in the project area has created a perfect habitat for birdlife. Woodland birds like Eagles, Buzzards, Francolins, Quails, Pigeons and doves, Louries and Rollers were observed while sounds of Honey guides, and Hornbills were heard. During the survey the following bird species were observed:
Table 6-7  Birds observed during surveys

<table>
<thead>
<tr>
<th>No.</th>
<th>Bird Species</th>
<th>Scientific Name</th>
<th>IUCN Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>African Dater</td>
<td><em>Anhinga rufa</em></td>
<td>Least Concern</td>
</tr>
<tr>
<td>2</td>
<td>African fish Eagle</td>
<td><em>Haliaeetus vocifer</em></td>
<td>Least Concern</td>
</tr>
<tr>
<td>3</td>
<td>African Pied Wagtail</td>
<td><em>Motacilla argimp</em></td>
<td>Least Concern</td>
</tr>
<tr>
<td>4</td>
<td>Bateleur</td>
<td><em>Terathopius ecaudatus</em></td>
<td>Least Concern</td>
</tr>
<tr>
<td>5</td>
<td>Blue Waxbill</td>
<td><em>Uraeginthus angolensis</em></td>
<td>Common</td>
</tr>
<tr>
<td>6</td>
<td>Common Bulbul</td>
<td><em>pycnonotus barbatus</em></td>
<td>Common</td>
</tr>
<tr>
<td>7</td>
<td>Crowned Hornbill</td>
<td><em>Tockus alboterminatus</em></td>
<td>Common</td>
</tr>
<tr>
<td>8</td>
<td>Emerald-spotted Dove</td>
<td><em>Turtur chalcospilos</em></td>
<td>Abundant</td>
</tr>
<tr>
<td>9</td>
<td>Fork-tailed Drongo</td>
<td><em>Dicrurus adsimilis</em></td>
<td>Common</td>
</tr>
<tr>
<td>10</td>
<td>Greater Honeyguide</td>
<td><em>Indicator indicator</em></td>
<td>Abundant</td>
</tr>
<tr>
<td>11</td>
<td>Grey Lourie</td>
<td><em>corhaixoides concolor</em></td>
<td>Abundant</td>
</tr>
<tr>
<td>12</td>
<td>Helmeted Guineafowl</td>
<td><em>Numida meleagris</em></td>
<td>Least Concern</td>
</tr>
<tr>
<td>13</td>
<td>Lilac-breasted Roller</td>
<td><em>Coracias caudata</em></td>
<td>Abundant</td>
</tr>
<tr>
<td>14</td>
<td>Little Bee-eater</td>
<td><em>Merops pusillus</em></td>
<td>Abundant</td>
</tr>
<tr>
<td>15</td>
<td>Miombo Grey Tit</td>
<td><em>Parus griseiventris</em></td>
<td>Common</td>
</tr>
<tr>
<td>16</td>
<td>Miombo Rock Thrush</td>
<td><em>Monicola angolensis</em></td>
<td>Common</td>
</tr>
<tr>
<td>17</td>
<td>Paradise Flycatcher</td>
<td><em>Terpsiphone viridis</em></td>
<td>Common</td>
</tr>
<tr>
<td>18</td>
<td>Pied Crow</td>
<td><em>Corvus albus</em></td>
<td>Common</td>
</tr>
<tr>
<td>19</td>
<td>Red-eyed dove</td>
<td><em>Streptopelia semitorquata</em></td>
<td>Abundant</td>
</tr>
<tr>
<td>20</td>
<td>Reed Cormorant</td>
<td><em>Phalacrocorax carbo</em></td>
<td>Least Concern</td>
</tr>
<tr>
<td>21</td>
<td>Rufousbelled Tit</td>
<td><em>Parus rufiventris</em></td>
<td>Uncommon</td>
</tr>
<tr>
<td>22</td>
<td>Wattled lapwing</td>
<td><em>Vanelius senegalii</em></td>
<td>Least concern</td>
</tr>
<tr>
<td>23</td>
<td>Tawny-flanked Tit</td>
<td><em>Prinia subflava</em></td>
<td>Common</td>
</tr>
<tr>
<td>24</td>
<td>Tropical Boubou</td>
<td><em>Laniarius aethioipicus</em></td>
<td>Common</td>
</tr>
<tr>
<td>25</td>
<td>White stork</td>
<td><em>Ciconia ciconia</em></td>
<td>Palearctic migrant</td>
</tr>
</tbody>
</table>

6.3.4 Reptiles And Amphibians

Reptiles reported to be present in the area included; snakes, lizards, Skinks, Geckos, Agamas, Chameleon, Tortoises (Leopards tortoise (Geochelone pardalis babcocki) and the Bell hinged (Kiniys belliana spekii) and frogs of different species. Snakes common to the area like African python, mambas, adders, and vipers were cited during interviews by local people. Cobras (*Naja spp.*), Mambaas (*Dendroaspis spp*.), Vipers (*Bitis spp*.), Adders (*Causus spp*.), Booslangs (*Dispholidus spp*.), and the African python (*Python sebae natalensis*) were cited during field surveys. During the survey, Nile Monitor, Striped Skink, and the Common Lizard, were also observed.

6.3.5 Invertebrates

Invertebrates like other organisms, are becoming reduced in abundance and extinct primarily through loss of habitat. The development of agriculture in Musakashi will certainly change forest habitat and change the composition of invertebrates and ultimately will affect even the bird life in the area.
6.3.6 Fish

A survey was carried out using the pictorial plates in ‘Field guide to Zambian Fishes, plankton and Aquaculture’ so that fishermen in the area could indicate what type of fish they catch in the area. A total of 67 species were identified as present in the river systems of the area.

A check list of the fish types found in Kafue river and what the fishermen indicated as present in the Kafue is attached in the annex. Fish is likely to be affected by use of fertilizers and pesticides in agriculture practices. Botanical pesticides must be encouraged in the area so that the environmental side effects of conventional pesticides are minimized.

6.4 Land Use and Settlement Patterns

Social economic surveys conducted in the project area revealed that several households will be affected by the proposed project. The land earmarked for the proposed irrigation scheme will result in people and social infrastructure as well as cultural sites being affected. Its definite that people will have to be relocated and infrastructure replaced elsewhere. There are about 110 households actually living within the areas designated for irrigation blocks at present and a further 50 households living close to the planned irrigation areas who would not have to re-locate. Consequently, the project initiated an exercise aimed at developing a Resettlement Action Plan through a comprehensive consultative process with all stakeholders at all levels including affected persons. For more reference should be made to the actual RAP.

6.4.1 Settlement

The Musakashi site was sparsely inhabited until the early 1990s when ex-mine workers (amongst others) began seeking for farm land on or close to the Copperbelt where they had been working. Figure 6-17 shows that only four people over the age of 25 reported having been on the site all their lives. Younger people in residence appear to be the family members of the retired workers.
The area of survey was made more complex by households reporting zones as their location of residence. These zones may be “flags of convenience” for obtaining subsidized agricultural inputs as well as convenient administrative areas for extension activities. The names of the zones are shown in Figure 6-15. 61 households did not report their residential area.

Musakashi consists of two farms on State land, number 4288 in the south which is unequivocally under the jurisdiction of MAL and 4287 in the north (once occupied by Kitwe Processing, later partly planned for re-settlement by Mufulira District Council but re-entered and now shown to be under the jurisdiction of MAL (refer to IDSP Report Verification of the Land Status of Musakashi, IDSP April 2013). Farm 4288 (about 2,500 ha) is under Musakashi camp and is divided into six zones (Nsofu, Kafue, Kabanana, Kapolopo, Tubombeshe and Chimbamilonga). Farm 4287 (about 1,880 ha) is under
Kangwena camp and also divided into six zones (Silungwe, Kwa Phiri, Shangira, Luanshimba, Kwasikanyika and Kobvina).

The Musakashi project area is a “farm block”. Farm blocks are areas of previously under-utilized State land identified by government in 2010 for investment in basic public infrastructure with the objective of creating an environment for establishing public-private partnerships in agro-business: a concept very similar to that espoused by IDSP. Musakashi has never been developed in terms of infrastructure and access to the area is poor with few public services. Also land suitability is poor: a semi-detailed soil survey for irrigation (Soil Survey of the Proposed Musakashi Site, IDSP April 2012) shows that much of the area is unsuitable due to shallow depth and coarse material in the profile.

See Figure 6-11: Musakashi: Land Use and Settlement in Annex 1: Maps folder.

Land use is dominantly rainfed cereals (65% maize and a little millet), roots (18% cassava, Irish and sweet potatoes) and pulses and oilseeds (12% groundnuts and Bambara nuts) grown on rotation on State land. Gardens often have some irrigation facility but it is undoubtedly temporary and informal. Here vegetables are grown (about 7% of the cultivated area overall). Title to land is not clear, most farms have temporary leases granted by Mufulira District Council, rather than full leases from the Commissioner of Lands.

6.4.2 Demography

According to the census (RAP IDSP, 2013) 1,826 people were counted at the Musakashi site in early September 2013. The frequency of household size is shown in Figure 6-16. The maximum number of members reported in one household was 15 and the mean was five members (SD=3.0). The average age of the population (1,714 of which reported their age) is 27 years of age and the sex ratio is 1,140 males to 1,000 females. This ratio (which is the opposite of that normally observed amongst residents of a permanent village in Zambia) suggests male in-migration.

Figure 6-16   Frequency of Reported Household Members

According to the CSO 2010 population census, the population grew at a rate of 2.85% per annum during the period 2000-2010, with an average rural growth rate of 2.06% per annum and an urban growth of 4.20% during the same period. The annual population growth rate during the period 2008-2012 is
estimated as 3.2% in the World Bank population database. Figure 6-17 shows that the birth rate appears relatively low in the last 15 years. The Figure also shows that women outnumber men only in the age class 45-55.

![Age Distribution by Sex](image)

Figure 6-17  Age Distribution by Sex

### 6.4.2.1 Family Structure

The overall family structure of Musakashi households is shown diagrammatically in Figure 6-18 in relationship to HHH. The family appears to have an extended structure, with only 77% of people being reported as household heads, spouses and sons and daughters. Further, the proportions are not as expected: sons outnumber daughters and HHH outnumber spouses. 23% are other relatives (though 90% of those are recorded as grandchildren and nephews and nieces). The data suggest that the “households” reported are incomplete in the sense that some family members are not resident on site and other relatives have joined the family group at the site, perhaps on a temporary basis.

![Family Relationship to HHH](image)

Figure 6-18  Family Relationship to Household Head
6.4.2.2 Marital Status

Of the 362 households, 55% reported the presence of a spouse or a wife (15%). 18 of the spouses were male, so about 5% of households are headed by a woman, the husband of whom was reported to be present.

The incidence of recorded polygamy in Musakashi HHH is negligible – only one HHH reported having two wives. This is congruent with both the findings of the Musakashi Land Inventory (see (Musakashi Irrigation Project Land Inventory Report 2011-2012, Irrigation and Land Husbandry and Land Department, 2012) and the Pre-feasibility Study’s Socio-economic Baseline Report, June 2010.

6.4.2.3 Occupations

The occupation of Musakashi residents was reported to be overwhelmingly agrarian. Of the total population, 41% consider themselves to be farmers. 35% are either school pupils or children not yet attending school. 20% reported no occupation. Considering adults of working age, 92% are farmers and a further 2% are workers (probably on-farm). Of the remainder the occupations include business (8), miner (6), driver (5), bricklayer (4), charcoal burner (2), government worker (6), marketing agent (2), and security guard (2). Individuals reported their occupations to be electrician, soldier, tailor and welder. 834 adults reported an occupation, 669 of them said they were farmers or farm workers.

6.4.2.4 Education

Figure 6-19 shows that Musakashi residents over 16 years old usually achieve an education of grade 7 or higher. Only 170 persons over 16 years old did not report any educational level attained – one may assume that their access to education has been minimal so this number was added to those reporting no education attainment.

![Education Grade Reported as Attained](image-url)
The data suggest that about 20% of people in Musakashi over the age of 16 cannot read and write. The remaining 80% may achieve some understanding of formal training material presented to them. This is against the backdrop that two basic schools are accessible from the site, Lukoshi and Lubongo, both situated in Kalulushi zone. These provide primary education up to Grade 9 and attended by about 500 pupils with a staff of about 20 teachers.

6.4.2.5 Community Health
An unexpectedly small number of persons (27) were reported as disabled in the census. Blindness or partial sight was the most common (13 individuals). Epilepsy, anaemia, asthma, heart disease, HIV and mental illness were reported by individuals. About 10 accidents or cases of temporary sickness were also reported.

Medical facilities are available at Lukoshi Rural Health Centre at Kalulushi. There are 5 beds for interned patients and four qualified staff. Eight community health workers are reported as being present on the Musakashi site.

6.4.3 Governance
The Musakashi site is located within Lukashi Ward of Mufulira District in Copperbelt Province. The civil administration of the ward is the overall responsibility of DC Mufulira and the technical support of the administration (including the District Agricultural Office) is also in Mufulira District. The district administration has been highly supportive in the identification and design of the proposed project.

The Musakashi block farm is under State land tenure under the administration of MAL, though Mufulira DC has been engaged in land use planning of the block, to the extent of allocating farm areas and drawing up an outline land use plan. The responsibility for land administration has recently been clarified as being the responsibility of MAL. However, it is worth remarking that very little progress has been made in locating the population on its designated farms and that infrastructure support to the area will have to be implemented under the IDSP project.

6.4.4 Housing, Social Infrastructure and Services
6.4.4.1 Housing
The standard of housing is basic at the Musakashi site. Connection to utilities (electricity, water supply and sanitation) is almost non-existent. Most houses are constructed with local materials and many do not have solid roofing. Houses are not designed for rain-water harvesting or the use of improved stoves.

6.4.4.2 Social Services
Social services are limited to basic schools, a rural health clinic, unreliable road access and a power line to which hardly any households are connected. A coherent potable water supply and sanitation system does not exist. The lack of social services can be attributed to Musakashi being a block farm designated for development but not yet implemented. IDSP will endeavour to provide social services as it would be extremely imprudent to build an irrigation
scheme without planning and constructing the social services that will be required to support it.

6.4.5 Energy, Water Supply and Sanitation

Only about 2% of households in Musakashi have an electrical connection in the home (despite the location of the power line bisecting the area). The supply of electricity is said to be moderately reliable. No public buildings have a power supply. Other commercial energy sources are scarce – there is nowhere locally to buy petrol or diesel and kerosene is available only in small quantities. The most commonly used fuel is locally gathered firewood which is used for cooking. Candles and kerosene lanterns are used for light.

No homes have a water connection. About 15% of households have individual wells and a further 25% share a well. Other water sources are rivers and streams. Availability of water probably explains present population distribution – it is hardly practical to take up a farm allocation if it is kilometers away from any water supply. It is reported that 80% of households have a pit latrine and the remaining 20% use the surrounding bush.

6.4.6 Infrastructure and Transportation

Musakashi is very poorly served for transport, with a few small private trucks in the area. The standard of the interior rural roads is very poor and there are a number of dambo crossings which are unfeasible in the rains. The area is not on a regular bus route and hiring is necessary if transport is required on site. The number of private motorbikes and cars is very small.

There is a grain storage warehouse at Chambishi and a small go-down for use of the ZARI research station on the right bank of the Musakashi stream.

Cellular telecommunication is said to be good over 90% of the area and about 40% of adults have mobile phones.

The nearest hammer mills are at Simwanza, Hikembe and Mwanza. The cost of milling is about Kwacha 1.5 per 5 kg. Very little other agricultural processing is reported.

6.4.7 Land Ownership and Tenure

It is now established that MAL is responsible for land distribution and administration issues in the project area. The lack of clarity in responsibility over the last few years has led to a confusion of land rights: it has not been known for sure who is present on site and what land rights they have. The census counted 1,826 people in 362 households, a population density of about 240 people per km$^2$ (compared with Mwomboshi, 190 per km$^2$ and Lusitu 283 per km$^2$). A second “census” was carried out in 2011 in the form of a farm register prepared by Musakashi Block Supervisors which includes 910 entries, 68% of which are in Farm 4287 and 32% in Farm 4288, Because MAL is the controlling authority for the use of State land in the Musakashi Block, the Block Supervisors report has been taken as the official list of allocation of land holdings.

Referring to Table 6-8, over 40% of entries refer to female land holders. This suggests the farmers listed are not equivalent to households: it was possible that husband and wife (or even another member of the household) could both
be land holders. To attempt to convert land holders to the equivalent number of households, an adjustment based on names of holders apparently of the same household and listed adjacently on the list reduced the list by 13%, leading to an estimate of 4,300 people in 788 households.

Table 6-8  Distribution of Land Holders and Households

<table>
<thead>
<tr>
<th>Farm</th>
<th>Block</th>
<th>Zone</th>
<th>Block Register 2011</th>
<th>RAP Census 2013</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Male Holders</td>
<td>Female Holders</td>
</tr>
<tr>
<td>4287</td>
<td>Kangwena</td>
<td>Luanshimba</td>
<td>143</td>
<td>116</td>
</tr>
<tr>
<td>4287</td>
<td>Kangwena</td>
<td>Shangira</td>
<td>95</td>
<td>56</td>
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<tr>
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<td>Kangwena</td>
<td>Kobvina</td>
<td>49</td>
<td>29</td>
</tr>
<tr>
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<td>Kangwena</td>
<td>Kwasikanyika</td>
<td>37</td>
<td>26</td>
</tr>
<tr>
<td>4287</td>
<td>Kangwena</td>
<td>Silungwe</td>
<td>21</td>
<td>31</td>
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<tr>
<td>4287</td>
<td>Kangwena</td>
<td>Kwa Phiri</td>
<td>8</td>
<td>7</td>
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<tr>
<td></td>
<td></td>
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<td>265</td>
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</tbody>
</table>

Sub-total Farm 4287

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<tr>
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<th>Zone</th>
<th>Block Register 2011</th>
<th>RAP Census 2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>4288</td>
<td>Musakashi</td>
<td>Kapolopolo</td>
<td>46</td>
<td>15</td>
</tr>
<tr>
<td>4288</td>
<td>Musakashi</td>
<td>Chimbamilonga</td>
<td>34</td>
<td>28</td>
</tr>
<tr>
<td>4288</td>
<td>Musakashi</td>
<td>Kabanana</td>
<td>31</td>
<td>21</td>
</tr>
<tr>
<td>4288</td>
<td>Musakashi</td>
<td>Tobombeshe</td>
<td>16</td>
<td>11</td>
</tr>
<tr>
<td>4288</td>
<td>Musakashi</td>
<td>Kafue</td>
<td>36</td>
<td>23</td>
</tr>
<tr>
<td>4288</td>
<td>Musakashi</td>
<td>Nsofu</td>
<td>24</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>187</td>
<td>105</td>
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</table>

Sub-total Farm 4288 (SADA)

Not located

<table>
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<th>Zone</th>
<th>Block Register 2011</th>
<th>RAP Census 2013</th>
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<td></td>
<td></td>
<td>Male Holders</td>
<td>Female Holders</td>
</tr>
<tr>
<td>Not known</td>
<td></td>
<td></td>
<td>7</td>
<td>7</td>
</tr>
</tbody>
</table>

Total for Musakashi Totals 540 370 910 788 251 113 362

Despite the adjustment between holders and households, the number of holders remains substantially higher than number of HH reported in the RAP census 2013, though quite a high proportion of farmers in residence could be located on the Farm Register, see Table 6-9.

Table 6-9  Comparison of Farm Register and HHH reported in 2013 Census

<table>
<thead>
<tr>
<th>Farm</th>
<th>Number of Farms on register</th>
<th>HH in 2013 Census</th>
<th>% of farms existing in 2013</th>
<th>In 2013 census and on Farm Register</th>
<th>% on register</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farm 4287</td>
<td>527</td>
<td>143</td>
<td>27%</td>
<td>103</td>
<td>72%</td>
</tr>
<tr>
<td>Farm 4288 (SADA)</td>
<td>261</td>
<td>212</td>
<td>81%</td>
<td>133</td>
<td>63%</td>
</tr>
<tr>
<td>Not known</td>
<td>0</td>
<td>7</td>
<td>0%</td>
<td>0</td>
<td>0%</td>
</tr>
</tbody>
</table>

The table suggests that many farmers on the block register may not have taken up residence, or have subsequently left, and some of those that are resident on the site may not be the people registered as land holders by the Block Supervisor. The issue is discussed in more detail in the Musakashi RAP; in short those with an interest in land in Musakashi Block are classified as follows:

- Having been allocated a farm holding prior to 2011 but not present on the site at the time of census and not ordinarily resident (910 individuals minus 295 individuals with titles identified in 2013 = 615 individuals).
- Having been allocated a farm holding prior to 2011 and present on the site at the time of census with sub-categories:
- Household head has title (236 households);
- Another family member has title (six households);
- Multiple title households, a subset of 1 above (50 households, all of which include title by household head).

Not appearing on the Farm Register or 2013 census and therefore officially a squatter, but with strengthening land rights depending on their reported period of residence (120 households).

### 6.4.8 Economic Activities

#### 6.4.8.1 Land Organisation

Each household was asked questions about the area of land they had access to, the crops grown and the responsibility within the household for cultivation and disposal of those crops. Respondents distinguished between their land holding inside Musakashi and the land held “outside”. Only about 3% of the total land area claimed by respondents is outside the Musakashi block. If this is so, it suggests that even though some respondents may have other residences outside Musakashi their land resources are inside.

#### 6.4.8.2 Control and Tenancy

Respondents were asked who “controlled” (assumed to be equivalent to provision of inputs and disposal for sale) each plot within the garden and parcels. The results are reported in Table 6-10. The results are incomplete, but it would appear that the partner(s) of the HHH tend to control about 10% of the total household plots. Some plots are cultivated for family use. An interesting element is the interest of “workers” in a few plots – possibly in (part) return for work on the farm, hired labour is allowed a portion to cultivate on their own account.

<table>
<thead>
<tr>
<th></th>
<th>Garden</th>
<th>Parcel 1</th>
<th>Parcel 2</th>
<th>Parcel 3</th>
<th>Parcel 4</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>HHH</td>
<td>163</td>
<td>268</td>
<td>2</td>
<td>2</td>
<td></td>
<td>435</td>
</tr>
<tr>
<td>spouse</td>
<td>16</td>
<td>23</td>
<td>8</td>
<td>4</td>
<td>1</td>
<td>52</td>
</tr>
<tr>
<td>Family</td>
<td>20</td>
<td>9</td>
<td>6</td>
<td>3</td>
<td></td>
<td>38</td>
</tr>
<tr>
<td>other family members</td>
<td>5</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>13</td>
</tr>
<tr>
<td>Workers</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>209</td>
<td>308</td>
<td>16</td>
<td>9</td>
<td>1</td>
<td>543</td>
</tr>
</tbody>
</table>

Respondents were asked how they viewed their occupancy status of each plot. Those who responded were quite clear that their occupancy was on State land. Not one however reported that they held title. There were no reports of informal or formal arrangements for sub-letting.

The number of livestock in the Musakashi area is very small. This may be because of the impermanence of residence of many households.

### 6.4.9 Vulnerable Groups

#### 6.4.9.1 Definition of Vulnerable Groups

An IDSP community stakeholder is anyone who has material interest in the irrigation being developed within the community by the project. During project
identification and design by IDSP \textit{a priori} assumptions had been made that different (particularly relatively disadvantaged) stakeholder groups can be identified by gender, access to land, disability and age. Equitable distribution of benefits is always an issue with irrigation development since without affirmative action on behalf of the poorest the relatively well-resourced and able always capture a disproportionate share. Disadvantaged households are usually likely to be food insecure and these have been identified in the RAP.

\textbf{6.4.9.2 Food Insecure Households}

Areas in the garden plot and parcels were summed to give the total area cultivated for each household by crop. It was found that 66\% of households were producing more kcals per annum than required for basic food consumption by the reported household members. Beyond making this observation (and noting that cereal yields are nearly twice those reported at Lusitu and the proportion of area cultivated to root crops is substantially greater) it is not possible to go further with the data to hand. Many households are non-resident (implying that they may have unreported livelihood activities) and household membership data is incomplete (it may be over-estimated by inclusion of people who belong to other households, and under-estimated by un-reported family members who are resident elsewhere). There was no way of identifying households who are intrinsically food insecure without more complete data on household members and livelihoods outside the Musakashi zones, which was beyond the scope of the census carried out.

\textbf{6.4.9.3 Youth}

The issue of the access of youth to land resources in Musakashi, while important, has to be considered in a different land tenure context compared with communities on customary land. As a block farm on State Land, holdings have already been allocated to designated farmers. Only about 40\% of these holdings appear to have been taken up and access to land is not limiting – though access to land of quality with adequate infrastructure may be an issue. The community is “open” in the sense that households are neither nuclear nor necessarily resident. The issue of rights of “youth” to land should be postponed and re-considered when final allocations are made.

\textbf{6.4.9.4 Female Headed Households}

There are 111 female-headed households reported in the census, or 32\%. The Farmer Register reports land allocations having been made to 41\% of women (see Table 6-11). This is an important proportion the characteristics of which should be known. Referring to Table 6-11 and in marked contrast to Lusitu group 1 site, female HHH are not demonstrably worse off than male HHH in terms of food security and size of cultivated area. The data do suggest some slight disadvantages in terms of female education. The households of female HHH tend to be slightly larger and younger.
Table 6-11  Variance of Mean HH Characteristics: Female and Male HHH

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th></th>
<th>df</th>
<th>Fstat</th>
<th>sig. level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>unit</td>
<td>Female</td>
<td>Male</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number</td>
<td>no.</td>
<td>117</td>
<td>245</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food balance</td>
<td>mkcals</td>
<td>4.5</td>
<td>8.8</td>
<td>361</td>
<td>1.1</td>
</tr>
<tr>
<td>HH members</td>
<td>no.</td>
<td>5.7</td>
<td>4.8</td>
<td>361</td>
<td>7.2</td>
</tr>
<tr>
<td>Size of cultivated area</td>
<td>ha</td>
<td>1.9</td>
<td>2.5</td>
<td>361</td>
<td>0.84</td>
</tr>
<tr>
<td>Age of HH</td>
<td>years</td>
<td>56.0</td>
<td>54.0</td>
<td>351</td>
<td>0.22</td>
</tr>
<tr>
<td>Age of HHH</td>
<td>years</td>
<td>28.7</td>
<td>34.6</td>
<td>351</td>
<td>10</td>
</tr>
<tr>
<td>Education of HH</td>
<td>grade</td>
<td>5.8</td>
<td>7.5</td>
<td>282</td>
<td>8.5</td>
</tr>
<tr>
<td>Education of HHH</td>
<td>grade</td>
<td>6.2</td>
<td>6.8</td>
<td>327</td>
<td>2.2</td>
</tr>
</tbody>
</table>

Notes
Education level of HH is the average Grade achieved by HH members
Age of HH is the average age of HH members
Food balance is kcal million required by HH - kcal million produced on farm

There should be no question that female headed HH are equally eligible to an irrigation allowance as male headed HH. However, there is no evidence for the need for access to opportunity in promoting women’s access to irrigation over men at Musakashi.

6.4.9.5 Squatters

120 households were identified as “squatters”. No family member appears to be recorded in the 2011 Farm Register and therefore, on the assumption that the register is an official document, these families have no land rights. Such squatters on State land have no land rights under Zambian law and can be evicted at any time. However, their position must be considered as part of the RAP. Years of residence reported on the site by squatters are shown in Figure 6-20. “No response” (7 cases) is presumed to be zero years. Almost 40% of squatters may have arrived at Musakashi within the last four years, in other words subsequent to the announcement that Musakashi was to be developed as a block farm. This opportunistic behaviour is expected given the number of farmholdings available, about 910. Some squatters may be relatives of those with title.

Figure 6-20  Years of Residence of Squatters at Musakashi
It is also worth examining if squatters have any different social characteristics compared to those with land rights. There is no significant difference in a cross tabulation of sex of household head against title, about 24% of households without title are headed by women, as against 37% of those with title. Other household characteristics are examined in Table 6-12. Some rather weak correlations exist. Squatter households are slightly smaller, younger and better educated. Squatter households also show a tendency to cultivate larger areas and have a more positive food energy balance. There is no indication to suggest squatter families are in any way disadvantaged compared with households with title – other than they have no demonstrated title to the holding they are cultivating.

Table 6-12  Variance of Mean Household Characteristics: Titled and Squatters

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th></th>
<th>df</th>
<th>Fstat</th>
<th>sig. level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>unit</td>
<td>Squatter</td>
<td>Titled</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number</td>
<td>no.</td>
<td>120</td>
<td>242</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food balance</td>
<td>mkcals</td>
<td>12.5</td>
<td>4.9</td>
<td>361</td>
<td>3.4</td>
</tr>
<tr>
<td>HH members</td>
<td>no.</td>
<td>4.2</td>
<td>5.5</td>
<td>361</td>
<td>16.1</td>
</tr>
<tr>
<td>Size of cultivated area</td>
<td>ha</td>
<td>3.1</td>
<td>1.9</td>
<td>361</td>
<td>2.6</td>
</tr>
<tr>
<td>Age of HH</td>
<td>years</td>
<td>48.0</td>
<td>58.0</td>
<td>351</td>
<td>8.9</td>
</tr>
<tr>
<td>Age of HHH</td>
<td>years</td>
<td>30.6</td>
<td>33.8</td>
<td>351</td>
<td>3</td>
</tr>
<tr>
<td>Education of HH</td>
<td>grade</td>
<td>8.1</td>
<td>6.4</td>
<td>282</td>
<td>10.6</td>
</tr>
<tr>
<td>Education of HHH</td>
<td>grade</td>
<td>7.3</td>
<td>6.2</td>
<td>327</td>
<td>9.6</td>
</tr>
<tr>
<td>Period of Residence of HH</td>
<td>years</td>
<td>10.4</td>
<td>13.5</td>
<td>343</td>
<td>9.2</td>
</tr>
</tbody>
</table>

Notes
Education level of HH is the average Grade achieved by HH members
Age of HH is the average age of HH members
Food balance is kcal million required by HH - kcal million produced on farm

6.4.9.6  Farm Models

In order to examine the impact of the proposed project on the economy it is necessary to have a more precise statement of the baseline information described above. Table 6-13 shows the aggregate financial farm budget for the area using crop areas and livestock numbers compiled from the 2013 census and gross margins and fixed costs available from the Engineering Study Interim Report, the Prefeasibility Study and Consultants estimates. According to both the 2013 census and the Farm Register hardly any livestock are present on site except a few chickens.
Table 6-13  Musakashi Farm Budget, 2013, (US$)

<table>
<thead>
<tr>
<th>Enterprise/activity</th>
<th>Area wet season (%)</th>
<th>Area dry season (%)</th>
<th>Area wet season (ha)</th>
<th>Area dry season (ha)</th>
<th>Gross margin wet per ha</th>
<th>Gross margin dry per ha</th>
<th>Financial Gross Margin</th>
</tr>
</thead>
<tbody>
<tr>
<td>maize</td>
<td>60%</td>
<td></td>
<td>532.3</td>
<td></td>
<td>161</td>
<td></td>
<td>85,702</td>
</tr>
<tr>
<td>millet</td>
<td>5%</td>
<td></td>
<td>47.7</td>
<td></td>
<td>150</td>
<td></td>
<td>7,162</td>
</tr>
<tr>
<td>oilseeds</td>
<td>9%</td>
<td></td>
<td>81.2</td>
<td></td>
<td>150</td>
<td></td>
<td>12,175</td>
</tr>
<tr>
<td>pulses</td>
<td>3%</td>
<td></td>
<td>22.6</td>
<td></td>
<td>180</td>
<td></td>
<td>4,061</td>
</tr>
<tr>
<td>roots</td>
<td>17%</td>
<td></td>
<td>154.6</td>
<td></td>
<td>120</td>
<td></td>
<td>18,546</td>
</tr>
<tr>
<td>vegetables</td>
<td>3%</td>
<td>3%</td>
<td>26.82</td>
<td>26.82</td>
<td>500</td>
<td>1,000</td>
<td>40,232</td>
</tr>
<tr>
<td>Net Crop Returns</td>
<td>97%</td>
<td>3%</td>
<td>865.16</td>
<td>26.82</td>
<td></td>
<td></td>
<td>167,879</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Livestock</th>
<th>No. Units</th>
<th>GM/unit</th>
<th>Fin.GM</th>
</tr>
</thead>
<tbody>
<tr>
<td>cattle</td>
<td>0</td>
<td></td>
<td>50</td>
</tr>
<tr>
<td>goats</td>
<td>0</td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>chicken</td>
<td>0</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td><strong>Net Livestock Returns</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Less Fixed Costs</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other expenses</td>
<td></td>
<td></td>
<td>8,941</td>
</tr>
<tr>
<td>Farm tools and other expenses</td>
<td></td>
<td></td>
<td>22,351</td>
</tr>
<tr>
<td>Irrigation equipment</td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td><strong>sub-total</strong></td>
<td></td>
<td></td>
<td>31,293</td>
</tr>
<tr>
<td><strong>Net Farm Household Returns</strong></td>
<td></td>
<td></td>
<td>136,585</td>
</tr>
</tbody>
</table>

1/ Miscellaneous expenses at US10/ha, farm tools at US$25/ha and irrigation equipment at $50/ha

The total labour requirement can be estimated on a per hectare basis by crop as 30,000 labour days per annum, see Table 4-9. Assuming that no labour is hired from outside the area, the Musakashi population is about 1,800 people of which 62% (adults over 14 years of age) are available full time for 220 days per annum and a further 10% (children between the ages of 10 and 14) are available in school holidays for three months a year, the farm labour required (field labour and livestock herding only) amounts to only about 11% of total labour availability. The return to household labour is about US$ 4.90 per labour-day. The agricultural wage rate is estimated in the Engineering Study Interim Report as US$ 5.00 per day. The estimated premium on the return to own labour on the farm is therefore low.
Table 6-14  Musakashi Village Labour Budget

<table>
<thead>
<tr>
<th>Enterprise/activity</th>
<th>Family days/ha</th>
<th>Hired days/ha</th>
<th>Family days</th>
</tr>
</thead>
<tbody>
<tr>
<td>maize</td>
<td>30</td>
<td>0</td>
<td>15,969</td>
</tr>
<tr>
<td>millet</td>
<td>30</td>
<td>0</td>
<td>1,432</td>
</tr>
<tr>
<td>oilseeds</td>
<td>72</td>
<td>0</td>
<td>5,844</td>
</tr>
<tr>
<td>pulses</td>
<td>20</td>
<td>0</td>
<td>451</td>
</tr>
<tr>
<td>roots</td>
<td>20</td>
<td>0</td>
<td>3,091</td>
</tr>
<tr>
<td>vegetables</td>
<td>110</td>
<td>0</td>
<td>2,950</td>
</tr>
<tr>
<td><strong>Crop labour requirement</strong></td>
<td></td>
<td></td>
<td><strong>29,738</strong></td>
</tr>
<tr>
<td>Livestock</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cattle</td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>goats</td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>chicken</td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><strong>Stock labour requirement</strong></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td><strong>Farm labour requirement</strong></td>
<td></td>
<td></td>
<td><strong>29,738</strong></td>
</tr>
<tr>
<td>Maintenance Labour</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total labour requirement</strong></td>
<td></td>
<td></td>
<td><strong>29,738</strong></td>
</tr>
</tbody>
</table>

The food security status of the village can also be re-estimated, as shown in Table 6-15. Total food production in food energy equivalent (excluding fisheries, forest products etc. for which no data is available) is about 6,873 million kcals. This is based on modest rainfed yields reported in the Musakashi Pre-feasibility Study of 1.8 tons per ha for maize, 1.3 tons per ha for millet, about one ton per ha for pulses and oilseeds and about 3.75 tons per ha for roots. For irrigated vegetables; 3 tons per ha is assumed in the wet season and 5 tons per ha in the dry season. No contribution is assumed from livestock products. The total requirement for the Musakashi population is in the order of 1,466 million kcals (assuming a population of about 1,826 and a daily requirement of 2,200 kcals). Superficially, a substantial margin between food energy production and demand can be demonstrated. However:

- No account is taken of storage and processing losses (but feed and seed are accounted for).
- No account is taken of food products sold outside the area.

9 FAOSTAT’s Food Balance Sheet for Zambia 2009 states that 5% of the national diet is from animal products.
10 The Food Balance Sheet estimates 1,900 kcals per capita per day is actually available at national level.
Table 6-15  Estimated Food Security Status in Musakashi, 2013

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Production, tons</th>
<th>mkcals per ton</th>
<th>mkcals</th>
<th>Proportion sold, %</th>
<th>Home consumption, tons</th>
<th>mkcals</th>
</tr>
</thead>
<tbody>
<tr>
<td>maize</td>
<td>952</td>
<td>3.072</td>
<td>2,925.88</td>
<td>0%</td>
<td>952.4</td>
<td>2,925.88</td>
</tr>
<tr>
<td>millet</td>
<td>63</td>
<td>3.096</td>
<td>194.85</td>
<td>0%</td>
<td>62.9</td>
<td>194.85</td>
</tr>
<tr>
<td>oilseeds</td>
<td>88</td>
<td>4.59</td>
<td>404.44</td>
<td>0%</td>
<td>88.2</td>
<td>404.44</td>
</tr>
<tr>
<td>pulses</td>
<td>19</td>
<td>2.32</td>
<td>43.16</td>
<td>0%</td>
<td>18.6</td>
<td>43.16</td>
</tr>
<tr>
<td>roots</td>
<td>604</td>
<td>0.95</td>
<td>576.16</td>
<td>0%</td>
<td>603.5</td>
<td>576.16</td>
</tr>
<tr>
<td>vegetables</td>
<td>61</td>
<td>0.25</td>
<td>15.21</td>
<td>0%</td>
<td>60.8</td>
<td>15.21</td>
</tr>
<tr>
<td>Crop mkcal production</td>
<td>4,159.69</td>
<td>4,159.69</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Livestock

| Milk | 0.00 | 0.55 | 0.00 | 0% | 0.00 | 0.00 |
| Beef | 0.00 | 1.94 | 0.00 | 0% | 0.00 | 0.00 |
| Goat meat | 0.00 | 1.02 | 0.00 | 0% | 0.00 | 0.00 |

Livestock mkcal production | 0.00 | 0.00 |

mkcal production | 4,159.69 | 4,159.69 |

Total requirement per household, mkcals | 1,466.28 | 1,466.28 |

Farm Food energy balance, mkcals | 2,693.41 | 2,693.41 |

Disaggregating the village data into farm models based on farm size, the food security situation can be demonstrated to be more precarious for medium and small farms. Using a simple categorization of the census data into very large farms (average 21.3 ha, 13 farmers), large farms (average 5.2 ha, 18 farmers), medium (average 3.1 ha, 112 farmers), small farms (average 0.81 ha, 219 farmers) the estimates can be disaggregated. It would be tedious to show farm budgets for each group, so Table 6-6 summarizes the main findings.

Table 6-16  Farm Return, Food Energy and Labour by Farm Type

<table>
<thead>
<tr>
<th>Farm category</th>
<th>Number</th>
<th>Net farm return, US$</th>
<th>Share of net farm return, %</th>
<th>Energy production mkcals</th>
<th>Energy demand mkcals</th>
<th>% energy demand satisfied</th>
<th>Farm labour requirement, days per annum</th>
<th>Labour supply, days per annum</th>
</tr>
</thead>
<tbody>
<tr>
<td>very large</td>
<td>13</td>
<td>39,852</td>
<td>29%</td>
<td>1,414</td>
<td>72</td>
<td>1977%</td>
<td>9,370</td>
<td>10,966</td>
</tr>
<tr>
<td>large</td>
<td>18</td>
<td>13,149</td>
<td>10%</td>
<td>411</td>
<td>69</td>
<td>599%</td>
<td>2,848</td>
<td>11,005</td>
</tr>
<tr>
<td>medium</td>
<td>112</td>
<td>51,704</td>
<td>38%</td>
<td>1,533</td>
<td>456</td>
<td>336%</td>
<td>11,511</td>
<td>72,542</td>
</tr>
<tr>
<td>small</td>
<td>219</td>
<td>31,849</td>
<td>23%</td>
<td>802</td>
<td>841</td>
<td>95%</td>
<td>6,127</td>
<td>134,860</td>
</tr>
<tr>
<td>Total</td>
<td>362</td>
<td>136,553</td>
<td>100%</td>
<td>4,160</td>
<td>1,437</td>
<td>290%</td>
<td>29,856</td>
<td>229,373</td>
</tr>
</tbody>
</table>

Many household members of small farms are food insecure (overall 95% margin on food energy requirements is small) and must sell labour off-farm or engage in alternative livelihood activities to make ends meet. Shortage of labour is only an issue for very large farms, though some are certainly partly mechanised. All other farms have a substantial excess of labour. Bearing in mind there are few non-farm income generating activities in Musakashi it is obvious that labour must look outside the site for other opportunities.

Unlike Lusitu, farming in Musakashi is not a functioning community system. Farm size is set exogenously (by the District Council). Household composition in Musakashi is selected by economic factors rather than demography: many
households are not truly resident at site and activities outside also support incomes. Farming is provides livelihood for most households – the value of production is only US$ 150 per cultivated ha. At Lusitu it is twice that, at about US$ 300 per cultivated ha.

6.5 Health and Sanitation

6.5.1 Diarrhea

Diarrhea is usually a symptom of gastrointestinal infection, which can be caused by a variety of bacterial, viral and parasitic organisms. Infection is spread through contaminated food or drinking-water, or from person to person as a result of poor hygiene. Diarrhea kills more children under five worldwide than HIV, malaria and measles combined. In Zambia, it causes 40 young children’s deaths every day and accounts for 840,000 clinic visits and 63,000 hospital referrals a year.

Field findings indicated that in Musakashi, diarrhea cases increase steadily from the month of September to December. This is mainly attributed to lack of clean water as the shallows wells tend to dry, the number of house flies increase during this period and much of the cooked food that are kept overnight tend to go bad and when eaten one experiences a lot of stomach upsets. Furthermore according to health center records there are only two safe water points in its catchment population. The health center has further conducted tests on some wells in the area which were found to be contaminated with fecal matter. This was as result of some wells not being protected during the rainy season.

According to UNICEF:

- 88% of diarrheal disease is attributed to unsafe water supply, inadequate sanitation and hygiene;
- Improved water supply reduces diarrhea morbidity by 21%;
- Improved sanitation reduces diarrhea morbidity by 37.5%;
• The simple act of washing hands at critical times can reduce the number of diarrheal cases by up to 35%;
• Additional improvement of drinking-water quality, such as point of use disinfection, would lead to a reduction of diarrhea episodes of 45%.

6.5.2 Malaria

Malaria affects more than 4 million Zambians annually, accounting for approximately 30 percent of outpatient visits and resulting in almost 8,000 deaths each year. Under-five-year-old children and pregnant women are the most vulnerable, especially those in more remote and impoverished areas, with 35-50 percent of under-five mortality and 20 percent of maternal mortality attributable to malaria.

Malaria is both preventable and treatable, but it is a complicated disease whose prevention and control requires multiple interventions. Preventing malaria requires creating a malaria-free environment, which means spraying the inner walls of populated structures (homes, schools, hospitals, businesses, and other institutions) with insecticides and always sleeping under insecticide-treated nets (ITNs). Other measures include environmental control to prevent the development of mosquito breeding grounds.

For those for whom prevention measures fail, prompt and effective treatment is imperative. Treatment begins with recognizing the symptoms of malaria, seeking treatment immediately at the onset of illness, and having access to community or facility based health care workers who have the knowledge to treat malaria at its various stages. Cases of malaria in the project area are illustrated in the figure below. It can be observed from the figure 6-25 that malaria cases decline during cooler months than wet warm months.

![Malaria cases at Lukoshi RHC](image)

Figure 6-22 Malaria Cases at Lukoshi RHC (Source: Lukoshi RHC)

6.5.3 Pneumonia and Respiratory Tract Infection

Pneumonia and Respiratory tract infections (RTIs) were mentioned loosely and no data was provided for RTIs but it was mentioned that both diseases are common and record many cases in between April and June, 2012. The
infection rate stabilized between July and August and increased sharply in the month of November. See figure 6-23.

![Figure 6-23 Pneumonia cases at Lukoshi (Source Lukoshi RHC)](image)

### 6.5.4 HIV&AIDS and Sexually Transmitted Infections (STIs)

HIV&AIDS is currently the leading epidemic in Zambia, with significant social and economic impact on the country. The most recent data estimates indicate that there are approximately 1 million adults and children living with HIV&AIDS in Zambia (NAC, 2007). Approximately 800,000 people have died from HIV/AIDS, leaving an estimated 600,000 children orphaned (NAC, 2006). HIV/AIDS morbidity and mortality accounts for 50% of general hospital admissions. HIV infection is highest among the most economically productive age group (men and women from 15-49 years old). Recent surveys have indicated a reduction in the prevalence of HIV. The prevalence in adults aged between 15 and 49 years is said to have reduced from 16.1% in 2002 to 14.3%, with women accounting for a high proportion. Figure 6-24 below depicts the trend of HIV/AIDs as reported by Lukoshi health centre derived from people that come to seek HIV/AIDS counseling and testing and outreach services normally conducted twice a year.
6.5.5 Schistosomiasis

The clinic staff reported some unconfirmed cases of bilharzia. However no statistics were available at the clinic that could be attributed to bilharzia cases. The control programme involves spraying infected areas with nuclosamid and keeping shorelines free of the Salvinia auriculata.

6.6 Sanitation/Water and Health

As mentioned in the findings above poorly (traditional) designed water systems and irrigation, inadequate housing, poor waste disposal and water storage, deforestation and loss of biodiversity, are the contributing factors to the most common vector-borne diseases including malaria and Diarrhea. Lukoshi clinic continues to record steady cases of diarrhea, dysentery and malaria, all resulting from poor hygiene and lack of access to safe water.

6.7 Occupational Health and Safety

Projects such as development of Musakashi irrigation scheme, involve employees of various categories working on site simultaneously. As work progresses particularly during construction of reservoirs, access roads, irrigation pipe network and associated infrastructure the ambient conditions at site will tend to change and as a consequence this may bring about a number of potential hazards. Workers are likely to be exposed to a wide variety of health hazards while on duty that typically include four classes: chemical, physical, biological and social hazards. The severity of each hazard will depend on the concentration and duration of exposure to a given task.

Evaluating either primary or bystander exposure will require knowing the tasks being done and the composition of ingredients and by-products associated with each job or task. This knowledge though available may not be available at the job site.
6.7.1 Chemical hazards
Chemical hazards will be airborne in form of dust, fumes, or gases due to certain project tasks and exposure to such hazards is by inhalation, absorption through intact skin such as agro-pesticides. Considering the nature of the project, a number of agro-chemicals will be used even though none hazardous.

6.7.2 Physical hazards
Physical hazards will include noise, heat and cold, radiation, vibration from construction equipment and machinery such as pneumatic hammers. In addition, heat and cold hazards will arise primarily due to exposure to extreme weather.

6.7.3 Biological hazards
Biological hazards will include exposure to infectious micro-organisms, toxic substances of biological origin or animal attacks. For instance during excavation workers can develop histoplasmosis, an infection of the lung caused by a common soil fungus.

6.7.4 Social hazards
Social hazards will stem from the social organization of the project. Employment may be intermittent and constantly changing, and control over many aspects of employment is limited because construction activity is dependent on many factors over which construction workers have no control, such as the state of an economy or the weather.

6.7.5 Controlling Occupational Hazards
Exposure varies with the concentration of the hazard and the frequency and duration of the task. As a general approach to hazard control, MAL will ensure that the contractors working on site reduce hazard exposure by reducing the concentration or the duration or frequency of the task. Since exposure in construction is already intermittent, administrative controls that rely on reducing the frequency or duration of exposure may be less practical than in other industries. MAL will ensure that contractors control exposure through provisions good working environmental, sanitary facilities and awareness creation.

In general MAL will ensure that contractors employ appropriate controls to minimize worker exposure to hazards that include:

- Engineering controls that targets the source.
- Environmental controls targeting the environment.
- Personal protective clothing for workers.

6.8 Cultural Heritage
The major finding at Musakashi was that there are no visible Cultural Heritage sites to be taken care of. The interviews conducted with the oldest inhabitants on the project area lead to the conclusion that the local people have no relationship with past cultural sites or traditions. Further, no grave yards of interest to the community are present inside the project site area, though isolated burials may come up during the construction work. From the interviews
and surveys done by field-walking, no ancient site seems to be present apart from a single iron smelting furnace. The main religious grouping in the area is Christianity and the churches found within the area are Catholic, Seventh Day Adventist, Apostolic, Jehovah’s Witness and Reformed Church. Change find procedures must be followed according to OP/BP 4.11 regulations in case Cultural Heritage sites will be discovered during construction of Project works.
7 IMPACT ASSESSMENT

7.1 General Considerations

The high population growth rate Zambia has poses a challenge to planning for public investment: over time population growth means reduced value of services per capita. For example, on an irrigation scheme the number of households and the population increases, leading to reduced availability of irrigated holdings and a reduction in irrigated area per capita. The rural population continues to grow as estimated by CSO (say 2% per annum) despite another 2.5% of the rural population migrating to the towns.

The EIA study showed relatively no serious adverse impacts of exceptional significance that would be considered unprecedented or irreversible in nature. The positive and negative impacts identified with due consideration to issues discussed in earlier sections were based on the development designs, project details, environmental and socio-economic baseline studies as well as expert judgment. Current land use practices were also identified in order to contextualize and understand the impacts of the Irrigation scheme on the ecosystem. The table below gives the criterion used and classification of possible impacts.
Table 7-1  Criterion and Classification of Impacts

<table>
<thead>
<tr>
<th>Item</th>
<th>Impact Criterion</th>
<th>Effect Consideration on Environment</th>
<th>Classification of Effect Expression</th>
<th>Effect Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Positive or Negative</td>
<td>Will impact have positive or negative on environment</td>
<td>Positive</td>
<td>A positive impact</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Negative</td>
<td>A Negative impact</td>
</tr>
<tr>
<td>ii</td>
<td>Likelihood of occurring</td>
<td>What certainty of occurrence is associated with potential impact</td>
<td>Certain</td>
<td>Impact will occur</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Unlikely</td>
<td>Impact may not occur</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Possible</td>
<td>Impact may occur</td>
</tr>
<tr>
<td>iii</td>
<td>Duration</td>
<td>What timeframe or period is effect to be felt or last</td>
<td>Permanent</td>
<td>Will last a lifetime</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Short term</td>
<td>Will last up to end of construction activities</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Medium Term</td>
<td>Will last as long as operation activities</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Long Term</td>
<td>Will last beyond project operation life</td>
</tr>
<tr>
<td>iv</td>
<td>Timing</td>
<td>At what stage will impact occur or felt</td>
<td>Immediately</td>
<td>Will occur upon starting project activities</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Near Future</td>
<td>Will occur during project operation activities</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Distance future</td>
<td>Will occur beyond project operation activities</td>
</tr>
<tr>
<td>V</td>
<td>Significance</td>
<td>How severe will the impact be</td>
<td>Low</td>
<td>Little impact</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Medium</td>
<td>Moderate impact</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>High</td>
<td>High impact</td>
</tr>
<tr>
<td>Vi</td>
<td>Extent</td>
<td>Areal extent or coverage of impact</td>
<td>Project Area</td>
<td>Effect confined to project area</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Surrounding Environs</td>
<td>Effect to be felt by surrounding areas</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Beyond Surrounding Environs</td>
<td>Effect to be felt within, surroundings and beyond environs</td>
</tr>
<tr>
<td>Vii</td>
<td>Overall Rating</td>
<td>How important is impact in project design</td>
<td>Insignificant</td>
<td>Impact not substantial needs no mitigation/ enhancement</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Low</td>
<td>Impact of little importance needs limited mitigation / enhancement</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Moderate</td>
<td>Impact has influence and requires mitigating/ enhancing</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>High</td>
<td>Impact of great importance mitigation/ enhancement a must</td>
</tr>
</tbody>
</table>
7.2 Impacts during the Construction Phase

7.2.1 Anticipated Positive Socio-Economic Impacts

The proposed project will increase labour opportunities. At present there are about 700 ha of rainfed cultivation in the project area which, according to the Engineering Interim Report require about 28 labour days per ha per year. In addition existing (partly irrigated) fruit and vegetables, say 45 ha, offers an additional 100 days per ha. Therefore the labour requirement for cultivation of field crops alone is in the order of 25,000 person days a year. The total labour availability within the project area is (assuming 362 households and distinguishing adult from child labour), is in the order of 261,000 days per annum. Therefore cultivation of crops only accounts for about 11% of community labour availability in the without-project situation.

The incremental labour requirement for the proposed irrigation project for field operations alone is about 15,000 days per annum on Tier 1, 9,000 days per annum on Tier 2 and 3,400 days per annum on Tier 3, a total of about 27,000 days (an estimate based on cropping patterns recommended in the Feasibility Study). About 55% of this will accrue to irrigated holdings cultivated by the community (Tier 1). As a whole the irrigation project is likely to increase the labour requirement for the cultivation of crops from about 25,000 days per annum to over 60,000 days per annum. Cultivation of crops will account for about 22% of community labour availability in the with-project situation.

The increase in labour opportunity will raise the labour occupancy rate and increase household income, not only from increased labour days available but also from an increase in returns to own-labour. In summary, the socio-economic impacts will include:

- Improved security;
- Improved social infrastructure such as access roads;
- Employment Opportunities at various stages of development. During site preparation and construction phases, a number of unskilled workers will be employed. This direct impact will increase the affected person’s incomes and social standing;
- Economic Growth at local and national level as a result of the new development;
- Skills Transfer to community members.

7.2.2 Anticipated Negative Socio-Economic Impacts

There will be displacement of people from the project area by the project. There are about 115 households actually living within the areas designated for irrigation blocks at present and a further 45 households living close to the planned irrigation areas who would not have to re-locate. Land presently in farms within the areas designated for irrigation will be re-allocated. In Tier 1 and 2 areas the land will be re-distributed as irrigation allocations. Further, the proposed project may introduce social pressures which may lead to conflict.

- Displacement of settlements. There will be no displacement of people from the project area by the project. However, the present housing of a
number of households may have to be moved outside irrigation block areas. There will be need to re-allocate land presently in farms within the areas designated for irrigation;

- Loss of community agricultural fields and some burial sites. For instance, 10,576 m² of land will be lost due to excavation for reservoirs and 2100.72 m² for pumping stations;
- Loss of livelihood for vulnerable groups in the short term in the surrounding communities;
- Disturbance to cultural sites that include cemeteries;
- Increased traffic making accessing project site difficult;
- Population Growth and Migration. Increase in population in the scheme will lead to reduced availability of irrigated holdings and a reduction in irrigated area per capita.

7.2.3 Anticipated Negative Bio-Physical Environmental Impacts

- Clearing of land exposes it to erosion, displaces or destroys wildlife and generally reduces biodiversity. The land preparation will disrupt soil fauna and can create dust and noise from blasting and heavy traffic;
- Soil erosion. Construction works on Tier 3 north of the project area and located between two streams is likely to cause sediment deposition into the nearby streams. The ultimate impact of deposition of sediments is alteration of river channel morphology as well as effect on water quality and aquatic life;
- Disturbance to wildlife habitat;
- Pollution due to solid waste, oil spills and fuels;
- Loss of indigenous flora (biodiversity & conservation of forest ecosystem);
- Pollution to Groundwater Quality. Activities such as spills of petroleum products and chemicals, will have negative effect on ground water quality Dust Pollution;
- Noise Pollution. An increase in ambient noise levels will arise from the clearing of vegetation, and the subsequent movement of heavy construction machinery;
- Loss of habitat for fauna especially insects, reptiles such as lizards and small mammals;
- Loss of agricultural fields due to construction of access roads, Soil erosion due to construction equipment.

7.3 Impacts during the Operational Phase

7.3.1 Anticipated Positive Socio-Economic Impacts

At operation stage the project will further result in demand for more skilled and none skilled labour. Consequently more people will be employed and as a result more income among the communities. Demand for inputs for the irrigation scheme that range from seeds, fertilizers, agrochemicals and irrigation equipment will increase as a result of the scheme. This will have a multiplier effect on other sectors as more people will be employed to meet the production demand.
- Increased crop production providing the opportunity for earning the country foreign exchange;
- Improved income levels at household level, improved diet and general health of children and expectant mothers as well as improved socio-cohesion among the community;
- Economic multiplier effects at the national level;
- More income for government through various taxes;
- The irrigation scheme will contribute to national food security through sustainable irrigated crop production under the three tiers;
- Contributions to national fiscal benefits;
- The scheme will have positive socio-economic impacts on Mufulira District and the Province as a whole through improved employment opportunities and increased income;
- Increased income and improved standards of living;
- Employment, skills transfer and human resource capacity development;
- Improved diet among the communities especially children due increased income;
- Increased number of children attending school;
- Economic multiplier effects at the local level;
- Improved housing, water supplies and sanitation facilities for employees;
- Improved health and education facilities for employees and their families;
- Improved access road infrastructure. At full development the Musakashi scheme is expected to produce 6,000 tons of grains (maize and wheat), 2,600 tons of soya and 6,000 tons of vegetables a year. Haulage requirements from and to the scheme will have to be to commercial level. The project will provide interior farm roads with suitable standard to allow passage to field machinery especially to serve Tier 2 and 3.

7.3.2 Anticipated Positive Bio-Physical Environmental Impacts

- Increased groundwater recharge will take place. Groundwater recharge will result from infiltration as residue water from irrigation;
- Sustainable agriculture contributing to preservation of biodiversity due to use of appropriate land management practices;
- Contributions to ameliorating climate change through good management practice involving preservation strips of woodland in all areas that are not meant for development;
- Technology impacts to soil structure and water conservation through improved agricultural practices that include limited tillage and strict nutrient management and use of an efficient and effective irrigation system;
- National and international level impacts. Project production could generate significant trade revenue from maize and save on wheat imports;
- Economic multiplier effects at the national level;
- Contributions to national food security from crop production;
- Contributions to national fiscal benefits;
- Provincial and district impacts;
- Employment, skills transfer and human resource capacity development. The IDSP plans for skills transfer and human resource capacity development are significant and include the development of a national irrigation company, allowing smallholder farmers to gain experience in the establishment and operation of WUG, improving smallholder irrigators’ technical skills for the eventual operation of a commercial farm and through training and financing encourage the setting up of value addition in agricultural processing, marketing and micro-businesses;
- Local area and site impacts;
- Contribution to household incomes and food security;
- Improved housing, water supplies and sanitation facilities;
- Improved health and education facilities;
- Social conflict. The supply of potable water at Musakashi is fragmented and of poor quality, limited to private wells (15% of the population), shared wells (25%) and unprotected rivers and streams. This fragmentation relieves social conflict and competition for water but exposes the population to the risk of contaminated water and prevents the overall settlement of the site: much of the area has no accessible water supply.

7.4 Negative Impacts Anticipated During the Operation Phase

- Pollution may also result due to leaching of applied fertilizer or chemicals, or run-off of soil containing fertilizer and pesticides;
- Intensive agriculture will inevitably lead to an increase in pesticide use and fertilizer use. Increased nutrient loading (e.g. Nitrate and Phosphate) from artificial fertilizer application upstream would lead to eutrophication. Over use of pesticides may reduce the populations of some insects and micro-organisms, and herbicides will reduce the presence of some wild plants.

7.4.1 Anticipated Negative Socio-Economic Impacts

- Migration and temporary employment effects;
- Unsociable behavior from increased disposable income;
- Casualization of labour impacting on employee’s welfare because of uncertainty that is created among workers;
- Population density-related disease impacts. The possibility of transmission of infectious disease through the irrigation system (if, lacking a potable water system, it is used to source drinking water);
- Poor sanitation practices leading to environmental soil, water and air contamination. The sanitation issue means that the whole community is at risk from infectious disease;
- Over utilization of natural resources by communities;
- Occupational health and safety (OHS) due to inhalation of biotic dust and silica particles etc. Wild animal confrontations may increase with improved access to the Kafue River (mainly with hippopotamus and crocodile). Heavy metal accumulation in soil, crops and water as a
result of releases from existing and planned tailings dams on the Musakashi stream;

- Increased HIV/AIDS and other STIs due to increased interaction between project workers (who may come from outside) and locals. This could lead to increase in transmission of communicable diseases such as STIs, HIV/AIDS, TB, etc. in the area;
- Deterioration of road infrastructure which is currently in a state of disrepair.

### 7.4.2 Anticipated Negative Bio-Physical Environmental Impacts

The irrigation scheme will result in demand for water for irrigation purposes to increase putting more pressure on Kafue River being the main source of water. While this is a positive impact in economic terms for the local community, the downstream users may be affected. In summary impacts will include:

- **Hydrological effects.** Increased evapotranspiration is one of the main hydrologic effects that the irrigation project will bring about in the Musakashi project area. This will arise from the extended irrigation areas in the three tiers;
- **Effects on Water demand /supply of water.** Once the project is operational abstraction of water from the river will reduce the flow for the downstream section of the river. The areas include the intake point for Mulonga Water and Sewerage Company (MWSC), Lake View Estate and other further downstream riparian water users. The reduction is however not significant considering that the extent of abstraction will not recede water levels to the lowest extreme;
- **Soil erosion.** For Musakashi top-soils are generally light and friable, and most of the area has slopes, some reaching 6%. The highest risk of erosion is found close to drainage lines in Tier 3, both north and south;
- **Water quality pollution due to leaching of salts, nutrients, herbicides, fungicides, and insecticides with high salinity and alkalinity.** There is the risk of pollution from nearby mining activities – specifically polluted irrigation water abstracted from the Kafue River, and airborne sulphur dioxide from nearby smelters;
- **Increased energy consumption patterns;**
- **Water and soil pollution due to increased pesticide and herbicide use.** Exposure of groundwater to contamination by pesticides and other chemicals will impact on groundwater for the Musakashi, Kangwena and surrounding settlements;
- **Soil degradation due to increased use of fertilizers;**
- **Reduced water quantity on downstream reaches of Kafue River but not to worst levels;**
- **Soil degradation from inappropriate land use practices due to use of inappropriate methods of farming by communities in surrounding areas;**
- **Air quality deterioration due to dust from the roads and fields during land preparation.** Dust pollution, will arise from the transportation of raw
materials from supply sources to the construction site, as well as to the excavations at construction sites;

- Noise pollution due to use of farm equipment and vehicles that are not regularly maintained;
- Light pollution from center pivots;
- Pollution due to inappropriate disposal of agricultural chemicals and containers;
- Change in geomorphic processes in dambos, streams and rivers;
- Impacts on terrestrial ecological and ecosystem services process due to fragmentation of vegetation and edge effects and invasion of alien species;
- Loss of species of special concern and biodiversity;
- Loss and fragmentation of sensitive habitats;
- Loss of faunal diversity;
- Impacts on climate change due to clearance of woodland for agricultural fields;
- Aesthetic and landscape quality impacts of woodland removal;
- Aesthetic and landscape quality impacts of center pivots and farm structures;
- Deterioration in Water quality in downstream reaches of Kafue River: The contamination into these water bodies will be from pest control chemicals and fertilizers. This will occur by runoff from the irrigation fields to the Kafue River and other open water bodies within the project area;
- Increased incidences of HIV/AIDS and STIs. Construction workers will have extra disposable income compared to unemployed residents within the project area. This sudden acquired affluence may translate itself into antisocial behaviour including excesses on beer and other social vices e.g. prostitution and hence the spread of STIs and HIV/AIDS cases;
- Noise pollution;
- Pollution from inappropriate disposal of agricultural chemicals and containers;
- Pollution from poor storage, management, use and disposal of agricultural chemicals and containers;
- Erosion of the top soil. Construction works on Tier 3 north of the project area located between two streams is likely to cause sediment deposition into the nearby streams.

7.5 Impact Evaluation Mechanisms
### 7.5.1 Biophysical Environment

Table 7-2  Impact Characterization for biophysical environment

|----------------------------|-------------------------------------------------------------------------------------------------|--------------------------|---------------------|------------------|-------------------|------------------|---------------------|-------------------------------|--------------------------|
| **Flora**                  | May be affected due to land clearing cultivation, settlements and other built structures. These include:  
- Disturbance of terrestrial ecological & ecosystem services processes  
- Loss of natural habitat for small mammals, birds and insects.  
- Loss of species of special concern  
- Loss & fragmentation of sensitive habitats | Negative                | Moderate              | Within irrigation scheme area | Medium Term       | Site preparation | Continuous         | Certain                       | None                      |
| **Fauna**                  | May be affected due to land clearing cultivation, settlements and other built structures. These include:  
- Disturbance to wildlife habitat  
- Loss of fauna diversity | Negative                | Moderate              | Within irrigation scheme area | Medium/Long Term  | Site preparation | Continuous         | Certain                       | None                      |
| **Air Quality**            | May be affected by emission form equipment used. Also dust generating especially during construction may affect air quality:  
- Dust emissions  
- Nuisance of dust pollutes the air and may affect workers | Negative                | Moderate              | Project area        | Medium Term       | Clearing and Construction phases | Occasional | Likelihood | High                          |                           |
| **Noise Quality**          | Heavy duty clearing and construction equipment may cause local noise disturbances:  
- Noise pollution | Negative                | Moderate              | Project area        | Medium Term       | Clearing, Construction phases | Infrequent | Certain | Low                           |                           |
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</tr>
</thead>
<tbody>
<tr>
<td>Land/Soil</td>
<td>Removal of soil will occur within the area specific areas where the land will be leveled for the center pivot installation and other civil engineering works. Contamination of soil may occur due to oil spillages:</td>
<td>Negative</td>
<td>high</td>
<td>Project area &amp; Surrounding areas</td>
<td>Medium Term</td>
<td>Site Preparation</td>
<td>Continuous</td>
<td>Certain</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>- Loss of agricultural and grazing fields</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>- Soil erosion</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Surface Water</td>
<td>Contamination of Kafue River and other streams May occur due to accidental spillage of oils &amp; lubricants:</td>
<td>Negative</td>
<td>Low</td>
<td>Project area</td>
<td>Short term</td>
<td>Site preparation</td>
<td>Continuous</td>
<td>Unlikely</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>- Pollution due to solid waste</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>- Pollution due to oil/fuel spills.</td>
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<tr>
<td>Ground Water</td>
<td>Contamination of groundwater May occur due to accidental seepage of oils/hydraulic fluids; Increased seepage Pollution to Groundwater Quality due leaching and oil/fuel spills</td>
<td>Negative</td>
<td>Moderate</td>
<td>Project area</td>
<td>Short term</td>
<td>Site preparation</td>
<td>Infrequent</td>
<td>Unlikely</td>
<td>Low</td>
</tr>
<tr>
<td>Habitat</td>
<td>Clearing of vegetation, digging may cause habitat fragmentation;</td>
<td>Negative</td>
<td>Moderate</td>
<td>Project Area</td>
<td>Long term</td>
<td>Project life</td>
<td>Continuous</td>
<td>Certain</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>- Loss of habitat for fauna especially insects, reptiles such as lizards and small mammals</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Overall Biodiversity</td>
<td>Clearing of vegetation and digging of foundations/landscaping may have an effect on both terrestrial and aquatic biodiversity.</td>
<td>Negative</td>
<td>Moderate</td>
<td>Project area</td>
<td>Short term</td>
<td>Site preparation phases</td>
<td>Continuous</td>
<td>Unlikely</td>
<td>None</td>
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<tr>
<td>2.0 PROJECT PHASE – OPERATION</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Flora</td>
<td>May be affected due to land clearing and movement of equipment during operations;</td>
<td>Negative</td>
<td>Moderate</td>
<td>Project area</td>
<td>Short term</td>
<td>Operation phases</td>
<td>Continuous</td>
<td>Likely</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>- Loss of species of special concern and biodiversity</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td></td>
<td>- Loss and fragmentation of sensitive habitats</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Fauna</td>
<td>May be affected due to land clearing and movement of equipment during operations;</td>
<td>Negative</td>
<td>Moderate</td>
<td>Project area</td>
<td>Medium term</td>
<td>Operation phases</td>
<td>Continuous</td>
<td>Likely</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>Loss of faunal diversity</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Air Quality</td>
<td>May be affected by emissions from the machines farm tractors used.</td>
<td>Negative</td>
<td>Moderate</td>
<td>Project area</td>
<td>Medium term</td>
<td>Operation phases</td>
<td>Continuous</td>
<td>Likelihood</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>- Dust pollution</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Noise Quality</td>
<td>May be affected during farming and harvesting operations.</td>
<td>Negative</td>
<td>Low</td>
<td>Project area</td>
<td>Long term</td>
<td>Operation</td>
<td>Occasional</td>
<td>Certain</td>
<td>Low</td>
</tr>
<tr>
<td>Occupational Health</td>
<td>Health related diseases for workers</td>
<td>Negative</td>
<td>Low</td>
<td>Project area</td>
<td>Short/medium term</td>
<td>Operation</td>
<td>Occasional</td>
<td>Likely</td>
<td>Low</td>
</tr>
<tr>
<td>Animal habitat</td>
<td>Human-animal conflict</td>
<td>Negative</td>
<td>Moderate</td>
<td>Project area</td>
<td>Long term</td>
<td>Operation</td>
<td>Occasional</td>
<td>Likely</td>
<td>Low</td>
</tr>
<tr>
<td>Land/Soil</td>
<td>Land/soil may be impacted by moving farm machines through compaction and contamination and oil leaks/seepages during operations.</td>
<td>Negative</td>
<td>Moderate</td>
<td>Project area</td>
<td>Short term</td>
<td>Operation</td>
<td>Infrequent</td>
<td>Certain</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>- Soil degradation due to increased use of fertilizers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Soil loss from inappropriate land use practices</td>
<td></td>
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</tr>
<tr>
<td><strong>Surface Water</strong></td>
<td>May be contaminated by leakages from machines during operation; - Polluting due to inappropriate disposal of agricultural chemicals and containers - Change in geomorphic processes in dambos, streams and rivers - Water and soil pollution due to increased pesticide and herbicide use - Water quality pollution due to Poor leaching within the irrigation scheme</td>
<td>Negative</td>
<td>Low</td>
<td>Project area</td>
<td>Short term</td>
<td>Operation phases</td>
<td>Occasional</td>
<td>likely</td>
<td>None</td>
</tr>
<tr>
<td><strong>Habitat</strong></td>
<td>The presence of people and operations of farm machines may disturb the peace of wildlife; - Impacts on terrestrial ecological and ecosystem services process - Loss and fragmentation of sensitive habitats</td>
<td>Negative</td>
<td>Moderate</td>
<td>Project Area</td>
<td>Long term</td>
<td>Project life</td>
<td>Certain</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td><strong>Overall Biodiversity</strong></td>
<td>Clearing of vegetation and digging of foundations may have an effect on both terrestrial and aquatic biodiversity.</td>
<td>Negative</td>
<td>Low</td>
<td>Project area</td>
<td>Short term</td>
<td>Operation phases</td>
<td>Continuous</td>
<td>Unlikely</td>
<td>None</td>
</tr>
</tbody>
</table>

### 3.0 PROJECT PHASE–CLOSURE

| **Land use**              | Removal of structures and equipment will make land available for other uses; | Positive | High | Project area | Long term | Post closure | Continuous | Certain | None |
| **General safety**        | Access to site by people or animals may cause injury if foundations are not filled | Negative | Moderate | Project area | Long term | Post closure | Continuous | Certain | Low |
### 7.5.2 Socio-Economic Environment

Table 7-3: Impact characterization for socio-economic environment

<table>
<thead>
<tr>
<th>Environmental Aspect/Issue</th>
<th>Potential Environmental Impact</th>
<th>Environmental Impact Characterization</th>
<th>Likelihood of Impact Occurring</th>
<th>Risk To Human Population</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.0 PROJECT PHASE – SITE CONSTRUCTION</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Land clearing</td>
<td>Relocation of people due to irrigation scheme</td>
<td>Negative high Within irrigation scheme</td>
<td>Occasional Certain low</td>
<td>low</td>
</tr>
<tr>
<td>Cultural Sites</td>
<td>Disturbance or loss of cultural sites</td>
<td>Negative low Within irrigation scheme</td>
<td>Occasional likelihood none</td>
<td></td>
</tr>
<tr>
<td>Population Growth</td>
<td>Increased population in the area</td>
<td>Negative moderate Within irrigation scheme</td>
<td>Continuous certain high</td>
<td></td>
</tr>
<tr>
<td>Traffic</td>
<td>Increased traffic</td>
<td>Negative Moderate Within irrigation scheme</td>
<td>Infrequent Likelihood low</td>
<td></td>
</tr>
<tr>
<td><strong>2.0 PROJECT PHASE – SITE OPERATION</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Animal Habitat</td>
<td>May occur due to depletion of habitat - Human-Animal Conflict</td>
<td>Negative low Within irrigation scheme</td>
<td>Continuous likely low</td>
<td>low</td>
</tr>
<tr>
<td>Migration</td>
<td>Increased employment opportunities; Increase in the local population Increase in Local Economic Threat to Human Health</td>
<td>Negative Moderate Within irrigation scheme</td>
<td>Occasional Certain none</td>
<td></td>
</tr>
<tr>
<td>Sanitation</td>
<td>Concentration of people due to population growth</td>
<td>Negative Moderate Within irrigation scheme</td>
<td>Occasional Likelihood high</td>
<td></td>
</tr>
<tr>
<td>National Revenue</td>
<td>Increased economic activity</td>
<td>Positive Moderate Beyond project area</td>
<td>Occasional Likelihood high</td>
<td></td>
</tr>
<tr>
<td>Community Safety</td>
<td>Increased traffic in the area.</td>
<td>Negative low Within irrigation scheme</td>
<td>Infrequent Likelihood low</td>
<td></td>
</tr>
<tr>
<td>Occupational Health Safety</td>
<td>Poor working environmental</td>
<td>Negative Moderate Within irrigation scheme</td>
<td>Occasional Likelihood high</td>
<td></td>
</tr>
<tr>
<td>HIV/ AIDS</td>
<td>Increased interaction among the people and migratory workers</td>
<td>Negative High Project area Within irrigation scheme</td>
<td>Continuous certain high</td>
<td></td>
</tr>
</tbody>
</table>

**Table Notes:**
- **Positive/Negative Impact:** Indicates whether the impact is positive or negative.
- **Intensity of Impact:** Describes the level of impact (e.g., high, moderate).
- **Extent of Impact:** Specifies the scope of the impact (e.g., within irrigation scheme).
- **Duration of Impact:** Indicates the duration (e.g., long term).
- **Timing of Impact:** Describes when the impact occurs (e.g., construction stage).
- **Frequency of Impact:** Specifies how often the impact occurs.
- **Likelihood of Impact Occurring:** Describes the likelihood of the impact occurring (e.g., continuous, occasional).

**Risk To Human Population:** Describes the risk to the human population (e.g., low, high).
8 IMPACT MITIGATION AND ENHANCEMENT MEASURES

8.1 Possible Mitigations and Enhancements - Construction Phase

Under this section, proposed mitigation and enhancement measures to be carried out during construction and operation stages of the project are elaborated.

8.1.1 Enhancements of Positive Socio-Economic Impacts

- Employment Opportunities at all stages of development (critical factor in this project).

**Mitigation:** MAL will ensure good agricultural practices are adopted and adopt an efficient as well as effective management system to sustain productivity. Priority will be given to the local people.

- Economic Growth at local and national level as a result of the new development

**Mitigation:** MAL will adopt a robust and profit oriented marketing system for agricultural yields to ensure high returns in order to contribute to the national treasury. MAL will also ensure that the employees are encouraged to buy most things from within the area.

- To Skills Transfer to Local People

**Mitigation:** MAL should ensure there is skill transfer through an elaborate training programme which is a dedicated overall project component on its own. Only skills that will not be available within the local community will be sourced from other areas. Skills base for the area will be increased by training the locals especially those skills that can be mastered within a short time.
8.1.2 Mitigations of Negative Socio-Economic Impacts

- **Loss of agricultural fields and some burial sites**
  
  **Mitigation:** Those displaced from farming within block areas will receive “land for land” compensation outside. Each resident HH will be entitled to one or more irrigation allocations in Tier 1.

- **Loss of livelihood for vulnerable groups in the short term:**
  
  **Mitigation:** Alleviating negative impacts on vulnerable groups through training, land reorganisation and entitlement to resources through the RAP.

- **Disturbance of cultural and archaeological sites**
  
  **Mitigation:** Take a precautionary measure i.e. should any effect of historical nature be discovered during construction, relevant authorities (National Heritage Conservation Commission) will be notified immediately by MAL. (Safeguard referred to OP/BP 4.11)

  In addition, this will apply to:

  - All the construction works that include access roads, dam, power lines, pumping stations, fences, irrigation network and associated infrastructure that will be initiated by MAL;
  - MAL should consider Having on site a trained personnel able to immediately identify archaeological artifacts and Eco facts;
  - Oversee any accidental finding of an isolated grave and the reburial of the remains according to local customs;
  - MAL should ensure that the plateau Malende shrine on a list of places not to be at all impacted, by any future roads or other infrastructure construction.

- **Increased traffic causing difficulties in accessing project sites**
  
  **Mitigation:** During construction, MAL should in consultation with local authorities ensure that road users observe road sign and also provide for speed limiting structure.

- **Increased HIV/AIDs and other STDs**
  
  **Mitigation:** MAL should ensure that the contractor as part of the contract sensitize workers and the communities on the dangers of HIV/AIDs and other STDs. Toolbox sessions and extended community awareness sessions should be part of the contract. MAL will also support local programmes by Ministry of Health regarding HIV/AIDs.

- **Population Growth and Migration**
  
  **Mitigation:** MAL should allocate about 11% of the available land for irrigation allocations available on Tier 1 to youthful persons.

8.1.3 Mitigations of Negative Environmental Impacts

- **Disturbance to wildlife habitat**
  
  **Mitigation:** MAL should ensure that implementation of the EMP is mandatory for the contractor and that should include limiting 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.

- **Pollution due to solid waste**
Mitigation: MAL should ensure that the contractor puts measures in place for waste collection at selected points for proper disposal at a designated site.

- Loss of some indigenous flora (biodiversity & conservation of forest ecosystem)

Mitigation: Contract signed by MAL for construction should ensure that clearance of vegetation is limited only to critical areas; awareness campaigns among staff and community on the need to conserve nature and adopt strict good practices in conservation are conducted.

- Pollution to Groundwater Quality

Mitigation: MAL should ensure all machinery and equipment at site are regularly maintained by contractor, limit servicing and repair of machinery and equipment to designated areas and dispose any used oil at a designated place in accordance with the law.

- To Dust Pollution

Mitigation: MAL should ensure that the contractor regularly waters the area during construction works.

- Disturbance to fauna habitat especially insects, reptiles such as lizards and small mammals

Mitigation: MAL should ensure limit clearance of vegetation only to critical areas, Conduct awareness campaigns among staff and community on the need to conserve nature.

- Loss of agricultural and grazing fields

Mitigation: MAL should implement recommendations made in the RAP that include—Replacement of land through reorganization and compensation for loss of field land.

8.2 Possible Mitigations and Enhancements Operational Phase

8.2.1 Enhancements of Positive Socio-economic Impacts

- National and international level impacts

To enhance positive national and international socio-economic impacts, MAL should ensure that the scheme increases its crop production levels by increasing the land under irrigation. This will not only increase overall size of land under irrigation but will positively contribute to grain production. This will further have a positive multiplier effect on regional trade ties among countries.

- Economic multiplier effects at the national level

To enhance economic multiplier effects at national level, MAL should embark on an expansion and replication of the initiative that will resulting in demand for more inputs such as seed, chemicals, farm equipment and associated services. This will result in a chain effect by creating demand for inputs from other firms who in turn be made to increase their production levels by acquiring more equipment and employing more staff. This will have an economic multiplier effect on the general economy of the country.
- Contributions to national food security from crop production
  MAL should support increased investment in more farm equipment and support infrastructure such as dams. Such an investment will enable the operations to sustainably increase its crop production level thus ensuring national food security and indirectly regional food security.

- Contributions to national fiscal benefits
  MAL must develop a long term strategic plan for the expansion of the irrigation scheme in a manner that will have minimum environmental impacts while increasing crop production levels thus contributing significantly to the country’s Gross Domestic product (GDP) through increased earnings in foreign exchange.

- Economic Boom at Provincial and district level impacts
  To enhance positive economic impacts provincial and local, MAL should ensure that scheme management improves its irrigation scheme to make it not only economically viable but environmentally sustainable by putting in place long term environmental management plans for optimum utilization of natural resources within and surrounding catchment. This would ensure improved employment opportunities and increased income in form of taxes for local authorities resulting into improved availability and access to social services.

- Employment, skills transfer and human resource capacity development
  Development of human resource capacity through establishment of a robust human resources development plan and incorporate systems to ensure that human resource development is carried out correctly must be top on the agenda for MAL. This should be done in a manner that will boost efficiency and effectiveness of crop production processes in the scheme.

- Local area and site impacts
  Working together with other stakeholders, MAL must develop social economic programmes that will conserve natural resources within and surrounding areas while ensuring the irrigation scheme is not threatened by activities such as cutting of trees which may affect availability of water resources. Ensure involvement of the local communities in planning and designing such social economic programmes to ensure acceptability and increased willingness for participation in implementing such programmes.

- Contribution to household incomes and food security
  Expand crop production levels by increasing the number of agricultural fields under irrigation and purposefully MAL should employ more women where appropriate. Employing more women will have a direct positive impact on the income of the household and improve the welfare of children.

- Improved housing, water supplies and sanitation facilities
  MAL should establish linkages with other ongoing initiatives regarding a long term water and sanitation programme to ensure facilities are available without compromising the environment.
- Improved health and education facilities
  MAL should involve relevant government departments and local authorities for improved health and education facilities in order for the scheme to benefit from a wealth pool of human resources and other inputs available from the respective ministries.

8.2.2 Enhancements of Positive Environmental Impacts
- Biodiversity contributions to sustainable agriculture
  Ensure that appropriate land management practices including preservation of strips of undisturbed vegetation are fully embraced. This will provide an environment for restoring woodland belts and interconnectivities critical for sustaining wildlife, creating positive biodiversity consequently enhancing sustainable agricultural production through soil improvement and natural controls on pests and diseases.

- Contributions to ameliorating climate change
  Apart from ensuring that strips of undisturbed woodland are preserved, MAL should put in place a deliberate policy to engage communities in surrounding areas to preserve trees and practice conservation agriculture. This would positively mitigate climate change because the conservation intervention measures will cover a much larger area than it is currently.

- Technology impacts to soil structure and water conservation
  Using its experience and expertise, MAL should ensure good agricultural practices that include limited tillage and strict nutrient management are applied. As a result, there will be fewer impacts on the soil structure. Embrace new technology on the market and invest in best practices in managing water resources for efficient and effective utilization of water resources.

- Biodiversity contributions to sustainable agriculture
  Ensure appropriate land management practices involving preservation of strips of undisturbed vegetation that provides an environment for restoring woodland belts and interconnectivities critical for sustaining wildlife creating positive biodiversity.

- Contributions to ameliorating climate change
  Ensure good management practice by preserving strips of woodland in all areas that are not meant for development. When these areas remain relatively undisturbed woodland they will collectively contributes to mitigate climate change acting as a carbon sink reservoir.

8.2.3 Mitigations of Negative Socio-economic Impacts
- Human animal conflict
  MAL should work together with ZAWA, to provide for animal corridors and conduct awareness among communities on the need to co-exist with wildlife. Maintain the riparian vegetation wherever possible and conserve dambos areas.

- Social Conflict
  MAL will ensure that a measure of water adequate for animal watering is made available as well as for irrigation to avoid conflict due to increased water demand.
- **Migration and temporary employment effects**
  
  Migration and temporary employments effects are a common feature in all areas where there are emerging economic activities due to high unemployment levels. This is beyond the control of the scheme since it cannot directly be prevented. MAL can mitigate this by simply improving operations at the scheme.

- **Unsociable behavior from increased disposable income**
  
  To mitigate against unsociable behavior, MAL should ensure that the scheme designs induction programmes for newly appointed workers and provide sensitization and behavioral change programmes for all workers. This will assist workers in managing their income and provide guidance for improved lifestyle choices. Social activities that include social infrastructure such as football grounds and women’s clubs should be promoted.

- **Casualisation of labour**
  
  No mitigation measure is required since the employment policy will be to employ permanent workers based on labour needs that run throughout the year. However, at peak production times such as harvesting time, capacity of permanent employees becomes inadequate. Since the demand for more labour force is tied to these peak production times, it’s prudent that temporary workers are engaged for a specific period of time based on demand to supplement existing work force.

- **Population density-related disease impacts**
  
  Collaborate with other stakeholders such as local authorities and other commercial farms in the area in promoting community sensitization programmes and also promote community social activities such as women’s clubs.

- **Poor sanitation practices**
  
  - MAL should ensure communities are sensitized on good hygiene practices,
  - Depletion of natural resources,
  - Ensure good agricultural practices and conservation measurements,
  - Occupational health and safety impacts.
  
  MAL should ensure that the contractor and scheme management develop and implement programmes for community awareness and training of workers on safety procedures as well as providing protective clothing and equipment.

### 8.2.4 Mitigations of Negative Environmental Impacts

- **Soil erosion and siltation in canals and drains and gully extending into the irrigated area**
  
  In consultation and guidance from Forestry Dept., MAL should carry out reforestation of the disturbed area after construction activities. Limit movement of heavy machinery only to designated access routes and operational areas.

- **Water quality pollution due to Poor leaching within the irrigation scheme;**

- **Stick to good practices of irrigation infrastructure operation rules of ensuring minimum flows in times of low flow;**

- **Impact on energy consumption patterns.**
Use energy efficient equipment should be promoted by MAL and also use encourage people to use other forms of energy such as solar for none critical areas such as lighting of households

- **Impact due to use of pesticide and herbicide**

Working with relevant authorities, MAL should ensure that recommended dosage and frequency of application of agro chemicals are observed ensure recommended types of agro-chemicals are used and conduct awareness campaign among communities on dangers of agro chemicals. Avoid use of highly toxic pesticides found on the and instead promote and encourage use of botanical pesticides particularly for Tier 1 and 2. In addition;

- Ensure adherence to an Integrated Pest Management (IPM) Plan,
- Train the communities especially in Tier 1, 2 and 3 in IPM in order to reduce the use of hazardous pesticides,
- Provide training in safe handling and usage of pesticides as well as safe disposal of containers.

- **Increased use of fertilizers**

MAL should encourage practice conservation and green farming, encourage organic farming, careful choice of crops which replenish soil fertility as well as use organic fertilizers. This would be more practical for Tier 1 and 2. In addition:

- Retain crop residues where it does not pose a pest risk. Crop rotation will facilitate this,
- Practice mulching to create a conducive environment for soil fauna a flora which are active in cycling nutrients, and introduces organic matter,
- Use leguminous crops such as beans and groundnuts, together with inoculants,
- Plant green manures and/or mulch crops when the land is not required for cash crops,
- Promote use of livestock manure,
- Conduct regular soil analysis so that fertilizer application is tailored to crop requirements – this measure is only practical for Tier 3 and 2, unless Tier 1 gets external support.

- **Impact on water quantity on downstream reaches**

This will be minimal as illustrated under the hydrological analysis section. However, MAL will ensure that efficiency in the use of water is promoted.

- **Soil degradation from inappropriate land use practices**

MAL through its extension services should ensure that use of inappropriate methods of farming by communities in surrounding areas is avoided as it poses a risk of erosion and river siltation that may affect ecological biodiversity. Conduct sensitization programmes and training in good agricultural practices. In addition:

- Ensure initial ripping before 1st plantings,
- Conduct training in reduced tillage & conservation farming Tier 1 and 2,
- Use of minimal tillage in Tier 3,
- Use contour ridges where required,
• Train tier 1 farmers in correct usage of the hose-furrow system plus regular follow up inspections and training by an extension officer.

- Air quality deterioration

Dust is an important factor of environmental pollution. The generation of dust from the access roads to be constructed and fields during land preparation may have an impact on the air quality especially during the dry season when wind speed is high. Ensure contractor regularly waters the construction site

- Noise pollution

Use of farm equipment and vehicles that are not regularly maintained can lead to noise pollution. Ensure that the equipment and plant machinery are well maintained by the contractor and in good condition such that noise emitted is within acceptable level

- Light pollution from center pivots

MAL should ensure that the project design of agricultural layout of the fields will be coupled with interconnectivity of patches of woodlands that will separate the fields to help minimize light pollution from the center pivots in operation.

- Pollution from inappropriate disposal of agricultural chemicals and containers

Ensure a well-designed infrastructure for storage of chemicals. Manage usage of the chemicals through implementation of procedures in line with regulations set out by ZEMA. Therefore impacts of pollution from inappropriate disposal of agricultural chemicals and containers are insignificant. Ensure proper disposal methods of chemicals and containers are being carried out.

- Impacts on geomorphic processes in dambos, streams and Kafue River

Ensure good agricultural practices that minimise the risk of soil erosion. Ensure layouts of agricultural fields are restricted to areas that are generally flat with good drainage whilst areas with steep slopes will be avoided. However, activities by communities in surrounding areas pose a risk to geomorphic processes.

- Impacts on ecological processes in dambos, streams and rivers

Ensure that usage of agricultural chemicals that includes chemicals and fumigant materials used to control pests in the field and storage areas are regulated.

Impacts on terrestrial ecological and ecosystem services processes

Ensure that when large areas are cleared for agriculture fields patches of vegetation connecting to each other through the area are left intact. Clearing of vegetation will only be confined to areas where irrigation facilities and associated facilities will be constructed.

- Loss of species of special concern and biodiversity

Ecological surveys showed no serious loss of species of special concern, and other species important to ecosystem functioning that may have resulted in loss of biodiversity. However, the scheme will limit clearance of vegetation to critical areas designated for development.
- Loss and fragmentation of sensitive habitats

Two habitats were identified as sensitive in Musakashi area; riparian vegetation and Dambo grasslands. These areas are important in maintaining the ecosystem functions:

- Leaving aside patches of key representative portions of each vegetation type within the project area as conservation area,
- Keep all areas of riparian forest as continuous as possible to maintain corridors within the farming areas,
- Keep all areas of floodplains (and dambos) as continuous as possible to maintain corridors within the farming areas,
- Impacts on climate change,
- Facilitate the planting of village woodlots within surrounding communities to offset loss associated with cleared areas,
- Avoid clearing woodlands which are in a mature or climax state,
- Where feasible, implement carbon emissions offsets elsewhere,
- Ensure use of well maintained, high efficiency diesel motors. Ensure use of energy efficient variable speed electric motors,
- Ensure use of energy efficient lighting, heating and ventilation in staff facilities,
- Ensure permanent and contracted staff does not harvest fuel wood or utilize charcoal from unsustainable harvesting,
- Where possible, utilize freight vehicles with emissions performance labelling,
- Ensure implementation of reduced speed limits,
- Ensure all vehicles remain at a high level of maintenance.

- Aesthetic and landscape quality impacts of woodland removal

MAL should consider promoting planting of woodlots within the project and surrounding areas as well as preserving strips of indigenous woodlands connected to each other within scheme.

- Aesthetic and landscape quality impacts of center pivots and farm structures

Ensure layout of agricultural fields is such that they are well spaced separated by undisturbed strip of woodland that is habitat to wildlife. Farm structures should also been designed and located in a manner that leaves the natural environment undisturbed.

- Soil loss from inappropriate land use practices

Ensure application of good agricultural practices that prevent soil loss and embark on community programmes that will sensitize communities in surrounding areas using inappropriate methods of farming leading to erosion and river siltation.

- Air quality deterioration

Avoid open air incineration of chemical waste. Construct properly designed incineration facilities to avoid air pollution.
• **Noise pollution**

Ensure equipment and plant machinery are well maintained and in good condition such that noise emitted is within an acceptable level. Workers operating in areas were noise emitted will be provided with protective clothing.

• **Polluting impacts of the storage, management, use and disposal of agricultural chemicals and containers**

Ensure a well-designed infrastructure for storage of chemicals. Management and use of these chemicals will be done following laid down procedures in line with regulations set out by ZEMA. In addition, ensure that:

- Chemical stores (including fuel, insecticides, etc.) are bonded and locked at all times;
- Access to such stores is controlled at all times,
- Inventories of stored chemicals are maintained, and their use regulated,
- All cautions/recommendations with respect to storage and use of hazardous chemicals should be carefully followed and implemented.

• **Impacts on surface water bodies, stream flows and water quality**

Ensure that no untreated waste is discharged in the water bodies and sanitation facilities are maintained.

• **Impact on faunal diversity loss**

To avoid loss of faunal diversity should ensure that the EMP is implemented fully. This should ensure that:

- Clearing or damaging intact habitats is avoided where possible,
- Exploitation of sensitive reptiles, e.g. Crocodiles, monitor lizards, chameleons and terrapins by communities and farm staff is prevented by running community workshops that explain sustainable resource use,
- Training of employees (induction training) and local villagers (workshops) about the necessity of protecting wildlife are conducted,
- Habitat connectivity, particularly to protected areas, via habitat corridors (through the offsite biodiversity offset) is maintained,
- Undertake habitat clearance only during winter when birds are not breeding.

• **Erosion of the top soil**

Stabilization and rehabilitation of the area will be practiced. Use of contour ridges where required, and well-designed drains for Tier 1 hose-furrow areas.
Mitigation Measures for Environmental Impacts during the: preparation/construction phase

Figure 8-1 Summary of Mitigation Measures

<table>
<thead>
<tr>
<th>Environmental Impact</th>
<th>Mitigation/Enhancement Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disturbance of terrestrial ecological &amp; ecosystem services processes</td>
<td>Clearing of vegetation will only be confined to areas where irrigation facilities and associated facilities will be constructed. Ensure that when large areas are cleared for agriculture fields patches of vegetation connecting to each other through the area are left intact.</td>
</tr>
<tr>
<td>Loss of natural habitat for small mammals, birds and insects.</td>
<td>Avoiding clearing or damaging riparian vegetation where possible, and limit river and stream crossings as far as possible. Avoid blockage or diversion of rivers and streams where possible. Avoid indirect effect of run-off erosion and sedimentation from roads that may lead to loss of riparian habitats. Monitor and maintain riparian habitat corridors and waterways in adjacent areas to maintain faunal connectivity and migration.</td>
</tr>
<tr>
<td>Loss of species of special concern</td>
<td>Clearing of vegetation will only be confined to areas where irrigation facilities and associated facilities will be constructed. Where possible avoid creating isolated ‘islands’ of Miombo habitat of less than 100 ha in extent as they will not serve as meaningful refugia for large mammals, snakes, etc</td>
</tr>
<tr>
<td>Loss &amp; fragmentation of sensitive habitats</td>
<td>Clearing of vegetation will only be confined to areas where irrigation facilities and associated facilities will be constructed. Avoid indirect effect of run-off erosion and sedimentation from roads that may lead to loss of riparian habitats. Monitor and maintain riparian habitat corridors and waterways in adjacent areas to maintain faunal connectivity and migration.</td>
</tr>
<tr>
<td>Loss of Fauna diversity</td>
<td>Clearing of vegetation will only be confined to areas where irrigation facilities and associated facilities will be constructed. Habitat connectivity, particularly to protected areas, via habitat corridors (through the offsite biodiversity offset) is maintained. Undertake habitat clearance only during winter when birds are not breeding.</td>
</tr>
<tr>
<td>Erosion of top soil</td>
<td>Clearing of vegetation will only be confined to areas where irrigation facilities and associated facilities will be constructed. Ensure application of good agricultural practices that prevent soil loss and embark on community programmes that will sensitize communities in surrounding areas using inappropriate methods of farming leading to erosion and river siltation. Use of contour ridges where required, and well-designed drains for Tier 1 hose-furrow areas. Making-good of borrow pits with topsoil and vegetation.</td>
</tr>
<tr>
<td>Pollution of surface water as a result of spills</td>
<td>Oils will be stored and used only in designated areas at the workshops. Dispose any used oil at a designated place in accordance with the law.</td>
</tr>
<tr>
<td>Contamination of Soil</td>
<td>All contaminated soil will be treated. The valuable top soil, containing organic material, nutrients as well as seeds and the soil fauna, will be excavated separately. This will be piled in an adequate manner for reuse. After completion of the construction works the contractor will ensure immediate restoration by spreading piled top soil and by sowing adequate grass. Put up erosion control measures such as gabions and gunny bags filled with soil where there is erosion signs to slow down storm water flow in these sections during heavy rains.</td>
</tr>
<tr>
<td>Contamination of soil, surface water and/or groundwater due to fuel spills</td>
<td>Regular servicing and maintenance of equipment and vehicles.</td>
</tr>
<tr>
<td>Noise pollution from the movement of the site vehicles can disturb workers, community</td>
<td>All mobile vehicles and equipment will have noise reducers. All land preparation activities will take place during the day and any work during night-time will be communicated to the state authorities and local community.</td>
</tr>
<tr>
<td>Nuisance dust pollutes the air, affect the health of site workers</td>
<td>Water bowsers will be employed on site to suppress dust on all site roads. Designated routes will be established on site for motor traffic. Site workers will be issued with personal protective attire. All the sand or soil heaps will be removed as soon as possible to avoid nuisance dust arising from prevailing.</td>
</tr>
</tbody>
</table>
Increased road traffic will lead to deterioration of dirty irrigation scheme roads

- Conduct routine road repair and maintenance.

Increased in road traffic may lead to reduced road safety among the rural communities

- Control traffic by introducing speed-humps and elaborate road signs.
- Road will maintained free of mud, pot-holes, debris and other traffic obstacles.
- Sensitize the community on general road safety to increasing traffic awareness.

Mitigation Measures for Socio-economic Impacts during the preparation/construction phase

<table>
<thead>
<tr>
<th>Environmental Impact</th>
<th>Mitigation/Enhancement Measures</th>
</tr>
</thead>
</table>
| Increased opportunities for skills transfer | Ensuring there is a skill transfer programme.  
Categorize staff and each group to be supervised by a dedicated skilled personnel to ensure on job training.  
Encourage job on training through observation and trial under supervision. |
| Increased revenue base for the government | The Scheme will adhere to all the tax requirements of the Government of the Republic of Zambia. |
| Increase in the local population | Measures will include) Adopt selective employment opportunities targeting locals, ii) Ensure adequate facilities are provided for staff such as sanitation facilities. |
| Increase in Local Economic Activities | To enhance this, developer will ensue that the employees are encouraged to buy most things from within the area. The developer will support improvement of market facilities in the area. |
| Threat to Human Health | Construction activities will expose the community to the non-local people which may lead to the spread of HIV/AIDS and other STIs. Measures to minimize this will include; i) sensitize staff and community on the dangers of HIV/AIDs and STIs.  
ii) support local programmes by Ministry of Health regarding HIV/AIDs |
| Increased lung problems due to dust emissions | Watering of the area and surroundings during the construction stage will be undertaken regularly. |
| Loss of grazing land | Designate some areas for grazing coupled with cultivated land for pasture. |
## Mitigation Measures for Environmental Impacts during the operation phase

<table>
<thead>
<tr>
<th>Environmental Impact</th>
<th>Mitigation/Enhancement Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pollution of surface water as a result of soil erosion</td>
<td>Ensure that all people at the farm are trained in handling chemicals/oils and so that no accidental spills are experienced.</td>
</tr>
<tr>
<td>Contamination of soil, surface water and/or groundwater due to fuel spills</td>
<td>Regular servicing and maintenance of equipment and vehicles.</td>
</tr>
<tr>
<td>Contamination of surface water and groundwater due to washing and servicing of equipment</td>
<td>All maintenance will be done in workshops. Hydrocarbon traps will be installed in the workshop drainage system to treat effluent prior to release to the farm surface drainage.</td>
</tr>
<tr>
<td>Contamination of water as a result of washing and servicing of equipment</td>
<td>Heavy equipment wash-bays equipped with impervious surfaces and containment to capture effluent from washing operations will be constructed at the open pit workshops.</td>
</tr>
<tr>
<td>Air pollution due to airborne dust generated from the operation of heavy farm equipment used in land clearance.</td>
<td>Regular servicing of vehicles and equipment.</td>
</tr>
<tr>
<td>Air pollution</td>
<td>The site will be routinely sprayed with water in order to suppress dust during operations phase.</td>
</tr>
<tr>
<td>Soil Contamination due to oil spills</td>
<td>The service, repair and maintenance of farm equipment and vehicles will be restricted to dedicated areas specifically designed for the purpose.</td>
</tr>
<tr>
<td>Contamination of Soil from disposal of agro-chemicals/containers</td>
<td>All scheme equipment using hydraulic fluid, oil, fuel or any other substance that has the potential to contaminate surface water, groundwater or soil if released into the environment will be subject to a preventative maintenance programme. Procedures laid down in the Emergency Response Plan will be followed in the event of a spill.</td>
</tr>
<tr>
<td>IPM training.</td>
<td></td>
</tr>
<tr>
<td>Loss of vegetation</td>
<td>Reforestate disturbed areas where appropriate. Minimize clearance of vegetation to critical areas. Facilitate the planting of village woodlots within surrounding communities to offset loss associated with cleared areas. Avoid clearing woodlands which are in a mature or climax state. Ensure use of well maintained, high efficiency diesel motors. Prevent harvest of fuel wood or utilize charcoal from unsustainable harvesting.</td>
</tr>
</tbody>
</table>
## Mitigation Measures for Socio-economic Impacts during the operation phase

<table>
<thead>
<tr>
<th>Environmental Impact</th>
<th>Mitigation/Enhancement Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased employment opportunities for locals</td>
<td>Priority will be given to the local people. Only skills that will not be available within the local community will be sourced from other areas. Skills base for the area will be increased by training the locals especially those skills that can be mastered within a short time.</td>
</tr>
<tr>
<td>Increased opportunities for skills transfer</td>
<td>Ensuring there is a skill transfer programme. Categorize staff and each group to be supervised by a dedicated skilled personnel to ensure on job training. Encourage job on training through observation and trial under supervision.</td>
</tr>
<tr>
<td>loss of agricultural fields</td>
<td>Compensation and replacement of land will be done after a RAP exercise is undertaken.</td>
</tr>
<tr>
<td>Increased revenue base for the government</td>
<td>The Irrigation scheme will adhere to all the tax requirements of the Government of the Republic of Zambia.</td>
</tr>
<tr>
<td>Increase in the local population</td>
<td>Measures will include) Adopt selective employment opportunities targeting locals, ii) Ensure adequate facilities are provided for staff such as sanitation facilities.</td>
</tr>
<tr>
<td>Increase in Local Economic Activities</td>
<td>To enhance this, MAL will ensure that the employees are encouraged to buy most things from within the area. The Scheme will support improvement of market facilities in the area.</td>
</tr>
<tr>
<td>Threat to Human Health</td>
<td>Construction activities will expose the community to the non-local people which may lead to the spread of HIV/AIDS and other STIs. Measures to minimize this will include; i) sensitize staff and community on the dangers of HIV/AIDS and STIs ii) support local programmes by Ministry of Health regarding HIV/AIDS.</td>
</tr>
<tr>
<td>Pollution of surface and groundwater</td>
<td>Provide adequate sanitation facilities and proper disposal of waste. Ensure communities are sensitized on good hygiene practices.</td>
</tr>
<tr>
<td>Health related diseases for workers</td>
<td>Ensure working environment is well kept and conducive for workers. Provide personal protective clothing. Develop and implement programmes for community awareness and training of workers on safety procedures.</td>
</tr>
<tr>
<td>Threat to human safety</td>
<td>Provide for undisturbed stretches of vegetation interconnected to provide animal passage.</td>
</tr>
</tbody>
</table>
9 ENVIRONMENTAL MONITORING AND MANAGEMENT

9.1 Environmental and Social Management Plan

An Environmental and Social Management plan (ESMP) has been elaborated under this section for purposes of addressing identified adverse and positive impacts. Due consideration has been given to various factors that include; on-site environmental deterioration as well as decrease in water quality and increase in sedimentation rates resulting from clearing of forest land for agriculture, use of agricultural chemicals.

9.2 Environmental Monitoring Plan

Under the Environmental Monitoring Plan (EMP), various mitigation measures have been organized into a well-formulated plan, which will serve as a guide for operation phase. While costs associated with implementing the EMP are often deemed unnecessary it’s important that adequate resources are allocated to implementation of the EMP in order to comply with the monitoring commitments in the EMP as well as ensuring that unexpected effects resulting from operational activities are detected early enough for mitigation without causing irreversible damage to the environment.
<table>
<thead>
<tr>
<th>Environmental Aspect/issue</th>
<th>Environmental Impact</th>
<th>Management Objectives</th>
<th>Mitigation/Enhancement Measures</th>
<th>Performance Indicators</th>
<th>Responsible person</th>
<th>Time Frame</th>
<th>Cost ZMK</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Removal of vegetation</strong></td>
<td>Disturbance of terrestrial ecological &amp; ecosystem services processes</td>
<td>To ensure minimal loss of vegetation</td>
<td>Clearing of vegetation will only be confined to areas where irrigation facilities and associated facilities will be constructed. Ensure that when large areas are cleared for agriculture fields patches of vegetation connecting to each other through the area are left intact.</td>
<td>Proportion of land left as connecting corridors of vegetation</td>
<td>FarmCo Scheme Manager</td>
<td>Start of Clearing and levelling</td>
<td>Prior to construction</td>
</tr>
<tr>
<td><strong>Loss of natural habitat for small mammals, birds and insects.</strong></td>
<td>To ensure minimal disturbance to the habitats</td>
<td>Avoiding clearing or damaging riparian vegetation where possible, and limit river and stream crossings as far as possible. Avoid blockage or diversion of rivers and streams where possible. Avoid indirect effect of run-off erosion and sedimentation from roads that may lead to loss of riparian habitats. Monitor and maintain riparian habitat corridors and waterways in adjacent areas to maintain faunal connectivity and migration.</td>
<td>Proportion of land secured against erosion and Area of land vegetation cover acting as habitat</td>
<td>FarmCo Scheme Manager</td>
<td>Start of Clearing and levelling</td>
<td>Prior to construction</td>
<td>75,000</td>
</tr>
<tr>
<td><strong>Loss of species of special concern</strong></td>
<td>To ensure minimal loss of vegetation</td>
<td>Clearing of vegetation will only be confined to areas where irrigation facilities and associated facilities will be constructed. Where possible avoid creating isolated ‘islands’ of Miombo habitat of less than 100 ha in extent as they will not serve as meaningful refugia for large mammals, snakes, etc</td>
<td>Proportion of land secured with intact Miombo vegetation Proportion of species of special concern</td>
<td>FarmCo Scheme Manager</td>
<td>Start of Clearing and levelling</td>
<td>Prior to construction</td>
<td>-</td>
</tr>
<tr>
<td><strong>Loss &amp; fragmentation of sensitive habitats</strong></td>
<td>To minimize clearance of vegetation</td>
<td>Clearing of vegetation will only be confined to areas where irrigation facilities and associated facilities will be constructed. Avoid indirect effect of run-off erosion and sedimentation from roads that may lead to loss of riparian habitats. Monitor and maintain riparian habitat corridors and waterways in adjacent areas to maintain faunal connectivity and migration.</td>
<td>Proportion of land under vegetation</td>
<td>FarmCo Scheme Manager</td>
<td>Start of Clearing and levelling</td>
<td>Prior to construction</td>
<td>150,000</td>
</tr>
<tr>
<td>Environmental Aspect/issue</td>
<td>Environmental Impact</td>
<td>Management Objectives</td>
<td>Mitigation/Enhancement Measures</td>
<td>Performance Indicators</td>
<td>Responsible person</td>
<td>Time Frame Start/End</td>
<td>Cost ZMK</td>
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<tr>
<td>Biophysical Environment</td>
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<tr>
<td>Preparation/Construction Phase</td>
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</tr>
<tr>
<td>Loss of Fauna diversity</td>
<td>To ensure minimum loss of habitat</td>
<td>Clearing of vegetation will only be confined to areas where irrigation facilities and associated facilities will be constructed. Habitat connectivity, particularly to protected areas, via habitat corridors (through the offsite biodiversity offset) is maintained. Undertake habitat clearance only during winter when birds are not breeding.</td>
<td>Proportion of land left as connecting corridors of vegetation acting as habitat</td>
<td>FarmCo Scheme Manager</td>
<td>Start of Clearing and levelling</td>
<td>Prior to construction</td>
<td>-</td>
</tr>
<tr>
<td>Erosion of top soil</td>
<td>To limit clearance of vegetation to critical areas</td>
<td>Clearing of vegetation will only be confined to areas where irrigation facilities and associated facilities will be constructed. Ensure application of good agricultural practices that prevent soil loss and embark on community programmes that will sensitize communities in surrounding areas using inappropriate methods of farming leading to erosion and river siltation. Use of contour ridges where required, and well-designed drains for Tier 1 hose-furrow areas. Making-good of borrow pits with topsoil and vegetation.</td>
<td>Proportion of land secured against erosion Proportion of land left as under vegetation cover Soil loss due to erosion (Tons/ha)</td>
<td>FarmCo Scheme Manager</td>
<td>Start of Clearing and levelling</td>
<td>Prior to construction</td>
<td>250,000</td>
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<tr>
<td>Spills and/or accidental releases.</td>
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<tr>
<td>Spills and/or accidental releases.</td>
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<td></td>
<td>Number of spills recorded per quarter</td>
<td>Workshop Manager</td>
<td>Prior to construction</td>
<td>On-going 50,000</td>
</tr>
<tr>
<td>Pollution of surface water as a result of spills</td>
<td>To prevent contamination of water as a result of oil spills</td>
<td>Oils will be stored and used only in designated areas at the workshops. Dispose any used oil at a designated place in accordance with the law.</td>
<td>Number of spills recorded per quarter</td>
<td>Workshop Manager</td>
<td>Prior to construction</td>
<td>On-going 50,000</td>
<td></td>
</tr>
<tr>
<td>Contamination of Soil</td>
<td>To prevent contamination of soil</td>
<td>All contaminated soil will be treated. The valuable top soil, containing organic material, nutrients as well as seeds and the soil fauna, will be excavated separately. This will be piled in an adequate manner for reuse. After completion of the construction works the contractor will ensure immediate restoration by spreading piled top soil and by sowing adequate grass. Put up erosion control measures such as gabions and gunny bags filled with soil where there is erosion signs to slow down storm water flow in these sections during heavy rains.</td>
<td>Level of contaminants in the soil budget allocated to environmental management</td>
<td>FarmCo Scheme Manager</td>
<td>Start of Vegetation clearing Activities</td>
<td>On-going 300,000</td>
<td></td>
</tr>
<tr>
<td>Pollution of groundwater</td>
<td>To avoid groundwater pollution</td>
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</tr>
<tr>
<td>Environmental Aspect/issue</td>
<td>Environmental Impact</td>
<td>Management Objectives</td>
<td>Mitigation/Enhancement Measures</td>
<td>Performance Indicators</td>
<td>Responsible Person</td>
<td>Time Frame</td>
<td>Cost ZMK</td>
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</tr>
<tr>
<td><strong>Use of equipment and vehicles</strong></td>
<td>Contamination of soil, surface water and/or groundwater due to fuel spills</td>
<td>To prevent the contamination of water and soil as a result of spills and leakages from machines.</td>
<td>Regular servicing and maintenance of equipment and vehicles.</td>
<td>Number of equipment/machinery emitting smoke</td>
<td>FarmCo Scheme Manager</td>
<td>Start of clearing activities</td>
<td>On-going</td>
</tr>
<tr>
<td><strong>Noise emission and vibration</strong></td>
<td>Noise pollution from the movement of the site vehicles can disturb workers, community</td>
<td>To minimize noise emission and vibration</td>
<td>All mobile vehicles and equipment will have noise reducers. All land preparation activities will take place during the day and any work during night-time will be communicated to the state authorities and local community.</td>
<td>Level of noise during operations</td>
<td>FarmCo Scheme Manager</td>
<td>At start of land clearing</td>
<td>End of construction</td>
</tr>
<tr>
<td><strong>Atmospheric emissions</strong></td>
<td>Nuisance dust pollutes the air, affect the health of site workers</td>
<td>To reduce dust emissions during construction</td>
<td>Water bowsers will be employed on site to suppress dust on all site roads. Designated routes will be established on site for motor traffic. Site workers will be issued with personal protective attire. All the sand or soil heaps will be removed as soon as possible to avoid nuisance dust arising from prevailing.</td>
<td>Level air emissions in the area</td>
<td>FarmCo Scheme Manager</td>
<td>At start of land clearing</td>
<td>End of construction</td>
</tr>
<tr>
<td><strong>Safety</strong></td>
<td>Increased in road traffic may lead to reduced road safety among the rural communities</td>
<td>To reduce road traffic accidents</td>
<td>Control traffic by introducing speed-humps and elaborate road signs. Road will maintained free of mud, pot-holes, debris and other traffic obstacles. Sensitize the community on general road safety to increasing traffic awareness.</td>
<td>Number of accidents recorded</td>
<td>FarmCo Scheme Manager</td>
<td>At start of land clearing</td>
<td>End of construction</td>
</tr>
<tr>
<td>Environmental Aspect/issue</td>
<td>Environmental Impact</td>
<td>Management Objectives</td>
<td>Mitigation/Enhancement Measures</td>
<td>Performance Indicators</td>
<td>Responsible person</td>
<td>Time Frame</td>
<td>Cost ZMW</td>
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</tr>
<tr>
<td><strong>Improved Livelihoods</strong></td>
<td>Increased employment opportunities for locals</td>
<td>To increase employment opportunities for the local people in the area</td>
<td>Priority will be given to the local people. Only skills that will not be available within the local community will be sourced from other areas. Skills base for the area will be increased by training the locals especially those skills that can be mastered within a short time.</td>
<td>Number of people employed</td>
<td>FarmCo Manager &amp; Human Resource Manager</td>
<td>Prior to construction</td>
<td><strong>150,000</strong></td>
</tr>
<tr>
<td><strong>Increased opportunities for skills transfer</strong></td>
<td>To encourage training of staff on site</td>
<td>Ensuring there is a skill transfer programme. Categorize staff and each group to be supervised by a dedicated skilled personnel to ensure on job training. Encourage job on training through observation and trial under supervision.</td>
<td>Level of skills among locals</td>
<td>FarmCo Manager &amp; Human Resource Manager</td>
<td>Prior to construction</td>
<td><strong>100,000</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Revenue for the government from taxes</strong></td>
<td>Increased revenue base for the government</td>
<td>To enhance the tax base for the government for infrastructure development</td>
<td>The Scheme will adhere to all the tax requirements of the Government of the Republic of Zambia.</td>
<td>Tax compliance level at the scheme</td>
<td>FarmCo Manager &amp; Human Resource Manager</td>
<td>Prior to construction</td>
<td><strong>-</strong></td>
</tr>
<tr>
<td><strong>Migration</strong></td>
<td>Increase in the local population</td>
<td>To reduce pressure on local resources</td>
<td>Measures will include: i) Adopt selective employment opportunities targeting locals, ii) Ensure adequate facilities are provided for staff such as sanitation facilities.</td>
<td>Level of depletion of natural resources in the area</td>
<td>FarmCo Manager</td>
<td>Prior to construction</td>
<td><strong>55,000</strong></td>
</tr>
<tr>
<td><strong>Increase in Local Economic Activities</strong></td>
<td>To increase the market for local goods and services in the area</td>
<td>To enhance this, developer will ensure that the employees are encouraged to buy most things from within the area. The developer will support improvement of market facilities in the area</td>
<td>Capacity of markets to adsorb products</td>
<td>FarmCo Manager</td>
<td>Start of clearing</td>
<td><strong>185,000</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Threat to Human Health</strong></td>
<td>To reduce the incidences of HIV/AIDS</td>
<td>Construction activities will expose the community to the non-local people which may lead to the spread of HIV/AIDS and other STIs. Measures to minimize this will include; i) sensitize staff and community on the dangers of HIV/AIDs and STIs ii) support local programmes by Ministry of Health regarding HIV/AIDs</td>
<td>Number of new effections in the area</td>
<td>FarmCo Manager</td>
<td>Prior to construction</td>
<td><strong>275,000</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Occupational Health &amp; Safety</strong></td>
<td>Increased lung problems due to dust</td>
<td>To reduce the incidences of lung problems</td>
<td>Watering of the area and surroundings during the construction stage will be undertaken regularly.</td>
<td>Number of new cases of lung</td>
<td>FarmCo Manager</td>
<td>Start of Clearing</td>
<td><strong>160,000</strong></td>
</tr>
<tr>
<td>Environmental Aspect/Issue</td>
<td>Environmental Impact</td>
<td>Management Objectives</td>
<td>Mitigation/Enhancement Measures</td>
<td>Performance Indicators</td>
<td>Responsible Person</td>
<td>Time Frame</td>
<td>Cost ZMW</td>
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</tr>
<tr>
<td>Land Clearing for scheme development</td>
<td>Loss of grazing land</td>
<td>To limit clearing of vegetation to critical areas only</td>
<td>Designate some areas for grazing coupled with cultivated land for pasture</td>
<td>Proportion of grazing land left</td>
<td>FarmCo Manager</td>
<td>Start of Clearing</td>
<td>On-going</td>
</tr>
<tr>
<td>Environmental Aspect/issue</td>
<td>Environmental Impact</td>
<td>Management Objectives</td>
<td>Mitigation/Enhancement Measures</td>
<td>Performance Indicators</td>
<td>Responsible person</td>
<td>Time Frame</td>
<td>Cost ZMW</td>
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<tr>
<td>Biophysical Environment</td>
<td></td>
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</tr>
<tr>
<td>Operation Phase</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Spills and/or accidental releases.</td>
<td>Pollution of surface water as a result of soil erosion</td>
<td>To prevent contamination of water as a result of soil erosion.</td>
<td>Ensure that all people at the farm are trained in handling chemicals/oils and so that no accidental spills are experienced</td>
<td>Proportion of land secured against erosion</td>
<td>FarmCo Scheme Manager</td>
<td>Year 1</td>
<td>On-going</td>
</tr>
<tr>
<td>Use of equipment and vehicles</td>
<td>Contamination of soil, surface water and/or groundwater due to fuel spills</td>
<td>To prevent the contamination of water and soil as a result of spills and leakages from machines.</td>
<td>Regular servicing and maintenance of equipment and vehicles.</td>
<td>Pollution level in water sources Existence of pollution sources</td>
<td>FarmCo Scheme Manager</td>
<td>Year 1</td>
<td>On-going</td>
</tr>
<tr>
<td>Contamination of surface water and groundwater due to washing and servicing of equipment</td>
<td>To prevent the contamination of water and soil as a result of spills and leakages from machines.</td>
<td>All maintenance will be done in workshops. Hydrocarbon traps will be installed in the workshop drainage system to treat effluent prior to release to the farm surface drainage.</td>
<td></td>
<td></td>
<td>FarmCo Scheme Manager</td>
<td>Year 1</td>
<td>On-going</td>
</tr>
<tr>
<td>Contamination of water as a result of washing and servicing of equipment</td>
<td>To prevent the contamination of water and soil as a result of spills and leakages from machines.</td>
<td>Heavy equipment wash-bays equipped with impervious surfaces and containment to capture effluent from washing operations will be constructed at the open pit workshops</td>
<td></td>
<td></td>
<td>FarmCo Scheme Manager</td>
<td>Year 1</td>
<td>On-going</td>
</tr>
<tr>
<td>Atmospheric emissions</td>
<td>Air pollution due to airborne dust generated from the operation of heavy farm equipment used in land clearance.</td>
<td>To minimize atmospheric pollution due emissions from vehicles and other machines</td>
<td>Regular servicing of vehicles and equipment</td>
<td>Level of air emissions</td>
<td>FarmCo Scheme Manager</td>
<td>Year 1</td>
<td>On-going</td>
</tr>
<tr>
<td>Air pollution</td>
<td>To control/minimize the generation of dust from the movement of haul trucks and other heavy equipment for dam construction</td>
<td>The site will be routinely sprayed with water in order to suppress dust during operations phase</td>
<td>Level of dust emissions Number of times water is sprayed</td>
<td>FarmCo Scheme Manager</td>
<td>Year 1</td>
<td>On-going</td>
<td>165,000</td>
</tr>
<tr>
<td>Soil Degradation</td>
<td>Soil Contamination due to oil spills</td>
<td>To prevent contamination of soils at the workshop.</td>
<td>The service, repair and maintenance of farm equipment and vehicles will be restricted to dedicated areas specifically</td>
<td>Number of spills recorded per</td>
<td>FarmCo Scheme Manager</td>
<td>Year 1</td>
<td>On-going</td>
</tr>
<tr>
<td>Environmental Aspect/issue</td>
<td>Environmental Impact Biophysical Environment</td>
<td>Management Objectives</td>
<td>Mitigation/Enhancement Measures</td>
<td>Performance Indicators</td>
<td>Responsible person</td>
<td>Time Frame</td>
<td>Cost ZMW</td>
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</tr>
<tr>
<td>Contamination of Soil from disposal of agrochemicals/ containers</td>
<td>Operation Phase</td>
<td>To prevent contamination of soil caused by an accidental release of fuel or oil.</td>
<td>All scheme equipment using hydraulic fluid, oil, fuel or any other substance that has the potential to contaminate surface water, groundwater or soil if released into the environment will be subject to a preventative maintenance programme. Procedures laid down in the Emergency Response Plan will be followed in the event of a spill. IPM training</td>
<td>Availability of disposal site</td>
<td>FarmCo Scheme Manager / SHEQ</td>
<td>Year 1</td>
<td>On-going</td>
</tr>
<tr>
<td>Chemical pollution</td>
<td>Increased usage of fertilizers and agrochemicals</td>
<td>To ensure usage of agrochemicals/fertilizers is according to standards</td>
<td>Promote use of organic manures Practice conservation and green farming, Encourage organic farming, careful choice of crops which replenish soil fertility</td>
<td>Tons of fertilizers used</td>
<td>FarmCo Manager</td>
<td>From operation</td>
<td>On-going</td>
</tr>
<tr>
<td>Climate Change</td>
<td>Loss of vegetation</td>
<td>To minimize loss of vegetation</td>
<td>Reforestate disturbed areas where appropriate Minimize clearance of vegetation to critical areas Facilitate the planting of village woodlots within surrounding communities to offset loss associated with cleared areas. Avoid clearing woodlands which are in a mature or climax state Ensure use of well maintained, high efficiency diesel motors Prevent harvest of fuel wood or utilize charcoal from unsustainable harvesting</td>
<td>Proportion of vegetation left intact</td>
<td>FarmCo Manager</td>
<td>Prior to land clearing</td>
<td>145,000</td>
</tr>
</tbody>
</table>
### Table 9-3 Environmental & Social Management Plan during the operation phase

<table>
<thead>
<tr>
<th>Environmental Aspect/issue</th>
<th>Environmental Impact</th>
<th>Management Objectives</th>
<th>Mitigation/Enhancement Measures</th>
<th>Performance Indicators</th>
<th>Responsible person</th>
<th>Timing</th>
<th>Cost ZMW</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Improved Livelihoods</strong></td>
<td>Socio-economic Environment</td>
<td>Operation Phase</td>
<td>To increase employment opportunities for the local people in the area</td>
<td>Priority will be given to the local people. Only skills that will not be available within the local community will be sourced from other areas. Skills base for the area will be increased by training the locals especially those skills that can be mastered within a short time.</td>
<td>Number of locals employed</td>
<td>FarmCo Scheme Manager &amp; Human Resource Manager</td>
<td>Year 1</td>
</tr>
<tr>
<td><strong>Increased opportunities for skills transfer</strong></td>
<td></td>
<td></td>
<td>To encourage training of staff on site</td>
<td>Ensuring there is a skill transfer programme. Categorize staff and each group to be supervised by a dedicated skilled personnel to ensure on job training. Encourage job on training through observation and trial under supervision.</td>
<td>Availability of various Skills among locals</td>
<td>FarmCo Scheme Manager &amp; Human Resource Manager</td>
<td>Year 1</td>
</tr>
<tr>
<td><strong>Land</strong></td>
<td></td>
<td></td>
<td>To ensure affected households are not left worse off than before</td>
<td>Compensation and replacement of land will be done after a RAP exercise is undertaken</td>
<td>% number of disputes relating to compensation Level of improvement in lifestyle</td>
<td>FarmCo Scheme Manager</td>
<td>Year 1</td>
</tr>
<tr>
<td><strong>Revenue for the government</strong></td>
<td></td>
<td></td>
<td>To enhance the tax base for the government for infrastructure development</td>
<td>The Irrigation scheme will adhere to all the tax requirements of the Government of the Republic of Zambia.</td>
<td>tax compliance level for the scheme</td>
<td>FarmCo Scheme Manager</td>
<td>Year 1</td>
</tr>
<tr>
<td><strong>Migration</strong></td>
<td></td>
<td></td>
<td>To reduce pressure on local resources</td>
<td>Measures will include) Adopt selective employment opportunities targeting locals, ii) Ensure adequate facilities are provided for staff such as sanitation facilities.</td>
<td>Number of new immigrants to the area</td>
<td>FarmCo Scheme Manager</td>
<td>Prior to construction</td>
</tr>
<tr>
<td><strong>Increase in Local Economic Activities</strong></td>
<td></td>
<td></td>
<td>To increase the market for local goods and services in the area</td>
<td>To enhance this, MAL will ensure that the employees are encouraged to buy most things from within the area. The Scheme will support improvement of market facilities in the area</td>
<td>Level of improvement in livelihood for local people % reduction in the number of none school going children</td>
<td>FarmCo Scheme Manager</td>
<td>Start of clearing</td>
</tr>
<tr>
<td>Environmental Aspect/issue</td>
<td>Socio-economic Environment</td>
<td>Mitigation/Enhancement Measures</td>
<td>Performance Indicators</td>
<td>Responsible person</td>
<td>Timing Start</td>
<td>Timing End</td>
<td>Cost ZMW</td>
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</tr>
<tr>
<td>Threat to Human Health</td>
<td>Poor Sanitation</td>
<td>To reduce the incidences of HIV/AIDS Construction activities will expose the community to the non-local people which may lead to the spread of HIV/AIDS and other STIs. Measures to minimize this will include: i) sensitize staff and community on the dangers of HIV/AIDS and STIs ii) support local programmes by Ministry of Health regarding HIV/AIDS</td>
<td>Number of new effections of HIV/AIDS Number of HIV/AIDS programmes supported per quarter</td>
<td>FarmCo Scheme Manager</td>
<td>Prior to construction</td>
<td>On-going</td>
<td>140,000</td>
</tr>
<tr>
<td></td>
<td>Pollutioin of surface and groundwater</td>
<td>To avoid depletion of water resources due to contamination Provide adequate sanitation facilities and proper disposal of waste. Ensure communities are sensitized on good hygiene practices</td>
<td>Number of sanitary facilities available State of sanitary facilities</td>
<td>FarmCo Scheme Manager</td>
<td>Start of Clearing</td>
<td>On-going</td>
<td>60,000</td>
</tr>
<tr>
<td>Health related diseases for workers</td>
<td>Occupational Health</td>
<td>To minimize any health hazards to workers Ensure working environment is well kept and conducive for workers Provide personal protective clothing Develop and implement programmes for community awareness and training of workers on safety procedures</td>
<td>Number of new cases recorded Number of staff complaining of chest health problems</td>
<td>FarmCo Scheme Manager</td>
<td>135,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Threat to human safety</td>
<td>Human Animal Conflict</td>
<td>To prevent risk of animal attach Provide for undisturbed stretches of vegetation interconnected to provide animal passage</td>
<td>Number of cases of animal human confrontations recorded</td>
<td>FarmCo Scheme Manager</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Management Objectives</td>
<td>Performance Indicators</td>
<td>Responsible person</td>
<td>Timing Start</td>
<td>Timing End</td>
<td>Cost ZMW</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Operation Phase</td>
<td>Performance Indicators</td>
<td>Responsible person</td>
<td>Timing Start</td>
<td>Timing End</td>
<td>Cost ZMW</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Environmental Impact</td>
<td>Performance Indicators</td>
<td>Responsible person</td>
<td>Timing Start</td>
<td>Timing End</td>
<td>Cost ZMW</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Environmental and Social Impact Assessment</td>
<td>Performance Indicators</td>
<td>Responsible person</td>
<td>Timing Start</td>
<td>Timing End</td>
<td>Cost ZMW</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Musakashi IDSP Group 1 sites</td>
<td>Performance Indicators</td>
<td>Responsible person</td>
<td>Timing Start</td>
<td>Timing End</td>
<td>Cost ZMW</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CP&amp;CB Provider IDSP</td>
<td>Performance Indicators</td>
<td>Responsible person</td>
<td>Timing Start</td>
<td>Timing End</td>
<td>Cost ZMW</td>
</tr>
</tbody>
</table>

**SOFRECO**
Table 9-4   Environmental Monitoring Programme

<table>
<thead>
<tr>
<th>Program</th>
<th>Description</th>
<th>Monitoring Location</th>
<th>Frequency</th>
<th>Parameters</th>
<th>Compliance Requirement</th>
<th>Responsible Person</th>
<th>Cost  ZMK</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Surface water Monitoring</strong></td>
<td>Ambient surface water quality – upstream and downstream of the area of disturbance</td>
<td>Kafue River, Upstream and Downstream of reservoirs</td>
<td>Monthly</td>
<td>pH, EC, TDS, TSS, SO₄, Cu, Fe, Co, Mn, NO₂, PO₄, Ca-Hardness, Ca, Mg, Pb, Co, Cd Pesticides</td>
<td>Key statutory limits that will be adhered to include the Statutory Limits for effluent discharged to surface waters.</td>
<td>FarmCo Manager</td>
<td>20,000</td>
</tr>
<tr>
<td><strong>Biological Monitoring</strong></td>
<td>Aquatic and terrestrial flora and fauna</td>
<td>Location will be selected in line with the baseline assessment to monitor impacts on biological data</td>
<td>Bi-Annual</td>
<td>Selection of parameters to be determined in consultation with relevant regulatory authorities to ensure potential impacts are detected.</td>
<td>Compliance requirements – to minimize impacts and compare to baseline environmental data.</td>
<td>FarmCo Manager</td>
<td>50,000</td>
</tr>
<tr>
<td><strong>Land Monitoring</strong></td>
<td>Areas disturbed and rehabilitated</td>
<td>Entire Scheme area</td>
<td>Up-dated annually</td>
<td>Record area disturbed versus area rehabilitated.</td>
<td></td>
<td>FarmCo Manager</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Success of rehabilitation</td>
<td>Plots will be determined once rehabilitation has begun and will include analogue sites in undisturbed areas.</td>
<td>Annually</td>
<td>To be determined, will include: Erosion rates, growth rates, species richness, important values, species dominance etc.</td>
<td>To meet stable, sustainable landforms at closure.</td>
<td>FarmCo Manager</td>
<td>50,000</td>
</tr>
<tr>
<td>Program</td>
<td>Description</td>
<td>Monitoring Location</td>
<td>Frequency</td>
<td>Parameters</td>
<td>Compliance Requirement</td>
<td>Responsible Person</td>
<td>Cost ZMK</td>
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</tr>
<tr>
<td>Air Emissions Monitoring</td>
<td>Meteorology</td>
<td>Put up a meteorological station within the Scheme area</td>
<td>Continuous</td>
<td>Temperature Rainfall Humidity Wind (speed, direction) Pressure Evaporation</td>
<td>No compliance requirements – monitoring of natural conditions to supplement other monitoring including runoff volumes, ambient dust loads and noise levels.</td>
<td>FarmCo Manager</td>
<td>150,000</td>
</tr>
<tr>
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<tr>
<td>Ambient dust</td>
<td>Locations will be established around the area of disturbance to record ambient dust levels – mostly during construction phase</td>
<td>Monthly totals Total dust levels</td>
<td>Monthly</td>
<td></td>
<td>Statutory dust emission limits as detailed in Pollution Control Regulations – Third Schedule</td>
<td>FarmCo Manager</td>
<td>5,000</td>
</tr>
<tr>
<td>Noise</td>
<td>Ambient and point Source</td>
<td>Construction areas</td>
<td>Monthly</td>
<td>Survey undertaken quarterly to record noise levels in comparison to baseline measurements</td>
<td>Statutory limit for noise levels</td>
<td>FarmCo Manager</td>
<td>5,000</td>
</tr>
<tr>
<td>Traffic</td>
<td>Consistent with baseline monitoring program</td>
<td></td>
<td>Annually</td>
<td>Vehicle movements</td>
<td>No compliance requirements – to monitor impacts and ensure mitigation measures are appropriate.</td>
<td>FarmCo Manager</td>
<td>:</td>
</tr>
</tbody>
</table>
10 CONCLUSION

The environmental assessment showed that although the project will have adverse impacts on the environment most of them can easily contained within acceptable limits. The assessment further showed that there are many positive impacts that will accrue from the Irrigation scheme project. Thus, it is the opinion of the study team that social economic and environmental impacts resulting from operations at Musakashi Scheme can effectively be managed and reduced to acceptable levels as long as proposed mitigation measures are applied. Consequently, the benefits arising from operations of Scheme as a developmental project outweigh the environmental costs.
11 REFERENCES


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