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<td>AFLEG</td>
<td>African Forest Law Enforcement and Governance</td>
</tr>
<tr>
<td>BOQ</td>
<td>Bill of Quantities</td>
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<tr>
<td>CBD</td>
<td>Convention on Biological Diversity</td>
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<tr>
<td>CCD</td>
<td>Convention to Combat Desertification</td>
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<tr>
<td>CP&amp;CB</td>
<td>Community Participation and Capacity Building</td>
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<tr>
<td>DACO</td>
<td>District Agriculture Coordinator</td>
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<tr>
<td>EIA</td>
<td>Environmental Impact Assessment</td>
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<td>EMA</td>
<td>Environmental Management Act</td>
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<tr>
<td>EMP</td>
<td>Environmental Management Plan</td>
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<tr>
<td>ESIA</td>
<td>Environmental and Social Impact Assessment</td>
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<tr>
<td>FAO</td>
<td>Food and Agriculture Organisation</td>
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<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>
</tr>
<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>
</tr>
<tr>
<td>IBRD</td>
<td>International Bank for Reconstruction and Development</td>
</tr>
<tr>
<td>ICBP</td>
<td>International Council for Bird Preservation</td>
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<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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<tr>
<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>
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<tr>
<td>ISF</td>
<td>Investment Support Fund</td>
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<tr>
<td>IUCN</td>
<td>International Union for the Conservation of Nature</td>
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<tr>
<td>Abbreviation</td>
<td>Full Form</td>
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<tr>
<td>LDPE</td>
<td>Low Density Polyéthylène</td>
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<td>MAL</td>
<td>Ministry of Agriculture and Livestock</td>
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<tr>
<td>MIGA</td>
<td>Multilateral Investment Guarantee Agency</td>
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<td>NAP</td>
<td>National Agricultural Policy</td>
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<td>NIP</td>
<td>National Irrigation Plan</td>
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<td>NWP</td>
<td>National Water Policy</td>
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<td>O&amp;M</td>
<td>Operation and Maintenance</td>
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<td>Operational Procedure</td>
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<td>PAPs</td>
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<td>PPP</td>
<td>Public Private Partnership</td>
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<td>SAR</td>
<td>Sodium Absorption Ratio</td>
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<td>SCAFÉ</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>
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<td>Société Française de Réalisation, d’Etudes et de Conseil</td>
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<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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<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

Project 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:
Chirundu District, Lusaka 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$ 3.7 million. Project commencement date is 2014.

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

GENERAL
Seasonal rainfall variability makes agricultural production in Zambia vulnerable especially that almost 70% of food crops are produced by traditional farmers who depend on dry land farming. Coupled to this are re-occurrences droughts over the past decades resulting in food insecurity thereby threatening 80 percent of the population. The Government of the Republic of Zambia recognizes Agriculture as one of the priority sectors. Statistics show that 80 percent of the population is dependent on agriculture with about 70 percent of the country’s labour force being employed in the sector. Therefore 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.

PROJECT DETAILS
The Ministry of Agriculture and Livestock is the project implementing agency through 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 and government. The proposed Lusitu project site is located on the left bank of the Zambezi River, 12km south of Chirundu town at latitude 16°06’32” south and longitude 28°50’31” east, and an elevation of 382 masl., 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 labour to profitably grow mainly field crops; and
Tier 3 consisting 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.

Key features of the project will include: Pumping stations, Irrigation equipment, reservoirs as well as irrigation fields. Lusitu Irrigation Scheme with total area of 210 ha (phase One), will have an estimated investment cost of US$ 3.7 million and is expected to commence by the end of 2014.

THE ENVIRONMENTAL IMPACT ASSESSMENT AND STAKEHOLDER OUTCOME

A scoping exercise was conducted to identify potential environmental (socio-economic and biophysical) impacts, contemplate environmentally options for the design detail, and identify issues of concern for Interested and Project Affected Persons (PAPs) and stakeholders. It included review of the project literature, targeted consultations with the relevant authorities and stakeholders and public consultation in form of general meetings. The concern of most stakeholders was related to the resettlement and land re-organisation that will accompany the irrigation development. Concern was also raised about human-animal conflict involving elephants, re-organisation of common rights to land, animal-human conflict, loss of grazing land, access to Zambezi River 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 analysed: 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 utilised that may result in less income for the communities and continued poverty. With Project Option 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 have their income levels increased resulting in improved livelihood. Therefore this option is preferred.

Project Site Alternatives

Lusitu site was a preferred site due to availability of suitable soils, climate and terrain for irrigation, cost effectiveness, availability of water, and minimum disturbance to biophysical and socio-economic environments. The options to construct the IDSP irrigation scheme elsewhere in the province was found to be economically and socially unattainable as it falls short of providing a comparable site that meets standard criteria for construction or irrigation and associated infrastructure.

Alternative Processes

The adequacy of minimum flows in the Zambezi River makes makes direct abstraction using a pump the best option. 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 equally found to be inappropriate for commercial agricultural purposes even though it’s good for domestic purposes.
Technological Alternatives

Centre pivot has a high initial capital investment cost but its high in water application efficiency and can cover a large area of land (thus its an ideal for certain categories of farmers with over 50ha) while conserving water for other users that include the environment. Flood irrigation has the lowest capital investment cost and water utilisation efficiency and environmentally unsound because 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 (ideal for more than 1 ha to 5 ha 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:

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. Small centre pivots (for Tier 2): Centre pivots have a higher efficiency (85%) than normal sprinkler layouts and cause less soil damage, labour requirement is very low, allowing one operator to control several pivots. 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).

IMPACTS/ MITIGATIONS MEASURES

Major Impacts – Construction Stage

- **Loss of indigenous flora:** 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;
- **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 in accordance with national regulations;
- **Disturbance to fauna habitat:** MAL should ensure the contractor limits 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 reorganisation and compensation for relocation;
- **Loss of community assets:** Relocation and compensation of affected persons through an elaborated RAP that has already been prepared as part of the consultancies initiated by MAL;
Loss of livelihood in the short term: Alleviating negative impacts on vulnerable groups through training, land reorganisation and entitlement to resources which is already part of the project design;

Employment Opportunities: MAL should ensure good agricultural practices are adopted and adopt an efficient as well as effective management system 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 under is a dedicated project component;

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) sensitisise workers and the communities on the dangers of HIV/AIDS and other STDs;

Increased access to water for livestock: MAL should sensitisise the community about conservation of water resources.

Major Impacts – Operation Stage

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;

Loss of 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;

Loss of biodiversity: Ecological surveys showed no serious loss of species of special concern, important to ecosystem functioning that may result in loss of biodiversity. However, MAL through the contractor should limit clearance of vegetation to critical areas designated for development;

Loss of faunal diversity: To avoid loss of faunal diversity MAL should ensure that the EMP is implemented fully;

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;

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;

- **Soil erosion and siltation:** In consultation and guidance from Forestry Department, 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 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 and instead promote and 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.

**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 Lusitu Irrigation Scheme as a developmental project outweigh environmental costs.

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POSITION: Hydrological Modeller
1 INTRODUCTION

1.1 Policy Context and Development Strategy

1.1.1 Contribution of Agriculture to the Economy

Agriculture contributes to 40% of Gross Domestic Product (GDP) and 12% of export earnings. Statistics show that 80% of the population is dependent on agriculture with about 70% of the country’s labour force being employed in the sector. It supplies raw materials to agro-industries accounting for about 84% of the manufacturing value-added in the country. Out of the national population of 13.8 million, about 60% are based on smallholder farms cultivating 2 ha or less of dry land farming and dependant on agriculture or agriculture-related activities for their livelihoods. The growth of the agricultural sector, however, has been slower than other sectors such as mining, construction, and services. Therefore, any strategy to reduce poverty and accelerate economic growth must allocate a leading role to the agriculture sector particularly the smallholder agriculture and infrastructure development.

1.1.2 Characteristics of the Agriculture Sector

Zambia’s agricultural sector is characterised 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.

However, 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 hindering productive agriculture in Zambia. Despite numerous efforts made in the past to improve agricultural production; Positive performance in the sector by 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 organisation 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.

1.1.3 Policy Responses

In response to the earlier highlighted challenges in the agricultural sector, the Government put 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 signalling the economic value and costs of water. It focuses on:

- Water resources management;
- Rural water supply and sanitation;
- 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 Public Private Partnership (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) provides a strategic framework for “sustained economic growth and poverty reduction” focussing on Water Resources Management and Development and Water Supply and Sanitation. Its goal in agriculture 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 GRZ aims to construct 30 irrigation schemes through the Sustainable Land and Water Management Programme across the whole of the country with the aim to increase the irrigable area from 173,000 ha in 2011 to 187,500 ha by 2015.

1.1.4 Proposed Project in the National Context

Lusitu irrigation scheme will have all the features designed specifically to conform to national policy documents in which these features are rooted. These include:
• Taking advantage of Zambia’s irrigation potential;
• Developing Public Private Partnership (PPP) to improve the leverage of government investment in irrigation development;
• Involving the private sector in irrigation to improve implementation efficiency, realise benefits of scale in production and therefore accelerate economic growth;
• 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 line with the above, Lusitu 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 ipso 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 Proposed Project in the Local Context

Although it took a bit of time to win the support currently being demonstrated, the proposed project is well supported at local level 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) organised 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 has been participating in project activities.

1.2 Project Design Concept

1.2.1 Principles

The project design concept is based on four principles:

• 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, and improved access to markets, better prices through value addition, realistically priced water and more cost effective O&M than hitherto;
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;

- 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;
- 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:

- According to the Resettlement Action Plan (RAP) census, a total of 1,906 people in 382 households will be direct project beneficiaries with access to irrigation allocations in Tier 1. In addition there will be some opportunity for farm labour on Tier 2 and 3 though at this site irrigated bananas are planned for Tier 2 and 3 which will not provide much more than 2,000 labour days per year, compared with about 50,000 labour days per annum 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;
- 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.

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

The Government of the Republic of Zambia recognizes Agriculture as one of the priority sectors as it contributes significantly to socio-economic development of the country. As earlier stated, statistics show that 80 percent 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.

Although 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 utilised and less than 5% is under irrigation. This goes to show that the irrigation potential in Zambia remains underdeveloped (See figure 1-11).

As a corrective measure, the Government of the Republic of Zambia (GRZ) 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, thus creating an investment opportunity.

1.4 Location and Layout

The proposed Lusitu project site is located on the left bank of the Zambezi River, 12km south of Chirundu town at latitude 16°06'32" south and longitude 28°50'31" east, and an elevation of 382m asl. The site falls within the customary land controlled by the Sitinkwe community, and can be accessed from both Lusitu town on the Siavonga road and from Chirundu via un-metalled roads which are difficult to pass during the rainy season (See figure 1-2 and 1-3).
Figure 1-1  Lusitu Group 1 Site Location Map
1.5 Spatial Extent of the Study

The spatial extent of the study area will be Zambezi River sub-catchment including Lusitu (210 irrigated ha to be developed) and surrounding areas in Chirundu district in Southern province. See the Figure 1-4: Contributing Catchments to the Zambezi River between Kariba Dam and Chirundu in Annex 1: Maps folder3.

1.6 ESIA Study Objectives

The objectives of the ESIA study were to:

- To 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;
- Characterise 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;
- To 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;
- To take environmental factors into consideration from the outset in order to optimise the functions of the project in the landscape;
- To prevent polluting and nuisance impacts before they are realized;
- Minimising these impacts where they are unavoidable;
- To providing management tools for identified environmental risks and hazards;
- To develop monitoring tools to optimise project operations that also minimise environmental, social, environmental extreme event and hazards.

1.7 Project Justification

Farming involves heavy capital investment and many times beyond affordability of many household level farmers as well as small scale farmers. In view of this, small scale 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. With this realisation, Government has sourced funds to undertake an irrigation scheme project at three selected sites across the country, of which Lusitu 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.

Further, the National Irrigation Policy states that of the 58% of land suited for arable use, only 14% is currently being utilised and less than 5% is under irrigation in Zambia. This means that 5% of arable land is under irrigation at most during the

3 Figure 1-4: Contributing Catchments to the Zambezi River between Kariba Dam and Chirundu is available in Annex 1: Maps folder
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, the proposed project will contribute to an increase in land under irrigation and wealth creation among targeted beneficiaries when implemented.

1.8 EIA Scope and Approach

1.8.1 Scoping Studies

Environmental scoping aimed at 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 (PAPs) 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 PAPs into their planning and design decisions. This process is vital for ensuring transparency and accountability in decision-making.

1.8.2 Approach

A step-wise approach was used 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 site, 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 Environmental and Social Impact Assessment (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. 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;
- Establishing existing infrastructure such as schools, clinics and churches that may be affected by the project;
- Determining employment opportunities;
- Determining benefits and liabilities that may arise from the project.

For the minutes of the consultative meetings held at Lusitu project site refer to the Annex 15.

### 1.8.3 Outcome of Stakeholder Consultations

Most participants raised concerns related to loss of agricultural fields and land reorganisation that will accompany the irrigation development. Concern was also raised about the re-organisation of common rights to fuel wood, people’s access to the Zambezi River when the scheme is fenced, grazing land, animal conflict, and other common resources. Impact on vulnerable groups, social services and capacity building were other areas of concern expressed by stakeholders.

Concerns about resettlement and land reorganisation 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 reorganisation and entitlement to resources. See Table 1-1.
### Table 1-1 Key Issues Raised at Scoping Meetings

<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. Simpbanda</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. The 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. Kalinina</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. Kalinina</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, are 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: The community in the area experience Elephants crossing from the Zimbabwean side and destroy their crops. Hence the need for measures to prevent this threat;
- Water Availability for animals: The need to ensure that reservoir within the scheme are not open reservoirs as this will attract wild animals increasing the human animal conflict;
- The need to ensure the community have easy access to the water front of Zambezi River;
- The need to ensure land for grazing for domestic animals is available;
- The need for equity and thoroughness regarding compensation for all affected persons as well as host community.

1.9 Limitations to the ESIA

The ESIA study in its scope covered social, cultural and ecological aspects. However, the study had its own limitations. One of the limiting factors regarding ecological aspects was the fact that 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 of Agriculture and Livestock (MAL) has with support from cooperating partners developed a number of earth dams across the country to support irrigation and animal husbandry. The Ministry comprises of ten departments each headed by a Director who reports to the Permanent Secretary.
<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>LUSITU IN CHIRUNDU 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>MS DEBORAH PHIRI</td>
</tr>
<tr>
<td>Designation</td>
<td>SAFEGUARD SPECIALIST</td>
</tr>
<tr>
<td>Telephone Office</td>
<td>+260-211-251629</td>
</tr>
<tr>
<td>Fax:</td>
<td>+260-211-252029</td>
</tr>
<tr>
<td>Mobile:</td>
<td>0977988114</td>
</tr>
<tr>
<td>Email</td>
<td><a href="mailto:phiri.deborah78@yahoo.com">phiri.deborah78@yahoo.com</a></td>
</tr>
</tbody>
</table>
2 PROJECT RATIONALE

2.1 Scope
Lusitu will have three Tier arrangement system; the 1st tier being small-holders 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. Lusitu is a relatively small scheme of only 270 ha. Water will be abstracted from the Zambezi River. The proposed area of the each tier is shown in table 2.1 below.

Table 2-1 Proposed tier areas, Lusitu

<table>
<thead>
<tr>
<th>Tier</th>
<th>Gross area ha</th>
<th>Net irrigated area ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tier 1, small-holder</td>
<td>135</td>
<td>121</td>
</tr>
<tr>
<td>Tier 2, emergent</td>
<td>36</td>
<td>35</td>
</tr>
<tr>
<td>Tier 3, commercial</td>
<td>99</td>
<td>92</td>
</tr>
<tr>
<td>Total</td>
<td>270</td>
<td>248</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 Lusitu irrigation scheme to be served by the project. It also aims at sustaining the increase in 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 Cost**

The basic investment cost of Lusitu Irrigation Scheme is estimated to be US$ 3.7 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 2-2  Lusitu Irrigation Scheme Investment Costs, US$$**

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost in USD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conveyance system</td>
<td>2,380,650</td>
</tr>
<tr>
<td>Irrigation System</td>
<td>1,309,743</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3,690,393</strong></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). Tier 1-3 is currently none existant and government will have to establish them, see the Table 3-1

- 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. 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.

Table 3-1  Diagrammatic Representation of IDSP Irrigation Schemes

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:

(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, 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 up to farm gate; and roads within the scheme;
- Supporting infrastructure, including: 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 this component 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);

- Management and Coordination.

The objective of management and coordination 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

- **Irrigation system**

  A main pump station will abstract water from the Zambezi and deliver it to the tiers via reservoirs and secondary pump stations. The Tier 1 block (135 ha) will be divided into 270 plots of 0.5 ha each, irrigated with a closed low-pressure hose-and-furrow system. It is envisaged that each beneficiary household will be allocated one plot of 0.5 ha, although if they have the capacity, they could be allocated more. The Tier 2 block (36 ha gross, 35.1 ha net) will be divided into 13 plots of 2.7 ha net, irrigated by mini-sprinklers (micro-jet). Individual farmers or farmer-groups may be allocated one or more plots. The Tier 3 block (99 ha gross, 98.1 ha net) has been designed for 34 plots of 2.7ha net, irrigated by micro-jet and managed as one plantation by a private company with a long term lease.

  The three tiers are separate entities, which is particularly useful with regard to disease control in the proposed banana plantations. See figure 1-5: Layout of proposed irrigation system (Z&A, 2013/3) in Annex 1: Maps folder.

- **Cropping patterns**

  The typical cropping pattern that exists in Lusitu is tabulated below. The typical cropping pattern that exists in Lusitu is tabulated below. According to the social and agro-economic baseline survey conducted by Z&A in 2012/13 and the RAP Census 2013, the average farm size is 5 ha (range: <1 to 10 ha), of which only 40% is cultivated due to constraints on labour, tools, inputs and draught power.
Table 3-2  Existing cropping patterns, Lusitu

<table>
<thead>
<tr>
<th>Crop</th>
<th>% of HH</th>
<th>% of cropped area</th>
<th>Average ha/HH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize</td>
<td>90%</td>
<td>44%</td>
<td>1.0</td>
</tr>
<tr>
<td>Sorghum</td>
<td>92%</td>
<td>19%</td>
<td>0.8</td>
</tr>
<tr>
<td>Millet</td>
<td>31%</td>
<td>15%</td>
<td>0.5</td>
</tr>
<tr>
<td>Cotton</td>
<td>10%</td>
<td>3%</td>
<td>n/a</td>
</tr>
<tr>
<td>Beans and oilseeds</td>
<td>n/a</td>
<td>2%</td>
<td>n/a</td>
</tr>
<tr>
<td>Vegetables</td>
<td>n/a</td>
<td>8%</td>
<td>0.45</td>
</tr>
</tbody>
</table>

A high proportion of households (approx. 80%) practice irrigation on a very small scale. They produce vegetables such as cabbage, tomato, okra, rape and impwa (wild eggplant). The community also makes use of the residual moisture in the floodplains, planting maize as the river level drops. This practice is risky, as unpredictable rises in water level due to releases from Kariba Dam can inundate the standing crops.

The proposed cropping pattern is given in the table 3-2. The target yields in Tier 1 will be modest for irrigated crops, but realistic considering that there will be many small growers involved, with varying abilities and resources. It is proposed that both Tier 2 and 3 will produce bananas, as this is a high value crop suited to the local climate and the proposed areas are too small for extensive irrigated arable crops like wheat. The Tier 2 and 3 areas will not be fully planted in the first year, and it is expected that some annual cropping will initially take place in these areas, and probably continue in Tier 2. It is proposed that Tier 2 farmers will be out-growers of bananas for Tier 3, taking advantage of the market linkages, packing facility, supply of inputs and extension services available from Tier 3.
### Table 3-3   Proposed cropping pattern, Lusitu (Z&A, 2013/1)

<table>
<thead>
<tr>
<th>Tier</th>
<th>Crop</th>
<th>Full planting area ha</th>
<th>Target yields, per ha</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>p.a.</td>
<td>Yr 1</td>
</tr>
<tr>
<td>1</td>
<td>Maize</td>
<td>73 T/ha</td>
<td>5.0</td>
</tr>
<tr>
<td></td>
<td>Dry beans</td>
<td>12 T/ha</td>
<td>0.6</td>
</tr>
<tr>
<td>1</td>
<td>Tomatoes</td>
<td>36 T/ha</td>
<td>20</td>
</tr>
<tr>
<td>1</td>
<td>Cabbage</td>
<td>24 T/ha</td>
<td>20</td>
</tr>
<tr>
<td>1</td>
<td>Okra</td>
<td>12 T/ha</td>
<td>5.0</td>
</tr>
<tr>
<td>1</td>
<td>Rape</td>
<td>12 T/ha</td>
<td>5.0</td>
</tr>
<tr>
<td>1</td>
<td>Onion</td>
<td>24 T/ha</td>
<td>15.0</td>
</tr>
<tr>
<td>1</td>
<td>Green maize</td>
<td>24 T/ha</td>
<td>15.0</td>
</tr>
<tr>
<td>2</td>
<td>Banana</td>
<td>19 T/ha</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>Maize</td>
<td>16 T/ha</td>
<td>5.0</td>
</tr>
<tr>
<td>2</td>
<td>Onion</td>
<td>16 T/ha</td>
<td>15.0</td>
</tr>
<tr>
<td>3</td>
<td>Banana</td>
<td>92 T/ha</td>
<td>0</td>
</tr>
</tbody>
</table>

The target yields in Tier 1 are achievable for irrigated crops, but ambitious considering that there are many small growers involved, with varying abilities and resources. It is proposed that both Tier 2 and 3 will produce bananas, as this is a high value crop suited to the local climate and the proposed areas are too small for extensive irrigated arable crops like wheat. The target yield for bananas is realistic for commercial terms (industry norm is 50 T/ha), but as there are no reliable records for local minimum temperatures, it would be prudent to estimate 35 T/ha for Tier 3 and 25 T/ha for Tier 2. Bananas cease growing below 10°C, and average commercial yields in Livingstone, which suffers from relatively cold winters, are only 25 T/ha.

**Water supply and conveyance system**

**Water supply**

Water for irrigation will be abstracted from the Zambezi River. The peak design supply for the project at full scale would be 21,300 m³ per day (300 l/s on a 20 hr pumping day). The peak requirement occurs in October when evapo-transpiration (ET₀) averages 7.53 mm/day. The design peak supply is equivalent to 7.9 mm gross/day over the full 270 ha, however it is expected that the Tier 1 area will not be fully planted at this time, and certainly part of the area will have immature crops which require less than the ET₀. Bananas, which are the thirstiest of the proposed crops, are expected to occupy 133.2 ha at full scale, and require 9.5 mm gross/day at peak. This is equivalent to 12,100 m³ per day. Tier 1 is expected to require a maximum of 9,000 m³ per day if fully planted. Therefore, the design will be able to supply the peak requirements for the scheme.

The annual water requirement of the scheme is estimated to be 3,212,000 m³. The minimum flow in the Zambezi at Victoria Falls is normally around 1,000 m³/sec (Zambezi River Authority), but discharge from Kariba Dam
can fall as low as 400 m³/sec in drought years with reduced turbine activity (Beilfuss, R., 2012). The scheme at peak is estimated to use only 0.06% of the minimum discharge from Kariba Dam.

**Water conveyance system**

The proposed design features a main pumping station (PSz) fed by an earthen canal on the left bank of the Zambezi River. PSz will be situated above the maximum expected flood level and will have a wet-well with submersible pumps to feed a central reservoir (R1, 5,000 m³) via a buried 500mm rigid polyvinyl-chloride (uPVC) pipeline of 1,630 m length. From R1 water will be delivered in three directions:

- PS1 to tier 1 through a 500 mm uPVC pipeline of 290m;
- By gravity to a reservoir for tier 2 (R2, 1,500m³) through a 315 mm uPVC pipeline of 2,010 m; and
- By PS3 to a reservoir for tier 3 (R3, 3,800m³) through a 355 mm buried uPVC pipeline of 3,200 m.

At R2 and R3 there will be pump stations (PS2A and PS3A) that will pressurise the field application systems of tiers 2 and 3 respectively.

**Primary pump stations**

Five pump-stations are proposed and will all be constructed with reinforced concrete below ground and a brick or concrete block superstructure above-ground. All pumps will be under some degree of water pressure to avoid the need for priming. All pump stations will be fully enclosed for safety and security purposes. The pump-houses appear to have been over-designed and costly but this was to ensure safety and security and meet international standards. Damage or loss of pumping and electrical equipment may have serious implications for all the farmers in the scheme, so there are no practical alternatives for pump houses on public land. All pumps will be electric-powered with 3-phase motors. Diesel-engines are proposed to be an alternative power source but these are much more expensive to run and maintain, and more liable to breakdown. This justifies the capital cost of bringing electrical supply to all pump stations.

It is proposed that pump stations supplying reservoirs (PSz, PS3) should be controlled by level sensors in the reservoirs. This could be replaced by manual operation at a lower capital cost but the running cost would be higher (labour and communications) and the risks of over-flow or dry-running would be higher. Even if the pump-stations are constantly manned, it is considered that automatic controls on PSz and PS3 would be justified. The proposed automation of pumps supplying field systems (PS1, PS2, PS3A) is based on pressure sensors in the pipeline, so if the outlets are closed then the pump switches off, and vice versa. Compared to manual operation this is more expensive to install, but is justified on tiers with multiple users (T1 & 2) to avoid human error and pipe bursts. In Tier 3 it is unnecessary.

**Main pump station (PSz)**

The main pump station near the river will be fed by an earthen canal of about 130 m in length from the river itself. The last 10 m section of the
canal will be concrete-lined and protected by a screen. There will be three identical vertical line-shaft pumps (axial-flow), two for normal operation and one stand-by unit. The submersible pump ends will be situated below the minimum water level, driven by 75 kW electric motors mounted 6m above in the upper room which is at ground level. The transformer and generator (if required) will be situated in an adjoining room. The design provides for 2 pumps operating for 20 hrs/day to deliver the peak water requirement for the scheme, with a flow of 150 l/s from each pump, and a Manometric head requirement of 28 m. Powerlines will run along access roads thus no extra land will be required for powerlines.

3.4 Water impoundment and storage elements

Three proposed reservoirs that will serve to balance the water supply to the various tiers are proposed, and will provide a limited amount of storage in the case of breakdown at an upstream pump station (table 3-4). The capacities of the reservoirs have been carefully calculated to balance the different supplies and demands of the pump stations as they have different operating regimes. For example PS1 supplying Tier 1 will only operate 10 hrs/day, whereas PSz will operate up to 20 hrs/day.

Table 3-4  Reservoir capacities, Lusitu

<table>
<thead>
<tr>
<th>Reservoir</th>
<th>Supplies</th>
<th>Capacity m$^3$</th>
<th>Hrs storage at peak usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>All tiers</td>
<td>5,000</td>
<td>6.5</td>
</tr>
<tr>
<td>R2</td>
<td>Tier 2</td>
<td>1,500</td>
<td>13</td>
</tr>
<tr>
<td>R3</td>
<td>Tier 3</td>
<td>3,800</td>
<td>13</td>
</tr>
</tbody>
</table>

The rectangular reservoirs will be excavated from the ground, with the excavated material used to form embankments. They will be lined with a HDPE membrane, backed by geo-textile. An outlet pit will supply downstream pipes and pumps, and a drain. The depth of water will be up to 3m. It is further proposed that reservoir levels will be controlled automatically. All reservoirs will be 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 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. An alternative lining is water-proofed cement but these are liable to cracking and leaks. Concrete reservoirs of the size required would be excessively expensive. The membrane-lined earth reservoir was therefore found to be the best option.
3.5 Electrical infrastructure

In addition to the irrigation infrastructure, the project will include 11 kV overhead power lines to the pump-stations with appropriate transformers, and gravelled access roads to all tiers. It is expected that access to the nearest main road will be improved to all-weather standard.

3.6 Housing and social infrastructure

84 new houses and amenities for the community are planned to be constructed in three resettlement areas. Contingency of an extra 13 houses has been included for forced re-settlement from feeder roads and reservoirs. The area which will be utilized to build the houses is 776 500 square meters (77.50 ha). Details for this infrastructure are elaborated in the RAP. The development of Tier 3 will involve staff housing, offices, a workshop, packing shed and general stores. For Tier 2 some permanent structures such as a chemical store, office, equipment store and a cooperative crop storage facility, primarily for Tier 1 is planned. The 3 irrigation blocks will be fenced to protect the crops from wildlife and livestock, with the riverside boundary being electrified. However, concern was raised as to whether gates will be provided to enable people access the Zambezi River.

3.7 Water delivery and irrigation infrastructure

Pipelines and distribution network

In Tier 1 the main and secondary network will use buried rigid poly vinyl chloride (uPVC) pipes of diameters ranging from 355 down to 75 mm, these will feed into the tertiary distribution network of buried high-density polyethylene (HDPE) 50 mm PN6 pipes, supplying hydrants fitted with ball valves. The Tier 2 and 3 main and secondary network will use buried uPVC PN6 pipes of diameters ranging from 355 down to 110 mm, then feeding into the surface-laid tertiary network of HDPE 75 mm manifold pipes and low-density polyethylene (LDPE) 25 mm lateral pipes.

The main pressurised pipelines (P1 and P3) are specified as PN10 (maximum operating pressure of 10 bar) but the pipes are likely to 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 under 6 bars. The other main and secondary pipelines are PN6 (class 6).

All main and secondary pipes will be permanently buried to protect them from damage imposed by traffic, vandalism, UV light and excessive temperatures. The pipes will be encased with at least 15 cm of excavated material free of stones.

All main and secondary pipelines will be of rigid un-plasticised poly vinyl chloride (uPVC), except for the manifolds immediately after pumps which will be steel due to the need for extra rigidity and strength. The selection of uPVC is justified by the engineers on its “excellent technical
characteristics, such as chemical and mechanical resilience, thermo-endurance and light weight" (Z&A 2013/3). It is also the most commonly used material in irrigation networks in Zambia and it is therefore easy to find replacements and the skills required for installation. Use of modified PVC (mPVC) would be better if similar pipes were readily available for replacements, but they are not.

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, galvanised 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.

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 Existing Components

There are two pumping stations close to the project site. One was installed in the 1970s to supply piped potable water to the newly-resettled community at that time. This is primarily for domestic use but is also used to water livestock and small gardens, and there is considerable demand upon it. In existence also is a pump-station for the 35 ha cooperative scheme (south of the project site), just upstream of the proposed location for the main pump station (PSz). The latter pumps water into a canal system which supplies 1 ha plots by flood irrigation. The pump station is in a fair state of repair but most of the canals are in need of maintenance. Water losses and wastage were observed to be high. Note that the two pump stations belonging to the cooperative scheme are outside the project and as such will not be included in the project. There is no existing irrigation infrastructure at the proposed project site itself.
3.9 Main Project Activities

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

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

- 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).

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

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

  The installation of in-field irrigation systems will be relatively quick as it will involve 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 Lusitu scheme.

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

- 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. The length of powerline will only be known when the project is approved by ZEMA and ZESCO is engaged to carry out feasibility studies for construction of powerlines.

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

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

- Access Roads.

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

- Sensitisation and training.

Given the magnitude, scope and complexity of the proposed scheme, the beneficiary community will be sensitised and trained in order to maximise the benefits.

- 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 have been assessed, quantified and people affected established through a socio-economic survey leading to development of a resettlement action plan.

### 3.10 Equipment and Raw Materials Use

A large tracked excavator will be used for the constructing the three reservoirs, the canal feeding PSz, and the pump-stations. The pipeline routes will be cleared by bulldozer. Trenches for main and secondary pipelines will be dug with a wheeled backhoe digger, while minor trenches for tertiary pipes will be dug by hand. Road-making equipment including bulldozers, graders, loaders, tipper trucks, water bowser and compactors will be required for the new access roads and upgrading of the main access roads. Since it was established that there is no nearby supply of pre-mix concrete, a concrete mixing plant will be acquired for pump-station construction. Equipment and pipes will be transported to project site by large trucks of 28 tons capacity or more.

### 3.11 Chemical Use

#### 3.11.1 Expected Agro-Chemical Usage

**Usage**

Due to the intensive nature of irrigated production, most crops will receive pesticides, but their use will be minimised through the use of Integrated Pest Management (IPM -see annex 1). Of the 3,720 units (kg or lt) expected to be used each year, only 20% 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 10 units (kg or lt) of product per ha.p.a.

**Residues & pollutants**

If the quantities estimated are applied according to the IPM plan, and erosion controlled, there is no harmful residues or pollution from pesticides.
are expected. All the chemicals to be used will have low persistence in the environment. Only in the event of spillage or incorrect application shall pollution be an issue, but it would be much localised.

3.11.2 Expected usage of Fertiliser

Expected usage

All field or vegetable crops on Tiers 1 and 2 are expected to receive some fertiliser, with the possible exception of dry beans. However, dry beans will benefit from basal fertiliser.

Bananas require high rates of fertiliser to achieve high yields. A 45 T/ha crop requires 500 kg/ha nitrogen, 250 kg/ha phosphorus, and 1,250 kg/ha of potassium (Amiran, 2010). Table 3-4 below shows the expected quantity of fertiliser to be applied per year when the scheme is at full scale. The vast majority will be used by Tier 3.

Table 3-5 Expected fertiliser usage at full-scale, Lusitu

<table>
<thead>
<tr>
<th>Tier</th>
<th>Crops</th>
<th>Area Ha</th>
<th>Rate kg per ha</th>
<th>Qty p.a. T</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Basal Top-dress</td>
<td>Basal Top-dress</td>
</tr>
<tr>
<td>Tier 1</td>
<td>Vegetables</td>
<td>150</td>
<td>350 400</td>
<td>53 60</td>
</tr>
<tr>
<td>Tier 1</td>
<td>Maize</td>
<td>80</td>
<td>250 200</td>
<td>20 16</td>
</tr>
<tr>
<td>Tier 1</td>
<td>Beans</td>
<td>15</td>
<td>150 -</td>
<td>2 -</td>
</tr>
<tr>
<td>Tier 2</td>
<td>Vegetables</td>
<td>16</td>
<td>350 400</td>
<td>6 6</td>
</tr>
<tr>
<td>Tier 2</td>
<td>Maize</td>
<td>16</td>
<td>250 200</td>
<td>4 3</td>
</tr>
<tr>
<td>Tier 2</td>
<td>Bananas</td>
<td>19</td>
<td>200 3,000</td>
<td>4 57</td>
</tr>
<tr>
<td>Tier 3</td>
<td>Bananas</td>
<td>92</td>
<td>200 4,000</td>
<td>18 367</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>388</td>
<td></td>
<td>106 510</td>
</tr>
</tbody>
</table>

Residues and pollutants

Leaching of nitrogen from the irrigated areas into groundwater and the Zambezi River is expected in light soils of Lusitu. The risk of phosphorus pollution will be lower as it will be relatively immobile in the soil and would only be lost through soil erosion. Potassium, although applied in large quantities to bananas and vegetables, is not a major risk because if it is leached from the topsoil it tends to be bound up by clay particles in the subsoil and can still be extracted plant roots.

3.12 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. 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 Alternatives which is the current state of affairs which is associated with negative economic and social impacts due to none utilisation of the irrigation potential that exists in Lusitu. Consequently there is no meaningful economic activity in the area and as a result, the well-being of most communities remains below poverty level datum line. In view of the above, a ‘NO’ Project Option is not the best option since choosing this option would entail continued diminishing income for the communities. Apart from limiting the land under irrigation, choosing the without project option would mean limiting Government’s source of revenue for effective management of the environment itself. This option was therefore not preferred.

4.1.2 With Project Alternatives

Irrigated farming involves heavy capital investment and many times beyond affordability of many household level farmers as well as small scale farmers. Small scale farmers in Lusitu lack necessary technical know-how, inputs, equipment and irrigation infrastructure to necessitate sustainable agriculture. As a result, Lusitu farmers most often attain crop yields below optimum. In view of these challenges, Government has sourced funds to undertake an irrigation scheme project at three selected sites across the country, of which Lusitu 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 out of the 58% of land suited for arable use, only 14% is currently being utilised and less than 5% is under irrigation in Zambia. This means that 5% of arable land is under irrigation at most during the eight months of dry season. Therefore, Lusitu scheme if implemented will contribute to an increase in land under irrigation and
wealth creation among targeted beneficiaries. Therefore this option is preferred.

The scheme is expected to lead to generation of sustainable income for beneficiaries (PPP participants), 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-economics groups.

In conclusion, choosing this option would result in several beneficiaries i.e. direct and indirect beneficiaries. The overall project 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

**Construct the IDSP irrigation scheme at Lusitu site:**

Lusitu project site 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:**

Another comparable site that meets standard criteria for construction of an irrigation scheme and associated infrastructure may not be found. 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 Zambezi River for purposes of irrigation. Due to fluctuations in river flow and strict crop watering schedules, this type of harnessing is normally not ideal. However, for the Zambezi River this is not the case because even at minimum flow, hydrological analysis showed that there is more than enough water to sustain the scheme. Choosing this alternative would therefore mean irrigation will be possible during the dry season when flow in the river is at its minimum. Therefore this alternative was preferred.
4.3.2 Abstraction from groundwater

Abstraction of groundwater would be another alternative but still requires a reservoir for storage. Lusitu 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 100 ha.

4.3.3 Rainwater harvesting

Rainwater water harvesting is environmentally sound and should be promoted were appropriate. However, it depends on rainfall intensity and availability of infrastructure to harvest the rain water and store it in reservoirs. However, 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.

4.4 Technological Alternatives

Irrigation Systems

Centre pivot irrigation system has 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 utilisation 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 1 ha to 5 ha of land.

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.

Irrigation Field Application System

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

Hose-furrow (proposed for Tier 1)

Hose-furrow system involves hand-moved 30m-long plastic garden hoses with 32 mm nominal diameter connected to a low-pressure main. The hoses are used to supply 25 m-long furrows between crop rows or beds at 1.0 m spacing, moved from furrow to furrow as required (see Figure 4-1). Each 0.5 ha 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 5.3 m³/hr at about 1 bar.

The irrigation schedule will be designed to apply 32.4 mm net every 5 days (6.4 mm net/day). The peak crop water requirement would be 9.9 mm/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 6 mm/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.
Figure 4-1  Hose furrow system for Tier 1

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 pressurised 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>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flood irrigation (from hydrants or field channels)</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>Hose-basin</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>Sprinklers (hose move)</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>Sprinklers (solid-set)</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>Drip</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>Micro-jet</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>Moving rain-gun (e.g., Rotrix)</td>
<td>Very low labour requirement;</td>
<td>Unsuit to small plots of under 1ha;</td>
</tr>
<tr>
<td>Centre-pivot</td>
<td>Very low labour requirement</td>
<td>Unsuit 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.

**Hose-move sprinkler**

The layout will be divided into 2.7 ha plots (180 x 150 m) and standard sprinklers at a spacing of 15 x 15 m and a pressure of 3 bar. Each 2.7 ha plot will have two surface-laid 75mm HDPE laterals, which will simultaneously feed 12 sprinklers each, on 33 m draglines of 25 mm PE hose. Each sprinkler will have 5 positions and will be moved manually (see Figure 4-2). 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).
The system has been designed to apply 8.8 mm gross/day, which will give 6.6 mm 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 9.9 mm/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 6.6 mm/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.

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 a 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 lt/sec at 2 bar pressure, operating for 16 hrs/day, which will give 8.2mm gross/day or 7.0 mm net/day. If planted to wheat, the peak demand will be 7.3 mm net/day, and 3.5 mm net/day if planted to early maize in October. Therefore, with a small increase in operating hours (to 17 hrs), 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>

Centre Pivots (proposed for Tier 3)

Centre pivot are the most popular form of large-scale irrigation in Zambia today. 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 52 ha 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 52 ha 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 fertilisers and some soil-acting chemicals and biological treatments to be easily applied through the irrigation water with a tank and injection system at the centre.
The designed irrigation duty for Tier 3 pivots is 6.5 mm net/day (8mm gross) on a 20 hr pumping day, which is only just adequate for wheat where the peak requirement will be 7.3 mm net/day (Aug), which requires pumping for 23 hrs/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 utilisation of land</td>
<td>Requires canal or flexible pipe for water supply, limited regional experience/support</td>
</tr>
</tbody>
</table>

4.5 Materials Options

The hose-move sprinkler system uses surface-laid HDPE laterals and PE dragline hoses. Sprinkler and tripod construction is not specified, but the more durable brass sprinklers on galvanised 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 36 m is standard. 25 mm PE pipes are not generally used for hose-move systems in Southern Africa.

Alternative pipeline materials

Alternative pipeline materials evaluated included.

- mPVC: Its 10-15% cheaper, and lighter than uPVC and tougher due to the high compression (18MPa v 12.5MPa) 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 630 mm), 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 630 mm), more difficult to install and repair than uPVC, and more expensive.

High density polyethylene (HDPE) will be used in the distribution (or tertiary) network which has been selected because it is easier to install and has less joints than uPVC. HDPE comes in 50 m or 100 m rolls, while uPVC comes in 6 m 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, galvanised 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 IDSP concept involves a commercial operator of the irrigation system at all sites. In the case of Lusitu the operator is expected to be the Tier 3 farmer, as the scheme is too small to justify an independent operator. The purpose of including a commercial operator is to ensure 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 subsidised by the project in the early years to ensure affordability (CEPA, 2013).
5 POLICY, LEGAL AND INSTITUTIONAL FRAMEWORKS

5.1 General Legal Framework

Socio-economic development should be undertaken in such a manner so as to avoid environmental degradation in accordance with legislative requirements. 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

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.
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 Lusitu 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.

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 Lusitu site will affect land under Traditional 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.

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 Zambezi River and that requires a water right governed by this Act.

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

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.

The Ministry of Agriculture and Livestock will be required to abide by the provisions of this Act.
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.

The 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.

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 5 ha in extent under tier 2.

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 project will be implemented at Lusitu site falling under Chirundu District.

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

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 Zambezi River where abstraction will be done.

**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.

**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.

**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 traditional land.

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

**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.

**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.

**The Forest Act, CAP 199 of 1999**

This act provides for, among others, the participation of local communities, traditional institutions, non-governmental organisations 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.


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.

### 5.3 Natural Resources Policies

**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.

**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.

**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 0.5 ha will be exempted from water permits by the new water legislation.

**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.

**Biodiversity Protocols**

The Convention on Biological Diversity (CBD), the associated Cartagena Protocol on biopiracy, 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.

**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.
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 in situ 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”

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 decentralisation 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 SCAFE, 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.
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 favourable environment for the proliferation of certain invasive plant species.


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.

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 utilisation 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.

*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 cognisance should be taken of the context of the Convention.

### 5.5 Relevant International Finance Corporation Policy Guidelines

**Relevant World Bank Policy 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 environmental, social and disclosure policies. By nature of the proposed IDSP project, eight (8) 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 Safeguard policies:

- Environmental Assessment;
- Natural Habitats;
- Forest;
- International waterways;
- Pest Management;
- Involuntary Resettlement, Cultural property and Safety of Dams.

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 minimising 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:
- Policy Guidelines;
- Pollution Prevention and Abatement Handbook.

The World Bank Group’s Pollution Prevention and Abatement Handbook 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

**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.

**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, marshlands and headwaters and take into account climate change and the challenges posed by climate change, plan for and ensure the sustainable and rational utilisation, 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 Rainfall

The southern part of Zambia receives less annual rainfall in comparison to the central and northern parts of the country. Lusitu and surrounding areas lie in agro-ecological region 1 where annual rainfall is less than 800 mm. Due to lack of rainfall data in the Lusitu area, a nearby meteorological station at Chipepo was used. According to the rainfall records at Chipepo, southwest of Lusitu, annual rainfall can be as low as 350mm in drier years and can also be as high 1200 mm (figure 6-1). The average rainfall in the past 20 years has been 845 mm. The annual rainfall pattern is however consistent with the regional average of 800 mm or less.

Figure 6-1  Average annual rainfall at Chipepo (1994 – 2011), MET Department
6.1.2 Climate and agricultural irrigation potential

The Lusitu site falls within Agro-Ecological Zone I which is characterised by rainfall of less than 800 mm. The mean annual rainfall recorded at Chirundu station (12 km north) is 678 mm, and that at Kariba station (47 km south) is 767 mm, which is the most continuous data representative of the project site. The chart in figure 6-1 below displays average data from Kariba, and illustrates that the monthly evapo-transpiration (ETo) exceeds rainfall in all but three months (Dec-Feb) of the year, and exceeds the effective rainfall in these three months. This explains the low yields achieved in the area from rain-fed cropping, and illustrates the need for irrigation to achieve economic yields in all but the most drought-tolerant crops.

![Figure 6-2 Climate for Kariba](image)

The mean monthly minimum temperatures recorded at Chirundu station range from 10.3°C in July to 23.2°C in October, and maximum ranges from 26.0°C in July to 36.6°C in October. It is a suitable area for frost-sensitive (sub) tropical crops like bananas, but the high evapo-transpiration levels (average 4.76 mm/day, 7.53 mm/day in October) mean that crop water requirements for crops are particularly high.

6.1.3 Temperature

Temperature ranges in Lusitu are typical of those found in the valleys. The minimum temperature in this region is range from 14°C to 25°C. Maximum temperature range is between 30°C and 37°C. Figure 6-3 indicates that’s minimum temperature occur in June but can be as high as 30°C in some years. This explains why the area is usually hot most part of the year. See figure 6-3.
6.2 Hydrogeology and Geology

The project area lies entirely over the sedimentary rock formation which belongs to the Upper Karoo. According to the Geological map, the dominant rocks covering the Lusitu area are sandstones and inter-bedded mudstones and red sandstones. Most of the sandstones are calcareous and some contain pyritic concretions (IDSP, 2010)

Lusitu area is covered by an extensive aquifer which extends to the neighbouring parts of the project area (figure 6-4). This aquifer has a relatively low ground water potential as evidenced by the low number of groundwater sources such as boreholes and wells. Other parts of the area have unproductive aquifers. These are portions on the northern and western parts of Lusitu area as indicated in figure 6-2. Figure 6-4 also shows the typical landscape of the area. 

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4 See Figure 1-6: Hydrogeological map of Lusitu area (Source: GRESP, 2007) in Annex 1: Maps folder.
6.3 Hydrology

The flows on the Zambezi River downstream of the Kariba Dam are mainly outflows from the dam and are regulated. The flows therefore represent a combination of turbine and spillway discharge. There are also contributions from ungauged tributaries such as Mbendele, Mutulanganga and those from the Zimbabwean side.

Historical discharge records at Chirundu bridge indicate peak flows ranging from 5,000 m$^3$/s to 7,000 m$^3$/s while minimum flow are as low as 450 m$^3$/s (table 6-1). This is consistent with historical outflows from the dam as summarised by the flow regime statistics in table 6-1.

Table 6-1 Flow regime of the Zambezi between Kariba Dam and the Kafue River confluence

<table>
<thead>
<tr>
<th>Station</th>
<th>Q$_{avg}$</th>
<th>Q$_d$</th>
<th>Q$_{max}$</th>
<th>Q$_{95}$</th>
<th>Q$_{185}$</th>
<th>Q$_{275}$</th>
<th>Q$_{355}$</th>
<th>Q$_{min}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kariba Dam</td>
<td>1299</td>
<td>756</td>
<td>6668</td>
<td>1083</td>
<td>904</td>
<td>729</td>
<td>482</td>
<td>455</td>
</tr>
</tbody>
</table>

In comparison to the historical flow regime, the recent hydrographs (1993 to 2012), shows that peak flows ranged from 4200 m$^3$/s to about 7,000 m$^3$/s (table 6-5 & 6-6). The comparison indicates the flows on the Zambezi River between Kariba Dam and Chirundu have also been consistent over the years. In both scenarios (historical and recent), the extreme peak flows occur when the spillway gates are opened to regulate the water level in the reservoir.
In terms of water availability, the Zambezi River consistently provides water for different users along its length. Based on statistical analysis of the daily flows, the Flow Duration Curve (FDC) in Figure 6-7 indicates that 95% of the time, the river carries 490 m$^3$/s (42,336,000 m$^3$/day) and 50% of the time the flow is above 1000 m$^3$/s (86,400,000 m$^3$/day). This is an indication that with just the minimum flow, the river is able to meet the required crop water requirement of 5500 m$^3$/Ha for 262 Ha over a period of 150 days. Figure 6.8 shows water availability in the Zambezi River and the respective demands. However the flow exceeds the 490 m$^3$/s due to other contributing catchments downstream of the Kariba Dam.
Figure 6-7  Flow Duration Curve for the Zambezi River flow between Kariba Dam & Chirundu

Also see Figure 1-4: Contributing Catchments to the Zambezi River between Kariba Dam & Chirundu in Annex 1: Maps folder.
Figure 6-8  Schematic and estimated water demand on the Zambezi River in Lusitu area
6.4 Water Quality

Due to lack of boreholes in the area, groundwater sampling and testing of groundwater was not done. However, surface water onsite sampling and testing was done at three points on the Zambezi River. The results are shown in annex 4.

Irrigation Water Quality

Irrigation water quality was analysed with respect to 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.

Salinity hazard

According to the guidelines (Table 6-2) for assessing salinity hazard modified from Bauder et al (2008), generally none of the samples present any salinity hazard problem.

Table 6-2 General guidelines for assessment of salinity hazard of irrigation water

<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>

Electrical Conductivity

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 6-3 shows the guidelines for assessing sodium hazard based on SAR and EC.

All the samples on the Zambezi River have SAR below 3. Irrigation water with low salt content and high SAR can contribute to poor soil permeability. However, the relatively low SAR in all the samples and bicarbonate values in most of the samples may reduce the risk of sodium hazard overall. In order to remedy the sodium hazard, such water requires to have its pH and bicarbonate reduced using, for instance, sulphuric acid or adding soluble calcium.

Table 6-3 Guidelines for assessing sodium hazard

<table>
<thead>
<tr>
<th>Limitation (EC, µS/cm)</th>
<th>None</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>When SAR = 0-3 and EC</td>
<td>&gt;700</td>
<td>200 - 700</td>
<td>&lt;200</td>
</tr>
<tr>
<td>When SAR = 3-6 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)
Heavy metals and other Parameters

The heavy metals results were below detection limit for all the heavy metals analysed, that is, aluminium (Al), cadmium (Cd), Copper (Cu), lead (Pb) and zinc (Zn). The results for other parameters (sodium, calcium, magnesium, bi-carbonate, chloride and sulphate) show that they were within the recommended limits for drinking water.

6.5 Topography and Soil

The area is flat or gently undulating with elevations ranging from 380 to 410 masl. There are steep slopes dropping down to the alluvial shelf or flood plain near the Zambezi River, which are heavily eroded in places. The Tier 1 and 2 areas are bordered by such slopes on their eastern boundaries, but are otherwise relatively flat. Tier 3 has south-facing slopes of 1-3%.

Soil suitability

The soils at the project site were surveyed by Dr Hungwe in Oct/Nov 2011 (Hungwe 2012). The results showed a range of alluvial soils of increasing age as one moves west from the Zambezi River. Of the 5,000 ha surveyed, only 40% was classified as suitable for irrigation. Of the unsuitable soils (44%), most of it is very hard sodic soil, with the rest being younger, highly erodible soils (see Figure 6-9. below). Since the proposed Lusitu irrigation scheme is restricted to Sitinkwe community, it entails that most of the suitable soil has been excluded from the project, and it is the limited amount of suitable soil which has restricted the project to only 270 ha.

Since the proposed irrigation blocks fully occupy the available areas of suitable soil, it is expected that there will be areas of marginal soils included within the boundaries. This is particularly so for the Tier 3 block which is on a narrow band of suitable soil hemmed in by large blocks of hard, sodic soil. The soil type 2 on which Tier 1 and 2 are located is deep (>150 cm) and ranges from sandy loams to loamy sands which are non-sodic. The soil type 1 which occupies Tier 3 has slightly more clay and is classified as sandy clay loam to sandy loams. They are non-sodic with a depth of over 120 cm.

Also see Figure 1-7: Map of soil suitability for irrigation, Lusitu (Z&A 2013/3) in Annex 1: Maps folder.

Nutrient Cycling

The levels of nitrogen in the both soil types are low, but phosphate is moderate to high and potassium is variable. Organic matter levels are low, especially in soil type 1. Considering their high pH, the cation exchange capacity (CEC) of the soils, which is a measure of fertility, is low to moderate. Originally, being alluvial deposits, these soils would have had high fertility, but many years of intensive cultivation with minimal fertiliser, has led to their current depleted condition.

The agricultural practices that will be employed should make full use of the natural sources of plant nutrients so as to reduce dependence on artificial
fertilisers. However, production systems will be very intensive in order to make an economic return on investment and labour, so it is expected that all crops planted will receive some artificial fertiliser. Practical methods that will be used to reduce the quantity of artificial fertiliser 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;
- Mulching – creates an environment conducive to soil fauna a flora which are active in cycling nutrients, and introduces organic matter.
- Use of leguminous crops such as beans and groundnuts;
- Use of leguminous cover crops in bananas as long as they are low and don't climb on to the bananas;
- 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 fertiliser application is tailored to crop requirements – this measure is only practical for Tier 3 and 2, unless Tier 1 gets external support.

Soil Deterioration Risks

Soils can be affected both chemically and physically. The risks of chemical deterioration are considered minimal as the quality of the irrigation water from the Zambezi River is considered to be good, and the proposed irrigation systems will be controlled to avoid salinity levels from increasing. Considering that there are sodic soils in the area and sub-soils in the irrigated areas may have high levels of sodium. These will be leached out through correct irrigation practices that lead to a net downward movement of water.

The hose-furrow system may potentially lead to salination of the top-soil on ridges or beds between the furrows, as the irrigation water rises from the root zone to the surface. The risks are not perceived to be high due to the low levels of sodium in the selected soils for Tier 1 (ESP <3%, A Hungwe, 2012).

The risks of physical damage are considered to be more serious, mainly on Tier 1 where there will be frequent cultivation and the possibility of erosion or capping caused by heavy application of water with hosepipes. The hosepipes discharge 1.5 lt/sec, which equates to a velocity of 3 m/sec. In the relatively light Lusitu soils, this could wash away beds or ridges in if not carefully directed. Tillage practices may damage soils by over-cultivating (pulverising) the top-soil, and creating a plough-pan through continued shallow cultivation.

6.6 Water Supply, Demand and Allocation

The source of domestic water for Lusitu area is mainly the Zambezi River. Water is abstracted by direct pumping at the Lusitu Intake Pump Station (figure 6-12). The estimated daily abstraction at this station is 158 m³/hour (3,792 m³/day or 3,792,000 litres/day) and it is done on a 24 hour basis. The water is mainly supplied to the riparian residents of the Zambezi River
in Lusitu, Ngombe Illede area and is also extended to the Lusitu township which is about 10 kilometres away from the pump station.

Figure 6-9  Water intake point and reservoir at Lusitu Pump House

Apart from domestic water, small scale irrigation farming is another water use in the area. These are mainly downstream of the Lusitu pump house whose abstraction is also done on a 24 hours basis. The quantity of water abstracted by the irrigation schemes is not well documented. However, considering the pumping capacity of pumps (30 horsepower), the estimated daily abstraction is 0.056 m$^3$/s (4,844 m$^3$/day).

According to the Water Act of 1948, which has since been repealed and replaced by the Water Resources Management Act of 2011, water allocation on the trans boundary water courses such as the Zambezi River was not provided for. Water abstraction records are thus not available at the newly created Water Resources Management Authority (formerly Water Board). The new Water Act now incorporates issuance of water permits for all water courses (inland and trans boundary). The proposed irrigation project will therefore be required to apply for a Water Permit as required by the current water law.
6.7 General description of the vegetation

6.7.1 Vegetation Cover

The land cover shows a heavily degraded character due to recent human usage (see figure 6-13 below). In ancient times, with a much lower occupation density, woodland must have been quite extensive. This is confirmed by published studies of the vegetation cover between 1954 and 1992. During this period bare soils increased by 5%, natural vegetation decreased by 60%, settlement areas increased by 9%, and agricultural areas increased by 46% (Petit and Lambin, 2001).

See Figure 1-8: Lusitu project area vegetation cover in 1992. Deep yellow: herbaceous savannah; Green: woodland savannah; White, light blue and red: bare land (Source: Scudder, 2005) in Annex 1: Maps Folder.

6.7.2 Vegetation Types

According to Trupnel (Vegetation classification of Zambia, 1969), Lusitu vegetation falls under Mopane vegetation, largely with Colophospermae mopane as the dominant tree species. However, field surveys conducted in the area indicated that the area has mixed vegetation that included; riparian, open woodland with mixed tree species. The amorphous arrangement of settlements with agriculture practices coupled with poor rainfall patterns (average annual rainfall range of 625 mm – 677 mm), has led to fragmented and stunted vegetation in the area to such an extent that most plant species are at shrub level. See the figure 1-9: Vegetation of the Project Area in Annex 1: Maps folder and the figure 6-14 below.

6.7.3 Vegetation Classification

RIPARIAN VEGETATION

Riparian vegetation was observed close to the banks of Zambezi River. The riparian band ranged between 3 m to 12 m with tree species that included; Diospyros sp, Tamarindus indica, Acacia nigrescens, Ficus niloticus, Lonchocarpasa capasa, Syzygium cordatum, Phoenix reclinata (Wild date palm), Hyphaene petersiana and some scattered Borassus aethiopum. The Raphia species of the palm family was found to be absent in the area.
GRASS SPECIES IN THE RIPARIAN AREAS

The river banks of the Zambezi River were found to be mostly lined with papyrus grass species with varying heights and densities depending on the establishment of a particular community. In certain instances continuous patches of highly hydrophilic grass species like *Leptochloa fusca* (swamp grass, *Echinochloa pyramidalis* and *Echinochloa colona* were observed along the rivers banks. Also commonly observed was *Arundinella nepalensis*. Most areas of the riparian vegetation are currently under cultivated due to rich soils and availability of water.

OPEN WOODLAND (SCRUB LAND)

The open woodland in Lusitu area was observed to have scattered woody species arranged in two layers: old big scattered trees species mostly ranging from 4 – 8 m high and the shrubs constituting a different combination of plant species. Old tree species observed included *Adansonia digitata*, *Accacia nigescens*, *Lonchocarpus capassa*, *Acacia tortilis*, *Kigelia African*, *Kirkia accuminata*, *Sclerocarya caffra*. 
6.7.4 Eco-System Sensitivity; Habitats and Species of Special Concern

Sensitive Habitats

Riparian Vegetation

In Lusitu area the riparian vegetation is highly modified. Unlike on the Zimbabwean side that constitutes a conservation area where the riparian zone is more intact, in the Lusitu area this is not the case.

Riparian vegetation has many hydrological functions, provides food and refuge to animal life. Riparian ecosystems are further noted for having high levels of plant diversity (D M Richardson et al., 2007). With the influx of people expected as a result of the proposed project, riparian vegetation is expected not to be under threat as the project activities will not extend into riparian zone.

6.7.5 Species of Special Concern

Lusitu area has *Adansonia digitata* as a species of special concern. *Adansonia digitata* has become, in the recent time an economically important tree species for its fruit which is rich in vitamin C. Though no threats are known to the tree yet, except for elephants that depend on its barks as food. Thus, measures should be put in place to conserve this plant species.

6.7.6 Ecologically Important Areas

There are two game management areas close to Lusitu project area about a kilometer and half away; the Zambezi Hunting area in Zimbabwe (just
across the Zambezi River) and the Chiawa Game Management area on the Zambian side. Both areas are rich in wildlife species; elephant, warthog, buffalo, and hippopotamus are common. The two areas have been designated as hunting areas. The pressure from hunting created on wildlife causes animals to go in open areas were where settlements for communities are found thus leading to frequent animal-human conflict. Besides, animals also follow cultivated crops as food.

See Figure 1-10: Protected Areas around the Project Area in Annex 1: Maps folder.

The other protected area observed within the vicinity was Mutulanganga national forest which is said to be a sanctuary for elephants whenever threatened by hunting in Chiawa and the Zimbabwean side.

6.8 Fauna

Literature shows that Lusitu area was once rich in fauna especially mammalian species. However, most of the mammalian life has been disturbed largely due to anthropogenic factors such as poaching, habitat fragmentation, unplanned fires, illegal hydro power activities, and deforestation.

Ansell (Mammals of Zambia, 1978) documented small and large mammal species that existed in the, Chirundu the project area as well as nearby areas such as Siavonga, Sinazongwe. There were more than 39 mammal species reported by Ansell in the late 1970’s, with the more significant species including Sable Antelope, African Wild Dog, Lion, Waterbuck, Common Reedbuck, and Impala.

Field surveys showed that to the contrary, 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.

Hunting in the area is controlled by the Zambia Wildlife Authority (ZAWA) even though its capacity to monitor and control use of wildlife resources has been limited. This has resulted in illegal hunting of most large mammal species going on unabated.

Little is known of the reptiles, amphibians and let alone the inveterbrate life in the area. So far 21 reptile, and 24 amphian (mostly frogs and toads) species have been identified and documented in the subject area of study.

According to documented evidence there is rich bird life in the project area, especially water-birds. Much of the vegetation required to support terrestrial birds has not been affected by human activities. The field study was meant to confirm the existence of these documented species and identify the possible threats to their survival in view of the envisaged agriculture development.

Terrestrial Fauna in the Lusitu Area

_Mammals_

Historically Lusitu 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: Eland, hartebeest, kudu, lion, sable antelope, waterbuck, and wild dog. All these species are said to be locally extinct in the area. 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. The latter two are non-selective. Elephants and buffaloes are common in the area because of the game reserve across the Zambezi in Zimbabwe.

Figure 6-12  Photo Showing Dung as Evidence of Elephants

Field surveys revealed that not all large mammals have gone into extinction in the project area. A number of large mammal species still exist in the Lusitu area; although illegal hunting continues to be the major threat to their survival and existence. Human wildlife conflict is another factor that has raised the intolerance of people towards wild animals. The following animals exist in the area:
<table>
<thead>
<tr>
<th>No.</th>
<th>Species</th>
<th>Scientific Name</th>
<th>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>Ant Bear sp*</td>
<td>Orycteropus afer</td>
<td>Rare</td>
<td>Least Concern</td>
</tr>
<tr>
<td>3</td>
<td>Baboon chacma*</td>
<td>Papio ursinus jubilaeus</td>
<td>Abundant</td>
<td>Least Concern</td>
</tr>
<tr>
<td>4</td>
<td>Bush baby*</td>
<td>Galago crassicaudatus</td>
<td>Abundant</td>
<td>Least Concern</td>
</tr>
<tr>
<td>5</td>
<td>Bush Squirrel*</td>
<td>Paraxerus cepapi</td>
<td>Abundant</td>
<td>Least Concern</td>
</tr>
<tr>
<td>6</td>
<td>Bushbuck*</td>
<td>Tragelaphus scriptus</td>
<td>Rare; locally threatened</td>
<td>Least Concern</td>
</tr>
<tr>
<td>7</td>
<td>Bushpig*</td>
<td>Potamochoerus porcus</td>
<td>Rare</td>
<td>Least Concern</td>
</tr>
<tr>
<td>8</td>
<td>Duikers Common*</td>
<td>Sylvicapra grimmia</td>
<td>Rare</td>
<td>Least Concern</td>
</tr>
<tr>
<td>9</td>
<td>Elephant</td>
<td>Loxodonta Africana</td>
<td>Common</td>
<td>endangered</td>
</tr>
<tr>
<td>11</td>
<td>Leopard*</td>
<td>Panthera pardus</td>
<td>Rare</td>
<td>Least Concern</td>
</tr>
<tr>
<td>12</td>
<td>Monkey vervet*</td>
<td>Cercopithecus pygerythus</td>
<td>Common</td>
<td>Least Concern</td>
</tr>
<tr>
<td>13</td>
<td>Porcupine sp*</td>
<td>Hystrix afercaustralis</td>
<td>Common</td>
<td>Least concern</td>
</tr>
<tr>
<td>14</td>
<td>Pangolin*</td>
<td>Manis temminckii</td>
<td>Common</td>
<td>Least concern</td>
</tr>
<tr>
<td>15</td>
<td>Spring hares</td>
<td>Pedetes capensis</td>
<td>Common</td>
<td>Least Concern</td>
</tr>
<tr>
<td>16</td>
<td>Warthog*</td>
<td>Phacochoerus aethiopicus</td>
<td>Rare</td>
<td>Least Concern</td>
</tr>
</tbody>
</table>

The animals mentioned above were sighted or at least the spoor was observed. Animals which were physically seen included, spring hare, common Duiker, bush baby, vervet Monkeys, chacma Baboons, and the african civet. The spring hare, Bush Baby and the african civet were actually seen during a night drive.

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 to improve quality of life. 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 illegal hunting by local people principally for game meat.
6.8.1 Birdlife in Lusitu area

A total of 378 birds have been recorded in the area. The greatest concentrations of birds are found in the riverine vegetation. Bird species of the valley of local importance included; the sombre bulbul (Andropadus importunus), red-capped robin (Cossypha natalensis egregior), the barred long-tailed cuckoo (Cercococcyx montanus), the dark-backed weaver (Ploceus bicolor) and the mottled spinetail (Telecanthura usscheri).

Table 6-5  Birds observed during the survey

<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>Anhinga rufa</td>
<td>Least Concern</td>
</tr>
<tr>
<td>2</td>
<td>African fish Eagle</td>
<td>Haliaeetus vocifer</td>
<td>Least Concern</td>
</tr>
<tr>
<td>3</td>
<td>African Pied Wagtail</td>
<td>Motacilla arguimp</td>
<td>abundant</td>
</tr>
<tr>
<td>4</td>
<td>Bateleur</td>
<td>Terathopius ecaudatus</td>
<td>Least Concern</td>
</tr>
<tr>
<td>5</td>
<td>Blue Waxbill</td>
<td>Uraeginthus angolensis</td>
<td>Common</td>
</tr>
<tr>
<td>6</td>
<td>Common Bulbul</td>
<td>pycnonotus barbatus</td>
<td>Common</td>
</tr>
<tr>
<td>7</td>
<td>Crowned Hornbill</td>
<td>Tockus alboterminatus</td>
<td>Common</td>
</tr>
<tr>
<td>8</td>
<td>Emerald-spotted-wood Dove</td>
<td>Turtur chalcospilos</td>
<td>Abundant</td>
</tr>
<tr>
<td>9</td>
<td>Fork-tailed Drongo</td>
<td>Dicrurus adsimilis</td>
<td>Common</td>
</tr>
<tr>
<td>10</td>
<td>Greater Honeyguide</td>
<td>Indicator</td>
<td>Abundant</td>
</tr>
<tr>
<td>11</td>
<td>Grey Lourie</td>
<td>corthaixoides concolor</td>
<td>abundant</td>
</tr>
<tr>
<td>12</td>
<td>Helmeted Guineafowl</td>
<td>Numida meleagris</td>
<td>Least Concern</td>
</tr>
<tr>
<td>13</td>
<td>Lilac-breasted Roller</td>
<td>Coracias caudata</td>
<td>Abundant</td>
</tr>
<tr>
<td>14</td>
<td>Little Bee-eater</td>
<td>Merops pusillus</td>
<td>Abundant</td>
</tr>
<tr>
<td>15</td>
<td>Paradise Flycatcher</td>
<td>Terpsiphone viridis</td>
<td>Common</td>
</tr>
<tr>
<td>16</td>
<td>Pied Crow</td>
<td>Corvis albus</td>
<td>Common</td>
</tr>
<tr>
<td>17</td>
<td>Red-eyed dove</td>
<td>Streptopelia semitorquata</td>
<td>Abundant</td>
</tr>
<tr>
<td>18</td>
<td>Reed Cormant</td>
<td>Phalacrocorax carbo</td>
<td>Least Concern</td>
</tr>
<tr>
<td>19</td>
<td>Rufousbellied Tit</td>
<td>Parus rufiventris</td>
<td>Uncommon</td>
</tr>
<tr>
<td>20</td>
<td>Tawny-flanked Prinia</td>
<td>Prinia subflava</td>
<td>Common</td>
</tr>
<tr>
<td>21</td>
<td>Tropical Boubou</td>
<td>Laniarius aethiopicus</td>
<td>Common</td>
</tr>
<tr>
<td>22</td>
<td>White stork</td>
<td>Ciconia</td>
<td>Paleartic migrant</td>
</tr>
</tbody>
</table>

6.8.2 Reptiles and amphibians in Lusitu area

The area is habitat to snakes, lizards, Skinks, Geckos, Agamas, Chameleons, Tortoises and frogs of different species; common in different seasons and habitats. Crocodiles and hippos are abundant in the area and considering the size ratio the populations are on the increase. There is however, more concentration of crocodiles and hippos on the Zimbabwean bank than on the Zambian due to the presences of a game reserve on the other side.
The abundance of crocodiles and hippos on the Zambezi and their continued increase in number means potentially increased human-animal conflict in the area as the human population equally grows with immigration and natural growth. The Nile crocodile is a commercially important species and eggs and adults have been removed from the area since the 1960s (Fergusson, 2009). As the Zambezi River is a shared resource exploitation levels differ in Zimbabwe and Zambia, as does the dataset accompanying this exploitation. Several surveys have been carried out, both by Zambian and Zimbabwean researchers.

Tracks of snakes were observed across paths and snakes common to the area were cited during interviews with local people. During the survey, Nile Monitor, savannah Monitor, House Gecko, Striped Skink, and the Common Lizard, were seen 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 interviews as common snakes in Lusitu area. Two types of tortoises were reported in the area: Leopards tortoise (Geochelone pardalis babcocki) and the Bell hinged (Kiniys belliana spekii).

Invertebrates

All animals without backbones are invertebrates. They may be small, but are often numerous and play major roles in ecosystem processes. A significant reduction in numbers or extinction means a change in ecosystem processes. Invertebrates like so many other organisms, are becoming reduced in abundance and extinct primarily through loss of habitat. The development and extension of agricultural in the area will certainly change forest habitat and change the composition of invertebrates.

6.8.3 Fish in Lusitu area

The Zambezi River and its tributaries is host to a number of fish species. The most important of these for the sport fishing industry include the Tiger Fish (Hydrocynus vittatus) and the breams belonging to the family Cichlidae. Concern has been expressed about the health of the fish stock.
in the Zambezi and, although there is no empirical evidence to back it up, many feel that stocks are declining. In addition, *Tilapia niloticus*, which has escaped from fish breeding initiatives upstream, has apparently become well established in the Zambezi River.

### 6.9 Land Use and Settlement Patterns

Lusitu is on customary land under the jurisdiction of Chief Chipepo in Southern Province. About 270 ha of irrigation will be constructed within Sitinkwe village area of about 4,000 ha with a mix of irrigating commercial, emergent and smallholder farmers. Sitinkwe village was established in the 1950s to resettle the Gwembe Tonga during the flooding of the Kariba Dam.

Figure 6.14 shows the settlement and land use patterns of the Lusitu area. Red dots represent the geographical locations of households. The settlements of Ng’ombe Illede and Gwembe are in the south east; Gwembe is the residence of Chief Chipepo who *inter alia* has overall responsibility for the administration of customary land use in the area. Settlement in the east adjacent to the Zambezi River includes the villages of Sitinkwe, Siajongoto and Chisamu. The history and administration of the Lusitu study area is unusually complex - about 3,000 ha were made available in 1958 for the involuntary re-settlement of subjects of Chief Chipepo who were displaced by the creation of Lake Kariba.

![Figure 6-14 Land Use and Settlement](image)

Land use is dominantly rain fed cereals (maize, sorghum and millet) grown on rotation on customary land. In these areas field boundaries are visible on the satellite imagery. Land not in cultivation or under fallow usually has sodicity in the soil profile. On the satellite imagery it has a high albedo where it is cleared and grazed, or shows as dense bush land vegetation.
cover. Typically it occurs on the foot slopes of the upper Zambezi terraces. This land may also be used for house sites or grazing.

Close to settlements and water sources are small areas of minor irrigation and gardens. There is an irrigated banana scheme within the Lusitu study area, shown on the imagery this is State Land on which title has been given. About 23 farm families are linked to the Simanyangu-Sikanyulu Cooperative Society and have benefited from funds and equipment provided under the Gwembe-Tonga project (2003-2005) to irrigate about 35ha of land close to the river. The scheme has recently been augmented. The scheme was established as early as 1985 and has an operational WUG with 23 male and 24 female members. The banana scheme is outside the area of interest for project development.

The area of interest for the establishment of the Lusitu Irrigation Project is Sitinkwe village in the NE of figure 6-14 shown as a black rectangle and covering from east to west the Zambezi floodplain (unsuitable for irrigation because of risk of flooding), the lower terrace of the Zambezi (highly suitable) and the upper terraces (suitable in part, the main limitation being large areas of sodic soils). Siajongoto is to the south of Sitinkwe: it shares contiguous blocks of land highly suitable for irrigation with Sitinkwe on the lower Zambezi terrace. Siajongoto also has access to the nearby Banana Irrigation Scheme (never considered as part of IDSP initiatives), while Sitinkwe residents do not. Scheme development has been focussed on Sitinkwe village: there is unwillingness on the part of both villages to share in development activities.

Social economic surveys conducted in the project area revealed that several households will be affected by the proposed project. Land earmarked for the proposed irrigation scheme, will result in people and social infrastructure as well as cultural sites being affected. The project area has 382 households with an estimated Tonga population of 1,900 people entirely dependent on agriculture. Livestock ownership accounts for 30% of net farm income. It’s definite that people will have to be relocated and infrastructure replaced elsewhere. 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 details reference should be made to the RAP report.

6.10 Demography

According to a census carried out by IDSP, of 382 households at Lusitu site (RAP, IDSP, 2013), there about 1,900 people at the Lusitu site as of July 2013. The frequency of household size is shown in figure 6-15.

The maximum number of members reported in one household was 15 and the mean was five members (SD=2.7). The average age of the population (1,765 of which reported their age) is only 20 years of age and the sex ratio is 906 males to 1,000 females.
The CSO 2010 population census indicates that the population in the area 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. 

The birth rate appears high in the last 15 years. About two thirds of the Lusitu population are under 25. The Figure also suggests a higher male mortality rate in the over 25 age group, with consistently more females than males in each age group, some of which may be attributed to HIV/AIDS related deaths and/or there may have been a small amount of male out-migration.
6.11 Social Composition

Settlement

The recent history of the Lusitu site is that it was very sparsely inhabited in the early 1950s and was then used to re-settle the Gwembe Tonga displaced by the flooding of Kariba Dam.

Many have now died so the in-migration, which must have been substantial, is not very marked on the graph. Very little in-migration took place in the subsequent 30 years. Then within the last 20 years a few families (supposed to be so because the variance of the age of immigrants is wide) numbering about 200 people in total appear to have entered the area, increasing the population by about 10%. Nevertheless, and as shown in figure 6-17 the solid line representing age equal to period of residence, the vast majority of Lusitu residents (90%) have lived there all their lives.

Figure 6-17 Years of Residence by Age

The area of survey is made more complex by households reporting sub-village areas as their location of residence. On the one hand these sub-villages may be “flags of convenience” for obtaining subsidised agricultural inputs. On the other they may be clan areas where specific family groups are found. Village officials sometimes refer to 14 key zones: there are 16 locations with groups of more than 50 households.
Family Structure

The family has a nuclear structure, with 93% of people being reported as household heads, spouses and sons and daughters in equal proportion. A small but significant proportion is grandchildren, suggesting that children may remain associated with parents after their marriage, or that possibly children with separated or deceased parents may be cared for by grandparents.

Marital Status

Marital status is a useful distinction to identify social composition because of its association with wealth. Married households (219 cases) and polygamous households (12 cases) are substantially better endowed with productive and material resources than unmarried households (150 cases). They reported twice the farm area (4.6 ha) than the un-married group (2.3 ha) significant at 99% (df=380, F=32.1). The number of TLU
held by married households (>3) and polygamous households (>4) is more than triple that of unmarried households (<1). The married and polygamous household group holds a greater share of the total wealth of the community, proportional to its number of households, than any other.

Occupations

The occupation of Lusitu residents is overwhelmingly agrarian. Of the total population 34% are reported to be farmers, and a further 2% are “farm workers”. 50% are either school pupils or children not yet attending school. 11% reported no occupation. Considering adults of working age, 91% are farmers and a further 5% are farm workers. Of the remainder the occupations include business (9), “working” (8), teacher (2), driver (2) and thatcher (2). Individuals reported their occupations to be architect, brick layer, guard, house maker, pump operator (of either the water supply system or possibly at the banana scheme), shop keeper and shop assistant. 706 adults reported an occupation, 673 of them said they were farmers or farm workers. The number of occupational fisherman was very low considering the proximity of the Zambezi (only 2). Probably most serious fishermen at the site join the lucrative fishing industry on Lake Kariba and are no longer resident in Lusitu.

Education

Very few Lusitu residents are educated above grade 7, as shown in figure 6-20. Over 700 persons did not report any educational level attained – one may assume that their access to education has been minimal.

![Education Grade Reported as Attained](image)

**Figure 6-20  Educational Grade Reported as Attained**

The data suggest that about 25% of people in Lusitu over the age of 15 cannot read and write. The remaining 75% may achieve some understanding of formal training material presented to them.

A basic school in Sitinkwe village provides primary education to Grade 7, attended by 318 boys and 334 girls, has a staff of four male and four female teachers. The number of pupils correlates quite well with the census, which counted 523 children between the age of 5 and 15:
Sitinkwe School’s catchment extends a little to the south of Sitinkwe village. A government secondary school in Ng’ombe Illede educates pupils from Grade 9 to 12. Only 68 boys and 50 girls attend, taught by three male and two female teachers. Ng’ombe Illede is over one hour’s walk from Sitinkwe village.

Community Health

An unexpectedly small number of persons were reported as disabled in the census. Blindness or partial sight was the most common (7 individuals), followed by asthma (4). Individuals reported deafness, epilepsy, cancer and an amputation.

The area is well provided with medical facilities, Chipepo Rural Health Centre is only one or two kilometres from the village. There are 14 beds for interned patients. In addition there are 10 community health workers in Sitinkwe village.

6.12 Governance

The Lusitu site is located within Ng’ombe Illede Ward of the newly created Chirundu District in Lusaka Province. Chirundu District is composed of the six northerly wards of the old Siavonga District of Southern Province which used to comprise 13 wards in total. The area of Ng’ombe Illede Ward is not immediately available, but inspection of ward maps suggests that the Lusitu area occupies less than 20% of the ward area which indicates a ward area of more than 25,000 ha. The ward population in 2010 was 11,782 (CSO Population Census 2010). The Area (Ward) Council represents a larger area and population than the Lusitu study area.

The civil administration of the ward is the overall responsibility of DC Chirundu, but the technical support of the administration (including the District Agricultural Office) has until recently been based in Siavonga District because of very limited resources in the new District. Both district administrations have been highly supportive in the identification and design of the proposed project.

The Lusitu project area is under customary land tenure under the administration of Chief Chipepo whose palace is in Gwembe. Mr Sakanunda is Chief Chipepo’s advisor; both are based in Lusaka. Mr Lungu is resident chief headman at “Lusitu”. The “Lusitu” Group 1 site is associated with the village of Sitinkwe. To avoid confusion the name Lusitu is retained to describe the location of the site. Chief Chipepo has the allegiance of more than 3,000 people identified in the project area and their land rights are customary in the sense that they can be allocated and disposed of by Chief Chipepo within the parameters of the 1958 agreement. Nevertheless, Chief Chipepo’s authority is reduced by claims on land by neighbouring Chief Sikoongo and coloured by varying degrees of community loyalty.

Therefore in terms of ward authority, district administration and customary rights, governance in the project area is not as clear-cut as is desirable. Scarcity of water in the area aggravates disputes. The present water supply (known as the “Chico line” for the Chinese contractor that
constructed it) was designed for piped potable water, with pipe sizes matched to expected potable water demand, but this has been used by both the Sitinkwe and Siajongoto communities for both minor irrigation (gardens) and livestock watering, resulting in long queuing times and a resultant unwillingness to pay any contribution to MOM costs to the operator: the D-WASHE committee which has since ceased to operate. Water supply has to be rationalized by use, made fit for purpose and MOM responsibilities reviewed as part of the Feasibility Study for the site.

The communities in the Lusitu area have a poor reputation for cooperation with (Siavonga) District functionaries: a reputation which is distinguished by village and community sub-group. On the other hand, the community has already experienced the results of (insensitive) involuntary re-settlement in the 1950s and a spirit of resentment has apparently been kept alive. The area is drought prone, in food deficit and has a low school attendance record, so the community is seen as disadvantaged relative to others in the two Districts.

6.13 Housing, Social Infrastructure and Services

Housing

The standard of housing is basic at the Lusitu site. Connection to utilities (electricity, water supply and sanitation) is 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.

Social Services

Social services are limited to basic schools above, a rural health clinic which is difficult to access due to a poor road and power supply to which hardly any households are connected. The piped potable water supply is not being operated according to its design and a sanitation system does not exist.

A covered warehouse storage of about 300 tons capacity can be found at Pambazana about 2.5 km from the village. This was constructed to facilitate the delivery and distribution of food aid.

Cellular telecommunication is said to be good over 90% of the area and about 20% of adults have mobile phones.

The nearest hammer mill is about 1.5 km from the site. The cost of milling is about Kwacha 3 per 5 kg. Very little other agricultural processing is reported apart from some oil expelling which is not done commercially.

6.14 Energy, Water Supply and Sanitation

Only about 2% of households have an electrical connection in the home, though the supply of electricity is said to be good. The Chipepo Rural Health Centre has power, but this is the only public building with this facility. Other commercial energy sources are scarce – there is nowhere locally to buy petrol, diesel or kerosene. Charcoal is not regularly found
Environmental and Social Impact Assessment Lusitu ISDP Group 1 sites
CP&CB Provider, IDSP

6.15 Transportation

Lusitu is very poorly served for transport, with only three small private trucks in Sitinkwe village. About three public taxis visit the site weekly but the village is not on a regular bus route. The number of private motorbikes and cars is very small. Three car owners live on site and there are six other car owners and three owners of motorbikes living close to the site.

6.16 Land Ownership and Tenure

The IDSP Lusitu Prefeasibility study reported that in the Lusitu area the traditional leadership is responsible for land distribution and administration issues in the project area. The report found that about 40% households had obtained land through village headmen and a further 4% had obtained land directly through the Chief. The remainder inherited mainly from fathers or uncles. Land tenure rights in the project area are customary and without issuance of individual titles to households, the traditional leaders uphold the tenure rights of all community members.

The prefeasibility report also indicated that the average farm size was about 5 ha while The Lusitu Irrigation Project Land Inventory Report 2011-2012 (MAL Irrigation and Land Husbandry and Lands Department) found that on average 2.5 hectares of land is cultivated each year. The RAP census suggests that the average cultivated area per farm is slightly greater, 3.62 ha (SD=3.86).

Received wisdom indicated that land is allocated by headmen according to household size. A regression analysis of number of household members on farm size suggests there is a small but significant correlation ($R^2=0.11$, $F=44.3$) with a 0.32 ha increase in reported farm size for every additional family member. This beta coefficient is significant ($t=6.7$, significant at 99%). Nevertheless the weakness of the correlation suggests other variables are also important in determining farm size. Both men and women of the community can be land holders but inheritance is through the male line. A widow retains her dead husband’s land at the discretion of her in-laws.

Though land holdings are “secure” within the customary system, the security of individuals within the community leaves much to be desired. As described in The Relationship between Household Wealth, Marital Status, and Gender of Household Heads at Lusitu Group 1 Site (op. cit.),
households in the lowest wealth quartile may have as little as 4% of community wealth, whereas those in the highest quartile have over 50%. The data suggest that access to land is the principle determinate of household wealth, but gender (men own cattle) and marital status (married and polygamous households have larger families) are also important explanatory variables. For the land-poor, access to land may remains difficult particularly because new settlers with better financial standing and support of the traditional leaders easily get land. Land markets never develop because customary land cannot be bought or sold: thus the community retains its land but access to land by individuals (particularly by young people within the community is constantly declining.

6.17 Economic Activities

Land Organisation

Agriculture is the most important economic activity in the project area. Given this, the degree of access to land and water determines the quality of life. As part of the RAP census 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 the village and the land held “outside”, which was either on the Zambezi floodplain or in the western interior: two very different land types. About 25% of the land area claimed by respondents is outside what the residents consider to be their village area. Taking into account enumeration difficulties (the area of more remote land is reported less carefully) there appears to be very little difference between the two distributions: households with small land holdings in the village do not appear to be allocated land outside for example, which suggests holders of small land holdings are not marginalised by being allocated land outside. Many large land holders within the village area also have large holdings outside. Regressing the area of land holding outside the village on land held inside (case by case) gives a highly significant $R^2$ of 0.83. This suggests that land availability is not critical in Lusitu – the largely benevolent customary system would ensure that if land was scarce those households with little land close to home and wanting or able to cultivate more land would be allocated land further away, if it was available.
Land is divided into separate “parcels” for each household, within which “plots” are distinguished on which different crops are grown. Some of these crops will be intercropped or double cropped, but the census was not able to distinguish such subtleties. The questionnaire asked respondents to distinguish a “garden” parcel followed by other parcels listed in order of their choosing. 72% of households have what was classified as a garden plot and all respondents claimed that their garden plot was “irrigated”. This irrigation takes place as recession agriculture on the banks of the Zambezi as well as using water supply from the Chico line on household plots. Nearly 60% of garden plots were less than 0.25 ha.

Table 6-6  Holders’ Parcel Areas

<table>
<thead>
<tr>
<th>Holders</th>
<th>Area, ha</th>
<th>Fallow, ha</th>
<th>Average ha</th>
<th>% of HH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Garden plot</td>
<td>274</td>
<td>158</td>
<td>0</td>
<td>0.58</td>
</tr>
<tr>
<td>Parcel 1</td>
<td>354</td>
<td>643</td>
<td>21</td>
<td>1.82</td>
</tr>
<tr>
<td>Parcel 2</td>
<td>92</td>
<td>187</td>
<td>16</td>
<td>2.04</td>
</tr>
<tr>
<td>Parcel 3</td>
<td>30</td>
<td>40</td>
<td>1</td>
<td>1.32</td>
</tr>
</tbody>
</table>

Parcels 1-3 were never reported as irrigated and intensity of use (defined by the variety and type of crop grown, consistently declined with ranking of the plot. Clearly, the number of parcels under the control of a household declined with the size of their total holding within the village area: only 8% of households had a Parcel 3 of significant area (over 0.5 ha) and these households all had a total holding size of over 1.5 ha. The area reported

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5 Households often move temporarily to small structures associated with these gardens during the dry season for the cultivation of vegetables.
as “fallow” is probably more correctly described as unused land because the proportion on each parcel does not conform to any expected rotation system.

**Crop Areas**

Bearing in mind it is usually not worthwhile to ask for accurate areas of cropped areas by recall, it was decided only to request parcel areas and ask the respondent to report plots (identified by crops grown) within it. The results show a large number of enterprises (crop types) reported for each parcel; the areas were derived by dividing the total number of enterprises reported in the parcel into the total parcel area. Some enterprises were not reported and no account was taken of the area reported as unused, so the areas are only approximate.

Table 6-7  Crop Enterprises by Parcel, net ha

<table>
<thead>
<tr>
<th>Enterprise</th>
<th>Garden</th>
<th>Parcel 1</th>
<th>Parcel 2</th>
<th>Parcel 3</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruit</td>
<td>0.6</td>
<td>1.0</td>
<td>9.0</td>
<td>10.6</td>
<td></td>
</tr>
<tr>
<td>Vegetables</td>
<td>144.8</td>
<td>21.6</td>
<td>1.9</td>
<td>0.5</td>
<td>168.9</td>
</tr>
<tr>
<td>Cotton</td>
<td>22.6</td>
<td>3.7</td>
<td></td>
<td></td>
<td>26.3</td>
</tr>
<tr>
<td>Oilseed, pulses and roots</td>
<td>3.5</td>
<td>6.6</td>
<td>0.2</td>
<td>1.0</td>
<td>11.3</td>
</tr>
<tr>
<td>Cereals</td>
<td>8.0</td>
<td>580.9</td>
<td>186.7</td>
<td>25.3</td>
<td>801.0</td>
</tr>
<tr>
<td>Total</td>
<td>156.9</td>
<td>632.7</td>
<td>192.5</td>
<td>35.8</td>
<td>1,017.9</td>
</tr>
</tbody>
</table>

The garden parcel is mostly cultivated with a wide variety of vegetables the most important of which are okra, tomato and rape. There are also small areas of maize. Parcel 1 is mostly in cereals, dominated by maize. Cotton is also a significant crop. Parcels 2 and 3 are also dominated by cereals, with the proportion of drought tolerant millet and sorghum increasing – plot 3 is almost entirely cultivated with sorghum. At 1,114 ha (a few respondents did not report crops grown) the total cropped area at the Lusitu site is almost double earlier estimates. In addition there is a further 352 ha reported outside the village area, of which about 45% was said to be cropped in 2013, though the type of crops grown here was not asked for in the census.

**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 incomplete, but it would appear that the partner(s) of the HHH tend to control about 15-20% of the total household plots. This conforms to the assertion in the pre-feasibility study that women are allocated plots for their personal use.
Table 6-8  Reported Control over Individual Plots

<table>
<thead>
<tr>
<th></th>
<th>Garden</th>
<th>Parcel 1</th>
<th>Parcel 2</th>
<th>Parcel 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>HHH</td>
<td>335</td>
<td>294</td>
<td>65</td>
<td>20</td>
</tr>
<tr>
<td>Spouse</td>
<td>75</td>
<td>40</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Wife</td>
<td>9</td>
<td>4</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>daughter</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>grandmother</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>grandson</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Not reported</td>
<td>1,162</td>
<td>1,069</td>
<td>321</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>1,583</td>
<td>1,409</td>
<td>400</td>
<td>26</td>
</tr>
</tbody>
</table>

Respondents were asked how they viewed their occupancy status of each plot. Very few “informal” tenancy arrangements exist – only about 5% of the parcel area is either rented or borrowed. 66% of respondents acknowledged their land was held on a customary basis, whole 16% claimed “ownership”. The distinction probably depends on the view of the respondent to his/her land rights under the customary system because none of the land in the village area is State Land.

Table 6-9  Reported Tenancy Arrangements over Parcels

<table>
<thead>
<tr>
<th></th>
<th>Garden</th>
<th>Parcel 1</th>
<th>Parcel 2</th>
<th>Parcel 3</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not reported</td>
<td>2</td>
<td>97</td>
<td>24</td>
<td>15</td>
<td>138</td>
<td>13%</td>
</tr>
<tr>
<td>Borrowed</td>
<td>9</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>16</td>
<td>2%</td>
</tr>
<tr>
<td>Customary</td>
<td>122</td>
<td>391</td>
<td>142</td>
<td>25</td>
<td>680</td>
<td>66%</td>
</tr>
<tr>
<td>Owner</td>
<td>21</td>
<td>130</td>
<td>14</td>
<td>0</td>
<td>165</td>
<td>16%</td>
</tr>
<tr>
<td>Rented</td>
<td>4</td>
<td>18</td>
<td>8</td>
<td>0</td>
<td>30</td>
<td>3%</td>
</tr>
<tr>
<td>Total ha</td>
<td>158</td>
<td>643</td>
<td>187</td>
<td>40</td>
<td>1,028</td>
<td></td>
</tr>
</tbody>
</table>

The number of cattle in the Lusitu area is estimated to be about 1,120 head. Sheep and goats total about 3,400 head but only about 6% of the total is sheep. The area is well known as a goat rearing area. Livestock ownership is important; the average number of TLU owned per household was 3.4 of which about 70% were cattle. The importance of stock is borne out by the farm models and may be an issue in irrigation management. Alternative livelihoods include artisanal activities, handicrafts, fishing, charcoal production and poaching. No quantitative economic data are available.

Health Centres

Lusitu project area has two government rural health clinics that is Chipepo Rural (were about 70% of the population within the project area go i.e. 12 km from the ngombe Illede junction: and Lusitu clinic which is about 16 km away from Chipepo clinic. The nearest referral hospital is Mtendere mission hospital about 22 km away from Chipepo clinic.
Figure 6-22 Chipepo Clinic

Catchment population for Chipepo Rural Health centre is 14059 people. This is the facility were 80 per cent of the population in the project area go to.

Figure 6-23 Lusitu Health Centre
Catchment population for Lusitu Rural Health centre is 10315. This is the facility were 20 per cent of the population in the project area go to.

Diarrhoea cases during the hot season, Respiratory Tract Infections (RTIs), Muscular skeletal especially in Chipepo clinic catchment population and eye infections are common. This is because most people are engaged in intensive labour work in their gardens. Being in the valley the households have limited access to water as such would want to maximise on gardening. It was further observed that there was no program in place to improve sanitation levels through health education on importance of having a pit latrine and possible construction of pit latrines to improve sanitation levels.

Table 6-10  Staffing levels at each centre and available facilities

<table>
<thead>
<tr>
<th>Item</th>
<th>Chipepo Clinic</th>
<th>Lusitu</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staffing</td>
<td>1 EHT</td>
<td>1 EHT</td>
</tr>
<tr>
<td></td>
<td>2 Midwives</td>
<td>1 Midwives</td>
</tr>
<tr>
<td></td>
<td>1 Nurse</td>
<td>1 Nurse</td>
</tr>
<tr>
<td></td>
<td>1 Male Nurse</td>
<td>1 Clinical Officer</td>
</tr>
<tr>
<td></td>
<td>2 daily classified employees</td>
<td>2 daily classified employees</td>
</tr>
<tr>
<td>Catchment Population</td>
<td>13,479</td>
<td>9,181</td>
</tr>
<tr>
<td>Equipment lacked</td>
<td>Ambulance, X-ray and scanning ,machines</td>
<td>Ambulance, X-ray and scanning ,machines</td>
</tr>
</tbody>
</table>

As shown in the table above it is clear that the two clinics are understaffed with each centre having 4 health staff against the catchment populations. More over none of the clinic had a Doctor on site.

6.18 Health and Safety

Diarrhoea

Diarrhoea is the passage of 3 or more loose or liquid stools per day, or more frequently than is normal for the individual. It 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.

Diarrhoea 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. Parents lack knowledge of how to prevent and treat diarrhoea at home and a severe shortage of trained health workers compounds the problem; Zambia has only seven nurses for every 10,000 people, one-ninth the UK rate.
Though data was not available at Chipepo RHC at the time of field visits. Lusitu showed an increase in blood diarrhoea from October to January. Though non-blood diarrhoeal was also on the increase between January and May 2012.

Figure 6-24   Diarrhoeal Cases at Lusitu RHC

According to UNICEF:

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

**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.

**Figure 6-25   Malaria Cases at Lusitu RHC**
Source: Lusitu RHC

- 1.2 million people die of malaria each year, 90% of whom are children under 5.
- There are 396 million episodes of malaria every year; most of the disease burden is in Africa south of the Sahara.
- Intensified irrigation, dams and other water related projects contribute importantly to this disease burden.
- Better management of water resources reduces transmission of malaria and other vector-borne diseases.

**Respiratory Tract Infections (RTI)**

Top five diseases in Lusitu project area for the period January to December, 2012 include respiratory infections which reached a peak of 569 in the month April. Respiratory infections (non pneumonia) are the second leading cause of morbidity in Zambia.

**Figure 6-26   Respiratory Tract Infections**
Source: Chipepo RHC
Pneumonia

The trends over the past three years have shown that the national respiratory infections (non-pneumonia) incidence rate increased from 193 per 1,000 population in 2006 to 219 per 1,000 population in 2007 and then reduced to 198 per 1,000 population in 2008. In 2006, 2007 and 2008, Southern province recorded the highest incidence of respiratory infections (non-pneumonia).

![Pneumonia cases at Lusitu RHC](source)

**Figure 6-27** Pneumonia Cases at Lusitu RHC (Source Lusitu RHC)

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.

According to the field surveys conducted in the area and information collected at Lusitu rural health centre, prostitution in the area is said to be high. This risk behaviour is prominent among school going children aged between 12 years and 25 years. On the other hand there has been cases of drug abuse in the area and among common drugs abused are marijuana and alcohol. This has contributed to increase in new effections of HIV/AIDs and other sexually transmitted infections (STI).
Efforts are however, being made by stakeholders in the area to address the situation. Some of the activities that have undertaken in the past include:

- Free male and female condoms distribution
- Health talks on HIV/AIDS, transmission, prevention and safer sex.
- Male circumcision to minimise sexually transmitted diseases
- Free voluntary counselling and testing for HIV/aids

It is therefore the feeling of the project that these measures are adequate as long as they are sustained. The Ministry will therefore support already existing efforts in dealing with HIV/AIDS in the area during all stages of the project.

Other Diseases

Schistosomiasis

Simaundu Village in the project area was particularly singled out as one of the areas were suspected bilharzia cases have been recorded at the clinic. This is because most children swim in abandoned ponds which usually have stagnant water. No WASHE program in place.

- An estimated 160 million people are infected with schistosomiasis;
- The disease causes tens of thousands of deaths every year, mainly in sub-Saharan Africa;
- It is strongly related to unsanitary excreta disposal and absence of nearby sources of safe water;
- Basic sanitation reduces the disease by up to 77%;
- Man-made reservoirs and poorly designed irrigation schemes are main drivers of schistosomiasis expansion and intensification.

The control programme consists of spraying infected areas with nuclosamid and keeping shorelines free of the *Salvinia auriculata*

Trachoma

Eye infections were reported under Chipepo RHC and it was mentioned as one of the five diseases in the project area. Eye infections were attributed to poor hygiene.

According to UNICEF:

- 500 million people are at risk from trachoma;
- 146 million are threatened by blindness;
- 6 million people are visually impaired by trachoma;
- The disease is strongly related to lack of face washing, often due to absence of nearby sources of safe water;
- Improving access to safe water sources and better hygiene practices can reduce trachoma morbidity by 27%;
- 133 million people suffer from high intensity intestinal helminthic infections, which often lead to severe consequences such as cognitive impairment, massive dysentery, or anemia;
- These diseases cause around 9400 deaths every year;
- Access to safe water and sanitation facilities and better hygiene practice can reduce morbidity from ascariasis by 29% and hookworm by 4%.
6.19 Occupational Health and Safety

Projects such as development of Lusitu irrigation scheme, involve employees of various categories working on site simultaneously. As work progresses particularly during construction of the dam, 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.

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.

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.

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.

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.

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 minimise worker exposure to hazards that include:

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

### 6.20 Cultural Heritage

#### Cemeteries

A few households were observed to have a specific individual graves nearby. Field walking with a guide showed the tombs are not well marked and with time all signs on them ill disappear and knowledge about them will only remain in oral history. It was reported that Tongas do not have a strong relationship with deceased people, and only in a few rare instances do they need to come back to their ancestor’s cemeteries.

![Figure 6-28 Position of the Malende, of the three potters’ house, of the community meeting place, of the Zambezi River (Source: Google Earth image).](image)

#### Shrines

One **Malende** shrine was located at 16°06.825 South & 28°50.581 East (see fig.6-28). The ritual associated with this Malende does not differ markedly from others, like the ones in the Mwomboshi project area. It has got only an area surrounded by trees, without any pots, potsherds nor iron hoes associated. Without information from the villagers, it would be impossible to locate it.

#### Important landmarks

No important landmarks were identified nor mentioned by the villagers. Only a large tree used as the community meeting place located at 16°07.250 South & 28°50.508 East (see fig.6-28).
A sacred stone was identified outside the project area, inside a village, north of the Lusitu River. It was reported that the stone has been there forever, and anyone touching it is liable to disappear though no evidence was provided. Further investigation is needed into this specific case.

**Ancient cultural Sites**

Initially two ancient sites (Site 1 and 2) were located by the villagers and a site visit confirmed this. Later, during surveys, a third one (site 3) was identified near to Ingombe Ilede. Each site has on the surface potsherds by the dozens, large pieces of *daga* (Ndoro, 1990) with the imprints of wooden poles, grounding and grinding stones, etc. On the surface are buried artefacts disturbed by agricultural ploughing. The potsherds and pots found are similar to so-called Traditions of Early Iron Age date, possibly dating back to 1,000 years or more.

![Figure 6-29](image)

Figure 6-29  Position of the three archaeological sites identified, the position of the world-famous Ingombe Ilede site, and of the Zambezi River (Source: Google Earth image).

At site #3, a few hundred meters from the world-famous Ingombe Ilede archaeological site (see fig.6-29), the remains are only found on the surface, and no survey was carried out of the erosion gullies going down to the modern flood plain. It is noteworthy the three archaeological sites found are on high standing ground overlooking the Zambezi River flood plain. Moreover, sites #1 and #2 are both in the area where tier 1 and tier 2 irrigation systems will be set up.

Position of ancient cultural heritage sites:

- Site #1: 16°06.886 South & 28°50.663 East at 383 meters altitude;
- Site #2: 16°07.430 South & 28°50.908 East at 384 meters altitude;
- Site #3: 16°09.065 South & 28°48.002 East at 401 meters altitude.
7 IMPACT ASSESSMENT

7.1 General Considerations

Planning for the public investment in Zambia is challenging due to very high population growth rate. 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.

No serious adverse impacts of exceptional significance that would be considered unprecedented or irreversible in nature were revealed by the ESIA. 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 contextualise and understand the impacts of the Irrigation scheme on the ecosystem. Table 7-1 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</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 850 ha of rain fed 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 170 ha, offers an additional 100 days per ha. Therefore the labour requirement for cultivation of field crops alone is in the order of 41,000 person days a year. The total labour availability within the project area is in the order of 244,000 days per annum. Therefore cultivation of crops only accounts for about 17% of community labour availability in the without-project situation.

The incremental labour requirement for the proposed irrigation project for field operations alone is about 50,000 days per annum on Tier 1, 600 days per annum on Tier 2 and 1,500 days per annum on Tier 3, a total of about 52,000 days (an estimate based on cropping patterns recommended in the Feasibility Study). At least 95% of this will accrue to irrigated holdings cultivated by the community (Tier 1). Banana cultivation on Tiers 2 and 3 contributes little to the incremental labour requirement, though it is likely that some employment will be available to the community on Tier 3 land. As a whole the irrigation project is likely to increase the labour requirement for the cultivation of crops from about 41,000 days per annum to over 76,000 days per annum. Cultivation of crops will account for about 31% 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:

- Employment Opportunities at various stages of development;
- 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 no displacement of people from the project area by the project. However, the present housing of a number of households (HH) estimated to be 114HH (RAP report, 2013) have to be moved outside irrigation block areas (Tiers 1 and 2 only, while the area demarcated for Tier 3 has no occupants). 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. The customary land of the village is earmarked for conversion to State land under formal title. In summary negative socio-economic impacts will include:
• Loss of community agricultural fields and some burial sites. For instance, 5,361 m² of land will be lost due to excavation for reservoirs and 927.2 m² for pumping stations;
• Lack of easy access to Zambezi River by local communities;
• Loss of livelihood for vulnerable groups in the short term in the surrounding communities;
• Disturbance to cultural and archaeological sites that include Shrines: one Malende shrines (Tonga) and 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.

• 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;
• Dust Pollution;
• Noise Pollution;
• Loss of habitat for fauna especially insects, reptiles such as lizards and small mammals;
• Loss of agricultural and grazing 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 Chirundu 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.

7.3.2 Anticipated Positive Bio-Physical Environmental Impacts

• Increased groundwater recharge will take place in Sitinkwi and surrounding villages on Tiers 1, 2 and 3. Groundwater recharge will result from infiltration as residue water from irrigation. One study has acknowledged and proved that using a root zone modelling approach, recharge occurs on irrigated farmlands (Jimenez-Martinez et al, 2009);
• 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.

7.3.3 Anticipated Negative Socio-Economic Impacts

• Human animal conflict may occur. Presence of Hippo, crocodiles and elephants entails Human-wildlife conflict in terms of threat to human life and crop raiding. The challenge lies in the fact that the reservoir of these animals is the Zimbabwean side rendering cropping a non-solution to the problem;
• Social conflict due to supply of potable water vs water for livestock. Currently, there is no water supply and sanitation committee operational at community level;
• Migration and temporary employment effects;
• Unsociable behavior from increased disposable income. The Lusitu community has a reputation for difficulty in respect of development due to the history of involuntary re-settlement but even this unfortunate history has not resulted in overt social conflict;
• Casualisation of labour impacting on employee’s welfare because of uncertainty that is created among workers;
• Population density-related disease impacts;
- 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;
- Increased HIV/AIDS and other STDs 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 STDs, HIV/AIDS, TB, etc. in the area;
- Deterioration of road infrastructure which is currently in a state of disrepair. At full development Tier 1 alone is expected to produce 750 tons of maize and 4,000 tons of vegetables a year, which would require haulage equivalent to two or three seven ton trucks per day for every day of the year. Tier 2 and 3 will produce up to 4,000 tons of bananas per year, which require the service of a similar transport fleet;
- Loss of grazing land.

7.3.4 Anticipated Negative Bio-Physical Environmental Impacts

The irrigation scheme will result in demand for water for irrigation purposes to increase putting more pressure on Zambezi 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 Lusitu project area. This will arise from the extended irrigation areas in the three tiers;
- Effects on Water demand /supply of water. The main water user downstream of the project site is the population in Chirundu township whose water demand is mainly domestic. Abstraction of water for the proposed irrigation project will certainly reduce downstream flow of water but not to extreme extent where water availability reduces to worst levels. Although the magnitude of the impact is low, the effect still remains negative. Furthermore, considering that water demand in Chirundu may increase as the population rises, the impact of upstream abstraction may manifest;
- Soil erosion since as the much of the soil surrounding the proposed irrigation blocks is highly-erodible and devoid of vegetation for much of the year. The highest risk is found on the southern boundary of Tier 3 which borders onto erodible soil and a drainage line and already has some gullies. There are also areas on the eastern margins of Tiers 1 and 2;
- Water quality pollution due to leaching of salts, nutrients, herbicides, fungicides, and insecticides with high salinity and alkalinity. Although the area has an effective soil cover, as indicated in the groundwater vulnerability map of Lusitu and surrounding areas, this kind of contamination is possible as some studies have shown that pesticides
leaches more commonly in finer-textured soils than coarser, sandy textured soils (Hallberg, 1989);

- Increased energy consumption patterns;
- Water and soil pollution due to increased pesticide and herbicide use;
- Soil degradation due to increased use of fertilizers;
- Reduced water quantity on downstream reaches of Zambezi River but not to worst levels. According to the hydrological analysis, the Zambezi river carries sufficient runoff (minimum of 490m$^3$/s) to support the proposed irrigation project as well as other downstream water users (Chirundu township water supply facility, Private Lodges and other individual water users);
- 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;
- 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 Zambezi River;
- Increased incidences of HIV/AIDS and STIS;
- 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.

7.4 Impact Evaluation Mechanisms
### 7.4.1 Biophysical environment

Table 7-2: Impact Characterization for biophysical environment

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</thead>
<tbody>
<tr>
<td><strong>Flora</strong></td>
<td>May be affected due to land clearing.</td>
<td>Negative</td>
<td>Low</td>
<td>Within irrigation scheme area</td>
<td>Short Term</td>
<td>Site preparation</td>
<td>Continuous</td>
<td>Certain</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>- Disturbance of terrestrial ecological &amp; ecosystem services processes</td>
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<td></td>
<td>- Loss of natural habitat for small mammals, birds and insects.</td>
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<tr>
<td></td>
<td>- Loss of species of special concern</td>
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<td></td>
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<tr>
<td></td>
<td>- Loss &amp; fragmentation of sensitive habitats</td>
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</tr>
<tr>
<td><strong>Fauna</strong></td>
<td>May be affected due to land clearing and fencing of the scheme</td>
<td>Negative</td>
<td>Low</td>
<td>Within irrigation scheme area</td>
<td>Short Term</td>
<td>Site preparation</td>
<td>Continuous</td>
<td>Certain</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>- Disturbance to wildlife habitat</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Loss of Fauna diversity</td>
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</tr>
<tr>
<td><strong>Air Quality</strong></td>
<td>May be affected by emission from construction equipment. Also dust generating especially during construction may affect air quality.</td>
<td>Negative</td>
<td>Moderate</td>
<td>Project area</td>
<td>Medium term</td>
<td>Clearing and Construction phases</td>
<td>Occasional</td>
<td>Likely</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>- Nuisance dust pollutes the air, affect the health of site workers</td>
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<tr>
<td><strong>Noise Quality</strong></td>
<td>Heavy duty clearing and construction equipment may cause local noise disturbances;</td>
<td>Negative</td>
<td>Moderate</td>
<td>Project area</td>
<td>Medium term</td>
<td>Clearing, Construction &amp; Operation phases</td>
<td>Infrequent</td>
<td>Certain</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>- Noise pollution from the movement of the site vehicles can disturb workers, community</td>
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</tr>
<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; - Loss of agricultural and grazing fields - Soil erosion - Contamination of Soil - Loss of individual graves</td>
<td>Negative</td>
<td>High</td>
<td>Project area</td>
<td>Medium Term</td>
<td>Site Preparation</td>
<td>Continuous</td>
<td>Certain</td>
<td>None</td>
</tr>
<tr>
<td>Surface Water</td>
<td>Contamination of Zambezi River and other streams May occur due to accidental spillage of oils &amp; lubricants; - Pollution due to solid waste - Pollution due to oil/fuel spills.</td>
<td>Negative</td>
<td>moderate</td>
<td>Project area &amp; surrounding areas</td>
<td>Short term</td>
<td>Site preparation</td>
<td>Continuous</td>
<td>likely</td>
<td>Low</td>
</tr>
<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 &amp; surrounding areas</td>
<td>Short term</td>
<td>Site preparation</td>
<td>Infrequent</td>
<td>likely</td>
<td>low</td>
</tr>
<tr>
<td>Habitat</td>
<td>Clearing of vegetation, digging may cause habitat fragmentation; - Loss of habitat for fauna especially insects, reptiles such as lizards and small mammals</td>
<td>Negative</td>
<td>Low</td>
<td>Project Area</td>
<td>Long term</td>
<td>Project life</td>
<td>Continuous</td>
<td>Certain</td>
<td>Low</td>
</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. - Loss of biodiversity</td>
<td>Negative</td>
<td>Low</td>
<td>Project area</td>
<td>Short term</td>
<td>Site preparation phase</td>
<td>Continuous</td>
<td>Unlikely</td>
<td>None</td>
</tr>
<tr>
<td>PROJECT PHASE – Operation</td>
<td>Impact</td>
<td>Likely</td>
<td>Likelihood</td>
<td>Area</td>
<td>Term</td>
<td>Phases</td>
<td>Likelihood</td>
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</tr>
<tr>
<td>Flora</td>
<td>May be affected due to land clearing and movement of equipment during operations; - Loss of species of special concern and biodiversity - Loss and fragmentation of sensitive habitats</td>
<td>Negative</td>
<td>Low</td>
<td>Project area</td>
<td>Short term</td>
<td>Operation phases</td>
<td>Likely</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>Fauna</td>
<td>May be affected due to land clearing and movement of equipment during operations - Loss of faunal diversity</td>
<td>Negative</td>
<td>High</td>
<td>Project &amp; surrounding areas</td>
<td>Long term</td>
<td>Operation phases</td>
<td>Likely</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Air Quality</td>
<td>May be affected by emissions from the machines farm tractors used. - Dust emissions</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>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>Human Safety</td>
<td>Increased in road traffic may lead to reduced road safety among the rural communities</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>Land/Soil</td>
<td>Land/soil may be impacted by moving farm machines through compaction and contamination and oil leaks/seepages during operations. - Lack of easy access to Zambezi River - Soil degradation due to increased use of fertilizers - Soil loss from inappropriate land use practices</td>
<td>Negative</td>
<td>Moderate</td>
<td>Project area</td>
<td>Medium/Long term</td>
<td>Operation</td>
<td>Infrequent</td>
<td>Certain</td>
<td>None</td>
</tr>
<tr>
<td>Surface Water</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>Infrequent</td>
<td>certain</td>
<td>high</td>
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<tr>
<td>Habitat</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>low</td>
<td>Project Area</td>
<td>medium term</td>
<td>Project life</td>
<td>occasional</td>
<td>Certain</td>
<td>none</td>
</tr>
<tr>
<td>Overall Biodiversity</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>
<tr>
<td>Agro-chemicals</td>
<td>Increased usage of fertilizers / agro-chemicals</td>
<td>Negative</td>
<td>Low</td>
<td>Project area &amp; surrounding areas</td>
<td>Medium/long term</td>
<td>Operation phases</td>
<td>Continuous</td>
<td>certain</td>
<td>high</td>
</tr>
<tr>
<td>Climate Change</td>
<td>Clearing of land leading to loss of vegetation</td>
<td>Negative</td>
<td>Low</td>
<td>Beyond Project area</td>
<td>Long term</td>
<td>Operation phases</td>
<td>Continuous</td>
<td>Unlikely</td>
<td>None</td>
</tr>
<tr>
<td>PROJECT PHASE – Closure</td>
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<tr>
<td>Land use</td>
<td>Removal of structures and equipment will make land available for other uses;</td>
<td>Positive</td>
<td>High</td>
<td>Project area</td>
<td>Long term</td>
<td>Post closure</td>
<td>Continuous</td>
<td>Certain</td>
<td>None</td>
</tr>
<tr>
<td>General safety</td>
<td>Access to site by people or animals may cause injury if foundations are not filled</td>
<td>Negative</td>
<td>Moderate</td>
<td>Project area</td>
<td>Long term</td>
<td>Post closure</td>
<td>Continuous</td>
<td>Certain</td>
<td>Low</td>
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</table>
### 7.4.2 Socio-economic environment

Table 7-3 Impact characterization for socio-economic environment

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<tbody>
<tr>
<td><strong>PROJECT PHASE – SITE CONSTRUCTION</strong></td>
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</tr>
<tr>
<td>Cultural Sites</td>
<td>Disturbance or loss of cultural sites such as graves</td>
<td>Negative</td>
<td>Moderate</td>
<td>Within irrigation scheme</td>
<td>long term</td>
<td>Construction/phases</td>
<td>Occasional</td>
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<tr>
<td>Population Growth</td>
<td>Increased population in the area</td>
<td>Negative</td>
<td>low</td>
<td>Within irrigation scheme</td>
<td>Short term</td>
<td>Construction phase</td>
<td>Continuous</td>
<td>certain</td>
<td>high</td>
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<tr>
<td>Traffic</td>
<td>Increased traffic</td>
<td>Negative</td>
<td>Moderate</td>
<td>Within irrigation scheme</td>
<td>Short term</td>
<td>Construction phases</td>
<td>infrequent</td>
<td>Likelihood</td>
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<tr>
<td>Livelihood</td>
<td>Increased employment opportunities for locals</td>
<td>Positive</td>
<td>high</td>
<td>Within irrigation scheme</td>
<td>Medium/long term</td>
<td>Construction phases</td>
<td>continuous</td>
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<td>National Revenue</td>
<td>Increased revenue base for the government</td>
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<td>Short term</td>
<td>Construction phases</td>
<td>continuous</td>
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<tr>
<td>Occupational Safety &amp; Health</td>
<td>Increased lung problems due to dust emissions</td>
<td>Negative</td>
<td>Moderate</td>
<td>Within irrigation scheme</td>
<td>long term</td>
<td>Construction phases</td>
<td>occasional</td>
<td>Likely</td>
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<tr>
<td>Land clearing</td>
<td>Loss of grazing land</td>
<td>Negative</td>
<td>Moderate</td>
<td>Within irrigation scheme</td>
<td>Short term</td>
<td>Construction phases</td>
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<td><strong>PROJECT PHASE - SITE OPERATION</strong></td>
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<tr>
<td>Animal Habitat</td>
<td>May occur due to depletion of habitat Human-Animal Conflict</td>
<td>Negative</td>
<td>low</td>
<td>Within irrigation scheme</td>
<td>Medium Term</td>
<td>Construction stage</td>
<td>Continuous</td>
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<td>Migration</td>
<td>increased employment opportunities</td>
<td>Negative</td>
<td>Moderate</td>
<td>Within irrigation scheme</td>
<td>Medium/long term</td>
<td>Construction/Operation phases</td>
<td>Certain</td>
<td>none</td>
<td></td>
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<tr>
<td>Sanitation</td>
<td>Concentration of people due to population growth</td>
<td>Negative</td>
<td>Moderate</td>
<td>Within irrigation scheme</td>
<td>Short term</td>
<td>Construction phase</td>
<td>Occasional</td>
<td>high</td>
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<tr>
<td>Community Safety</td>
<td>Increased traffic in the area.</td>
<td>Negative</td>
<td>low</td>
<td>Within irrigation scheme</td>
<td>Medium term</td>
<td>Construction phases</td>
<td>infrequent</td>
<td>low</td>
<td></td>
</tr>
<tr>
<td>Occupational Health Safety</td>
<td>Poor working environmental</td>
<td>Negative</td>
<td>Moderate</td>
<td>Within irrigation scheme</td>
<td>Long term</td>
<td>Operation</td>
<td>Occasional</td>
<td>high</td>
<td></td>
</tr>
<tr>
<td>HIV/ AIDs</td>
<td>Increased interaction among the people and migratory workers</td>
<td>Negative</td>
<td>High</td>
<td>Within irrigation scheme &amp; surrounding areas</td>
<td>Short term</td>
<td>Construction &amp; Operation phase</td>
<td>certain</td>
<td>high</td>
<td></td>
</tr>
</tbody>
</table>
8 IMPACT MITIGATION AND ENHANCEMENT MEASURES

8.1 Possible Mitigations and Enhancements - Construction Phase

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 (if available) outside. Each resident HH will be entitled to one or more
irrigation allocations in Tier 1. Graves will either be secured permanently with concrete slabs and or relocated depending on the preference of the affected household.

- **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 which is already part of the project design.

- **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. 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 sensitise workers and the communities on the dangers of HIV/AIDs and other STDs. 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 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.

- 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 reorganisation 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.

- Provincial and district impacts:

To enhance provincial and local positive impacts, 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:
  Mitigation: 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:
  Mitigation: MAL will ensure that measure water 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:
  Mitigation: 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:
  Mitigation: 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:
  Mitigation: 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:
  Mitigation: MAL should ensure communities are sensitized on good hygiene practices.

• Depletion of natural resources:
  Mitigation: Ensure good agricultural practices and conservation measurements.

• Occupational health and safety impacts:
  Mitigation: 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:
  Mitigation: 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:
  Mitigation: Stick to good practices of irrigation infrastructure operation rules of ensuring minimum flows in times of low flow.

• Impact on energy consumption patterns:
  Mitigation: 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:

Mitigation: 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 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:

Mitigation: 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 fertiliser 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:

Mitigation: 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:

Mitigation: 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 farmer in correct usage of the hose-furrow system plus regular follow up inspections and training by an extension officer.

- Air quality deterioration:
Mitigation: 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:

Mitigation: 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:

Mitigation: 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:

Mitigation: 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 storage, management and use are insignificant. Ensure proper disposal methods of chemicals and containers are being carried out.

- Impacts on geomorphic processes in dambos, streams and Zambezi River:

Mitigation: 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:

Mitigation: 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:

Mitigation: 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:

Mitigation: 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:

Mitigation: Two habitats were identified as sensitive in the 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 utilise
    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:
  Mitigation: 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:
  Mitigation: 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:
  Mitigation: Ensure application of good agricultural practices that prevent soil loss and
  embark on community programmes that will sensitise communities in surrounding
  areas using inappropriate methods of farming leading to erosion and river siltation.

- Air quality deterioration:
  Mitigation: Avoid open air incineration of chemical waste. Construct properly designed
  incineration facilities to avoid air pollution.

- Noise pollution:
  Mitigation: 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:
  
  **Mitigation:** 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:
  
  **Mitigation:** Stabilisation and rehabilitation of the area will be practiced. Use of contour ridges where required, and well-designed drains for Tier 1 hose-furrow areas.
### Table 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. 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 natural habitat for small mammals, birds and insects.</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. 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>Environmental Impact</td>
<td>Mitigation/Enhancement Measures</td>
</tr>
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<td>-----------------------------------------------------------</td>
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<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>Pollution of groundwater</td>
<td>Ensure that wood is cleared from the dam area prior to filing of the dam.</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>
<tr>
<td>Increased road traffic will lead to deterioration of dirty irrigation scheme roads</td>
<td>Conduct routine road repair and maintenance</td>
</tr>
<tr>
<td>Increased in road traffic may lead to reduced road safety among the rural communities</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>
</tr>
</tbody>
</table>
### Mitigation Measures to Social Impacts during the preparation/construction 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. Categorise 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>Increased revenue base for the government</td>
<td>The 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: (i) 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, 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>
</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 minimise this will include: (i) sensitise staff and community on the dangers of HIV/AIDS and STIs (ii) support local programmes by Ministry of Health regarding HIV/AIDS</td>
</tr>
<tr>
<td>Increased lung problems due to dust emissions</td>
<td>Watering of the area and surroundings during the construction stage will be undertaken regularly.</td>
</tr>
<tr>
<td>Loss of grazing land</td>
<td>Designate some areas for grazing coupled with cultivated land for pasture</td>
</tr>
</tbody>
</table>
### Mitigation Measures to 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>Increased usage of fertilizers and agro-chemicals</td>
<td>IPM training</td>
</tr>
<tr>
<td>Loss of vegetation</td>
<td>Promote use of organic manures. Practice conservation and green farming, Encourage organic farming, careful choice of crops which replenish soil fertility</td>
</tr>
<tr>
<td></td>
<td>Reforestate disturbed areas where appropriate. Minimise 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 utilise charcoal from unsustainable harvesting</td>
</tr>
</tbody>
</table>
### Mitigation Measures to Social 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. Categorise 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 and graves</td>
<td>Compensation and replacement of land will be done after a RAP exercise is undertaken. Graves will be either secured or relocated as preferred by affected household.</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>Increased local population</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>
</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 minimise this will include; i) sensitise staff and community on the dangers of HIV/AIDs and STIs ii) support local programmes by Ministry of Health regarding HIV/AIDs</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 MANAGEMENT & MONITORING

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 organised 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>Responsible person</th>
<th>Time Frame</th>
<th>Cost ZMK</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Biophysical Environment Preparation/Construction Phase</strong></td>
<td><strong>Removal of vegetation</strong></td>
<td><strong>To ensure minimal loss of vegetation</strong></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>FarmCo Scheme Manager</td>
<td>Start of Clearing and levelling</td>
<td>Prior to construction</td>
</tr>
<tr>
<td>Disturbance of terrestrial ecological &amp; ecosystem services processes</td>
<td>Loss of natural habitat for small mammals, birds and insects.</td>
<td><strong>To ensure minimal disturbance to the habitats</strong></td>
<td>Avoiding 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>FarmCo Scheme Manager</td>
<td>Start of Clearing and levelling</td>
<td>Prior to construction</td>
</tr>
<tr>
<td>Loss of species of special concern</td>
<td>Loss of species of special concern</td>
<td><strong>To ensure minimal loss of vegetation</strong></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>FarmCo Scheme Manager</td>
<td>Start of Clearing and levelling</td>
<td>Prior to construction</td>
</tr>
<tr>
<td>Loss &amp; fragmentation of sensitive habitats</td>
<td>Loss &amp; fragmentation of sensitive habitats</td>
<td><strong>To minimise clearance of vegetation</strong></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>FarmCo Scheme Manager</td>
<td>Start of Clearing and levelling</td>
<td>Prior to construction</td>
</tr>
<tr>
<td>Environmental Aspect/issue</td>
<td>Environmental Impact</td>
<td>Management Objectives</td>
<td>Mitigation/Enhancement Measures</td>
<td>Responsible person</td>
<td>Time Frame</td>
<td>Cost ZMK</td>
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<tr>
<td><strong>Biophysical Environment</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>Preparation/Construction Phase</strong></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Loss of Fauna diversity</strong></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>FarmCo Scheme Manager</td>
<td>Start of Clearing and levelling</td>
<td>Prior to construction</td>
<td>-</td>
</tr>
<tr>
<td><strong>Erosion of top soil</strong></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 sensitise 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>FarmCo Scheme Manager</td>
<td>Start of Clearing and levelling</td>
<td>Prior to construction</td>
<td>200,000</td>
</tr>
<tr>
<td><strong>Pollution of surface water as a result of spills</strong></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>Workshop Manager</td>
<td>Prior to construction</td>
<td>On-going</td>
<td>45,000</td>
</tr>
<tr>
<td><strong>Contamination of Soil</strong></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>FarmCo Scheme Manager</td>
<td>Start of Vegetation clearing Activities</td>
<td>On-going</td>
<td>250,000</td>
</tr>
<tr>
<td>Environmental Aspect/issue</td>
<td>Environmental Impact</td>
<td>Management Objectives</td>
<td>Mitigation/Enhancement Measures</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>FarmCo Scheme Manager</td>
<td>Start of clearing activities</td>
<td>On-going 160,000</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 minimise 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>FarmCo Scheme Manager</td>
<td>At start of land clearing</td>
<td>End of construction 40,000</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>FarmCo Scheme Manager</td>
<td>At start of land clearing</td>
<td>End of construction 180,000</td>
</tr>
<tr>
<td></td>
<td>Increased road traffic will lead to deterioration of dirty irrigation scheme roads</td>
<td>To prevent and minimise damage of dirty roads resulting from traffic</td>
<td>Conduct routine road repair and maintenance</td>
<td>FarmCo Scheme Manager</td>
<td>At start of land clearing</td>
<td>End of construction 250,000</td>
</tr>
<tr>
<td><strong>Safety</strong></td>
<td>Increase 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>FarmCo Scheme Manager</td>
<td>At start of land clearing</td>
<td>End of construction 350,000</td>
</tr>
</tbody>
</table>
### Table 9-2: Environmental & Social Management Plan during the preparation/construction phase

<table>
<thead>
<tr>
<th>Environmental Aspect/Issue</th>
<th>Environmental Impact</th>
<th>Management Objectives</th>
<th>Mitigation/Enhancement Measures</th>
<th>Responsible person</th>
<th>Time Frame Start/End</th>
<th>Cost ZMW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improved Livelihoods</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>FarmCo Manager &amp; Human Resource Manager</td>
<td>Prior to construction/On-going</td>
<td>120,000</td>
</tr>
<tr>
<td></td>
<td>Increased opportunities for skills transfer</td>
<td>To encourage training of staff on site</td>
<td>Ensuring there is a skill transfer programme. Categorise 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>FarmCo Manager &amp; Human Resource Manager</td>
<td>Prior to construction/On-going</td>
<td>80,000</td>
</tr>
<tr>
<td>Revenue for the government from taxes</td>
<td>Increased revenue base for the government for infrastructure development</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>FarmCo Manager &amp; Human Resource Manager</td>
<td>Prior to construction/On-going</td>
<td>-</td>
</tr>
<tr>
<td></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>FarmCo Manager</td>
<td>Prior to construction/On-going</td>
<td>45,000</td>
</tr>
<tr>
<td>Migration</td>
<td>Increase in Local Economic Activities</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>FarmCo Manager</td>
<td>Start of clearing/On-going</td>
<td>175,000</td>
</tr>
<tr>
<td>Threat to Human Health</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 minimise this will include: i) sensitise staff and community on the dangers of HIV/AIDS and STIs ii) support local programmes by Ministry of Health regarding HIV/AIDS</td>
<td>FarmCo Manager</td>
<td>Prior to construction/On-going</td>
<td>250,000</td>
<td></td>
</tr>
<tr>
<td>Environmental Aspect/issue</td>
<td>Environmental Impact</td>
<td>Management Objectives</td>
<td>Mitigation/Enhancement Measures</td>
<td>Responsible person</td>
<td>Time Frame</td>
<td>Cost ZMW</td>
</tr>
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</tr>
<tr>
<td>Occupational Health &amp; Safety</td>
<td>Increased lung problems due to dust emissions</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>FarmCo Manager</td>
<td>Start of Clearing</td>
<td>On-going</td>
</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>FarmCo Manager</td>
<td>Start of Clearing</td>
<td>On-going</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>Responsible person</th>
<th>Time Frame</th>
<th>Cost ZMW</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Biophysical Environment</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operation Phase</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<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>FarmCo Scheme Manager</td>
<td>Year 1 On-going</td>
<td>50,000</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>FarmCo Scheme Manager</td>
<td>Year 1 On-going</td>
<td>160,000</td>
</tr>
<tr>
<td></td>
<td>Contamination of surface water and/ground water due to washing and servicing of equipment</td>
<td>To prevent the contamination of water as a result of washing and servicing of farm 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>
<td>FarmCo Scheme Manager</td>
<td>Year 1 On-going</td>
<td>60,000</td>
</tr>
<tr>
<td></td>
<td>Contamination of water as a result of washing and servicing of equipment</td>
<td></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>Year 1 On-going</td>
<td>120,000</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 minimise atmospheric pollution due emissions from vehicles and other machines</td>
<td>Regular servicing of vehicles and equipment</td>
<td>FarmCo Scheme Manager</td>
<td>Year 1 On-going</td>
<td>160,000</td>
</tr>
<tr>
<td>Air pollution</td>
<td>To control/minimise 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></td>
<td>FarmCo Scheme Manager</td>
<td>Year 1 On-going</td>
<td>150,000</td>
</tr>
<tr>
<td>Environmental Aspect/Issue</td>
<td>Environmental Impact</td>
<td>Operation Phase</td>
<td>Management Objectives</td>
<td>Mitigation/Enhancement Measures</td>
<td>Responsible person</td>
<td>Time Frame</td>
</tr>
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</tr>
<tr>
<td><strong>Biophysical Environment</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Soil Degradation</strong></td>
<td>Soil Contamination due to oil spills</td>
<td>Operation Phase</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 designed for the purpose.</td>
<td>FarmCo Scheme Manager</td>
<td>Year 1</td>
</tr>
<tr>
<td></td>
<td>Contamination of Soil from disposal of agro-chemicals/ 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.</td>
<td>FarmCo Scheme Manager / SHEQ</td>
<td>Year 1</td>
</tr>
<tr>
<td><strong>Agro- Chemicals</strong></td>
<td>Increased usage of fertilizers and agro-chemicals</td>
<td>Operation Phase</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>FarmCo Manager</td>
<td>From operation</td>
</tr>
<tr>
<td><strong>Climate Change</strong></td>
<td>Loss of vegetation</td>
<td>Operation Phase</td>
<td>To minimise loss of vegetation</td>
<td>Reforest disturbed areas where appropriate Minimise 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 utilise charcoal from unsustainable harvesting</td>
<td>FarmCo Manager</td>
<td>Prior to land clearing</td>
</tr>
<tr>
<td>Environmental Aspect/Issue</td>
<td>Environmental Impact</td>
<td>Management Objectives</td>
<td>Mitigation/Enhancement Measures</td>
<td>Responsible person</td>
<td>Timing</td>
<td>Cost</td>
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<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>FarmCo Scheme Manager &amp; Human Resource Manager</td>
<td>Year 1</td>
<td>On-going</td>
</tr>
<tr>
<td></td>
<td>Increased opportunities for skills transfer</td>
<td>To encourage training of staff on site</td>
<td>Ensuring there is a skill transfer programme. Categorise 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>FarmCo Scheme Manager &amp; Human Resource Manager</td>
<td>Year 1</td>
<td>On-going</td>
</tr>
<tr>
<td><strong>Land</strong></td>
<td>loss of agricultural fields</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>FarmCo Scheme Manager</td>
<td>Year 1</td>
<td>Farm Closure</td>
</tr>
<tr>
<td><strong>Revenue for the government</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 Irrigation scheme will adhere to all the tax requirements of the Government of the Republic of Zambia.</td>
<td>FarmCo Scheme Manager</td>
<td>Year 1</td>
<td>On-going</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) Adopt selective employment opportunities targeting locals, ii) Ensure adequate facilities are provided for staff such as sanitation facilities.</td>
<td>FarmCo Scheme Manager</td>
<td>Prior to construction</td>
<td>On-going</td>
</tr>
<tr>
<td></td>
<td>Increase in Local Economic Activities</td>
<td>To increase the market for local goods and services in the area</td>
<td>To enhance this, MAL will ensue 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>FarmCo Scheme 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>Responsible person</td>
<td>Timing</td>
<td>Cost ZMW</td>
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<tr>
<td>Socio-economic Environment</td>
<td>Operation Phase</td>
<td></td>
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<tr>
<td>Threat to Human Health</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 minimise 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 that include; - Free male and female condoms distribution - Health talks on HIV/AIDs, transmission, prevention and safer sex. - Male circumcision to minimise sexually transmitted diseases - Free voluntary counselling and testing for HIV/aids</td>
<td>FarmCo Scheme Manager</td>
<td>Prior to construction</td>
<td>On-going</td>
<td>100,000</td>
</tr>
<tr>
<td>Poor Sanitation</td>
<td>Pollution of surface and groundwater</td>
<td>To avoid contamination of water resources</td>
<td>Provide adequate sanitation facilities and proper disposal of waste. Ensure communities are sensitized on good hygiene practices</td>
<td>FarmCo Scheme Manager</td>
<td>Start of Clearing</td>
<td>On-going</td>
</tr>
<tr>
<td>Occupational Health</td>
<td>Health related diseases for workers</td>
<td>To minimise any health hazards to 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>
<td>FarmCo Scheme Manager</td>
<td></td>
<td>120,000</td>
</tr>
<tr>
<td>Human Animal Conflict</td>
<td>Threat to human safety</td>
<td>To prevent risk of animal attack</td>
<td>Provide for undisturbed stretches of vegetation interconnected to provide animal passage</td>
<td>FarmCo Scheme Manager</td>
<td></td>
<td>-</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>
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<tr>
<td>Surface water Monitoring</td>
<td>Ambient surface water quality – upstream and downstream of the area of disturbance</td>
<td>Zambezi 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>
</tr>
<tr>
<td>Biological Monitoring</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 minimise impacts and compare to baseline environmental data.</td>
<td>FarmCo Manager</td>
</tr>
<tr>
<td>Land Monitoring</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>
</tr>
<tr>
<td></td>
<td>Success of rehabilitation</td>
<td>Plots will be determined once rehabilitation has began 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>
</tr>
</tbody>
</table>
| Air Emissions Monitoring| Meteorology                                                                  | Put up a meteorological station within the Scheme area                                | Continuous         | - Temperature  
- Rainfall  
- Humidity  
- Wind (speed, direction)  
- Pressure  
- Evaporation | No compliance requirements – monitoring of natural conditions to supplement other monitoring including runoff volumes, ambient dust loads and noise levels. | FarmCo Manager     | 150,000  |
<table>
<thead>
<tr>
<th>Program</th>
<th>Description</th>
<th>Monitoring Location</th>
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<th>Parameters</th>
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<th>Responsible Person</th>
<th>Cost ZMK</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<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</td>
<td>Total dust levels</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

According to the results of the public consultations and baseline studies conducted, it is evident that implementation of the proposed Lusitu irrigation scheme will result in overall economic growth and development. The potential negative impacts can be easily mitigated without any major effect to the environment. Therefore, it is the opinion of the study team that social economic and environmental impacts resulting from operations at Lusitu 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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