Government of the Republic of Malawi

Ministry of Agriculture and Food Security

Irrigation, Rural Livelihoods and Agricultural Development Project

Environmental and Social Management and Monitoring Plan for Nkhate Irrigation Scheme – Chikwawa

January 2009
EXECUTIVE SUMMARY

This document is an Environmental and Social Management and Monitoring Plan (ESMP) for the rehabilitation of an existing Nkhate Irrigation Scheme located in Livunzu EPA in Chikwawa District in the Southern Region of Malawi. The ESMP is a strategic tool that will guide rehabilitation of the project in order to maximise socio-economic benefits whilst minimising adverse environmental and social effects that may arise from the rehabilitation activities.

Nkhate Irrigation Scheme was built by the Chinese (Taiwanese) Agricultural Mission between 1979 and 1980. The scheme is a gravity fed surface irrigation scheme with a net irrigable area of 233ha. The main crop grown in this scheme is rice, however maize, beans, sweet potatoes and pigeon peas are grown during the winter/dry season to a lesser extent.

The scheme is currently experiencing a number of challenges that include (but not limited to):

- siltation of Nkhate River and surrounding streams due to wash down of eroded materials from upstream cultivation activities,
- flooding of Nkhate River and surrounding streams resulting in loss of crop and damage to scheme infrastructure,
- low flow events resulting in areas not being irrigated
- siltation and blockage of intake structures of the scheme due to eroded sediments,
- lack of maintenance of structures resulting in water losses,
- reduced productivity due to soil degradation and continued loss of nutrients
- Lack of organisational structure and capacity amongst farmers in getting mobilised to access better credit to purchase inputs and better and more reliable markets for outputs.

Implementation of the project shall involve a number of rehabilitation activities that shall include (but not limited to):

- Rehabilitation of the existing weir and replacement of worn out or vandalised parts,
- Repair and rehabilitate main supply and distribution canals in order to minimise water losses and enhance irrigation water flow
- Construction of a storage reservoir for irrigation water
- Installation of water distribution structures like flumes in canals to improve water management,
- Land preparation and levelling of fields in the scheme,
- Reconstruction of drainage and flood protection structures,
- Improvement of electricity supply and potable water supply for the scheme
- Improvement of access roads for the scheme.

It is envisaged that project activities, both during the construction and operational phases, will potentially have both positive and negative impacts on the socio economic status and on the environment. The potential positive impacts shall include (but not limited to):

- Improvement of the socio-economic life of the farmers in the area through enhanced food security and access to income,
- Improvement in ecosystem management of Nkhate River and
- Gain of knowledge and skills related to agriculture and land resources management by farmers.

Potential negative impacts, on the other hand, will include (but not limited to):

- Loss of crop production during the construction phase,
- Surface/groundwater and soil pollution due to agricultural chemical inputs,
- Potential crop failure due to low flow in the river and resulting low flow conflicts with other stream users (up and downstream)
- Potential crop failure due to soil salinisation and excessive nutrient loss if no appropriate drainage water management practices are implemented
- Increased water borne and water vectored diseases if drainage water is not well managed
- Potential occupational safety incidents for construction workers

This Environmental and Social Management and Monitoring Plan has prescribed a number of mitigation measures for addressing the negative impacts. These include:-

- Improved soil and water management practices by beneficiary farmers
- River catchment conservation plan including introduction of widespread land conservation practices and rehabilitation of the riverine ecology (including tree planting)
- Introduction of sanitation infrastructure and launch of sensitisation programme on all water borne disease and HIV AIDS
- Implementation of Health and safety measures during construction phases

Furthermore, the plan has made recommendations on responsible authorities for effective implementation of the proposed measures. In general, most of the measures will be implemented throughout the project lifecycle.

A corresponding monitoring plan with associated verifiable indicators with baseline data has been prepared. The monitoring plan also indicates the frequency of monitoring and lists the responsible institutions for carrying out the monitoring activities,

In conclusion, this ESMP has provided recommendations to the implementing and monitoring stakeholders aimed at ensuring that the benefits of this plan are realised as expected. Overall, these recommendations have emphasised that unless the ecosystem of Nkhate River is properly managed and proper agricultural/land conservation practices are employed by farmers at all times, the sustainability of the scheme will be compromised and the benefits will not be realised as expected.
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1 INTRODUCTION AND BACKGROUND INFORMATION

1.1 Introduction
This document is an Environmental and Social Management and Monitoring Plan (ESMP) for the rehabilitation of an existing Nkhati Irrigation Scheme located in Livunzu EPA in Chikwawa District in the Southern Region. It is a strategic tool that will guide rehabilitation of the project in order to maximise socio-economic benefits whilst minimising adverse environmental and social effects that may arise from the rehabilitation activities.

Effective implementation of this ESMP will be dependent on concerted efforts by concerned stakeholders during the rehabilitation and throughout the project life span so as to sustain the expected benefits and avoid a decline in environmental quality.

1.2 Main Objective of the Environmental and Social Management Plan (ESMP)
The main objective of this Environmental and Social Management and Monitoring Plan is to identify potential environmental and social impacts, both negative and positive; analyse them and propose preferred measures for mitigating the negative impacts at various stages of the project. Furthermore, the plan recommends appropriate institutions as responsible authorities for the implementation and monitoring of the management plan.

1.3 Structure of the Report
This ESMP document is organised into 7 sections. Section 1 provides the introductory information to the document, including the objectives of the management and monitoring plan. Section 2 outlines the main objective of the project, its location and bio-physical attributes, current challenges being experienced by the scheme and the main project activities to be implemented. Section 3 provides an overview of the methodology for data collection and analysis during the development of this ESMP. Section 4 provides an outline of the physical, biological and socio-economic aspects of the scheme, while Section 5 outlines the environmental and social impacts of the project, both negative and positive, including the impact-severity matrix for negative impacts. Section 6 contains the environmental and social management and monitoring plans in tabulated format. Finally, the conclusions and recommendations of the ESMP are presented in Section 7 of the document. The Annexe of the document has a list of stakeholder consulted.
2.0 PROJECT DESCRIPTION

2.1 Location and brief history of the project site
Nkhate Irrigation Scheme site is situated in Livunzu EPA, Chikwawa District, in the Southern Region. The scheme is located 17 Kms from Thabwa turnoff along the East Bank Road. It is a gravity fed irrigation scheme commanding a land area of 243 ha which is irrigated by water drawn from Nkhate River and benefits a total of 1032 farmers at present.

A location map has been enclosed under Annexe 2.

Nkhate Irrigation Scheme was built by the Chinese (Taiwanese) Agricultural Mission between 1979 and 1980. The main crop grown in this scheme is rice, however maize, beans, sweet potatoes and pigeon peas are grown sometime during the year to a lesser extent.

Nkhate River flows from the eastern escarpment of the Shire River and falls over 1200 m gradient before it reaches the scheme’s in take point. Despite being perennial, Nkhate River is at present carrying large volumes of sand and boulders down towards the scheme resulting in destruction of some sections of the scheme. This is predominantly due to catchment degradation being caused by intensive cultivation and deforestation of uphill areas & riverine vegetation resulting in soil erosion. Nkhate Irrigation Scheme does not have a night storage reservoir for irrigation water and this deficiency undermines the potential of the scheme in utilising the water from Nkhate River for crop production.

2.2 Main objective of the project
The main objective of this project is to rehabilitate the infrastructure of Nkhate Irrigation Scheme in order to restore and enhance its productivity potentials so as to sustain the socio-economic status of the people in the area through increased food security and income without compromising environmental quality.

2.3 The main challenges being experienced by the scheme at present
Nkhate scheme is currently experiencing a number of negative impacts arising mainly from the degradation of the surrounding ecosystem and farmers’ management capacity deficiency. These include but not limited to:
   a) Siltation of Nkhate River and surrounding streams due to wash down of eroded materials from cultivation activities in the Shire escarpments resulting in reduced water flows;
   b) Diversion of Nkhate River and surrounding streams resulting in flooding of some sections of the scheme;
   c) Siltation and blockage of in take structures of the scheme due to eroded sediments;
   d) Degradation of Nkhate River catchment area and its riverine ecosystem;
   e) Lack of maintenance of structures resulting in water losses;
   f) Reduced productivity due to soil degradation and continued loss of nutrients;

2.4 Main rehabilitation activities to be undertaken
The main project activities for the rehabilitation of Nkhate Irrigation Scheme shall include the following:
   a) Rehabilitation of the weir to provide for better flow of water especially when levels are low;
   b) Rehabilitation of regulating gates at the low flow channel of the weir;
   c) Construction of a night storage reservoir (NSR) in to optimise efficient use of the available water resources
   d) Resurfacing by plastering some sections of the main supply canal and secondary canals in order to seal off exposed concrete aggregates thereby reducing water losses;
e) Improvement of the sand trap flushing channel for Nkhate River by establishing a 110 m long by 1m deep excavation with an invert 2m width;

f) Improving the carrying capacity of main canals 1 and 2 by raising their sides by 10 cm over a distance of about 70 metres;

g) Repair of hydraulic structures (weirs; gates; distribution boxes) in canals introduction of water measurement devised to improve water management

h) Construction of a new lined canal in order to improve supply of water to some blocks of the scheme, especially block P and Q;

i) Reconstruction of secondary canal embankments destroyed by farmers in their efforts to expand their plots;

j) Replacement of existing stop-log system or installation of steel lift gates, whichever is most appropriate and cost effective, to enable accurate diversion of water into feeder canals;

k) Reconstruction and improvement of existing tertiary canal net work

l) Land levelling in order to improve water flow gradient in some areas;

m) Re-excavation of field drains to a depth of 0.6 metres and invert width of 0.5 metres;

n) Unblocking some of the main external drains and construction of a number of culverts to carry water within these drains across internal access roads;

o) Reconstruction of all the flood protection structures

p) Repair and maintenance of staff houses through replacement of broken/worn out doors, window panes, ceilings, electrical wiring, plumbing works and general painting, amongst others;

q) Repair and maintenance of offices, workshops and sheds;

r) Installation of a transformer by ESCOM to power a grinding mill within the limits of the scheme office complex;

s) Improvement of portable water supply by installing an electrical submersible borehole pump and repairing pipelines and storage tanks;

t) Repair of all access roads, bridges and culverts.

u) Construction of washing points for surrounding communities along the main supply canal.

v) Construction of pit latrines at strategic points on the scheme to reduce incidence of water borne diseases.
3. METHODOLOGY FOR DATA COLLECTION

A number of methods for data collection were employed during the development of this ESMP; however the main ones include field survey through site observations, stakeholder consultations through interviews and focus group discussions; and literature review.

3.1 Field Survey

A number of field visit were conducted to the project site over the period May 2008 – December 2008 during which a detailed assessment was made for the rehabilitation of the Scheme. Specific discussions took place on 23rd December 2008 in order to hold discussions on the environmental and social impact of the proposed rehabilitation. This was done in order to appropriately ascertain the current problems and environmental challenges within the project area and to determine the type of impacts that will likely be experienced during implementation of rehabilitation activities of the scheme and the operation phase.

Some of the bio-physical components of the environment observed during the field visit include but not limited to ecological regime of the surrounding surface waters, especially Nkhate River, current land use practices on and around the project site, the type of water uses that compete with the scheme, the topography of the area, presence and sufficiency of sanitary hardware including latrines and sources of potable water.

3.2 Stakeholder Consultation

A number of stakeholders were consulted during data collection which included government departments’ personnel that had and will have a direct stake in the planning and implementation of the project. The personnel consulted were therefore from the Ministry of Irrigation & Water Development (District Irrigation Advisory Service Unit) and the Ministry of Agriculture and Food Security. Other stakeholders that were consulted include beneficiary farmers, scheme management committee members and the interim Water Users Association (WUA) committee members. Direct interviews and focus group discussions are the main methods that were used to capture information from these stakeholders.

3.3 Literature Review

Some of the information used in this ESMP came from published and unpublished literature. This information includes bio-physical parameters like water and soil quality, climatic conditions, topographic attributes of the area, flora and fauna, and demographic statistics, all of which were used to derive preferred mitigation and enhancement measures for the identified impacts of the project.
4. DESCRIPTION OF THE BIOLOGICAL, PHYSICAL AND SOCIO ECONOMIC ENVIRONMENT

4.1 Physical environment

4.1.1 Climate
Being in the Lower Shire Valley and having an altitude ranging between 70 and 100 masl the climate is characterised by high temperature during most months of the year. Rainfall is limited to the months of Dec – April and the LTM average is about 800mm per annum. Rainfall is unreliable and often erratic. Due to the high temperature evaporation and evapotranspiration are also high (approx 2000mm and 1780mm per annum respectively) A summary of the weather data for the closest weather station has been provided in Table 1 below. Detailed weather data can be obtained in the Preliminary Design Report.

<table>
<thead>
<tr>
<th>Month</th>
<th>Nchalo Total Rain (mm)</th>
<th>Nchalo Total pan (mm)</th>
<th>Kasinthula Max Temp</th>
<th>Kasinthula Min Temp</th>
<th>Chikwawa Rainfall (mm)</th>
<th>Nkhate Rainfall 1969-1990</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>182</td>
<td>185.1</td>
<td>170.7</td>
<td>5.5</td>
<td>33.4</td>
<td>23.3</td>
</tr>
<tr>
<td>February</td>
<td>136.1</td>
<td>157.5</td>
<td>149.8</td>
<td>5.3</td>
<td>33.1</td>
<td>23</td>
</tr>
<tr>
<td>March</td>
<td>99.9</td>
<td>168.3</td>
<td>160.1</td>
<td>5.2</td>
<td>32.8</td>
<td>22.5</td>
</tr>
<tr>
<td>April</td>
<td>35.1</td>
<td>151.3</td>
<td>144.1</td>
<td>4.8</td>
<td>31.6</td>
<td>20.8</td>
</tr>
<tr>
<td>May</td>
<td>12.7</td>
<td>129.7</td>
<td>122.6</td>
<td>4</td>
<td>30</td>
<td>17.5</td>
</tr>
<tr>
<td>June</td>
<td>14</td>
<td>108.9</td>
<td>100.9</td>
<td>3.4</td>
<td>28</td>
<td>15.3</td>
</tr>
<tr>
<td>July</td>
<td>18.6</td>
<td>120.3</td>
<td>112.4</td>
<td>3.6</td>
<td>27.8</td>
<td>14.9</td>
</tr>
<tr>
<td>August</td>
<td>7</td>
<td>157.1</td>
<td>155.6</td>
<td>5</td>
<td>30.1</td>
<td>16.1</td>
</tr>
<tr>
<td>September</td>
<td>7</td>
<td>200.1</td>
<td>199.1</td>
<td>6.6</td>
<td>33.1</td>
<td>18.8</td>
</tr>
<tr>
<td>October</td>
<td>14.4</td>
<td>247.4</td>
<td>244.7</td>
<td>7.9</td>
<td>34.9</td>
<td>21.2</td>
</tr>
<tr>
<td>November</td>
<td>55</td>
<td>240.2</td>
<td>232.3</td>
<td>7.7</td>
<td>35.6</td>
<td>22.7</td>
</tr>
<tr>
<td>December</td>
<td>131.3</td>
<td>198</td>
<td>186.2</td>
<td>6</td>
<td>34.2</td>
<td>23.2</td>
</tr>
<tr>
<td>Total/Avg</td>
<td>713</td>
<td>2064.1</td>
<td>1978.5</td>
<td>5.4</td>
<td>32</td>
<td>20</td>
</tr>
</tbody>
</table>

4.1.2 Topography,
The scheme is situated on the Rift Valley floor at the edge of the escarpment. The scheme has a gentle slope in the east to west direction dropping towards the Shire River. The adjacent escarpment (from which the Nkhate rises) is very steep and characterised by numerous stream and river valleys that cut through the slopes.
A contour and general layout map has been included in Fig. 1 overleaf Detailed drawings of the scheme and rehabilitation works can be found in the Detailed Rehabilitation Design Report.

4.1.3 Soils
Nkhate Soils are typically heavy sandy clays and sandy clay loams. They are suited to rice growing as they can hold water on the surface for prolonged periods. A soil survey identified 5 soil types of which one showed above normal salinity levels on the surface as well as at depth (60cm). An area of the scheme has also been inundated by flood waters and subsequent sediment deposition.
The soils have good inherent fertility and ability to hold nutrients, however due to repeated cultivation; some macro nutrients have become depleted which have to be replenished by application of fertilizers.
Nitrogen and Phosphorus are the two main nutrients which need to be applied according to crop requirements. Details of the soil survey and soil sample analysis can be obtained from the Preliminary Design Report.

Baseline data:
There is a requirement to collect representative samples of the entire scheme at depths 0-30cm and 30-60cm and conduct analysis for pH, salinity and basic cations (Ca and Mg and Na) to provide baseline information for future monitoring purposes. This data must be collected as early as possible.

4.1.4 Water resources

a) Water quantity

There is not sufficient water flow in the Nkhate River during the dry season to ensure that the entire scheme remains irrigated throughout the year. Furthermore, with the poorly functioning irrigation network (due to lack of maintenance and flood damage) and lack of night storage capacity only 50-80ha can be cultivated during the dry season (June-Dec).

Rehabilitation of the canal network and other infrastructure and introduction of an NSR will have a positive impact in reducing water losses through improved water conveyance, distribution and application, and water management.

Details of River flow data have been presented in the Table 2.

For future collection of river flow data, there is a requirement to rehabilitate and re-calibrate the existing river discharge gauging station and it is necessary to ensure that consistent records are kept.

Table 2. Average recorded LTM flow rates (m³/sec) for Nkhate River 1978-1995

<table>
<thead>
<tr>
<th>Nkhate Scheme</th>
<th>Nkhate River</th>
<th>Monthly Average Flows (m³/sec)</th>
<th>1978 to 1995</th>
<th>(Monthly Hydro records)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Season</td>
<td>Sept Oct Nov Dec</td>
<td>Jan Feb Mar Apr</td>
<td>May June July Aug</td>
<td>Average</td>
</tr>
<tr>
<td>1977-78</td>
<td>0.22 0.14 0.17 0.35</td>
<td>0.57 0.28 1.00 1.43</td>
<td>0.48 0.64 0.40 0.27</td>
<td>0.49</td>
</tr>
<tr>
<td>1978-80</td>
<td>0.26 0.24 0.21 0.40</td>
<td>0.65 1.91 1.80 1.02</td>
<td>0.68 0.52 1.04 0.39</td>
<td>0.76</td>
</tr>
<tr>
<td>1979-81</td>
<td>0.17 0.15 0.08 0.15</td>
<td>0.41 0.37 0.21 0.52</td>
<td>0.42 0.51 0.28 0.21</td>
<td>0.29</td>
</tr>
<tr>
<td>1980-81</td>
<td>0.41 0.20 0.15 0.16</td>
<td>0.36 1.30 1.42 0.69</td>
<td>0.74 0.40 0.36 0.28</td>
<td>0.54</td>
</tr>
<tr>
<td>1981-82</td>
<td>0.20 0.19 0.21 0.10</td>
<td>0.36 0.29 0.45 0.36</td>
<td>0.48 0.31 0.45 0.23</td>
<td>0.30</td>
</tr>
<tr>
<td>1982-83</td>
<td>0.20 0.10 0.12 0.17</td>
<td>0.35 0.34 0.44 0.30</td>
<td>0.12 0.27 0.21 0.48</td>
<td>0.26</td>
</tr>
<tr>
<td>1983-84</td>
<td>0.10 0.10 0.10 0.20</td>
<td>0.39 0.21 0.41 0.30</td>
<td>0.23 0.22 0.20 0.13</td>
<td>0.21</td>
</tr>
<tr>
<td>1984-85</td>
<td>0.20 0.48 0.23 0.63</td>
<td>0.92 1.20 2.50 3.32</td>
<td>0.73 0.53 0.36 0.47</td>
<td>0.96</td>
</tr>
<tr>
<td>1985-86</td>
<td>0.42 0.26 0.63 1.53</td>
<td>1.73 1.78 1.20 1.20</td>
<td>0.95 0.77 0.49 0.45</td>
<td>0.95</td>
</tr>
<tr>
<td>1986-87</td>
<td>0.18 0.07 0.20 0.60</td>
<td>0.80 0.87 0.29 0.30</td>
<td>0.25 0.16 0.14 0.20</td>
<td>0.34</td>
</tr>
<tr>
<td>1987-88</td>
<td>0.17 0.22 0.53 0.73</td>
<td>0.78 1.60 0.90 0.75</td>
<td>1.14 0.47 0.36 0.30</td>
<td>0.66</td>
</tr>
<tr>
<td>1988-89</td>
<td>0.22 0.20 0.38 0.31</td>
<td>0.00 0.05 1.00 1.14</td>
<td>0.74 0.74 0.45 0.28</td>
<td>0.51</td>
</tr>
<tr>
<td>1989-90</td>
<td>0.24 0.15 0.15 0.15</td>
<td>0.65 0.70 0.39 0.77</td>
<td>0.41 0.69 0.31 0.31</td>
<td>0.41</td>
</tr>
<tr>
<td>1990-91</td>
<td>0.15 0.27 0.17 0.25</td>
<td>0.29 0.83 0.31 0.48</td>
<td>0.31 0.35 0.21 0.21</td>
<td>0.32</td>
</tr>
<tr>
<td>1991-92</td>
<td>0.04 0.05 0.10 0.07</td>
<td>0.15 0.15 0.13 0.15</td>
<td>0.10 0.10 0.08 0.07</td>
<td>0.10</td>
</tr>
<tr>
<td>1992-93</td>
<td>0.10 0.10 0.08 0.20</td>
<td>0.20 4.50 0.36 0.25</td>
<td>0.19 0.10 0.15 0.14</td>
<td>0.53</td>
</tr>
<tr>
<td>1993-94</td>
<td>0.08 0.04 0.05 0.05</td>
<td>0.48 1.00 1.00 0.50</td>
<td>0.26 0.13 0.26 0.07</td>
<td>0.33</td>
</tr>
<tr>
<td>1994-95</td>
<td>0.05 0.05 0.05 0.40</td>
<td>1.22 0.90 1.20 0.60</td>
<td>0.40 0.24 0.11 0.10</td>
<td>0.44</td>
</tr>
<tr>
<td>Average</td>
<td>0.19 0.16 0.20 0.36</td>
<td>0.58 1.04 0.83 0.78</td>
<td>0.48 0.40 0.33 0.25</td>
<td>0.47</td>
</tr>
<tr>
<td>Max</td>
<td>0.42 0.48 0.63 1.53</td>
<td>1.73 4.50 2.50 3.32</td>
<td>1.14 0.77 1.04 0.48</td>
<td>0.96</td>
</tr>
<tr>
<td>Min</td>
<td>0.04 0.04 0.05 0.05</td>
<td>0.11 0.15 0.13 0.15</td>
<td>0.10 0.10 0.08 0.07</td>
<td>0.10</td>
</tr>
</tbody>
</table>
b) Water quality

Water from the Nkhate River is suitable for irrigation (physical; chemical and biological parameters); however there is a consistent problem of silt load during the rainy season that requires adequate measures at the intake and in the main canal to reduce silt contamination (the current sediment trap mechanism is not working well) River water is not suitable for human consumption, however, the borehole at the Scheme offices has good quality and is of acceptable quality for human consumption.

Provision of washing points, pit latrine toilet facilities and improving in-field and scheme drainage would positively reduce risk of water borne diseases. (Diarrhoea, cholera, malaria, and bilharzia).

Baseline data:
There is a requirement to collect additional water samples through a period of 1 year from predetermined and fixed points (including river, drainage and stored water) and carry out physical, chemical and biological analysis. This information will provide baseline data against which the performance of ESMP measures can be gauged.

4.1.5 Land

Following massive deforestation and intensified vegetation loss due to intensive unplanned arable farming without even minimal land conservation measures the Nkhate river catchment is experiencing accelerated soil erosion. Furthermore, uncontrolled and activities along the river banks (incl. other upstream irrigation activities) are causing massive damage to the River ecosystem and the banks of Nkhate River are being badly eroded. Massive silt and boulder loads result in clogging up the headworks and intake.

The southern dyke which protects the scheme form flood water from the Nkhate River has been badly damaged and breached in several places and needs urgent repair. The eastern dyke that protects the scheme form two tributaries (Tambala and Namichimba) also needs urgent repair to both the dyke and the storm drain that carries water past the scheme (currently nonexistent). Most of the dykes and storm water drains are being used to cultivate crops which results in more damage.

4.2 Biological environment

4.2.1 Vegetation and Flora

The scheme catchment area has over time experienced a lot of natural indigenous vegetation loss (forests and grasslands) as land demand is increasing with increased population numbers practicing arable agriculture (maize, pigeon peas, sweet potatoes), more roads being built and settlements growing up. The increase in population also results in higher demand for wood for fuel so many remaining trees (esp. riverine vegetation) is diminishing through tree harvesting for fuel wood.

The rehabilitation works will include minimal removal of natural vegetation for the construction works. The main impact will be removal of a number of trees and shrubs form the proposed NSR site.

4.2.2 Fauna

There are no recorded large wildlife species in the area apart from Hippos and crocodiles in Shire River that, at times, come up to the scheme to forage on crops and fish (crocs). Impact on these animals will be minimal. There are numerous (but not studied) bird, insect and reptile species within the project area that play an important role in the ecosystem.
According to the 2006/2007 livestock census, there were 5337 heads of cattle, 9995 goats and 204 sheep, 1124 pigs and 60,280 chickens in Livunzu EPA. The cattle, goats and sheep are often found grazing in the less productive (uncultivated) grasslands as well as the non cultivated areas within the scheme (e.g. drains).

A number of fish species are found in the canal network and the scheme fish ponds. Scheme rehabilitation will enhance occurrence of fish especially if the NSR is constructed - providing large body of well aerated water for fish production.

4.2.3 Riverine Ecosystem
The Nkhate river is currently characterised as being heavily degraded and having very little natural vegetation remaining. The lower parts of the river (adjacent to the scheme) have been inundated by excessive sediment and sand deposition.

Baseline data: There is a requirement to undertake a baseline survey of the river ecosystem to assess occurrence of key indicator aquatic species at set locations along the river that can be used for future comparisons to assess rehabilitation progress and availability of minimum ecological flow of the river.

4.3 Social and economic environment

4.3.1 Scheme Membership and Organisational Structure

Nkhate scheme has a total arable area of 233ha which is divided into 20 blocks each of approximately 12 ha. There are a total of 1032 scheme members each holding one or more plots. The beneficiaries are made up of 471 male members and 531 female members.

Farmers elect a Scheme Management Committee with the responsibility of scheme management. The committee is made up of 10 members (8 men and 2 women). There are a number of sub-committees as follows:

- **Block Committee.** Made up of the 22 Block Chairmen. Block Chairmen have the responsibility of managing water distribution, clearing canals of sand and grass, resolving of minor disputes and ensuring that all land is cultivated. Any unresolved disputes are referred back to the Scheme Management Committee.
- **Disciplinary Committee** with 4 members (3 men and 1 woman). Deal with any disciplinary issues affecting scheme management.
- **Finance Committee** with 4 members. Responsibilities include collection of the annual MK100/plot levy and MK500 entry fee, bank deposits and withdrawals for maintenance expenditure, reports back to farmers on the financial status.
- **Marketing Committee** with 10 members. Searches for markets, negotiates selling prices, checks that measuring devices, scales etc., are accurate
- **Audit Committee** with 4 members. Audits and reports on all financial transactions.

The scheme is being supported by Government who employ the Scheme Manager and a number of Agricultural Extension and Development Officers (AEDO’s).
4.3.2 Social Infrastructure around the Scheme

a) Health Facilities
There are two Health centres near the scheme namely Mapellela and Livunzu Health Centres. There is an under five clinic at Nkhate. The closest in-patient hospital is Chikwawa District Hospital.

b) Education Facilities
There are two primary schools around the scheme (Nkhate FP School and Jeke JP School). There is one Community Day Secondary School at Limpangwi.

c) Domestic Water Supply
There is an existing borehole at the scheme offices which has a manual pump. In the past there was a motorized pump which pumped water up to storage tanks which supplied a piped water system to all management houses and offices. This system is no longer functional and requires rehabilitation. Water tests of the borehole showed that the water is suitable for human consumption.

d) Electricity Supply
There is a power-line which passes the scheme office and housing complex, however there is no connection for power at both scheme offices and housing area. It would be beneficial if power supply was provided to the scheme offices and housing area.

e) Sanitation
There is one pit latrine at the scheme main office, however there are no latrines in the scheme itself. The scheme management houses have toilets and septic tanks but there is no running water in the houses. There is a requirement to install water supply to the management houses. In addition, there is a requirement to increase the number of latrines to improve sanitation throughout the scheme.

3.3.3 Access Roads
There is only one access road to the Scheme which is a gravel road that has sections which are in very bad condition (esp. drainage and bridges). This has a massive impact on the viability of the scheme as transport costs are high for all input sand outputs.

3.3.4 Telecommunications
Access by both CELTEL and TELEKOM mobile phone telecommunication networks is available at the scheme. There are no fixed lines or internet facilities.

3.3.5 Problems faced by Scheme members

The long serving farmer members mentioned the following as present social and economic problems:-

- Presently there is insufficient water to meet scheme requirements.
- Some areas are not being supplied by irrigation network (reduced area)
- Major water losses being experienced through lack of improved infrastructure (lining) and water management practices (distribution and scheduling).
- River flood damage is causing alot of damage to the scheme and reducing the arable irrigable area as well as threatening the scheme infrastructure.
- Poor condition of roads (both main access road and the scheme roads) result in high cost of transport.
• Lack of coordination amongst farmers to access reliable markets resulting in farmers being forced to accept low prices from middle men and vendors
• Lack of coordination of farmers to access credit and to negotiate reduced input costs with suppliers
• High cost of inputs – esp. fertilizers
• Lack of capacity building on crop production and marketing
• Reduction in the number of extension workers;
• Decline in productivity of the soils due to poor practices in the past (mono culture with no rotation) and lack of nutrient replenishment
5. DETERMINED ENVIRONMENTAL AND SOCIAL IMPACTS

Considering that Nkhate Irrigation Scheme is an already existing scheme, determination of impacts followed the auditing approach which ensures that both current and future impacts are brought into perspective at various stages of the project. Notably, the rehabilitation of this scheme will have both positive and negative impacts on the environment as outlined below.

5.1 Positive Environmental Impacts

These include but not limited to:

i. Enhancement of biodiversity conservation practices in the catchment area of Nkhate River;
ii. Restoration of Nkhate riverine ecology;
iii. Promotion of land resources conservation practices within the scheme area and amongst upstream communities;
iv. Enhancement of habitats for wildlife due to increased vegetative cover along Nkhate River and its catchment area as a result of riverine afforestation initiatives;
v. Reduced water losses due to rehabilitation of scheme intake and distribution canals;
vi. Improved drainage systems resulting in improved water and soil management;
vii. Reduction in flooding events in the scheme and related damage to crops.

5.2 Potential Negative Environmental Impacts

These include the following:—

i. Potential loss of nutrients due to soil erosion and leaching as a result of over-cultivation and over application of irrigation water;
ii. Potential Soil salinisation due to water logging that will result from poor drainage water management;
iii. Soil contamination as a result of persistent agricultural chemical inputs;
iv. Ground and surface water pollution due to agricultural chemical inputs and construction debris, as well as oil and fuel leakages from construction machinery;
v. Disturbance and loosening of soils due to earth moving works and mechanical cultivation;
vi. Noise and air pollution from construction machinery;
vii. Potential risk of crop failure or yield reduction due to soil salinity and nutrient loss;
viii. Potential loss of crop due to incorrect flood events into the scheme.

5.3 Potential Positive Social Impacts

These include the following:

i. Improved crop production capacity due to improved availability of irrigation water and increase in land for cultivation;
ii. Poverty reduction amongst farmers due to increased income from sales of surplus crop yields;
iii. Improvement in health and nutritional status of farmers due to availability of food at domestic level;
iv. Improvement in farming practices and techniques amongst farmers and surrounding communities as a result of IRLADP capacity building initiatives;
v. Creation of employment to surrounding communities during the construction phase.

5.4 Potential Negative Social Impacts

These include the following:—

i. During the construction phase, construction workers will likely be exposed to health and safety hazards that could lead to injury;
ii. Loss of crop production during the implementation of rehabilitation works
iii. Land use conflicts due to loss of agricultural land as a result of reclaim of riverine buffer zone;
iv. Increase in water borne and vectored diseases like bilharzias and malaria;
v. Accidents caused by drowning in drains and canals by both adults and children;
vi. Water use conflicts within the scheme as well as with up- and downstream users, due to increased demand for irrigation water against decreased water supply quantities.

5.5 Level of severity of Different Impacts.

The above mentioned impacts were assessed and classified according to level of severity (from 0 (no significant impact) to -3 (High adverse impact)) and according to length of impact (Short term to long term impacts). Table 1 (overleaf) provides an overview of the level of severity and the time frame for the identified impact for two phases of the project (construction and operation phases).

5.6 Suggested mitigation measures to overcome Potential Negative Environmental and Social Impacts

A number of mitigation measures have been suggested to mitigate and overcome the potential negative impacts associated with rehabilitation of the scheme. These mitigation measures have been listed in detail in Table 3 within the proposed ESMP. The proposed measures form part of the construction and operational stages.
Table 1: Impact – Severity Matrix for Negative Environmental and Social Impacts of the Project

<table>
<thead>
<tr>
<th>Project Phase</th>
<th>Bio-Physical and Social Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Terrestrial biodiversity</td>
</tr>
<tr>
<td>Construction Phase</td>
<td>-1M</td>
</tr>
<tr>
<td>Operational phase</td>
<td>0L</td>
</tr>
</tbody>
</table>

Legend:  
-1 = Low adverse impact  
-2 = Moderate adverse impact  
-3 = High adverse impact  
0 = No significant impact  
L = Long Term  
M = Medium Term  
S = Short Term
6 ENVIRONMENTAL AND SOCIAL MANAGEMENT AND MONITORING PLANS

6.1 ESMP

Table 3 (overleaf) provides a comprehensive overview of the suggested Environmental and Social Management Plan. The plan has taken into consideration only significant negative environmental and social impacts that require attention by concerned stakeholders, based on the existing and projected biophysical and social conditions in the project area, in order to avoid a decline in environmental quality and to ensure that benefits are sustained. The plans include the time frame in which the implementation is to be completed.

6.2. Estimated Budget for the ESMP

The estimated cost of implementation of the ESMP has been developed and a summary of which has been presented in Table 2 below. The costs have been generated from either the detailed BoQ from the Detailed design report.

Table 2 – Estimated ESMP budget

<table>
<thead>
<tr>
<th>Item</th>
<th>Activity</th>
<th>Estimated Total Cost</th>
<th>Annual Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Year 1</td>
</tr>
<tr>
<td>Collection of Water quality measurement</td>
<td></td>
<td>312,000</td>
<td>312,000</td>
</tr>
<tr>
<td>Baseline Information</td>
<td>Soil salinity samples</td>
<td>90,000</td>
<td>90,000</td>
</tr>
<tr>
<td></td>
<td>Assessment of Riverine Indicator Aquatic Species</td>
<td>375,000</td>
<td>375,000</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>75,000</td>
<td>75,000</td>
</tr>
<tr>
<td></td>
<td>Sub total - Baseline data Collection</td>
<td>852,000</td>
<td>852,000</td>
</tr>
<tr>
<td>Catchment Conservation plan</td>
<td>Coordination and administration</td>
<td>5,000,000</td>
<td>2,170,000</td>
</tr>
<tr>
<td></td>
<td>Farmer training land conservation practices</td>
<td>7,500,000</td>
<td>3,255,000</td>
</tr>
<tr>
<td></td>
<td>Tree nurseries and planting</td>
<td>5,500,000</td>
<td>2,387,000</td>
</tr>
<tr>
<td></td>
<td>Conservation crop nurseries and planting</td>
<td>7,000,000</td>
<td>3,038,000</td>
</tr>
<tr>
<td></td>
<td>Sub Total</td>
<td>25,000,000</td>
<td>10,850,000</td>
</tr>
<tr>
<td>River Training and Dykes</td>
<td>See detailed BoQ</td>
<td>46,828,300</td>
<td>28,096,980</td>
</tr>
<tr>
<td>Maintenance of dykes</td>
<td>See detailed BoQ</td>
<td>702,400</td>
<td>234,133</td>
</tr>
<tr>
<td>Maintenance of Drains</td>
<td>See detailed BoQ</td>
<td>161,400</td>
<td>53,800</td>
</tr>
<tr>
<td>Training of Farmers</td>
<td>Sustainable Practices and Soil Management</td>
<td>7,500,000</td>
<td>2,500,000</td>
</tr>
<tr>
<td>Health Sensitization campaign</td>
<td>HIV AIDS and Water Borne Disease Prevention</td>
<td>1,500,000</td>
<td>500,000</td>
</tr>
<tr>
<td></td>
<td>Installation of Water Supply</td>
<td>750,000</td>
<td>750,000</td>
</tr>
<tr>
<td></td>
<td>Installation of Electricity Supply</td>
<td>806,000</td>
<td>806,000</td>
</tr>
<tr>
<td></td>
<td>Installation of Pit Latrines</td>
<td>50,000</td>
<td>50,000</td>
</tr>
<tr>
<td></td>
<td>Total ESMP costs</td>
<td>84,150,100</td>
<td>44,692,913</td>
</tr>
</tbody>
</table>

6.3 Monitoring Plan

An Environmental and Social Monitoring plan has been presented in Table 4. The plan includes verifiable mitigation actions as well as verifiable indicators which can be compared to baseline (current) indicator information for both the construction and operational phases of the project. The plan also indicates the monitoring frequency and which institutions are deemed responsible to carry out the monitoring activities.
Where baseline information is not available, a budget with estimated costs of acquiring the information has been included in Table 2 above.

6.4 Environmental Audit Plan
The proposed audit plan for monitoring implementation of mitigation measures and their effectiveness is as follows:-

a) During the construction phase – monthly including contractor mobilisation and decommissioning
b) During the operational phase – every 6 months.

The audit would be carried out by IRLAD staff and EAD officials in conjunction with respective representatives from District offices.

6.5 Estimated Costs for Monitoring
The estimated costs for monitoring activities which are described in detail in Table 4 are listed below:-

<table>
<thead>
<tr>
<th>Monitoring Item</th>
<th>Analysis/Activity</th>
<th>No of Samples</th>
<th>Est. Cost per Sample (MK)</th>
<th>Estimated Total Cost</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groundwater analysis</td>
<td>Depth, Physical, Chemical and Biological Analysis</td>
<td>50</td>
<td>2,600.00</td>
<td>130,000</td>
<td>Annual</td>
</tr>
<tr>
<td>Soil Chemical Analysis</td>
<td>pH, Ec and Basic Cations analysis</td>
<td>230</td>
<td>1,200.00</td>
<td>276,000</td>
<td>Annual</td>
</tr>
<tr>
<td>Surface water quality analysis</td>
<td>Physical, Chemical and Biological Analysis</td>
<td>85</td>
<td>2,600.00</td>
<td>221,000</td>
<td>Annual</td>
</tr>
<tr>
<td>River Discharge Recording</td>
<td>Daily River Gauge Station Readings</td>
<td></td>
<td>12,500</td>
<td></td>
<td>Annual</td>
</tr>
<tr>
<td>Inventory of Riverine Ecology</td>
<td>Annual Surveys</td>
<td></td>
<td>125,000</td>
<td></td>
<td>Annual</td>
</tr>
<tr>
<td>Analysis of Catchment Conservation</td>
<td>Aerial Photos or Satellite Imagery</td>
<td></td>
<td>250,000</td>
<td></td>
<td>Every 3 years</td>
</tr>
<tr>
<td></td>
<td>Total estimated cost for monitoring</td>
<td></td>
<td></td>
<td>1,014,500</td>
<td></td>
</tr>
<tr>
<td>SN</td>
<td>Environmental/Social Impact</td>
<td>Type of Impact and Severity</td>
<td>Preferred Mitigation Action</td>
<td>Implementation Timeframe</td>
<td>Estimated Costs</td>
</tr>
<tr>
<td>----</td>
<td>------------------------------------------------------------------------------------------------</td>
<td>----------------------------</td>
<td>---------------------------------------------------------------------</td>
<td>---------------------------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>1.0</td>
<td><strong>Construction Phase</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1</td>
<td>Degradation of aquatic life downstream of the intake point on Nkhate River due to a decrease in water quantities;</td>
<td>Negative but low in severity</td>
<td>Ensuring a considerable flow of water beyond the intake point.</td>
<td>Immediate and daily control until commissioning</td>
<td>Part of construction contract</td>
</tr>
</tbody>
</table>
| 1.2| Water quality degradation in Nkhate River due to construction debris, as well as oil and fuel leakages from construction machinery | Negative and moderate in severity | i. Avoid and minimise pushing construction debris towards the river or storage of the same near the riverine  
ii. Timely maintenance of construction equipment to minimise unnecessary oil and fuel leakages;  
iii. Washing/servicing of construction machinery away from the river course or drains. | Immediate and daily control until commissioning | Part of construction contract | Contractor, Project Manager, Ministry of Irrigation and Water Development |
| 1.3| Disturbance and loosening of soils during excavations of irrigation water ways & water storage reservoir and land levelling/preparation; | Negative and moderate in severity | i. Appropriate compaction of access roads and earth lined canals to minimise erosion of soils by both wind and water;  
ii. Minimal tillage during land levelling to reduce amount and depth of soil loosening. | Immediate and weekly control until commissioning | Part of construction contract | Contractor, Project Manager |
| 1.4| Noise and Air pollution due to construction machinery and dust emission during excavations of irrigation water ways & water storage reservoirs and land levelling/preparation | Negative and moderate in severity | i. Use of ear protection;  
ii. Sprinkling of water, where appropriate, to minimise dust emission | Immediate and daily control until commissioning | Part of construction contract | Contractor, Project Manager, Department of Occupational Safety & Health of the Ministry of Labour. |
| 1.5| Exposure of construction workers to health and safety hazards like dust and equipment;          | Negative and moderate in severity | Provision of appropriate protective wear to workers and orientation on appropriate occupational & safety measures during construction | Immediate and daily control until commissioning | Part of construction contract | Contractor, Project Manager and Department of Occupational Safety & Health Ministry of Labour. |
| 1.8| Loss of crop production during the implementation of rehabilitation works.                      | Negative but moderate in severity | Adequate Planning  
Shortening the construction phase by engaging competent contractors | Immediate and weekly control until commissioning |                | Contractor Project Manager IRLADP                                                  |
<table>
<thead>
<tr>
<th>SN</th>
<th>Environmental/Social Impact</th>
<th>Type of Impact and Severity</th>
<th>Preferred Mitigation Action</th>
<th>Implementation Timeframe</th>
<th>Estimated Costs</th>
<th>Responsible Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.0</td>
<td>Operational Phase</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td>Degradation of aquatic life downstream of the intake point on Nkhate River due to a decrease in water quantities;</td>
<td>Negative and moderate in severity</td>
<td>i. Ensuring a considerable flow of water beyond the intake point, especially during periods of minimal river flow; ii. Appropriate supply of irrigation water to fields depending on crop-water demand to avoid unwarranted water over-abstraction.</td>
<td>i) Monthly monitoring of river flow – Apply min flow ii) Irrig. schedule implemented at start of each irrigation season Farmer training in Year 1-3</td>
<td>Catchment conservation: K25 million River training and Dykes: K46.8 million Maintenance of dykes: K700,000/</td>
<td>WUA, Ministry of Irrigation and Water Development.</td>
</tr>
</tbody>
</table>

| 2.2 | Risk of extreme flows (flooding and river drying up) which in turn will lead to loss of production and possible water use conflict amongst beneficiaries | Negative and high in severity | i. Develop integrated catchment conservation plan and along the Nkhate river ii. Improve river training and flood protection iii. Low flow conflict resolution mechanisms | Develop appropriate agro-chemicals list and programme year 1 Introduction of land conservation measures – Year 1 onwards Farmer training Year 1-3 | K25 million (as above) | Dept.of Land Resources/ Dept of Forestry IRLADP Ministry of Irrigation and Water Dev. Min of Agriculture |

| 2.3 | Ground and surface water pollution due to agricultural chemical inputs | Negative and high in severity | iv. Application of appropriate quantities of chemical inputs to avoid concentration of unused chemical load in soils; v. Promotion of appropriate agricultural and land conservation practices that enhances optimal water retention capacity of soils thereby minimising chemical movement through leaching and erosion; vi. Promotion of ecological methods for pest control to minimise use of pesticides. | Farmer training Year 1-3 | n/a | WUA, Ministry of Agriculture & Food Security and Ministry of Irrigation & Water Development. |

<p>| 2.4 | Loss of nutrients due to soil erosion and leaching as a result of over-cultivation and irrigation | Negative and high in severity | i. Promotion of appropriate agricultural and land conservation practices, including minimal tillage and compost making, amongst farmers; ii. Application of appropriate quantities of irrigation water to crops depending on crop-water demand requirements to avoid | Introduction of land conservation measures – Year 1 onwards Farmer training Year 1-3 | Training and Capacity Building:- K2.5 million per annum for 3 years | WUA, Ministry of Agriculture &amp; Food Security, Ministry of Irrigation and Water Development. |</p>
<table>
<thead>
<tr>
<th>SN</th>
<th>Environmental/Social Impact</th>
<th>Type of Impact and Severity</th>
<th>Preferred Mitigation Action</th>
<th>Implementation Timeframe</th>
<th>Estimated Costs</th>
<th>Responsible Institution</th>
</tr>
</thead>
</table>
| 2.5 | Soil salinisation due to water logging poor drainage water management | Negative and high in severity | i. Construction of sufficient drains at appropriate terrains to remove excess water and avoid blockage of the drains at all times;  
ii. Application of appropriate quantities of irrigation water to crops depending on crop-water demand requirements to avoid water logging | Drainage Maintenance Year 1 onwards | K7.5 million | Contractor, Project Manager, WUA, Ministry of Irrigation and Water Development. |
| 2.6 | Soil contamination as a result of persistent agricultural chemical inputs | Negative and high in severity | i. Application of appropriate quantities of chemical inputs to avoid concentration of unused chemical load in soils;  
ii. Promotion of organic farming through use of compost manure in order to minimise inorganic fertilizer inputs;  
iii. Use of agro-chemicals (pesticides, herbicides etc) with short degradation cycle. | Year 1 onwards | Capacity Building and field demonstrations: K450,000 per annum | Ministry of Agriculture and Food Security |
| 2.7 | Siltation of the intake point due to sediment transported from upstream of the intake point; | Negative and moderate in severity | i. Use of silt/debris traps on the intake system to prevent clogging of the system;  
ii. Promotion of appropriate agricultural and land conservation practices on fields upstream of the intake point to minimise soil erosion;  
iii. Conservation of vegetation and re-planting of trees along Nkhate River. | Catchment conservation initiatives Year 1-3 Farmer training Year 1-3 | Sensitization campaigns: K500,000/annum for 3 years K1.5 mln | Contractor, Project Manager, Ministry of Agriculture and Food Security, Department of Forestry, WUA. |
| 2.8 | Land use conflicts due to loss of agricultural land as a result of reclaim of riverine buffer zone | Negative but low in severity | Incorporation of farmers with loss in agricultural land into the scheme area. | Year 1 onwards | As above | WUA |
| 2.9 | Increase in water borne and vectored diseases like bilharzias and malaria; | Negative and moderate in severity | i. Sensitization of farmers on proper sanitary behaviour in the scheme area when undertaking agronomic practices;  
ii. Promotion of appropriate sanitary practices in the surrounding communities;  
iii. Minimise water logging in the scheme | Year 1 onwards | As above | WUA, Ministry of Health, Ministry of Irrigation and Water Development |
<table>
<thead>
<tr>
<th>SN</th>
<th>Environmental/Social Impact</th>
<th>Type of Impact and Severity</th>
<th>Preferred Mitigation Action</th>
<th>Implementation Timeframe</th>
<th>Estimated Costs</th>
<th>Responsible Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>through appropriate irrigation techniques.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.10</td>
<td>Proliferation of HIV/AIDS due to increased promiscuity as a result of increased income amongst farmers;</td>
<td>Negative and high in severity</td>
<td>Sensitization of farmers and surrounding communities on issues related to HIV/AIDS</td>
<td>Year 1 onwards</td>
<td>As above</td>
<td>Ministry of Health</td>
</tr>
<tr>
<td>2.11</td>
<td>Water use conflicts due to increased demand for irrigation water against decreased water supply quantities</td>
<td>Negative and high in severity</td>
<td>i. Establishment of an appropriate system on sharing of water by farmers; ii. Application of appropriate quantities of irrigation water to crops depending on crop-water demand requirements.</td>
<td>Year 1 onwards</td>
<td>As above</td>
<td>WUA, Ministry of Irrigation and Water Development.</td>
</tr>
<tr>
<td>2.12</td>
<td>Accidents caused by drowning in drains and canals by both adults and children.</td>
<td>Negative and high in severity</td>
<td>i. Sensitization of farmers and surrounding communities on the dangers related to drains and supply canals; ii. Provision of access cross-over points, in a form of bridges, at strategic places on canals and drains.</td>
<td>Year 1 onwards</td>
<td>As above</td>
<td>Contractor, Project Manager, Farmers, WUA.</td>
</tr>
<tr>
<td>2.13</td>
<td>Loss of crop due to flood events into the scheme.</td>
<td>Negative and high in severity</td>
<td>i. Construction of flood protection structures like bunds and drains on the boundaries of the scheme; ii. Stabilization of the banks of Nkhate River and surrounding streams by reclaiming and re-vegetating the buffer zone; iii. Promotion of appropriate agricultural and land conservation practices on fields upstream of the River/streams to minimise siltation due to soil erosion</td>
<td>During Construction and annual maintenance thereafter</td>
<td>As above (2.2)</td>
<td>Contractor, Project Manager, Forestry Department, Department of Land Resources Conservation</td>
</tr>
<tr>
<td></td>
<td><strong>Total Estimated Costs</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>K84.15 million</strong></td>
<td></td>
</tr>
</tbody>
</table>
## Table 4: Environmental Monitoring Plan

<table>
<thead>
<tr>
<th>SN</th>
<th>Environmental Impact</th>
<th>Type of Impact and Severity</th>
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<tbody>
<tr>
<td>1.0</td>
<td>Construction Phase</td>
<td>Degradation of aquatic life downstream of the intake point on Nkhate River due to a decrease in water quantities; Negative but low in severity due to insignificant abstraction of water.</td>
<td>Ensuring a considerable flow of water beyond the intake point.</td>
<td>Volume of water flowing in Nkhate River and presence of indicator aquatic species</td>
<td>M3/sec or l/s of river flow</td>
<td>Daily flow readings</td>
<td>Project Manager, Ministry of Irrigation and Water Development WUA</td>
</tr>
</tbody>
</table>
| 1.1 | 1.2 | Water quality degradation in Nkhate River due to construction debris, as well as oil and fuel leakages from construction machinery | Negative and moderate in severity | i. Avoid and minimise pushing construction debris towards the river or storage of the same near the riverine  
ii. Timely maintenance of construction equipment to minimise unnecessary oil and fuel leakages;  
iii. Washing/servicing of construction machinery away from the river course or drains. | Weekly check of river flow  
Clauses in contract | Weekly during construction | Contractor, Project Manager, Ministry of Irrigation and Water Development |
| 1.3 | Disturbance and loosening of soils during excavations of irrigation water ways & water storage reservoir and land levelling/preparation; Negative and moderate in severity | i. Appropriate compaction of access roads and earth lined canals to minimise erosion of soils by both wind and water;  
ii. Minimal tillage during land levelling to reduce amount and depth of soil loosening. | Clauses in contract  
Verification of contract activities  
Number of beneficiaries and contract employees trained in erosion control | Amount of soil eroded  
Visible signs of gulleys and other erosion features | Weekly during construction by consultant  
Monthly Audit | Contractor, Project Manager |
| 1.4 | Soil erosion by wind Negative but low in severity | i. Minimise depth of tillage of soils during land levelling;  
ii. Sprinkling water on tilled surfaces to minimise blowing off of soils by wind | Amount of soils eroded | No. of complaints by communities surrounding the site | Weekly during construction contract | Contractor, Project Manager |
<p>| 1.5 | Noise and Air pollution due to dust emission during excavations of irrigation Negative and moderate in severity | i. Avoid earth-moving construction works on windy days; | Identification of noise dust prone areas. Implementation of dust | No. of complaints by communities surrounding the site | Weekly during construction contract | Contractor, Project Manager |</p>
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<tr>
<td>1.6</td>
<td>Exposure of construction workers to health and safety hazards like dust and equipment;</td>
<td>Negative and moderate in severity</td>
<td>ii. Sprinkling of water, where appropriate, to minimise dust emission</td>
<td>control measures Enforcement of ear protection</td>
<td>Record of the number of occupational health and safety incidents or accidents Availability of protective wear amongst workers</td>
<td>Number of incident and accident free days. Record of accidents</td>
<td>Daily during construction contract</td>
</tr>
<tr>
<td>1.7</td>
<td>Loss of crop production during the implementation of rehabilitation works.</td>
<td>Negative but moderate in severity</td>
<td>Shortening the construction phase by engaging competent contractors</td>
<td>Land area cultivated and frequency of cultivation</td>
<td></td>
<td></td>
<td>Contractor, IRLADP</td>
</tr>
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### 2.0 Operational Phase

#### 2.1 Degradation of aquatic life downstream of the intake point on Nkhate River due to a decrease in water quantities;

- Negative and moderate in severity
- i. Ensuring a considerable flow of water beyond the intake point, especially during periods of minimal river flow;
- ii. Appropriate supply of irrigation water to fields depending on crop-water demand to avoid unwarranted water over-abstraction.

- i)Volume of water flowing in Nkhate River and presence of indicator aquatic species
- ii)Irrigation Schedule
- iii)Water Management Records

- M3/sec or l/s of river flow above and below offtake
- Comparison of indicator to baseline
- mm of water applied per ha vs water requirement

- Daily flow readings
- Annual inventory of indicator species
- Daily irrigation records

- Ministry of Irrigation and Water Development WUA, |

#### 2.2 Risk of extreme flows (flooding and river drying up) which in turn will lead to loss of production and possible water use conflict amongst beneficiaries

- Negative and high in severity
- i. Application of appropriate conservation practices on fields upstream of intake point
- ii. Improve river training and flood protection
- iii. Develop integrated catchment conservation plan and along the Nkhate river
- iv. Low flow conflict resolution mechanisms

- Availability of silt traps at in-take point
- Presence of appropriate land conservation practices on fields upstream of intake point
- Regular Flow measurements
- Amount of vegetation along Nkhate River

- Daily record of silt level in sediment trap. Ha’s of effectively conserved land in catchment vs target. M3/sec or l/sec river flow
- Ha’s of riverine forest (by aerial photo or direct measurement).

- Daily
- Annual
- Daily
- Annual

- Ministry of Agriculture and Food Security, Department of Forestry, WUA |

#### 2.3 Ground and surface water

- Negative and high in severity
- i. Application of appropriate conservation practices on fields upstream of intake point

- Availability and Chemical analysis

- Representative

- Ministry of
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<tr>
<td></td>
<td>pollution due to agricultural chemical inputs</td>
<td>High in severity</td>
<td>quantities of chemical inputs to avoid concentration of unused chemical load in soils;</td>
<td>implementation of appropriate water management practices.</td>
<td>Ground and scheme surface water samples compared to baseline soil data</td>
<td>Annually</td>
<td>Ministry of Agriculture and Food Security and Ministry of Irrigation &amp; Water Development. WUA</td>
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<td></td>
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<td></td>
<td>i. Promotion of ecological methods for pest control to minimise use of pesticides.</td>
<td>Regular collection and analysis of surface and ground water samples</td>
<td>Amount of IPM and organic pest control methods</td>
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<td></td>
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<td></td>
<td>ii. Regular collection and analysis of surface and ground water samples</td>
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<td></td>
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<td>Availability of appropriate water management practices</td>
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<td>2.4</td>
<td>Loss of nutrients due to soil erosion and leaching as a result of over-cultivation and irrigation</td>
<td>Negative and high in severity</td>
<td>i. Promotion of appropriate agricultural and land conservation practices, including minimal tillage and compost making, amongst farmers; ii. Application of appropriate quantities of irrigation water to crops depending on crop-water demand requirements to avoid water logging and subsequent leaching of nutrients.</td>
<td>Regular collection and analysis of soil samples</td>
<td>Chemical analysis of soil samples compared to baseline soil data Verifiable land conservation structures per ha vs target</td>
<td>Annually</td>
<td>WUA, Ministry of Agriculture &amp; Food Security, Ministry of Irrigation and Water Development.</td>
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<td>2.5</td>
<td>Soil salinisation due to water logging and poor drainage water management</td>
<td>Negative and high in severity</td>
<td>i. Construction of sufficient drains at appropriate terrains to remove excess water and avoid blockage of the drains at all times; ii. Application of appropriate quantities of irrigation water to crops depending on crop-water demand requirements to avoid water logging</td>
<td>Regular collection and analysis of soil samples</td>
<td>Level of Soil EC vs benchmark and baseline No and capacity of drains per ha No of functional well maintained drains</td>
<td>Annual audit</td>
<td>WUA, Ministry of Irrigation and Water Development.</td>
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<td>2.6</td>
<td>Soil contamination as a result of persistent agricultural chemical inputs</td>
<td>Negative and high in severity</td>
<td>i. Application of appropriate quantities of chemical inputs to avoid concentration of unused chemical load in soils;</td>
<td>Regular collection and analysis of soil samples</td>
<td>Chemical analysis of soil samples compared to baseline soil data</td>
<td>Annual</td>
<td>Ministry of Agriculture and Food Security</td>
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| 2.7 | Siltation of the intake point due to sediment transported from upstream of the intake point; | Negative and moderate in severity | i. Use of silt/debris traps on the intake system to prevent clogging of the system;  
ii. Promotion of appropriate agricultural and land conservation practices on fields upstream of the intake point to minimise soil erosion;  
iii. Conservation of vegetation and re-planting of trees along Nkhate River. | Availability of silt traps at intake point  
Ha’s of appropriate land conservation practices on fields upstream of intake point  
Amount of vegetation along Nkhate River monitored by aerial photo’s | Daily record of silt level in sediment trap.  
Ha’s of effectively conserved land in catchment vs target.  
M3/sec or l/sec river flow  
Ha’s of riverine forest (by aerial photo or direct measurement). | Daily  
Annual  
Daily  
Annual | Ministry of Agriculture and Food Security, Department of Forestry, WUA. |
| 2.8 | Land use conflicts due to loss of agricultural land as a result of reclaim of riverine buffer zone | Negative but low in severity | Incorporation of farmers with loss in agricultural land into the scheme area. | Absence of land use conflicts amongst farmers | Recording system for land-use conflicts | Annual summary of records | WUA |
| 2.9 | Increase in water borne and vectored diseases like bilharzias and malaria; | Negative and moderate in severity as awareness in hygienic practices is already prevalent in the area. | i. Sensitization of farmers on proper sanitary behaviour in the scheme area when undertaking agronomic practices;  
ii. Promotion of appropriate sanitary practices in the surrounding communities;  
iii. Minimise water logging in the scheme through appropriate irrigation techniques. | Records of water borne diseases’ prevalence  
Availability of appropriate sanitary hardware such as toilets and potable water in surrounding communities | Incidence of disease per unit of population vs baseline data (2008)  
Water analysis vs baseline  
No of toilets | Monthly (MoH)  
Monthly (Central Water Laboratory)  
Annual | Ministry of Health, Ministry of Irrigation and Water Development WUA |
<p>| 2.10 | Proliferation of HIV/AIDS due to increased | Negative and high in | Sensitization of farmers and surrounding communities on issues | Sensitisation campaign | Incidence of disease per unit of | Annual | Ministry of Health |</p>
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<td></td>
<td>promiscuity as a result of increased income amongst farmers;</td>
<td>severity</td>
<td>related to HIV/AIDS</td>
<td></td>
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<td>2.11</td>
<td>Water use conflicts due to increased demand for irrigation water against decreased water supply quantities</td>
<td>Negative and high in severity</td>
<td>i. Establishment of an appropriate system on sharing of water by farmers; ii. Application of appropriate quantities of irrigation water to crops depending on crop-water demand requirements to avoid water wastage.</td>
<td>Establishment of effective WUA structures – esp on conflict resolution</td>
<td>Number of Conflicts related to water use amongst farmers</td>
<td>Annual</td>
<td>WUA, Ministry of Irrigation and Water Development.</td>
</tr>
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<td>2.12</td>
<td>Accidents caused by drowning in drains and canals by both adults and children.</td>
<td>Negative and high in severity</td>
<td>i. Sensitization of farmers and surrounding communities on the dangers related to drains and supply canals; ii. Provision of access cross-over points, in a form of bridges, at strategic places on canals and drains.</td>
<td>Sensitization events</td>
<td>Number of accidents in drains and canals</td>
<td>Annual</td>
<td>WUA. Ministry of Irrigation and Water Development</td>
</tr>
<tr>
<td>2.13</td>
<td>Loss of crop due to flood events into the scheme.</td>
<td>Negative and high in severity</td>
<td>i. Construction of flood protection structures like bunds and drains on the boundaries of the scheme; ii. Stabilization of the banks of Nkhate River and surrounding streams by reclaiming and re-vegetating the buffer zone</td>
<td>Effective flood water control structures in place Maintenance of flood water control structures Catchment conservation initiatives (see 2.1 and 2.2)</td>
<td>Records of flood incidents</td>
<td>Annual</td>
<td>WUA, Ministry of Irrigation and Water Development Foresty Department, Department of Land Resources Conservation</td>
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7.0 CONCLUSIONS AND RECOMMENDATIONS

The Nkhate Irrigation Scheme has a high potential to further improve the socio-economic profile of the communities in Livunzu EPA for the better. However, there is need to ensure that the proposed mitigation measures outlined in this management and monitoring plan are given prior consideration at appropriate stages of the project as suggested. All the beneficiaries and responsible implementing and monitoring stakeholders will have a role in the effective sustainability of this project.

Below are the recommendations for this Environmental and Social Management and Monitoring Plan, which have dwelled much on the sustainability of the scheme as a function of the stability of the ecosystem in and around the project area. Thus;

a) The stability and sustainability of rehabilitated infrastructures at Nkhate Scheme will depend on the management efforts of scheme beneficiaries as well as prime stakeholders like government departments and Non Governmental Organisations (NGOs); otherwise the benefits of the rehabilitation efforts will be short-lived. Catchment management shall require coordinated efforts by Nkhate Scheme and upstream farmers in order to put in place land resource management measures. Government departments will also be required to coordinate their efforts throughout the project life; examples of which are the Forestry Department and Water Development Department that will be expected to put in place catchment management programmes for Nkhate River Water Shed.

b) Proper water management practices in the scheme will require strict adherence at all times in order to avoid soil salinity. This is because soil salinisation has been known to shorten lifespans of irrigation schemes dramatically worldwide and in the process causing significant irreversible adverse socio-economic effects on beneficiaries;

c) Vandalism of scheme infrastructure will require stringent preventive measures other wise the efficiency of some of the scheme’s processes will be compromised. The scheme irrigation management committee will be required to strengthen its by-laws and enforcement of the same in order to arrest the malpractice.
REFERENCES


### ANNEXE 1: List of Stakeholders Consulted During the Assessment

1. Mr Godfrey Malunga  
   President, Water Users’ Association (WUA)

2. Mr Elton Mulikho  
   Member, Nkhate Irrigation Management Committee;

3. Mr Watson Kusowa  
   Member, Nkhate Irrigation Management Committee;

4. Mr Peter Kamwaza  
   Secretary, Water Users’ Association (WUA)

5. Mr Thom Enerst  
   Vice Secretary, Water Users’ Association (WUA)

6. Village Headman Mmodzi

7. Mrs Liness Jabesi  
   Agricultural Extension Development Officer

8. Mr Donnex Zopangana  
   Scheme Manager
ANNEXURE 2 – LOCATION MAP NKHATE SCHEME