Ministry of Water and Sanitation **Blantyre Water Board**

MALAWI WATER AND SANITATION PROJECT-1 (MWSP-1)

Terms of Reference: Feasibility and Detailed design of Mulanje Dam, Mombezi Multipurpose Dam and Associated Structures

PROCUREMENT REFERENCE: MW-BWB-333207-CS-QCBS

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1.0 INTRODUCTION

1.1. Background

The Government of Malawi (GoM) is committed to providing adequate, reliable and sustainable water and sanitation services to the urban, peri-urban, towns and rural population of Malawi to meet the ever-increasing demand for safe water for domestic, institutional, industrial, commercial and agricultural use. One focus area is Blantyre City, which currently faces a number of challenges related to water supply and sanitation services delivery. Some of the challenges include; high population growth, dwindling water resources, climate change, lagging infrastructure development and aging water and sanitation systems with high levels of non-revenue water creating large gaps between supply and demand, leading to unreliable services. The current water and sanitation situation in the city is alarming, which calls for comprehensive measures that will bring about sustainable and reliable improved services.

GoM through Blantyre Water Board (BWB) and Blantyre City Council (BCC) with financial support from the International Development Agency (IDA) of the World Bank intends to implement the Malawi Water and Sanitation Project-1 (MWSP-1). The MWSP-1 seeks to address the immediate and medium-term water and sanitation needs and support a long-term solution to Blantyre City's growing demand for improved water services and safely managed sanitation services.

BWB and BCC which are the implementing entities for the MWSP-1 commit themselves to successful implementation of the project which aligns with Malawi's development goals as well as strategic plans for the two institutions. The project is consistent with the Government's priorities, as it directly aligns with Malawi's commitment to improving urbanization as stipulated in the Malawi 2063.

1.1 Project Development Objective and Components for the Malawi Water and Sanitation Project (MWSP)

The project development objective (PDO) is to increase access to improved water supply and sanitation services in Blantyre metropolitan area and to enhance the operational and financial efficiency of the Blantyre Water Board. The PDO will be achieved through development and rehabilitation of water and sanitation infrastructure for Blantyre City and surrounding areas so that the city has adequate and reliable potable water supply with sufficient pressure and improved sanitation services. The project focuses on four components that contribute to the achievement of the PDO.

Component 1: Water supply improvements

This component (which is the object of the current ToRs) will finance investments to improve water production, stabilize and improve network operational efficiency, reduce water losses,

increase energy efficiency, improve water supply service quality, and expand water access to unserved areas, increasing energy efficiency, and boosting water access. The component will also finance studies which will focus on ensuring sustainability of future water demand from dam sources.

Component 2: Priority sanitation investments

This component involves several interventions to increase access to safely managed sanitation and reduce environmental pollution that has public health impacts. This component is not part of the present ToR.

Component 3: Institutional capacity strengthening

This component will finance a set of institutional development activities aimed at enhancing BWB's financial efficiency and governance systems through a Performance Based Financing Mechanism (PBFM), improving BCC's capacity to manage sanitation services and supporting the water sector investment planning and policy development to enhance the sustainability of urban water services.

Component 4: Technical Assistance (TA) and Project Management Support

This component will finance TA activities designed to support the project implementing unit and the incremental operating costs for project management, including safeguards, communications, and project monitoring and evaluation. The project will also finance relevant training to enhance financial management, procurement, and safeguards capacity for the implementing entities.

1.2 Mombezi and Makuwa Dam Water Source

In the years 2009-2012, Government of Malawi through Blantyre Water Board received funds from the International Development Association (IDA) to finance the National Water Development Project II (NWDP II). Part of the portion of the proceeds was used to finance studies for a new water source for Blantyre.

Sogreah Consultants and Henderson & Partners were engaged and carried out feasibility study and preliminary design for Blantyre's new water source. The results of the multi-criteria analysis carried out at the Feasibility Study stage showed that the "Mombezi – Makuwa" scheme was the best option provided that the dam is designed as a multi-purpose dam to enable the development of an irrigation scheme. The considered scheme will supply water to meet: Additional drinking water demand by the year 2035: 94,310 m^3 /d, Irrigation demand: 13,720 m^3 /d (247 ha), Fisheries demand: 335 m^3 /d during dry season. Figure 1, shows the selected and associated preliminary design.

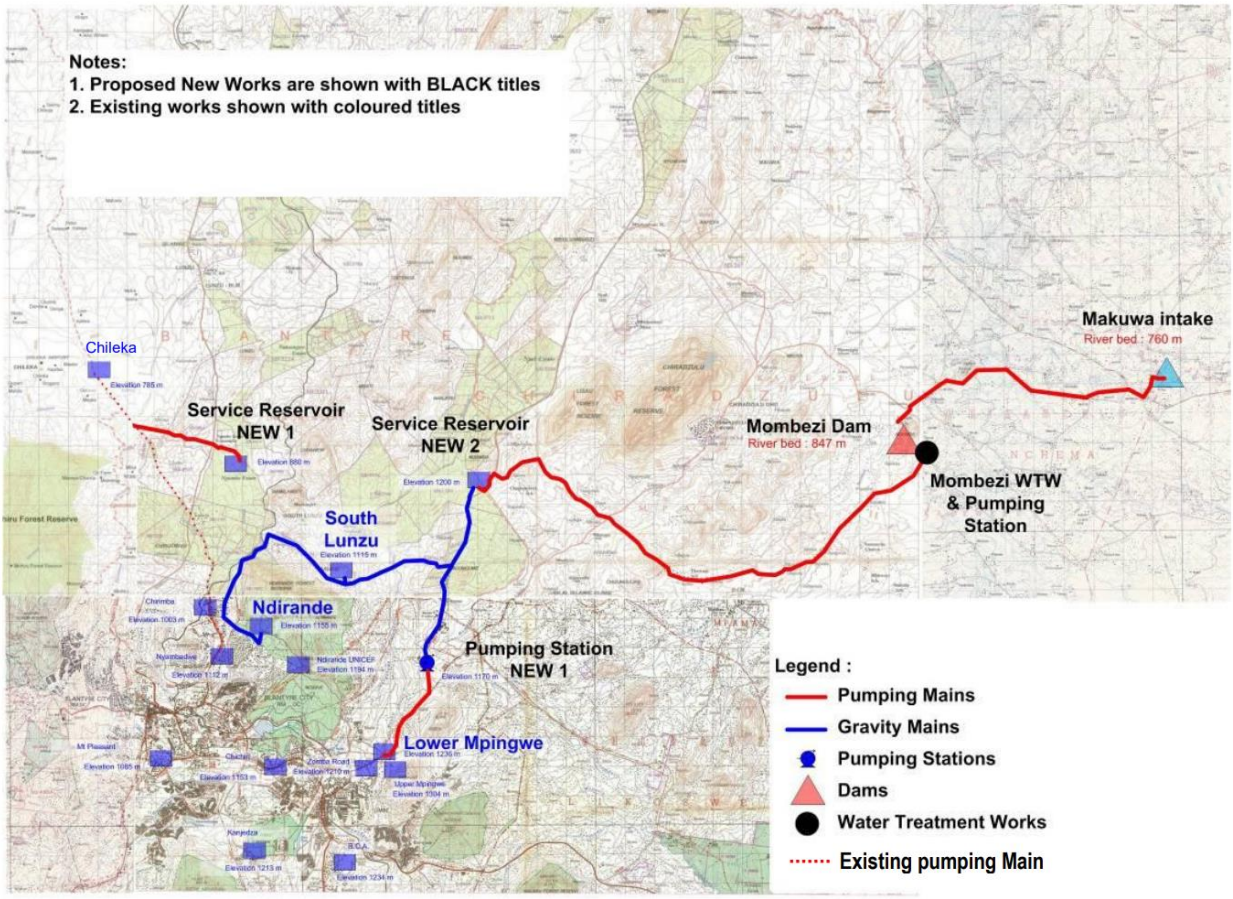

Figure 1: Mombezi Dam Design

Based on preliminary design report (Appendix-1), the system was considered to have the following facilities:

Dam and an Intake- The Mombezi dam was designed to have an active storage capacity of 71.6 Mm ^{3} and a maximum height of 48 m including the freeboard and would be a rockfill dam. Due to its height, two saddle dams were provided on left and right banks. The spillway was designed to directly blast in the outcrop of the hill on the right bank and will allow spilling the damped Maximum Probable Flood, i.e.2,400 m^3/s. The water intake is located within a draw off tower located on the right bank. The tower was

designed to be accessible using the tower itself and a gallery at its bottom, containing the outlet pipes.

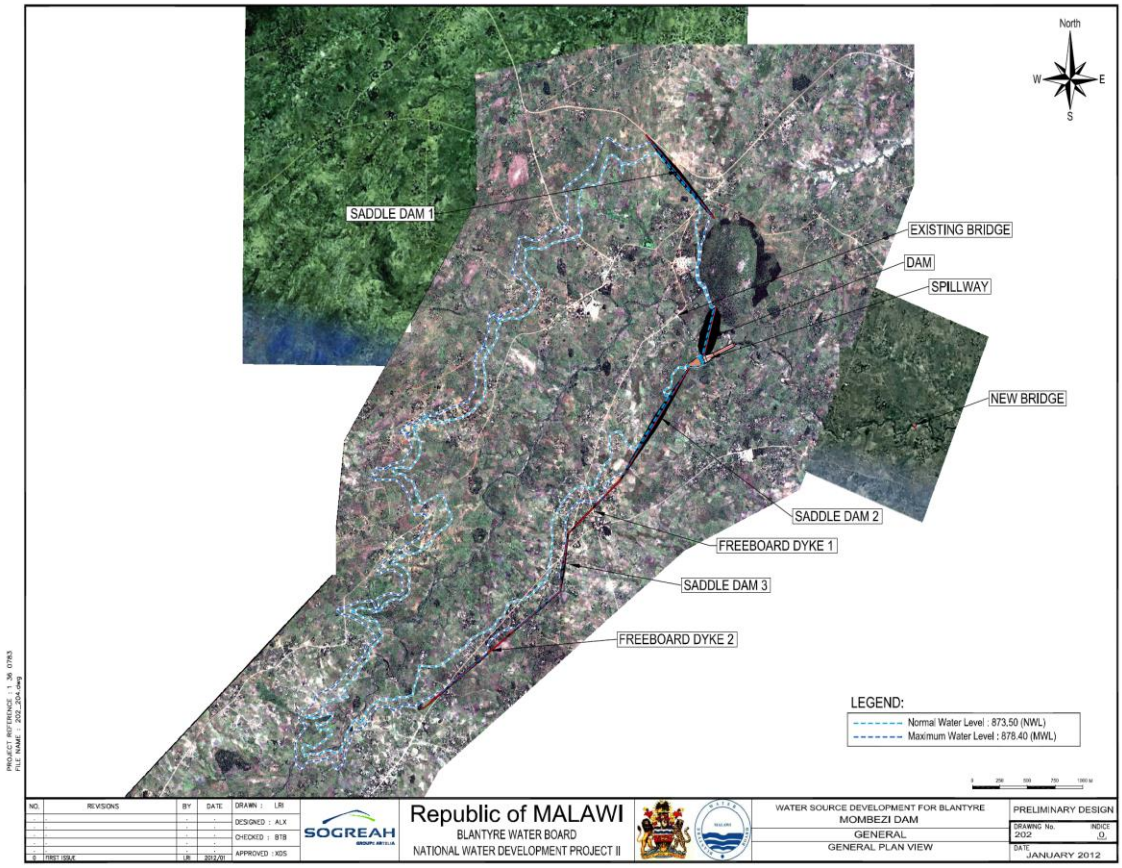

Figure 2: General layout of the Dam

Water treatment plant- The water treatment plant was designed to be located around 1 km downstream of the dam, on the right bank of the river. Its capacity is 57,500 m^3/d for the first stage and 57,500 m^3/d too for the second stage. The proposed process was a conventional process (coagulation, flocculation, filtration, disinfection). Sludge was designed to be treated through lagoons filled over a year time and with a hydraulic residence time of 48 hours. The supernatant was designed to be sent back to Mombezi River.

Water transmission system- The transmission system was designed to comprise of (i) three (3) pumping stations, (ii) pipelines ranging from 250mm to 900mm for a length of around 100km and (iii) three (3) new reservoirs, of which two of them would be constructed with the city of Blantyre while one would be located at the treatment works.

Makuwa intake -The so-called "Makuwa" intake was designed to increase the yield of the dam by increasing artificially its runoff through a water transfer from the nearby

Namadzi River. This river intake is located some 10 km eastward of the dam, upstream of an existing bridge. It will collect all the water of the river from the minimum environmental flow of 53 l/s up to the maximum flow of 2.3 m^3/s. The river intake was designed to comprise of (i) a weir across the river with a calibrated weir for the environmental release, (ii) a pipe intake in the shelter of a stilling basin, (iii) the pumping station. Two pipelines DN 900 mm would convey the water up to Mombezi dam. The interest of this dual pipeline is to avoid sedimentation in a large pipeline when the transferred flow is low (in that case, only one pipeline is used).

Project duration and cost- The overall duration of the works was estimated to be around 2.5 years with an additional 1 year for filling the dam. The estimated cost of the project in the year 2012, was US$186 million including a 12 % contingency

The feasibility study and preliminary design however, did not carry out the following critical investigations:

- Topographical surveys: for the pipeline route (strip survey along the pipeline routes)
- Geotechnical surveys: additional boreholes and laboratory testing
- Complete water quality analyses on Mombezi River for the design of the water treatment plant.

The consultant would therefore be expected to review the available feasibility study and preliminary designs and come up with a revised feasibility study and a detailed design for the construction of Mombezi Dam.

1.3 Dam for the Mulanje Water Supply system

In 2019 Blantyre Water Board therefore implemented and commissioned a new water supply system from Mulanje River in Mulanje to keep pace with the ever-increasing demand of portable water in the short to medium term with support from the Government of India (GOI)'s Line of Credit (Exim Bank). The project was designed to produce a maximum of 20,000 m^3/day.

The objectives of the project were two-fold, namely:

- to supplement the existing water supply systems from Walkers Ferry and Mudi Dam by adding 20,000 m^3/day, and hence sufficing the present demand of water.
- to help in reducing the exorbitant electricity costs as the system is largely operated under gravity, specifically the raw water transmission main. Consequently, help in leveraging the operational costs.

The design of the Mulanje water supply system is mainly dependent on the amount and availability of water in the Mulanje river throughout the year. These two parameters have therefore been studied. Apart from flow measurements that were carried at different seasons of the year by the Board, the design also used the previous reports (e.g. Sogreah, 2012) to analyse

the yearly flows. The average flows in the Mulanje River on month-to-month basis was found as follows:

Table 1: Average flows in Likhubula River (Sogreah 2012)

Month	Flows For Mulanje (m^3/Day)
Jan	117,158.40
Feb	158,215.68
Mar	182,131.20
Apr	154,897.92
May	84,326.40
Jun	55,987.20
Jul	41,264.64
Aug	30,274.56
Sept	21,772.80
Oct	15,759.36
Nov	20,044.80
Dec	57,784.32

Apart from being a source of water for Blantyre Water Board the Mulanje River is currently serving other organisations and individual through several abstraction rights. The major abstractions are being done by Tea Estate Companies and Southern Region Water Board besides minor uses from the surrounding communities in the riparian region. Sogreah 2012 provides a list of water abstraction rights and their corresponding withdrawal quantities. Some more abstractions were added as they had come after the Sogreah report. The maximum total abstraction was found to be 27,101.00 m^3 per day.

Table 2: Abstraction rights for Likhubula River (Sogreah 2012)

Entity	Amount (m^3/Day)
Eastern Produce Mw Ltd	403.10
Eastern Produce Mw Ltd	204.30
Mandala Ltd Chakali Estate	2,292.00
Mandala Ltd Chakali Estate	4,583.00
Mandala Ltd Chakali Estate	1,968.00
Mandala Ltd Chakali Estate	720.00
Eastern Produce Mw Ltd	1,818.00
British African Tea Estates	1,818.00
Eastern Produce Mw Ltd	68.30
Sayama Tea Estate	622.00
Lujeri Tea Estate Ltd	262.00
Chief Water Supply Officer	1,590.00

Synod of Blantyre	230.00
British African Tea Estates	1,818.00
Eastern Produce Mw Ltd	1,818.00
Eastern Produce Mw Ltd	1,818.00
Eastern Produce Mw Ltd	68.30
Southern Region Water Board	5,000.00
Total Abstraction	27,101.00

Based on the analysis of available flows and abstraction requirements from other water users and stakeholders, it was established that the Mulanje River would only manage to meet the desired design capacity for eight months of the year with minimal or no abstraction in the months of August, September, October and November which ae lean flow months. The situation of flows in the rivers has also been recently excavated by climate change and catchment degradation. The Mulanje system therefore is not complete to sustainably provide the required production for the whole year and as such there is need to construct a multi-purpose dam in order to ensure sustainable provision of water throughout the year. The construction of the dam would also only be sustainable if complemented with associated catchment restoration activities in the Mulanje mountain.

Under this consultancy component, the Consultant shall be expected to carry out a full feasibility study and detailed design for the construction of a dam for the Mulanje water supply system.

2.0 OBJECTIVES

2.1 Main Objective

The main objective of this consultancy work is to conduct feasibility study and prepare detailed designs and bidding documents of Mulanje and Mombezi Multipurpose Dams and associated infrastructure.

2.2 Specific Objectives

a. Mulanje Dam

The specific objectives are:

- Conducting a technical, financial and economic feasibility study for construction of the dam;
- Carrying out a full Environmental and Social Impact assessment for the construction of the Dam;
- Preparing an optimized design of Mulanje dam coupled with associated infrastructures and the conveyance system to Nguludi Treatment Works;
- Carrying out detailed design of the Mulanje dam and associated infrastructures (including the conveyance system) to Nguludi Treatment Works;
- Reviewing the designs for Nguludi Treatment Works and Associated Infrastructures and recommend whether expansions are necessary in line with the proposed dam works;
- Preparing the dam safety management plan (DSMP) including the Construction Supervision and Quality Assurance Plan (CSQAP), the dam Instrumentation Plan (IP), the Operation & Maintenance (O&M) Plan, and the Emergency Preparedness Plan (EPP), in compliance with ESS4-Annex 1 and following recommendations of WB's Good practice note on dam safety (https://openknowledge.worldbank.org/handle/10986/35484); and
- Preparing bid documents for the Mulanje dam coupled with associated infrastructures (including the conveyance system) to Nguludi Treatment Works

b. Mombezi Dam

The Specific objectives are:

a. Reassessing to confirm or suggest better recommendations of the existing feasibility (Technical, Environmental and Social, financial and economic) studies of the Mombezi dam;
b. Reviewing and updating the preliminary design of the Mombezi dam, Makuwa intake, Treatment plant, the conveyance network to Blantyre and associated structures;
c. Carrying out detailed design of the Mombezi dam, Makuwa intake, Treatment plant, the conveyance network to Blantyre and associated infrastructures;
d. Preparing the dam safety management plan (DSMP) including the Construction Supervision and Quality Assurance Plan (CSQAP), the dam Instrumentation Plan (IP),

the Operation & Maintenance (O&M) Plan, and the Emergency Preparedness Plan (EPP), in compliance with ESS4-Annex 1 and following recommendations of WB's Good practice note on dam safety (https://openknowledge.worldbank.org/handle/10986/35484); and

e. Preparing bid documents for the Mombezi dam, Makuwa intake, Treatment plant, the conveyance network to Blantyre and associated structures.

3.0 SCOPE OF WORK

The Consultant is required to carry out a full Feasibility Study and Detailed Designs of the Mulanje and Mombezi Multipurpose Dams and all the required infrastructural works and dam safety measures for the project in accordance with World Bank requirements. The details of the scope of work for this assignment shall comprise, but not limited to, the following:

3.1 Baseline Data

3.1.1 Topography

The consultant is required to carry out Engineering and topographic surveys for the proposed Dam sites and associated infrastructure to aid design and best route determination for associated pipe works.

3.1.2 Hydrology and Climate

a. Describe general hydrological characteristics of the river basins of Mulanje and Mombezi Dams.
b. Examine and validate all available historical hydrological and climatological information used for the design of Mulanje and Mombezi Dams.
c. Provide an updated available long-term daily runoff record;
d. Simulate catchment runoff as a required input to multipurpose project optimisation modelling that involves water supply, irrigation, fisheries and environmental water needs;Provide flood analysis for dimensioning the discharge works of Mulanje and Mombezi Dams. Outputs shall be peak river flows (with probability P = 0.01%, P = 0.1% P = 1% and P = 5% and Probable Maximum Flood), and corresponding hydrographs.
e. Carry out a reservoir volume analysis and surface area as a function of water depth;
f. Provide input to the environmental and social impact assessments in the form of maps of the multipurpose dam, indicating inundated areas for the various potential project designs as a basis for the planning of resettlement and compensation arrangements for people living in areas that will be inundated or affected by the new dam;
g. Design and establish hydrological (flows and water quality) and meteorological (rain, wind, evaporation, temperature) stations to monitor the inflows and outflows for the dam;
h. Design and establish a sampling station for monitoring of suspended sediment transport;
i. Assess the amount of sediments, which can be expected to accumulate in the dam created;
j. Assess the influence of future land use within the catchment, in order to evaluate the risks for increased sediment transport due to deforestation increased agricultural activities etc.;

k. Determine appropriate methods to manage dam sedimentation, including sediment sluicing, flushing, by-passing, reduction of sediment inflow to the dam such as soil conservation, reforestation programmes, erosion control, vegetation protection etc.;
l. Determine the nature of the sediments that can be expected to enter the project's waterways, in order to facilitate design and choice of equipment;
m. Assess and determine the design of de-sanders, in order to economically reduce the accumulation of sediments in the dam and entry of sediments into the project's waterways.
n. Carry out hydrological time series analysis to establish precipitation-runoff regime as a basis for estimation of inflows into the dam.

3.1.3 Geology and seismicity

The Consultant will undertake geological and geotechnical investigations to ensure adequate capacity to support the dam including: geological interpretation and designs taking into account environmental and social concerns, design of site works and cofferdams, and materials sources and borrow-pits opportunities.

The geological and geo-technical investigations will include the activities to the extent considered necessary by the Consultant as suggested in the following:

a. Carry out the core drilling at the site of the dam and tunnels including rock stress measurements comprising: (i) Core drilling, augering and test pit excavations, (ii) diamond core drill holes with core sampling and water leakage tests drilled along the proposed dam axis and in critical sections along the tunnel alignments, etc;
b. Undertake geophysical surveys such as seismic refraction surveys, in order to (i) obtain information on rock weathering and soil overburden depth; (ii) obtain information/indications on variation in soil overburden strata; (iii) localise any fault zone in the bedrock; (iv) obtain information on the depth of open fractured bedrock; (v) obtain data on rock mass quality;
c. Carry out a Seismic Hazard Assessment including an earthquake hazard study for the project site, providing earthquake-loading estimates as a function of annual exceeding probability;
d. Evaluate landslide risks including geo-technical features and risks of landslides in the reservoir;
e. Perform test pit and trench excavations in the dam and reservoir areas and at potential source sites for construction materials to: (i) identify nature of soil overburden types with respect to slope stability, future foundation design and excavation works;(ii) investigate the potential material sources for filter and impervious cores in embankment dams; (iii) investigate potential aggregate materials; (iv) evaluate stability of banks in the future reservoir(s); (v) assess depth of loose and weak materials to be removed at dam foundations; and (vi) allow for disturbed and undisturbed soil sampling for laboratory testing. The Consultants should also suggest additional tests, and the associated unit rates; however, the latter will NOT be used in the evaluation. Final investigation program will be agreed at inception stage with the selected Consultant
f. Tests on rockfill materials (density, Los Angeles test, Unconfined Compression Test, Petrography, Alkaline Reaction Test, e.t.c)

g. Tests on earthfill materials (density, water contents, Atterberg limits, friction angle, cohension.)

The consultant shall as a result of the regional geological assessment and the geotechnical and geophysical investigation produce a Geotechnical Baseline Report (GBR) for the Mulanje and Mombezi Dams, which will provide input for the feasibility design. The GBR aims to establish a contractual understanding of the site conditions, referred to as the geotechnical / geological baseline. The procedure of data acquisition, analysis and interpretation must be transparent and according to accepted international standards and practice. (see, for example "ASCE 2007, Geotechnical Baseline Report for Construction – *Suggested Guidelines").*

The Consultant shall prepare regional geological maps, regional geological cross sections and seismic-tectonic maps. The consultant shall integrate geological, geophysical, and geotechnical investigations into topographic maps and establish the engineering geological conditions of the project area and components (dam, intake works, etc.).

The consultant shall identify potential or possible special problems or risks related to the dam foundation, spillway and energy dissipation structures, intake works, reservoir slopes, etc.

3.2 Feasibility Study

3.2.1 Mulanje Dam

Carry out a full Feasibility Study for construction of a multi-purpose dam. The study will include but not limited to:

a. Carry out technical assessment and determine the final location of the proposed dam. This analysis shall present alternatives and propose the optimum option to be taken forward into the detailed design stage. It will describe key decision points, triggers and uncertainties to be refined in subsequent design stages;
b. The economic and financial analysis to ascertain validity of the selected option (Internal rate of return analysis, identification and analysis of costs and benefits).
c. Carry out Preliminary Environmental and Social Impact assessment to identify Positive and Negative Impacts of the proposed Dam guided by the Government of Malawi's regulations and the World Bank Safeguards policies.

3.2.2 Mombezi Dam

Review the existing Feasibility study and preliminary design and further enhance the study in areas not limited to:

a. Technical assessment and determination the final location of the proposed dam. Evaluate previous identified alternatives and propose the optimum option to be taken forward into the detailed design stage;
b. The economic and financial analysis to ascertain validity of the selected option (Internal rate of return analysis, identification and analysis of costs and benefits).

c. Carry out a review of the previous Preliminary Environmental and Social Impact assessment to identify Positive and Negative Impacts of the proposed Dam and associated Infrastructure guided by the Government of Malawi's regulations and the World Bank Safeguards policies..

3.3 Detailed Designs

Carry out the detailed design of Mulanje and Mombezi Dams. The study will include but not limited to:

a. Prepare detailed designs of Dam works (As power is a major operational cost for BWB the design of the systems should ensure energy efficiency).
    i. Carry out a preliminary design including but not limited to the following parameters (i) storage reservoir size; (ii) spillway capacity; (iii) dam height, slopes and other key dam data; (iv) design head; (v) design discharge; (vi) the corresponding saddle dams and the reservoir. The design of the dam should include downstream aprons to protect downstream scouring, the required concrete mixing ratios and all the necessary reinforcing steel to concrete structures;
    ii. Conduct detailed designs for the components of the dams;
    iii. Carry out physical model tests, if required, to optimize design of spillway and energy dissipation structures, including derivation of performance indicators to be included in the Operation and Maintenance Plan of the Dam (see below).
    iv. Design spillway with energy dissipation devices based on the optimal solution in terms of construction and operation;
    v. Design instrumentation and monitoring facilities, and include relative description, operation procedures, design-based reference values, in the Instrumentation Plan of the Dam (see below);
    vi. Design and develop safety measures including flooding and incorporate relative instructions in the O&M Plan and Emergency Preparedness Plan (EPP) (see below);
    vii. Design and develop a mechanism for preventing and controlling aquatic weeds in the reservoir and at the intakes; and
    viii. Design aquatic life migration mechanisms (if and where necessary), e.g. fish ladders.
    ix. Conduct financial, economic and risk analysis, and propose a financing strategy
b. Design Auxiliary works and Temporally structures:
    i. Prepare detailed designs of intake works (with facility to abstract water at different level), pumping station(s), transmission mains and storage facilities for water supply;
    ii. Carry our pre-feasibility studies for potential irrigation sites for Mombezi Dam;
    iii. Identify, and map construction campsites and associated temporary facilities needed during the construction period.
    iv. Design all the necessary coffer dams arrangements and water diversion routines that will be used during the construction of the dam, and design necessary measures to maintain normal (environmental) river flow;

v. Identify and prepare layout of power supply system to cover the needs during and after construction including permanent power supply to the treatment and pump stations.

c. Design a cathodic protection system for the pipelines taking into account the cathodic protection to existing pipelines and effects of power lines;
d. Detailed design suitable protection against water hammer including specifications of characteristics of check valves on pump delivery pipe work;
e. Carry out an assessment of access roads to the intake site and design the access roads and other infrastructure (e.g. offices, staff accommodation, guard house, power, water and sanitation facilities);
f. Prepare detailed construction drawings for the dam and all associated works designed.
g. Prepare drawings for any associated electrical works for the dam if applicable which shall include single line diagrams for main items of equipment and the associated control systems, supplemented and developed into complete layout drawings showing connections to all equipment and fixtures, electrical circuits and wiring/cabling schedules specifying gauge and number of wires/cores, conduit diameters and their layout and all pertinent details.
h. Show clearly all mechanical equipment for the dam on the plans, including its mechanical and electrical connections and general installation details.
i. Construction plans for the water transmission main shall show location and profiles with details of all appurtenances such as cut-off valves, drains, air release valves, thrust blocks, and special installation details where necessary including details of road and river crossings;
j. Design instrumentation and control systems for the dam system to support decision support on efficient system management and automated operation. This shall include specification of sensors, telemetry, visualization for system operators as well as control rooms at Nguludi and BWB main offices. The control system should permit manual operation in the event of instrument failure;
k. Prepare construction implementation framework which shall include packaging for procurement, the construction plan for each construction phase, location of construction camp sites and associated temporary facilities needed during the construction period.;
l. Identify and prepare layout of temporary power supply system to cover the needs during construction;
m. Prepare necessary and detailed institutional arrangements including manuals for operation, servicing and maintenance of the system; and
n. Identify sources of construction materials.

3.4 Dam Safety Management Plan

The Consultant shall Prepare the DSMP, including the Construction Supervision and Quality Assurance Plan (CSQAP), the dam instrumentation plan (IP), the Operation and Maintenance (O&M) Plan, and the Emergency Preparedness Plan (EPP) in compliance with Environmental Social Standard 4 and following recommendations of World Bank's Good practice note on dam safety and related appendices (https://openknowledge.worldbank.org/handle/10986/35484);

3.5 Environmental and Social Impact Assessment

The consultant shall conduct a detailed Environmental and Social Impact Assessment (ESIA); and Prepare an Environmental and Social Management Plan (ESMP), with the associated Environmental and Social Monitoring Plan for the construction of Mulanje and Mombezi Dams.

The broad scope to carry out Environment and Social Impact Assessment of the Mulanje and Mombezi dam will be guided by the Government of Malawi's regulations and the World Bank Safeguards policies. The activities to be undertaken by the Consultant under this task shall include the following, but not necessarily limited to:

a. Scoping of environmental and social issues;
b. Description of the proposed project components;
c. Description of the Policy, Legislative, Regulatory and Institutional framework;
d. Description and establishment of environmental and Socio-Economic baseline conditions of the project;
e. Public participation and consultations and grievances redress mechanism (GRM);
f. Analysis and determination of potential Environmental and Social impacts of the project;
g. Propose mitigation measures to adverse Environmental and Social Impacts of the project;
h. Development of an Environmental and Social management Plan (ESMP); and
i. Preparation of an Environmental and Social Management Monitoring Plan (ESMMP).

3.6 Preparation of Tender Documents

The Consultant shall prepare tender documents for the construction of the Mombezi Multipurpose Dam and Mulanje Dam and their associated infrastructures. Specifically, the Consultant should:

a. Prepare tender documents including contract documents, specifications and bill of quantities for civil works for the dams, including unit rates associated with tasks related to the ESMP provisions, site investigation and laboratory tests, all electro-mechanical works for the dam, intake structure, pumping station, transmission mains and storage structures;
b. Prepare engineers cost estimates for all the works.
c. Prepare terms of reference for the consultancy on construction supervision and quality assurance of all works for the construction of the dam and associated works. Tasks should cover the organization, staffing levels, procedures, equipment, and qualifications for supervision of the construction of the dam.

The Consultant should produce design drawings in CAD and PDF format with sufficient scale and described in sufficient detail of all the components of the works under this assignment.

The submissions shall be in accordance with the appropriate version of the World Bank Guidelines and Standard Bidding Documents for the Prequalification process and Procurement of works.

A complete set of Tender documents shall comprise of:

- Part 1 - Bidding Procedures;

- Part 2 - Works Requirements (scope of works, specifications, environmental and social requirements, drawings and supplementary information)
- Part 3 - Conditions of Contract and Contract Form.

4.0 EXPECTED DELIVERABLES AND TIMEFRAME

The consultancy assignment is expected to be conducted over a period of 18 calendar months.

Table 5 below provides a summary of the expected deliverables during this period. For each deliverable, the consultant shall prepare and submit to the Client one [1] electronic copy, preferably in MS Word, on CD Rom/ Flash Pen and five (5) hard copies of the reports

Table 3: Summary of the Expected Deliverables for Mulanje Dam

Report No.	**Report Description**	**No. of hard copies (Microsoft Word format)**	**Due date** (No. of months from commencement date)
1	Inception	5	0.5
2	Pre-feasibility Study Report for irrigation potential	5	2.5
3	Draft report on optimized design of dam	5	5.0
4	Final report on optimized design of dam	5	6.0
4	Site Investigations and associated Geotechnical Baseline Report;	8	9.0
5	Hydraulic model tests report	5	12.0
6	Risk Register.	5	12.0
7	Draft detailed design report	10	14.0
8	Final detailed design report	10	16.0
9	Draft construction framework	5	14.0
10	Final construction framework	10	16.0
11	Draft institutional arrangement	10	14.0
12	Final institutional arrangement	5	16.0
13	Dam Safety Management Plan	5	15.0
14	Draft tender documents	5	14.0
15	Final tender documents	5	17.0
16	Draft consultancy report	5	16.0
17	Final draft consultancy report	5	17.0
18	Terms of Reference for Construction Supervision and quality assurance	5	17.0
19	Final consultancy report	10	18.0

Table 4: Summary of the Expected Deliverables for Mombezi Dam

Report No.	Report Description	No. of hard copies (Microsoft Word format)	Due date (No. of months from commencement date)
1	Project Management Plan (PMP)	5	0.5
2	Pre-feasibility Study Report for irrigation potential	5	2.5
3	Draft report on optimized design of dam	5	5.0
4	Final report on optimized design of dam	5	6.0
4	Site Investigations and associated Geotechnical Baseline Report;	8	9.0
5	Hydraulic model tests report	5	12.0
6	Risk Register.	5	12.0
7	Draft detailed design report	10	14.0
8	Final detailed design report	10	16.0
9	Draft construction framework	5	14.0
10	Final construction framework	10	16.0
11	Draft institutional arrangement	10	14.0
12	Final institutional arrangement	5	16.0
13	Dam safety management plan	5	15.0
14	Draft tender documents	5	14.0
15	Final tender documents	5	17.0
16	Draft consultancy report	5	16.0
17	Final draft consultancy report	5	17.0
18	Terms of Reference for Construction Supervision and quality assurance	5	17.0
19	Final consultancy report	10	18.0

5.0 TEAM COMPOSITION & QUALIFICATION REQUIREMENTS FOR THE KEY EXPERTS

The Consultant shall provide a team of experts all of whom shall be adequately qualified and experienced in their respective fields and be eligible for registration with the relevant professional bodies in Malawi. The following is a guide on the expected minimum staff requirements and minimum qualifications and experience of the personnel:

(a) The **Team Leader** shall have a multi-disciplinary experience in the interventions on the detailed design works of dam projects. In particular, he/she should have:

(i) At least a Masters Degree in Hydraulic engineering or Civil Engineering with a minimum of 15 years relevant experience in design and supervision of dam construction, but also in team leadership in similar projects;
(ii) Be affiliated to relevant professional bodies;
(iii) Proven capabilities in handling multi-disciplinary donor funded projects of this nature;
(iv) worked in African or developing countries preferably in SADC Region

b) A **Dam Design Engineer** with a minimum of a Masters degree in Civil Engineering or equivalent and at least 10 years relevant experience in conventional dams, run-of-river dams, river diversion etc or a minimum of a BSc in Civil Engineering or equivalent with at least 15 years experience.
The team shall have at least one seasoned Large Dams Engineer with experience in dam monitoring equipment;

c) **A Geologist/Seismologist**, with a minimum of a Master Degree in Geology and at least 10 years relevant experience. S/he should have experience in seismic hazard assessment, including the identification of sources of seismic activity, the assignment of earthquake magnitudes to each source, and the methodology for determining vibration parameters at the site for maximum credible and design basis earthquakes.

d) A **Geo-technical Engineer** with a minimum of a Masters degree in geotechnical engineering or equivalent with at least10 years experience, or a minimum of a BSc in Civil Engineering with at least 15 years experience in geo-technical works;

e) A **Water Supply Engineer** with a minimum of a Masters Degree in Water Engineering or related field with at least10 years of professional experience in related field. He / She should have experience in design of urban water supply conveyance systems in the last five years or a minimum of a BSc in Civil Engineering with at least 15 years experience in water supply works.

f) A **Hydrologist/Hydraulics Specialist** with a minimum of a Master's Degree in Hydraulics/Water Resources or equivalent with at least 10 years' relevant experience in hydrological and hydraulic modelling, and dam break analysis. The specialist will model and plot the flood hydrographs generated by dam failure and the estimation of flood water levels in the downstream area. The specialist will review and update of the critical design flood and the hydraulic design of the spillways and outlet works.

g) An **Electrical Engineer** with a minimum of a Masters degree in electrical engineering or the relevant field with experience of at least 10 years in design of water related infrastructure such as electrical equipment of spillway and outlet works of dams, pumping works, or a B.Sc. in Mechanical Engineering with at least 15 years experience in the design of dams equipment and water pumping works,

h) **A Mechanical Engineer** with a minimum of a Masters degree in the relevant field with experience of at least 10 years in design of water related infrastructure such hydromechanical equipment of dams and pumping works or a B.Sc. in Mechanical

Engineering with at least 15 years experience in the design of hydromechanical equipment of dams and water pumping works.;

i) An **Environmental Specialist** with at least a Masters degree in Environmental Management with a minimum of a 10 years relevant experience in water related projects;

j) An **Economist** with at least a Masters degree in Economics with 10 years relevant experience in water related projects.

The Level of Effort of professional staff to be provided by the Consultant is estimated at 85-man months as provided in the table 5.

Table 5: Level of Effort for key expert in man-months

Expert	Man-Months
Team Leader	18
Dam Engineer	12
Geologist/Seismologist	8
Geotechnical Engineer	8
Water Supply Engineer	10
Hydrologist/Hydraulics	6
Electrical Engineer	6
Mechanical Engineer	6
Environmental Specialist	6
Economist	5
Total	85

The estimated staff-months are indicative only. The consultant may propose an alternative level of effort, if it is supported by sufficient documentation in their proposal to show that it can successfully meet the assignment's objectives. The Team Leader/ Resident Engineer shall be full time on the assignment.

6.0 REPORTING

The Consultant will report to the Project Implementation Unit Manager of Blantyre Water Board on contractual issues and Blantyre Water Board's assigned Contract Manager on daily operational issues. To ensure quality assurance and guidance the Board shall be assisted with an independent Panel of Experts (POE).

7.0 PAYMENT SCHEDULE

The assignment will be administered through a lump sum contract arrangement. Payments for the assignment shall therefore be based on approved deliverables. Tables 6 and 7 show the expected

payment schedule for Mulanje and Mombezi dams Respectively (subject to negotiation with winning bidder).

Table 6:Payment Schedule for Mulanje Dam

No.	Deliverable	Proportion of Payment
1	Inception Report	2%
2	Pre-feasibility Study Report for irrigation potential	5%
3	Draft report on optimized design of dam	5%
4	Final report on optimized design of dam	5%
5	Site Investigations and associated Geotechnical Baseline Report;	5%
6	Hydraulic model tests report	5%
7	Risk Register.	5%
8	Draft detailed design report	5%
9	Final detailed design report	5%
10	Draft construction framework	5%
11	Final construction framework	5%
12	Draft institutional arrangement	5%
13	Final institutional arrangement	5%
14	Dam safety plan	5%
15	Draft tender documents	5%
16	Final tender documents	5%
17	Draft consultancy report	5%
18	Final draft consultancy report	5%
19	Terms of Reference for Construction Supervision and quality assurance	5%
20	Final consultancy report	8%
		100%

Table 7: Payment Schedule for Mombezi Dam

No.	Deliverable	Proportion of Payment
1	Inception Report	5%
2	Pre-feasibility Study Report for irrigation potential	5%
3	Draft report on optimized design of dam	5%
4	Final report on optimized design of dam	5%
4	Site Investigations and associated Geotechnical Baseline Report;	5%
5	Hydraulic model tests report	5%
6	Risk Register.	5%
7	Draft detailed design report	5%
8	Final detailed design report	5%
9	Draft construction framework	5%
10	Final construction framework	5%
11	Draft institutional arrangement	5%

No.	Deliverable	Proportion of Payment
12	Final institutional arrangement	5%
13	Dam safety plan	5%
14	Draft tender documents	5%
15	Final tender documents	5%
16	Draft consultancy report	5%
17	Final draft consultancy report	5%
18	Terms of Reference for Construction Supervision and quality assurance	5%
19	Final consultancy report	10%
		100%

8.0 OBLIGATIONS OF THE CLIENT

8.1 Data and Reports:

The Client will assist on the following:

a) Information on customs, taxes and import duties and restrictions imposed by Government of Malawi (GoM);
b) Copies of Feasibility Study Report and Preliminary Designs and other relevant available study reports/documents;
c) Consultation with relevant stakeholders (Ministries / Departments and other institutions);

8.2 Counterpart Staff

The Client will provide counterpart staff to work with the Consultant to facilitate channels of communication and as a means of capacity building.

8.3 Liaison

The Client will provide liaison through its Infrastructure Development and Research (IDR) division and will ensure that the Consultant has access to all available information required for timely execution of the assignment.

8.4 Immigration and Residence Permits

The Client will provide the Consultant any assistance required to obtain necessary immigration and residence work permits for the approved expatriate personnel and their dependants.

9.0 OBLIGATIONS OF THE CONSULTANT

The Consultant is expected to be fully self sufficient in all respects for undertaking the assignment including accommodation, office space, equipment and supplies, communication, and transport. The Consultant is also expected to produce Terms of Reference for the knowledge transfer to the counterpart staff to be approved by the Client before commencement of the assignment and provide on-the-job training to counterpart staff.

Furthermore, the Consultant will be responsible for the payment of local taxes and duties for all goods and services including levies during execution of the project.

The Consultant is, therefore, expected to liaise with tax authorities, National Construction Industry Council (NCIC) and Blantyre City and District Councils in this respect.

The copyright of all documents prepared by the Consultant in connection with the agreement will automatically be transferred to the Client. The Consultant may make copies of such documents but shall not use the contents thereof for any purpose unrelated to the services without prior written approval of the Client.

Appendix 1- Feasibility study and preliminary design report of Mombezi Dam (Provided Separately)