SFG1799 V1

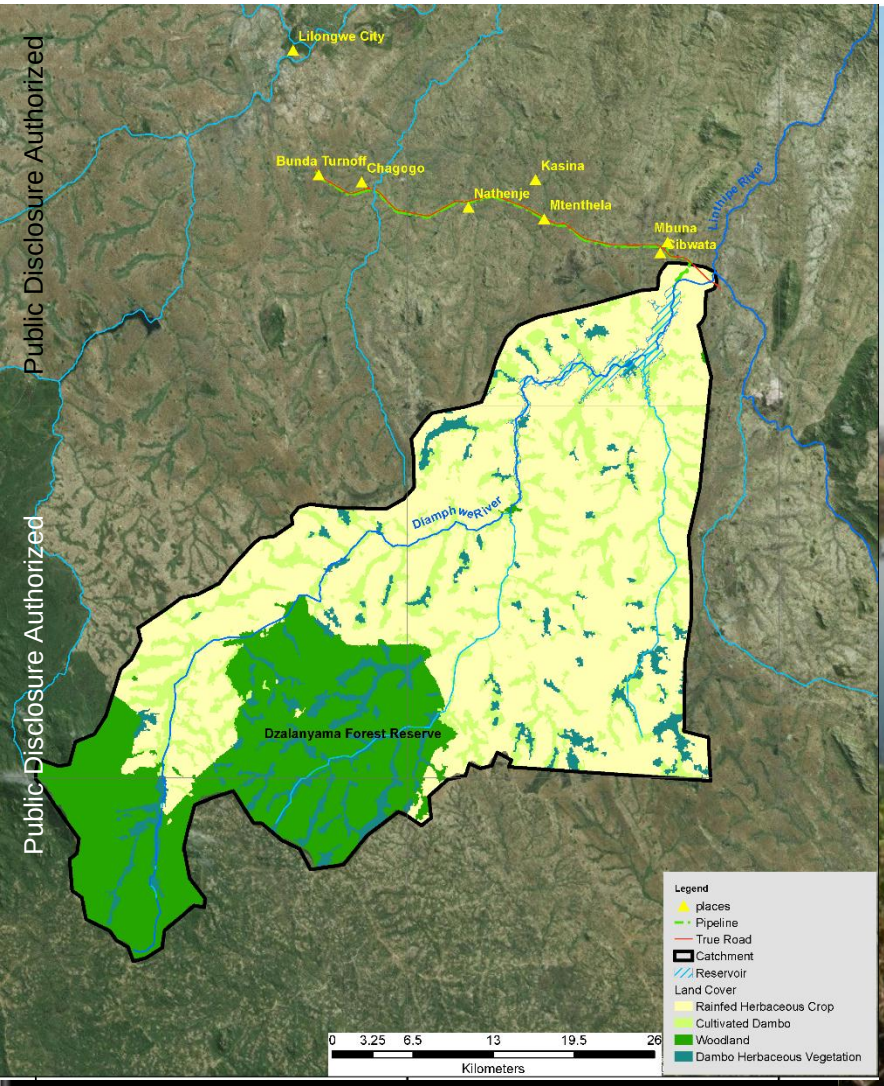
Ministry of Agriculture, Irrigation and Water Development

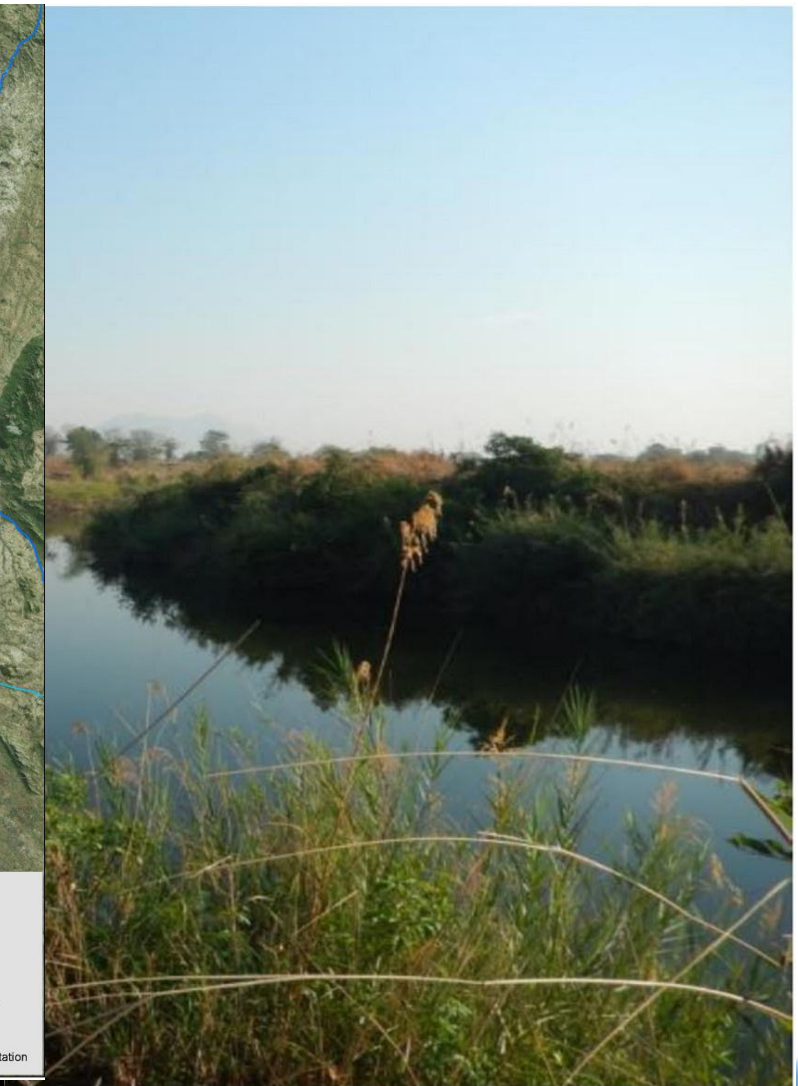
Diamphwe Multipurpose Dam & Associated Structures ESIA and RAP

Volume 1 Main Report

Environmental & Social Impact Assessment Draft Report
February 2016

Prepared for:
Ministry of Agriculture, Irrigation and Water Development





SMEC
Local People. Global Experience.

www.smec.com

DOCUMENT CONTROL

Title	Environmental and Social Impact Assessment for Diamphwe Multipurpose Dam and Associated Structures.			
Prepared for	Ministry of Agriculture Irrigation and Water Development			
Project Ref				
	Name	**Position**	**Signed/Approved**	**Date**
Originator	Luke Palfreeman Penny Geerts Chaitali Ghosh	Team Leader Sociologist GIS Expert		11/02/2016
Approval	Luke Palfreeman	Team Leader		11/02/2016

CONTACT DETAILS

SMEC International Pty Ltd| www.smec.com

Area 14, Plot 81, P.O. Box 30348, Lilongwe3, Malawi
Tel: +265 (0) 1 772 824

Representative:
Wongani Chisala | Country Manager – Malawi

SMEC International Pty Ltd

wongani.chisala@smec.com

ACKNOWLEDGEMENTS

SMEC International acknowledges the assistance provided by numerous individuals, with particular reference to the following:

- Officials of the Government of Malawi, and particularly the Ministry of Agriculture, Irrigation and Water Development (MoAIWD), the National Water Development Programme (NWDP) of the Ministry, the Lilongwe Water Board (LWB), and Offices of the Dedza and Lilongwe District Councils;
- Members of Non-Governmental Organisations (NGOs) and Civil Society Organisations (CSOs) who gave of their time to be interviewed;
- Traditional Authorities, Group Village Heads (GVHs), Village Heads (VHs), and representatives of the Dam Project Committees, who assisted SMEC in the various activities being undertaken in the Project study area;
- The potential Project affected people (PAP) and household members who were interviewed, and asset surveyors and enumerators who undertook the surveys; and
- Other community members who gave support to the Project in different ways.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF PLATES

LIST OF TABLES

ABBREVIATIONS AND ACRONYMS

Table 0.1 Abbreviations and Acronyms

Abbreviation	Description
ADB	Asian Development Bank
ADC	Area Development Committee
ADMARC	Agriculture Development and Marketing Corporation
AEC	Area Executive Committee
AFDB	African Development Bank
AIDS	Acquired Immune Deficiency Syndrome
ASTER	Advanced Spaceborne Thermal Emission and Reflection
BOD	Bio-chemical Oxygen Demand
CBO	Community Based Organisation
CBR	Crude Birth Rate
CDR	Crude Death Rate
CHIA	Cultural Heritage Impact Assessment
cm	Centimetre
COD	Chemical Oxygen Demand
CONGOMA	Council For Non-Governmental Organisations in Malawi
CSO	Community Service Organisation
CTG	Compensation Task Group
DBH	Diameter at Breast Height
DC	District Council
DCS	District Council Secretariat
DCT	District Water Coordinating Team
DEA	Director of Environmental Affairs
Dead	Dead Storage Capacity
DEC	District Executive Committee
DESC	District Environmental Subcommittee
DFID	Department for International Development (United Kingdom)
DGPS	Differential Global Positioning System
DMECC	District Monitoring and Evaluation Coordinating Committee
DNPW	Department of National Parks and Wildlife
DPC	Dam Project Committee
DPD	Director of Planning and Development
EA	Environmental Assessment
EAD	Environmental Affairs Department
EBRD	European Bank for Reconstruction and Development
EC	Electrical Conductivity
EHS	Environmental, Health and Safety
EIA	Environmental Impact Assessment
EIB	European Investment Bank
EMA	Environment Management Act
ESA	Environmental and Social Assessment
ESAP	Environmental and Social Assessment Procedures
ESCOM	Electricity Supply Corporation of Malawi
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
ESMS	Environmental and Social Management System
ESRP	Environmental and Social Review Procedures
Ex FL	Extreme Flood Level
FAO	Food and Agriculture Organisation (United Nations)
FL	Flood Level
FLWSP	First Lilongwe Water Supply Project
FPIC	Free Prior and Informed Consent
FSL	Full Supply Level
GHG	Greenhouse gases

Abbreviation	Description
GIS	Geographical Information System
GM	Grievance Mechanism
GMTG	Grievance Management Task Group
GoM	Government of Malawi
GP	Good Practice (Statement of the World Bank)
GPS	Global Positioning System
GRM	Grievance Redress Mechanism
GTZ	Deutsche Gesellschaft fur Technische Zusammenarbeit
GVH	Group Village Head
ha	Hectare
HIV	Human Immunodeficiency Virus
H & S	Health & Safety
HSA	Health Surveillance Assistants
IAP	Interested and Affected Party
ICOS	International Council of Monuments and Sites
IDA	International Development Association
IFAD	International Fund for Agricultural Development (United Nations)
IFC	International Finance Corporation
IFCPS	International Finance Corporation Performance Standards
IUCN	International Union for Conservation of Nature
JICA	Japan International Cooperation Agency
Kg/d	Kilograms per day
km	Kilometre
kW	Kilowatt
LRI	Livelihood Restoration / Improvement
LRP	Livelihoods Restoration Plan
LWB	Lilongwe Water Board
LWDP	Lilongwe Water Development Programme
LWP	Lilongwe Water Program
LWSP	Lilongwe Water Supply Project
m	Metre
M	Magnitude earthquake (Richter Scale)
m^3/d	Cubic Metres per day
m^3/s	Cubic Metres per second
Masl	Metres Above Sea Level
MBS	Malawi Bureau of Standards
MDG	Millennium Development Goals
M & E	Monitoring & Evaluation
MECDO	Malingunda Environmental Community Development Organisation
MGDS	Malawi Growth and Development Strategy
MHRC	Malawi Human Rights Commission
Min OL	Minimum Operating Level
ML/d	Mega Litres per day
mm	Millimetres
Mm^3	Million Cubic Metres
MoAIWD	Ministry of Agriculture, Irrigation and Water Development
MP	Member of Parliament
MWL	Maximum Water Level
NASFAM	National Association of Smallholder Farmers of Malawi
NEAP	National Environmental Action Plan
NEIS	National Earthquake Information Centre
NEP	National Environmental Policy
NGO	Non-Governmental Organisation
NRW	Non Revenue Water
NSO	National Statistical Office
NSoER	National State of Environment Report
NWDP	National Water Development Project

Abbreviation	Description
O & M	Operations & Maintenance
OP	Operational Policy (World Bank)
OP	Operational Procedures
OPC	Office of the President and Cabinet
PAC	Project Affected Communities
PAFs	Project Affected Families
PAP	Project Affected Persons
PCR	Physical Cultural Resources
PDC	Project Development Committee
PIU	Project Implementation Unit
PMF	Probable Maximum Flood
PMU	Programme Management Unit
ppm	Parts per million
PPP	Public-Private Partnership
PRA	Participatory Rural Appraisal
PS	Performance Standard (IFC)
PSC	Project Steering Committee
QA/QC	Quality Assurance and Quality Control
RAP	Resettlement Action Plan
RCC	Roller Compacted Concrete
SADC	South African Development Community
SLWSP	Second Lilongwe Water Supply Project
SGD	Small Group Discussion
Shannon DI	Shannon Diversity Index
SMEC	Snowy Mountains Engineering Corporation
SNDP	Sustainable Development Network Programme
SP	Studio Pietrangeli
SRTM	Shuttle Radar Topography Mission
STI	Sexually Transmitted Infection
TA	Traditional Authority
TDCs	Teacher Development Centres
TDS	Total Dissolved Solids
TFR	Total Fertility Rate
The Project	The Diamphwe Multipurpose Dam Project
TLWSP	Third Lilongwe Water Supply Project
UN	United Nations
UNAIDS	Joint United Nations Programme on HIV/AIDS
UNDP	United Nations Development Programme
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNFPA	United Nations Population Fund
UNICEF	United Nations Children's Fund
UNIFEM	United Nations Development Fund for Women
USCS	United Soil Classification System
UTM	Universal Transverse Mercator
VAP	Village Action Plan
VDC	Village Development Committee
VDP	Village Development Plan
VH	Village Head
VIP	Ventilation Improved Pit Latrine
WB	World Bank
WHO	World Health Organisation
WTP	Water Treatment Plant
WQEM	Water Quality and Environmental Management (Division)

EXECUTIVE SUMMARY

Note:

As part of ESIA studies a comprehensive census and asset survey was undertaken to identify Project Affected Persons and to collate socio-economic information. Census survey of the main Dam reservoir has been completed, which identified a total of 5,178 Project Affected Persons (PAP) and 733 affected structures. The census survey is ongoing in the infrastructure area and along the 30 kilometre section of pipeline route to Bunda Turnoff. This information will be available within approximately two weeks and the ESIA updated accordingly. It is not anticipated that significant numbers of people or assets will be affected in these areas.

S.1 Introduction to the Project

Lilongwe is the Capital of Malawi and the country's largest city, with a population of approximately one million people. This is expected to grow to approximately 1.88 Million by 2036 and 2.43 Million by 2045. Water supply capacity is inadequate in meeting current demands, which results in severe water restrictions and disruptions.

In response to the increasing shortfall of water supply, the Government of Malawi through the Ministry of Agriculture, Irrigation and Water Development (MoAIWD) and in collaboration with the Lilongwe Water Board (LWB) undertook feasibility studies to identify a suitable water source. The preferred option that best meets financial, technical and environmental and social aspects is to develop a dam on the Lower Diamphwe River, approximately 35 kilometres south east of Lilongwe.

The Diamphwe Multipurpose Dam (The Project) is a sub-component of the second phase of the National Water Development Project (NWDP II). Project studies have been financed by the International Development Association (IDA), while Project development will be funded by multiple financiers including the European Investment Bank (EIB), African Development Bank (AFDB), IDA and Private Sector (Public-Private Partnership – PPP) arrangement.

This Environmental Study and Impact Assessment (ESIA) has identified and assessed potential Project impacts on sensitive environmental, social, cultural and health receptors. Appropriate mitigation measures are defined to either prevent or reduce impacts to levels acceptable to the Government of Malawi (GoM), the Environment Management Act (1996) and international World Bank Performance Standards on Environmental and Social Sustainability.

This report has been undertaken in conjunction with the preparation of a Resettlement Action Plan (RAP).

S.2 Institutional framework

S.2.1 Water resources management

The Government of Malawi operates and functions on a decentralised structure with the ministries at central level, and the local government structure at local level, consisting of City, Town and District Councils. The District Council also has a decentralised administration of traditional authority areas, village groups, villages and communities. This arrangement ensures smooth coordination and collaboration on various development projects in Malawi. Malawi's institutional framework for the water sector is centred mainly on:

- The Ministry of Agriculture, Irrigation and Water Development (MoAIWD);
- Five parastatal water boards: Blantyre, Southern Region, Lilongwe, Central Region and Northern Region;

- The Ministry of Local Government and Rural Development through City, Town and District Councils, and
- The Ministry of Health.

Other involved ministries include the Ministry of Natural Resources, Energy and Mining, and the Ministry of Physical Planning. Their roles are to provide policy direction, coordination of programs, sector planning, policy formulation, policy reviews, policy enforcement, and to establish guidelines and standards (*National Water Policy, 2005*).

Donor agencies support various water development initiatives in Malawi both technically and financially through the established institutions. The Government of Malawi (GoM) has already initiated the Lilongwe Water Program (LWP), which is eligible to receive funding from donors for the improvement of water delivery in Lilongwe City. The Program's objective is to expand access to water services in Lilongwe through improved bulk water supply, distribution and capacity of the MoAIWD and the LWB to better manage water services. Objectives will be delivered by three Program components:

1. *Lilongwe bulk water supply*: This component is to secure a new water source for Lilongwe to meet the city's water demand until 2045. Physical investments cover the capital requirements for the bulk water supply system, comprising the Diamphwe Lower multipurpose dam, raw water transmission system, water treatment plant, and treated water transmission main to the city.
2. *Lilongwe water distribution system*: This component is to improve access to water supply for customers in Lilongwe, particularly the poor. The water supply reticulation system in Lilongwe is old and requires rehabilitation and expansion to meet the growing needs of the city.
3. *Technical assistance and program management*: This component is to enhance the capacity of MoAIWD and LWB to provide efficient and sustainable water and sanitation services and to support management of the Program.

S2.2 Project Implementation

A number of agencies, governmental and non-governmental, will play a role in the implementation of the Diamphwe Multipurpose Dam Project, including in the pre-planning, resettlement and restoration of livelihoods, construction and operation phases. In particular, implementation of the Project will be dependent on the development of a strong institutional base.

The Project is managed by the Programme Management Unit (PMU) of the National Water Development Programme (NWDP), which operates within the MoAIWD. The Project is being delivered by the Project Implementation Unit (PIU) of the LWB. Close interaction and cooperation is required between the following organisations:

- The relevant bodies associated with the MoAIWD, and particularly the PMU of the NWDP and the PIU of the LWB;
- District Council Offices and Committees that will be involved in the Project;
- Statutory Corporations providing a relevant service to the Project;
- Traditional Authorities (TAs), including Group Village Heads (GVHs) and Village Head (VHs), of the Project Affected Communities (PAC);
- Local-level structures set up specifically for the project, such as Project Development Committees (PDCs);
- Agencies identified as having a role in the implementation of Project related activities, including Development Organisations and Non-Governmental Organisations (NGOs); and

- Other interested stakeholders, including religious bodies, private investors and political parties.

S.3 Project Justification and Alternatives

Lilongwe's water supply is currently sourced from two dams on the Lilongwe River. The current water demand is 109 Megalitres per day (ML/d) and there is a water supply shortfall of approximately 47 ML/d. Planned upgrade works will increase production by an additional 60 ML/d, however a new bulk water source will be needed by 2020, after which severe water shortfalls are predicted.

Selection of the Lower Diamphwe River site was based on a rigorous assessment of alternatives. Six alternative sites were appraised, which were narrowed down to three viable alternatives; two sites on the Diamphwe River and another on the Likuni River, which flows into Lilongwe River downstream of the existing Kamuzu dam. Initial analysis considered hydrology and water quality, site and technical conditions, social and environmental constraints, financial aspects and security of supply to 2035. Further analysis was undertaken to assess the potential for multipurpose use including providing water for irrigation, fisheries and hydropower. Multi-criteria analysis confirmed that the Lower Diamphwe River site would provide the greatest benefit due to its capacity for multipurpose use and accrued benefits related to agricultural opportunities. Following selection of the Diamphwe River site the design was optimised to increase water security to 2045.

Development of the Diamphwe Multipurpose Dam will secure Lilongwe's water supply to 2045. Further, the development will provide significant opportunities to supply water to rural villages and for irrigation and fish farming, thereby substantially improving food security and livelihoods.

Not proceeding with the Project would therefore:

- Significantly impair the sustainability of Lilongwe's water supply after year 2020.
- Reduce the likelihood that rural communities surrounding the development could benefit from a sustainable water source and reduce dependency on groundwater wells.
- Eliminate the opportunity to improve or, with the threat of climate change, to sustain food security and economic benefits by not developing irrigated farmland and fish farms.

S.4 Background and ESIA Methodology

There have been numerous studies undertaken to identify a suitable water supply for Lilongwe. Preliminary studies commenced in about 2002, which canvassed potential dam sites. A more detailed options analysis was undertaken in 2011 (Sogreah), which assessed the Diamphwe Multipurpose dam as being the most suitable option. A feasibility and preliminary ESIA were then completed and a recommendation made to proceed with more detailed investigations for a multipurpose dam on the Lower Diamphwe River. Detailed hydrological and engineering studies commenced in 2014 (Studio Pietrangeli) and in mid-2014 the MoAIWD commissioned a full ESIA and RAP to be undertaken (WAPCOS). A Draft ESIA was completed in October 2014. In August 2015 the MoAIWD subsequently commissioned SMEC International to complete ESIA and RAP documentation to Malawi and World Bank requirements.

SMEC's approach to undertaking the work was to:

Step 1 Thoroughly review previous studies and other relevant information, and address any shortfalls or gaps. During this stage SMEC personnel visited the site and had preliminary discussions with local communities.

Step 2 Confirm relevant national and international regulatory requirements, and World Bank and IFC best practice standards to be addressed during environmental and social studies.

Step 3 Define the Project study area.

Step 4 Prepare an inception report outlining potential information gaps. This formed the basis for focusing studies on the following important issues:

- *Consultation, identification of PAP, and asset determination*: Stakeholder consultation and identification of PAP and assets potentially affected by the Project. During the course of the study more than 80 individuals and groups were consulted and more than 10,000 census, socio-economic and asset surveys completed.
- *Mapping*: Ground-truthing and mapping the study area. This included extensive ground surveys and compilation of a GIS database. Mapping and geo-referencing was completed for 5,178 plots of land and numerous other structures within the Project area.
- *Biodiversity***:** Further terrestrial and aquatic surveys were undertaken to better understand habitat importance and species diversity. Surveys included transect trapping and observations, and fish and macroinvertebrate sampling along the river.
- *Cultural studies*: Site surveys were undertaken to assess the presence of important archaeological and heritage sites, including potentially affected graveyards.
- Other site investigations including for health, water quality, noise and traffic monitoring.

Step 5 Assessment of potential environmental and social impacts was undertaken in the following manner:

- *Impact assessment*: Identification and assessment of potential environmental and social impacts with reference to applicable country and international regulations, standards and guidelines. Impact assessment also includes identifying opportunities to enhance beneficial impacts of the Project and to improve social development opportunities.
- *Mitigation measures*: Mitigation measures have been developed with consideration of baseline conditions; identified constraints; concerns and suggestions raised by the community; GoM, WB, IFC and other relevant requirements, and the level of design information available at the time of preparation of this ESIA. Mitigation may include:
  - Environmental controls (eg. measures for minimising harmful noise, air, water and waste emissions);
  - Design optimisation (eg. relocation of dam wall to avoid graveyard);
  - Procedural measures (eg. setting up catchment management committee);
  - Avoidance/reduction (eg. waste minimisation process management to conserve water);
  - Compensatory measures (eg. biodiversity offsets); and
  - Timing measures (eg. no construction at night).
- *Risk assessment*: Risk assessment has been undertaken to gauge the level of 'Residual' impact after mitigation and acceptability against international criteria and sustainability principles. Further opportunities for reducing identified 'high' risk residual impacts are then canvassed.

Step 6 Following impact assessment an Environmental and Social Management Plan (ESMP) was prepared, which provides a framework for ensuring the Project meets all the commitments presented in the ESIA. The ESMP sets out how environment and social issues will be effectively managed, staffing arrangements and a preliminary budget to implement ESIA recommendations.

Detailed study methodologies are described in specialist reports, which are included in Appendices (Volume 2).

S.5 Regulatory Framework

S.5.1 Malawi regulatory requirements

The MoAIWD and LWB are committed to ensuring that the Project incorporates international best practices and are undertaken in compliance with Malawi regulations and international treaties and conventions to which Malawi is a signatory. The ESIA study was implemented in accordance with Malawian laws and policies as well as satisfying international standard policies, particularly those of the World Bank.

a) **Governance of large infrastructure projects:** *The Constitution of the Republic of Malawi*, (1994) and further national laws and regulations, form the statutory basis for developing large scale infrastructure such as the proposed Diamphwe Multipurpose Dam. International regulations, conventions and treaties to which Malawi is a signatory provide further standards and sustainable guidelines for the Project.

b) **Approval process**: The *Environmental Management Act (1996)* outlines an EIA process for Malawi and requires project developers to comply with that process. The Act specifies that the types and sizes of projects subject to EIA be prescribed and gazetted. Accordingly, the Project activities are subject to approval under the Act. As such, the ESIA has been undertaken in strict accordance with this regulatory framework, as well as the Environmental Affairs Department's EIA Guidelines. A project brief, stating the matters provided for under section 24(2) of the Act, was previously submitted to the Director of Environmental Affairs. The Director, satisfied that there was sufficient information in the project brief, instructed the developer in writing to conduct an EIA in accordance with prescribed Terms of Reference.

c) **Land acquisition and compensation**: Other important legislation such as the *Land Act (1965)* and *Lands Acquisition Act (1971)* relate to recognition of land rights and entitlement, and acquisition of customary land. In this regard SMEC has prepared a detailed database of PAP and land ownership, and has communicated the Proposed Project to relevant stakeholders. The accompanying RAP includes an Entitlement Framework and Relocation Framework that sets out the compensation and resettlement implementation process, in line with World Bank standards and Malawi legislation.

d) **Water resources**: Water focused regulation including the *Water Resources Act (1969)*, *Waterworks Act (1969)* and *Irrigation Act (2001)*, and related Policies and standards are particularly relevant to this Project, due to the potential impact the proposed Dam could have on the Diamphwe River and the larger Linthipe River that flows into Lake Malawi. The ESIA provides full details of the proposed dam, including assessing alternatives and providing justification for its approval. The Project's potential impact on water resources has been evaluated and, where necessary, appropriate mitigation measures have been incorporated into the design and development of the Dam, as well as management of the water catchment.

e) **Natural resources**: Malawi's biodiversity has significantly declined in recent years due to population growth and land clearing. The Project will potentially contribute to cumulative impacts, and measures have been incorporated to protect and enhance environmental qualities in accordance with the provisions of the various natural resources legislation including the *National Parks and Wildlife Act (2004), Fisheries Conservation & Management Act (1997)* and *Forestry Act (1997)*, all of which promote the protection and stainability of natural systems.

f) **Health and Livelihood**: The Project will potentially directly impact on 5,178 people (PAP) and thus directly affect upwards of 26,149 people. The ESIA has been guided by the provisions of various legislations that promote and protect livelihoods, health, culture and gender equality,

which include the *Public Health Act (1948), Monuments and Relics Act (1990)* and *Gender Equality Act (2003) and Occupational Safety, Health and Welfare Act (1997),* as well as a range of Policies and standards such as the *National HIV AIDS Policy (2003).*

S.5.2 World Bank and relevant international guidelines.

The World Bank EIA process is implemented through a set of Operational Policies/Procedures whose primary objective is to ensure that Bank operations do not cause adverse impacts. These compliment Malawi regulations and provide a rigorous format for assessing and managing impacts.

The ESIA has carefully considered relevant World Bank requirements as well as related guidance such as the IFC Performance Standards. In accordance with these Policies this ESIA has been undertaken in a participatory way, as evidence by completing over 10,000 survey and asset questionnaires. This level of participation provided a wealth of information related to the social and biophysical environment and associated interconnections, for example the reliance on ecosystem resources to sustain livelihoods. Identified impacts were appraised of the risks and residual risks assessed following mitigation.

Operational Procedures provided ESIA guidance for undertaking a comprehensive consultation and census survey and preparing a valuable database of information necessary to move forward with land acquisition and possibly involuntary resettlement. The GIS linked database provides detailed landuse data on Project affected land plots and structures, which provides a sound basis for substantiating a cut-off date and assessing reasonable and fair compensation.

S.6 The Project

S.6.1 Project Description

The Diamphwe Multipurpose Dam will supply water to Lilongwe City and the surrounding areas until 2045 and support large scale irrigation and fish farming. The Project is located approximately 35 kilometres south-east of Lilongwe on the lower Diamphwe River, a tributary of the Linthipe river that flows north-east to Lake Malawi. Administratively the Project lies in the Central region between two Districts comprising of Traditional Authorities (TAs) Mazengela, Kalumbu and Chadza on the Lilongwe District (west) side; and Traditional Authorities Kaphuka and Chilikumwendo on the Dedza District (east) side. Key aspects of the Project are:

- The Dam will be constructed approximately two kilometres upstream of the Diamphwe River Bridge on the Blantyre - Lilongwe M1 road. Ancillary infrastructure will comprise of a temporary diversion channel, booster pump and raw water transmission pipeline, and water treatment plant with a capacity of 147.7 Mega litres per day (ML/d). Treated water will be pumped to balancing tanks and then delivered 30 kilometres via dual gravity mains to the Bunda Turnoff near Lilongwe city.
- The Dam will have an operational capacity of 134 Million Cubic Metres with separate outlets provided for downstream irrigation and the WTP. The Dam reservoir will inundate approximately 2,328 hectares (ha) of predominantly cropping and grazing land.
- The Project area will impact on a total of 2,682 ha of land as shown in *Table 0.2*.

Table 0.2 Project Affected Area

Project component	Permanent (ha)	Permanent Buffer (ha)	Temporary (ha)	Total Disturbed (ha)	Description
Reservoir	2,328	156		2,484	▪ This includes the dam inundation area up to a FSL of 1180.3 masl. ▪ A 15 metre wide buffer zone to be situated around the dam. This zone will be planted with endemic forest woodland species.
Dam Infrastructure	16	124	22	162	▪ Structures will include the dam wall and associated structures, raw water pump station and pipeline, WTP and pipeline, balancing tanks, access roads and office / accommodation buildings. ▪ Exclusion zones will be maintained around dam components. ▪ Temporary construction areas will include some access roads, laydown areas and quarry. These areas include directly impacted and buffer areas and will be subsequently rehabilitated.
Service Pipeline			60	60	The 30 km pipeline will be constructed within the road easement. On completion the area will be rehabilitated and unrestricted access permitted.
TOTAL	**2,342**	**258**	**82**	**2,682**	

- A total of 5,178 PAP have land and other assets that will be directly affected by the Reservoir and buffer zone. Of these 733 structures will need to be relocated to new areas. Community assets such as graveyards, churches and sports grounds will also need to be relocated to new sites With an average household size of 5,05 it is estimated that 26,149 people will be directly affected by these components of the Project.
- Construction is planned to commence in 2017 and take approximately 3.5 years, with commissioning expected in early 2022.

S.6.2 Bio-physical characteristics

The Diamphwe River is a tributary of the Linthipe River, which has a total catchment area of 8,641 km^2 and flows generally north-east to join Lake Malawi near Salima. The Diamphwe Dam catchment covers an area of approximately 1,403 km^2 and includes the protected Dzalanyama State forest in its upper reaches.

Outside of the forest most of the catchment has been substantially cleared for agricultural use. Cropland is the dominant landuse and is farmed for approximately 120 to 150 days during the rainy season. Dambos (seasonal wetlands) support a variety of riparian vegetation and agricultural landuses, including providing fish resources during the wet season. Dambos accumulate water during the rainy season and maintain the moisture throughout the dry season, thereby supporting productive agricultural land throughout the year. Important animal habitats include forest woodland, which is mainly represented by isolated graveyards, and riparian grassland along the river and tributaries. The catchment has been extensively degraded due to land clearing, illegal tree cutting and charcoal burning.

Project site characteristics are summarised below:

a) **Topography**: The Diamphwe River originates in the Dzalanyama Mountains at an altitude of 1,300 metres above sea level (masl) and drops approximately 149 metres to around 1,151 masl at the Dam site. Topography around the Project site is typically flat to undulating, with the occurrence of localised rock outcrops and inselbergs. Low lying dambos occur along the river banks, and are particularly prominent where tributaries join the river. The pipeline route along the M1 Road to Bunda Turnoff is undulating and drops 102 metres over a distance of 30 kilometres.

b) **Geology and soils**: Underlying geology is typically metamorphic rock overlain by approximately 15 metres of alluvial and loose deposits. Soils are described as being deep (>150 millimetres) clay loam and sandy loam on the Lilongwe side, and clay loam and sandy loam on the Dedza side. Soils are categorised as Class S3 Soils, which are marginally suited for agriculture, but have significant limitations with potential yields being only 40 to 60% of the maximum. Soils are slight to moderately prone to erosion.

c) **Climate**: The Project area experiences a warm tropical climate and distinct wet (November to mid-April) and dry (August to October) seasons. Average rainfall is less than 5 millimetres (mm) during the dry winter period and up to 248 mm in mid-summer (January). Average temperatures are relatively mild in summer and cool in winter. Prevailing winds are east to north-east in winter, trend to the east in early summer, and then to the north-west during late summer.

d) **Water resources**: The highest average flow of 68.3 Million cubic metres (Mm^3) occurs in March and then rapidly declines to just 0.4 Mm^3 in October. For the available 35 year data set yearly flows ranged from 22 Mm^3 to 893 Mm^3, with an average of 254 Mm^3. Dry season flows can be limited to just a few litres per second, which is mostly a result of percolated water draining from the water retaining dambo areas. During below -average rainfall conditions the river can have zero flow and cease to flow completely, thereby creating a series of isolated pools. Available data shows that very low or zero flows have occurred during 7 months (June to December). Flood peaks range from 558 to 1,570 Mm^3 for respective 20 and 1,000 year flood events. The Probable Maximum flood flow was estimated to be 3,809 Mm^3. Flood events last for approximately four days with the estimated peak occurring after approximately 30 hours.

   Overall water quality is good, with no evidence of persistent gross pollution or ecological stress. This is further evidenced by a healthy aquatic ecosystem. However water quality can deteriorate during low flow conditions due to reduced flushing and mixing. During wet weather conditions water quality can be affected by increased erosion in the catchment, while sewage contamination remains an ongoing problem due to poor sewerage infrastructure and a growing population.

   Groundwater occurs at approximately 40 metres depth, with an average yield of 0.19 Litres per second, and water quality is generally suitable for potable use. Groundwater resources are extensively used throughout the catchment and wider region.

e) **Landuse**: The reservoir and buffer zone area cover 2,484 ha, of which 62.9 % is cropland, 20% cultivated dambo, 15.2 % dambo grassland with patches of cultivated land and riparian grassland, 0.4 % forest woodland (mostly graveyards) and settlement 1.5 %[1].

f) **Biodiversity:** Important terrestrial habitat includes forest woodland and riverine (grassland dambo) vegetation. These habitats comprise of approximately 2 % (55 ha) of the Project area. The majority of animals identified use these habitats to varying extent, including to transit to areas outside of the Project area. Further, woodland and riverine grassland provide important ecological resources to local communities and four tree species have conservation significance.

[1] Percentages will change slightly following the asset survey of infrastructure area and pipeline.

Terrestrial wildlife is represented by 21 mammal, 57 avifauna and 13 reptile/amphibian species, of which 14 species have conservation significance. All species are regionally represented and none are classified as endangered.

Ten fish and 68 macroinvertebrate species use the project area, with one macroinvertebrate having conversation significance. There is also a high diversity of macroinvertebrates, indicating a healthy river system. Fisheries are also an important ecological resource.

S.6.3 Socio Economic environment

This information is based on census data of PAP within the project reservoir and buffer zone areas.

a) **Ethnicity:** Resident population comprises of almost 80 % Chewa, 20 % Ngoni and less than 1 % Yao. As a matrilineal society, property and land rights are inherited through the mother. *Gule wamkulu* has become a title for secret societies of traditional Chewa religious practices, a tradition included on the UNESCO Representative List as a masterpiece of intangible cultural heritage under the 2003 Intangible Cultural Heritage Convention.

b) **Gender and age distribution:** There are more women (51.7%) than men (48.3%); 87 % of household members were 45 years and younger, with over half of these being younger than fifteen, supporting the trend towards a youthful population.

c) **Religion:** Most religions have a Christian base, with only 14 % of PAP following animism and *Gule wamkulu*, and 0.1% being Muslim. There are a variety of churches; however, the main church following was with the Church of Central African Presbyterian (CCAP), the African Abraham Church, and Catholicism.

d) **Education**: Educational facilities available to residents of the Project Area include: Primary Schools in Mwango, Kanama, Ulongwe, Mpaso, Mlodzenzi, Luwani, Niuchi, Kanyezi, Bua, Mkomela, Mdedza, Kaundama, Bango and Chilembwe villages; Mkomela Day, Chingwenje Night, and Kaundama Secondary Schools, with night classes offered in Kawelama; nursery schools at Malenya and Chingwenje villages, and Community Based Childcare (CBCC) in Kawelama; and adult literacy classes offered in Chingwenje.

   Nearly 70 % of children less than 15 years of age were at primary school. Adult education levels were low; 12 % percent had no formal education, 80 % percent had completed primary school; 8 % had attained a secondary education, and few had vocational training or a university education. There was little evidence of gender discrepancies in educational attainment, other than men attaining marginally higher secondary education levels and above.

e) **Employment status and livelihood activities**: The status of household members indicated:

   - Over 60 % were children, either scholars/students or not at school;
   - Of the adults, 94 % were self-employed, primarily farmers; 0.4 % had formal employment; 1.3 % had informal/seasonal employment; 0.1% were unemployed, actively seeking work; 2.3% were unemployed, not seeking work; and 0.4 % were disabled and not employed; and
   - The dependency ratio was 1.7:1.

   Since the Project area is primarily an agricultural society, the majority of the population in the working age group are involved in farming activities.

f) **Household income:** Income levels were relatively low, with nearly one-third earning on average less than 20,000 Kwacha per month. Although local livelihoods are mostly based on subsistence farming, a large percentage (43 %) of household income was through the sale of crops, vegetables and fruit, with a further 13 % through the sale of animals and animal products. Other income sources included: salaries and wages (22 %); migrant remittances (4 %); sale of firewood

and charcoal (3 %); and operating a shop, store or informal stall (2 %). The sale of fish did not play a significant role in household income.

g) **Land use and agricultural activities**: The reservoir and buffer zone will directly impact on approximately 2,484 ha of land. The Asset surveyors surveyed 2,259.48 ha of productive land, used for cultivation, grazing, graveyards and residence.

With agriculture as the main livelihood, fertile land adjacent to the Diamphwe River and its tributaries, and particularly in the dambos, is essential to the lives of residents. The rainy season (November to mid-April) is the main agricultural season. Primary crops grown were maize (79 % of crops grown), beans (5 %), ground nuts (5 %), and potatoes (3 %), tomatoes, cabbages, sugar cane, cassava, rice, sorghum, pumpkin, onions and tobacco. Crops grown in dambo areas over drier times include seedlings for tobacco and maize, for replanting in time for the rainy season.

Land owned and used by the PAP households showed the following:

- 45 % of the land owned/used by PAP they believe to lie within the Dam inundation area;
- Land was mostly owned by household heads (81 %) or other household members (19 %);
- 35 % of the land was used directly by the household; 65 % was through some rental/leasing or sharecropping arrangement;
- Average number of land parcels owned/used by PAP households was three, with an average land parcel size of 3.6 ha; and
- 88 % of those with land relied on rainfed rather than irrigated agriculture. Some farmers had dug shallow wells; a small percentage (0.8 %) used pumped irrigation from the river.

h) **Tree ownership:** Trees classified as fruit and nut bearing, indigenous, and exotic are owned by PAP, and are mostly grown for domestic use. Fruit and nut trees included mango, banana, pawpaw/papaya, orange, guava, tangerine, lemon, peaches, cashew nut and cocoa plants.

i) **Livestock ownership and grazing patterns:** Livestock play a significant role in farming activities. Households kept an average of 5 animals, mostly chickens (owned by 62 %), goats (22 %) and pigs (11 %). Few households had cattle (3 %), and some kept sheep and duck.

Nearly forty percent of households use land within the Reservoir and buffer zone area for grazing their animals. Over the wet season animals graze in surrounding hills and at village dambos along the rivers, and over the dry season in the harvested agricultural land and uncultivated hills.

j) **Homesteads and household composition**: The majority of households had lived on their site for more than 5 years. Homesteads mostly comprised two to four structures, with structures of similar type: no foundation, mud/earth floors, unplastered clay/burnt bricks or mud for walls, no material used for windows other than wood, steel, glass and plastic, and roofing made of wooden poles with iron/tin or thatching grass. Most construction materials are sourced from the Diamphwe River or surrounds.

Household size was generally large, with an average of 5.05 members. Almost all household members lived at the homestead, with a small percentage away studying (0.8 %) or working (0.3 %). Most adult household members were married (88 %), through traditional means and/or a formal civil ceremony, or living in a *de facto* marriage; 5 % were single; 3 % were separated or divorced; and 4 % were widowed.

k) **Service provision and resource use:**

- *Energy and fuel*: Wood was primarily used, mostly in combination with other energy sources. Few households used generators or had access to an electrical connection; some were using solar power. Charcoal is not used by many households for private use; rather, it is regarded as an income source, for sale at markets.

- *Water source and natural resource base*: Livelihoods depend directly on availability of natural resources. The river and its resources are used for domestic and commercial use: water, fish, reeds, grasses, sand and clay, and edible and medicinal plants.

  Wells/boreholes are the most common domestic water source. Over 80 % used public facilities with pumps; 12 % used private unprotected wells/boreholes. Seven percent used the river alone as a main water source; 18 % used it in combination with wells/boreholes.

- *Sanitation facilities*: Most households used a pit latrine toilet system in a yard (97 % their own, and 3 % belonging to another household). Few households indicated that they use open fields for sanitation. Garbage disposal is through burying or burning in the yard.

l) **Movement and Access:** Roads in the area are unsealed and in relatively poor condition, being particularly inaccessible over the wet season. There is little public transport offered, and people walk or use motor bikes or bicycles. Bridges in the area comprise a bridge over the M1, a bridge from Bisai to Chimpaze, a bridge between Kakhosi and Kamsapa, and a concrete causeway at Katete.

m) **Health:** Communities in the area receive health services from: Chitowo, Mdedza, Kasina, Diamphwe, Kamphata, Katchale, Kanyezi and Nathenje Health Centres; a clinic at Nyamanzi; and Under-Five clinics in Mwango, Chaponda, Ulongwe, Mpaso, and in Chingwenji. Patients with severe illnesses are referred to Dedza District Hospital, and Bwaila, Nkhoma and Kasina Hospitals, some distance away. Health Surveillance Assistants (HSAs) support communities in dealing with health problems, and there are several local healers and traditional herbalists. Health services are also offered by NGOs such as CARE, NASFAM and Feed The Children.

   Common health-related problems highlighted by stakeholders include: illnesses and diseases, such as malnutrition, malaria, diarrhoea, bilharzia, Acute Respiratory Infection (ARI), HIV/AIDS and other STIs; early marriages and teenage pregnancies; under-resourced health centres; and difficulty in accessing health facilities.

n) **Cultural heritage:** A total of 21 heritage sites were identified during the field surveys in the Project area, including 16 archaeological sites of variable ages. The archaeological sites include eight evident settlements dating back to the Iron Age. In addition, there are 14 graveyards and two isolated grave sites within the Project Reservoir and buffer zone area.

S.7 Stakeholder Consultation

Historically there has been an extensive consultation process for the Project, which has continued with this study. Consultations undertaken as part of this ESIA include:

- Formal meetings, report backs and presentations to the Client, represented by the MoAIWD, the NWDP, the LWB, the WB and the International Finance Corporation (IFC).
- Direct interviews with stakeholders, and particularly representatives of national and district level governmental institutions, service providers and Non-Government and Community Service Organisations.
- Formal meetings with representatives of Traditional Authorities (TAs) and District Council (DC) organised by the Client.
- On site community meetings with village members, TA representatives, and Dam Project Committee (DPC) members, organised by the Client.
- Small focus group discussions with special interest groups; and
- Undertaking: ground-truthing of the Project area; Asset, Census and Socio-Economic surveys; specialist studies related to biodiversity, physical environment, health and cultural heritage; and other RAP-related activities.

There is strong community support for the proposed dam and high expectations that livelihoods would be improved by better access to a clean and sustainable water source, as well as opportunities afforded by irrigation, fisheries and new businesses. However there remains significant apprehension about the impact the dam could have on people's homes and livelihoods.

The majority of those consulted would prefer to remain in the immediate area. People were unhappy about the prospect of relocating, losing their agricultural land, and leaving their cultural attachments to their villages and graveyards. Some were concerned about not being able to cross the river, however most queries related to what restrictions there might be on accessing the reservoir for fishing, washing and watering their animals. A number of people were interested in opportunities for setting up businesses and supplying seedlings for use in rehabilitation areas.

S.8 Project impacts

S8.1 Project footprint

Over a period of approximately three years PAP and community facilities (such as graveyards, schools and churches) will be relocated from the Project area, structures removed or made safe, and large trees removed. The Development of the reservoir and associated infrastructure will result in disturbance of approximately 2,682 ha of land, which includes sterilising from further use an estimated 2,600 ha of land, of which approximately 98% is agricultural land. Only about 2% or 55 ha has high habitat value comprising of approximately 10 ha of forest woodland (mostly graveyards) and the remainder riparian grassland (dambo).

A 15 m wide buffer covering approximately 156 ha will be established around the reservoir perimeter and vegetated with endemic forest woodland trees and scrubs. Landscape buffers totalling approximately 124 ha will be established around key infrastructure components, while the remainder of the disturbed area will be rehabilitated to pre-construction landuse.

Construction impacts will generate significant activity and hence potential for impacting on the surrounding environment. Operational impacts will be longer term and may add to cumulative impacts already experienced in the broader Linthipe catchment.

Potential impacts may be both positive and negative. Positive impacts relate to the accrued benefits that the project will have as a result of the Project's planning, construction and operation. Negative impacts may directly or indirectly have an impact on environmental and social qualities.

S.8.2 Positive impacts

There will be significant Project benefits as summarised below.

- ***Employment Opportunities***

Short term benefits will be presented through Project developments, particularly employment opportunities offered during the construction phase of the Project works, and economic opportunities to provide services to supply the needs of contractors and workforce over such times. In the long term, employment will be created through the operation and maintenance of the Dam and Pipeline, and through associated projects, such as irrigation development.

Up to 300 people will be employed during construction and there will be approximately 50 full time positions once the Dam and Treatment Plant are operational. Direct employment will also be generated through catchment management activities, such as riparian and re-afforestation work to be undertaken around the reservoir perimeter, as well as more general land management activities within the broader catchment. Increased economic activity generated by the Project will further create additional employment opportunities. In addition it is recommended, for example, that house construction at the resettlement sites preferably use local labour, for skilled and unskilled tasks. Using locally sourced materials for house construction will also financially assist local business enterprises.

- ***Economic Development***

The Project provides great potential for long-term economic benefits, through the creation, diversification and growth of income-generating activities, to increase food security and reduce poverty in the area. This potential will present itself through the following:

- *An improved, regular water supply* to urban areas in Lilongwe, reducing the reliance on Kamuzu Dams as the current sole providers of water to the city. The risk of low flows and water shortages will decrease. This will encourage investment in the city, facilitate all-round economic growth, create employment opportunities, and thereby increase income levels and reduce poverty.
- *Easy access to a potable water source* for households affected by the Project, which will relieve domestic tasks in the collection of water. This could present women, not only with more leisure time, but opportunities to spend time in farming and income-generating activities.
- *Improved agricultural production* realised through irrigation development, with opportunities for the diversification of agricultural activities; a steady flow of water, over all seasonal periods, including downstream of the Dam wall; and implementation of livelihood restoration measures. A more modern market- and cash-orientated agriculture will be introduced, leading to increased production and improvement in the general standard of living and welfare of the PAP. Irrigated agriculture by relocated famers will lead to an increase in food production, including for external markets; food security will thus be enhanced, not only locally but on a broader regional level.
- *Potential for creating new economic opportunities,* such as through support to fish farming and other non-agricultural livelihood restoration/improvement (LRI) income-generating activities.
- *Emigrants* with higher incomes and improved employment opportunities may be attracted to return to their families, re-introducing skills into the area, and establishing a more settled home environment.
- *Economic benefits* will become evident through in-migrants creating a buyer's market for local goods and services; sale of land to those affected; and the potential for other opportunities presented by the Project, such as the creation of a tourist industry.
- *Tourism is likely to become popular as* the Dam is close to Lilongwe and is easily accessible from the M1 Main road, and has the potential to attract local as well as international tourists.

- ***Improved Infrastructure and Service Provision***

Benefits relating to infrastructure development and service provision will include:

- *New and improved housing* - at the resettlement sites, provided that housing principles are adhered to in house construction.
- *Improved physical and social infrastructure* - including roads, water supply, health care, education and other social services.
- *Improved downstream regulation of water* - with the monitoring of water flows and discharges, water quality and sediment loads etc. will benefit water users (for irrigation and drinking water). The control and regulation of water levels and in-stream flow requirements of the Diamphwe River by the LWB will provide a more reliable steady source of water, particularly over the dry season.

- *Improved transport and communication* - The upgraded roads on site will provide both motorists and pedestrians an easier, safer and quicker access to health clinics, trading centres, markets and other places where they access goods and services, and aid in the movements of such goods and services. In addition, this increased accessibility and mobility will enable access to new income generating and marketing opportunities, and encourage investment by outsiders. It will also enable the creation of a public transport system, and a reduction in transport-operating costs.
- *Community skills development* - The many activities to be undertaken during the Project construction works will likely require the contractor to train local people. The acquired skills will benefit the individuals as well as communities in the Project area during and after the life of the Project.

➢ ***Biodiversity***

The Project will have positive benefits on biodiversity as a result of catchment management initiatives, as well as establishment of extensive riparian and woodland habitats around the Dam perimeter. This includes rehabilitation of approximately 156 ha of woodland vegetation. The reservoir will also provide habitat to significant numbers of native animals including birds and fish.

➢ ***Dam operations***

The proposed Dam will assist in delaying and lowering flood peaks, which will reduce the potential for major downstream flooding. During dry months the Dam will regulate more consistent base flows and improve yearly availability of water to downstream users. This will be a substantial benefit compared to the current situation whereby the river can cease to flow altogether. The Project will therefore have an overall positive impact by providing an adaptive mechanism to protect against climate change induced dry periods and more intense rainfall patterns.

S.8.3 Biophysical impacts

The Project is a major infrastructure Project and there will be significant landscape changes and potential impacts during construction of the Dam and associated infrastructure, and flooding of 2,328 ha of mainly agricultural land. Dam operations will alter hydrological flow regimes and water quality, which may adversely affect downstream areas, as well as biodiversity changes.

A thorough assessment of potential impacts has been undertaken with regard to Malawi regulatory requirements, World Bank Operational Procedures and other relevant standards and guidelines such as IFC Performance Standards. Potential impacts have been ranked according to the severity of the Risk after applying suitable mitigation measures. A summary of potential impacts in Risk ranked order is provided below.

➢ ***High Risk Impacts***

The ESIA found a number of potential impacts that, even after mitigation, would remain a High residual risk for environmental impact. Impact categorised as High risk generally pose a significant threat to health, livelihoods and protection of environmental qualities. These risks can be accommodated in a project of this size, however comprehensive and effective monitoring measures will be required and further mitigation may include halting or modifying project activities.

Three High Risk impacts were identified:

1. **Landuse**	
▪ ***Impacted Area**:* - Project affected land (2,682 ha) - Permanent affected land (2,600 ha incl. 258 ha buffer) - Temporary affected land (82 ha) ▪ *Losses:* - Cropland: 1,562.47 ha (62.9% of the total area) - Cultivated Dambo: 496.3 ha (20.0%) - Dambo Grassland: 378.4 ha (15.2%) - Forest/Natural Vegetation: 9.5 ha (0.4%) - Settlement: 37 ha (1.5%)	▪ ***Mitigation*** - RAP implementation - Forest buffer around reservoir (156 ha) - Relocation of forest woodland graveyards (10 ha) - Rehabilitation disturbed areas - Plant Riparian dambo grassland around reservoir - Irrigation downstream (1,000 ha) - Fisheries (Pilot + 20 ponds)
The Project will significantly impact on landuse, with approximately 2,600 ha predicted to be permanently sterilised from further use. This includes an extensive area of agricultural land that currently supports in some way an estimated 26,149people. There will therefore be widespread disruption and significant diminution of food security and livelihoods. An extensive census survey has been undertaken and a comprehensive RAP prepared in accordance with applicable Malawian and World Bank requirements. Compensatory land resources include development of 1,000 ha of downstream irrigation cropland, up to 20 community based fish farms and extensive forest woodland propagation around the dam. The residual risk remains High due to the significant level of resources required to successfully implement proposed mitigation measures.	

2. **Air Quality**	

▪ ***Impact***
- Air particulate levels consistently exceed IFC guidelines of:
  ○ 50 g/m3 for 24-hour average PM_{10} for the Project considered alone; and
  ○ 20 g/m3 for annual average PM_{10} due to the Project and other sources.
- Health related impacts on sensitive receptors
	▪ ***Mitigation***
	- Program dust generation activities outside of hot and dry months (September and October) as much as possible.
	- Construction Management Plan detailing monitoring and mitigation requirements, including sealing access road, water spraying active areas and re-planning activities during adverse weather conditions.

The potential for significant dust generation will generally occur during the first 26 months of construction when major earthworks are being undertaken. Dust dispersion will be partially contained by surrounding topography, however there remains potential for dust to impact on sensitive receptors, which poses potential health risks. The objective air quality criteria at sensitive receptors will be in accordance with IFC standards, however it is expected that this criteria may be exceeded on occasion, which will prompt further mitigation. Prior to mitigation this risk was assessed as Extreme due to potential health risk to surrounding communities. It is expected that mitigation can significantly reduce potential for dust generated impacts, reducing this Risk to High. However this will require careful programing to avoid adverse weather conditions and successful implementation of a range of site mitigation and monitoring measures.	

3. **Dam Failure**	
▪ ***Impact*** The dam is located in a seismic active area and damage due to earthquake or other unforeseen event (eg. security breach or explosion) could result in uncontrolled water discharge and potential loss of life	▪ ***Mitigation*** - Dam design has thoroughly assessed and incorporated design elements to mitigate potential damaging scenarios such as seismic events. - Inspection & Maintenance Plan - Security Management Plan - Emergency Response and Preparedness Plan
Dam failure is unlikely to occur during the life of the Project however the consequences of it happening could be catastrophic with the loss of life and widespread and potentially irreparable impacts on livelihoods and quality of life. Without mitigation the assessed risk is Extreme; however this can be effectively mitigated by incorporating appropriate design measures and implementing effective monitoring, maintenance and security procedures. An Emergency Response and Preparedness Plan would mitigate consequences should a dam break occur.	

i. ***Medium Risk Impacts***

Medium risks are tolerable if mitigation measures are in place, however management procedures will need to ensure necessary actions are quickly taken in response to perceived or actual environmental damage. Due to the sale of the Project most risks occur within this range.

4. **Traffic**	
▪ ***Impact*** - Increased Traffic on the access road at the M1 Road intersection and access road to the construction area could interfere with public traffic and deteriorate safety (especially the school children and elderly people), spillage of fuels and chemicals, and damage to infrastructures and properties due to vibration.	▪ ***Mitigation*** - Implement ECP 15: Road Transport and Road Traffic Management. - Include in the contractor's traffic management plan to ensure uninterrupted traffic movement during construction: detailed drawings of traffic arrangements showing all detours, temporary road, temporary bridges, temporary diversions, necessary barricades, warning signs / lights, road signs, construction schedule etc.
Construction traffic will vary over the course of construction. In the early stages of construction large trailer trucks will be required to move heavy plant and equipment. Water carts will also regularly use public roads to fill from offsite locations. Following excavation works deliveries will mainly relate to delivery of construction components, cement and other construction materials. Small vehicle movements including private cars and mini vans will be generated from personnel living offsite. The main potential impact is related to traffic congestion at the M1 road intersection and safety issues. Due to the possibly of accident this is rated as an Extreme risk with the possibility of death. Traffic mitigation will include a wide range of measures and their implementation will significantly reduce the likelihood that serious accidents would occur. However this risk is at the upper medium end and mitigation requires diligence and ongoing monitoring to ensure risk does not escalate.	

5. **Occupational Health and safety**	
▪ ***Impact*** - Poor worker safety systems - Safety threats to workers and the community	- Occupational health and safety procedures will be enforced at site. Each contractor will be required to prepare, obtain approval of, and implement an occupational health and safety (OHS) plan. These

5. **Occupational Health and safety**	
- Poor health management, including lack of HIV/AIDS awareness. - Unacceptable Worker Lost Time	plans will be prepared in compliance with the ECP 18: Workers Health and Safety and World Bank Group's Environment, Health, and Safety (EHS) Guidelines. - All workers will be adequately trained and provided with proper personal protection equipment (PPE).Frequent supervision will be carried out by supervision consultants to ensure they are wearing proper PPE at all times. - Contractor OHS plan to describe the tasks and methods to be used by workers associated with construction and diving operations, and how to perform them safely and state how potential hazards are identified and handled. Contractors will ensure that construction workers are adequately informed about the OHS plan. - Contractors will train workers to deal with safety from hazards such as crocodile attack and snake bite. - Special attention will be focused on safety training for workers to prevent and restrict accidents and deal with emergencies.
OH&S issues will be significant on a project of this scale, with significant potential for accidents includiong fatalities. In addition the influx of workers significantly increases the potential for spreading infectous diseases, including HIV/Aids. Due to the potential loss of life and impact on surrounding communities this risk is assessed as Extereme. OH&S are well established and implementing appropriate systems will significantly decrease the liklehood of accidents or health problems. However this takes a great deal of effort, including ongoing monitoring, training and ensuring a safe worksite. This risk is therefore manageable, however significant effort is required to mange any escalation of the risk.	

6. **Terrestrial Habitat**	
▪ ***Impact*** - Loss of important forest woodland - Loss of riparian dambo grassland (riverine vegetation) habitat (55 ha). - Removal of protected tree species without approval: Bleedwood teak, African mahogany, Coast Gold leaf and Yellow Wood - Reduced water flow to downstream riverine vegetation causing vegetation stress and loss of habitat connectivity. - Proliferation of invasive species (Azolla filiculoides) - Loss of ecological resources to local communities - Cumulative impact due to continuing loss of habitat in the wider catchment.	▪ ***Mitigation*** - Plant forest woodland buffer around reservoir (156 ha) - Relocation of forest woodland graveyards (10 ha) - Plant Riparian dambo grassland around dam shoreline - Ensure approval for removing protected tree species - Maintain environmental flows to minimise impact on downstream riverine habitat - Implement program to monitor and manage invasive vegetation species - Catchment management initiatives to include better management of natural habitat within the dam catchment, including the Dzalanyama Forest Reserve.

6. **Terrestrial Habitat**
Important terrestrial habitat includes forest woodland and riverine (grassland dambo) vegetation. These habitats comprise of approximately 2 % (55 ha) of the permanently affected Project area, with the remainder (2287 ha) comprising of agricultural land. The majority of affected animals use these habitats to varying extent, including to transit to areas outside of the Project area. Further, woodland and riverine grassland provide important ecological resources to local communities and four tree species have conservation significance. At a catchment level the loss of these habitats will contribute to ongoing cumulative loss due to clearing and illegal landuses. Consequently this risk is rated as High, however proposed offset planting of compensatory habitat around the Dam and catchment management initiatives will substantially mitigate this to a Medium risk. However this remains at the higher end of the Medium range due to the significant level of effort required to implement mitigation measures. Over time this Risk will reduce as forest woodland and riparian vegetation becomes established and catchment management initiatives become apparent. In the longer term (about 10 years) there is likely to be an increase in species diversification and abundance. The Project will therefore have an overall positive impact to biodiversity.

7. **Terrestrial Wildlife**	
▪ ***Impact*** 1. *Mammals*: - 21 identified species will be displaced by the Dam, most of which use riverine and forest woodland habitat. - Mammal species of conservation significance are the larger common duiker, jackal, spotted hyena and the clawless otter. Approval will be required to interfere with their habitats. 2. *Avifauna:* - 57 identified species use the Project area, including two of international significance (Little Sparrow Hawk and Peregrine Falcon), while four species are protected under the National Parks and Wildlife Act, 2004 (Broadbilled Roller, Red Winged Francolin, Guinea fowls and Owls). - Approval will be required to interfere with their habitats. Riverine and forest woodland are the most important habitats. Most affected will be ground dwelling birds (such as guinea fowls, red francolin and quails) and less mobile birds (Owls) inhabiting riverine and woodland habitats. 3. *Reptiles & Amphibians:* - 13 identified species use the Project area. Species of conservation significance include the Nile Crocodile, Nile Monitor Lizard and two snakes: Python and Mamba. Small and less mobile animals such as frogs may require physical relocation.	▪ ***Mitigation*** - Ensure planting of forest woodland buffer and new graveyard sites reflect habitats of affected species. - Salvage appropriate vegetation (hollow logs, seedlings, seeds, etc) affected by the project and reuse in areas to be planted with forest woodland and riverine vegetation. - Ensure approval for removing protected animal species. - Undertake further site surveys during the wet season, particularly for amphibian species. - Management plan to capture and relocate animals that cannot easily leave the affected area to a suitable habitat. Affected animals could include ground dwelling birds, sedentary owls, and small and less mobile animals such as python and frogs. - Management plan to minimise adverse crocodile / human interactions.

7. **Terrestrial Wildlife**	
- Surveys were undertaken over a 4 week period during the dry season, which may not reflect the status of some animals, such as frog populations.	

Terrestrial wildlife is represented by 21 mammal, 57 avifauna and 13 reptile/amphibian species, of which 14 species have conservation significance. All species are regionally represented and none are classified as endangered. Most of these species will be capable of relocating to nearby habitats, however some will require capture and release into suitable areas. Without mitigation there will be a net loss of animals, which will contribute to the catchment wide cumulative loss of biodiversity, hence giving this an initial High risk ranking.

Replacement of woodland and riverine habitat around the Dam will likely increase species diversity and abundance and, in combination with other mitigation measures, would reduce the assessed risk to Medium. However effective and prolonged mitigation is required to successfully ensure habitats are fully established.

As noted in the mitigation for terrestrial habitat, the successful implementation of mitigation measures will substantially reduce this risk and in the longer term there will be a positive impact to biodiversity.

8. **Aquatic Fauna**	
▪ ***Impact***	▪ ***Mitigation***
1. Fish:	- Plant riparian vegetation around Dam perimeter.
- 10 identified fish species use the study area. None are listed as having conservation significance.	- Maintain environmental flows to minimise impact on downstream riparian habitat, river flows and water quality.
- Some species will readily adapt to Dam conditions, although some will rely on establishment of riparian vegetation around the Dam. It is expected that 3 species - *Labeo cylindricus* (Ningwe), *Labeobarbus johnstonii* (Mphondo) and *Amphilius uranoscopus* (Nkholokolo) -will be affected by changes to habitat and flow conditions and will relocate upstream of the dam.	- Construction management plan to minimise potential water quality impacts.
- Downstream fish populations could be affected by changes to flow regimes and poor water quality.	- Dam operational procedures to include management of environmental flow discharges to ensure poor quality dam water is not released.
- Proliferation of non-native species resulting in competition and changes to existing biodiversity.	- Suitable mesh on Dam inlet structure to prevent fish from being sucked into the inlet pipe.
2. Macro invertebrates:	- Manage influx of introduced species
- 68 identified species use the study area. One species (medical leach, *Hirudo medicinalis*) has conservation significance.	
- Dam will impact on species diversity, however this will be localised and species abundance will likely increase.	

Ten fish and 68 macroinvertebrate species use the project area, with one macroinvertebrate having conversation significance. There is also a high diversity of macroinvertebrates, indicating a healthy river system. Fisheries are also an important ecological resource and an estimated 1,800 fishers are active in the Project area. Fish migration from Lake Malawi is not a significant issue due

8. **Aquatic Fauna**
to a natural five metre high waterfall situated approximately 52 km downstream of the proposed Dam, close to the Linthipe / Lilongwe River confluence near Mayani in Dedza. This fall is vertically steep, making it very unlikely that fish can migrate upstream of this point. The project will mainly affect three species of fish that are unlikely to readily adapt to an impoundment and changed habitat conditions, however none of the identified species are expected to be regionally impacted. Macroinvertebrates will likely increase in abundance, however species diversity within the dam and immediately downstream is expected to decline. Mitigation will include restoration of riparian habitat around the dam perimeter and careful management of downstream environmental flows, however these measures will need to be successfully implemented to effectively manage this risk. In the longer term there will be an increase in fish stocks and successful establishment of riparian vegetation around the dam will increase species diversity and abundance resulting in improved biodiversity and positive Project benefits.

9. **Hydrology & Water Quality**	
▪ ***Impact*** *Hydrology* - Flooding of valley and creation of a large reservoir (2,328 ha). - Significant reduction in downstream flows and changes to current flow regimes. - Impact on river as a result of water extraction during construction. - Increased flooding. *Water Quality* - Erosion and sedimentation - Contaminated stormwater from operational areas containing potential pollutants such as oils, solvents, paints, fuels & waste materials. - Uncontrolled liquid spills of contaminants such as fuel and oils. - Sewage and wastewater discharges. - Dam impacts on water quality including deterioration of water quality due to physio-chemical changes and downstream discharge of poor quality water. - Non-compliance with IFC and Malawian water quality requirements.	▪ ***Mitigation*** - Construction management plan addressing management of soil and water runoff, wastewater, solid and hazardous waste and materials handling. - Clearing large vegetation stands of vegetation within the reservoir area and restricting agricultural activities for at least six months prior to inundation. - Water extraction during construction will only be undertaken during suitable flow conditions. - Decommission diversion channel at beginning of wet season to minimise time required for dam to reach operational level (1161.9 masl) and commencement of environmental flow discharges - Maintain environmental Flows equivalent to 90% percentile compensation flow (Q90), which is the flow that is available 90% of the time - Dam operational procedures to include management of environmental flow discharges to ensure poor quality dam water is not released. - Dam operated to reduce flood peaks for major floods - Emergency Response and Preparedness Plan - Implementation of water flow and quality monitoring system, including real time monitoring of key indicator water quality parameters. - Secure buffer forest buffer around the reservoir to prevent activities that may affect catchment degradation and water quality. - Set up Catchment Management Committee. Catchment management initiatives to include substantial revegetation around the dam perimeter, erosion control management within the catchment and improved management of the

9. **Hydrology & Water Quality**	
	Diamphwe River headwaters within the Dzalanyama Forest Reserve.

The proposed dam will change river flows and affect water availability and quality to downstream users and riparian habitats. The Diamphwe catchment comprises of approximately 16% of the major Linthipe River catchment and the Dam could result in a corresponding reduction in water flowing into Lake Malawi. However potential impacts would be significantly higher in the section of river between the proposed Dam and the first major tributary, approximately 3 km downstream, making this a High risk. There would also be attendant impacts on water quality due to construction impacts,reduced downstream flows and physical-chemical changes resulting from the Dam impoundment.

Proposed mitigation measures include maintaining a 90% percentile compensation flow, combined with careful regulation of water quality in water releases and catchment management initiatives. These measures will substantially lower environmental risk, as well as providing positive benefits during periods of below average flow conditions and by reducing flood peaks for major flood events.

10. **Noise**	
▪ ***Impact***	▪ ***Mitigation***

Noise
- Noise levels consistently exceed IFC guidelines of:
  ○ 55 $L_{Aeq,1hr}$ (dBA): Residential, institutional and educational; and
  ○ 70 $L_{Aeq,1hr}$ (dBA): Industrial and commercial.
- Short term noise exceedances during construction operations causing nuisance, sleep deprivation and possible health issues for excessive noise levels.
- Unacceptable vibration at sensitive receptors such as houses and community assets.
- Long term noise disturbance due to operational noise from Dam and pump operations, WTP and office/accommodation area.
	- Contractor to undertake detailed noise modelling assessments prior to major construction activities, such as quarrying and crushing, river diversion works and at various stages of dam construction. Modelling results would form the basis for implementing appropriate mitigation measures, including scheduling the works, selection of plant and equipment and temporary noise barriers.
	- Construction Management Plan detailing monitoring and mitigation requirements for noise and vibration.
	- Areas near sensitive areas, such as the Water Treatment Plant and accommodation / office areas, will be surrounded by a minimum 200 meter buffer. If necessary additional acoustic controls will be incorporated into the design, such as muffling systems, pump covers, noise barriers, etc.

Dam construction will be a significant undertaking over a period of 3.5 years. Noise generation will vary in accordance with the construction schedule, hence mitigation measures will require evaluation and modification on a regular basis. In the longer term people living around operational plant such as the WTP and accommodation / office area may experience elevated noise.

The objective noise criteria at sensitive receptors will be in accordance with IFC standards, however it is expected that this criteria may be exceeded on occasion, which will prompt further mitigation response. Consequently this risk is rated as Moderate, whereby risks are tolerable but quick response is required.

11. **Waste**	
▪ ***Impact***	▪ ***Mitigation*** - Waste Management Plan.

11. **Waste**	
- Poor waste management causing pests and disease. - Litter and dumping on public areas and roads. - Contamination of stormwater runoff. - Spillage of potentially hazardous materials	- Avoidance, minimisation and reuse' policy. - Proper handling and containment of waste. - Use appropriate waste disposal contractors.
Construction activities will generate a range of waste types such as surplus unsuitable fill materials, general construction rubbish, domestic and sanitation waste from construction camps and potentially hazardous wastes such as oils and solvents. The objective will be to minimise waste generation as much as possible, but when this is unavoidable then to reuse and recycle either on site or through local businesses. Waste to be disposed of will be removed from the site by an approved waste contractor. Despite mitigation measures this remains as a moderate risk due to potential for spillage and poor waste management, resulting in pollution and possible contamination of air, soil or water mediums.	

12. **Groundwater**	
▪ ***Impact*** - Groundwater recharge may be affected. - Groundwater drawdown due to water extraction during construction. - Groundwater pollution from uncontrolled waste water discharges and spills of hazardous materials.	▪ ***Mitigation*** - Groundwater will not be used for non-potable water use during construction. - Groundwater will be used for potable use during construction, however this will be closely monitored and potable water would be trucked in from Lilongwe if necessary. - Construction management Plan to reduce potential for offsite pollution. - Implementation of groundwater level and quality monitoring system.
It is unlikely that the Project will adversely affect groundwater resources. Mitigation measures can be readily applied and in the longer term there is likely to be a positive benefit as local villages rely less on groundwater as a potable water source.	

S.8.4 Socio Economic Impacts

A. NEGATIVE IMPACTS

i. ***Scope of Impacts and mitigation***

The ESIA and RAP reports cover the range of potential socio-economic impacts associated with Project, which mainly relate to relocation and disruption of PAP and their families.

Negative impacts will include the following:

- The loss of land-holding, and privately owned assets on that land, resulting in the possible need to relocate. Land loss incorporates: Cultivation land, residential/homestead sites; Productive resources on the land, Household structures and other privately owned business enterprises and community assets owned by organisations, such as non-governmental organisations (NGOs) and religious bodies.
- The loss of communal resources and assets including productive land, river resources and structures.
- The loss of government property including sports grounds, bridges and road infrastructure.

- Disturbances to livelihoods, subsistence levels and income-earning capacity, primarily through the loss of economic assets/resources and the need to relocate. This may in itself lead to an increase in poverty levels, and cause a decline in household nutritional and health standards.
- Loss of access to agricultural land, and to services and facilities, through the creation of the reservoir and other construction works.
- Impeded access and the relocation of large numbers of people may increase pressure on existing services in host areas, particularly on educational and health facilities.
- Environmental spin-off effects from resettlement; for example, pressure on water and sanitation facilities may affect water quality, or an increase in livestock grazing may cause soil erosion.
- Loss of access to a natural resource base, and particularly the river system, currently used extensively for domestic, agricultural and commercial purposes. This is particularly important where local people depend to a large extent on the physical environment for survival. The dam will lead to the loss of river and floodplain habitats, diverse ecosystems home to numerous plants, animals and fish used by the communities. This is compounded by other factors: for example, farmers displaced by the reservoir may clear forests in other areas to grow their crops and build new homes.
- A changed hydrological regime in the Diamphwe river downstream of the dam, affecting users with the impact of the unnatural pattern of flow variation, of water loss, and possible erosion of riverbanks. This could impact on agricultural practices dependent on seasonal changes in river flows and flood recession cropping, particularly in the dambo areas.
- Less quantifiable impacts on social groups; such as a breakdown in neighbourliness and support and coping strategies; potential community strife as a result of pressure on remaining resources, and socially destabilising effects; and changes in local movement patterns.
- Health may be affected in that reservoirs can become breeding grounds for disease vectors; for example, mosquitoes (as vectors for malaria) and snails (as vectors for bilharzia – Schistosomiasis) can take advantage of slow flowing water. In addition, a potential increase in Sexually Transmitted Diseases (STDs) in the area through in-migration, compounded by an increase in commercial sex work.
- Impacts on the aesthetic value of living conditions and scenery, particularly with the creation of the dam infrastructure.
- Collective adverse impacts on vulnerable groups/social categories who, because of their social position, may be vulnerable to changes brought about by project activities, or who may be excluded from its associated benefits.

Mitigation of Social impacts is fully documented in the RAP, which includes:

- Entitlement Framework and Relocation Framework;
- Institutional and Organisational Framework;
- Public Consultation and Disclosure Of Information;
- Grievance Procedures;
- Gender Mainstreaming;
- Monitoring and Evaluation;
- Resettlement Schedule; and

- Costs and Budget.

A summary of potential impacts is provided in *Table 0.3* and discussed below.

Table 0.3 Key Negative Socio-Economic Impacts for Reservoir and Buffer Zone

ES 8.3 Disclosure	ES 8.3 Disclosure
People affected	5,178 PAP affected through loss of land and/or assets on that land (structures, crops, trees); 2,322 in Lilongwe District and 2,856 in Dedza District. Assuming they all belong to different households, with an average household size of 5.05 an estimated 26,149 people will be directly affected.
Villages affected[2]	223 villages affected by land take: ▪ 76 in Lilongwe District; 3 in Chadza TA, 61 in Kalumbu TA, 12 in Mazengera TA. ▪ 147 in Dedza District; 15 in Chilikumwendo TA, 132 in Kaphuka TA.
Involuntary relocation	Relocation required for an estimated 644 homesteads of approximately 3,050 people, from 41 villages: ▪ 358 homesteads from 17 villages in Lilongwe District. ▪ 286 homesteads from 24 villages in Dedza District. Relocation required for an estimated 89 businesses with permanent structures: ▪ All from Lilongwe District; 1 from Mtsirikiza (Mazengera TA); 87 from Bisayi and 1 from Chingwenje (Kalumbu TA). ▪ 8 PAP had more than one business affected.
Acquisition of land	▪ Permanent acquisition of an inundation area of 2,328 ha at FSL of 1,180.3 masl, and an additional 15m Buffer Zone (BZ) of 156 ha, comprising of 2,484 ha (24.8 km²) in total. From land use mapping this was calculated at: - Cropland: 1,562.47 ha (62.9% of the total area) - Cultivated Dambo: 496.3 ha (20.0%) - Dambo Grassland: 378.4 ha (15.2%) - Forest/Natural Vegetation: 9.5 ha (0.4%) - Settlement: 0.4 km²/37 ha (1.5%). ▪ 2,259.48 ha of productive land, used for cultivation, grazing or graveyards, and residential plots was identified and surveyed by the Asset surveyors. ▪ The acquisition will lead to: - ***Permanent loss of cultivated crops, primarily for subsistence.*** - ***Permanent loss of individual productive trees, primarily for domestic use.*** - ***Loss of produce to local domestic markets and Lilongwe city & Dedza town.***
Acquisition of structures	▪ Permanent loss of an estimated 733 private structures; 644 residential homesteads and 89 businesses (as above). ▪ Permanent loss of 4 religious structures: Assemblies of God and Baptist Churches in Salima Ndinda village, and CCAP Church in Bisai village (Kalumbu TA, Lilongwe District); PIM Church in Zerela village (Kaphuka TA, Dedza District).
Loss of government infrastructure and social services	▪ Permanent loss of 3 sports grounds: Tsalakunja and Kawereng (Kaphuka TA, Dedza District); Botomani (Kalumbu TA, Lilongwe District). ▪ Permanent loss of road network and bridges.
Loss of livelihoods	▪ Loss of agricultural land and the produce from that land (crops, trees). ▪ Loss of 89 business structures, all in Lilongwe District, and mostly in Bisayi; 8 PAP are losing 2 businesses. ▪ Detrimental impact on health through loss of access to livelihood.

[2] This figure reflects the villages where land and assets on that land are affected.

ES 8.3 Disclosure	ES 8.3 Disclosure
Loss of access to natural resource base	▪ Loss of access to the Diamphwe River, and in its original form – used for multiple reasons and multiple resources, for domestic and commercial purposes ▪ Permanent loss of other natural resources such as grazing land, medicinal plants, sand and clay, reeds and grasses.
Severed/impeded access	▪ Permanent loss of: 2 bridges (from Bisai to Chimpaze, and Nyamazani to Kakhosi); 2 bridges under construction (at Kawereng, and Salima Ndinda to Zalera); a concrete causeway at Katete, and other crossing points over the Diamphwe River. ▪ Impeded access between communities on either side of the Diamphwe River, for agricultural land, infrastructure and social services, and visiting family and friends (networking).
Cultural impact, including graveyards	▪ Loss of 21 heritage sites, including 16 archaeological sites of varying age, with 8 being evident settlements of the Iron Age. ▪ Loss of traditional (Dambwe) sites for *Gule Wamkulu.* ▪ Inundation of an estimated 14 graveyards and two isolated grave sites. ▪ Loss of 995 graves: 511 in Lilongwe District, and 484 in Dedza District. ▪ Loss of social support networks.
Health impact	▪ Increase in waterborne vector diseases, especially malaria and bilharzia. ▪ Increase in communicable diseases in the area with in-migration of construction workers/people seeking work, and commercial sex work. ▪ Increase in required resourced health facilities in/around Project Area of Impact. ▪ Impact on physical and psychological well-being as a result of relocation. ▪ Noise, dust, vibrations.
Change in aesthetics	▪ Loss of visual experience from living close to the Diamphwe River. ▪ Unsightly construction works and Dam infrastructure.

ii. ***Land acquisition requirements***

The Project will result in the permanent acquisition of 2,526.5 ha of mostly agricultural land, of which 39 % is located in Lilongwe District and 61 % in Dedza District. This will result in a large number of affected people and assets.

- The Census survey identified a total of 5,178 people who will be affected by the Reservoir and buffer zone through loss of land and / or assets on that land (structures, crops and/or trees). With an average household size given at 5.05 members per household (from census), assuming the PAP came from different households, an estimated 26,149 people will be directly affected.
- A total of 223 villages will be affected through loss of land (residential, agricultural, communal) in Lilongwe District and 147 in Dedza District.
- A total of 644 residential homesteads will be affected by the inundation of the Reservoir including the buffer zone, and would thus require resettlement; at an average of 5.05 people per household, an estimated 3,252 people will be affected. These homesteads are situated in 41 villages, 17 villages (with 358 homesteads) in Lilongwe District, and 24 villages (with 286 homesteads) in Dedza District.
- A total of 89 businesses will be affected. These businesses are permanent structures, mostly made of brick, and sell a range of goods.

iii. ***Loss of Service Provision***

Assets identified in the census that will be lost through inundation of the Reservoir and buffer zone are four churches (2 each in Lilongwe and Dezda Districts) and three sports grounds (one in Lilongwe and two in Dedza Districts). A Junior Preparatory School will be affected through infrastructure development.

iv. ***Crop and Tree Loss***

Of particular concern is the extent of agricultural loss, given the dependence of local communities on subsistence farming and the amount of cropland that will need to be acquired for the Project. This includes Cropland (1,562.47 ha) and Cultivated dambo (496.29 ha), with additional patches of cultivated land in dambo grassland. Dambo gardening (flood recession agriculture) is an important economic activity in the Project area, and the main preoccupation for households residing close to the Diamphwe River and its tributaries: The acquisition of land will lead to:

- Permanent loss of cultivated crops, primarily for subsistence;
- Permanent loss of individual productive trees, primarily for domestic use; and
- Loss of produce supplying domestic markets in Lilongwe city and Dedza town.

v. ***Depletion of Natural Resource Base***

A range of natural resources that are useful to local communities will be affectd by the Project. These resources play an important role in the livelihoods of households and other resource user groups.

- *River usage*: The loss of access to the use of water of the Diamphwe River is one of the most significant negative impacts of the Project: for agricultural irrigation, domestic usage, recreation and watering of animals. The river is also used for other purposes such as fishing, sand and clay extraction for brick-making and use of reeds and grasses for house construction and/or basket-making.
- *Land-based natural resources*: Land loss will impact on forms of livelihood and income-generating activities that rely on land-related natural resources, such as medicinal and culinary plants and trees. The loss of these will particularly affect households who depend on these resources as income-generating activities; such as the sale of herbal plants, and of firewood. The harvesting of resources in other areas will create an added economic burden, and lead to increased pressure on those resources.

vi. ***Livelihood Impacts***

- *Income sources of affected households*. The local economy is primarily based on subsistence agriculture, however the majority of people also earn an income from farming. Some households are also affected through the loss of businesses, mostly run independently from the homestead.
- *Loss of produce*: This will result in considerable loss to the agricultural base and produce of many households. The loss of produce will not only directly impact on the livelihoods of affected households, but also have a number of spin-off affects. For example local services and infrastructure supporting the agricultural industry and receiving markets.
- *Livestock farming*: The majority of households affected by the Reservoir had some livestock, comprising of mostly goats, with a few cattle and other animals. Affected households may lose their stock through relocation and those remaining may also lose considerable areas of grazing land.

vii. ***Severed and Constrained Access***

The Reservoir will further impede existing access to services and facilities (such as transport, health facilities, schools, businesses, and market places for the sale/purchase of goods), and kinship, social and support networks. Two bridges and a concrete causeway will be flooded, as will two new bridges being constructed.

viii. ***Downstream/Upstream Impacts***

A changed water flow regime in the Diamphwe River will impact on the operations of farmers downstream of the Dam through changes to seasonal flooding, particularly for those dependent on flooding for agricultural production. Backwater affects from the Reservoir may also lead to flooding of agricultural lands immediately upstream of the Reservoir. These impacts will be mitigated by environmental flow release (90 % of normal flow) and potential impacts are not expected to be significant.

B. VULNERABLE GROUPS

Households classified as 'vulnerable' are affected households who may, by virtue of gender, ethnicity, age, physical or mental disability, economic disadvantage or social status, be particularly vulnerable to Project implementation, and changes induced by the Project. A household may become vulnerable when the head becomes aged, falls ill or becomes disabled, destitute or poverty stricken; and hopefully less vulnerable as their health and economic circumstances improve. Because vulnerability is a dynamic concept, the identification, assessment (and monitoring) of vulnerable households will be an ongoing process throughout the compensation/livelihood restoration programme.

C. HEALTH

Health-related impacts of concern include:

- *Physical resettlement and economic displacement*: This may impact on local livelihoods and increase the vulnerability of PAP, with the following potential health impacts:
  - Loss of housing and available land to support livelihoods, with impacts on nutrition and ability to afford services;
  - Reduced access to available basic social services, including health;
- *Vector-related illnesses*: The environment in and around the Project is conducive to the breeding of mosquitoes and creation of a reservoir may increase the number of breeding sites and thus vector densities. In-migration of people from areas where malaria is endemic may also carry the parasite into the area, increasing the risk of localised transmission of malaria. The Reservoir will also provide a breeding ground for bilharzia. A management plan will be implemented to manage vector pest species.
- *Project-induced influx with associated communicable disease transmission and social discord*: The Project will potentially result in the in-migration of returning residents, speculative migrants, and some movement closer to the Project from residents in the District. This is most likely to occur during the construction period, but may extend into operations.
- *Noise, vibrations, dust and traffic*: The construction and operation activities of the Project will include excavation, crushing and transportation of materials and personnel using heavy vehicles. As a result there are a number of environmental health determinants that may influence human health. These are discussed in detail as part of the various biophysical studies performed as part of the ESIA. It was concluded that potential dust issues are a High risk and will require effective mitigation. Noise is less of a health risk following mitigation, while water extraction will be carefully monitored. A comprehensive traffic plan will be put in place to minimise traffic hazards.

D. CULTURAL HERITAGE

i. ***Archaeological sites***

The development of the Reservoir will impact on the cultural heritage sites identified within the Project Area. A total of 21 heritage sites were identified as being impacted by the Reservoir during the field surveys. These include 16 archaeological sites of variable ages, with eight being evident settlements of the Iron Age. These sites and any other sites found during construction will be further invested and or relocated in accordance with a Management Plan prepared by the Department of Antiquities.

ii. ***Graveyard sites***

The Project will lead to the inundation of at least 14 graveyards and two isolated grave sites lying within the Project Reservoir and buffer zone area. An additional four graveyards will potentially be affected near the infrastructure area. Graveyards will be relocated to suitable sites in accordance with Department of Antiquity requirements. Suitable relocation sites have been identified and communications are ongoing with the relevant TAs.

S.9 Environmental and Social Management Plan

The ESIA includes an Environmental and Social Management Plan (ESMP) that will guide the actions necessary for implementation of commitments and mitigation measures identified in the ESIA and RAP, and facilitate proactive management of the environmental and socio-economic aspects of Project construction, operation and closure. In turn the RAP refers to additional requirements that will manage compensation and relocation of PAP, as well as mitigating impacts on livelihoods. The objectives of the ESMP are to:

- Ensure compliance with the ESIA and RAP, including minimising pollution and waste generation, minimising environmental and social impacts and ensuring support and integration with the local communities.
- Describe in detail mitigation measures to be carried out and assign responsibility for such measures.
- Provide details of monitoring requirements and a description of any training support that may be required.
- Maximize potential project benefits and control negative impacts.

i. ***ESMP Implementation***

A Program Coordination Committee (PCC) will be set up within MoAIWD to oversee and coordinate the Project at Ministry level. Project delivery will be the responsibility of the LWB, through its existing PIU. The PIU will be responsible for overall project management, including procurement and financial management. An Environmental, Social, Health, and Safety Unit (ESHSU) within the PIU will manage implementation of the ESMP through the Contractor.

The PIU will be supported by additional external resources including:

- Construction Supervision Consultants (CSC) responsible for supervising the contractors;
- Monitoring and Evaluation Consultant (MEC) who will carry out independent monitoring of the ESMP implementation;
- Contractor environmental team reporting to the ESHSU;
- Resettlement Working Committee (RWC) to monitor and coordinate day to day activities of the RAP implementation activities.

- Community Liaison and Participation Officer (CPLO) would have sufficient personnel and resources to ensure that the consultation activities are effectively implemented and managed.
- Grievance Officer (GO) within the PMU of the NDWP to co-ordinate all functions relating to grievances. The GO would liaise closely with a Grievance Sub-Committee (GSC) of the RWC.
- Dam catchment committee with responsibility for coordinating rehabilitation of the Dam buffer zone and catchment management activities within the Dam catchment

ii. ***Environmental and Social Management***

Environmental and social management will be facilitated by the following:

- *Environmental codes of practice (ECPs)*: 19 ECPs have been prepared for various environmental and social management aspects;
- *Site-specific Construction Environmental Management Plans*: These include 11 plans that are site-specific and where applicable, contract-specific. They will be prepared by various contractors prior to the commencement of construction activities.
- *Cumulative Impact Subplans*: These cover Soil Erosion & Sedimentation, HIV/AIDS Management, and Biodiversity.
- *Mitigation Plan*: This Plan is organised around various project activities and includes actions identified under the mitigation measures discussed in the ESIA. The Plan defines responsibilities for implementation as well as monitoring of each action, and also indicates the timing of these actions.
- *Resettlement Action Plan (RAP)*: The RAP will cover all components of adverse impacts incurred upon the affected population due to involuntary resettlement as a result of the implementation of the project. The RAP includes an Entitlement Framework that sets out requirements for the mitigation of losses and includes information on the legal framework, eligibility and entitlement criteria, and recommendations around compensation and other entitlements.
- *Communication Strategy*: A formal communication strategy will be necessary to promote and facilitate community consultation and to provide a mechanism for responding to community concerns. The RAP and ESIA outline the relevant stakeholders, and present recommendations in improving the institutional base and methods for consultation and disclosure of information. This includes details on a grievance mechanism for implementation during the early stages of resettlement.

iii. ***ESMP Budget***

The estimated budget to resource and implement the ESMP, including site restoration and reservoir buffer establishment costs, is US$7.7 Million.

S.10 Conclusion and Recommendations

The ESIA demonstrates that the Project can be successfully developed and implemented to meet relevant GoM regulatory and policy requirements, and World Bank Operational procedures.

The Project will secure Lilongwe's water supply to 2045 and provide significant opportunities to supply water to rural villages and for irrigation and fish farming, thereby substantially improving food security and livelihoods. The ESIA highlights a number of potential beneficial impacts likely to accrue as a result of Project development, including stimulating employment opportunities and economic development, improved infrastructure and service provision, enhanced biodiversity opportunities

and management of downstream river flows to reduce large flood peaks and improve water flow during below average flow conditions.

The Project will directly affect 26,149 people, including 5,178 PAP who have land or assets within the reservoir area. A total of 644 homesteads with approximately 3,050 people will need to be relocated to new areas. The RAP provides details on compensation and relocation requirements, which will require careful planning and diligence for successful implementation.

Mitigation and management measures have been developed, which will mitigate, minimise and/or manage potential impacts to Malawi and World Bank standards. These measures have been formalised into an Environmental and Social Management Plan and accompanying RAP that address environmental and social monitoring, implementation of mitigation measures and management of risks, and an Entitlement Framework.

Despite the application of mitigation measures and management plans, a range of potential 'residual' impacts remain and existing social and physical environments in the Project area will change. These issues will require proactive, dedicated and culturally sensitive leadership on behalf of MoAIWD to minimise the risk of harm to the environment or people affected by Project development, and maintain productive, friendly relationships with local communities.

In summary, while there are impacts associated with development of the Project, this report demonstrates that with commitment and strong leadership these impacts can be managed to conform to Malawi legal requirements and World Bank standards. In this regard the following recommendations are made:

1. *RAP Implementaion:* This should commence as soon as possible, including advising on a cut-off-date, establishing institutional arrangements and commemncing compensation activities.
2. *Project design:* The ESIA was based on feasibility level design. Detailed design should consider opportunities to further minimise environmental and social impacts by avoiding, where possible, sensitive areas or increasing positive biodiversity outcomes. For example minor relocation of the proposed balancing tank would avoid a wooded cemetery in Che Mbonga village, Traditional Authority Mazengera in Lilongwe District. Some parts of the proposed 15 m wide buffer zone may also be extended, subject to the availability of land and potential impacts on surrounding communities.
3. *Management measures*: This ESIA report and RAP have recommended a series of management measures, mitigation strategies and actions for the various environmental and social impacts created by the Project. These measures should be actively implemented and with committed intent to ensure that environmental and social impacts are managed appropriately.
4. *Residual risks*: There are three potentially high environmental risk areas; The loss of 2,342 ha of predominantly agricultural land will be a significant loss to a community that is heavily reliant on cropping for sustaining livelihoods. This is likely to have long term effects as compensatory irrigation, fish farming and forest woodland propagation become firmly established. Reduced air quality resulting from dust emissions during construction will require a high level of mitigation and vigilance to ensure compliance limits are achieved at sensitive receptors and that health of the community is not compromised. The third high residual risk relates to Dam failure and although this is unlikely to occur, the potential consequences could cause severe and hazardous downstream flooding. Appropriate resources should be allocated to monitor and manage successful implementation of proposed mitigation measures and immediate steps taken to resolve any escalation of these risks.
5. *Project verification:* There are a number of areas where early consultation, ongoing monitoring, evaluation and research is required for the verification of environmental and social management approaches. This consultation, monitoring, evaluation and research must also be undertaken in a timely manner and with commitment.

6. *Management Plans:* The key commitments to environmental and social impact management and mitigation are set out in the ESIA, ESMP and RAP. Prior to Project development these plans will need to be reviewed and updated to reflect specific development consent conditions and management details.

S.11 Disclosure

The ESIA, documenting the mitigation measures and consultation process, will be made available for public review in English. The Executive Summary of the ESIA will be published on the LWB, EAD, and the World Bank's websites. The full ESIA will be made available in the World Bank Infoshop and LWB website.

Chapter 1
Introduction

Environmental and Social Impact Assessment

February 2016

1. INTRODUCTION

1.1. Project Background

1.1.1. **Overview**

Lilongwe is the Capital of Malawi and the country's largest city, with a population of approximately one million people. This is expected to grow to approximately 1.88 Million by 2036 and 2.43 Million by 2045. Water supply capacity is inadequate in meeting current demands, which results in severe water restrictions and disruptions.

In response to the increasing shortfall of water supply, the Government of Malawi through the Ministry of Agriculture, Irrigation and Water Development (MoAIWD) and in collaboration with the Lilongwe Water Board (LWB) undertook feasibility studies to identify a suitable water source. The preferred option that best meets financial, technical and environmental and social aspects is to develop a dam on the Diamphwe River, approximately 35 kilometres south east of Lilongwe (Figure 1.1).

The Diamphwe Multipurpose Dam Project is a sub-component of the second phase of the National Water Development Project (NWDP II). Project studies have been financed by the International Development Association (IDA), while Project development will be funded by multiple financiers including the European Investment Bank (EIB), African Development Bank (AFDB), IDA and Private Sector (Public-Private Partnership – PPP) arrangement.

The MoAIWD has now commissioned Snowy Mountains Engineering Corporation (SMEC) International to assess potential impacts arising from the Diamphwe Multipurpose Dam and associated structures, and to prepare a detailed Environmental and Social Impact Assessment (ESIA) Report, an Environmental and Social Management Plan (ESMP) and a Resettlement Action Plan (RAP).

1.1.2. **Current Situation**

The city's water supply is sourced from two dams on the Lilongwe River with a combined storage capacity of 24.3 Million cubic metres (Mm^3) developed in three phases:

Phase 1: The First Lilongwe Water Supply Project (FLWSP) was completed in 1966 and included construction of Kamuzu Dam-I at Malingunde, with a water storage capacity of 4.5 Mm^3.

Phase 2: The Second Lilongwe Water Supply Project (SLWSP) was completed in 1992 and included construction of Kamuzu Dam-II at Msinja / Masula, with a water storage capacity of 9.2 Mm^3.

Phase 3: A Water Master Plan was prepared in 1994, which assessed water services to 2005. The Third Lilongwe Water Supply Project (TLWSP) was then completed in 1999 and included increasing the capacity of Kamuzu Dam-II to 19.8 Mm^3.

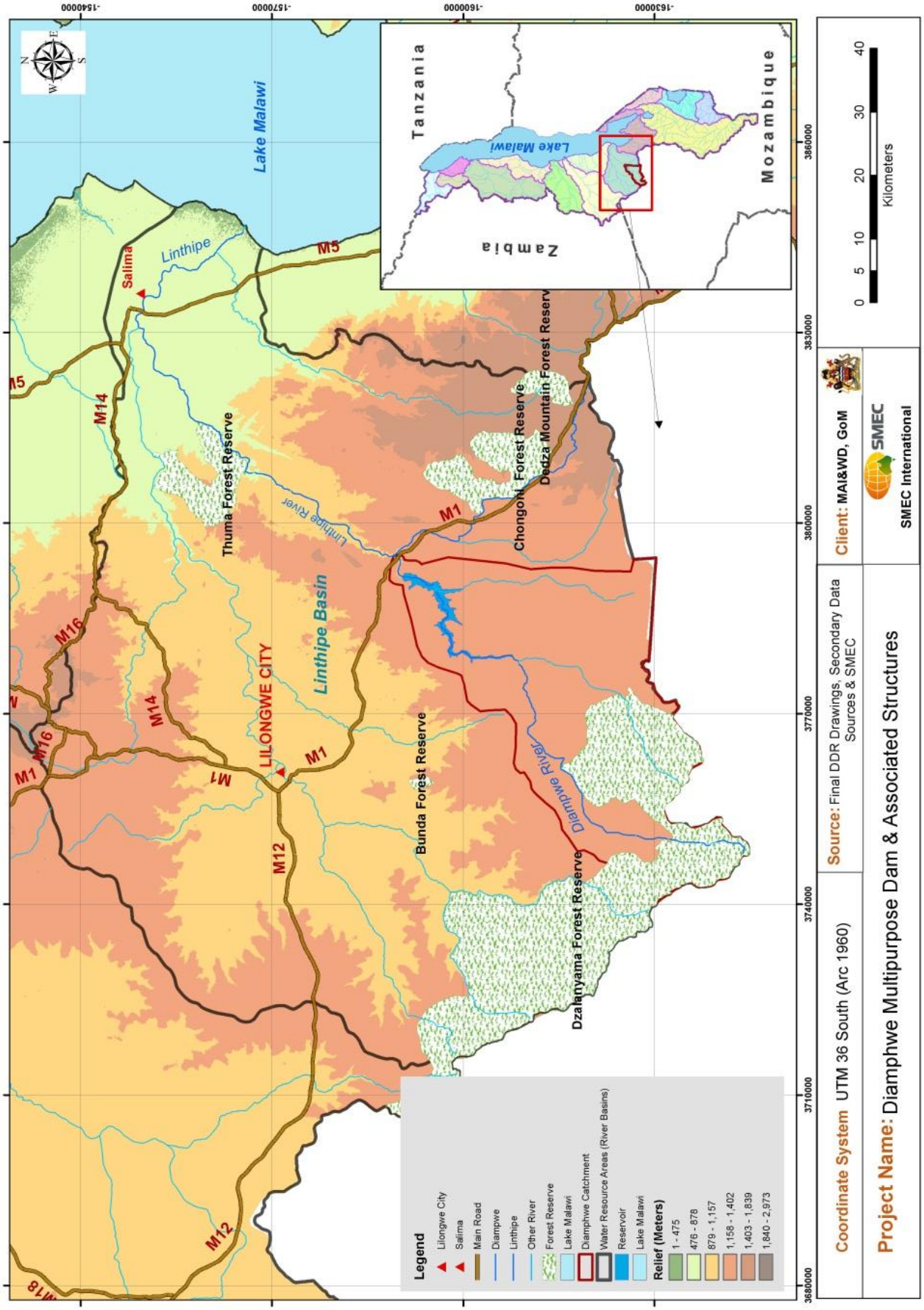


Figure 1.1: Project Location

Water delivery infrastructure comprises of two Water Treatment Plants (WTPs) and a pipe network of approximately 1,800 kilometres (km). The current water demand is 109 ML/d, however water production is only 95 ML/d with Non-Revenue Water (NRW) amounting to an additional 35%. This gives a current water supply shortfall of approximately 47 ML/d. The planned upgrade works will increase production by an additional 60 ML/d and consist of:

- Commissioning WTP II extension works in 2015 (30 ML/d); and
- Raising Kamuzu dam I and commissioning of WTP III in 2017 (30 ML/d).

Despite these initiatives a new bulk water source will be needed by 2020. In 2011 the World Bank funded a feasibility study that assessed several water sources including the Upper Diamphwe, Lower Diamphwe, third dam on Lilongwe, Ntofu, Lumbadzi and Likuni rivers. The study concluded that the Lower Diamphwe Dam is the most feasible new water source based on hydrological, technical, financial, economic, social and environmental factors. The Government has accepted this recommendation and has included the development of a bulk water scheme from the Diamphwe River as a key investment priority.

1.1.3. **Diamphwe Multipurpose Dam**

The Diamphwe Multipurpose Dam (The Project) will supply water to Lilongwe City and the surrounding areas until 2045 and support large scale irrigation and fish farming. The Project will therefore contribute significantly to meeting the goals promoted in the Second Malawi Growth and Development Strategy (MGDS II), which has the overriding philosophy of poverty reduction through sustainable economic growth and infrastructure development. The MGDS II aims to continue to facilitate the Millennium Development Goals (MDGs)[3], while maintaining a balance between the economic and social sectors of the economy. This is also in line with the National Water Policy of 2005 that seeks to achieve sustainable and integrated water resources management and developments that make water readily available and equitably accessible to all Malawians, while protecting the country's natural ecosystems. Key aspects of the Project are:

- The Project is located approximately 35 kilometres south-east of Lilongwe on the Diamphwe River, a tributary of the Linthipe river that flows north-east to Lake Malawi. Administratively the Project lies in the Central region between two Districts comprising of Traditional Authorities (TAs) Mazengela, Kalumbu and Chadza on the Lilongwe District (west) side; and TAs Kaphuka and Chilikumwendo on the Dedza (east) District side. The proposed Dam lies between the Ndomba Hill in Dedza district and the Chinzili and Phili la Fisi Hills in Lilongwe district (Figure 1.2).
- The Dam will be constructed approximately two kilometres upstream of the Diamphwe River Bridge on the Blantyre - Lilongwe M1 road and will be of Roller Compacted Concrete (RCC) construction. Ancillary infrastructure will comprise of a temporary diversion channel, booster pump and raw water transmission pipeline, and water treatment plant with a capacity of 147.7 Mega litres per day (ML/d). Treated water will be pumped to a balancing tank and then delivered 30 kilometres via dual gravity mains to the Bunda Turnoff near Lilongwe city. Project components are shown on Figure 1.3 and Figure 1.4.
- The Dam will have an operational capacity of 134 Million Cubic Metres (Mm^3) with separate outlets provided for downstream irrigation and the WTP. The Dam reservoir will inundate approximately 2,328 hectares (ha) of predominantly cropping and grazing land.

[3] The MDGs '*commit the international community to an expanded vision of development, one that promotes human development as the key to sustaining social and economic progress in all countries, and recognises the importance of creating a global partnership for development. The goals have been commonly accepted as a framework for measuring development progress'*

- A total of 5,178 Project Affected Persons (PAP) have land and other assets that will be directly affected by the Project. Of these 644 homestead and 89 businesses will need to be relocated to new areas. Community assets such as graveyards will also need to be relocated to new sites. It is estimated that 26,149 people will be directly affected by the proposal.

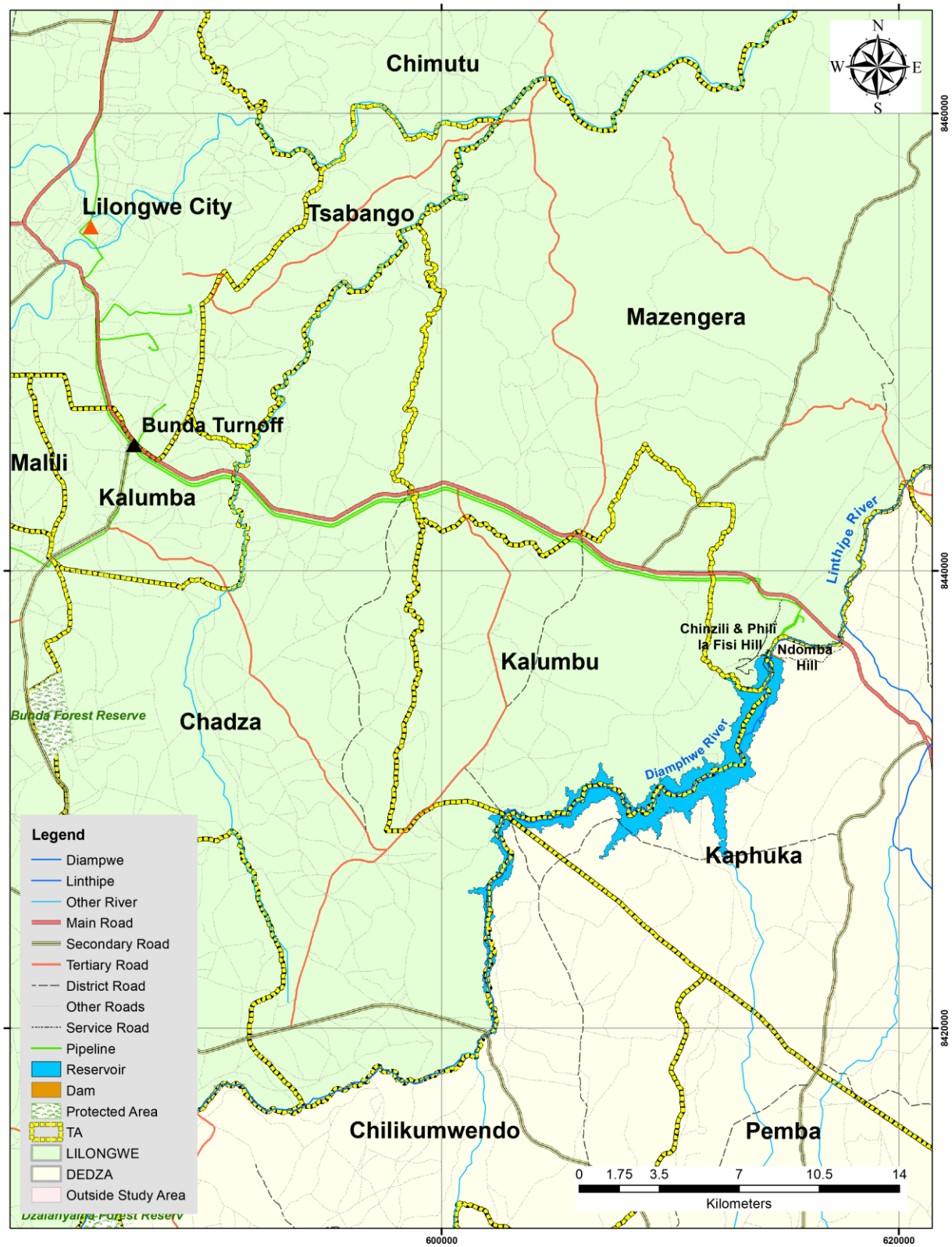


Figure 1.2: Site Location and Administrative Authorities

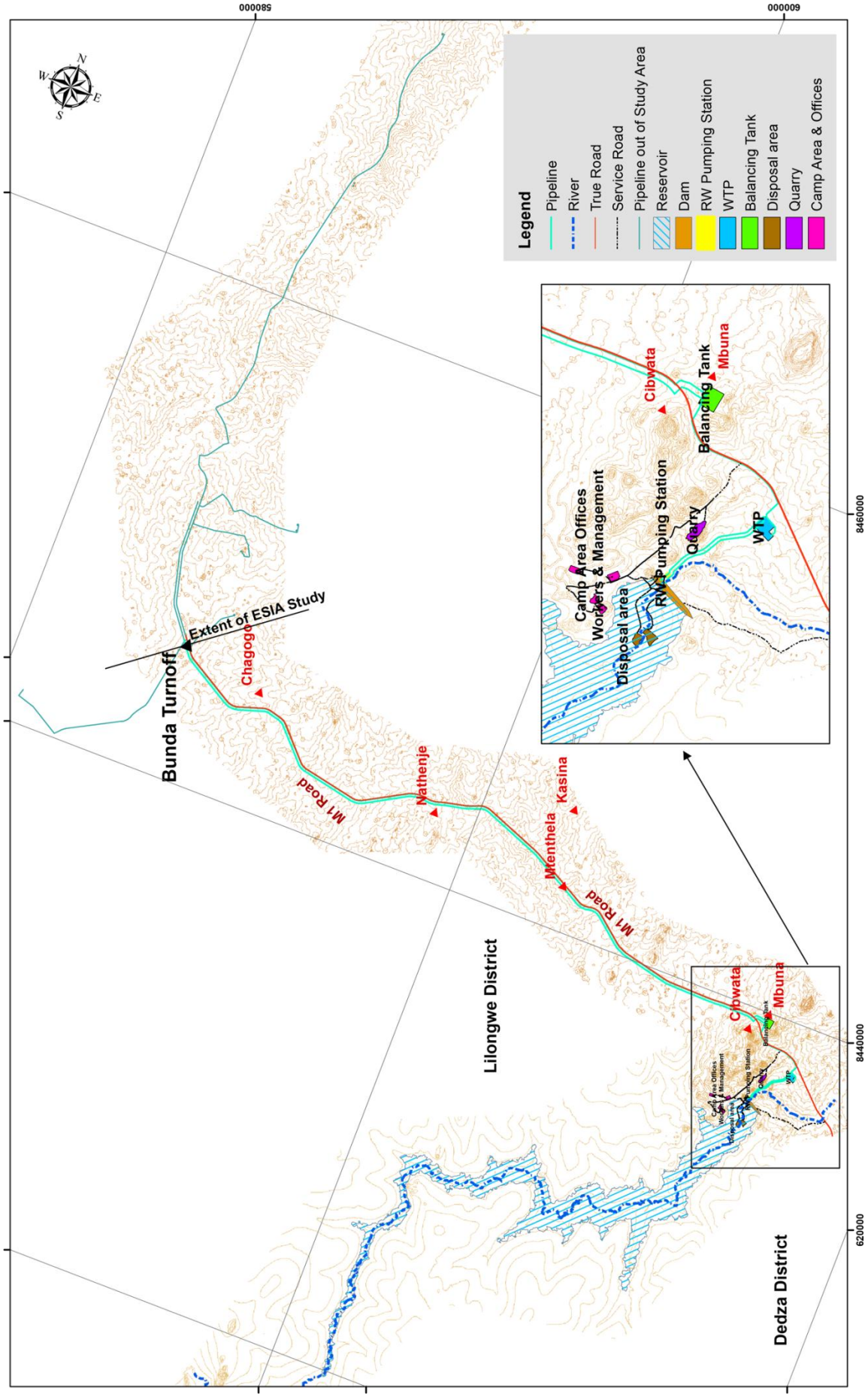


Figure 1.3: Project Footprint

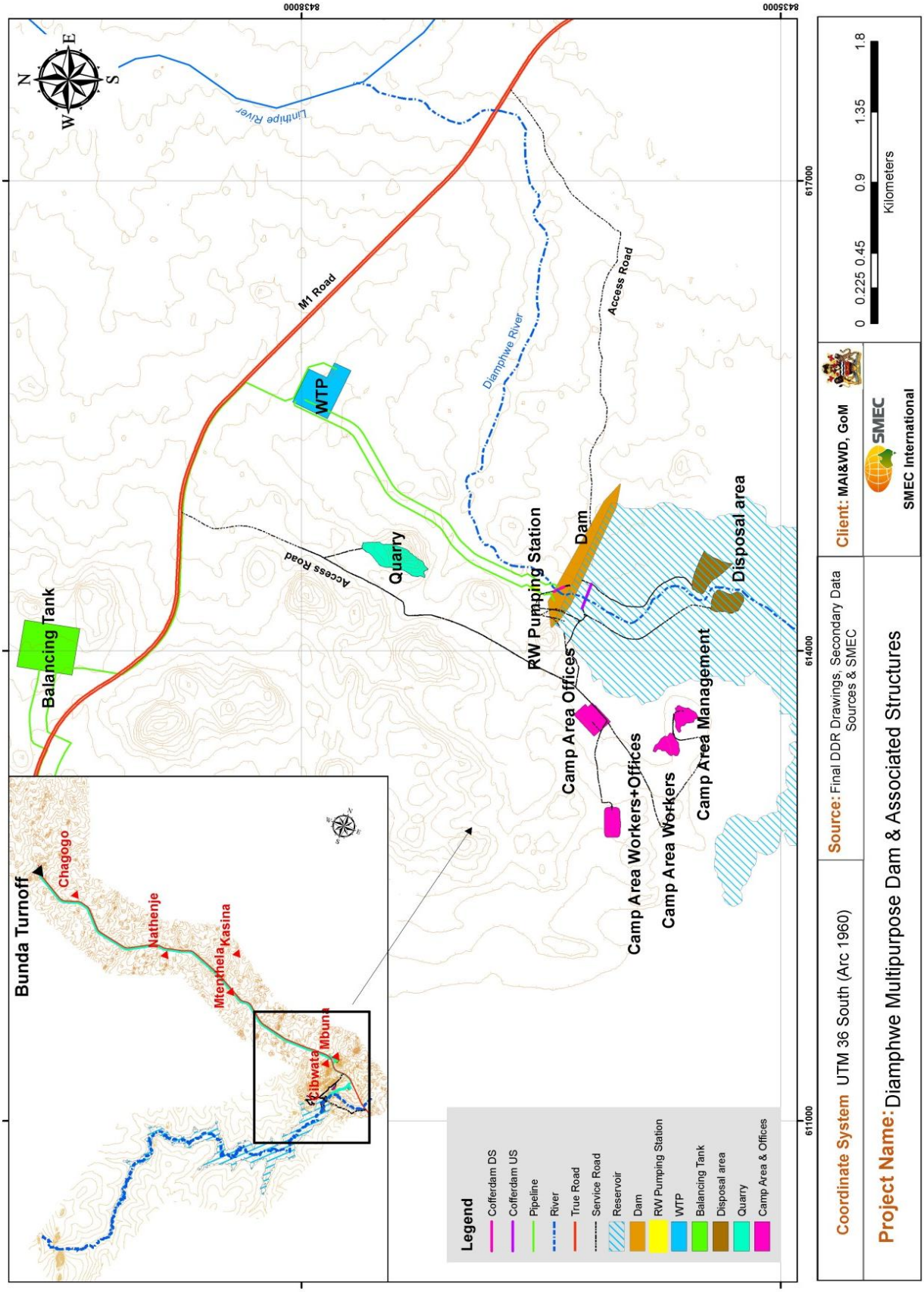


Figure 1.4: Infrastructure Area

1.2. Previous Studies

A number of feasibility and design studies have been undertaken, including environmental and social baseline and assessment investigations. The most relevant studies include:

- *WAPCOS* (2014-2015): Environmental & social reports comprising:
    - Inception Report;
    - Baseline Assessment Report;
    - Stakeholder Consultation Report; and
    - Draft ESIA report.
- *Studio Pietrangeli* (2014-2015): Design reports comprising:
    - Inception Report for detailed design of Diamphwe Multipurpose Dam & associated structures;
    - Topographical Report;
    - Hydrological Report;
    - Geological Report;
    - Spillway Physical Model;
    - Water Supply Technical report;
    - Detailed Design Drawings;
    - Consolidated Comments from World Bank & Review Report
    - Optimized Dam Design Report; and
    - Dam Design Technical Report.

Other related studies include:

- *SOGREAH* (2011): Preliminary ESIA of the Feasibility Study and Preliminary Designs for Lilongwe's New Water Source report;
- S*AFEGE* (2002): Preliminary ESIA under Engineering Studies; and

A comprehensive listing of reference information is provided in **Appendix 1**.

1.3. Scope and Objectives of the ESIA

The purpose of this Environmental Study and Impact Assessment (ESIA) is to identify and assess potential Project impacts on sensitive environmental, social, cultural and health receptors. Appropriate mitigation measures will be defined to either prevent or reduce impacts to levels acceptable to the Government of Malawi (GoM) Environment Management Act (1996) and international standards including the World Bank and IFC Performance Standards on Environmental and Social Sustainability.

Specific ESIA objectives are to:

1. Review and assess the adequacy and completeness of the preliminary ESIA studies done thus far, including the Inception, Baseline Assessment, Stakeholder Consultation and Draft ESIA reports prepared by WAPCOS (2015) and address any shortfalls or gaps.
2. Source and assess any other available social and environmental information relevant to the Project.
3. Confirm national and international regulatory requirements and World Bank and IFC best practice standards to be addressed during environmental and social studies.
4. Define the Project study area, which will form the basis for detailed impact assessment.
5. Prepare an Environmental and Social Impact Assessment (ESIA) that includes an Environmental and Social Management Plan (ESMP). The ESIA and ESMP will:
    - Identify probable biophysical, socio-economic and health and sanitation impacts that the Project will have on aspects of the physical (receiving) and social environment, and to analyse and determine the significance of these impacts;

- Identify and assess Project alternatives (including the 'Do Nothing' option), and justify the selected alternative;
- Identify measures required to prevent, minimise, mitigate or compensate for adverse impacts and for social and environmental enhancement;
- Prepare an Environmental and Social Management Plan (ESMP) that describes in detail mitigation measures to be carried out, costing, scheduling and assigning responsibility for such measures, a detailed monitoring process and schedule, and a description of any training support that may be required;
- Conduct public consultation with affected stakeholders throughout the Environmental Impact Assessment (EIA) process.

6. Prepare a Resettlement Action Plan (RAP) as a separate document.

1.4. ESIA Resourcing and ToR

The Ministry of Agriculture, Irrigation and Water Development (MoAIWD) contracted Snowy Mountains Engineering Corporation (SMEC International) of Australia to prepare an ESIA, ESMP and RAP for the proposed Diamphwe Multipurpose Dam and associated structures. The Contract for Consultancy Services was signed on August 2015 between the Client (MoAIWD) and the Consultant (SMEC International of Australia). Consultancy services commenced in late August and were undertaken over a five month period. Terms of Reference (ToR) are provided in **Appendix 2**.

The Consultancy Service requires the Consultant to carry out a detailed Environmental Impact Assessment (EIA) for the proposed Dam and associated structures in accordance with the requirements of Malawi's EIA process and to World Bank and IFC standards. The MoAIWD intends to incorporate all practical and cost-effective measures into the Project in order to avoid or minimize negative environmental impacts, capture environmental benefits and to ensure sound environmental management. A list of the Consultant's staff and their positions is presented in **Appendix 3**.

The Consultancy was supervised by the Program Manager, National Water Development Project (NWDP) within the MoAIWD (The Client). The consultant reported to the Director of Water Resources in the MoAIWD. The Client also assigned counterpart staff from within the Lilongwe Water Board (LWB) to work with the Consultant.

1.5. ESIA Report Content

The ESIA Report is arranged in two volumes, a main report (Volume 1) and an annex to the main report (Volume 2) containing various Appendices and specialist reports. This report is arranged as follows:

VOLUME 1: Diamphwe Multipurpose Dam ESIA

Chapter 1:	Introduction	Project background, institutional arrangement, ESIA objectives and Study Team
Chapter 2:	Institutional and Organisational Framework	Details institutional arrangements applicable to the Project.
Chapter 3:	Policy, Legal and Administrative Framework	Outlines the policy, legal and administrative framework for implementation of the Project.
Chapter 4:	Project Justification and Alternatives	Considers alternatives to achieving the Project objectives and also considers a 'Do nothing' option.

VOLUME 1: Diamphwe Multipurpose Dam ESIA

Chapter 5:	Project Description	Provides a description of the Project and its objectives.
Chapter 6:	Baseline Bio-physical Environment	Provides a description of the biophysical characteristics of the Project study area.
Chapter 7:	Baseline Socio economic Environment	Provides a description of the socio economic characteristics of the Project study area.
Chapter 8:	Environmental Impact Assessment	Identifies the social and environmental impacts from the Project.
Chapter 9:	Social Impact Assessment	Identifies the social impacts from the Project.
Chapter 10:	Risk Assessment	Provides a risk assessment of potential impacts before and after proposed mitigation.
Chapter 11:	Public Consultation	Provides details of the consultation undertaken as part of the ESIA.
Chapter 12	Environmental and Social Management Plan	Summarises the environmental and social management plan which is a separate stand-alone document. It lists the mitigation measures developed to minimise any adverse impacts and maximise Project benefits
Chapter 13:	Conclusion	Lists the key actions to be implemented, summarises the compensation and monitoring costs and outlines the recommendations of the ESIA.

VOLUME 2: Appendices

Appendix 1	References
Appendix 2	Terms of Reference
Appendix 3	ESIA Study Team
Appendix 4	Water Quality Monitoring report
Appendix 5	Specialist Biodiversity Report
Appendix 6	Specialist Fisheries Report
Appendix 7	MoAIWD advice on environmental flows and dam buffer zone with SMEC Water quality results
Appendix 8	Village, Structure, Land plot and Pipeline route maps
Appendix 9	Consultation Outcomes
Appendix 10	ESMP Annexes
Appendix 11	Field Photographs

Chapter 2
Institutional and Organisational Framework

Environmental and Social Impact Assessment

February 2016

2. INSTITUTIONAL AND ORGANISATIONAL FRAMEWORK

2.1. Introduction

A number of agencies, governmental and non-governmental, will play a role in the implementation of the Diamphwe Multipurpose Dam Project, including in the pre-planning, resettlement and restoration of livelihoods, construction and operation phases. In particular, implementation of the Project will be dependent on the development of a strong institutional base.

The Project is managed by the Programme Management Unit (PMU) of the National Water Development Programme (NWDP), which operates within the Ministry of Agriculture, Irrigation and Water Development (MoAIWD). The project is being delivered by the Project Implementation Unit (PIU) of the Lilongwe Water Board (LWB). Close interaction and cooperation is required between the following organisations:

- The relevant bodies associated with the MoAIWD, and particularly the PMU of the NWDP and the PIU of the LWB;
- District Council Offices and Committees that will be involved in the Project;
- Statutory Corporations providing a relevant service to the Project;
- Traditional Authorities (TAs), including Group Village Heads (GVHs) and Village Head (VHs), of the Project Affected Communities (PAC);
- Local-level structures set up specifically for the project, such as Project Development Committees (PDCs);
- Agencies identified as having a role in the implementation of Project related activities, including Development Organisations and Non-Governmental Organisations (NGOs); and
- Other interested stakeholders, including religious bodies, private investors and political parties.

2.2. Government Bodies

2.2.1. **Overview**

Government ministries and departments, at national and district level, have the responsibility for:

- Managing the Project, including resettlement planning and implementation, construction and operation;
- Providing infrastructure and services in the affected Project area and at the resettlement sites; and
- Assisting with programmes around restorative development.

Some have been involved in the Project in various ways; others will be brought into the Project as appropriate.

2.2.2. **National Bodies**

i. ***Ministry of Agriculture, Irrigation and Water Development (MoAIWD)***

As the Project proponent, the MoAIWD is responsible for all Project activities. The overall objectives of the Ministry of relevance to this Project include the following:

- To achieve sustainable and integrated water resources development, conservation and management that makes water access and use equitable to all beneficiaries;
- To increase agriculture production and enhance food security through irrigation;
- To ensure the existence of strategic and contingency water resources development and management plans that guarantee availability of water in cases of droughts, floods and population pressure;
- To ensure that all people have convenient access to sufficient quantities of water of acceptable quality, and associated water-related public health and sanitation services, at any time and within convenient distance;
- To promote the empowerment of user communities to own, manage and invest in water resources development;
- To promote public and private sector participation in water resources management, development, supply, and conservation; and
- To facilitate development and regular review of policies and regulations that promotes water resources development, conservation, management, protection and utilisation.

In order to achieve the above, the Ministry's roles and responsibilities focus on the coordination of programs, including the NWDP, which is overseeing the Project through the Division of Surface Water within the Directorate of Water Resources.

In addition to the supply of water to Lilongwe, and given that Diamphwe is a multipurpose dam, it is the responsibility of the Ministry to ensure that the different components of the Project, such as irrigation and fish farming, are developed with the involvement of appropriate Government Ministries and Departments.

ii. ***The National Water Development Programme (NWDP)***

The NWDP is responsible for managing donor projects within the MoAIWD. The Project was a sub-component of the second phase of the National Water Development Project (NWDP II), under the NWDP of the MoAIWD, financed through a Credit / Grant from the World Bank. Although the NWDP II closed in October 2015, a Project preparation facility was developed for the Project under the NWDP II, named the Lilongwe Water Project (LWP), receiving funding from the International Development Association (IDA) of the World Bank Group.

All activities of the Project Preparation Phase of the LWP is managed, co-ordinated and financed by the PMU of the NWDP, headed by the Programme Manager and assisted by an accounts section and an Environmental and Social Safeguards / Community Participation Specialist. The PMU reports directly to the Directorate of Water Resources within the MoAIWD.

The role of the Safeguards / Community Participation Specialist is to:

- Ensure that all Projects adhere to national environmental and social legislation, and the requirements of donor agencies;
- Co-ordinate, supervise and monitor the work of all agencies implementing projects, such as the LWB; and
- Work in close collaboration with the District Councils, such as with District Community Development Officers (DCDOs), District Water Officers (DWOs), and District Environmental Officers (DEOs) on development-related issues, and ensure that all communities participate in the developmental aspects of the Project, such as through Water Users Associations.

iii. *Lilongwe Water Board (LWB)*

The Lilongwe Water Board (LWB), established in 1947, was reconstituted as a parastatal organisation by an Act of Parliament, Water Works Act No 17 of 1995. The LWB is mandated to supply potable water to the City of Lilongwe and surrounding areas. The Board of Directors is appointed by the Government. Administratively it falls within the Department of Statutory Corporations under the Government's Office of the President and Cabinet (OPC). This Department is mandated '*to ensure parastatal sectors optimal utilization and management of resources, in compliance with Government regulations, thereby contributing to national development ….. (and) provides financial, administrative and managerial oversight to the parastatal sector*'.[4] Technically the Board falls under the MoAIWD.

The MoAIWD is an implementing body for projects within the NWDP, with all Water Boards acting as implementing agents for the NWDP. The LWB has been appointed as the implementing agent for this Project, coordinated by the PMU of the NWDP; it transacts through the PM of the PMU to the MoAIWD. As the main beneficiary of the Project, its role is '*to manage, operate and maintain the dam, and all the associated facilities*'[5].

Within the LWB the Project is managed by the Project Implementation Unit (PIU) of the Technical Services Department, assisted by the Water Quality and Environmental Management (WQEM) Division of the LWB. The head of the Division has the position of Safeguards Officer for this Project, and has been appointed counterpart to the NWDP. The Safeguards Officer works in close cooperation with, and reporting to, the Environmental and Social Safeguards Specialist of the NWDP for activities of this Project.

Activities of the LWB for the Project involve, for example:

- Assisting SMEC in linking up with the MoAIWD and the NWDP, undertaking site visits, being introduced to stakeholders, organising consultation meetings, providing feedback on issues and challenges raised by PAC, offering advice as and when required, sourcing Project information and to ensure the smooth running of the Project;
- In consultation with the MoAIWD and NWDP, reviewing and commenting on reports produced by SMEC and co-ordinating the response from the World Bank; and
- Public disclosure of the ESIA, ESMP and RAP, particularly at grassroots level.

As the LWB will be the main beneficiary of Diamphwe Dam, it will have an interest in the implementation of the ESMP and RAP, and the administration of the Dam and its facilities in different ways in the future. For example, on environmental issues it will implement adequate catchment management to ensure good water quality. The WQEM Division is responsible for environmental and social aspects within the LWB.

iv. *Department of Fisheries*

The Department of Fisheries manages fisheries and aquacultural throughout Malawi and operates under the Fisheries Conservation and Management Act (FCMA), 1997. The DoF will be be involved in the Project due to potential impact on the Diamphwe River fisheries. The DoF will also be involved in overseeing development of a Pilot fish farm and up to 20 community based fish farms. The DoF has an important role in managing pollution and monitoring of waterways.

v. *Department of Forestry*

The Department of Forestry manages forest resources throughout Malawi and operates under the *Forestry Act* (1997). The Deparment of Forestry will be involved ion the Project with regard to clearing natural areas, catchment management of the broader Diamphwe river catchment and in the establishment of forest woodland and riverine vegetation around the reservoir.

[4] www.lwb.mw

[5] MoAIWD. October 2015. Diamphwe MPP. *Detailed Design: Institutional Arrangement*. Prepared by: Studio Pietrangeli Consulting Services.

2.2.3. Local Government Administrative Structures

A number of formal administrative structures operate at the local District level, as outlined below.[6] These bodies illustrate the devolution of power from national government to Districts and Villages. Although this is a national Project, district-level organisations are, and will be in some way, involved in Project related activities such as resettlement.

i. *Traditional Authorities (TAs)*

As defined in the National Land Policy (2002), a Traditional Authority (TA) is '*the area of indigenous geo-political and socio-economic jurisdiction; an indigenous state (customary sovereignty) sometimes of a single lineage descent group that represents the source of authority of the Chief as the primus inter pares. The TA is also a symbol of kinship unity and its responsibilities devolve upon its living representatives, the Chief and his councilors*'.[7]

The Chiefs, Group Village Heads (GVHs) and Village Heads (VHs) form the TAs at a local level, and are the first line of contact with issues affecting the Project Affected Communities (PAC) and Project Affected Persons (PAP). They have been consulted, and involved in, all activities undertaken at community level to date. A list of TAs and affected villages is given in Table 2.1.

Table 2.1 Traditional Authorities (TAs) and Affected Villages

District Name	TA Name	Number of GVH	Number of Villages
Lilongwe	Chadza	2	3
Lilongwe	Kalumbu	12	61
Lilongwe	Mazengera	2	12
Dedza	Chilikumwendo	5	15
Dedza	Kaphuka	15	115
	Totals	**36**	**207**

ii. *District Councils (DCs)*

A District Council (DC) is the highest policy-making body in the District, responsible for promoting infrastructural and economic development. According to the Act, the Council is comprised of elected Ward Councilors, Members of Parliament (MPs), Chiefs (senior chiefs, chiefs or sub-chiefs) representing each TA, and representatives of interest groups as *ex-officio* members. The Council is headed by a chairperson elected from the Councilors.

The main functions of the DC are:

- Operating as an agent for Central Government;
- Making policies and decisions on local government and development;
- Passing by-laws to govern the operations of the Council and other stakeholders in the District;
- Reviewing, approving, coordinating and supervising development programs/projects in the District;
- Raising resources for executing functions under its jurisdiction; and

[6] Information for this section is taken primarily from the following sources: (i) Government of Malawi. September 2011. *Lilongwe District Socio-Economic Profile*; and (ii) Government of Malawi. 2013. *Dedza District Socio-Economic Profile 2013-2018*.

[7] Government of the Republic of Malawi, Ministry of Lands, Housing and Surveys. January 2002. *Malawi National Land Policy*.

- Consolidating and promoting democratic institutions and participation.

The mission statement of Dedza DC states: '*to create a conducive operating environment and enhance service delivery to achieve improved livelihood, good governance and other essential services for the people under the Council's jurisdiction*'.

The DC operates through a number of Service Committees, such as Finance, Health and Environment, Education, Public Works, Development, and Agriculture and Natural Resources.

As with the TAs, the Lilongwe and Dedza DCs will be involved in Project implementation through their various bodies, such as the District Council Secretariat (DCS), their District Offices / Departments, and Committees. Specific activities at the District and Project activity level will be conducted by the DCs and their District Offices, with support from the TAs, the Area Development Committees (ADCs), and the Village Development Committees (VDCs), under supervision of the Safeguards Specialists of the LWSP and the LWB.

iii. ***District Council Secretariat (DCS)***

The DCS is headed by the District Commissioner, with Directors from the Departments of: Planning and Development, Administration, Finance, Public Works, Health and Social Welfare, Agriculture and Natural Resources, and Education.

The Secretariat's main functions are to:

- Implement resolutions and policies of central government and the Council;
- Co-ordinate sector development projects and programs; and
- Mobilise and manage resources (human, financial, material etc.).

iv. ***District Executive Committee (DEC)***

The District Executive Committee (DEC) is a technical and advisory committee to the Council that meets at least one a month. It is composed of members from the Council (District Commissioners and Directors), government line ministries, statutory corporations, and Non Government Organisations (NGOs) and Civil Society Organisations (CSOs) working in the district.

The functions of the DEC are to:

- Co-ordinate District policies and activities with national policies;
- Advise the DC on sectoral policies and programs;
- Provide support in the formulation of District Development Plans (DDPs);
- Approve projects, and give technical advice on project implementation;
- Monitor and evaluate implementation of programs and projects; and
- Train development committees (AECs, ADCs, and VDCs) in leadership and management skills.

The District Commissioner chairs the DEC, with the Director of Planning and Development (DPD) in the role of Secretary. The DEC has a number of sub-committees. Of relevance to the Project are the following:

a. *District Environmental Subcommittee (DESC)*

The District Environmental Subcommittee (DESC) focuses on environmental activities of the District, including:

- Coordinating District-level environmental projects;
- Advising the DEC on the inclusion of environmental concerns in operative activities;

- Sitting on the DEC panel approving projects;
- Environmental screening of projects; and
- Monitoring the implementation of ESMPs.

The DPD chairs the DESC, and the Environmental District Officer (EDO) acts as the Secretariat. Directors of the District Offices are represented on the Committee, to include for example: Administration, Public Works, Agriculture, Forestry, Fisheries, Land and Land Resources Conservation, Irrigation, Water Development, Environmental Health, Community Development, and Social Welfare and Disaster. Specific NGOs, such as Concern Universal, CADACOM and World Vision, are invited to attend as they implement projects with environmental aspects.

b. *District Monitoring and Evaluation Coordinating Committee (DMECC)*

The District Monitoring and Evaluation Coordinating Committee (DMECC) coordinates all M+E activities on a District level. Comprising of Officers of all sectors of the District, each focusing on activities at a sectoral level, the DMECC assesses work plans against indicators and targets, evaluates whether projects are in line with planned activities, and makes recommendations on areas of improvement.

c. *District Water Coordinating Team (DCT)*

A District Water Coordinating Team (DCT) is involved in water, sanitation and hygiene (WASH) issues.

d. *Land Committees*

Under the *Customary Land (Development) Act* (1967, as amended in 1988) CAP 59.01, a Land Committee must be formed for each District, with local residents, and communication established with an Allocations Officer. Each Land Committee is to provide advice on customary law issues.

Under the provision for recording customary land, the Recording Officer records the land as one of the following categories:

- Village residential land;
- Dambo land;
- Unallocated garden land; or
- Land used for any other special purpose of the community.

v. ***District Council Sectors***

A number of national Government sectors are represented through offices at District Level. Those relevant to the Project through offering assistance in service provision include the following:

- District Commissioner (including Administration and Finance);
- District Planning and Development Office (including Land, Land Resource Conservation, Community Development, HIV/AIDS, and Monitoring and Evaluation);
- District Agricultural Office (including Agriculture Extension, Crops, Irrigation, Fisheries, Water Development, Housing and Environmental Health);
- District Water Development Office;
- District Forestry Office;
- District Environmental Office;
- District Health Office (including Social Welfare);

- District Gender & Community Development Office
- District Public Works Office;
- District Education Office (including Youth); and
- District Animal Health and Livestock Development.

The Offices are headed by District Officers, and have a number of staff within the District, based in the District Office or at village level, assisted by voluntary members of villages trained in certain activities.

vi. ***Statutory Corporations***

The management and development of the District involves the participation of Statutory Corporations which, apart from the LWB in Lilongwe, include:

- Electricity Supply Corporation of Malawi (ESCOM);
- Malawi Postal Corporation;
- Agriculture Development and Marketing Corporation (ADMARC);
- Roads Authority and Roads Fund Administration; and
- Malawi Energy Regulatory Authority.

As with the District Offices, these will provide necessary services required by the Project during implementation.

vii. ***Area Development Committees (ADC)***

An Area Development Committee (ADC) is a representative body of all Village Development Committees (VDCs), established by, and under the jurisdiction of a TA. There is one ADC in each TA.

The ADC comprises VDC Chairs, Ward Councilors, representatives of religious groups, youth and women groups, and the business community from within the TA. It is chaired by a person elected from its members, with the AEC Chairperson acting as its Secretary. The term of office for members is three years, except for Ward Councilors who remain members for the duration of their elected period.

The main functions of the ADC are, within the TA, to:

- Play an advisory role;
- Organise meetings to address community needs; and
- Identify and prepare project proposals, addressing community needs for submission to the DEC; and supervise, monitor and evaluate the implementation of projects, including mobilising communities and resources for projects.

viii. ***Area Executive Committee (AEC)***

The Area Executive Committee (AEC) is a technical and advisory committee to the ADCs. It comprises extension workers from core sectors of government ministries, NGOs, and statutory corporations working within the jurisdiction of the TA.

The main functions of the AEC are to:

- Assist and advise the ADC to identify and prepare proposals;
- Take a lead in the organisation of VDCs;

- Train and assist VDCs in setting their own guidelines and in the formulation of Village Action Plans (VAPs);
- Review project proposals before submitting them to the DEC for consideration; and
- Conduct data collection and analysis at community level.

ix. ***Village Development Committees (VDCs)***

A Village Development Committee (VDC) is a representative body of a village or group of villages set up by the DC. It is composed of one elected member from each village within the VDC, a Ward councilor, women representatives nominated by people within the VDC, and an elected extension worker. Members of the VDC elect a chairperson amongst themselves. The VDC's term of office is three years.

The main functions of the VDC are to:

- Act in an advisory role through GVHs and VHs;
- Identify and prioritise community needs through Village Action Plans (VAPs);
- Prepare project proposals based on VAPs for submission to ADCs;
- Supervise, monitor and evaluate the implementation of development activities in the villages;
- Initiate community self-help activities; and
- Mobilise communities to participate in development activities in their areas so as "to ensure ownership".

A challenge faced is that apparently a number of VDCs are not 'official', which affects development planning and associated project implementation and the allocation of resources.

2.3. Non-Governmental and Community-Based Organisations

2.3.1. Overview

Non-governmental Organisations (NGOs), including organisations referred to as Community Service Organisations (CSOs), national and international, faith-based and secular, and local Community-based Organisations (CBOs), form an important part of the development of the District.

GP 14.70 of the World Bank recognises the importance of NGOs and other organisations of civil society in the development process, believing that they can '*make important contributions toward ensuring that the views of local people are taken into account, promoting community participation, extending project reach to the poorest, and introducing flexible and innovative approaches*'[8]. The Bank encourages drawing on their experience, and involving them, as appropriate, in all stages of Project processing – identification, design, implementation, and monitoring and evaluation.

2.3.2. Non-Governmental Organisations (NGOs)

NGOs undertake a wide range of developmental activities complementing the work of the government, and in some instances filling the gaps. Social services provided include: water, sanitation and hygiene (WASH), health, HIV/AIDS, emergency relief operations, agriculture, employment, literacy, environment, civic education on human rights, good governance, micro-finance, and capacity building. Given their expertise in these fields they could assist as possible

[8]World Bank. July 1998. Good Practice (GP) Statement 14.70: *Involving Nongovernmental Organizations in Bank-Supported Activities*.

alternative development service providers, contracted to undertake specific tasks in the implementation of the resettlement and livelihood restoration programmes.

Although they may operate in partnership with the Government, their involvement in the Project would also provide some independence to the process.

Table 2.2 below summarises some of the NGOs operating in the District, and the services they provide[9]:

Table 2.2 NGO Service Provision

NGO	Thematic Areas of Operation
Action Aid (www.actionaid.org/Malawi)	Climate change; education; emergencies and conflict; food rights; governance; HIV/AIDS; women's rights.
Association for Rural Community Development (ARCOD) (www.cordaid.org)	Children and education; health care; gender; human rights; disaster response; entrepreneurship; women's leadership; food security; security and justice; investments.
Catholic Development Commission in Malawi (CADECOM)	Relief and Development: Disaster relief; health; education; agriculture and food security; water and sanitation; environmental rehabilitation (trees, soil erosion); income-generating activities and economic empowerment.
	Justice and Peace: Climate change; social advocacy, through human rights, good governance, rule of law; microfinance; gender; HIV/AIDS.
Catholic Health Commission	HIV testing and counselling.
CARE Malawi www.care.org/country/malawi	Food security; agriculture; health (e.g. HIV/AIDS, access to clean water); education; social and economic empowerment, especially for women.
Centre for Children Aid	Youth empowerment, training in life skills, on human rights, gender issues e.g. commercial sex workers, HIV/AIDS, early pregnancy, child labour; school enrolment; implementation of Child Care, Protection and Justice Act (No 22 of 2010).
Church and Society/Church of Central Africa Presbyterian (CCAP)	Relief for natural disasters, devastation; WASH; construction of houses for the 'needy'; establishment, management of Primary, Secondary schools, University in Nkhoma; health services (hospital at Nkhoma, clinics, mobile eye clinic); vegetable garden supplying produce to hospital, schools.
Concern Universal (www.concern-universal.org)	Agriculture; climate change and disaster risk management; WASH; microfinance; malaria prevention and control, and community mobilisation and capacity building; raising awareness of HIV/AIDS, gender equality; rights; environment.
Kasusu Community Based Orphan Care Organisation (KACO)	Educational support for orphans; material support to orphans and vulnerable people; enhancement of early childhood development; community population education.
National Institute for Civic Education (NICE) (www.nice)	Civic education and capacitation on good governance, human rights, leadership skills.
PLAN Malawi (https://plan-international.org/malawi)	Health; water and sanitation; education; gender and human rights; youth and child development.
Rights Advice Centre (RAC)	Paralegal; human rights; awareness e.g. human trafficking.
Women's Legal Resource Centre (WOLREC) (www.wolrec.org)	Access to legal, socio-political and economic justice, particularly for women and girls.

[9] Some are not working directly in the Project Area of Impact but could if required and resourced.

NGO	Thematic Areas of Operation
World Vision (www.wvi.org/malawi)	Justice for children, child rights and equity; development; livelihoods; disaster management; water and sanitation; health, M-Nech (Newborn and Child Healthcare); education and life skills; food security.

The CSO Network Committee operates in the District of Dedza, and was established to '*harmonise work to complement government effort*'. It is linked to the Council for Non-Governmental Organisations in Malawi (CONGOMA) (www.congoma.mw); the Water and Environmental Sanitation Network (WES Network); Scaling Up Nutrition (SUN), part of the National Nutrition Committee chaired by the Secretary for Nutrition, HIV and AIDS in the Office of the President; and the Civil Society Alliance in Malawi (CSONA). CSOs are given the position of Chair of the Network Committee for one year; currently it is CADACOM.

The Network Committee comprises all NGOs/CSOs operating in the area, and all NGOs/CSOs coming into Dedza DC have to register with the Committee to ensure that they are 'known', and that their work can be monitored. The Committee acts as the link with what is happening at DC level, and has signed a Memorandum of Understanding (MoU) with Dedza DC to clearly define the roles of the CSOs. Their three sub-committees, on WASH, Nutrition and Governance, each has a Chair, and is linked to national bodies in the same field of work.

2.3.3. **Community-Based Organisations (CBOs)**

Community-based Organisations (CBOs) refer to grassroots organisations that have no formal affiliation to government structures, such as youth groups, women's organisations and agricultural/ farmers associations. For example: women's savings groups, farmers unions, and co-operatives. The executive bodies of CBOs are to be consulted to determine their activities and the extent to which they could be included in programmes of action around resettlement and/or the restoration of livelihoods of the PAP.

There are many CBOs in both Districts involved in HIV/AIDS, human rights, child protection, early childhood development (ECD), Orphans and Vulnerable Children (OVC) services, vocational skills, and agriculture.

2.4. The Private Sector

The private sector may also be brought into the resettlement process, such as:

- Companies that may assist in service delivery or infrastructure provision;
- Companies that may have an interest in investing in the area in the long term; for example, in tourism; and
- Private banks, or microfinancing organisations, which could provide micro-credit for small business development.

2.5. International Aid Agencies

The World Bank Group, through the World Bank and IDA, has supported the Project, technically and financially, through the MoAIWD and more particularly the NWDP. Other donor agencies, such as the EIB and the AFDB, may assist in funding the construction works of the Project.

Other international agencies and programs currently operate in Malawi, and could possibly make a contribution to the Project, through assistance to affected individuals and/or communities, particularly to those being relocated.

Agencies of the UN that could be of assistance during implementation include:

- FAO: Food and Agriculture Organisation of the UN (www.fao.org)

- IFAD: International Fund for Agricultural Development (www.ifad.org)
- UNAIDS: Joint UN Programme on HIV/AIDS (www.unaids.org)
- UNDP: UN Development Programme (www.undp.org)
- UNEP: UN Environment Programme (www.unep.org)
- UNESCO: UN Educational, Scientific and Cultural Organisation (www.unesco.org)
- UNFPA: UN Population Fund (www.unfpa.org)
- UN-HABITAT: UN Human Settlements Programme (www.unhabitat.org)
- UNICEF: UN Children's Fund (www.unicef.org)
- UNIFEM: UN Development Fund for Women (www.unifem.org)
- WHO: World Health Organisation of the UN (www.who.int)
- WFP: World Food Programme (www.wfp.org)

Other potential international funding agencies may be consulted around funding specific aspects of the Project, for example, DFID (the United Kingdom Department for International Development); GTZ (Deutsche Gesellschaft fur Technische Zusammenarbeit); DANIDA (Danish International Development Agency); SIDA (Swedish International Development Cooperation Agency); and JICA (Japan International Cooperation Agency; www.jica.go.jp).

2.6. Project Structures

Recognising that the ESIA and RAP processes are consultative and representative, the MoAIWD, the NWDP and the LWB have been, and are currently, working in co-operation with Project structures set up specifically for the Project, as outlined below. However, there may be a need to re-constitute structures to be particularly relevant to the nature and extent of the Project, including the need for a comprehensive Project Steering Committee.

Preparation of the social environment is essential for the establishment of such structures, to enable effective consultation and dissemination of information to take place. This may involve:

- Finalising ToR of all organisational structures, including the roles and responsibilities of members; and
- Designing and implementing a capacity building programme for all participants as appropriate, including training around background to the Project and methods of reporting back, with a focus on the community/village-based representatives of the DPCs and PSC.

i. *Dam Project Committees*

Currently two committees have been established by the DCs specifically for the Project, in areas where there are potentially PAP, one in Lilongwe and one in Dedza. Named the Diamphwe Multi-Purpose Dam Main Centre Committees, they are referred to in this ESIA as the Dam Project Committees (DPCs).

These Committees comprise members elected from GVHs of villages of the affected TAs, and Councillors from affected Wards. They assist in work carried out for the Project; for example, together with TA representatives, members accompanied the Surveyors undertaking the Asset Survey to identify the landholders of parcels of land potentially affected by the Project.

The DPCs may be reconstituted, through a process of consultation, to become more inclusive of PAP directly affected by all aspects of the Project, including the Dam inundation area and its infrastructure, and the pipeline.

The main functions of the Committee would be to:

- Represent PAC and PAP on Project structures, and particularly the PSC;
- Assist with the resettlement programme on a ground level, such as with asset validation;
- Assist with the identification and confirmation of vulnerable households that may require additional support measures;
- Act as the first point of call for the resolution of grievances and disputes; and
- Assist with the planning and coordination of participatory monitoring and evaluation exercises in their areas of operation.

Of note: The LWB manages the catchment area around Kamuzu I and II dams in Malingunde. In order to assist in catchment protection, the Board facilitated the formation of a local CBO, the Malingunda Environmental Community Development Organisation (MECDO). They support the group in carrying out catchment management issues outside the buffer zone of the dams through initiatives including: training communities in the management of natural resources; provision of inputs such as providing tools and seeds for tree nurseries; and the financial management of funds generated from income generating activities.[10] The Board also works with Technical experts from the Government, LUANAR, and NGOs who offer their expertise in implementing environmental projects within the area.

The DPCs could be reconstituted, and their ToR extended, to fulfil similar roles over the long term, to develop income-generating opportunities for communities affected by the Project in the catchment area surrounding Diamphwe Dam.

ii. ***Project Steering Committee***

Since the Project will deal with a range of different communities and complex socio-economic systems and issues, a representative organisational structure will be required to ensure that all Project activities (and particularly those relating to resettlement) are properly planned, implemented and monitored.

It is recommended that a Project Steering Committee (PSC), dedicated to the Project, be created at to fulfil this 'managerial' function, to ensure proper coordination of compensation, mitigation (and, where required, relocation) activities.

The PSC will work parallel to, and in close co-operation with, the MoAIWD, NWDP and LWB, recognising that these ministerial bodies are ultimately responsible for co-ordination of Project activities. It will also work in close collaboration with the Project's existing DPCs.

The PSC would have representation from:

- The MoAIWD, the NWDP and the LWB;
- Concerned government departments and agencies, in particular at District level, and those providing required services in support of the Project;
- Representatives of the DPCs, including ward Councillors and Chiefs, GVHs and V;
- Other agencies that may be involved in resettlement issues, such as NGOs/CSOs; and
- Other key stakeholders as required.

[10] www.lwb.mw

The PSC will have the following key functions:

- Advising on the implementation of aspects relating to this RAP;
- Acting as a mechanism for information exchange, complementary planning and coordination of implementation activities;
- Ensuring adherence to the Project's compensation and relocation policies;
- Assessing the progress and efficacy of the Project's programme, and suggesting modifications where necessary;
- Identifying issues/areas of concern and suggesting corrective measures;
- Assisting with the identification of socio-economic development opportunities in the resettlement areas; and
- Disseminating Project information, reporting back to the organisations or people they represent, including the DPCs, PAC and PAP, on Project developments.

Specific issues requiring assessment and discussion may occur during the implementation of the Project. Where necessary, special Task Groups will be established within the PSC; for example, a Compensation Task Group (CTG) focusing on compensation rates and payment procedures; and a Grievance Management Task Group (GMTG) focusing on grievances and dispute resolution. The Task Groups will make recommendations to the PSC on resolutions for further action required.

2.7. Coordination

Consultation and coordination with other agencies and stakeholders assists in the development of a supportive institutional base, ensuring effective involvement and commitment to responsibilities.

It is recommended that the PMU of the NWDP, in collaboration with the LWB, prepares a programme of planning actions to facilitate such coordination. This programme will describe the roles and responsibilities of the various government agencies, the DPCs, the PSC, and other participating stakeholders in the resettlement and livelihood restoration process. For each role-player it will detail the required actions (inputs and outputs), the timing of the actions, and the resources required to undertake the actions. The capacity to fulfil responsibilities will be assessed and, if necessary, steps proposed to enhance this capacity.

Provisions need also be made for the transfer of responsibilities of implementing agencies (such as the managing of services/facilities) to appropriate bodies, including the ADCs and VDCs, at a later stage in the project.

Table 2.3provides examples of key activities, and resources and coordination required for Project implementation.

Table 2.3 Key complementary planning activities

KEY ACTIVITIES AND TASKS	INVOLVEMENT	RESOURCES
Consultation and public disclosure		
▪ Reconstitute consultation structures and mechanisms ▪ Establish Information Office ▪ Establish consultation protocols ▪ Public display of Project documentation	▪ Directorate for Water Resources of MoAIWD ▪ PMU of NWDP ▪ PIU of LWB ▪ Members of the PSC, including GMTG	▪ English copies of Project Reports, including ESIA, ESMP, RAP ▪ Copies of Report summaries in Chichewa

KEY ACTIVITIES AND TASKS	INVOLVEMENT	RESOURCES
▪ Ensure vulnerable households, women and special interest groups are represented in the Project consultative bodies ▪ Appoint participating NGOs/CSOs ▪ Establish grievances redress mechanism	▪ Other implementing agents	▪ ToR of DPCs and PSC in local language ▪ Chichewa copies of Entitlement Matrix ▪ Chichewa copies of grievance redress mechanisms ▪ Construction and land occupation/evacuation schedules
Verification of fixed assets		
▪ Finalise configuration of all Project components (Dam infrastructure) ▪ Reset cut-off date if necessary ▪ Assess and confirm land acquisition and temporary occupation requirements ▪ Verify areas of private land loss and remaining landholding ▪ Verify number and types of affected private/public structures ▪ Verify communal asset loss ▪ Verify any other assets affected by project activities	▪ PMU of NWDP ▪ PIU of LWB ▪ Resettlement Specialist ▪ Engineering consultant ▪ GIS database and mapping personnel ▪ Government officials ▪ DPC and PSC members ▪ Affected asset owners	▪ Maps and on-the-ground demarcation showing final alignment of all project components and areas permanently and temporarily required by Project activities ▪ Final database of PAC, PAP and assets
Compensation determination and payment		
▪ Finalise resettlement programme and schedule ▪ Determine available land for relocation ▪ Establish CTG of PSC ▪ Finalise compensation determination in terms of Entitlement Matrix ▪ Finalise entitlements and compensation packages for each PAC, PAP ▪ Finalise payment procedures ▪ Issue notices to vacate ▪ Disburse compensation ▪ Assist with relocation activities, especially for vulnerable groups	▪ PMU of NWDP ▪ PIU of LWB ▪ Resettlement Specialist ▪ CTG and GMTG of PSC, and PSC ▪ TA representatives ▪ Land Committees ▪ Land Valuation Officers ▪ Government officials, including DC Offices, particularly Financial Administration ▪ Other implementing agents e.g. banks	▪ Chichewa copy of ToR of Compensation Task Group ▪ Entitlement Matrix ▪ Database of affected assets according to PAC, PAP as established during asset verification ▪ Compensation packages for individual PAC, PAP

KEY ACTIVITIES AND TASKS	INVOLVEMENT	RESOURCES
▪ Acquire land ▪ Address grievances		
Mitigation measures, livelihood restoration, and local development		
▪ Determine livelihood restoration/ improvement (LRI) requirements ▪ Identify vulnerable PAP ▪ Appoint NGOs and other development agencies to assist with LRI activities ▪ Develop and implement capacity/training programme ▪ Arrange access to government health and poverty alleviation programmes, at national and DC level ▪ Monitor rehabilitation of vulnerable households ▪ Finalise and implement mitigation programmes of the ESMP ▪ Create/maintain database of all mitigation measures and LRI activities in relation to those affected	▪ PMU of NWDP ▪ PIU of LWB ▪ Resettlement Specialist ▪ CTG of PSC, and PSC ▪ Government officials, including DC Offices ▪ NGOs/CSOs, CBOs ▪ Other implementing agents	▪ ESMP for mitigation measures ▪ Household LRI plans ▪ Database of affected assets of PAP
Monitoring and Evaluation		
▪ Determine M+E framework ▪ Establish monitoring indicators ▪ Appoint Evaluation Panel ▪ Establish and implement internal monitoring ▪ Undertake participatory M+E ▪ Commission external monitoring	▪ PMU of NWDP ▪ PIU of LWB ▪ Evaluation Panel ▪ Affected communities ▪ Financing Agencies ▪ Other implementing agents	▪ Chichewa copies of monitoring indicators and protocols ▪ Evaluation Brief

2.8. Capacity Building

As stated, the capacity to fulfil responsibilities will be assessed and, if necessary, steps proposed to enhance this capacity. A Training Programme of theoretical and practical training would include:

- Specific capacity building training sessions for individuals who will be involved in implementation of the Project and RAP at the local level, such as members of the PSC.
- Provision of on-the-job training to select officials within organisations involved in mitigation and monitoring plans; such as training in resettlement-related issues to employees of the Water Quality and Environmental Management Division within the LWB; and
- Training on project information to staff, for example in a Project Information Centre.

SMEC

Local People. Global Experience.

Chapter 3
Policy, Legal & Administrative Framework

Environmental and Social Impact Assessment

February 2016

3. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

3.1. Introduction

3.1.1. ESIA Compliance

The MoAIWD is committed to conduct its activities with full compliance to the requirements of national regulations and its obligations under international conventions and treaties, and giving due consideration to international best practices and policies. This Environmental and Social Impact Assessment (ESIA) Report has been developed so as to comply with the laws and decrees of the Republic of Malawi and international conventions and treaties, and additionally to comply with international best practice standards.

i. ***Malawi Regulatory Framework***

The Constitution of the Republic of Malawi, 1994 and as amended, and further national laws and regulations, form the basis of requirements for development of such large scale infrastructure as the Diamphwe Multipurpose Dam. International regulations, conventions and treaties to which Malawi is a signatory provide further ideal standards for the project work. Mitigation of potentially adverse or negative impacts of the activities during construction and operation of the Diamphwe Multipurpose Dam to the surrounding environment and communities should be possible through compliance with those national and international standards.

The application of the ESIA process in Malawi is based on the principles in the *1992 Rio Declaration on Environment and Development* and the legislative requirements of the *Environment Management Act (1996)*. By signing the *Rio Declaration on Environment and Development*, Malawi has committed, among other things, to Principle 17 concerning EIA:

> *'Environmental impact assessment, as a national instrument, shall be undertaken for proposed activities that are likely to have a significant adverse impact on the environment and are subject to a decision of a competent national authority'.*

The *Environment Management Act* outlines an EIA process for Malawi and requires project developers to comply with that process. The process is managed by the Director of Environmental Affairs (DEA) in the Environmental Affairs Department (EAD). The Act specifies that the types and sizes of projects subject to EIA be prescribed and gazetted. Accordingly, the Project activities are subject to approval under the terms of *the Environment Management Act, 1996*. As such, the ESIA will be undertaken in strict accordance with this regulatory framework, as well as the Environmental Affairs Department's EIA Guidelines.

ii. ***International Standards and Guidelines***

The Diamphwe Multipurpose Dam is supported by the World Bank and the International Funding Corporation. Related policies and guidelines afford additional environmental and social safeguards and provide an ideal opportunity to maximise the project benefits to the people of Malawi while minimising any adverse impact, through compliance with these international and national best practice standards.

The World Bank provides guidance on ESIA requirements through the Environmental Assessment Sourcebook (World Bank 1994) which includes sectoral guidelines. The World Bank EIA process is implemented through a set of Operational Policies/Procedures. The primary objective is to ensure that Bank operations do not cause adverse impacts and that they "do no harm".

The International Finance Corporation (IFC) is a member of the World Bank Group, providing finance and development advice for private sector ventures and projects in developing countries. Their Performance Standards, guidance notes and Environmental, Health and Safety (EHS) Guidelines provide further guidance as a framework when implementing the practical Malawi national legislative and regulatory provisions, and the World Bank Operational Policies.

iii. *International Agreements*

Malawi is party to a number of internationally acceptable policies, conventions, treaties and protocols, which are relevant to the Project. These Agreements serve as the principal framework for international co-operation and collaboration between members of the international community in their efforts to protect the local, regional and global environment. Malawi is bound to the provisions of an international agreement/law only if it signs and submits instruments of ratification in respect of a particular agreement.

3.1.2. Summary of ESIA Regulatory Requirements

A listing of relevant Malawi regulatory and policy requirements, as well as International provisions is provided in Table 3.1. Details are provided in the following sections.

Table 3.1 Legislative, policy and International provisions

LEGISLATIVE, POLICY AND INTERNATIONAL PROVISIONS

MALAWI LEGISLATION AND POLICIES	
Legislation	
▪ Constitution of the Republic of Malawi (1994)	▪ Fisheries Conservation & Management Act (1997)
▪ Environment Management Act (1996)	▪ Forestry Act (1997)
▪ Land Act (1965)	▪ Public Health Act (1948)
▪ Lands Acquisition Act (1971)	▪ Gender Equality Act (2013)
▪ Local Government Act (1998)	▪ Monuments and Relics Act (1990) CAP 29.01
▪ Town and Country Planning Act (1988)	▪ Public Roads Act (1962)
▪ Water Resources Act (2013) & Waterworks Act (1996)	▪ Occupational Safety, Health and Welfare Act (1997)
▪ Irrigation Act (2013)	▪ Employment Act (2000)
▪ National Parks and Wildlife Act (2004)	▪ Labour Relations Act (1997)
Policies & Guidelines	
▪ National Environmental Policy (2004)	National HIV AIDS Policy (2003)
▪ Guidelines for Environmental Impact Assessment (1997)	▪ Gender Policy (2008)
▪ National Land Policy (2002)	▪ National Decentralization Policy (1998)
▪ National Water Policy (2005)	▪ National Environmental Action Plan (2002)
▪ National Irrigation Policy and Development Strategy (2011)	▪ National State of Environment Report (2010)
▪ National Sanitation Policy (2006)	▪ The Second Malawi Growth and Development Strategy (2012)
▪ Malawi National Forest Policy (1996)	▪ Other Relevant Malawi Standards
WORLD BANK	
Environmental Assessment Sourcebook (1994)	
Operational Procedures	
▪ OP 4.01: Environmental Assessment	▪ OP 4.20: Gender and development
▪ OP 4.04: Natural Habitats	▪ OP 4.36: Forests
▪ OP 4.09: Pest Management	▪ OP 4.37: Safety of Dams
▪ OP 4.11: Physical Cultural Property	▪ OP 7.50: International Waterways
▪ OP 4.12: Involuntary Resettlement	
Guidelines on Vulnerable People	

IFC PERFORMANCE STANDARDS
▪ PS1: Assessment and Management of Environmental and Social Risks and Impacts
▪ PS2: Labour and Working Conditions
▪ PS3: Resource Efficiency and Pollution Prevention
▪ PS4: Community Health, Safety, and Security
▪ PS5: Land Acquisition and Involuntary Resettlement
▪ PS6: Biodiversity Conservation and Sustainable Management of Living Natural Resources
▪ PS7: Indigenous Peoples
▪ PS8: Cultural Heritage
INTERNATIONAL AGREEMENTS
▪ African Convention on the Conservation of Nature and Natural Resources
▪ Convention on Wetlands of International Importance especially as Waterfowl Habitat (RAMSAR)
▪ SADC revised Protocol on Shared Watercourses
▪ SADC Protocol on Forestry
▪ SADC Protocol on Fisheries
▪ Zambezi Watercourse Commission (ZAMCOM)
▪ Other: - Rio Declaration, the Convention on Climate Change, the Montreal Protocol, the Convention to Combat Desertification, the Convention on Biodiversity and the Convention on International Trade in Endangered Species of wild fauna and flora (CITES) - The Convention on International Plant Protection, The Convention on Wetland of Significant Importance, The Convention concerning the Protection of World Cultural and Natural Heritage, The Convention on the Conservation of Migratory species of Wild Animals, The FAO International Undertaking on Plant and Genetic Resources, and The Convention on Biological Diversity - Millennium Development Goals (MDGs), Protocol on Gender and Development (2008), 1987 UN Convention on the Elimination of all Forms of Discrimination Against Women (CEDAW); the 1993 Vienna Conference on Human Rights; the Southern African Development Cooperation (SADC) Declaration on Gender and Development, 1997, and the Protocol to the African Charter on Human and People's Rights on the Rights of Women in Africa. - International Covenant on Economic, Social and Cultural Rights (1993).

3.2. The Constitution of the Republic of Malawi, 1995

3.2.1. Accountable and Transparent Decision Making

In line with the Constitutional principles set out in **section 12** of the Constitution, public participation and consultation is encouraged for projects such as the Diamphwe Multipurpose Dam and Associated Structures Project. This principle is based on the presumption that while organized society delegates its affairs to public institutions the public retain the right to have an input in decision making and enforcement processes, and to expect, as a minimum, transparency in government decision making. In that way institutions will not assume they are exclusive custodians of power and will ensure accountability in their actions. As in principle (1)(c): *"the authority to exercise power of State is conditional upon the sustained trust of the people of Malawi and that trust can only be maintained through open, accountable and transparent Government and informed democratic choice*".

Further, the Constitution in **section 146** establishes local government authorities to represent the people over whom they have authority, and to be responsible for their welfare, and gives them the responsibility of, among other things, promoting infrastructural and economic development, through

the formulation and execution of local government plans. Local government levels of consultation will be needed.

3.2.2. **Sustainable Environmental Management**

The Constitution provides a framework for the integration of environmental considerations into development programs. The implication of this provision is that Government, its cooperating partners and the private sector have a responsibility to ensure that development programs and projects are undertaken in an environmentally responsible manner. The State has a constitutional responsibility to ensure that all programs and projects are undertaken in an environmentally sustainable manner.

The Constitution contains principles of national policy in **section 13**, including that of sustainable environmental management. The section sets out a broad framework for sustainable environmental management at various levels in Malawi. Section 13 provides that the State shall actively promote the welfare and development of the people of Malawi by progressively adopting and implementing policies and legislation aimed at managing the environment responsibly in order to, under s13(d):

a. Prevent the degradation of the environment;
b. Provide a healthy living and working environment for the people of Malawi;
c. Accord full recognition to the rights of future generations by means of environmental protection and the sustainable development of natural resources; and
d. Conserve and enhance the biological diversity of Malawi.

The goal for rural life under section 13 (e) is: '*To enhance the quality of life in rural communities and to recognize rural standards of living as a key indicator of the success of Government policies*'.

3.2.3. **Land and Property Entitlements and Existing Rights**

The Constitution also provides the basis for and against land acquisition. **Section 28** (2) states that '*No person shall be arbitrarily deprived of property*' and section 44, states that '*Expropriation of property shall be permissible only when done for public utility and only when there has been adequate notification and appropriate compensation, provided that there shall always be a right to appeal to a court of law for redress*.' The activities of the proposed project will result in some people losing their land and property. In resolving this issue, under s13(l), the Constitution supports peaceful settlements of disputes, if they should arise, as a principle of national policy: '*To strive to adopt mechanisms by which differences are settled through negotiation, good offices, mediation, conciliation and arbitration*.'

Under s43 of the Constitution, on administrative justice:

"Every person shall have the right to:

(a) lawful and procedurally fair administrative action, which is justifiable in relation to reasons given where his or her rights, freedoms, legitimate expectations or interests are affected or threatened; and

(b) be furnished with reasons, in writing, for administrative action where his or her rights, freedoms, legitimate expectations or interests are affected."

It is imperative that this project is managed within the requirements of the Public of Malawi Constitution. All provisions but particularly **sections 12, 13, 28, 43, 44, and 146** provide practical guidance from the inception to completion phases of the project.

Summary of Key Constitutional Principles and Relevant Project Objectives	
Accountable and transparent decision making	▪ Public consultation and participation ▪ Public communication strategies ▪ Local government level consultation
Sustainable environmental management	▪ Maintain or improve healthy living environments ▪ Conserve or enhance biodiversity ▪ Protect or improve environmental sustainability ▪ Enhance rural quality of life as a key indicator of project success
Land and property entitlements and existing rights	▪ Establish peaceful mechanisms to resolve disputes ▪ Ensure mechanisms for resettlement and compensation ▪ Ensure mechanisms to address property rights ▪ Ensure equitable access to these mechanisms

3.3. Republic of Malawi National Legislative Framework

3.3.1. Environment Management Act (1996) CAP 60.02

The *Environment Management Act* (EMA) (1996) is described as a framework piece of legislation on environmental management, protection and conservation. The Act contains general provisions on protection, management, conservation and sustainable utilization for almost all forms of environmental media.

The Act provides for Environmental Impact Assessment (EIA) under **Part IV**. It further gives power to the Minister to publish in the Gazette the type and size of projects that shall not be implemented without an EIA. A prescribed list of projects for which EIA is mandatory is given in Malawi's Guidelines for EIA, 1997. sets out the EIA process that is required (ref. SADC 2 2007).

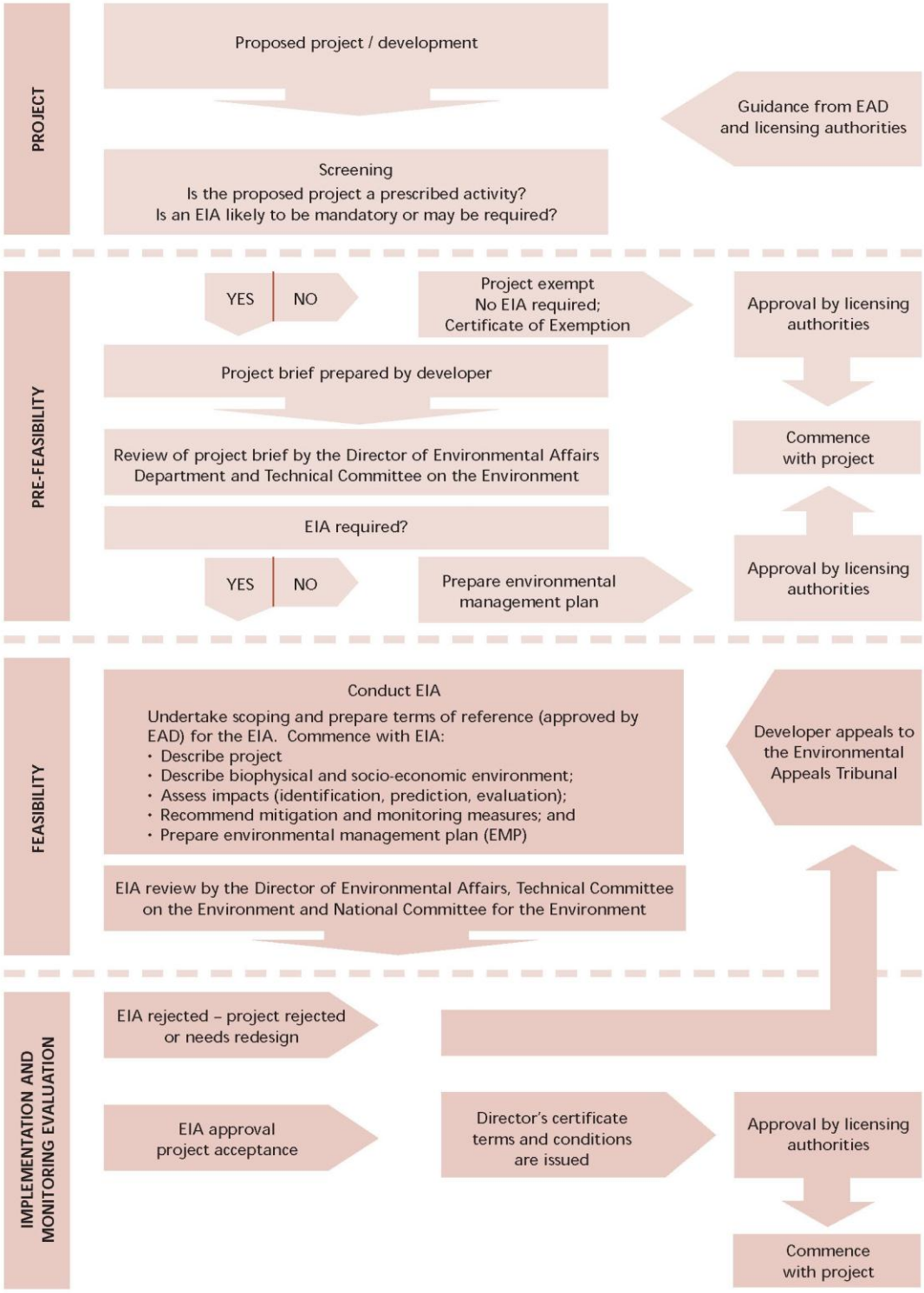


Figure 3.1: EIA Process (Ref. SADC 2 2007)

Environmental Impact Assessment is mandatory for the Project. The Act requires that every developer implementing a project requiring an EIA must submit to the Director of Environmental Affairs a project brief, stating the matters provided for under **section 24(2).** If the Director is satisfied that there is sufficient information in the project brief, he will require the developer in writing to conduct an EIA in accordance with prescribed guidelines and submit to the Director an EIA report giving the particulars stipulated in **section 25**(1).

Upon receipt of the EIA report the Director must invite written or oral comments from the public and may conduct public hearing or require the developer to redesign the project or conduct a further EIA or recommend to the Minister to approve the project subject to such conditions as the Director may impose. In making the decision whether or not to recommend to the Minister to approve the project or impose any conditions, the Director shall take into account any likely impact of the project on the environment and the actual impact of any existing similar project on the environment.

The *Environment Management Act, 1996* has a number of sections specifically pertaining to the project:

- Section 24 (1) indicates the types and sizes of projects which shall not be implemented unless an environmental impact assessment is carried out;
- Section 24 (2) requires submission of a Project Brief which describes the proposed project and expected generic impacts;
- Section 25 (1) requires an EIA and submission of the EIA to the Environmental Affairs Department (EAD);
- Section 25 (3) requires public inspection of the EIA report;
- Section 26 (1d) requires the developer to redesign the project if the Director deems so;
- Section 26 (2) requires the Director whether or not to recommend any Project to the Minister; and
- Section 27 (1) provides for periodic environmental audits of projects for which EIAs were previously undertaken.

Finally, it should be noted that no licensing authority can issue any license under any written law unless the Director certifies either that the project has been approved by the Minister under the EMA or that an EIA is not required.

Part IV of the EMA makes provision for pollution control that is, both air and water pollution. With regard to water pollution, the EMA prohibits discharging of any pollutants into the environment. It further makes it a duty of every person to prevent the discharge of any pollutant into the environment otherwise than in accordance with it and to comply with such general or specific directions of the Minister or Director for preventing, minimizing or cleaning up, removing or disposing of any pollutant discharged into the environment. Although the provision requires that any discharge of pollutants be in accordance with the EMA, the EMA has not made specific provision for that discharge. However the EMA does provide that where any person discharges any pollutant into the environment otherwise than in accordance with the Act, he or she may be required by the Minister to clean up, remove or dispose of the pollutant in such manner and within such period as the Minister shall direct.

The consultant therefore carried out an ESIA study to determine the potential positive and negative environmental and social impacts that could arise during project implementation and to derive an Environmental and Social Management Plan (ESMP) to enhance the positive impacts, and prevent, reduce and or mitigate the negative impacts. The ESIA for the proposed project is in compliance with the requirements of the Act and the Guidelines. Furthermore, the Director may, in consultation with a lead agency, also carry out or cause to be carried out periodic environmental audits of the project.

Summary of Key Environment Management Act Provisions and Relevant Project Objectives	
Ministerial assessment of developments for environmental impact:	▪ Ensure ESIA is conducted and presented within Director Requirements.
Manage adverse impacts on environment:	▪ Develop environmental management plan for construction and operation of the DAM. ▪ Mitigate, monitor and audit environmental and social impacts during construction and operation of the Dam.

3.3.2. **Land Act (1965) CAP 57.01**

The legislation *Land Act*, 1965, and as amended, mainly deals with issues of ownership, land transfer, use of land, and compensation. It recognizes that every person has a natural dependency on land and that it is therefore important that the Government provides for secure and equitable access to land as a multipurpose resource and an economic asset by defining issues of security of tenure. The *Land Acquisitions Act* (1971) CAP 58.04 additionally outlines procedures to be followed for land acquisition by individuals or the Government.

The Land Act classifies land into the following categories:

Public Land is defined as

'all land which is occupied, used or acquired by the Government and any other land not being customary or private land and includes

- *any land which reverts to the Government on the termination, surrender or falling in of any freehold or leasehold title under which any parcel of land concerned is held; and*
- *notwithstanding the revocation of the existing orders, any land which was immediately before the coming into operations of this Act not Public land within the meaning of the existing orders'*

The Malawi National Land Policy (2002) however stipulates that public land will be held in trust and managed by Government or Traditional Authorities and will be openly used or accessible to the public at large. Under **section 8** of the Land Act it is provided that all public land is vested in perpetuity in the President, while the Constitution in **section 207** provides that all land is vested in the Republic.

- *Private Land is defined as "all land which is owned, held or occupied under a freehold title, or a leasehold title or a Certificate of Claim or which is registered as private land under the Registered Land Act.*
- *Customary Land is defined as "all land which is held, occupied or used under customary law but does not include public land." The Malawi National Land Policy defines customary land as "all land falling within the jurisdiction of a recognized Traditional Authority and which has been granted to a person or a group of persons and is used under customary law.*
- *Government Land: The Malawi National Land Policy has introduced another category of land as Government land and the Special Law Commission recommends that Government land be defined as land acquired and privately owned by the Government and dedicated to a specified national use or made available for private uses at the discretion of Government.*

Under **section 5** of the *Land Act*, the Minister has power to '*make and execute grants, leases or other dispositions of public or customary land for any such estates, interests or terms, and for such purposes and on such terms and conditions, as he may think fit*'.

Summary of Key Land Act Provisions and Relevant Project Objectives	
Recognition of land rights and entitlements	▪ Confirmation of recognition of persons' dependency on land
Power to acquire and dispose of land	▪ Communication of Ministerial acquisition and disposition powers in relation to public and customary land.

3.3.3. **The Lands Acquisition Act (1971) CAP 58.04**

The *Lands Acquisition Act* (1971) provides power to acquire land, with adequate compensation and the procedures for acquisition of customary land and freehold land. Related provisions are provided in the *Public Roads Act* (CAP 69:01), including the power to undertake associated works for public roads, and the power to enter land for investigations related to public roads.

Identifiable groups of people hold existing rights and interests in the land that will be acquired for this project, and the land to which affected persons are moved. There will be a need to make sure that procedures set out in the relevant Acts are followed to ensure that the landowners and peoples whose landuse rights are affected are fairly and equitably compensated.

Under the related legislation for customary land, *Customary Land (Development) Act* (1967, as amended in 1988) CAP 59.01, a land committee must be formed for each affected local district, with local residents, and communication established with an allocations officer. Each land committee is to provide advice on customary law issues.

Under the provision for recording customary land, the Recording Officer records the land as one of the categories:

(a) village residential land;

(b) "dambo" land;

(c) unallocated garden land; or

(d) land used for any other special purpose of the community.

A person's customary rights in certain land are considered before they are registered as the proprietor of that land.

Under the related legislation for land other than customary land, the *Adjudication of Title Act* (1971) (CAP 58.05), claimed interests in land within each adjudication section are considered by the recorded by the Adjudication Officer and a notice is prepared to advise persons affected nearby of that person's claimed interest, before it is considered and resolved.

These provisions are relevant to both the areas that affected persons are moved from and the areas they are moved to, as people in those local resettlement areas will also become affected persons, given their local areas will undergo substantial change, and their existing rights may be affected. There will likely be issues of customary law and rights and interests in land other than customary laws, in the geographical areas involved in the project development, the existing settlement and landuse areas for Project Affected Persons (PAP) and in the resettlement areas.

Fair market value is to be paid for acquired land. Given comprehensive national land reforms in a consultation phase currently in Malawi, provisions under the *Land Act* and *Land Acquisitions Act* should be interpreted close to the time of application of acquisition provisions, if the client requests this assistance. The *Land Acquisition Act Amendment Bill*, as presented in 2013, incorporates the Land Reform Commissions' recommendations, providing for compensation of persons affected by land acquisitions.

A process of consultation and adjudication will be needed in ascertaining rights and interests in customary land, and in land other than customary land. It is recommended that a legal and administrative advisory process be confirmed and communicated with affected persons ahead of the initiation of the works of the Diamphwe Multipurpose Dam and Associated Structures.

Summary of Key Land Acquisition Act Provisions and Relevant Project Objectives	
Acquisition of customary land	▪ Confirmation of existing customary land rights ▪ Confirmation of formation of district land committees ▪ Ongoing consultation processes ▪ Communication and advisory channels with committees ▪ Confirmation of reallocation or compensation mechanisms ▪ Communication of customary land
Acquisition of land other than customary land	▪ Confirmation of existing landuse rights and entitlements ▪ Confirmation of reallocation or compensation mechanisms ▪ Confirmation of adjudication and dispute resolution mechanisms for rights and entitlements ▪ Communication of land acquisition and resettlement processes
Resettlement areas	▪ Consultation and adjudication mechanisms as required for customary land and non-customary land issues

3.3.4. **Local Government Act (1998)**

The Act mandates all local authorities to regulate planning and development within their jurisdiction and also empowers them to have by-laws that specify how development projects should minimize and avoid environmental degradation. This Act also devolves decision-making authority from central government to local authorities through the process of decentralization. The Act makes concrete provisions for participation of rural communities in development planning, implementation and monitoring.

The proposed project will adhere to the requirements of the Act by ensuring that various by-laws formulated by Lilongwe and Dedza District Council are followed throughout the project cycle.

Summary of Key Local Government Act Provisions and Relevant Project Objectives	
Regulation development by Local Planning Authorities	▪ Ensure that various by-laws formulated by Lilongwe and Dedza District Council are followed

3.3.5. **Town and Country Planning Act (1957) CAP 23.01**

This Act, as amended in 1991, makes provision with respect to town and country planning. It regulates land use planning and physical developments in Malawi. Generally, land use control plays a major role in environmental management through physical planning, zoning, and the creating of protected areas.

The Act creates the public office of the Commissioner for Town and Country Planning and it also creates the Town and Country Planning Board. **Section 20** provides for the development of a National Physical Development Plan in order to contribute to a balanced pattern of development and economical use of resources. The Act requires developers to obtain development permission from the local Planning Committee. The Planning Committee considers the foreseeable impacts of the

proposed development; noise, air, water, ground pollution, and any detrimental effect; traffic; and the contribution of the project to the economy before granting any development permission.

This therefore means that the construction works for the Diamphwe Multipurpose Dam need to be approved by the relevant Planning Committees. The approval will only be given if the developer satisfies the requirements under the Act including the zoning restrictions. Under **sections 52 and 53** of the Act, the Minister may declare any area a special area for the purpose of protecting the natural environment of the land or water from the harmful effects of development.

The Act regulates land use planning and physical developments in Malawi. It seeks to promote orderly physical planning in an attempt to optimize use of service infrastructure and protect and conserve fragile ecosystems. This is achieved by guiding physical developments through planning permission following appropriate scrutiny by local planning committees or the Commissioner for Physical Planning. **Section 40** of the Act regulates development by prescribing screening for environmental and socio-economic implications for large scale development projects before planning permission is granted. Since the proposed Project is large scale, it must undergo screening before permission is granted, hence need for the ESIA.

Summary of Key Town & Country Planning Act Provisions and Relevant Project Objectives	
Planning Committee approval requirements	▪ Screening for environmental and socio-economic implications ▪ Preparation of reports on development impacts ▪ Facilitation of Receipt of Planning Committee approval

3.3.6. **Water Resources Act (2013) CAP 72.03 & Waterworks Act (1996) CAP 72.01**

The management of water resources involves two related issues: (1) Provision of a wholesome supply and (2) The removal and disposal of contaminated liquid wastes from the water supply. The *Water Resources Act*, 2013 is the major statute dealing with management of water resources.

The *Water Resources Act, 2013* has a number of sections specifically pertaining to the project:

- Section 39. (1) No person shall abstract and use water unless authorized to do so.
- Section 40. (1) A person wishing to abstract and use water shall apply to the Authority in the prescribed form for a licence.
- Section 94: A permit to discharge effluent shall be issued subject to: (a) the protection of any water resource to which the discharge will be made as well as any existing or potential uses of the water resource

The Act specifically deals with control, conservation, apportionment and use of water resources of Malawi. The Act prohibits any person to divert, dam, store, abstract or use public water for any other purpose except in accordance with the provisions of this Act.

The principle aim of the Project is to enhance the provision of water for domestic, agricultural and commercial use. Construction will only proceed with due planning permissions in place.

Under **Section 16 (i):** It is an offence for any person to interfere with, alter the flow of or pollute or foul any public water. The Act defines pollution or fouling of public water to mean the discharge into or in the vicinity of public water or in a place where public water is likely to flow, of any matter or substance likely to cause injury whether directly to public health, livestock, animal life, fish, crops orchards or gardens which such water is used or which occasions, or which is likely to occasion, a nuisance. Further, under the Regulations, persons are not allowed to discharge into public water any water of less purity or any matter that might affect the river or fish. **Section 24:** No offence is

committed if a discharge is, inter alia, under the authority of the Act or any other written law as under the *Water Resources (Water Pollution Control) Regulations* made pursuant to Section 24 of the Act, the Board is given powers to consider applications for a Ministerial consent to discharge waste or effluent into public water.

Section 6: The right to use public water may be limited if the use may cause damage to natural resources of the area or in the vicinity.

The *Water Resources Act* operates in conjunction with the *Waterworks Act* (1996), which also provides for the establishment of Water Resources Boards and water-areas and for the administration of such water-areas and for the development, operation and maintenance of waterworks and waterborne sewerage sanitation systems in Malawi and for matters incidental thereto. The Water Resources Act gives the said Water Boards various powers and duties in connection with water supplies and waterborne sewerage sanitation in their respective water areas.

Firstly, the Act imposes a duty on the Water Boards to provide a supply of portable water sufficient for the domestic purposes of the inhabitants within their respective water- areas. This presupposes a supply of fresh and clean water, free of pollutants because only clean water can be safely used for household purposes.

The Act also empowers Water Boards to make by-laws for the regulation of the use and the prevention of pollution and the prevention of pollution of gathering grounds, waterworks and water therein.

The Act prohibits people from throwing or emptying into public sewers any:

(a) Matter likely to injure the sewer or drain, or to interfere with free flow of its contents, or to affect prejudicially the treatment and disposal of its contents; or

(b) Chemical refuse or waste steam; and

(c) Petroleum spirit or carbide of calcium.

In the construction and operation phases of the project, the contractors will be required to ensure that the existing water supply is not polluted or that any noxious matter is carried into the river and surrounding water systems.

The contractor t will need to mitigate pollution during the whole lifecycle of the project so that **section 16** of the Water Resources Act and the Regulations are not contravened.

Summary of Key Water Resources Act& Waterworks Act Provisions and Relevant Project Objectives	
Approval required to dam river	▪ Facilitate provision of required information for planning approval
Duties to safeguard safe water supply	▪ Mitigate pollutants that may enter the river system during construction
Administration of water resources	▪ Liaise with Water Resources Board

3.3.7. **Irrigation Act, 2001**

The Act makes provisions for the sustainable development and management of irrigation, protection of the environment from irrigation related degradation, establishment of the National Irrigation Board, the Irrigation Fund and other matters related to irrigation development in Malawi.

It mandates farmers to maintain irrigation canals, drains and other associated infrastructure in their holdings and prohibits people from engaging in practices which are destructive or potentially destructive to the catchment area of a river that provides water for irrigation. It prohibits livestock grazing and setting or causing to set fire on irrigation schemes or farms. The Act is silent on the

maintenance of buffer zones along riverbanks but as can be seen above it prohibits any actions that are destructive to the catchment.

Summary of Key Irrigation Act Provisions and Relevant Project Objectives	
Management of irrigation Protection	▪ Future irrigation areas must be properly maintained
Management of the environment	▪ Management measures to minimize impacts on the environment

3.3.8. National Parks and Wildlife Act (2004) CAP 66.07

The purposes of the *National Parks and Wildlife Act* (2004) are to conserve selected examples of wildlife communities, and to protect 'rare, endangered and endemic species of wild plants and animals'. In addition, conflict is to be minimised between people and animals.

Summary of Key National parks & Wildlife Act Provisions and Relevant Project Objectives	
Protection of flora and fauna	▪ Determine and assess threatened species
Manage impact on fauna and flora	▪ Mitigate adverse impact on local flora and fauna ▪ Reduce opportunity for conflict with local animal species during construction activities
Promotion of local participation in protection objectives	▪ Collaborate with local communities to plan ongoing conservation measures

3.3.9. Fisheries Conservation and Management Act (1997) CAP 66.05

The principal legislation regulating fisheries management is the *Fisheries Conservation and Management Act* (FCMA), 1997 which replaced the *Fisheries Act* of 1974. The FCMA was enacted to make provision for regulation, conservation and management of fisheries of the country. The Act provides for mandatory monitoring and control of pollution of various water bodies from toxic chemicals/substances including persistent organic pollutants. The Act further provides for penalties for both pollution and failure to remove pollutants. Under **section 43**, the Act prohibits pollution of rivers, streams and lakes. The Proponent for the Diamphwe Multipurpose Dam and Associated Structures should monitor water bodies, so as to actively mitigate potential adverse effects on species of fish in the river systems affected by the Dam project during construction,operational and decommissioning phases.

Summary of Fisheries Conservation and Management Act Provisions and Project Objectives	
Monitoring of pollution	▪ Manage and monitor potential pollutants in the Dam construction and operation.
Monitoring of fish species	▪ Mitigate adverse effects on fish species throughout construction

3.3.10. Forestry Act (1997) CAP 63.01

The *Forestry Act* (1997) deals with the management of indigenous forests on customary and private land; forest reserves and protected forest areas; woodlots and plantation forestry and also crosscutting issues including law enforcement and fire management. The Act among other things

seeks to: protect trees and other resources in forest reserves, conserve and enhance biodiversity, protect and facilitate management of trees on customary land, promote community involvement in the conservation of trees, promote sustainable utilization of timber and other forest produce and protect fragile areas such as river banks and water catchment. Diverse use of forest areas is encouraged under the provisions of the Act, so as to empower local communities' active management of their forest areas.

Forestry Rules set out protected species of trees, and outline permissions required before felling of any protected forest areas may be carried out.

Rehabilitation measures are to be conducted in a manner consistent with the provisions for coordinating forestry development and implementing the Forestry Programme of Action in the Southern African Development Community (SADC) region, as in **section 5** of the *Forestry Act*.

Summary of Key Forestry Act Provisions and Relevant Project Objectives	
Manage and protect natural forest resources	▪ Document biodiversity ▪ Document impact of Dam and associated structures ▪ Obtain necessary permits before felling forest areas ▪ Rehabilitate species
Forestry Programme of Action	▪ Liaise with Forestry Programme to plan rehabilitation of forest areas ▪ Liaise with Forestry Programme to initiate planning for development of recreational forest areas

3.3.11. **Public Health Act (1948), Cap 34.01**

The *Public Health Act* (1948) aims to consolidate the legislative provisions regarding the preservation of public health. The Act makes provision for the control and provision of a safe water supply, the amelioration of water pollution in general and also the use of public sewers so as to prevent pollution. The Act empowers local authorities to take all lawful, necessary and reasonably practicable measures for preventing any pollution of any supply of water which the public within its district has a right to use and does use for drinking or domestic purposes.

Where drinking water has been polluted, the Act also imposes a duty on the local Assemblies to take reasonable and lawful measures aimed at purifying such polluted water. The public are to be safeguarded from waterborne diseases which may be contained in polluted water. In order to recoup expenses that might have been incurred in the process of preventing water pollution or indeed purifying water that has already been polluted, the Act empowers the local authorities to take any necessary measures, including legal proceedings against any person polluting any such supply or polluting any stream so as to be a nuisance or danger to health.

The Act under **Part X** requires developers to provide adequate sanitary and health facilities near construction sites to safeguard and enhance the health of workers and avoid harmful effects of waste on public health. This is important for the proposed project as the contractor is likely to build various camp sites where different construction materials will be stored and subsequently some workers will reside on the site. During working hours, basic access to clean water and sanitation is a fundamental public health requirement. Also*, 'satisfactory separate latrine accommodation for persons of each sex'* is required to be provided under **section 88**.

Further, **section 82** prohibits persons from passing certain matters into public waters. The matters include petroleum spirit and any substance that may cause injury to public health. Adequate provision of waste facilities will be required for construction workers. The contractor is required to comply with the requirements of this Act by designing waste disposal facilities in accordance with the anticipated volumes of waste.

In a related provision, **section 96** states:

For the purpose of this Act—

(a) any collection of water, sewage, rubbish, refuse, ordure, or other fluid or solid substance, which permits or facilitates the breeding or multiplication of animal or vegetable parasites of human beings or domestic animals, or of insects or of other agents which are known to carry such parasites or which may otherwise cause or facilitate the infection of human beings or domestic animals by such parasites;

(b) any collection of water in any well, pool, gutter, channel, depression, excavation, barrel, tub, bucket, or any other article, found to contain any of the immature stages of the mosquito;

(c) any cesspool, latrine, urinal, dung pit or refuse pit found to contain any of the immature stages of the mosquito, shall be nuisances liable to be dealt with in the manner hereinbefore provided for the treatment of nuisances.

Construction facilities will include adequate waste disposal facilities, so as to prevent the breeding of animal or vegetable parasites, and monitor so as to be able to mitigate such breeding.

In combination, safeguarding the public water supply and managing water, sanitation and waste at the construction site will ensure that public health measures to prevent diseases and pollution dangerous to human health and to any water supply are in place.

Summary of Key Public Health Act Provisions and Relevant Project Objectives	
Safeguard water supply	▪ Safeguard clean water supply ▪ Provide construction workers with potable water
Enhance adequate sanitation	▪ Plan adequate sanitation facilities for construction workers ▪ Provide satisfactory separate latrine facilities for men and women at each camp site
Minimise breeding of animal or vegetable parasites	▪ Provide adequate waste disposal ▪ Educate workers to use the disposal systems correctly ▪ Prevent, monitor and mitigate mosquito breeding at camp sites

3.3.12. **Gender Equality Act (2003)**

The *Gender Equality Act* makes provisions for the Malawi Human Rights Commission (MHRC) to:

- *Monitor and evaluate the state organs, state agencies and public bodies including the private sector to promote gender equality and make recommendations that the Commission deems necessary;*
- *Carry out investigations and conduct searches in relation to any gender issues on receipt of complaint or on its own accord;*
- *Make recommendations to the Minister on any gender issues*
- *Provide information to any party in a gender dispute on rights, remedies or obligations; and,*
- *Perform functions on implementation of the Gender Equality Act.*

Summary of Gender Equality Act Provisions and Relevant Project Objectives	
Monitor and manage of gender equality issues	▪ Ensure gender issues are appropriately addressed in the ESIA, ESMP and RAP.

3.3.13. **Monuments and Relics Act (1990) CAP 29.01**

The *Monument and Relics Act* of 1990 provides statutory protection against the threat of development on declared monuments, historical buildings and archaeological, paleontological, geological, anthropological, ethnological, and other heritage sites to enable their preservation for posterity and socio economic development.

Section 29 of the *Monuments & Relics Act* of 1990 reads:

(1) A person in charge of any survey, excavation, exploration, construction or new development shall, at the earliest stages of planning for such activities, give notice to the Minister to enable, where necessary, rescue archaeology to be carried out (…)

(2) (…) the cost of such work shall … be borne by the person in charge of any survey, excavation, exploration, construction or other development.

The Malawi Cultural Policy (2014) and the Antiquities Policy (2012) also provide statutory and legal mandate of ensuring that Cultural Heritage Impact Assessment is conducted before embarking on large scale land altering development projects.

This Act and the Antiquities policy define cultural heritage in its tangible and intangible forms. Cultural heritage comprises the physical cultural heritage resources both movable and immovable including the following: -

a. Physical Cultural Heritage

- places, buildings, structures of cultural significance;
- places to which oral traditions are attached or which are associated with living heritage;
- historical settlements and townscapes;
- landscapes and natural features of cultural significance;
- geological sites of scientific or cultural importance;
- archaeological and palaeontological sites;
- graves and burial grounds, including ancestral graves, royal graves and graves of traditional leaders, graves of individuals designated by the Minister by notice in the Gazette, historical graves and cemeteries; and other human remains
- sites of significance relating to the history of slavery;
- movable objects such as archaeological and palaeontological objects and material, meteorites and rare geological specimens;
- objects to which oral traditions are attached or which are associated with living heritage such as ethnographic art and objects;
- iron smelting sites;
- objects of decorative or fine art;
- Ethnographic art and objects.

b. Intangible Cultural Heritage

- Oral traditions and expressions, including language as a vehicle of the intangible cultural heritage;
- Performing arts;
- Social practices, rituals and festive events;

- Knowledge and practices concerning nature and the universe;
- Traditional craftsmanship and skills transmitted from generation to generation.

Summary of Monuments and Relics Act Provisions and Relevant Project Objectives	
Preparation of Cultural Heritage Impact Assessment	▪ Undertake site survey & impact assessment for cultural sites ▪ Identify important sites and those directly and indirectly affected by the Project
Management of important sites	▪ Prepare plan for identification, documentation and management of important sites ▪ Prepare specific plan for management of affected graveyard sites

3.3.14. **Public Roads Act (1962) CAP 69.01**

A detailed compensation scheme is provided under the *Public Roads Act* (1962) for land that becomes public land.

- *Section 44 provides for the assessment of compensation payable, regarding the land or surface rights of an owner or occupier.*
- *Section 45 provides for the compensation for which land becomes public related to the acquisition for public road use, and specifically states that in the case of customary land compensation shall be in respect of disturbance.*
- *Section 46 outlines matters to be taken into consideration and matters to be disregarded in assessing compensation.*
- *Section 47 outlines the procedure to be followed when pursuing claims for compensation and*
- *Section 48 provides for the procedure before compensation boards.*
- *Sections 49 and 50 respectively deal with appeals to the High Court and state that there shall be no further appeal from the High Court.*

It should be confirmed that the provisions of Cap 69.02 are forwarded by the client to the contractor.

Summary of Public Roads Act Provisions and Relevant Project Objectives	
Acquisition of land for a public road	▪ Communication of the planned acquisition of land to land users ▪ Close interaction with the Roads Authority where existing public roads may be impacted, such as at the intersection of the M1 Road and proposed site access.
Assessment of damage or destruction in interests in land or surface use rights	▪ Confirmation of assessment process
Compensation provisions	▪ Confirmation of a compensation system for the land user ▪ Confirmation of customary land compensation mechanisms

Summary of Public Roads Act Provisions and Relevant Project Objectives	
	▪ Confirmation of land other than customary land compensation mechanisms

3.3.15. **Occupational Safety, Health and Welfare Act (1997) CAP 55.07**

The *Occupational Safety, Health and Welfare Ac*t (1997) regulates work conditions with respect to safety, health, and welfare of workers. The duty of ensuring safety, health, and welfare of workers rests with the employer. However, every employee is required to take reasonable care for his/her own safety and that of other workers.

- **Section 13(1)** places a duty on every employer to ensure the safety, health and welfare of all his employees at work, including a safe system of work. Training on safe work is also to be provided, given s 13 (*c*) requires '*the provision of information, instruction, training and supervision in accordance with section 65 to ensure the safety and health at work of his employees*'.
- ***Section 65 sets out the detailed training requirements as follows:***

(1) Every worker in a workplace shall be adequately and suitably—

(a) informed of potential health hazards to which he may be exposed to at the workplace;

(b) instructed and trained in the measures available for prevention and control and protection against health hazards at the workplace.

(2) All information, instruction and training referred to in subsection (1) shall be given in a language understood by the worker, and written, oral, visual and participative approaches shall be used to ensure that the worker assimilates the information, instruction or training, as the case may be.

(3) Specialized instruction and training shall be given to—

(a) drivers and operators of lifting appliances, transport vehicles, earth moving and materials handling equipment and plant, steam boilers and machinery or equipment of specialized or dangerous nature;

(b) workers engaged in the erection and dismantling of scaffolds;

(c) workers engaged in excavations, of shafts, earthworks, underground works or tunnels;

(d) workers handling explosives or engaged in blasting operations;

(e) workers in compressed air, coffer dams and caissons;

(f) workers engaged in the erection of prefabricated parts or steel structural frames or tall structures;

(g) workers handling hazardous substances;

(h) such other specialized categories of workers as by the Director may designate by notice published in the Gazette.

- **Section 51(1**) mandates that manufacturers, importers and suppliers of hazardous substances used at workplaces shall provide sufficient information on such substances as well as the precautions to be taken.
- **Section 81 (7)** stipulates that where the use of hazardous chemicals is likely to penetrate the skin and cause rash, skin contact with hazardous chemical shall be avoided and personal hygiene and the type of clothing worn shall be such as to enable rapid removal of any chemical from skin contact.

Considering that the project being proposed will involve a lot of labour force, heavy machinery and generation of hazards, the *Occupational Safety, Health and Welfare Act* is important in safeguarding the health and welfare of all workers. The contractor will need to ensure that there is adequate protection for the workers who will be on site as required by the Act.

Summary of Key Occupational Safety, Health and Welfare Act Provisions and Relevant Project Objectives	
Employer duty of care	▪ Safe systems of work ▪ Education and training for workers on work safety

3.3.16. The Employment Act (2000) CAP 55.01 & Labour Relations Act (1997) CAP 54.01

The Employment Acts regulate employment matters i.e. minimum wage, fair labour practices, non-discrimination and prohibition (in some cases) of employment of children. When employing people for the implementation of the project activities, the developer should ensure that provisions of this Act are complied with.

The *Employment Act* (2000) provisions on antidiscrimination, **section 5**, and equal pay, **section 6**, are noted, and should be complied with by the contractor and any sub-contractors.

Summary of Key Employment Act & labour Relations Act Provisions and Relevant Project Objectives	
Minimum standards of employment	▪ Compliance with fundamental principles including anti-discrimination and equal remuneration

3.3.17. Labour Relations Act (1997) CAP 54.01

Rights to reach collective agreements are protected under the *Labour Relations Act* (1997), and orderly and expeditious dispute settlement is supported. This Act serves to promote sound labour relations through the protection and promotion of freedom of association, the encouragement of effective collective bargaining and the promotion of orderly and expeditious dispute settlement, conducive to social justice and economic development.

Summary of Labour Relations Act Provisions and Relevant Project Objectives	
Mange labour relations	▪ This Act is applicable to the Project's construction and operational labour force.
Sound labour relations	▪ Allow for collective agreement negotiation ▪ Provide for respectful dispute settlement as needed

3.4. Relevant Policies and Institutions

3.4.1. National Environmental Policy, 2004

As part of the *Environment Management Act* (1996), in Part II, the National Environmental Policy (NEP), 2004, aims to manage the degradation of the environment and depletion of the natural resources on one hand and development on the other. The Policy promotes sustainable social and economic development through sound management of the environment and natural resources. The policy seeks, among other things to:

(a) Secure for all persons now and in the future an environment suitable for their health and wellbeing;

(b) Promote efficient utilization and management of the country's natural resources and encourage, where appropriate long-term self-sufficiency in food, fuel wood and other energy requirements;

(c) Facilitate the restoration, maintenance and enhancement of the ecosystems and ecological processes essential for the functioning of the biosphere and prudent use of renewable resources;

(d) Integrate sustainable environment and natural resources management into the decentralized governance systems and ensure that the institutional framework for the management of the environment and natural resources supports environmental governance in local government authorities;

(e) Enhance public education and awareness of various environmental issues and public participation in addressing them; and

(f) Promote local community, NGO and private sector participation in environment and natural resources management.

The NEP's overall objective is to manage and use water resources efficiently and effectively so as to promote its conservation and availability in sufficient quality and acceptable quality. In order to realize this objective, the NEP lays down a number of guiding principles. The NEP states that the precautionary approach to water quality management shall be pursued with a focus on pollution minimization and prevention. Further, the NEP advocates the incorporation of the 'polluter pays' principle in water policy and legislation so as to ensure that costs of unsustainable water utilization and management are borne by the party responsible for such conduct.

The NEP includes strategies on environmental planning and environmental impact assessment, audits and monitoring, among others. On environmental planning, the objective is to ensure that national and district development plans integrate environmental concerns, in order to improve environmental management and ensure sensitivity to local concerns and needs. The guidelines for EIAs, audits, monitoring and evaluation are regularly reviewed so that adverse environmental impacts can be eliminated or mitigated and environmental benefits enhanced.

In line with the environmental policy (on planning and EIAs, among others), the developers must integrate environmental concerns during the whole cycle of the project i.e. planning, design, and implementation. The implication of the policy is that the project has to put in place measures to reduce adverse impacts arising from the activities of the project and that implementation of the activities of this project must accommodate sustainability issues.

Summary of National Environmental Policy Provisions and Project Objectives	
Minimise impact on natural environment	▪ Confine necessary construction and associated facilities impact footprint
Encourage self-sufficiency	▪ Manage resources for construction process efficiently ▪ Aim for local resources being used only for local needs ▪ Construction needs to be brought in ▪ Waste management independent of local resources
Restore environment	▪ Assist with advice on rehabilitation plans of the Dam surrounds

3.4.2. **Guidelines for Environmental Impact Assessment (1997)**

The Guidelines for Environmental Impact Assessment (ESIA) outline the process for conducting ESIAs and facilitate compliance to the ESIA process by developers as provided for in the Environment Management Act, 1996. The guidelines provide a list of prescribed projects for which ESIA is mandatory. They act as a tool for integrating environmental concerns into development plans at all levels.

It is a requirement under **section 29** of the EMA that developers submit ESIA Reports to the EAD for review and approval. The proposed Project is a part of the list of projects for which ESIA is mandatory.

Sector Specific ESIA Guidelines (2006)

The Environmental Impact Assessment Guidelines for Water Sector Projects, 2006, outline the process for conducting Environmental and Social Impact Assessments (ESIAs) and facilitate compliance to the ESIA process by developers as provided in the Environment Management Act, 1996. The guidelines provide a list of prescribed water sector projects for which ESIA is mandatory. They act as a tool for integrating environmental concerns for the water sector into development plans at all levels.

Summary of Guidelines for Environmental Impact Assessment Provisions and Project Objectives	
Guidelines for undertaking ESIA to ensure compliance with Environment Management Act, 1996	▪ Ensure general ESIA guidelines and Water Specific Sector guidelines are appropriately adhered to.

3.4.3. **National Land Policy, 2002**

This is the principal policy that guides the land management and administration issues in Malawi. The policy introduces major reforms intended for land planning, use, management and tenure. It provides clear definition of land ownership categories (**Section 4**), and addresses the issue of compensation payment for land (**Section 4.6**). Compensation provisions are now also included in amendments to the *Land Act* (1965), *Land Acquisitions Act* (1971) and the *Public Roads Act* (1962).

The policy provides for Land Use Planning and Development, and Environmental Management. In terms of landuse planning, the policy provides that land allocation should be done in a manner as to obtain effective use and at the same time pay attention to the built environment and welfare of community. To achieve this policy objective, a comprehensive National Land Use and Physical Development Management Policy was developed.

The Policy supports the environmental management policies and strategies that are already in place. One of the serious problems identified in the policy is the management of solid and liquid waste, protection of sensitive areas, development in fragile areas, and coordination of multiple land use.

The policy also has provisions for environmental management covering issues related to both urban and rural management of solid and liquid waste, protection of sensitive areas, agricultural resource conservation and land use, community forests and woodland management, over-dependence on fuel wood, forest programs, co-ordination of multiple land use, water resources and wetlands, lakeshore environmental management and mining and minerals. Of particular importance is **Section 9.8.1 (c)** which states that development activities in fragile ecosystems such as wetlands, game reserves, forest reserves and critical habitats will only be permitted after the appropriate authority has conducted an environmental impact assessment. As such **Section 4.6** on compensations will guide the developer on how to deal with compensation matters for land and property and displaced persons.

Summary of National Land Policy Provisions and Project Objectives	
Land planning and use	▪ Compliance with planning regulations
Land ownership and entitlements	▪ Client to confirm compliance with acquisition and compensation principles

3.4.4. National Water Policy (2005)

Malawi's policy on water resources management requires that:

(a) Water should be managed and used efficiently and effectively in order to promote its conservation and future availability in sufficient quantity and acceptable quality; and

(b) All programs related to water should be implemented in a manner that mitigates environmental degradation and at the same time promotes the enjoyment of the asset by all.

For a long time rivers have been used as a cheap and convenient repository for human and industrial waste. Recently they have come to be recognized as the basis of unique ecosystems worthy of protection in their own right. If the water is to continue to perform this and other many important roles in a sustainable manner then unrestrained disposal of materials into the aqueous environment poses an unacceptable threat.

Sections 5.2.1 to 5.2.14 provide strategies for the prevention of pollution and the maintenance of water quality. This project will therefore have to ensure that it abides by the provisions of this policy in order to avoid the deterioration of water quality as a result of the project's activities.

Summary of National Water Policy Provisions and Project Objectives	
Comprehensive water resources management	▪ Prevent or mitigate pollution during construction ▪ Mitigate environmental degradation surrounding construction ▪ Contribute to plans to open areas of the Dam for public enjoyment

3.4.5. National Irrigation Policy and Development Strategy (2011)

The irrigation sector is guided by the National Irrigation Policy and Development Strategy (2011) that seeks to increase the area under sustainable irrigation, extend cropping opportunities, facilitate crop diversification, create an enabling environment for irrigated agriculture, enhance capacity for irrigated agriculture and promote a business culture in the small scale irrigated agriculture sector.

The Water Resources Department in conjunction with LWB, seek to identify and develop areas with irrigation potential to facilitate utilization of irrigable land in Malawi. The policy refers to environmental and social management considerations as follows:

- All irrigation development shall be integrated with other natural resource management activities to protect and conserve the environment;
- Environmental analysis shall be made to ensure that unacceptable environmental impacts are avoided and that features such as high water tables, salinity and erosion are monitored;
- Projects shall be designed, implemented and managed in compliance with the EIA guidelines for irrigation and drainage projects as defined by EAD;

- The impact of irrigation development on health shall be closely monitored and mitigated; and,
- Use of renewable energy sources shall be encouraged.

Summary of National Irrigation Policy and Development Strategy Provisions and Project Objectives	
Develop irrigation opportunities	▪ The project will provide significant irrigation opportunities
Environmental and social management	▪ Environmental and social issues will be appropriately addressed in the ESIA and ESMP.

3.4.6. **National Sanitation Policy (2006)**

The basic level of access to sanitation in Malawi is generally of a poor standard. This situation is further compromised by low levels of hygienic behaviour, which result in high levels of water related disease outbreaks. In the cities poor capacity to maintain urban sewerage facilities is threatening the health of residents. Key objectives of this Policy are:

1) ***To achieve universal access to improved sanitation;***
2) ***Improved health and hygiene behavior; and***
3) ***The common acceptance and use of recycling of human waste to protect the environment and create wealth.***

The Policy will enhance the capacity of Malawi to meet its commitments to reach its Millennium Development Goals (MDGs) of empowering the people of Malawi to achieve universal access to improved sanitation by 2020.

Summary of National Sanitation Policy Provisions and Project Objectives	
Improved sanitation	▪ Consider Project's scope to improve sanitation

3.4.7. **Malawi National Forest Policy (1996)**

The policy promotes sustainable contribution of national forests, woodlands and trees towards the improvement of the quality of life in the country by conserving the resources for the benefit of the nation and to the satisfaction of diverse and changing needs of Malawi population, particularly rural smallholders. The policy prevents unnecessary changes in land-use that promote deforestation, or endanger the protection of the forests which have cultural, biodiversity or water catchment values. It also discourages development activities in gazetted forests unless proven to be environmentally friendly for which suitable inter-sectoral and local consultations will be conducted.

Above all, the policy advocates the carrying out of environmental impact assessment where actions are likely to have significant adverse impacts on important forests and other resources.

Note that *Forestry Act* (1997) requirements were subsequently enacted, as above. Under those provisions, Directors now action Forestry Plans under their authority.

Summary of Malawi National Forest Policy Provisions and Project Objectives	
Sustainable forestry	▪ Consider original forest policy objectives of forestry protection ▪ Foster options for community use of forest areas

3.4.8. **Gender Policy (2008) and Gender Equality Act (2013)**

The Gender Policy (2008) identifies gender equality as a basic human right, also recognised in the Malawi Growth and Development Strategy as important for sustainable, social and economic development. Inequities are to be addressed over time as part of Malawi's development.

Practical issues such as food security are identified in the Policy as supporting women's fundamental welfare. Any disruption to the use of land for small scale agriculture, or disruption of normal employment can lead to food security issues. Food security minimises stress on households, and therefore protects women from the possibility of stress escalating to domestic violence situations. The project will need to develop interim food security plans as part of the social strategy ahead of construction activities or resettlement plans.

In addition to this important policy work, and in line with gender equality as one of 8 United Nations Millennium Development Goals, legislation has now been passed in Malawi.

The *Gender Equality Act* (2013) reflects Malawi's commitment to gender equality, and the provisions may be enforced by the Human Rights Commission (CAP 3.08). Women are to be facilitated to be able to take part in development activities.

Summary of Gender Policy & Gender Equality Act Provisions and Project Objectives	
Gender equality as a basic human right	▪ Ensure needs of both men and women are met equitably in social assessment and resettlement planning
Mainstreaming of both genders in decision making	▪ Actively include women in decision making in all levels of community involvement
Identify opportunities for betterment of women	▪ Maintain or improve women's empowerment in resettlement plans ▪ Ensure food security plans are in place ahead of construction activities or resettlement plans

3.4.9. **National HIV AIDS Policy (2003)**

The goal of this policy is to prevent HIV infections, to reduce vulnerability to HIV, to improve the provision of treatment, care and support for people living with HIV/AIDS and to mitigate the socio-economic impact of HIV/AIDS on individuals, families, communities and the nation. The objectives are to:

- Prevent HIV infections;
- Improve delivery of prevention, treatment, care and support services;
- Mitigate the impact of HIV/AIDS on individuals, the family and communities;
- Reduce individual and societal vulnerability to HIV/AIDS through the creation of an enabling environment; and
- Strengthen the multi-sectoral and multi-disciplinary institutional framework for coordination and implementation of HIV/AIDS programmes in the country.

Importantly, this Policy recognises the impact of HIV/AIDS on vulnerable people, including women, and the marginalisation and discrimination of people living with HIV/AIDS.

Summary of National HIV AIDS Policy Provisions and Project Objectives	
Prevent and manage HIV/AIDS infections.	▪ The Project will need to implement systems to manage the spread and treatment of HIV/AIDS from

Summary of National HIV AIDS Policy Provisions and Project Objectives	
	construction and operation employees, as well as from in-migration of people seeking Project benefits.
Recognise vulnerability and discrimination of those living with HIV/AIDS.	▪ Consider HIV/AIDS In Conjunction with Gender Policy.

3.4.10. **The Malawi Cultural Policy (2014) & the Antiquities Policy (2012)**

These Policies provide guidance to the *Monuments & Relics Act* (1990) for assessing Cultural Heritage impacts before embarking on large scale land altering development projects.

Summary of Malawi Cultural Policy (2014) & the Antiquities Policy Provisions and Project Objectives	
Preparation of cultural heritage Impact Assessment	▪ Undertake cultural site survey & impact assessment in accordance with the *Monuments & Relics Act*. ▪ Identify important sites and those directly and indirectly affected by the Project

3.4.11. **National Decentralization Policy (1998)**

The policy integrates government agencies at the district and local levels into a single administrative unit, the District Council, which comprises of elected members (councillors) with full executive powers as well as non- voting members (traditional and political leaders). Public sector heads at district level form a secretariat headed by the District Commissioner. The line ministries still retain responsibilities such as policy formulation, establishment of standards, international representation, law enforcement and inspectorate; and training/curriculum development. The policy empowers the local councils to make by-laws for regulating specific matters (including the environment) under the Local Government administration.

Under guidance of this policy, the District Councils, in consultation with the developer and Department of Forestry may make by-laws in consultation with various stakeholders including Environmental Affairs Department (EAD).

Summary of National Decentralization Policy Provisions and Project Objectives	
Local government administration: District Councils, District Commissioner, Public Sector Heads, Traditional Authorities & councillors.	▪ Ensure adequate consultation with local administrative authorities in Dedza and Lilongwe Districts.

3.4.12. **National Environmental Action Plan (NEAP), 2004**

The NEAP was prepared in 1994 in response to Agenda 21 that required signatories to the 1992 *Rio Declaration* to prepare an action plan for integrating environmental issues into socio-economic development programs. The NEAP was updated in 2004. The objectives of the NEAP are to:

(a) Document and analyse all major environmental issues and measures in order to alleviate them;

(b) Promote sustainable use of natural resources in Malawi; and

(c) Develop an environmental protection and management plan.

Key issues relevant to this Diamphwe Multipurpose Dam project include:

- Soil erosion;
- Water resources degradation and depletion;
- Threat to fish resources; and
- Threat to biodiversity.

In order to protect the environment from further degradation; the NEAP outlines actions that need to be considered to ensure adequate environmental protection. The actions relevant to the establishment of the project in question include:

- EIAs will be required for any development that may affect fragile ecosystems; and
- Government will ensure that workers in hazardous workplaces are supplied with the appropriate protective equipment and undergo pre-employment medical examinations and regular check-ups.

The environmental objectives are reflected in the *Environment Management Act* (1996). The policy recognises the integration of social issues with environmental issues, so requiring an integrated environmental and social assessment.

Summary of National Environmental Action Plan Provisions and Project Objectives	
Action plan for environmental assessment in development programs	▪ Integrate environmental and social assessment ▪ Develop environmental protection and management plan

3.4.13. **National State of Environment Report (2010)**

The objective of the National State of Environment Report (NSoER) is to provide the status of the environment at national level. The NSoER for Malawi analyses key environmental issues of concern in Malawi including issues related to water resources management. It presents the relationship between external pressures, status and responses to the problems facing water resources.

The main problems facing water resources, as highlighted in the NSOER include:

- Sediment loading into the rivers due to irrigation farming along the rivers;
- Soil erosion and chemical pollution due to intensive cultivation in the water catchment areas, without adequate conservation measures;
- Presence and extent of human settlement in the catchment areas; and
- Discharge of effluents into the rivers.

The NSoER therefore provides a basis for environmental planning and development of the proposed project. Based on the issues highlighted in NSoER, it is important that in the proposed project, issues pertaining to discharge of untreated effluents in the rivers are proactively managed.

Summary of National Environmental Action Plan Provisions and Project Objectives	
Key issues of environmental concern for the water sector	▪ Ensue ESIA and ESMP appropriately address key water resources issues related to poor catchment management.

3.4.14. The Second Malawi Growth and Development Strategy (2012) and Millennium Development Goals (MDGs)

The Second Malawi Growth and Development Strategy (MGDS II) is the overarching strategy for Malawi for 5 years from 2011 - 2016. The overriding philosophy is poverty reduction through sustainable economic growth and infrastructural development. Addressing poverty, more inclusive job creation and growth, promotion of gender mainstreaming and women empowerment, and increased productivity and economic diversification and sustainable economic development have been identified as priorities.

The Malawi Growth and Development Strategy aims to continue to facilitate the Millennium Development Goals (MDGs), while maintaining a balance between the economic and social sectors of the economy.

As a member of the UN, Malawi has an interest in aspiring towards the MDGs, which came out of international conferences/summits held in the 1990s, and the Millennium Declaration adopted by the UN. The goals '*commit the international community to an expanded vision of development, one that promotes human development as the key to sustaining social and economic progress in all countries, and recognises the importance of creating a global partnership for development. The goals have been commonly accepted as a framework for measuring development progress*'[11].

The goals establish the yardsticks for measuring results, not only for developing countries but also for countries that help to fund development programmes and for institutions that help countries institute them, guiding financiers in determining their development assistance. The first seven goals are directed at reducing poverty, through specific targets based on indicators, while the eighth – global partnership for development – is about the means to achieve these, mostly by 2015:

- Goal 1: Eradicate extreme poverty and hunger;
- Goal 2: Achieve universal primary education;
- Goal 3: Promote gender equality and empower women;
- Goal 4: Reduce child mortality;
- Goal 5: Improve maternal health;
- Goal 6: Combat HIV/AIDS, malaria and other diseases; and
- Goal 7: Ensure environmental sustainability (Target 10: Halve, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation).

Managing natural resources and the sustainable use of natural resources continues to be recognised as an essential aspect of environmental sustainability. This includes fisheries, wildlife, forestry, and environmental protection. Efforts in environmental protection will focus on improving compliance with environmental and natural resource management laws.

The developer should strive to comply with the priorities in the MGDS II and MDGs on the conservation of the environment during the project.

Summary of Second Malawi Growth and Development Strategy and Millennium Development Goals Provisions and Project Objectives	
Economic development	▪ Job creation ▪ Gender inclusiveness in job creation
Managing natural resources	▪ Promoting sustainable use of natural resources ▪ Sustainable practices during construction

[11] www.undp.org

Summary of Second Malawi Growth and Development Strategy and Millennium Development Goals Provisions and Project Objectives	
Environmental protection	▪ Vigilance of environmental impacts during construction

3.4.15. **Other Relevant Malawi Standards**

Malawi Bureau of Standards (MBS) formulates national standards in all fields of interest. The standards act as a base or guideline for measuring the quality, performance or fitness for intended use of a product or service. Standards that may be applicable for the Project are:

- **MS733:2005**: The Malawi Standard for borehole and shallow well water quality specifies the requirements for untreated or raw ground water in boreholes and shallow wells suitable for human consumption and all usual domestic purposes.
- **MS214:2005**: Malawi Standards for drinking water quality, specifies the physical, biological organoleptic and chemical requirements for drinking water.
- **MS 691:2005**: Tolerance limits for domestic / sewage effluents discharged into inland surface waters
- **MS 173:2005**: Acoustics – Noise pollution – Tolerance limits

3.5. Private Sector Capacity

Construction Contractors for the Project will be appointed through international competitive bidding and contract documentation will include environmental monitoring and management requirements. Such requirements are standard practice and most international contractors are aware of the need to carry them out. However, the level of adherence is often dependent on the environmental monitoring and management expertise of the Supervising Consultant and the relevant sectoral agency, which in this case is MoAIWD.

It is important therefore that Contractors are provided with detailed environmental monitoring and management plans and that Contractor staff are given on-site environmental training by the supervision consultant and MoAIWD throughout the construction period.

3.6. International Standards

3.6.1. **World Bank**

The World Bank provides guidance on ESIA requirements through the World Bank Group *Environmental, Health, and Safety Guidelines*, which includes sectoral guidelines. In particular, Vol. 2 of the Sourcebook dealing with Sectoral Guidelines for Environmental Assessment of Energy and Water Projects provides a detailed analysis of the potential environmental impacts associated with hydropower generation including dams and transmission structures. It also addresses environmental monitoring and management issues, and identifies typical mitigation measures.

The World Bank EIA process is implemented through a set of Operational Policies/Procedures whose primary objective is to ensure that Bank operations do not cause adverse impacts and that they "do no harm". Specific safeguard policies address natural habitats, pest management, cultural property, involuntary resettlement, indigenous peoples, safety of dams, projects on international waterways and projects in disputed areas. The safeguard policies can be broadly grouped into Environment, Rural Development and Social Development. The World Bank Pollution and Abatement Handbook (1998a) and Environmental Assessment Handbook (1999a) have also been used in the Project evaluation.

World Bank Operational Policies, and their applicability to the Project are summarised below.

i. ***Operational Policies***

APPLICABLE WORLD BANK OPERATIONAL POLICIES	
OP/BP 4.01: Environmental Assessment (January 1999 and as revised April 2013)	
Ensures that appropriate levels of environmental and social assessment are carried out as part of project design. It also deals with the public consultation process, and ensures that the views of project-affected persons/groups and local NGOs are taken into account. It outlines the contents of environmental assessment reports and environmental management plans for Category A projects. This Policy requires proper Information Disclosure as a prerequisite for meaningful consultation for Category A projects. Public participation is a requirement where a project involves involuntary resettlement or affects indigenous people. Category A projects also requires consultation with affected groups and other stakeholders during at least two stages of the EA process; shortly after categorisation of the project and during preparation of the EA.	This safeguard Policy is relevant because of the size and nature of the Project and its potential to cause significant adverse impacts potentially including the need for involuntary resettlement. The Project is designated as a Category A project and therefore requires information disclosure and two stages of consultation. Involuntary resettlement is also likely, thereby requiring public participation.
OP/BP 4.04: Natural Habitats (June 2001)	
Supports the conservation of natural habitats and the maintenance of ecological functions as a basis for sustainable development. The Bank does not support projects that involve the significant conversion or degradation of critical natural habitats.	The Project site contains a range of habitats that support a variety of terrestrial and aquatic animals, as well as providing ecological resources to local peoples. It is not anticipated that the Project would result in significant conversion or degradation of critical natural habitats.
OP/OP4.09: Pest Management World Bank 1998k	
Promotes the use of biological or environmental control methods and reduces reliance on synthetic chemical pesticides. Refers to the World Health Organisation's 'Recommended Classification of Pesticides by Hazard and Guidelines to Classification' criteria for pesticide selection and use.	The project may increase the prevalence of animal borne diseases and in particular the spread of malaria by mosquitoes. The ESIA will promote the use of ecologically based biological or environmental pest management and reduced reliance on synthetic chemical pesticides.
OP/BP 4.11: Physical Cultural Resources (July 2006)	
Cultural property is defined to include both remains left by previous human inhabitants (e.g. middens, shrines) and unique natural environmental features such as canyons and waterfalls. The Bank does not support projects that will significantly damage non-replicable cultural property and assists only those projects that are sited or designed so as to prevent such damage.	There are a number of cultural heritage sites, including graveyards, which will potentially be affected by the Project. It is not anticipated that significant damage will occur on non-replicable cultural property; however a detailed consultation and management plan will be needed to assess options that are culturally acceptable in relation to the potential destruction, removal or relocation of cultural sites.
OP/BP 4.12: Involuntary Resettlement (December 2001, and as updated in March 2007)	
Involuntary resettlement safeguarding regulations and requirements are triggered when a project leads to the involuntary taking of land resulting in a loss of shelter, assets, income and livelihoods.	The Project will result in loss of land, other private assets and income, as well as requiring resettlement of directly affected peoples. The RAP will be developed in compliance with OP 4.12.

APPLICABLE WORLD BANK OPERATIONAL POLICIES	
OP 4.12 requires that displaced persons are provided prompt and effective compensation at full replacement cost for losses of assets attributable directly to the project; provided assistance (such as moving allowances) during relocation; and provided with residential housing or housing sites. The policy also requires that taking of land and related assets may take place only after compensation has been paid and, where applicable, resettlement sites and moving allowances have been provided. In the context of this policy, "involuntary" means actions that may be taken without the displaced person's informed consent or power of choice, and "land" includes anything growing on or permanently affixed to land, such as buildings and crops.	
OP/BP 4.20 Gender Development (March 2003)	
This Policy is intended to assist member countries to develop their own gender equality action plans, as part of endeavours to reduce poverty. Malawi has successfully developed policy and legislation, *Gender Equality Act* (2013). These provisions will be used as guidance in all aspects of the ESIA.	The Project has potential to assist in gender equality, through appropriate provisions for both genders in social development and resettlement planning, and involvement of both men and women in all aspects of consultation, assessment and planning.
OP 4.36: Forests (November 2002)	
This Policy aims to reduce deforestation and enhance, through sustainable economic development, the environmental and social contribution of forests. The Bank does not support projects which involve significant conversion or degradation of critical forest areas or related critical natural habitats.	There are a number of reserve forests within and around the proposed dam catchment; however these are unlikely to be adversely affected by the project. Small areas of remnant forest within the Project footprint may be directly impacted, however it is not anticipated these areas are critical natural habitat.
OP/BP 4.37: Safety of Dams (October 2001 and as revised April 2013)	
Strict safety requirements are provided under this Policy, including that experienced specialists assist in the planning and construction of all World Bank Funded Dams. The Dam is required to *'be designed and its construction supervised by experienced and competent professionals'*. The owner is then responsible for the safety of the Dam for its life.	The Project is a major dam structure and all aspects related to design, construction and operational safety must be carefully assessed and managed by experienced and competent professionals. A range of internationally and locally accredited professionals have been involved throughout the feasibility, design and assessment studies for the Project. Experienced and accredited professionals will be carefully vetted and selected for the construction and operation of the dam and associated structures.
OP 7.50: Projects on International Waterways (June 2001, as revised March 2012	
This policy applies to large water projects on a waterway or tributary that flows into a body of water that forms a boundary between two or more states. The Bank requires that the international aspects of a project on an international waterway are dealt with at the earliest possible opportunity.	This Operational Policy is relevant since the Project is on a tributary that flows into Lake Malawi, which forms a boundary between a number of States (Malawi, Mozambique and Tanzania). The underlying requirement of this Policy is for communication of project design and

APPLICABLE WORLD BANK OPERATIONAL POLICIES	
	implementation features to the boundary state – in this case Mozambique and Tanzania - so that it can conduct reviews and transmit specific concerns, or lack thereof, to the Government of Malawi. Client confirmation that international discussion has been held at an appropriate level will be sought.
OP 8.60 Development Policy Financing (February 2012, as revised July 2014)	
This Policy on financing of development programs highlights the importance of consideration of social and environmental impacts of development programs. Adequate country policies and monitoring of development activities is essential. These in country policies and requirements are highlighted above, and are in place in Malawi. The World Bank retains the power to monitor effective implementation of these in country policies.	This Policy is relevant given the Project will comply with in country social and environmental impact processes, and operational information will be available to the World Bank as required, in a timely manner.

ii. ***World Bank guidelines on Vulnerable People***

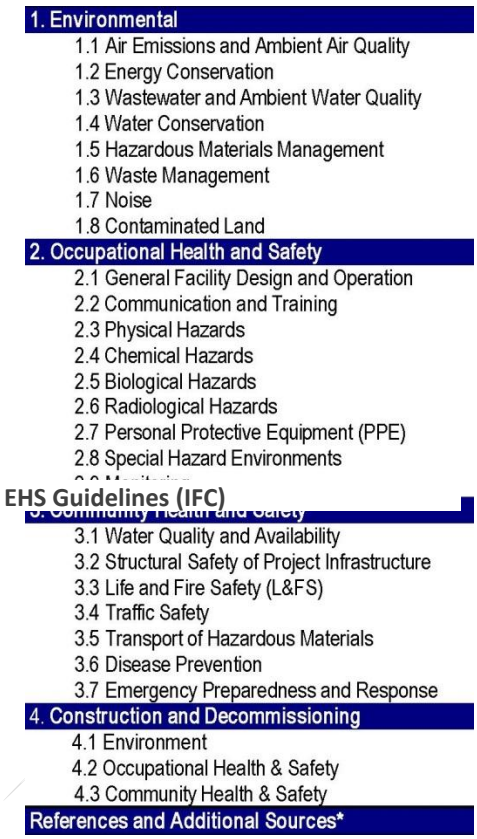
The World Bank resources and toolkits for vulnerable people are relevant to this project. They describe the vulnerable as those who are most likely to fall through the cracks of regular programs and need to be protected from negative outcomes and/or allowed participation.

Vulnerable people need to be given special attention to remove the barriers that stand in the way of equal participation in projects, or through special project components and targeting strategies tailored to their needs. The Project is likely to affect vulnerable groups, including women, children and disabled people.

3.6.2. International Finance Corporation (IFC) Standards and Guidelines

The International Finance Corporation (IFC) is a member of the World Bank Group, providing finance and development advice for private sector ventures and projects in developing countries. Their Performance Standards provide benchmarks for identifying and managing environmental and social risks.

This ESIA is cognisant of the eight IFC Performance Standards and associated guidance notes on Environmental and Social Sustainability (January 2012 edition), which together define the optimal environmental, social and health standards to be upheld throughout the life of a project, from planning to construction phases. Also relevant are World Bank Guidelines and Handbooks for specific issues such as Cumulative impact assessment and resettlement.



These Performance Standards provide further guidance as a framework when implementing the practical Malawi national legislative and regulatory provisions, and the World Bank Operational Policies. Specifically, they provide guidance to:

- Identify environmental and social impacts, risks and opportunities of projects, with effective community engagement and consultation.
- Identify and minimise impacts on workers, affected communities and the environment, and prioritise active management of impacts.
- Identify specific objectives, such as avoidance of damage of areas of cultural significance.

A demonstration of an awareness of these standards is expected as part of an environmental and social due diligence process to be undertaken by the financing institution.

IFC Performance Standards (PSs) and their applicability to the Project are summarised below.

APPLICABLE IFC PERFORMANCE STANDARDS	
PS1: Assessment and Management of Environmental and Social Risks and Impacts	
This PS promotes the importance of managing environmental and social performance throughout the life of a project through identification and management of risks, and implementation of an effective Environmental and Social Management System (ESMS).	The Project has potential to cause significant adverse impacts potentially including the need for involuntary resettlement. The ESIA will therefore identify potential risks and mitigation measures, and incorporate environmental & social measures to manage any residual risks.
PS2: Labour and Working Conditions	
This PS recognizes that the pursuit of economic growth through employment creation and income generation should be accompanied by protection of the fundamental rights of workers.	The Project will require a significant construction and operational workforce, which will be managed in accordance with local labour laws and applicable standards governing EH&S, non-discrimination and protection of vulnerable categories of workers.
PS3: Resource Efficiency and Pollution Prevention	

APPLICABLE IFC PERFORMANCE STANDARDS	
This PS addresses a project's contribution to pollutant emissions to air, water, and land, the use of non-renewable resources and the contribution to greenhouse gases (GHG).	The Project has potential to emit harmful pollutants to the environment, thereby requiring effective mitigation to limit potential impacts to acceptable levels. Sustainable resource management will be carefully considered throughout the Project's lifecycle.
PS4: Community Health, Safety, and Security	
This PS addresses a project's responsibility to avoid or minimize the risks and impacts to community health, safety, and security that may arise from project related-activities, with particular attention to vulnerable groups.	Due to the scale of the Project there is potential for the community to be at risk from an influx of workers to the area, and changes to socio-economic and cultural conditions. The ESIA will identify and assess potential risks and propose mitigation measures that safeguard the community in accordance with relevant human rights principles.
PS5: Land Acquisition and Involuntary Resettlement	
This PS addresses involuntary resettlement for both physical and economic displacement. Resettlement is considered involuntary when affected persons or communities do not have the right to refuse land acquisition or restrictions on land use that result in physical or economic displacement.	The Project will result in loss of land, other private assets and income, as well as requiring involuntary resettlement of directly affected peoples. The ESIA will identify opportunities to avoid displacement; however this may be limited due to the relatively fixed positioning of the dam inundation area. People displaced by the project will be fully compensated and assisted with relocation in accordance with a RAP that will be prepared in accordance with Malawi regulatory requirements and WB OP 4.12.
PS6: Biodiversity Conservation and Sustainable Management of Living Natural Resources	
This PS addresses sustainable development by biodiversity conservation, maintaining ecosystem services, and sustainably managing living natural resources.	The Project site contains a range of habitats that support a variety of terrestrial and aquatic animals, as well as providing ecological resources to local peoples. However the Project is unlikely to affect critical habitat and most of the areas affected will be cleared agricultural land. Mitigation will include re-establishing riparian vegetation around the dam perimeter as well as new graveyard vegetation sites.
PS7: Cultural Heritage	
This PS aims to ensure that cultural heritage is appropriately assessed and managed.	There are a number of cultural heritage sites, including graveyards, which will potentially be affected by the Project. It is not anticipated that significant damage will occur on non-replicable cultural property; however a detailed consultation and management plan will be needed to assess options that are culturally acceptable in relation to the potential

APPLICABLE IFC PERFORMANCE STANDARDS	
	destruction, removal or relocation of cultural sites.

3.6.3. **African Development Bank**

The African Development Bank (AFDB) has a set of environmental/social policies, requirements and recommendations that apply to its projects, similar to those developed by the World Bank. A number of documents are of relevance:

The Bank's policies provide general orientations to mainstream crosscutting themes in Bank projects, as in:

- *Involuntary Resettlement Policy* (November 2003)
- *African Development Bank Group's Policy on the Environment* (February 2004)

The Bank's procedures delineate how to proceed to integrate environmental/social issues in the project cycle, including the development of a resettlement plan when/if appropriate:

- *Environmental and Social Assessment Procedures for African Development Bank's Public Sector Operations* (June 2001)

The Bank's guidelines details requirements for any specific project, and when delineating potential beneficial/adverse impacts and corresponding enhancement/mitigation measures, outlines a component on migration and resettlement:

- *Integrated Environmental and Social Impact Assessment Guidelines* (October 2003)

The Bank's involuntary resettlement policy is set within the framework of the commitment '*to promote environmental and social mainstreaming as a means of fostering poverty reduction, economic development and social well-being*'. The policy covers involuntary displacement and resettlement of people '*when a project results in relocation or loss of shelter by the persons residing in the project area, assets being lost or livelihoods being affected*'.

The primary goal of the involuntary resettlement policy is "to ensure that when people must be displaced they are treated equitably, and that they share in the benefits of the project that involves their resettlement. The objectives of the policy are to ensure that the disruption of the livelihood of people in the project's area is minimised, ensure that the displaced persons receive resettlement assistance so as to improve their living standards … and set up a mechanism for monitoring the performance of the resettlement programs. Most importantly, the resettlement plan (RP) should be prepared and based on a development approach that addresses issues of the livelihood and living standards of the displaced person as well as compensation for loss of assets, using a participatory approach at all stages of project design and implementation"[12].

3.6.4. **The World Health Guidelines**

The World Health Organisation (WHO) is the directing and coordinating authority for health within the United Nations system. It is responsible for providing leadership on global health matters, shaping the health research agenda, setting norms and standards, articulating evidence-based policy options, providing technical support to countries and monitoring and assessing health trends.

WHO standards relevant to the Diamphwe Multipurpose Dam and Associated Structures include:

- Standards for drinking water;
- Standards for wastewater; and
- Standards for water quality parameters.

[12] African Development Bank. November 2003. *Involuntary Resettlement Policy*.

WHO also develops global guidelines such as the WHO Guideline on HIV/AIDS which are also relevant to the Project.

3.7. International Agreements

Malawi is party to a number of internationally acceptable policies, conventions, treaties and protocols in order to augment the national policies and laws. International laws and their institutions serve as the principal framework for international co-operation and collaboration between members of the international community in their efforts to protect the local, regional and global environment. Many environmental problems have a trans-boundary effect hence require a concerted effort to manage them. International environmental laws assist in capturing and building consensus between nations on goals for environmental protection, resource conservation and sustainable use. Malawi is bound to the provisions of an international agreement/law, only if it signs and submits instruments of ratification in respect of a particular agreement.

Malawi's environmental legislation, such as the *Environment Management Act* (1996), reflects its commitment under the *1992 Rio Declaration on Environment and Development*. Malawi is signatory a number of Agreements as summarised below:

- As noted in the Malawi National Forest Policy (1996): 'The Government of Malawi is also a signatory to numerous bilateral and international agreements and conventions linked to the environment and forestry; including the *Rio Declaration, the Convention on Climate Change, the Montreal Protocol, the Convention to Combat Desertification, the Convention on Biodiversity and the Convention on International Trade in Endangered Species of wild fauna and flora (CITES)*.'
- Malawi was an early signatory, in 1973, to the African Convention on the Conservation of Nature and Natural Resources. Malawi has additionally ratified, in 2001, the SADC revised Protocol on Shared Watercourses, in 2002, the SADC Protocol on Fisheries, and in 2003, the SADC Protocol on Forestry.
- As noted by the Malawi Sustainable Development Network Programme (SNDP), it is also a signatory to: The Convention on International Plant Protection, The Convention on Wetland of Significant Importance, The Convention concerning the Protection of World Cultural and Natural Heritage, The Convention on the Conservation of Migratory Species of Wild Animals, The Food and Agriculture Organization (FAO) of the United Nations International Undertaking on Plant and Genetic Resources, and The Convention on Biological Diversity.
- The Convention on Biological Diversity (1992) recognises that protecting biological diversity includes concerns relating to people, food security, medicine, fresh air, water, shelter and a clean and healthy environment.
- In addition, gender equality is a basic human right and development issue, as affirmed in a number of international and regional instruments to which Malawi is signatory, including the Millennium Development Goals (MDGs), and the Protocol on Gender and Development (2008). As noted in the Gender Policy (2008), instruments to which Malawi is committed include: 1987 UN *Convention on the Elimination of all Forms of Discrimination Against Women* (CEDAW); the 1993 Vienna Conference on Human Rights; the Southern African Development Cooperation (SADC) Declaration on Gender and Development, 1997, and the Protocol to the African Charter on Human and People's Rights on the Rights of Women in Africa. Malawi's commitment to gender equality has now been reflected in its *Gender Equality Act* (2013).
- In respect of social aspects of development, a commitment to labour rights and health is reflected in Malawi's signatory status on the *International Covenant on Economic, Social and Cultural Rights* (1993) and the Convention on the Rights of the Child (1989).

Details of Agreements with specific relevance to the Project are provided below:

Summary of Important International Agreement Provisions and Project Objectives	
African Convention on the Conservation of Nature and Natural Resources (Ratified in 1973)	▪ The Convention requires the contracting States to undertake and adopt measures necessary to ensure conservation, utilisation and development of soil, water, flora and fauna resources in accordance with scientific principles and with due regard to the best interests of the people. ▪ The Convention has implications to the Project due to the potential effects on soil, water, flora and fauna resources.
Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar) (Ratified in 1997)	▪ The Ramsar treaty provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. ▪ Malawi has only one wetland listed under Ramsar (Lake Chilwa) however this wetland is not affected by the Project.
Convention concerning the Protection of the World Cultural and Natural Heritage (Ratified in 1972)	▪ Acknowledge cultural identity related to the natural environment of each District.
Convention on Biological Diversity (Ratified in 1994)	▪ Mitigate impact on people, food security, medicine, fresh air, water, shelter and a clean and healthy environment.
SADC revised Protocol on Shared Watercourses (Ratified in 2001)	▪ The Protocol is aimed at fostering closer cooperation for judicious, sustainable and coordinated management, protection and utilisation of shared watercourses and advances the SADC agenda of regional integration and poverty alleviation. ▪ The Protocol is relevant to the Project as the Project is on a tributary that flows into Lake Malawi, a shared water body which forms a boundary between Malawi, Mozambique and Tanzania.
SADC Protocol on Forestry (Ratified in 2003)	▪ The Protocol applies to all activities relating to development, conservation, sustainable management and utilisation of all types of forests and trees, and trade in forest products throughout the SADC Region. ▪ The Project potentially impacts on riparian and remnant graveyard forests.
SADC Protocol on Fisheries (Ratified in 2002)	▪ The objective of this Protocol is to promote responsible and sustainable use of the living aquatic resources and aquatic ecosystems of interest to State Parties. ▪ The implication of the Protocol on the Project is that the activities of the Project have to ensure that they do not have significant adverse effect on the living aquatic

Summary of Important International Agreement Provisions and Project Objectives	
	resources and aquatic ecosystems of interest to Malawi.
Zambezi Watercourse Commission (ZAMCOM) (Ratified in 2005)	▪ The objective of the Commission "is to promote the equitable and reasonable utilization of the water resources of the Zambezi Watercourse as well as the efficient management and sustainable development thereof." ▪ The Protocol is relevant to the Project since the Diamphwe River flows into Lake Malawi and then the Zambezi River.

3.8. Compliance Status of Malawi Legislation and International Standards

The compliance status of the project with Malawi legislation and World Bank standards is summarised in Table 3.2.

Table 3.2 Compliance Status of the Project with Malawi Legislation and World Bank Standards

LEGISLATION & INTERNATIONAL STANDARDS	COMPLIANCE
MALAWI LEGISLATION AND REGULATIONS	
▪ ***The Constitution of the Republic of Malawi, 1995*** → Accountable and transparent decision making → Sustainable environmental management → Land and property entitlements and existing rights Other: - The Second Malawi Growth and Development Strategy (2012) and Millennium Development Goals (MDGs) - International treaties	▪ ***In 2014 - 2015 WAPCOS consultants undertook extensive consultations during initial environmental investigations. As part of this ESIA SMEC has undertaken additional and extensive public consultations with a wide range of stakeholders, including government agencies.*** ▪ ***This ESIA proposes a comprehensive suite of management measures to mitigate potential environmental impacts, as well as enhancing positive benefits.*** ▪ ***SMEC has comprehensively surveyed and assessed PAP, including completing more than 10,000 census, socio-economic and asset surveys.***
▪ ***Environment Management Act (1996);*** → Ministerial assessment of developments for environmental impact: → Manage adverse impacts on environment:	▪ ***Environmental Impact Assessment is mandatory for the construction and operation of the proposed Diamphwe Multipurpose Dam. A project brief, stating the matters provided for under section 24(2) of the Act, has been submitted to the Director of Environmental Affairs as required by the Act. The Director, satisfied that there is sufficient information in the project brief, has instructed the developer in writing to conduct an EIA in accordance with prescribed Terms of Reference (Attached as Appendix 2).***

LEGISLATION & INTERNATIONAL STANDARDS	COMPLIANCE
Other: - Guidelines for Environmental Impact Assessment (1997) - National Environmental Policy, 2004 - National Environmental Action Plan (NEAP), 2004 - National State of Environment Report (2010)	▪ ***SMEC has carried out an ESIA study to determine the potential positive and negative environmental and social impacts that could arise during project implementation, and to prepare an ESMP to enhance the positive impacts; and prevent, reduce and or mitigate the negative impacts. The ESIA for the Project is in compliance with the requirements of the Act and the Guidelines. The ESIA Report will be submitted to the Director with the particulars stipulated in Section 25(1).***
▪ ***Land Act (1965) & Lands Acquisition Act (1971)*** → ***Recognition of land rights and entitlements:*** → ***Power to acquire and dispose of land*** → ***Acquisition of customary land*** → ***Acquisition of land other than customary land*** Other: - National Land Policy (2002)	▪ ***SMEC has prepared a detailed database of PAP, which will be provided to the GOM.*** ▪ ***As part of consultations SMEC has communicated to PAP the GOM's role in acquiring public and customary land.*** ▪ ***The RAP includes an Entitlement Framework (Chapter 7) and Relocation Framework (Chapter 8) that sets out the compensation and resettlement implementation process, in line with World Bank standards and local legislation.***
▪ ***Local Government Act (1998)*** ▪ ***Town and Country Planning Act (1957*** → ***Ensure that various by-laws formulated by Lilongwe and Dedza District Council are followed*** → ***Planning Committee approval requirements***	▪ ***SMEC has consulted with Lilongwe and Dedza District Councils and the ESIA and ESMP addresses requirements of the Acts, including identifying potential impacts and assessing the contribution of the Project to the economy.*** ▪ ***With regard to the Town and Country Planning Act, The Minister has not declared any part of the Project area as a special area for the purpose of protecting the natural environment.***

LEGISLATION & INTERNATIONAL STANDARDS	COMPLIANCE
Other: - ***National Decentralization Policy (1998)***	
▪ ***Water Resources Act (2013)*** ▪ ***Waterworks Act (1996)*** → ***Approval required to dam river*** → ***Duties to safeguard safe water supply*** → ***Administration of water resources*** Other: - ***National Water Policy (2005)*** - ***National Sanitation Policy (2006)*** - ***Water Quality Standards –*** ○ ***MS733:2005: The Malawi Standard for borehole*** ○ ***MS214:2005: Malawi Standards for drinking water*** ○ ***MS 691:2005: Tolerance limits for domestic / sewage effluents***	▪ ***The ESIA provides full details of the proposed dam, including assessing alternatives and providing justification for its approval.*** ▪ ***The ESIA and ESMP have assessed water resources with regard to potential Project impacts and suitable mitigation measures. Important mitigation strategies include maintaining a 90 percentile environmental flow and instigating a range of catchment management initiatives.*** ▪ ***During preparation of the ESIA and ESMP, SMEC has maintained close communications with the Lilongwe Water Board.***
▪ ***Irrigation Act, 2001*** → Management of irrigation protection → Management of the environment Other: - ***National Irrigation Policy and Development Strategy (2011)***	▪ ***The ESIA provides information on the Project's multipurpose use as a water supply and irrigation dam.*** ▪ ***A proposed mitigation measure is to develop irrigation infrastructure for up to 1,000 ha of land downstream of the proposed dam.*** ▪ ***The ESIA and ESMP provide information about a range of catchment management initiatives, which will have substantial environmental benefits.***

LEGISLATION & INTERNATIONAL STANDARDS	COMPLIANCE
▪ ***National Parks and Wildlife Act (2004)*** → Protection of flora and fauna → Manage impact on fauna and flora → Promotion of local participation in protection objectives	▪ ***Biodiversity surveys have been undertaken as part of ESIA studies, which included both terrestrial and aquatic survey.*** ▪ ***Fifteen animal species of conservation significance have been identified in the Project area and approval from National Parks will be required prior to their disturbance. These species include four mammals (the larger common duiker, jackal, spotted hyena and the clawless otter), four birds (Little Sparrow Hawk, Peregrine Falcon, Broadbilled Roller, Red Winged Francolin, Guinea fowls and Owls), four reptiles (Nile Crocodile, Nile Monitor Lizard, Python and Mamba), and one macroinvertebrate (medical leach).*** ▪ ***No rare, endangered or endemic species of wild plants and animals have been identified.*** ▪ ***A range of catchment management initiatives and local participation have been proposed. This includes establishing nurseries for native trees and assisting with establishment of forest woodland habitat in the Dam buffer zone.***
▪ ***Fisheries Conservation & Management Act (1997)*** → Monitoring of pollution → Monitoring of fish species	▪ ***SMEC has undertaken an aquatic survey, which identified a number of fish species including some that support an important fishery. None of these fish has conservation significance and all are well represented throughout the wider Linthipe River system.*** ▪ ***The ESIA and ESMP provide a basis for monitoring, protecting and enhancing fisheries resources, which includes maintaining water quality and environmental flows, and establishing riparian habitat around the Dam foreshore.***
▪ ***Forestry Act (1997)*** → Manage and protect natural forest resources → Forestry Programme of Action Other: - ***Malawi National Forest Policy (1996)***	▪ ***The Forestry Department has been consulted during preparation of the ESIA.*** ▪ ***Biodiversity of the Project area has been documented and potential Project impacts addressed.*** ▪ ***Only about 2 % of the affected Project area has high habitat value, which includes forest woodland and riparian vegetation.*** ▪ ***Permits will be required prior to cutting down any trees. Specific approval will be required to cut down four species that have conservation significance, which include Bleedwood teak, African mahogany, Coast Gold leaf and Yellow Wood.*** ▪ ***Mitigation includes a range of catchment management initiatives, including establishing compensatory forest woodland and riparian vegetation around the Dam perimeter. This will result in a***

LEGISLATION & INTERNATIONAL STANDARDS	COMPLIANCE
	threefold increase in natural vegetation. Other initiatives include providing additional resources for protecting the Diamphwe river headwaters in the Dzalanyama Forest Reserve.
▪ ***Public Health Act (1948)*** → Safeguard water supply → Enhance adequate sanitation → Minimise breeding of animal or vegetable parasites Other: - ***National HIV AIDS Policy (2003)***	▪ ***A Health study has been undertaken as part of ESIA studies.*** ▪ ***The Project will deliver clean water to Lilongwe, as well as providing potable water to communities around the WTP and water delivery pipeline.*** ▪ ***Potable water for construction workers will be sourced from local groundwater or trucked in from Lilongwe. Appropriate sanitation and waste disposal facilities will be provided at the work camp.*** ▪ ***OH&S procedures will include appropriate training and requirements for protection against mosquitos and other parasites.***
▪ ***Gender Equality Act (2003)*** → Monitor and manage of gender equality issues → Guidelines and strategies to address gender disparities and inequalities that are 'barriers' to development. Other: - ***Gender Policy (2008)***	▪ ***Gender issues are appropriately addressed in the ESIA, ESMP and RAP.*** ▪ ***The RAP (Chapter 12) outlines Gender mainstreaming and makes recommendations for implementation.***
▪ ***Monuments and Relics Act (1990)*** → Preparation of Cultural Heritage Impact Assessment → Management of important cultural sites Other: - ***Signatory to the Convention Concerning the Protection of the***	▪ ***As part of ESIA studies the Department of Antiquities has undertaken a Cultural Herniate survey and has identified sites that require documentation and / or relocation.*** ▪ ***The Department of Antiquities was subsequently commissioned by the MoAIWD to undertake further site studies and investigations, including documenting affected graveyard sites and consulting with DCs, TAs and other stakeholders about managing these sites.*** ▪ ***The ESMP includes Cultural Heritage management measures.***

LEGISLATION & INTERNATIONAL STANDARDS	COMPLIANCE
World Cultural and Natural Heritage (1972) - ***Malawi Cultural Policy (2014)*** - ***Antiquities Policy (2012)***	
▪ ***Public Roads Act (1962)*** → Acquisition of land for a public road → Assessment of damage or destruction in interests in land or surface use rights → Compensation provisions	▪ ***Consultation has included communicating the planned acquisition of land to stakeholders including PAP, DC and TA.*** ▪ ***Surveys have included identifying local access roads and requirements for compensation. This has been included in the RAP.***
▪ ***Occupational Safety, Health and Welfare Act (1997)*** → Safe work place → Employer duty of care	▪ ***The ESMP recommends that an Occupational Health and Plan be put in place during both construction and operational phases. The Plan will address workplace safety and provide specialist instructions for hazardous activities such as handling hazardous materials, or working at heights or in deep trenches.***
▪ ***The Employment Act (2000)*** ▪ ***Labour Relations Act (1997)*** → Minimum standards of employment → ***Mange labour relations***	▪ ***The RAP (S7.2.11) has addressed compliance with fundamental principles including anti-discrimination, equal remuneration and protection of children.*** ▪ ***The construction contractor and Dam operator will be obliged to allow for collective agreement negotiations and respectful dispute settlement.***
WORLD BANK	
Early screening and Scoping	Early screening and scoping was conducted during mid-2014 to early 2015 by WAPCOS consultants, under the supervision of the Lilongwe Water Board. Activities included site visits, document review, meetings with the client and design teams, and consultative workshops / meetings in project affected communities (WAPCOS; Draft ESIA Report, 2014).
Participatory approach	Participatory activities have included workshops, consultation meetings and focus group discussions with affected communities in both Dedza and Lilongwe Districts. In addition over 10,000 census, socio-economic and

LEGISLATION & INTERNATIONAL STANDARDS	COMPLIANCE
	asset surveys have been undertaken of PAP. Survey organization included numerous meetings with Village Chiefs and other community leaders over a five month period.
Integrate Environmental assessment (EA) and social assessment (SA)	The ESIA study team has worked closely with affected communities in an integrated and consultative manner. Local villages have accompanied bio-physical and socio-economic field survey teams, and this has provided the ESIA with a wealth of information about a range of issues such as crop management, health, the presence of wildlife and use of ecosystem resources. The ESIA found that ecosystem resources play a pivotal role in people's livelihoods and this is reflected throughout the ESIA, ESMP and RAP reports.
Risk assessment	The ESIA includes a risk assessment of environmental and social issues (Chapter10). The risk methodology is based on the international standard AS/NZS ISO 31000:2009 – Risk Management – Principles and Guidelines, and uses a Likelihood and Consequence assessment matrix. Risk assessment for potential impacts was assessed before and after mitigation (residual risk). Where Residual Risks remained unacceptably high, then further mitigation was assessed and the Risk process re-run. The Risk assessment found 3 High residual risks that will require significant resources and due diligence to manage. These include impacts associated with Landuse, Air Quality and Dam failure. These three risks directly relate to livelihoods or health.
Climate Change	Climate change assessment was undertaken by the Project designers (Studio Pietrangeli, 2014) and included in the ESIA (Chapter 8.3) and findings integrated with the various studies. It was generally concluded that due to the current status of water shortages and threat to food security the proposed Dam will provide significant security of water supply, which would otherwise become more critical if the Project did not proceed. Further, the proposed Dam will better regulate downstream flows during below average flows, which will become more important as average flows decline due to Climate Change. The Project will therefore have an overall positive impact by providing an adaptive mechanism to protect against reduced rainfall and river flow.
Alternatives	Significant work has been undertaken in assessing a suitable future water supply for Lilongwe. These include detailed financial, technical, environmental and social comparisons of a range of alternatives (Sogreah, 2010 and Studio Pietrangeli, 2014). These studies have been summarised in the ESIA.
Pollution	ESIA studies have included aquatic survey and water monitoring, which added to previous work undertaken by the Dam designers and WAPCOS consultants. Pollution of waters and the general environment has been addressed in the ESIA and appropriate management measures recommended in the ESMP. It is concluded that with the appropriate resources all residual risks can be effectively managed.

LEGISLATION & INTERNATIONAL STANDARDS	COMPLIANCE	
LAND ACQUISITION AND INVOLUNTARY RESETTLEMENT		LAND ACQUISITION AND INVOLUNTARY RESETTLEMENT
Physical and economic displacement	▪ ***Involuntary resettlement refers to both physical displacement (relocation or loss of shelter) and economic displacement (loss of assets or access to assets that leads to loss of income sources/other means of livelihood).***	Physical and economic displacement Resettlement Action Plan (RAP)
Resettlement Action Plan (RAP)	▪ ***Implementation of actions is to be managed through the RAP. A RAP will be developed: designed to mitigate negative impacts of displacement; identify development opportunities; include a resettlement budget and schedule; establish entitlements of all categories of affected people (including host communities).***	
Minimising adverse effects	Where involuntary resettlement is unavoidable then adverse effects will be minimised, with appropriate measures taken to mitigate impacts planned/implemented: ▪ ***Alternative project designs will be explored.*** ▪ ***Forced eviction will be avoided.*** ▪ ***Compensation will be provided for loss of assets.*** ▪ ***Disclosure of information, consultation and informed participation of those affected will take place.*** ▪ ***Livelihoods/standards of living of displaced people will be ensured / improved.***	Minimising adverse effects
The poor and vulnerable	Particular attention will be paid to the needs of the poor and vulnerable.	The poor and vulnerable
Census	A full census will be conducted, including appropriate baseline data, of affected people to determine eligibility and discourage inflow of ineligible persons.	Census

LEGISLATION & INTERNATIONAL STANDARDS	COMPLIANCE	
Cut-off date	A cut-off date for eligibility will be established, and well documented and disseminated throughout the Project area.	Cut-off date
Compensation	▪ ***Compensation and benefits to cover the following:*** ▪ ***Compensation for asset loss at full replacement cost and other assistance to help improve/restore livelihood/standards of living.*** ▪ ***Community engagement and consultation and informed participation of PAP in planning, implementation, and monitoring and evaluation of compensation.*** ▪ ***Compensation standards transparent and applied consistently.*** ▪ ***Land based compensation offered where feasible.*** ▪ ***If people are required to move: (i) offered choices in resettlement options, including adequate replacement housing with security of tenure, or (ii) cash compensation where appropriate; and (ii) provided with relocation assistance.*** ▪ ***Take possession of acquired land/related assets only after compensation has been made available and, where applicable, resettlement sites and moving allowances have been provided.*** ▪ ***All transactions, compensation, relocation activities documented.*** ▪ ***Displaced people provided with opportunities to derive appropriate development benefits from the Project.***	Compensation
Economic displacement	Those affected by economic displacement, regardless of physical displacement:	Economic displacement

LEGISLATION & INTERNATIONAL STANDARDS	COMPLIANCE	
	▪ ***Provided with adequate opportunity to re-establish their livelihoods.*** ▪ ***Compensated at full replacement cost for loss of assets/access to assets.*** ▪ ***Given opportunities to improve or at least restore means of income-earning capacity, production levels and standards of living in addition to compensation.*** ▪ ***Provided with transitional support will based on a reasonable estimate of time needed to restore livelihoods.***	
PUBLIC CONSULTATION		PUBLIC CONSULTATION
Stakeholder engagement	▪ ***Stakeholder engagement is an ongoing process that involves: stakeholder analysis, disclosure and dissemination of information, consultation and participation.*** ▪ ***It will take place with PAP and PAC, including host communities.*** ▪ ***To continue during planning, implementation and monitoring/evaluation of compensation payments, livelihood restoration activities, resettlement.***	Stakeholder engagement
Process of consultation	In depth informed process of consultation with PAP and Affected Communities: ▪ ***Begin early in the process of identification of risks/impacts, and continue on an ongoing basis.*** ▪ ***Based on disclosure/dissemination of relevant, transparent, objective, meaningful, easily accessible/ understandable information, culturally appropriate and in a local language/s.*** ▪ ***Tailored to needs of disadvantaged/vulnerable groups***	Process of consultation

LEGISLATION & INTERNATIONAL STANDARDS	COMPLIANCE	
	▪ ***Free of external manipulation, interference, intimidation.*** ▪ ***Enabling meaningful participation.*** ▪ ***Captures both men's/women's views, if necessary through separate engagements, but reflects their different responses.*** To lead to the views of PAP being incorporated into decision-making e.g. on proposed mitigation, development benefits/opportunities, implementation issues.	
Disclosure of information, reporting	▪ ***Implement/maintain procedure for external communication.*** ▪ ***Disclosure of information to stakeholders, in particular to PAP and PAC, on: purpose, nature, and scale of Project, duration of activities; risks, impacts and mitigation measures and plans – such as the RAP, including the grievance mechanism – with summaries of key issues/ commitments.*** ▪ ***Ongoing reporting to PAP and PAC on the progress of implementation of the RAP, and on any updates and changes.***	Disclosure of information, reporting
Documentation of process	Document process; in particular, measures taken to avoid/minimise risks/impacts on PAP and PAC, and they will be informed about how their concerns have been considered.	Documentation of process
COMMUNITY HEALTH, SAFETY AND SECURITY		COMMUNITY HEALTH, SAFETY AND SECURITY
Risks on health and safety	Conduct an assessment of potential risks/impacts on health/safety of PAC during the Project life-cycle, and establish preventative/control measures to avoid/minimise risk, consistent with human rights principles and good international industry practice.	Risks on health and safety

LEGISLATION & INTERNATIONAL STANDARDS	COMPLIANCE	
Communicable diseases	Avoid/minimise potential community exposure to diseases resulting from Project activities, including communicable diseases associated with Project labour.	Communicable diseases
Emergency preparedness	Regarding emergency requirements: ▪ ***Assist/collaborate with relevant parties (PAC, local government) in preparing to respond to emergency situations.*** ▪ ***Document and disclose emergency preparedness/response activities, resources and responsibilities to relevant parties.***	Emergency preparedness
CULTURAL HERITAGE		CULTURAL HERITAGE
	In addition to complying with applicable laws, to identify/ protect cultural heritage by ensuring that internationally recognised practices for protection, field-based study and documentation of cultural heritage are implemented. Where there is a chance of impacts to cultural heritage, competent professionals to assist in identification/ protection of cultural heritage.	
	Where cultural heritage may be affected, consultation to take place with: ▪ ***PAC who use/have used the cultural heritage for long-standing cultural purposes, to identify cultural heritage and incorporate their views into the decision-making process.*** ▪ ***Relevant national/local regulatory agencies that are entrusted with the protection of cultural heritage.***	
	Where the site contains cultural heritage or prevents access to previously accessible cultural heritage sites used by PAC, to allow continued access to the cultural site, or provide an alternative access route, subject to overriding health, safety, and security considerations.	

LEGISLATION & INTERNATIONAL STANDARDS	COMPLIANCE	
	Develop provisions for managing chance finds (i.e. tangible cultural heritage encountered unexpectedly during project construction/operation) through a Chance Find Procedure, to be applied in the event that cultural heritage is subsequently discovered. No chance find to be disturbed further until an assessment by competent professionals is made and actions consistent with the requirements of OP are identified.	
LABOUR AND WORKING CONDITIONS		LABOUR AND WORKING CONDITIONS
Equal opportunities	Employment relationships to be based on the principle of equal opportunity and fair treatment, and will not discriminate with respect to any aspects of the employment relationship; in particular, measures will be taken to prevent/address discrimination in regard to women.	Equal opportunities
Child labour	No employment of children, including in supply chain, in a manner which is exploitative, or likely to be hazardous, interfere with education, or harmful to health or physical, mental, spiritual, moral or social development.	Child labour
Contracted workers	With respect to contracted workers, ensure that third parties who engage them operate in a manner consistent with legal requirements, and establish policies/procedures for managing/monitoring the performance of third party employers in relation to these requirements; and ensure the workers have access to a grievance mechanism.	Contracted workers
GRIEVANCE MECHANISM		GRIEVANCE MECHANISM
	▪ ***A grievance mechanism to be established as early as possible to receive/facilitate resolution of PAP and PAC concerns/grievances about compensation/relocation, seeking to resolve concerns promptly, impartially, using an***	

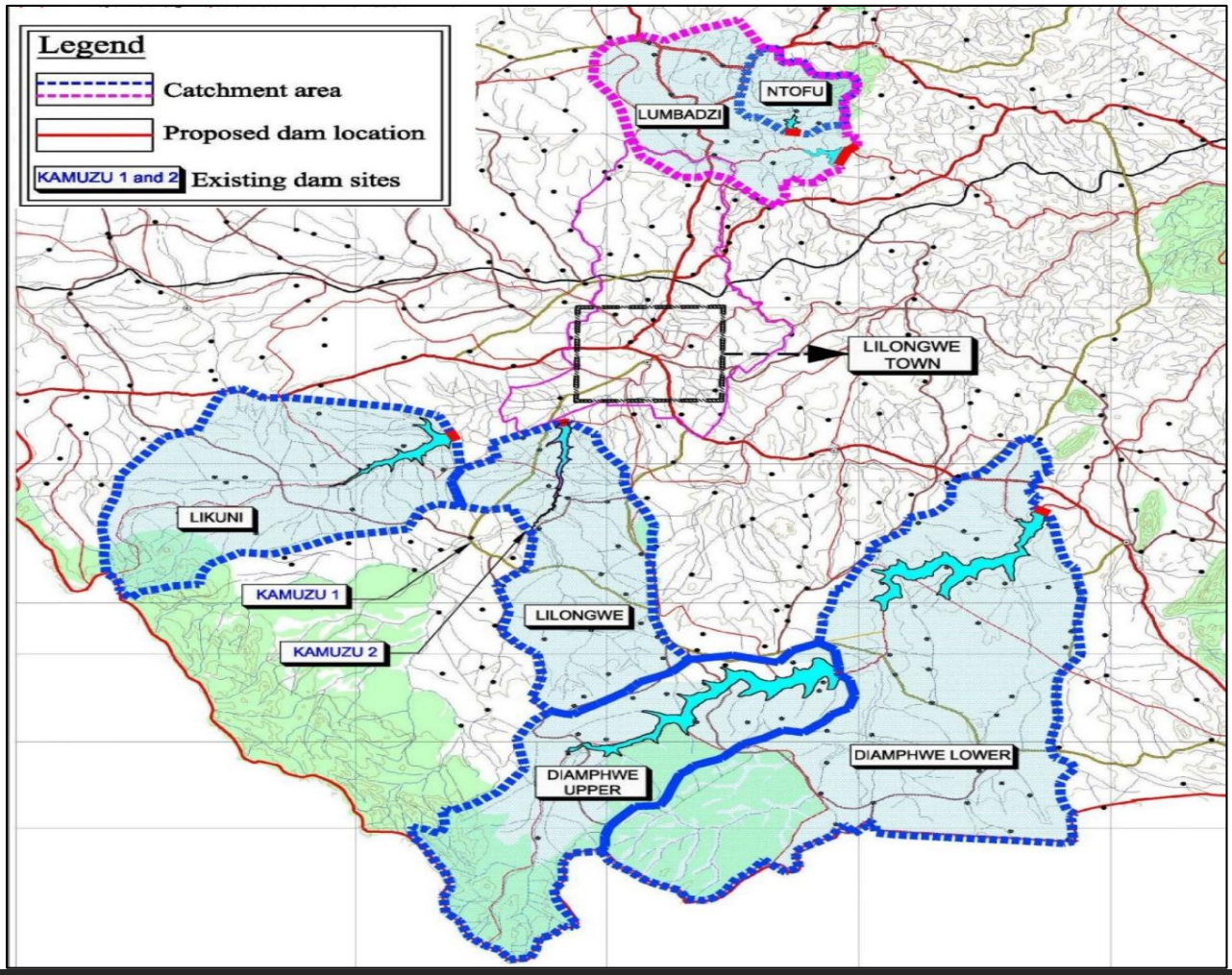
LEGISLATION & INTERNATIONAL STANDARDS	COMPLIANCE	
	understandable/transparent consultative process that is 'culturally appropriate', readily accessible, at no cost, without retribution to the party that originated the issue/concern, and which should not impede access to judicial/ administrative remedies. ▪ ***Affected Communities to be informed of the mechanism during stakeholder engagement.*** ▪ ***Grievances Mechanism to uphold and promote fundamental human rights.***	
	Project workers to have access to a grievance mechanism to raise workplace concerns.	
MONITORING AND EVALUATION		MONITORING AND EVALUATION
M+E process	▪ ***Establish procedures to monitor/measure the effectiveness of the RAP, and compliance with related legal/contractual obligations and regulatory requirements.*** ▪ ***Periodic review of performance to be based on systematic data collection/analysis.*** ▪ ***Document monitoring results and identify necessary corrective/preventive actions to ensure the RAP is being implemented.*** ▪ ***Collaborate with government/third party who is responsible for managing risks/impacts and mitigation measures to implement the actions.*** ▪ ***Follow up on the actions in upcoming monitoring cycles to ensure their effectiveness.*** ▪ ***Implementation of the RAP will require an external completion audit to assess performance of process.***	M+E process

LEGISLATION & INTERNATIONAL STANDARDS	COMPLIANCE	
	▪ ***PAP will be consulted during the monitoring process.*** ▪ ***Given that the Project has significant involuntary resettlement risks, resettlement professionals will provide advice on compliance and verify the monitoring information.*** ▪ ***Affected PAC, external experts to be considered for participation in monitoring activities.***	
GENDER		GENDER

Chapter 4
Project Alternatives

Environmental and Social Impact Assessment

February 2016



4. PROJECT JUSTIFICATION AND ALTERNATIVES

4.1. Information Sources

Assessment of Project alternatives are addressed in the following studies:

i. ***SOGREAH, 2009 - 2010: Feasibility Studies and Preliminary Design for Lilongwe's New Water Source. Relevant addendum reports include:***

- Inception Report – November 2009
  - Methodology for Site Selection – January 2010
  - Socio Economic Study – March 2010
  - Water Demand Assessment Report – March 2010
  - Water Resources Assessment Report – April 2010

Sogreah undertook feasibility studies of alternative water sources to supply water to Lilongwe until 2035. Studies included identifying alternative dam sites, assessing water demands and undertaking engineering, environmental and financial options analysis. A preferred water source option was then proposed.

ii. ***Studio Pietrangeli, 2014: Optimized Design of the Dam. Relevant reports include:***

- Topographical Report - 2014
- Hydrological Report - 2014
- Geological Report – 2014
- Water Supply Technical report - 2014

Studio Pietrangeli undertook studies to optimise the dam design with regard to engineering, environmental and cost parameters. Investigations considered topography, geology and hydrology aspects. In addition the design of the water transmission system was updated to reflect a longer planning horizon from year 2035 to 2045.

4.2. Project Justification

Lilongwe's water supply is currently sourced from two dams on the Lilongwe River, Kamuzi Dam -1 and Kamuzi dam -2, with a combined storage capacity of 24.3 Million cubic metres (Mm^3). Water delivery infrastructure comprises of two Water Treatment Plants (WTPs) and a pipe network of approximately 1,800 kilometres (km).

The current water demand is 109 ML/d, however water production is only 95 ML/d with Non-Revenue Water (NRW) amounting to an additional 35%. This gives a current water supply shortfall of approximately 47 ML/d. The planned upgrade works will increase production by an additional 60 ML/d and consist of:

Commissioning WTP II extension works in 2015 (30 ML/d); and

Raising Kamuzu dam I to provide an additional storage of 22.4 Mm^3 and commissioning of WTP III in 2017 (30 ML/d).

Despite these initiatives a new bulk water source will be needed by 2020, after which severe water shortfalls are predicted. This shortfall is expected to increase to 103 ML/d by year 2036 and 210 ML/d by year 2045.

Development of a new bulk water source will secure Lilongwe's water supply to year 2045. Further, the development would potentially provide significant opportunities to supply water to rural villages and for irrigation and fish farming, thereby substantially improving food security and livelihoods.

Not proceeding with the Project would therefore:

Significantly impair the sustainability of Lilongwe's water supply after year 2020.

- Reduce the likelihood that rural communities surrounding the development could benefit from a sustainable water source and minimise dependency on groundwater wells.
- Eliminate the opportunity to improve or, with the threat of climate change, to sustain food security and economic benefits by not developing irrigated farmland and fish farms.

4.3. Alternative Project Options

4.3.1. **Alternative Assessment Methodology**

The scope for selecting a suitable drinking water source for Lilongwe included consideration of a dam structure and water treatment and transmission facilities. The methodology included:

- Assessment of the existing situation;
- Water demand analysis to year 2035;
- Water resource study to review and validate the identified water sources;
- Definition of alternatives for water resource development;
- Environmental and social impact screening of alternatives;
- Economic and financial analysis of alternatives; and
- Ranking and selection of alternatives using multi-criteria analysis.

4.3.2. **Identification of Alternative Dam Sites**

With reference to an earlier study undertaken in 2002 (Safege) and review of suitable river catchments around Lilongwe, six alternative dam sites were identified. Alternative dam sites are listed below and shown on Figure 4.1.

- Likuni;
- Lilongwe 3;
- Diamphwe Upper;
- Diamphwe Lower;
- Ntofu ;and
- Lumbadzi.

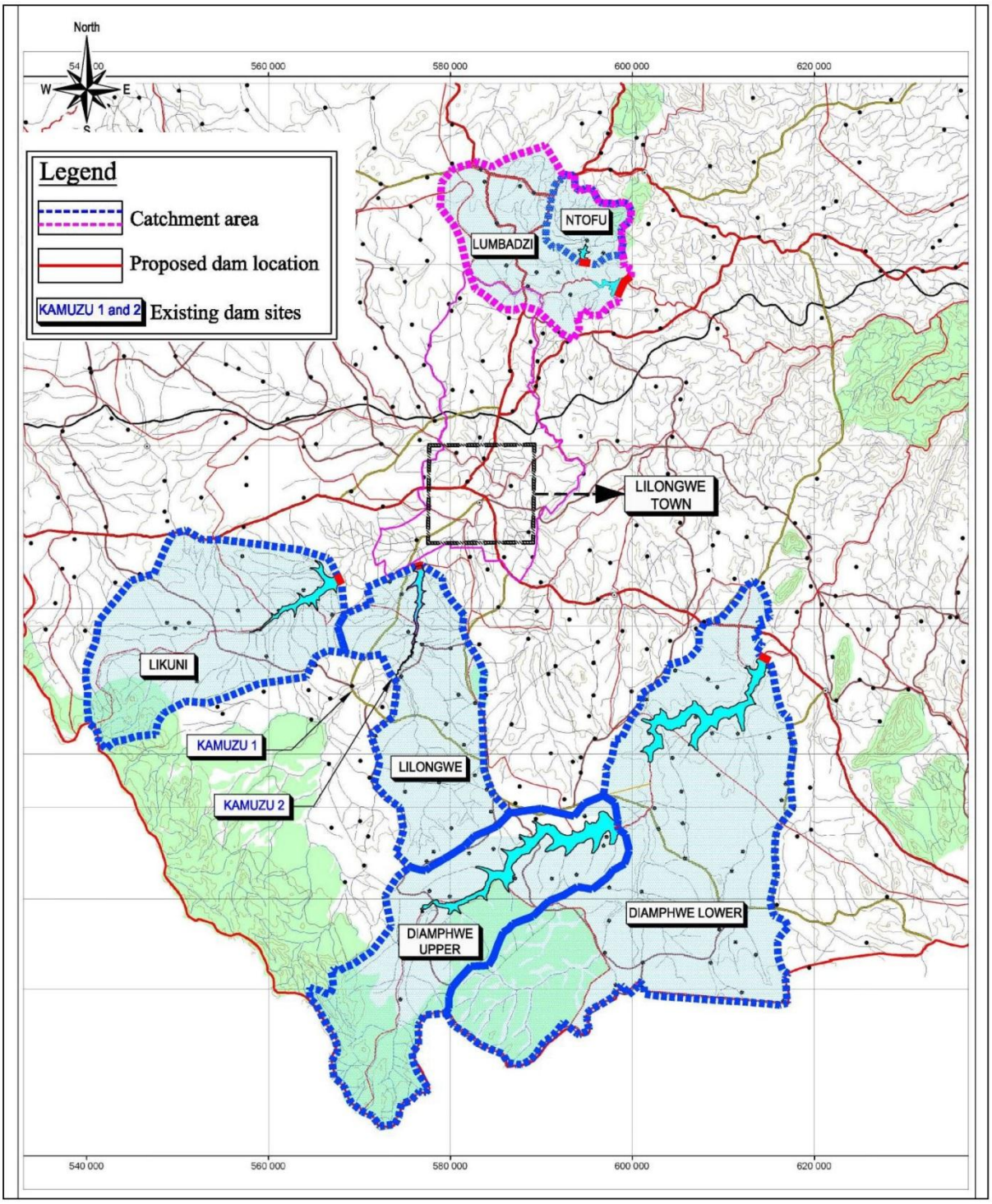


Figure 4.1: Alternative Dam Sites (Sogreah, 2010)

4.3.3. **Assessment of Alternative Dam Sites**

i. **Design Assessment**

Alternative analysis of dam design considered the following parameters:

- Water Demand Assessment, including:
  - Potable: Domestic, commercial, Industrial and Institutional;
  - Irrigation: Compensation and development irrigation;

- Fisheries: Pilot and traditional farms;
- Hydropower

- Hydrological Study, including:
  - Rainfall and runoff analysis
  - Flood characteristics
  - Sediment loads
- Dam site conditions including:
  - Geology and faults
  - Tectonic and seismic hazard
  - Lithology: bedrock, weathering and Alluvium
  - Hydrogeology
  - Construction materials

A summary of the design assessment is shown on Figure 4.2.

Dam site	Shape of valley Ratio Reservoir volume / Dam volume (*)	Geological conditions	Materials (for dam construction)	Storage capacity possible on site in hm^3 (Mcm)	Av. annual runoff at dam site in hm^3 (Mcm)
LILONGWE 3	40 at 22m water depth **Moderately favourable**	**Moderately favourable to uncertain** (no rock outcrops on banks)	No rock quarry close to site	up to 30 at 22m water depth	67
LIKUNI	57 at 26m water depth **Moderately favourable**	**Uncertain** (no rock outcrops on banks neither on the river bed)	No rock quarry close to site	up to 89 at 26m water depth	85
DIAMPHWE UPPER	251 at 22m water depth **Very favourable**	**Very favourable**	Available	up to 510 at 37m water depth	102
DIAMPHWE LOWER / LINTHIPE	340 at 26m water depth **Very favourable**	**Favourable**	Available	up to 300 at 26m water depth	306
NTOFU	10 at 26m water depth **Unfavourable**	**Very favourable**	Available	up to 48 at 42m water depth	9
LUMBADZI	19 at 29m water depth **Moderately unfavourable**	**Moderately favpurable**	Available	up to 58 at 35m water depth	34

Figure 4.2: Design Alternative Analysis (Sogreah, 2010)

ii. Preliminary Environmental and Social Evaluation

Preliminary environmental and social evaluation of the alternative dam sites considered:

- Physical / Chemical;
- Biological / Ecological;
- Social / Cultural; and
- Economic / Operational.

Preliminary evaluations were done in accordance with government NWDP requirements, as well as World Bank Operational Policies. A Rapid Impact Assessment Matrix evaluation methodology was used to rate alternative sites in order of acceptability. Results are summarised on *Figure 4.3*.

Priority ranking	Dam Site
1	Diamphwe Lower / Linthipe River;
2	Diamphwe Upper River;
3	Lilongwe 3 River;
4	Lumbadzi River;
5	Likuni River;
6	Ntofu River

Figure 4.3: Environmental and Social Alternative Analysis (Sogreah, 2010)

iii. River Water quality

Water quality assessment for each alternative considered the following parameters:

- Suspended solids
- Colloids and organic matter
- Iron
- Fluoride
- Bacteria and viruses

Assessment of alternative sites with regard to water quality is shown on Figure 4.4.

Proposed dam sites	Water quality
Diamphwe Upper	Favourable
Diamphwe Lower	Favourable
Lilongwe3	Less favourable
Likuni	Less favourable
Ntofu	Less favourable
Lumbadzi	Unfavourable - Due to high domestic pollution 15km upstream the possible dam site

Figure 4.4: Water Quality Alternative Analysis (Sogreah, 2010)

iv. Capacity and Production Yield

Model simulations were undertaken to assess reservoir fluctuations over several years to determine annual volume of water that can be abstracted and the storage volume required. Results for alternative dam sites are shown on Figure 4.5.

Dam characteristics					Abstraction volume		Population demand satisfied - if no priority is given to water supply (5% risk of stortfall for both water supply and irigation)		
FSL	Water depth	Reservoir volume	Reservoir surface area	TOTAL Irrigation needs (Comp + Dvlpt)	Constant during the year	Fluctuations according to irrigation needs	Abstraction volume Constant during the year	Abstraction volume : Fluctuations according to irrigation needs	
					Yield	Max Yield during dry season	Yield available for water supply	Yield available for water supply	Percentage of 2035 demand satisfied
m	m	Millions m3	km2	m3/day	m3/day	m3/day	m3/day	m3/day	%
Diamphwe upper									
1200	22	99	17	11 000	167 000	171 000	155 700	159 700	90%
1202	24	138	21	13 900	180 000	190 000	165 800	175 800	95%
1204	26	186	27	17 400	193 000	200 000	175 300	182 300	98%
1206	28	245	33	21 400	207 000	215 000	185 300	193 300	101%
Diamphwe lower (*)									
1174	16	45	10	8 600	154 000	156 000	145 100	147 100	85%
1175	17	60	13	10 800	210 000	213 000	198 900	201 900	104%
1176	18	75	15	68 800	245 000	263 000	175 900	193 900	102%
1177	19	90	18	69 100	267 000	285 000	197 600	215 600	109%
1178	20	109	20	69 100	290 000	310 000	220 600	240 600	118%
1184	26	300	39	68 800	510 000	525 000	440 900	455 900	193%
Lilongwe 3 (**)									
1072	22	30	5	3 600	81 000	84 000	77 100	80 100	62%
Likuni									
1102	26	89	10	10 600	127 000	137 000	116 100	126 100	78%
Lumbadzi									
1122	29	32	4	7 600	53 000	56 000	45 100	48 100	51%
1128	35	58	6	12 400	62 000	65 000	49 300	52 300	52%
Ntofu									
1184	26	9	1	1 900	13 000	14 000	10 800	11 800	38%
1194	36	26	2	4 100	17 000	18 000	12 600	13 600	39%

(*) Diamphwe Lower : calculations taking into account development irrigation from 1176m to 1184m FSL

(**) Lilongwe 3 : calculations taking into account the spilled volumes from Kamuzu I and II

Figure 4.5: Dam Yield Alternative Analysis (Sogreah, 2010)

Based on dam yield simulations it was determined that only Diamphwe Upper and Diamphwe Lower alternatives could satisfactory meet long term water demand forecasts. Diamphwe Lower was the only feasible alternative with sufficient land (up to 1,000 ha) for irrigation and potential for hydropower.

In summary, there were three dam alternatives that best met water demand requirements for Lilongwe. These are:

- Likuni plus Lilongwe3 sites;
- DiamphweLower / Linthipe site; and
- Diamphwe Upper site.

Each of the Diamphwe sites was found to be favourable based on technical, environmental and capacity parameters. The Likuni / Lilongwe 3 option is less favourable, however because this site was closest to Lilongwe it was studied to evaluate the opportunities of costs savings.

4.3.4. **Development of Project Options**

Further assessment of the selected options included assessing opportunities for multipurpose use, including providing water for compensation irrigation, fisheries and hydropower. A total of six Project Options were defined, which are summarised in Figure 4.6.

A detailed Multi-criteria analysis was then undertaken and results are summarised in *Figure 4.7*.

DEDICATED VOLUMES OF WATER in 2035 (m3/d) for each purpose and option	Dam water depth	Water Supply	Fisheries	Irrigation compensation + development	Hydropower	TOTAL
		WS	F	I	H	
Option 1 Diamphwe Upper WS+F	24m	180,000	300	13,900 + 0 *(203ha + 0ha)*	0	196,000
Option 2 Diamphwe Lower WS+F	17m	189,300	300	10,800 + 0 *(156ha + 0ha)*	0	200,400
Option 3 Diamphwe Lower WS+F+I	18m	189,300	300	12,200 + 56,600 *(177ha + 823ha)*	0	258,400
Option 4 Diamphwe Lower WS+F+H	26m	189,300	300	29,800 + 0 *(433ha + 567ha)*	305,670 *(910 kW)*	525,000
Option 5 Diamphwe Lower WS+F+I+H	26m	189,300	300	29,800 + 39,000 *(433ha + 567ha)*	266,670 *(830 kW)*	525,000
Option 6 Likuni / Lilongwe 3 WS+F	16m / 22m	189,300	300	14,200 + 0 *(200ha + 0ha)*	0	203,800

Figure 4.6: Project Options (Sogreah, 2010)

Criteria	Weighting	1	2	3	4	5
Environment						
Environmental and social impact	1.0	6.9	10.0	9.2	0.0	0.0
Finance						
Initial Capital Costs	1.0	10.0	7.6	6.0	0.8	0.0
LWB financial performance	1.0	10.0	0.0	3.9	9.5	9.5
GoM cash flows	1.0	0.8	0.0	2.7	9.7	10.0
Economy						
Cost Benefit Analysis	1.0	0.7	0.0	10.0	0.3	6.4
Security						
Power source	0.5	5.0	2.5	2.5	2.5	2.5
Water supply services						
Supply along pipeline route	0.5	4.3	5.0	5.0	5.0	5.0
Total		**37.7**	**25.1**	**39.3**	**27.8**	**33.4**
Total (rounded)		**38**	**25**	**39**	**28**	**33**

Figure 4.7: Project Options Assessment Using Multi-Criteria Analysis (Sogreah, 2010)

The analysis showed found that Hydropower was not viable and Option 1 (without irrigation) and Option 3 (with irrigation) were the favoured options. However Option 3 was determined to be more attractive due its multipurpose irrigation nature and accrued benefits related to agricultural opportunities and improving food security.

4.3.5. **Preferred Option**

The preferred Project is Option 3 (**Diamphwe Lower Dam, WS+F+I).** Sogreah subsequently prepared a preliminary design of the dam and associated structures with the following parameters:

DIAMPHWE LOWER DAM - MULTIPURPOSE:

- **Water supply;**
- **Fisheries; and**
- **Irrigation**

Design parameters:

- Full Supply Level: 1184 m
- Water depth: 18 m
- Abstraction volume for water supply: 189.3 ML/d
- Satisfaction of the population demand until 2035

4.4. Dam Design Optimisation

Studio Pietrangeli undertook an optimisation study of the dam and pipeline transmission system to better reflect site conditions and to meet forecast water demands in 2036 (Phase 1) and 2045 (Phase 2). The study considered environmental, topography, geology and hydrology aspects.

Key outcomes of the updated dam design are:

- Increase live storage of the reservoir from approximately 87 Mm^3 to 134 Mm^3. This modification is necessary to guarantee the water resources in a period of shortage (with a return period of 20 years).
- Increase spillway crest elevation from 1173 to 1175.7 masl. This was necessary to have a live storage of 134 Mm^3.
- Increase dam crest elevation from 1178.2/1179.2 to 1180.3 masl. This modification is necessary to contain the PMF (Probable Maximum Flow).
- Changing of the spillway and stilling basin dimensions. These modifications are necessary with regard to the updated Hydrological Study.
- Shifting of the dam axis by approximately 50 m upstream, in order to:
    - avoid re-locating the graveyard situated on the right bank of the dam; and
    - ensure a more suitable geological dam foundation.

The water transmission system design was updated to reflect the new planning horizon to 2045.

4.5. Future Detailed design

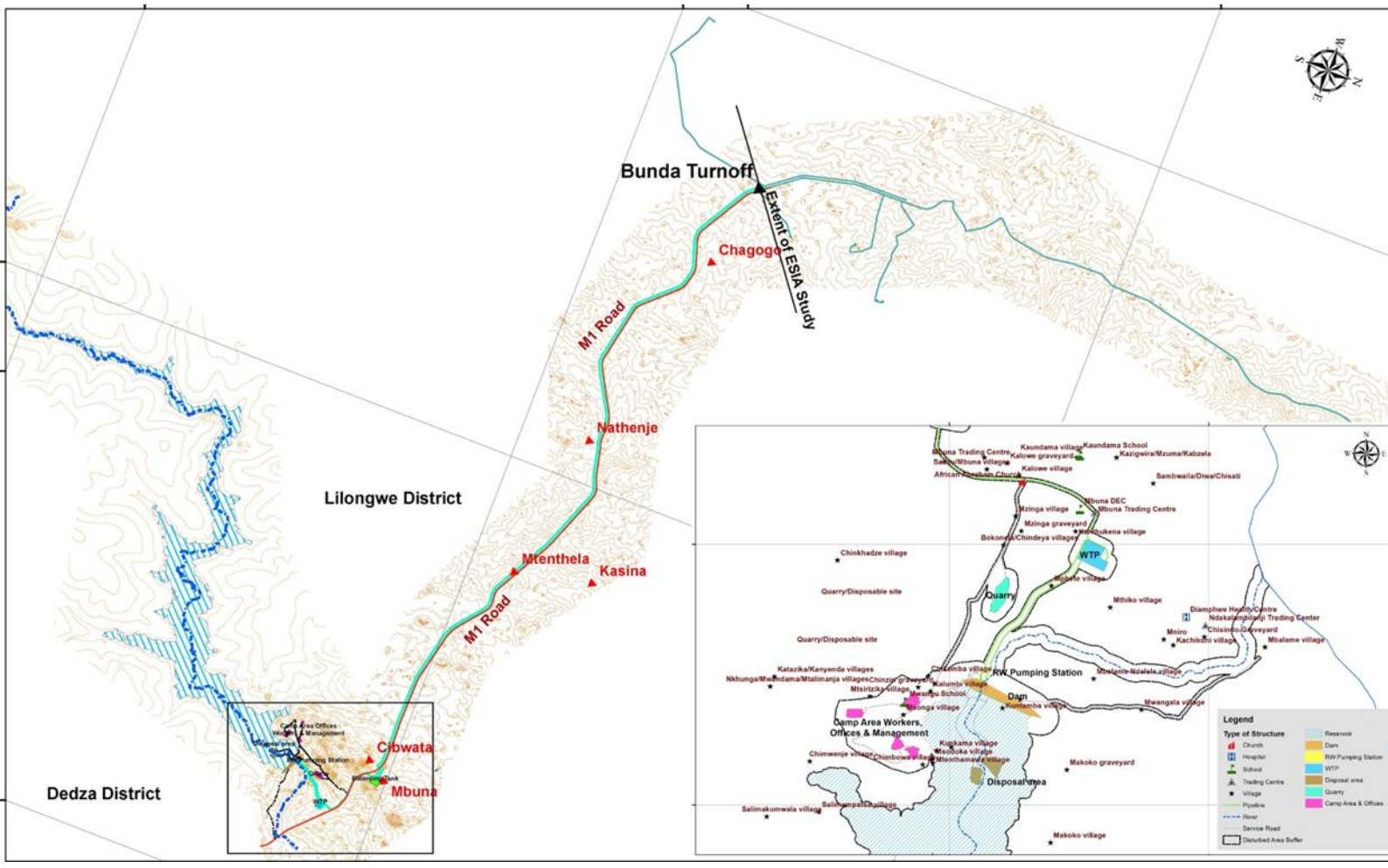
Following detailed ESIA and RAP investigations there it likekly scope for further design improvement, which would have positive envrionmetnal and social outcomes. Specific areas for design consideration include:

- Minor relocation of the proposed balancing tank, which would better avoid a wooded cemetery in Che Mbonga village, Traditional Authority Mazengera in Lilongwe District.
- Some parts of the proposed 15 m wide buffer zone may be extended further than 15 metres, subject to the availability of land and potential impacts on surrounding communities.

Chapter 5
Project Description

Environmental and Social Impact Assessment

February 2016



5. PROJECT DESCRIPTION

5.1. Project Design Studies

The Project Description is based on Project feasibility studies undertaken by Sogreah and recently updated by Studio Pietrangeli (SP). Relevant documentation are summarised in Table 5.1.

Table 5.1 Project Design Studies

Project Design Studies

Studio Pietrangeli	
Consultancy Services for detailed Design of Diamphwe Multipurpose Dam and Associated Structures	
▪ Inception Report (2014)	▪ Optimized Dam Design Report (2014)
▪ Topographical Report (2014)	▪ Dam & Auxiliary Works Report (2015):
▪ Hydrological Report (2014);	▪ Updated Water Supply Report (2015):
▪ Geological Report (2014);	▪ Updated Design Drawings (2015):
▪ Spillway Physical Model (2014);	▪ Construction Framework (2015):
▪ Water Supply Technical Report (2014);	▪ Quality Assurance Report (2015):
▪ Detailed Design Drawings (2014)	▪ Institutional Arrangement (2015):
Sogreah	
Feasibility Studies and Preliminary Design for Lilongwe's New Water Source	
▪ Report on Methodology for Site Selection (2009)	
▪ Water Demand Assessment Report (2010)	
▪ Updated Feasibility Study Report (2010)	
▪ Preliminary Design Report (2011)	

5.2. Project Overview

The Project will comprise of a new multi-purpose dam and associated infrastructure to supply Lilongwe's water demands to 2045, as well as providing water for local irrigation and fish farms. The Dam wall will be of Roller Compacted Concrete (RCC) construction, located approximately two kilometres upstream of the Diamphwe River Bridge on the Blantyre – Lilongwe M1 road. Key Project components are summarised below and comprise of the Diamphwe Dam and associated infrastructure, raw water transmission pipeline, water treatment plant, balancing tank, dual gravity pipelines from Mbuna to Bunda Turnoff, and construction facilities.

Pre-construction activities include implementation of a Resettlement Action Plan (RAP) and relocation of approximately 5178 Affected Persons and 19 graveyards. Construction is planned to commence in 2017 and take approximately 3.5 years, with commissioning expected in early 2022. Project details are presented in Table 5.2 and project footprint shown on Figure 5.1 and Figure 5.2.

Table 5.2 Key Project Components

PROJECT COMPONENT	PARAMETER
1. Construction	
▪ Construction Period	3.5 years
▪ Upgrade existing access road from Lilongwe M1 road	3.5 km
▪ New service roads to dam and quarry	4.7 km
▪ Workers & Management camps	42 ha
▪ Quarry	18 ha
▪ Spoil disposal area (within inundation area)	
▪ Coffer dams & River diversion	300 m
▪ Construction employees	250 -300
▪ Disturbed area to be rehabilitated	22 ha
2. Multipurpose dam and Ancillary structures	
▪ Dam statistics: - Area - Length x width (max) - Volume:	 2,328 ha 30 km x 1.6 km 215 Mm^3
▪ Roller Compacted Concrete (RCC) dam - crest length: - width: - maximum height - elevation (Full Supply Level) - spillway	 980 m 19 m 25 m 1180.3 masl 3800 m^3/s for PMF
▪ Buffer zone around inundation area	15 m wide (156 ha) from 100 year flood level
▪ Design Water Production Requirements - Phase 1 (Year 2036) - Phase 2 (Year 2045)	 174.4 ML/d 279.6 ML/d
▪ Raw water Pumping station (x4) & pipelines (x2) to WTP	2.86 m^3/s DN1200 mm for 2.5 km
▪ Water Treatment Plant (WTP), pumps (x5)	2.86 m^3/s or 147.65 ML/day
▪ Treated water pipeline (x2) to Balance tank	DN1100 mm for 3.4 km
▪ Balancing tanks (x2)	8.19 ML
▪ Accommodation and offices	42 ha
▪ Permanently affected infrastructure area (+ buffer)	38 (124)
▪ Employees (operational)	50-60
Main pipelines	
▪ Dual gravity pipelines extending from WTP & Balancing Tanks (x2) to the Bunda turnoff, and aligned along the southern side of the M1 road reserve.	DN900 & DN1100 mm for 30 km 2.71 m^3/s or 210.5 ML/d
▪ Disturbed area to be rehabilitated	82 ha

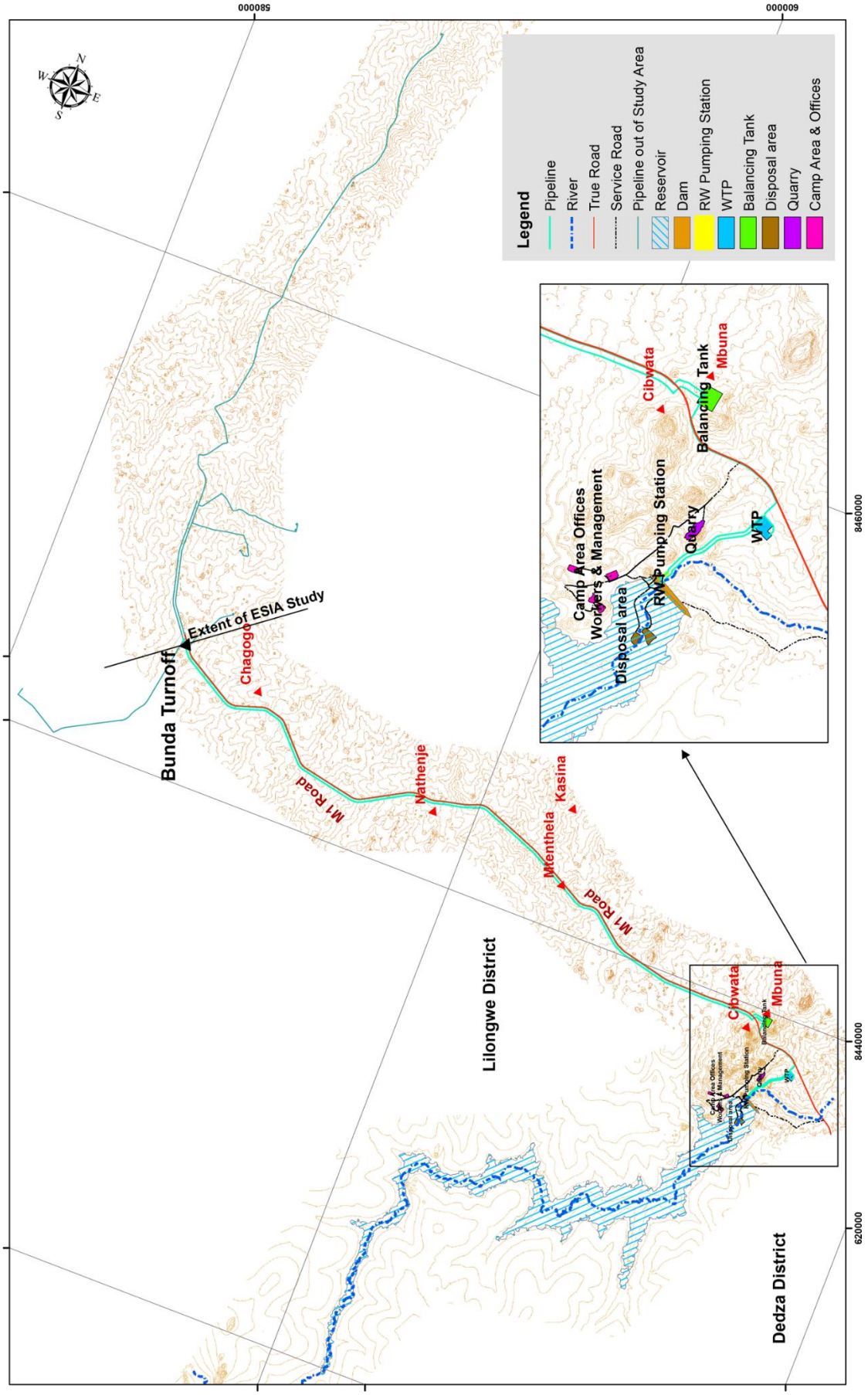


Figure 5.1: Project Footprint

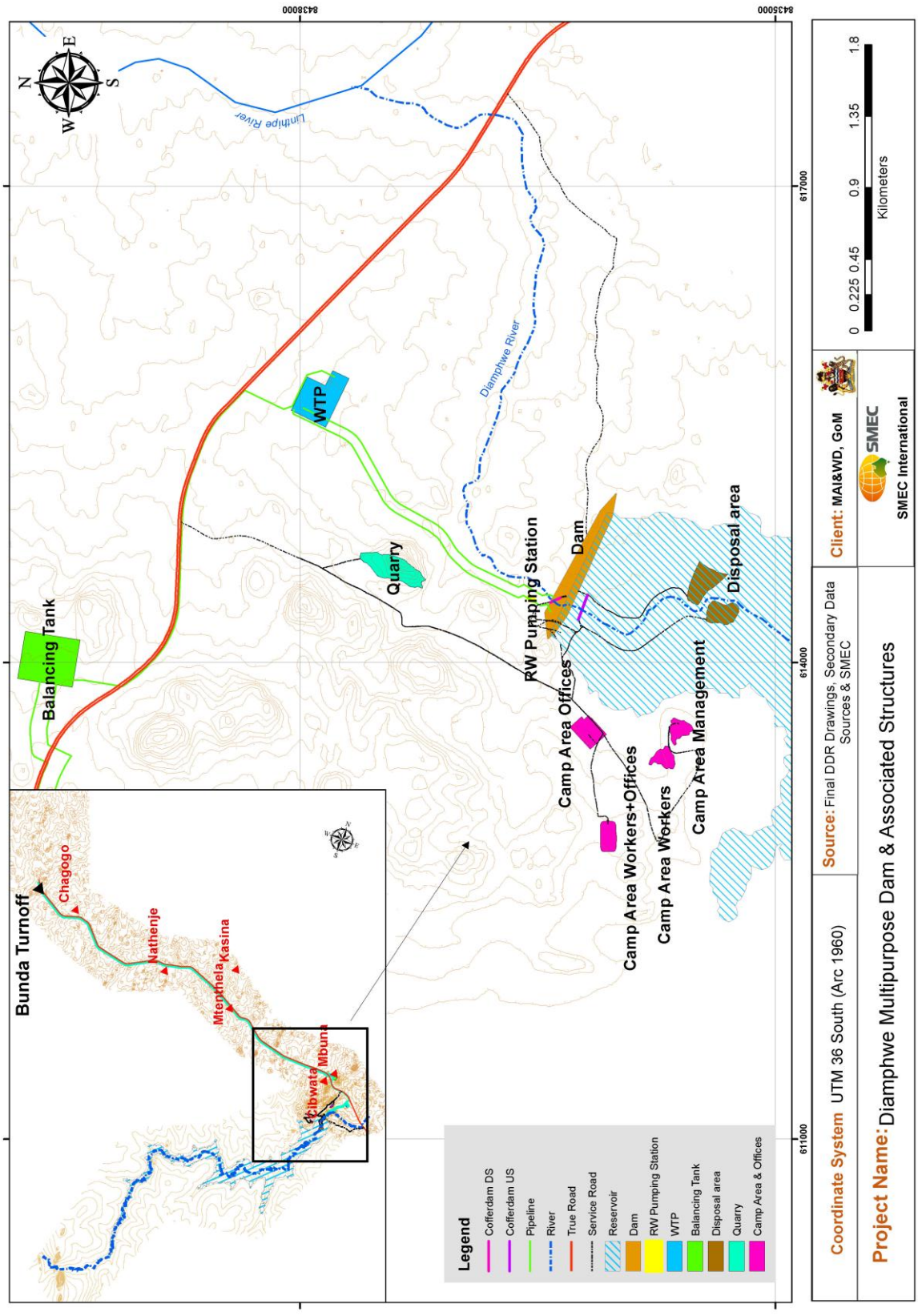


Figure 5.2: Infrastructure Layout

5.3. Water Demand and Supply

5.3.1. Overview of Water demands

Water demand feasibility studies assessed:

- *Domestic, commercial and industrial water demands*: Includes Lilongwe City, LUANAR, Projected northern and southern extension areas of Lilongwe Water Board, and along the proposed route of the transmission pipeline.
- *Irrigation*: Compensatory irrigation is a requirement of the NWDP II Resettlement Policy Framework. Water demand studies were based on irrigating up to 1000 ha of suitable agricultural land downstream of the proposed dam.
- *Fisheries*: New fish farming opportunities.

Sogreah estimated potable water demands up to 2035, and this was subsequently updated by Studio Pietrangeli to 2045.

5.3.2. Potable water demand and capacity

i. *Population forecast*

The annual population growth rate for Lilongwe is estimated to decline from 5.5% to 3.5% from 2008 to 2020, and then to 2.9% in 2035. The growth is then expected to remain steady to 2045. The population growth rate outside of the City was 3.1% in 2008 and this is expected to decrease by 0.1% per year until 2045. Population forecasts are summarised in in Table 5.3.

Table 5.3 Population estimates (x1000)

	2015	2036	2045
Lilongwe City	972	1,877	2,432
Outside City	74	90	92
Total	**1,046**	**1,967**	**2,523**

ii. *Projected water demands*

Water demands were based on population growth as well as the projected water service coverage operated by LWB, which is divided between kiosk and individual connection (IC). In Lilongwe City the proportion of the population with individual connections is expected to be 69% in 2036 and 78% in 2045. Outside of the city it was estimated that 50% of the population would have direct connections. Also considered was demand for LUANAR, which is located on the outskirts of the city. Projected potable water demands for the Planning Years 2036 (Stage 1) and 2045 (Stage 2) are summarised in Table 5.4.

Table 5.4 Projected Water Demands (Inhabitants x1000)

Water Service	2036 – Phase 1			2045 – Phase 2		
	Usage (lpcd)	Pop. (x1000)	Demand (ML/d)	Usage (lpcd[1])	Pop. (x1000)	Demand (ML/d)
Lilongwe City						
Individual connections	135	1,295	174.9	135	1,897	256.2
Kiosk connection	25	582	14.6	25	535	13.4
Sub-Total		*1877*	*189.5*		*2432*	*269.6*
Outside City						
Individual connections	58	45	2.6	58	46	2.6
Kiosk connection	25	45	1.1	25	46	1.1

Water Service	2036 – Phase 1			2045 – Phase 2		
	Usage (lpcd)	Pop. (x1000)	Demand (ML/d)	Usage (lpcd[1])	Pop. (x1000)	Demand (ML/d)
LUANAR			0.7			0.9
Sub-Total		*90*	*3.7*		*92*	*4.6*
Total		**1967**	**193.9**		**2523**	**274.2**

Note: 1. lpcd = litres per capita per day

It was assumed that the percentage of Non-Revenue Water (NRW) would be 25% of the total abstraction, giving the following average abstraction capacities:

Phase 1 (2036) 258.6 ML/d

Phase 2 (2045) 365.5 ML/d

iii. ***Existing capacity and planned upgrades***

Lilongwe's water supply system comprises of two dams on the Lilongwe River with a combined storage capacity of 24.3 Million cubic metres (Mm^3), two Water Treatment Plants (WTPs) and a pipe network of approximately 1,800 kilometres (km).

The current water demand is 109 ML/d, however water production is only 95 ML/d with Non-Revenue Water (NRW) amounting to an additional 35%. This gives a current water supply shortfall of approximately 47 ML/d. The planned upgrade works will increase production by an additional 60 ML/d and consist of:

- Commissioning WTP II extension works in 2015 (30 ML/d); and
- Raising Kamuzu dam I to provide an additional storage of 22.4 Mm3 and commissioning of WTP III in 2017 (30 ML/d).

Therefore, a total water production of 155 ML/d will be available from 2017. The shortfall in water supply for planning years is therefore:

Phase 1 (2036) 103.6 ML/d

Phase 2 (2045) 210.5 ML/d

iv. ***Diamphwe Dam Multipurpose Dam Capacity***

To meet Lilongwe's future potable water demands the Project has been designed to meet the following water design capacities (Table 5.5):

Table 5.5 Project Design Capacities- Potable Water demands

ML/d	PHASE 1 (2036)		PHASE 2 (2045)	
	Average	Peak	Average	Peak
Abstraction	105.3	123.5	210.5	234.3
Treatment capacity	100.0	117.0	200.0	234.0
Transfer capacity	80.0	93.6	160.0	187.2

5.3.3. Irrigation and Fisheries Water Demands

i. ***Irrigation***

Sogreah (2010) undertook a feasibility study to assess irrigation schemes to compensate the loss of agricultural land due to development of the dam, as well as further downstream opportunities to irrigate agricultural lands. The study considered a range of parameters including crop type and water demands, number of harvests, soil conditions, climate, accessibility, irrigation requirements and

water losses. Maize was considered the major crop, with other important crops being dry bean, groundnut, sweet potato, tomato, dry onion and cabbage.

The feasibility study concluded that up to 1000 ha of identified land could be practically irrigated, which includes 433 ha of compensatory land. Irrigation requirements during the dry season are summarised in Table 5.6.

Table 5.6 Irrigation requirements

	Land (ha)	Water needs (ML/d)
Compensation irrigation	433	29.8
Development irrigation	567	39.0
Total	**1,000**	**68.8**

ii. ***Fisheries***

Sogreah (2010) also assessed water requirements for the development of a viable fisheries industry. Following discussions with the Fisheries Department of the Ministry of Agriculture and Food Security it was assumed that a pilot fish farm (3 ha) and 20 traditional sized farms (500 m^2) would be developed. Water demands are mainly related to make-up water for seepage and evaporation from the ponds. It was calculated that 200 to 300 m^3/day would be required during the dry season.

5.3.4. Summary of Total Project Water Requirements

Total water requirements to be supplied by the Diamphwe multipurpose dam are summarised in Table 5.7.

Table 5.7 Total Dam Water Requirements

(ML/d)	PHASE 1 (2036)	PHASE 2 (2045)
Potable water	105.3	210.5
Irrigation	68.8	68.8
Fisheries	0.3	0.3
Total	**174.4**	**279.6**

5.4. Hydrology and reservoir design

Hydrology is addressed in Chapter in Chapter 6 (S6.6). Monthly flow rates show distinct wet (November to April) and dry (May to October) seasons. The highest average flow of 68.3 Mm^3 occurs in March and then rapidly declines to just 0.4 Mm^3 in October. For the available data set yearly flows ranged from 22 Mm^3 to 893 Mm^3, with an average of 254 Mm^3.

Flood flows range from 558 m^3/s to 805 m^3/s for respective 1 in 20 percentile and 1 in 100 year flood events. The Probable maximum flood was estimated to be 3809 m^3/s. Flood events last for around four days with the estimated peak occurring after approximately 30 hours. These flows were used as the basis for design of the spillway.

Reservoir design included determining the empirical relationship between reservoir area, elevation and volume, and then modelling inflows and outflows through the Dam. Area - volume curves are shown on Figure 5.3 and reservoir design parameters provided in Table 5.8.

Table 5.8 Reservoir Design Parameters

Reservoir design			Parameter
Reservoir Volume			215 Mm^3
Reservoir Area			22 km^2
Water Levels			
-	Dead storage capacity	(Dead)	1161.9 masl
-	Minimum operating level	(Min OL)	1168.0 masl
-	Full supply level	(FSL)	1175.7 masl
-	Flood level @ 10,000 years	(FL)	1178.4 masl
-	Extreme flood level	(Ex FL)	1180.3 masl

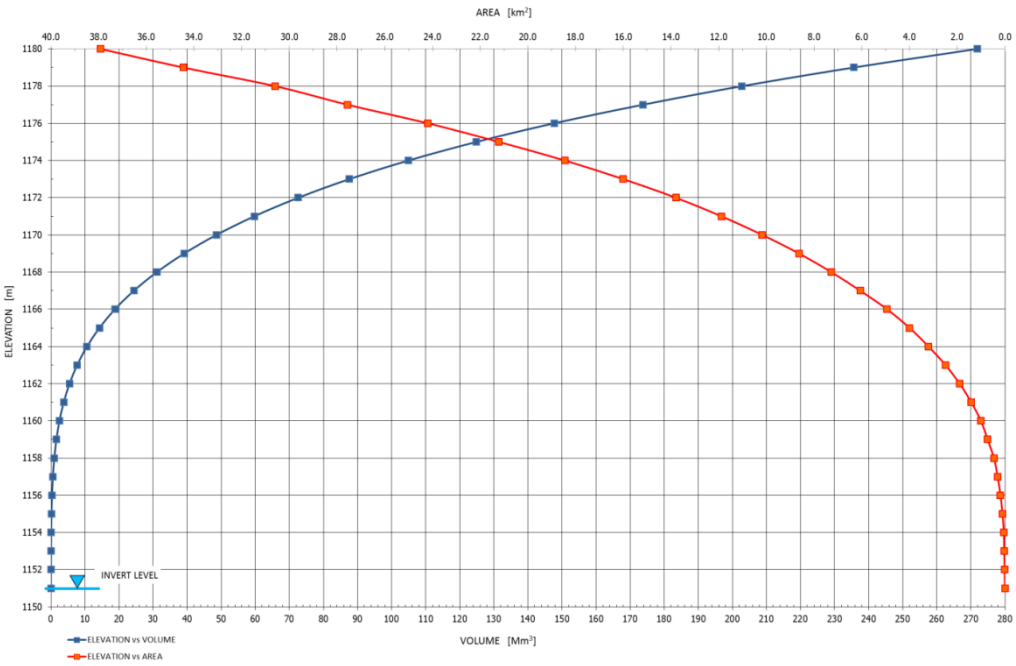


Figure 5.3: Area – Volume Curves (Ref. SP, 2015)

Dam outflows comprise of

- Total water demands for potable water supply, irrigation and fisheries (see Section 3.2). In 2045 this is equivalent to 279.6 ML/d.
- Environmental flow releases. The MoAIWD has determined that the proposed Dam should allow a 90% percentile compensation flow, or '*the flow which is available 90% of the time*'.
- Evaporation losses from the dam surface.

Model dam routing simulations were carried out to estimate the minimum reservoir capacity required to satisfy the water demand. The minimum operating level was set to 1161.9 masl, corresponding to a dead volume of 5.6 Mm^3 to accommodate silting of the Dam. The Full Supply Level required to satisfy water demands and non-emptying of the reservoir after the second year is 1175.7 masl.

A summary of model results is shown in Figure 5.4.

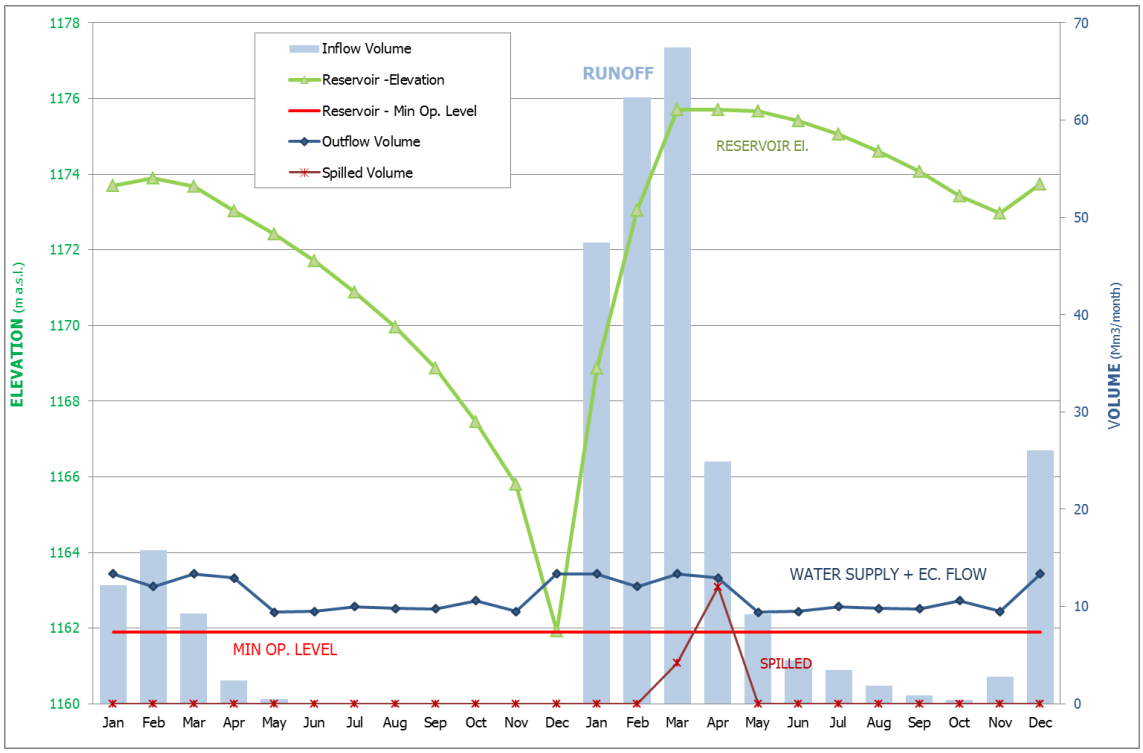


Figure 5.4: Diamphwe Dam Reservoir Routing Results

The above model shows that following construction the Dam will be at operational level in approximately two years. For average conditions the dam will spill for approximately two to three months between February and May, while for the remainder of the year thjere would be no spill for approximately nine months of the year.

5.5. Project Components and Operations

5.5.1. **Project Design and Site Layout**

Project components (Figure 3.1) comprise of a concrete dam wall and spillway, and associated infrastructure including raw water transmission pipeline, water treatment plant, balancing tank and 30 km pipeline from Mbuna near the Chilowa New Bridge, to Bunda Turnoff on the outskirts of Lilongwe city. The Project will be generally implemented in two phases:

- **Phase 1**: Covers the water demand up to 2036: 105.3 ML/d
- **Phase 2**: Covers the water demand up to 2045: 210.5 ML/d

The Project consists of two main systems:

i. ***Dam reservoir to balancing tank pipeline*:**

The Dam and associated structures will be designed and constructed to provide for ultimate Phase 2 (2045) water demands. Two similar diameter pipes will transfer water from the dam to the balancing tank and will be initially constructed to satisfy the forecast water demand up to 2045. Up until 2036 only one pipeline is considered to be working while the second one will be used in emergencies. The water treatment plant and electromechanical (EM) equipment will be initially constructed to supply Phase 1 water demand (2036), with provision to double its capacity to meet Phase 2 water demand (2045).

ii. ***Balancing tank to services areas pipelines:***

The transmission system from the balancing tank to the service areas (northern and southern) has been designed to satisfy the 2045 demand, but until 2036 will operate with only half the design discharge.

A plan layout of important infrastructure is shown on Figure 5.5 and Project components described below.

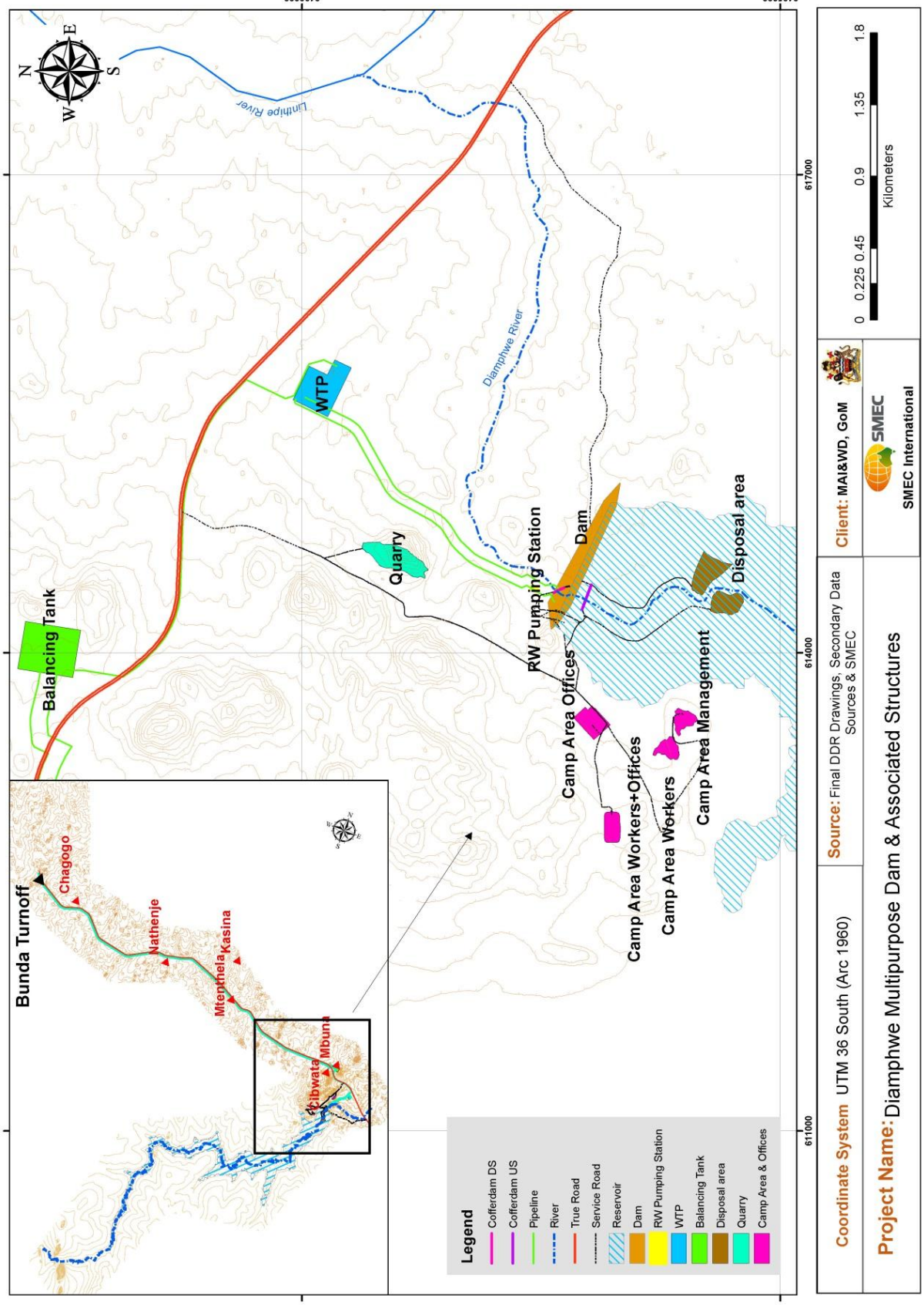


Figure 5.5: Major Infrastructure Layout

5.5.2. **Dam wall and associated structures**

i. ***Dam wall and spillway***

Dam wall design was based on extensive geological and design feasibility studies, initially undertaken by Sogreah (2010) and subsequently updated and optimized by Studio Pietrangeli (2014/2015). Siting and design of the Dam wall was based on optimising geological design and constructability parameters, and minimising environmental and social disruptions.

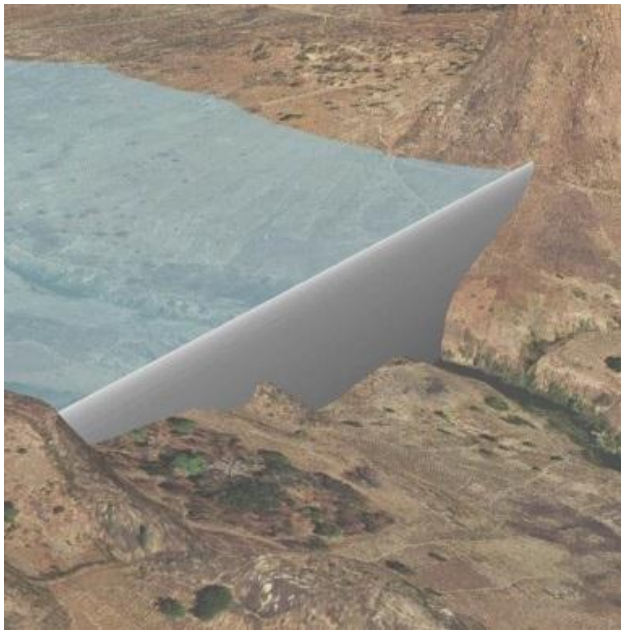
The Dam wall will be located between two hills with solid base rock between 2 and 10 metres below the ground surface. The Dam is designed as a concrete gravity dam at 988 m long and 30 meters high. An ungated and uncontrolled spillway will be located in the left (north) section of the Dam wall and designed to safely pass the Probable Maximum Flood (PMF). A drainage system and grouting curtain will be incorporated into the foundations.

Photograph 5.1: Dam Wall Location Looking south (right side) to north (left side)

Key design parameters are given in Table 5.9. Location of the Dam wall, Plan layout and longitudinal and cross sections are shown on Figure 5.5, Figure 5.6, Figure 5.7 and Figure 5.8 respectively. Dam wall and spillway cross sections are shown on Figure 5.9 and Figure 5.10.

Table 5.9 Dam Wall Design Parameters.

Heading	Heading
Crest length	988 m
Height	30 m
Crest elevation & maximum water level	1180.3 msal
Full supply level	1175.7 msal
Maximum water level	1180.3
Spillway crest length	140 m
Spillway chute	167 m
Downstream stilling basin	167 m wide x 30 m long



Photograph 5.2: Artist Impression

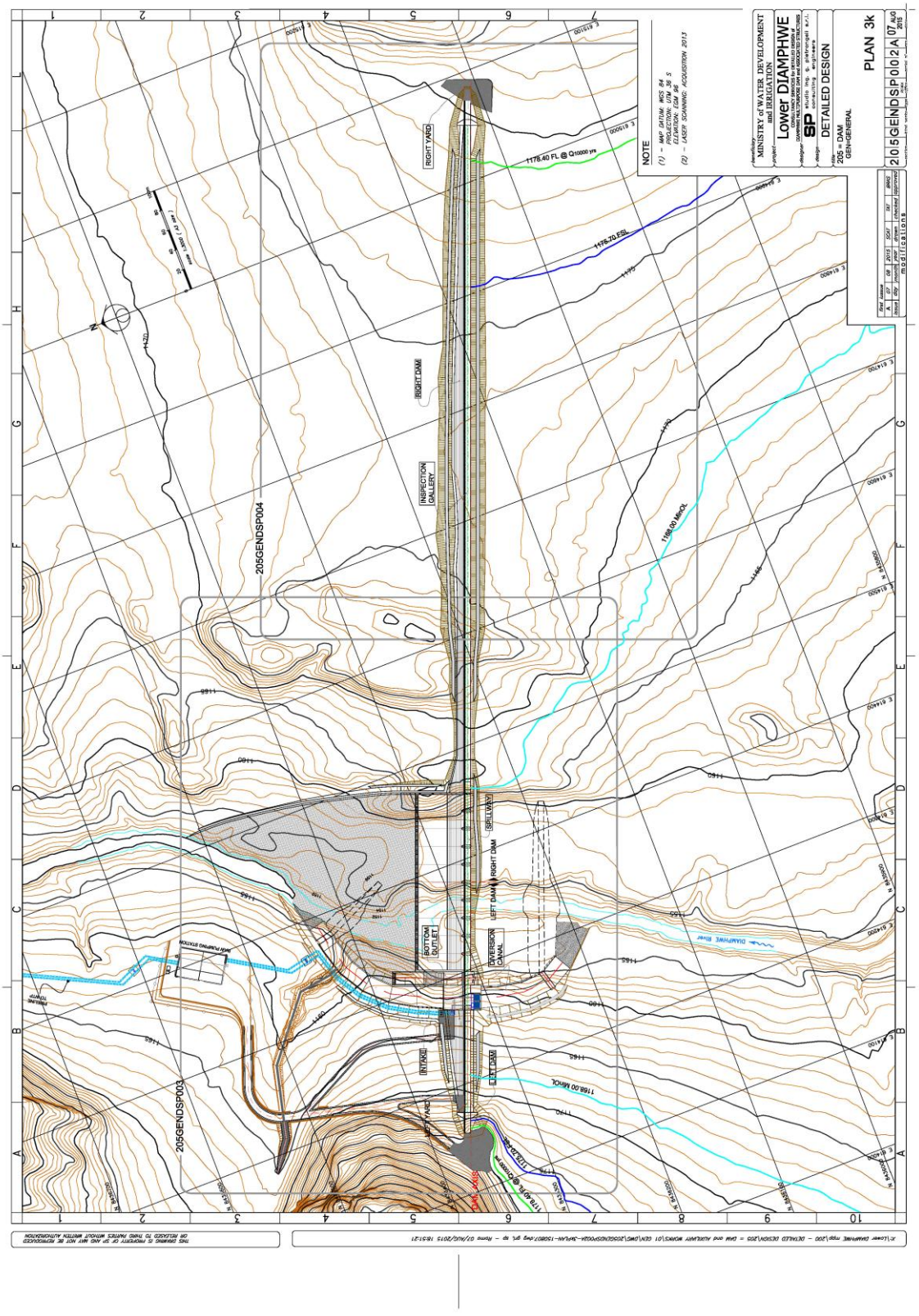


Figure 5.6: Plan of Dam Wall (Ref. SP 2015)

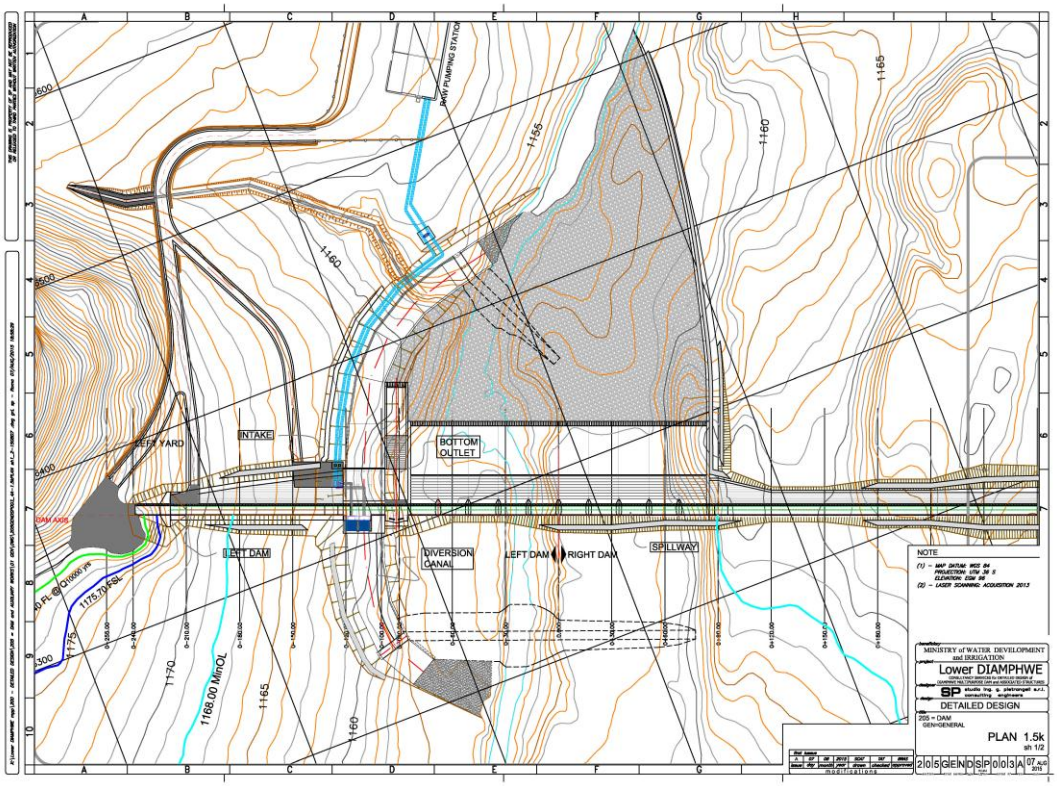


Figure 5.7: Left Dam Detail

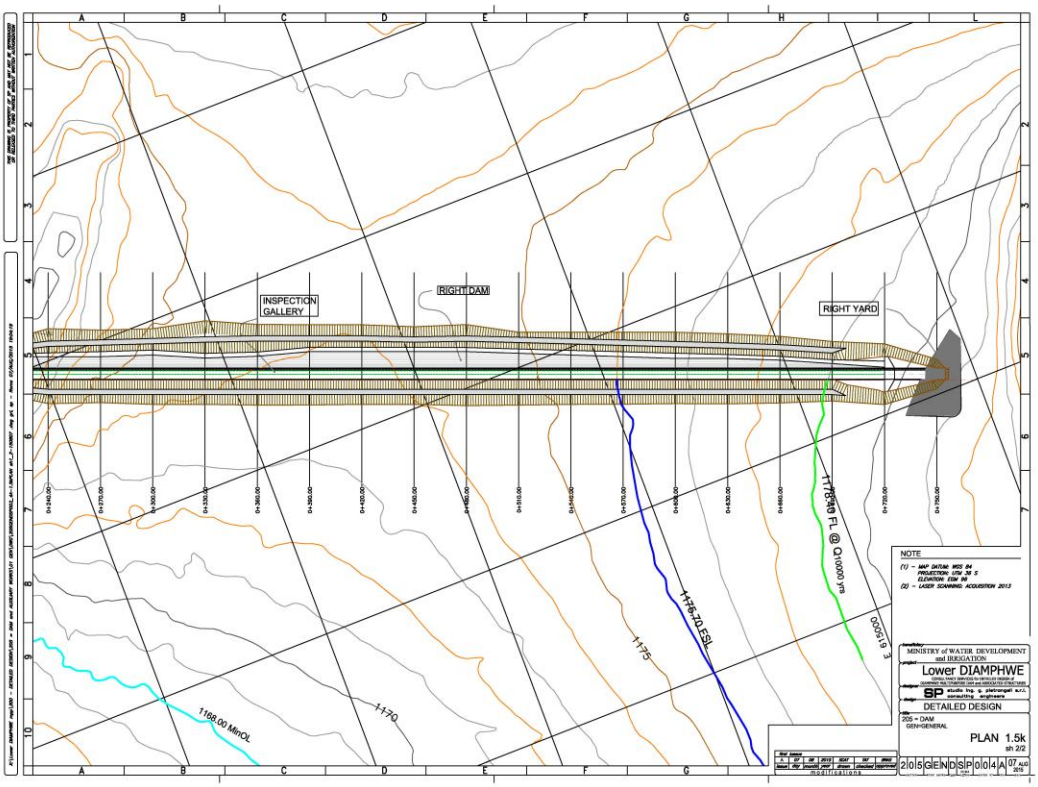


Figure 5.8: Right Dam detail

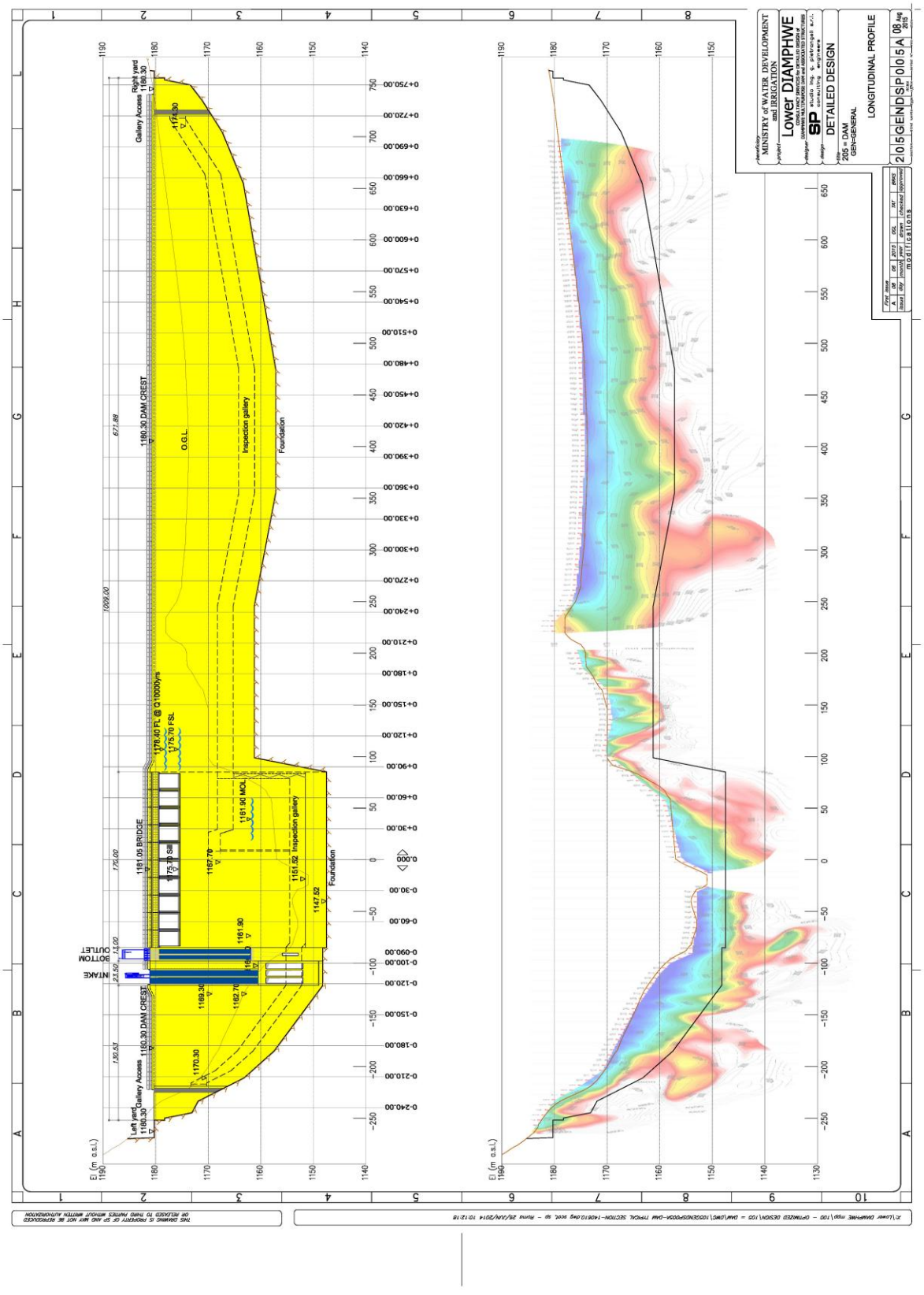


Figure 5.9: Dam Wall Longitudinal Section (Ref. SP 2015)

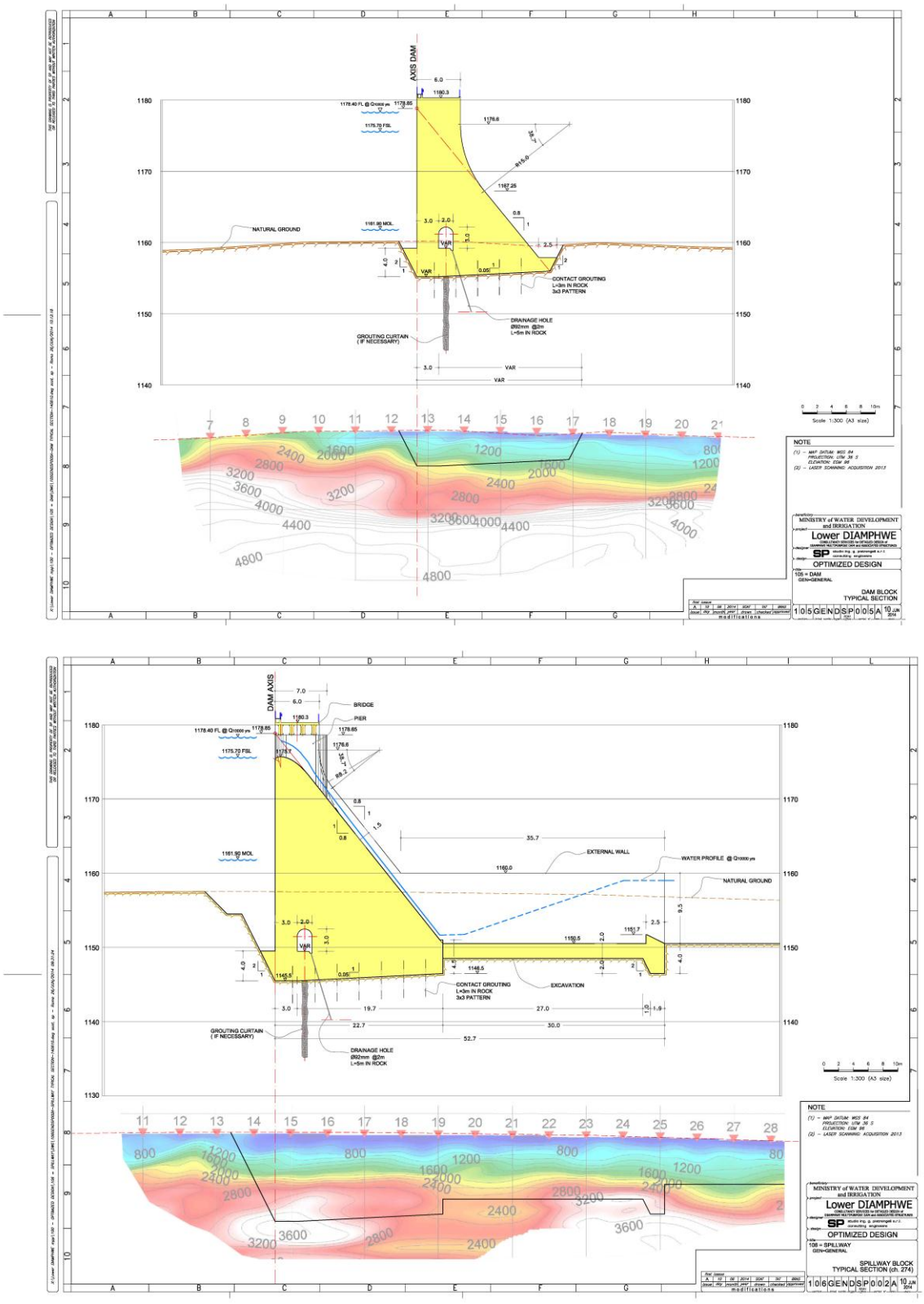


Figure 5.10: Dam Wall & Spillway Cross Sections (Ref. SP 2015)

ii. ***Bottom Outlet***

The bottom outlet is located on the left side of the Dam, between the diversion canal and the chute. Its function is to drawdown the reservoir in an emergency or for controlling the rate of reservoir impounding for operational and maintenance purposes. The bottom outlet has been designed to drawdown the reservoir water level from 1175.7 to 1162.3 masl in about 40 days. Water will discharge to an energy dissipating stilling basin (Figure 5.11).

The bottom outlet has a discharge system to release the environmental flow in open air. The discharge system has been designed to discharge the maximum flow that normally occurs in the river, which is estimated to be 1.62 m^3/s when the reservoir is at the minimum operating water level; 1168 masl.

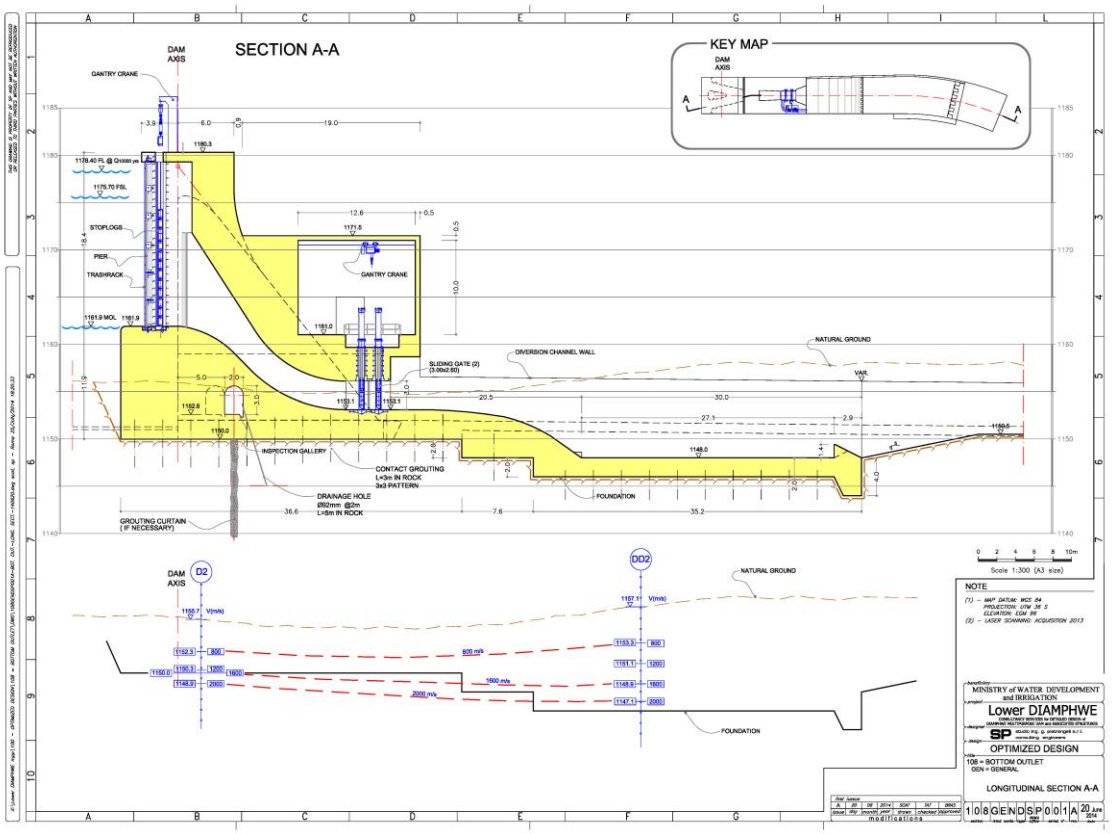


Figure 5.11: Bottom Outlet and Stilling Basin (Ref. SP 2015)

iii. ***Water Intake***

The intake comprises of two pipes designed to divert water with the best quality characteristics according to the levels present in the reservoir.

The upper pipe is designed to supply drinking water (2.8 m^3/s from 1170 masl) and the lower one for irrigation and fish farming (0.6 m^3/s from 1162 masl)

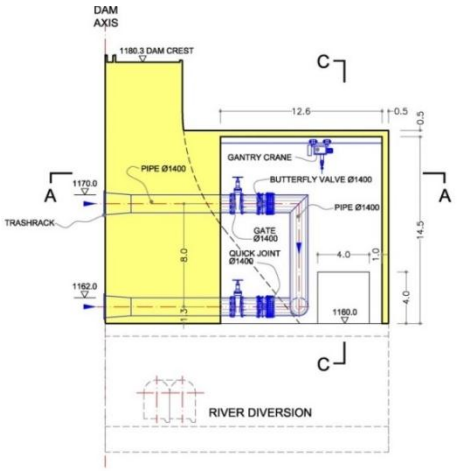
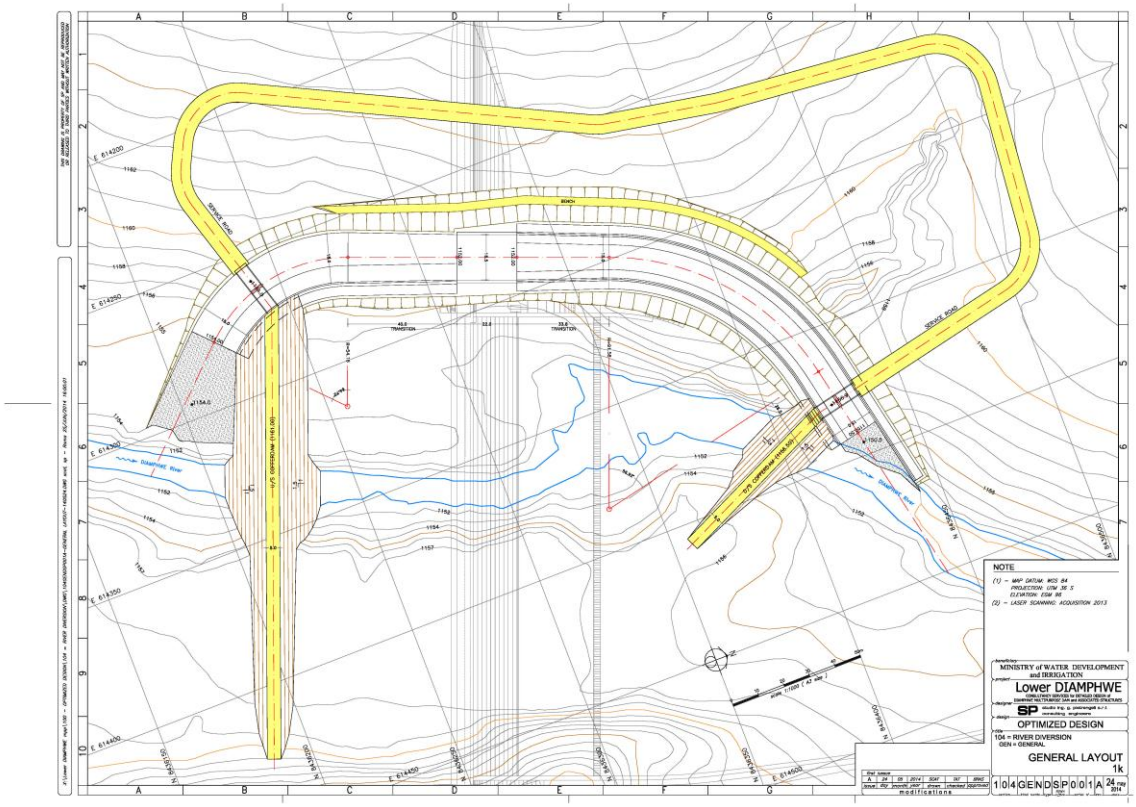


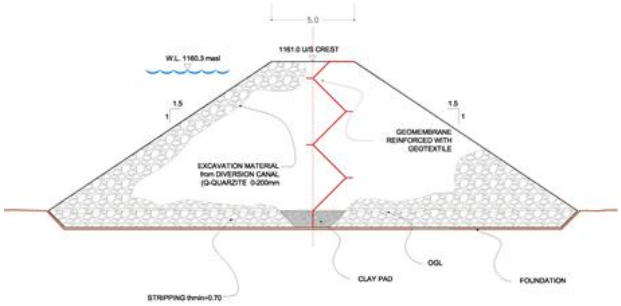
Figure 5.12 Intake Arrangement (Ref. SP 2015)

5.5.3. **River Diversion**

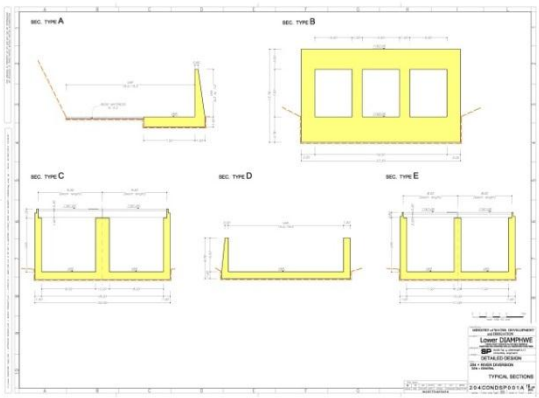
River diversion works will provide protection against flooding of the construction area. The River Diversion will comprise of upstream and downstream coffer dams, and a 300 m long excavated channel located on the left bank of the river. During construction water will be diverted into the diversion channel and around the construction area. In order to avoid inundation of the Dam area, the left side of the channel is designed as a vertical wall with variable height.

Due to high velocities the channel will be mainly built in concrete, except for the right side of the channel reach upstream of the dam block, which will be excavated with a rip-rap protection in the lower part of the bank. The transversal section geometry varies along the channel, which has a bottom width variable from 18 m to 15 m (Figure 5.13).





Typical Coffer Dam Profile



Typical Diversion Channel Profiles

Figure 5.13: River Diversion Works: Coffer Dams and Diversion Channel (Ref. SP 2015)

5.5.4. **Pump station and raw water pipeline to WTP**

The raw water transfer system from the Dam to the Water Treatment Plant (WTP) (Figure3.15) comprises of:

i. *Suction pipelines*: Two 1200 millimetre (mm) steel pipes connecting the two level dam water intake to the pumping station, a distance of approximately 300 m. Both pipelines will be constructed in Phase 1. The suction pipelines will run along the diversion channel's left wall for the first 180 meters and will be located in an excavated trench for the remaining length to the pumping stations, together with the discharge pipelines.

ii. *Pumping station* (Figure 5.14): Two independent pumping systems will each be commissioned for Phase 1 (2036) and Phase 2 (2045), with a combined capacity of 2.85 m^3/s. Each system comprises of three duty pumps and one standby pump. The total electrical load is 1429 Kilowatts (KW). The pumping station building will accommodate all pumps, two stand-by diesel generators and necessary electrical mechanical equipment. The diesel set will be supplied from a 120 litre fuel tank for daily use and nearby 15 m^3 underground tank, which will provide for at least 24 hour back up power generation.

iii. *Discharge pipelines* (Figure 5.15): Two 1200 millimetre (mm) steel pipes connecting the pumping station to the WTP, a distance of approximately about 2.0 km. Both pipelines will be constructed in Phase 1.

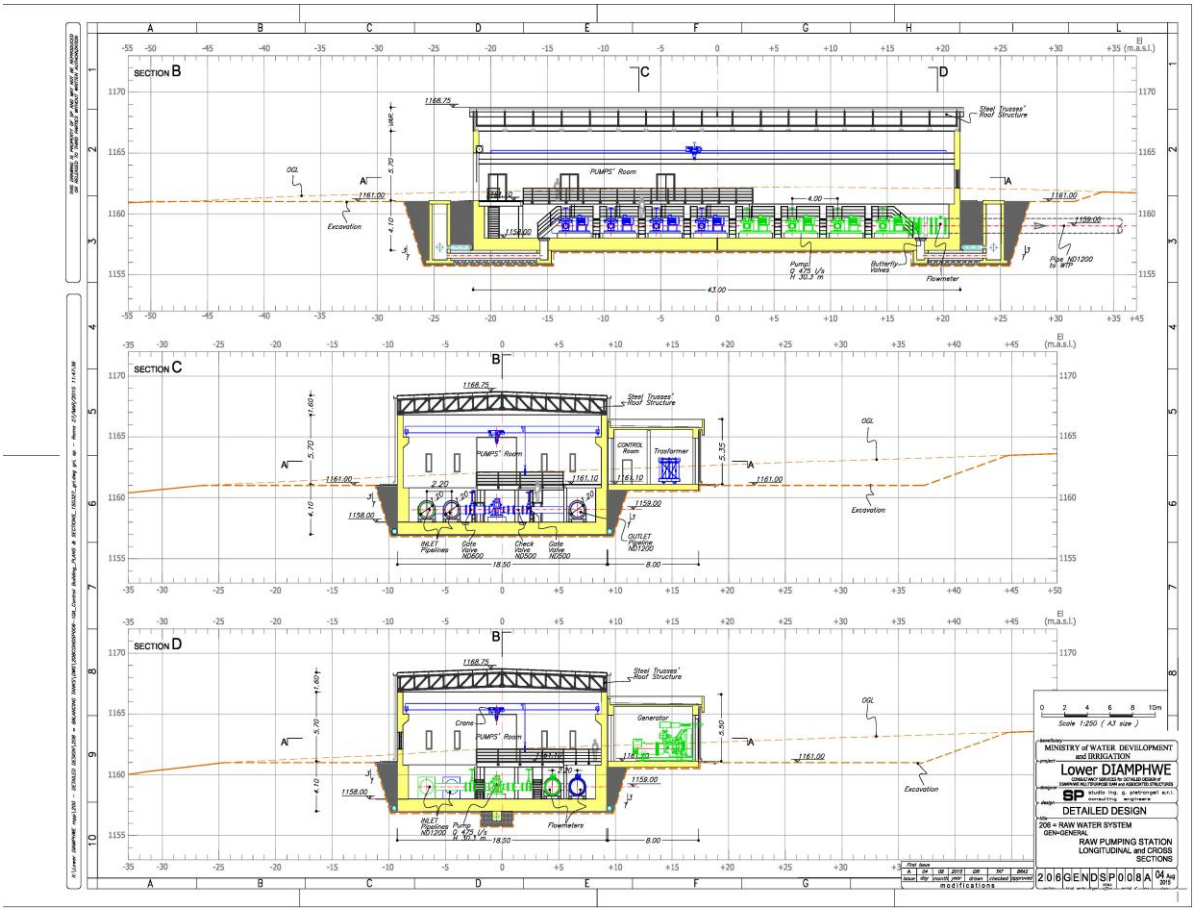


Figure 5.14: Raw Water Pump Station Elevation (Ref. SP 2015)

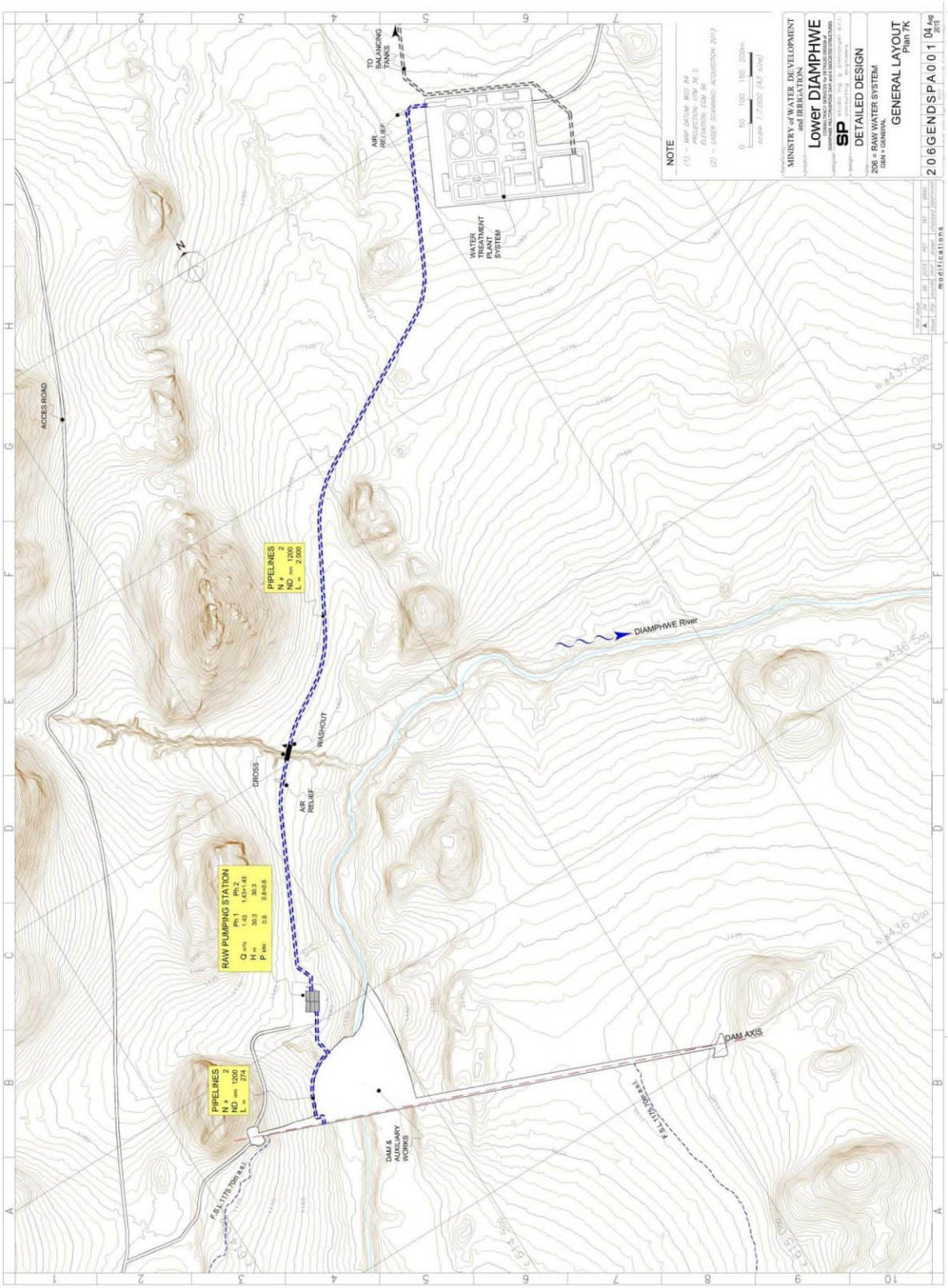


Figure 5.15: Pump station and Raw Water Pipeline (Ref. SP 2015)

5.5.5. **Water Treatment Plant (WTP)**

i. ***WTP* design**

The WTP will be located near the M1 road, approximately 2 km downstream of the Dam. Treatment will be a conventional process and will have a design capacity of 2.86 m3/s, to be constructed in two Phases:

Phase 1 (2036): 1.43 m3/s

Phase 2 (2045): 2.86 m3/s

WTP details are summarised in Table 5.10 and a layout shown on Figure 5.16.

Photograph 5.3: WTP Location (Looking north)

Table 5.10 Water Treatment Plant

TREATMENT PROCESS	COMPONENT
	Phase 1 (2036): 1.43 m^3/s
1 SCREENING SYSTEM 2 PRE-OXIDATION 3 COAGULATION 4 FLOCCULATION 5 SEDIMENTATION 6 FILTRATION SAND BED 7 FINAL DISINFECTION	▪ Arrival and distribution tank: consisting of Raw water Intake, Channel with screening system, Reactive mixing concrete pit for pre-oxidation phase (potassium permanganate); Pre-oxidation tank, divided into two independent units, measuring and Reactive mixing concrete pit for the clariflocculation process (polyelectrolyte); ▪ Clariflocculation tanks (x4): diameter 40 m, 4.5m high ▪ Filter buildings (x4): each equipped with No. 6 filters of approx. 75 m2 ▪ Contact tanks for the chlorination phases (x2): size 42.6 X 20.6 X 5.2 m ▪ Storage tanks for treated water (x2): size 60.9 x 30.4 x 8.4 m ▪ Water recovering tank: diameter 36 m, 4.5 m high ▪ Sludge thickener: diameter 12 m ▪ Sludge storage tank: diameter 12 m ▪ Filter presses (x2) ▪ Structures for filters containing pumps and backwash compressors (x2) ▪ Structure for the reactive dosage of the pre-oxidation and clariflocculation process ▪ Structure for the dosage of chlorine gas; ▪ Structure for stocking liquid chlorine; ▪ Structure for the housing of the personnel responsible of the treatment plant; ▪ Sewer system for rainfall water and relative clean waste water ▪ Sewer system for waste waters
	Phase 2: (2045): 2.86 m^3/s
	▪ Clariflocculation tanks (x2) ▪ Filtration structures(2) ▪ Contact basin for chlorination ▪ Holding tank for storage of treated water

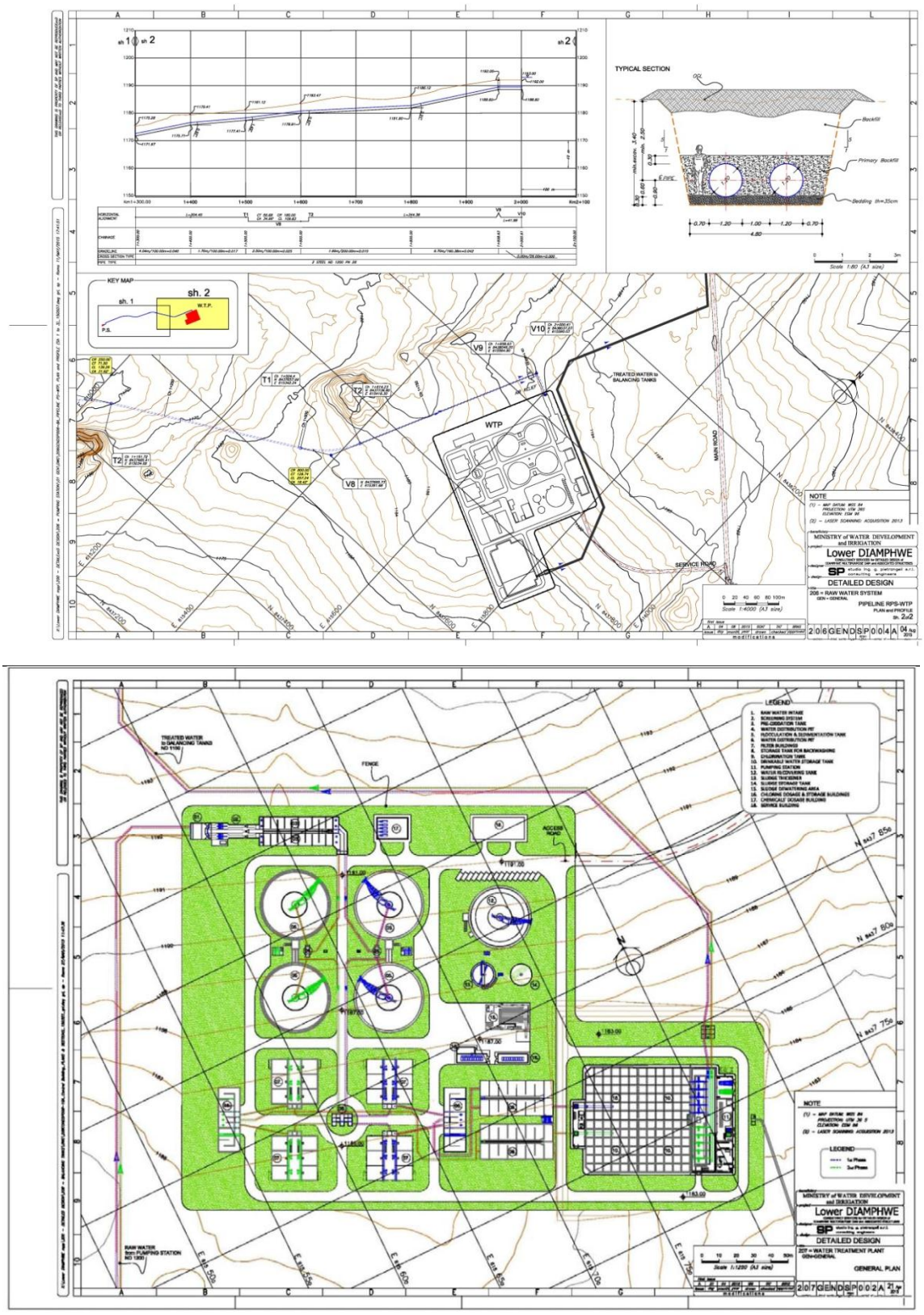


Figure 5.16: Water Treatment Plant Layout (Ref. SP 2015)

ii. ***WTP Process***

The design of the WTP is based on detailed analysis of water quality in the Diamphwe River and achieving a potable supply that meets the guidelines provided by the European directive 75/440/EEC and the World Health Organization. The water treatment process (Figure 5.17) is summarised in Table 5.11.

Table 5.11 Water Treatment Process

WATER TREATMENT PROCESS
1. Screening
The raw water from the pumping station will flow into a stilling tank and channel system containing fine-mesh screens, which will remove solids greater than 3.5 mm. Collected material will then be mechanically removed to a bin for later disposal.
2. Pre-Oxidation
Pre-oxidation will destroy the dissolved organic substances present in the raw water (including neurotoxins produced by algae) and reduce the life-span of the algae. The reactive agent in this process is potassium permanganate, which will be added at a rate of 2 parts per million (ppm) or 492 kilograms per day (kg/d) at ultimate Phase 2 production.
3. Clariflocculation
Clariflocculation reduces suspended solids by flocculation with a reactive (anionic polyelectrolyte) and then settling the resulting floc. This process will remove approximately 70-80% of the solids, with the remaining to be captured in the filtration process. The flocculants will be added at a rate of 2 parts per million (ppm) or 492 kilograms per day (kg/d) at ultimate Phase 2 production.
4. Filtration
The removal of the remaining suspended solids will be done during the filtration stage. The use of a mono granular sand filter is recommended, which has the advantage of ensuring that the clogging will involve the entire thickness of the filter bed and not only the top layer. The sand is placed onto a drainage layer composed of rows of plastic blocks containing drainage channels. The advantage of such a system is the much simpler clearing and maintenance of the filter bed. The maximum water height on the filter is approximately 1.5 m, which corresponds to the maximum clogging level of the filter. Once this value is reached, the backwashing phase will start.
5. Backwashing
The backwashing phase will start when the fixed head on the filter is reached or the turbidity in the treated water is increased. The backwashing process includes the following: ▪ 5 minutes: Air injection ▪ 10 minutes: Air and water injection from a single pump at low flow ▪ 5 minutes: Water injection at low flow to fill filter and to completely expel the air from the system; ▪ 10 minutes: Water injection at high velocity. The quantity of water necessary for the backwashing will be approximately 3.15 ML/d. Backwash water will be sent back to the recovery tank. Sludge will be dried in open ponds within the WTP buffer area. The sludge will be tested for suitability for reuse as a fertiliser, or alternatively buried at a suitable disposal site.
6. Disinfection
A mixture of water and chlorine will be injected into the contact tanks through a system of perforated pipes. Chlorine will be stored in a liquid state in 1 ton cylinders. It will then be transformed into a gaseous state through a relevant evaporator and added into the water through an injector. The dosage of Chlorine gas will be 4 ppm or 1,000 kilograms per day (kg/d) at ultimate Phase 2 production. The cylinder storage chamber will be equipped with safety/hazard equipment and have forced ventilation that can be used to treat the extracted gas.
7. Sludge Production and Treatment
Sludge will be produced from the clariflocculation and backwashing processes. Sludge will be thickened and dried in filter presses at an estimated rate of 8,125 kg/d

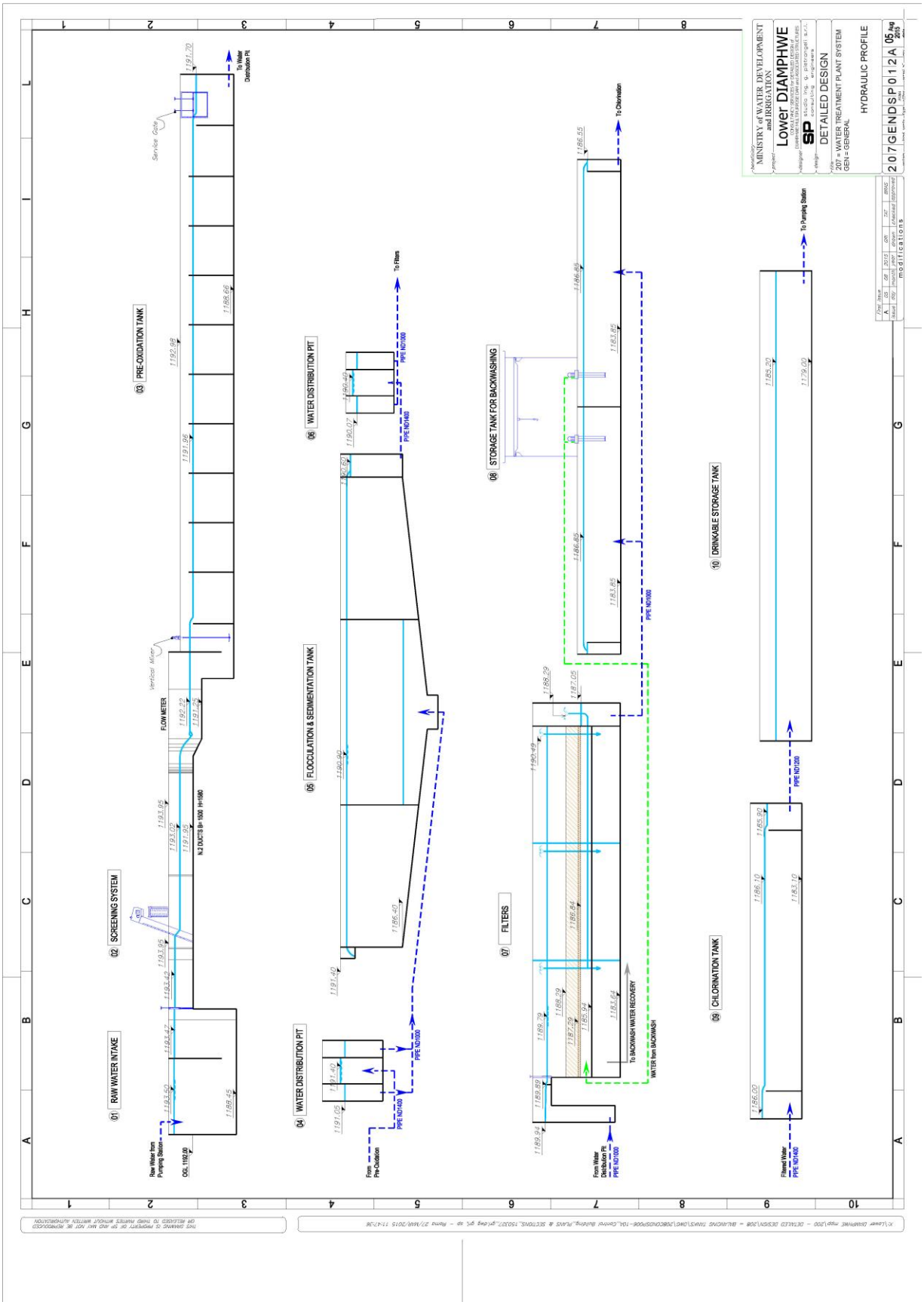


Figure 5.17: WTP Process Diagram (Ref. SP 2015)

5.5.6. **Treated water pipeline to balance tank**

The treated water transfer system from the Dam to the Water Treatment Plant (WTP) (Figure3.19) comprises of:

i. *Suction pipelines*: Two 1100 millimetre (mm) steel pipes connecting the treated water storage tank to the pumping station, a distance of approximately 10 m. Both pipelines will be constructed in Phase 1.

ii. *WTP pumping station:* Two independent pumping systems will each be commissioned for Phase 1 (2036) and Phase 2 (2045), with a combined capacity of 2.71 ML/s. Each system comprises of four duty pumps and one standby pump. The total electrical load is 4544 Kilowatts (KW). The pumping station building will accommodate all pumps, two stand-by diesel generators and necessary electrical mechanical equipment. The diesel set will be supplied from a 120 litre fuel tank for daily use and nearby 30 m^3 underground tank, which will provide for at least 24 hour back up power generation.

iii. *Treated water discharge pipelines* (Figure 5.18): Two 1100 millimetre (mm) steel pipes connecting the WTP pumping station to the balancing tanks, a distance of approximately about 3.4 km. Pipelines will be aligned on the southern side of the M1 road until they cross to the northern side near Mbuna village. Both pipelines will be constructed in Phase 1.

iv. *Balance Tanks* (Figure 5.19): Two adjacent balancing tanks will be located near Mbuna village on the northern side of the M1 road. Each tank will have dimensions 32 m x 32 m x 7 m high and have a combined storage capacity of 8.19 ML. The tank invert level is 1253 masl and water elevation will vary from 1257 to 1261 masl.

Photograph 5.4: Balance tank Location (Looking north)

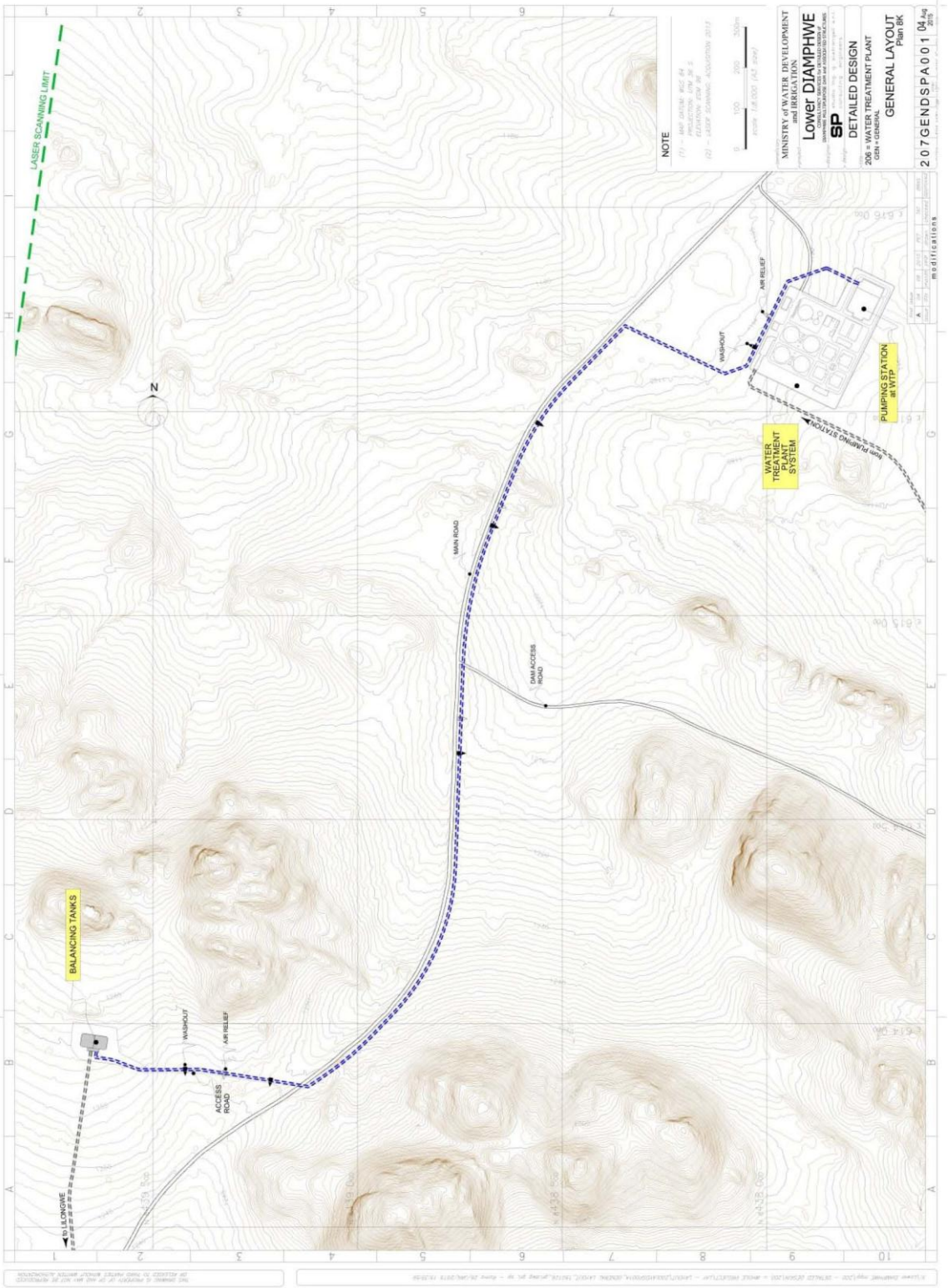


Figure 5.18: Treated Water Discharge Pipeline to Balancing Tanks (Ref. SP 2015)

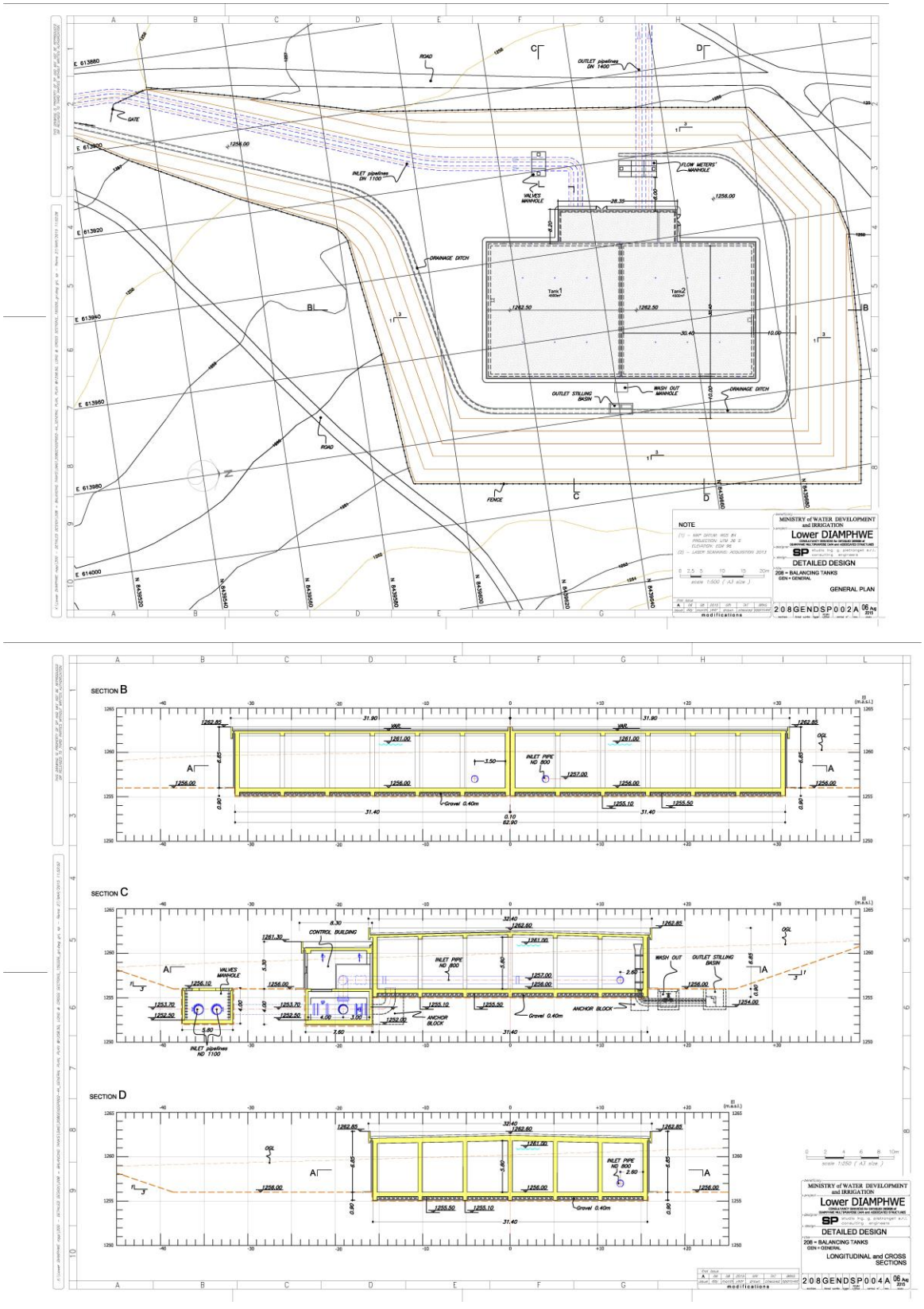


Figure 5.19: Balancing Tanks (Ref. SP 2015)

5.5.7. **Water pipeline to Lilongwe**

i. ***Water distribution system***

Treated water from the Diamphwe Dam will supply Lilongwe City and surrounding areas via seven service tanks, each having its own transmission system to Northern and Southern service zones. In addition, water will supply the area along the pipeline from the treatment plant to the Chikungu Reservoir Diversion at Bunda Turn-off. The tanks at Chikungu, the University area, Ngweya, Tsabango, Mwenda and Kanengo will be supplied by gravity from the balancing tanks, whereas Sandula will be supplied through a pumping station from Kanengo reservoir.

The transmission system to transfer treated water to Lilongwe city and surrounding areas from the balancing tanks consists of two main sub-systems:

- **Pipeline No. 1**: A gravity pipeline from the balancing tank to the Northern service zones consisting of a first gravity stretch from balancing tank to Kanengo reservoir and a pressurized stretch from Kanengo reservoir to Sandula reservoir.
- **Pipeline No. 2**: A gravity pipeline from the balancing tank to the Southern service zones.

A transmission network diagram and general system layout are shown in Figure 5.20 and Figure 5.21 respectively.

The Project study area subject of this ESIA includes the dual gravity mains (Pipelines 1 & 2) from the Balance Tanks to the Chikungu Reservoir Diversion at Bunda Turn-off.

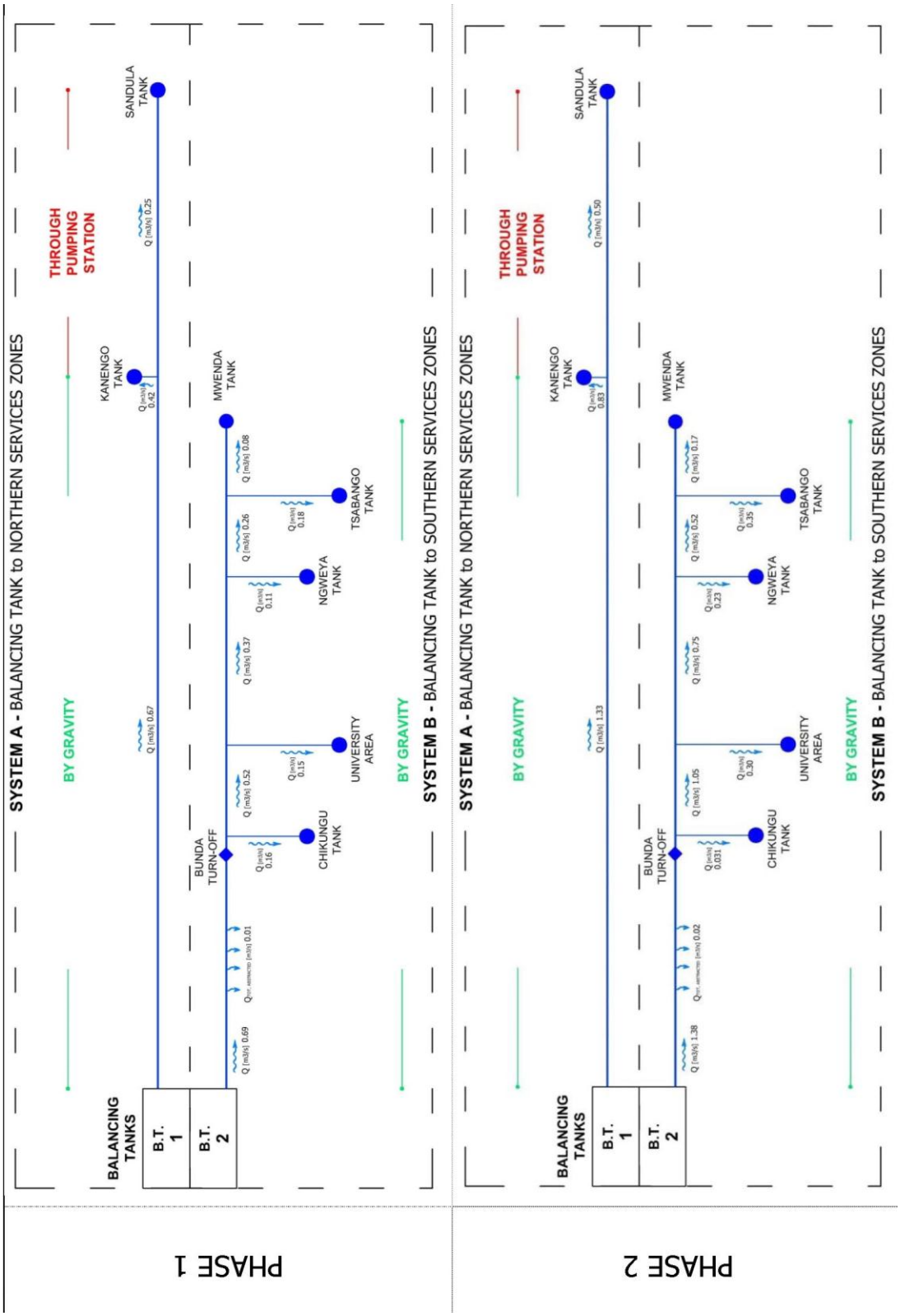


Figure 5.20: Water Transmission Network Diagram (Ref. SP 2015)

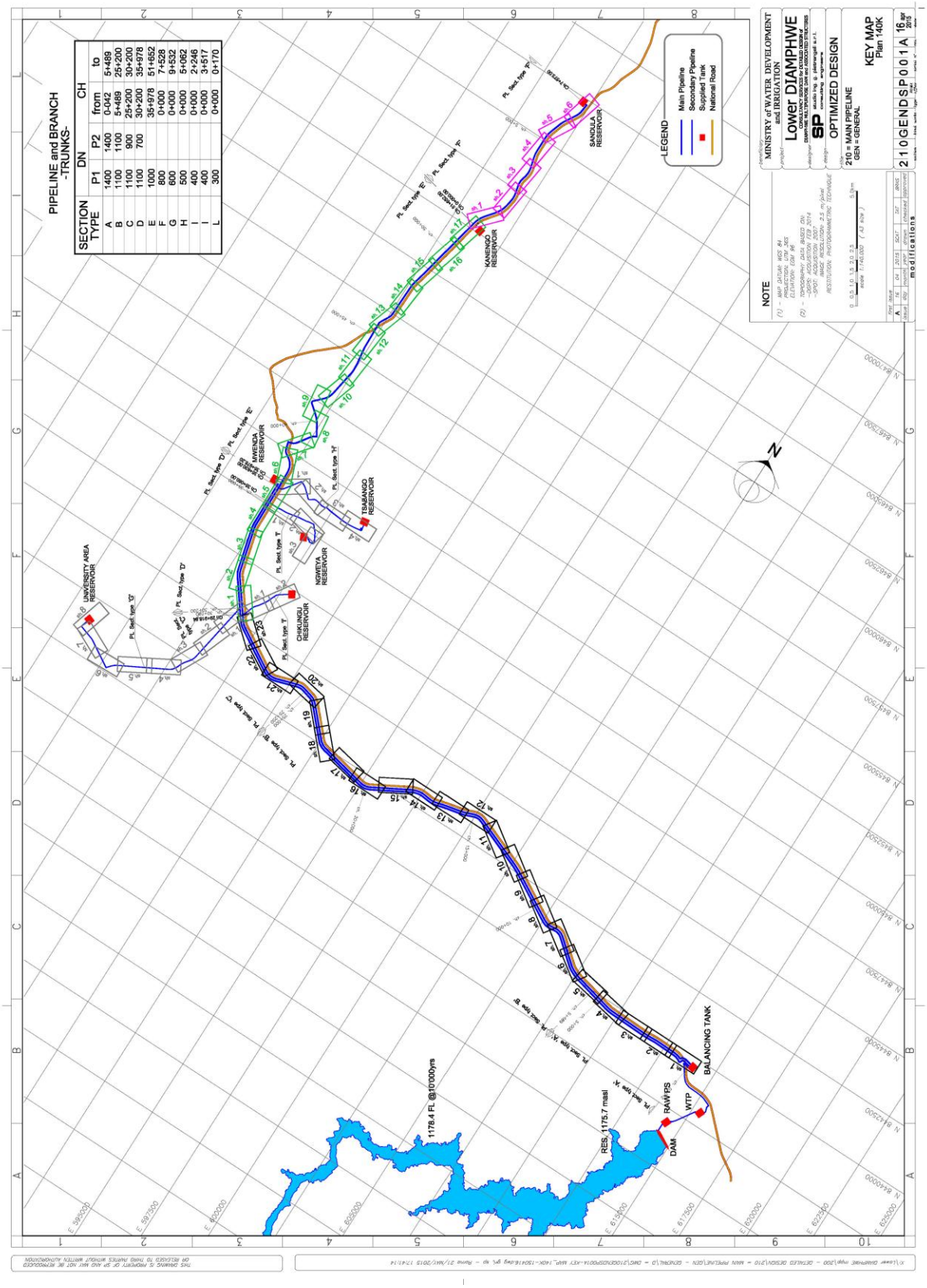


Figure 5.21: Main Pipe Distribution System (Ref. SP 2015)

ii. ***Pipeline route study area***

Dual gravity pipelines will extend from the Balance Tanks to the Chikungu Service Reservoir Diversion at Bunda Turn-off, a distance of approximately 30 km. A short distance from the Balance Tanks the pipelines will cross the M1 road (Figure 5.22) and then follow the southern side of the road to the Bunda Turn-off. The pipelines will generally be aligned within a 20 metre wide easement extending from the road centre-line. More detailed maps showing the pipeline route and salient features such as adjoining buildings, built up areas, etc. are provided in in Figure 6.25 (Chapter 6.7.5 – Landuse) and in Appendix 8.

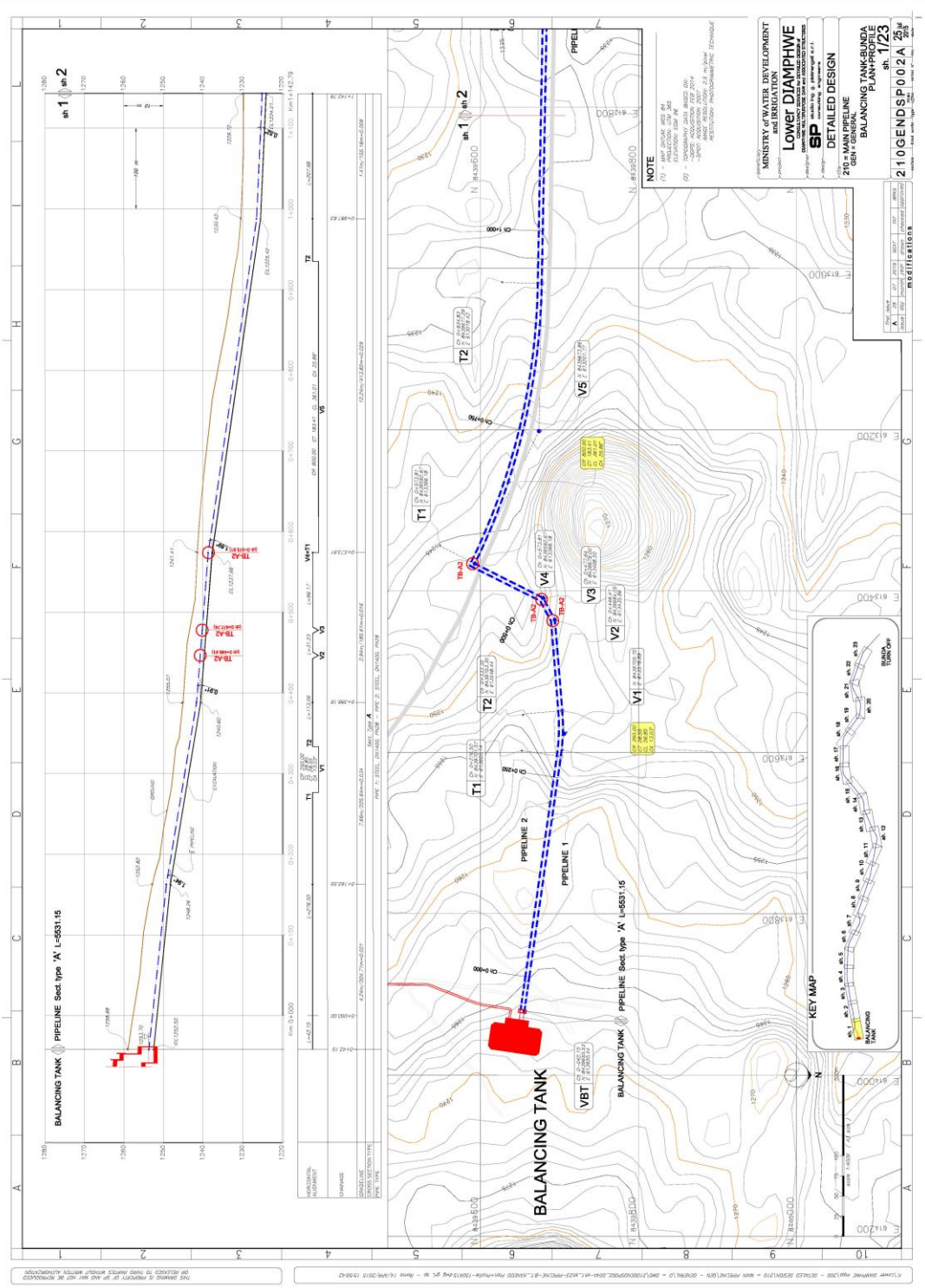


Figure 5.22: Dual Pipeline alignment from Balance Tanks to southern side of M1 road (Ref. SP 2015)

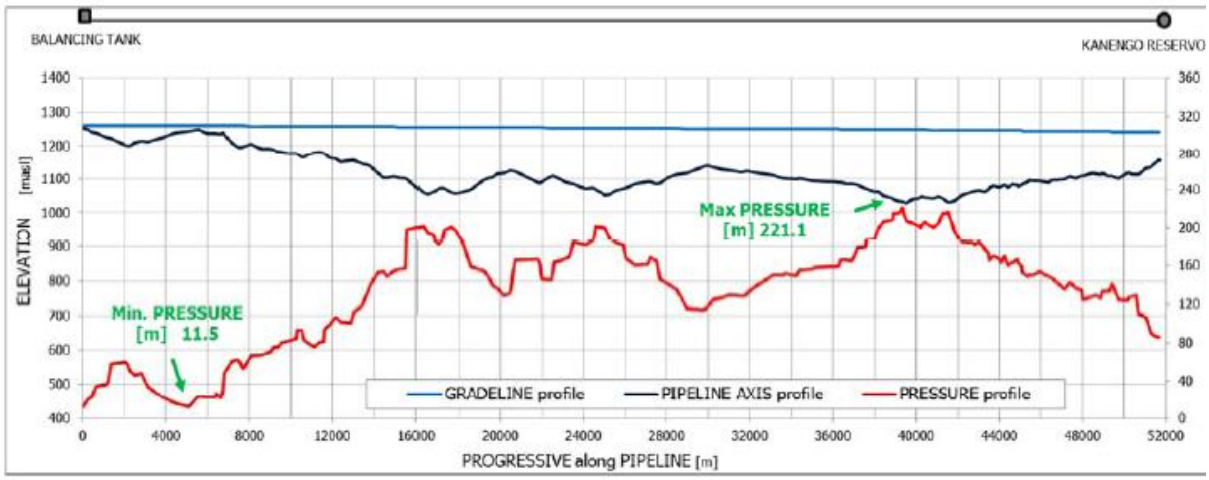
iii. ***Pipeline details***

Steel pipelines will be constructed in Phase 1 to satisfy ultimate 2045 demands, however they will only operate with half the design discharge up to 2036. Pipeline details from the Balance Tanks to the Bunda-Turnoff are provided in Table 5.12.

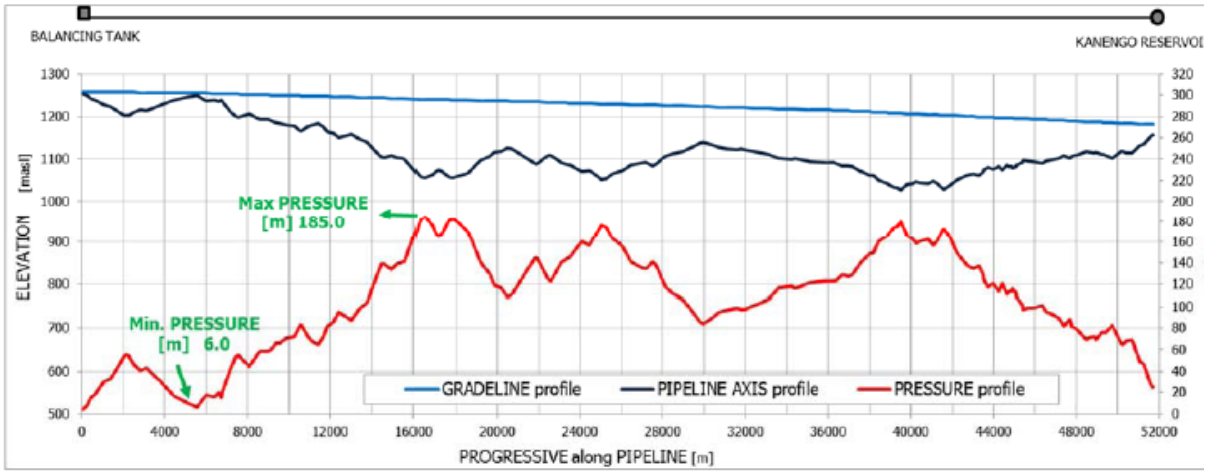
Table 5.12 Pipeline details

Pipeline	Capacity (m3/s)	Diameter (mm)
Pipeline 1 (Northern)	1.33	1400 to 1100
Pipeline 2: (Southern)	1.38	1400 to 900

Pipeline elevations over the 30 km distance range from 1257 masl at the maximum water level in the balance tanks down to 1150 masl at the Bunda Turn-off, a vertical drop of 107 m. Pipeline route elevations and a typical hydraulic profile is shown in Figure 5.23.



Phase 1 (2036)



Phase 2 (2045)

Figure 5.23: Pipeline Hydraulic Profile

Both pipelines will be laid in the same excavated trench, which will have a trapezoidal section with height and width depending on the pipe diameter (*Figure 5.24*). The pipes will be laid on a 30 or 35 cm thick sand bedding, depending on the pipe diameters.

The base width of the trench will vary from 4.2 to 5.2 m to assure an adequate space for handling and working on the pipes. For safety reasons the trench will be buried first with a primary backfill for at least 30 cm then a normal backfill up to the ground level.

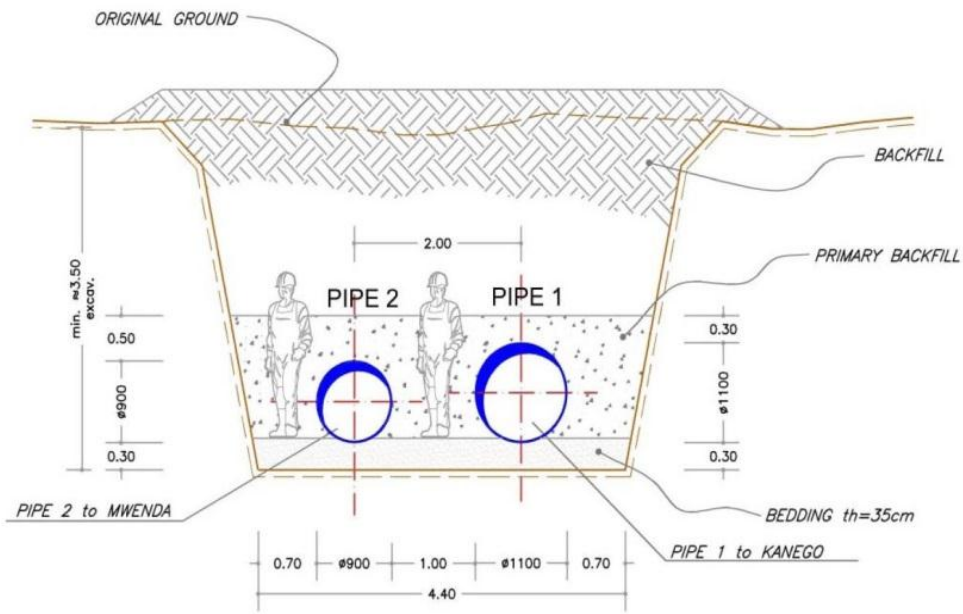


Figure 5.24: Typical Pipeline Section

5.5.8. **Office and Accommodation**

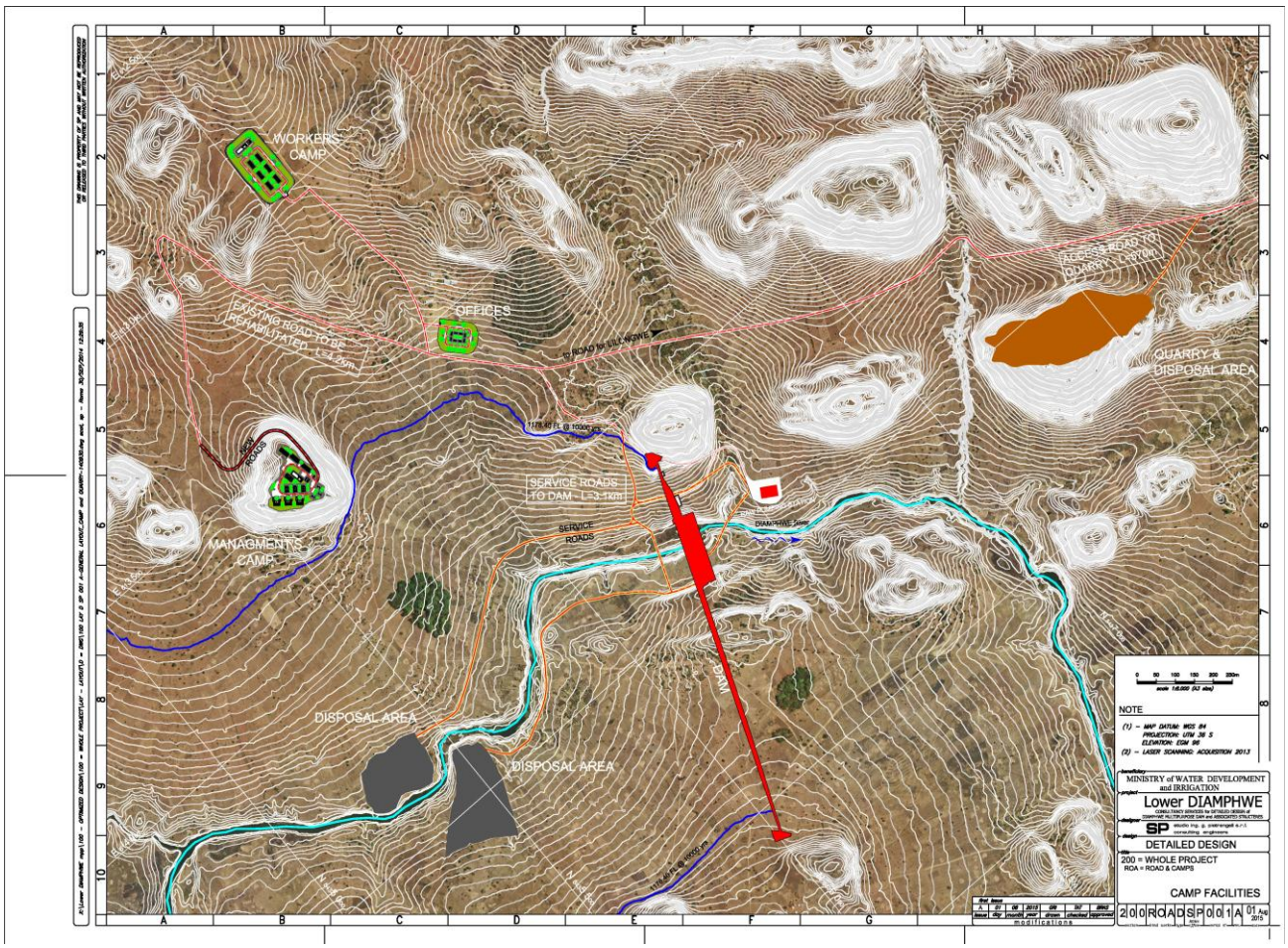
Office and accommodation will be located near the Left Dam wall (Figure 5.25) and comprise of:

- Family and guest houses (x3)
- Bachelors accommodation for family (x6)
- Bachelors accommodation for single (36)
- Clinic
- Mess
- Offices

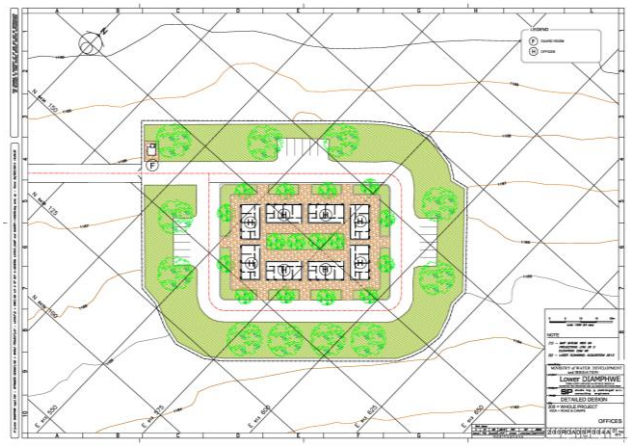
5.5.9. **Reservoir Buffer Zone**

The MoAIWD in corrospondene dated 18 November 2014 (Appendix 7) has advised that a 15 wde buffer riparian buffer zone be established around the perimeter of the Dam and should extend from the highest ever or 100 year flood level.

The proposal is to establish a 15 wide buffer zone extending from the maximum water level in the dam (1180.3 msal), which is above the 100 year flood contour. The buffer zone will be planted with forest woodland vegetation species endemic to the Diamphwe River catchment. The buffer zone will be established at the start of construction and will work will be advised by the Department of Forestry.



Worker Accommodation



Office Accommodation

Figure 5.25: Office and Accommodation (Ref. SP 2015)

5.5.10. **Utilities**

i. ***Power***

The main power demands will be for the raw water pumps and WTP treated water pumps. The total power requirement is 5,973 kilowatts (KW). Distribution transformers will be commissioned in Phase

1 and Phase 2, and power provided from existing 33 KV 3-Phase overhead power lines. An additional and similar power line will be required for Phase 2.

ii. ***Potable water***

Water for sanitary facilities, cleaning and washing will be from the potable water supply from the water treatment plant. Domestic hot water will be provided by an electric water heater.

iii. ***Sanitary system***

Sanitary wastewater from toilets, drains and wash sinks will drain directly to a septic tank.

iv. ***Communication and Security***

Telephone with integral intercoms will be provided in the control room. A security fence will encompass the entire site. Access into the site will be by motorized vehicular gate with control via radio frequency identification technology or keypad. Closed-Circuit TeleVision (CCTV) will be installed around the site including main site entrance, pumping stations, main entrance in the control building, generator and fuel tanks.

v. ***Fire Control System***

The fire detection system will be provided to protect the control room; diesel generator rooms; pump rooms; office, workshop and storage room. The plant will be NFPA 851 Standard compliant.

The pumping station fire-fighting system includes portable extinguishers for outdoor and indoor areas. In particular CO2 type fire extinguishers will be installed to be used for electrical equipment and powder extinctors to be used on fires of organic materials, plastics and liquid or gaseous hydrocarbons.

5.5.11. **Site access**

The main site access will be via an existing road linking the Left Dam with the Blantyre – Lilongwe M1 road, a distance of approximately 3.5 km. The road intersects the M1 in Lilongwe district approximately 3 km north of the Diamphwe river bridge. The road is currently unsealed and will be slightly realigned, widened and sealed prior to Dam construction. Internal access roads will access Project infrastructure including the dam and related structures, pumping station, transmission pipelines, WTP, offices and accommodation facilities. This access from the M1 will be used for all major construction and operational activities.

Photograph 5.5: Site Access (Looking south)

The Right Dam can be accessed from an existing road that joins the M1 just south of the Diamphwe river bridge. This road is unsealed and will require minor upgrade to facilitate access. This road will be mainly used during dam operation and will not be used for large vehicles or construction materials.

The Balance Tanks will be accessed via an existing road that joins the M1 road immediately north of the main site access. This road will require minor upgrading and will be used during construction and operational activities. Access roads are shown on Figure 5.26.

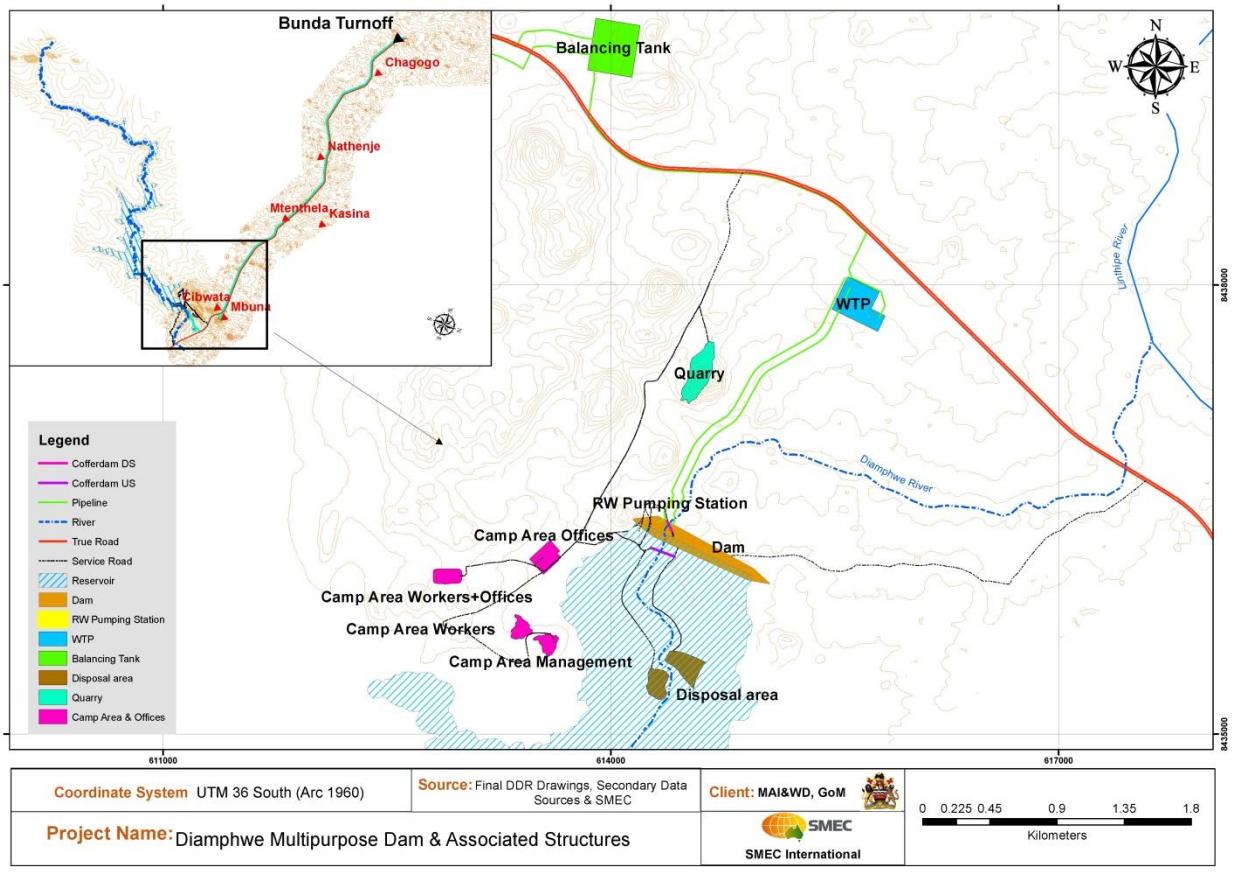


Figure 5.26: Road Access

5.5.12. **Employees**

The Dam and WTP will be operated by up to 50 employees comprising of the site manager, hydrologist, water quality specialist, laboratory technicians, WTP and Dam operators, and maintenance staff.

5.6. Construction

5.6.1. **Pre-Construction Activities**

Pre-construction activities will comprise of the following:

i. ***Resettlement Action Plan (RAP)***

- The RAP will need to be finalised and approved by relevant authorities.
- Implementation of the RAP will need to be completed at least as far as the areas involved in construction activities are concerned, i.e. Dam and entire pipeline system areas.
- Resettlement of Project Affected Persons (PAP) in the reservoir area should be commenced, but may proceed during the construction of the works, if the vegetation clearing operations within the impounding area do not harm the safety of the PAP still to be resettled.

ii. ***Project Approval***

All necessary approvals will need to be finalised before construction commences. This includes gaining approval approval from the Forrestry Department prior to natvive vegetation clearing and

the National Parks and Wildlife Department for disturbing habitat of species of conservation significance (See Chapter 8.6).

iii. ***Management Plan (ESMP)***

The ESMP included as part of this ESIA (Chapter 12) includes details of various management plans that will need to be implemented during Project development. Prior to Project implementation all management plans will need to be reviewed and updated under the supervision of the PMU. Contractors will need to update plans related to site construction activities such as noise, air quality, traffic, waste management and monitoring plans.

iv. ***Project Management Unit (PMU)***

It is advisable that, prior to construction, the Client establish a Project Management Unit (PMU) to act as interface and point of contact among the various parties to the project, i.e., civil works contractor, electromechanical contractor, engineer, financing institutions, etc. The members of the PMU and their number should be selected from the Client's internal resources and/or other relevant authorities or ministries.

5.6.2. Construction Program

Construction will take approximately 42 months (3.5 years) and comprise of the following activities:

ACTIVITY	MONTHS						
	6	12	18	24	30	36	42
A. Contractor Mobilisation/Demobilisation							
B. Roads & Camps							
C. Diversion Works							
D. Dam Activities							
E. Spillway Activities							
F. Bottom Outlet							
G. Intake Structure							
H. Water System							

5.6.3. Mobilisation

The contractor's mobilisation will consist of:

- PMU to provide safeguards induction of the contractor and the staff. This should cover all aspects of the ESMP to ensure that Contractors are fully aware of their responsibilities and liabilities.
- Mobilisation of necessary labour, materials, equipment, tools, and supervision to commence work on the project.
- Continued processing of the required submittals which includes administrative and procedural requirements for submitting project work plans, product data, samples and any other submittals required in the project specifications.
- Take possession of the work sites, including establishment of boundaries, entry ways, warnings against trespassing and any other necessary and standard security measures.

- Identification and fencing of stockpiling, waste disposal and quarry areas.
- Setting-up of temporary camps to be used by the contractor, engineer and client in the areas foreseen for the Permanent Camps (Management Camp, Workers Camp and Office Camp). Construction of the Permanent Camps will commence at the same time as the construction of the project components and continue throughout the entire project period until completion.
- Setting-up of site laboratory equipped to perform tests on soil, rock and concrete (conventional and RCC).
- Installation of crushing plant
- Installation of batching plant (conventional concrete and RCC).

5.6.4. **Site Preparation**

Significant trees or landscape items designated to be saved will be flagged and protected. During clearing and excavation reasonable efforts will be taken to ensure the survival of trees.

Trees, shrubs, and brush designated for removal will be cut to the ground surface within the areas of excavation. Debris, including subsurface root material and small vegetation, will be sized and staged and prepared for transportation and waste disposal site. Suitable topsoil will be stockpiled for use in final land restoration. Care will be taken when clearing activities are undertaken near structures or sensitive locations such as the graveyard near the right side of the proposed dam wall.

Structures left abandoned as a result of the implementation of the RAP will need to be demolished and the resulting waste material and debris transported to the waste disposal area for treatment and disposal.

Trees, vegetation and structures within the inundation area will generally remain in situ, although some clearing may take place if deemed hazardous to Dam operations.

An opportunity will be provided to local communities to beneficially use any of the resources prior to construction and reservoir inundation.

5.6.5. **Access Roads**

Site access for construction will be via an existing unsealed road linking the Left Dam with the Blantyre – Lilongwe M1 road, a distance of approximately 3.5 km. The road intersects the M1 in Lilongwe district approximately 3 km north of the Diamphwe river bridge. Upgrade works will consist of:

- Widening of the carriageway;
- Culvert construction for approximately 1.6 km; and
- Road foundation construction.

In addition, it will be necessary to construct approximately five kilometres of new service roads, which will access quarry and disposal areas, and main infrastructure.

Approximately 300 m of the existing road from the M1 road to the Balance Tank area will require minor upgrading, including regrading and road foundation construction.

The Right Dam can be accessed from an existing road that joins the M1 immediately south of the Diamphwe river bridge. This road is unsealed and will require minor upgrade to facilitate access. This

road will be mainly used during dam operation and will not be used for large vehicles or construction materials.

Upgrade road works will take approximately two months.

5.6.6. **Construction of Diversion Works**

The diversion works have a crucial importance on the overall duration of the project since a majority of the activities, such as the excavation and construction of the spillway, bottom outlet and portion of the dam etc., can only be started after the river is diverted from the main construction area.

River Diversion will consist of:

- An approximately 300 m long excavated canal; and
- Upstream (U/S) and downstream (D/S) cofferdams in the form of a rock filled embankment.

Diversion works will take a total of approximately 5.5 months. At the end of the Dam and auxiliary works construction the culvert will be plugged.

5.6.7. **Construction of Dam and Associated Infrastructure**

Dam body and spillway construction will commence following completion of river diversion works and will include:

- Foundation Excavation and Treatment (contact grouting);
- Construction of dam body, spillway, bottom outlet, intake structures and stilling basin; and
- Concrete placement at a rate of approximately 1000 m3/day.

Construction of these components will take approximately 11 months.

5.6.8. **Raw Water System, WTP and balancing tanks**

Foundation work for the raw water pipes, pump house, WTP and balancing tanks will be undertaken early in the program, followed by construction of the various components, most of which will be manufactured elsewhere and transported to the site.

Construction of the raw water pipes, pumping house and WTP will be undertaken over a 36 moth period.

5.6.9. **Construction of main pipeline**

The transmission system to transfer treated water to Lilongwe city and surrounding areas from the balancing tanks consists of two main sub-systems:

- Pipeline No. 1: A gravity pipeline from the balancing tank to the Northern service zones
- Pipeline No. 2: A gravity pipeline from the balancing tank to the Southern service zones.

The Project study area subject of this ESIA includes the dual gravity mains (Pipelines 1 & 2) from the Balance Tanks to Bunda Turn-off, a distance of approximately 30 km. Pipeline Laying consists of pipe placement on sand bedding and trench backfill (primary and tout-venant). Pipe laying should progress at a minimum rate of 150 m/day.

Main pipeline construction will be done in conjunction with other transmission system works over a 36 moth period.

5.6.10. **Restoration and Mobilisation**

All temporary works and structures will be removed as soon as possible after their use and affected areas appropriately restored. This includes construction access roads, stockpile and laydown areas, quarry site, laboratory, site installations, sheds, garages, workshops, temporary fencing, barriers and work site signposts.

5.6.11. **Construction Materials and equipment**

i. ***Construction materials***

Estimated quantities of construction materials are given in Table 5.13.

Table 5.13 Material Quantity Estimates

Material	Unit	Quantity (X1000)
1. Excavation in soft and weathered ground	m^3	100.0
2. Excavation in rock	m^3	150.0
3. Conventional Concrete	m^3	53.5
4. Mass concrete	m^3	125.6
5. Reinforcement bars	Tonnes	2.3
6. Formworks	m^2	50.7
7. Rockfill for cofferdam	m^3	17.8

ii. ***Construction equipment***

Plant and equipment will include light vehicles, trucks, concrete trucks, dozers, excavators, Vibro roller compactor compactors, rock breaker and crushing plant, drilling rig, concrete batching, loaders and mobile cranes.

iii. ***Traffic***

There will be a need for traffic management during construction to safely manage transportation of equipment, materials and work force since there will be increased traffic in the Project area as the contractor transports equipment and materials to and from the site.

5.6.12. **Construction Water Demands**

Non potable water will be required for dust suppression, washdown areas and for concrete production. Water will be generally sourced from the Diamphwe River, however this will be subject to prevailing conditions and maintaining environmental flows (see Section 8.2). If necessary water can be sourced from the larger Linthipie River further downstream and trucked to the site. Construction activities and scheduling will be carefully managed to ensure water extraction does not significantly affect water resources.

Potable water will be required for the construction workforce. Groundwater will generally be used, however this will be closely monitored and potable water would be trucked in from Lilongwe if necessary. Groundwater will not be used for construction purposes.

Daily water demand estimates are shown in Table 5.14.

Table 5.14 Water Demands

Water Quality	Parameter	M^3/day
Non potable water		
▪ Dust suppression and washdown	X2 water carts operating for 10 hours per day at a rate of 2,500 litres per minute	1,500
▪ Concrete production	Lay 1,000 m3 of concrete per day; Water 50% volume	500
Total		**2,000**
Potable water		
Camp amenities	Maximum 300 workers during construction @ 150 litre per day per person	45
Total		**45**

5.6.13. **Construction Workforce**

It is envisaged that there will be between 200 and 300 workers on the Project during the various stages of construction. Out of these about 100 will be unskilled workers who will most likely come from the local area, another 100 will be skilled workers (technicians and artisans, drivers, plant operators etc.) who will be Malawian and may come from other areas of the country while about 50 will be expatriate from elsewhere (i.e. the region or abroad) whose special skills will be required from time to time so they will all not be there during the whole construction period. However up to ten expatriate employees (for the Consultant and the Contractor) will be on site for almost all the time.

5.6.14. **Area of Project Impact**

The Project will impact on **2728 ha** of land, which comprises of:

- The dam impoundment will result in the permanent loss of 2,328 ha of mostly agricultural land. A further 38 ha will be lost due to dam related infrastructure.
- Public access will be restricted to a 15 m wide buffer zone around the impoundment perimeter, which equates to approximately 156 ha of land. Buffer areas around Dam infrastructure will account for an additional 124 ha.
- Construction activities will temporarily impact on approximately 82 ha of land. This affected area will be rehabilitated to pre-construction landuses.

A breakdown of affected areas is shown in Table 5.15.

Table 5.15 Project Land Requirements

Project component	Permanent (ha)	Permanent Buffer (ha)	Temporary (ha)	Total Disturbed (ha)	Description
Reservoir	2,328	156		2,484	▪ This includes the dam inundation area up to a FSL of 1180.3 masl. ▪ A 15 metre wide buffer zone to be situated around the dam. This zone will be planted with endemic forest woodland species.
Dam Infrastructure	16	124	22	162	▪ Structures will include the dam wall and associated structures, raw water pump station and pipeline,

Project component	Permanent (ha)	Permanent Buffer (ha)	Temporary (ha)	Total Disturbed (ha)	Description
					WTP and pipeline, balancing tanks, access roads and office / accommodation buildings. ▪ Exclusion zones will be maintained around dam components. ▪ Temporary construction areas will include some access roads, laydown areas and quarry. These areas include directly impacted and buffer areas and will be subsequently rehabilitated.
Service Pipeline			60	60	The 30 km pipeline will be constructed within the road easement. On completion the area will be rehabilitated and unrestricted access permitted.
TOTAL	**2,342**	**258**	**82**	**2,682**	

5.6.15. Management of Storm Water, Wash Water and Effluent on Construction Sites

Discharge of any pollutants from construction sites into the neighbouring environment, such as chemicals and fuels, as well as untreated sewage effluent shall be prevented. It is required that the Contractor comply with all relevant laws and regulations in Malawi concerning water provision, sanitation, and wastewater discharge when planning its worker's camp, other buildings, sanitation infrastructure, etc. on site.

Drainage structures (channels, ditches, sumps) shall be constructed to effectively drain runoff from work sites. These will be designed by the Contractor once appointed. Particular care shall be taken to ensure that facilities are capable of dispersing maximum predicted rainfall.

5.7. Project Cost

The total Project construction cost is estimated to be US$237.0 Million. A cost breakdown is provided in Table 5.16.

Table 5.16 Project Construction Cost Breakdown

ITEM	DESCRIPTION	COST (US$ Million)
A	**Construction Cost**	**198.0**
1	Site installation and services	4.0
2	River diversion works	4.9
3	Dam and spillway	37.0
4	Bottom outlet	5.7
5	Intake	3.2
6	Dam instrumentation	0.3
7	Raw water system	5.1
8	WTP: Raw water intake, screening system, pre-oxidation tank	2.0
9	WTP: Distribution pits and flocculation-sedimentation tanks	4.8
10	WTP: Water distribution pit	0.5
11	WTP: Filter buildings	7.6
12	WTP: Storage tank for backwashing	2.1
13	WTP: Chlorination tanks	1.9
14	WTP: Chlorination tanks 2	3.0
15	WTP: Potable water pumping station	7.8
16	WTP: Water recovering tank	1.1
17	WTP: Sludge dewatering area	0.3
18	WTP: Chlorine dosage and storage buildings	1.7
19	WTP: Chemicals' dosage and storage buildings	0.5
20	WTP: Chemicals dosage building	0.2
21	Balancing tanks	3.0
22	Main pipe line	101.1
B	**Contingencies**	**20.0**
C	**Technical assistance**	**19.0**
1	Institutional strengthening to LWB	
2	Water and Sanitation Master Plan	
3	Project Management	
	Total Project Cost	**237.0**

Excluding Distribution network, compensation for land and the PPA.

Chapter 6
Existing Environment

Environmental and Social Impact Assessment

February 2016

6. BASELINE BIOPHYSICAL ENVIRONMENT

6.1. Introduction

6.1.1. Study Area

The Project study area comprises of a number of distinct areas that may be either directly or indirectly affected by the Project. These areas are shown on Figure 6.1 and Figure 6.2, and described below:

i. ***Direct Impact Areas***

Direct impacts occur due to physical disturbance to land, soil, water, air or impacts on sensitive receivers, such as residential homes. These areas will be subject to detailed investigations, including preparation of detailed land use maps and field studies. These areas include:

- **Reservoir**: This includes the area that will be directly inundated by the Dam up to the maximum supply level of 1180.3 masl and a mandatory 15 m wide exclusion zone.
- **Infrastructure and downstream:** This area covers the Dam and ancillary structures and includes land and buffers required for construction of infrastructure such as access roads, construction camps, office, pump station, raw water pipeline, WTP and balancing tanks. Also included is a wider area that may be affected by construction and operational activities such as laydown areas, material stockpiles, noise, dust and traffic.

  Direct impacts may occur downstream of the Dam due to construction activities and changes to natural river flows. The study area also incorporates an approximate 3 km downstream stretch of the Diamphwe river to its confluence with the Linthipe river.

- **Main service pipelines**: This area includes a 20 metre wide area along the pipeline alignment, which extends approximately 30 kilometres to Lilongwe from the Balance tanks to the Bunda turnoff.

ii. ***Indirect Impact Areas***

These areas may be indirectly influenced by the Project and generally include the catchment area contributing runoff to the Dam. Landuse maps will be prepared, however not to the same detail as areas directly affected by the project footprint and related impacts.

The Diamphwe Dam catchment covers an area of approximately 1403 km^2 and includes protected State forest in its upper reaches. Management of the wider catchment will be necessary to maintain Dam water quality, while indirect impacts may relate to regional wildlife movements and changes to social economic characteristics.

6.1.2. Baseline Investigations

i. ***Previous studies***

Relevant information was sourced from a variety of sources. A list of information and data identified is provided in **Appendix 1**. Important documents include:

- WAPCOS (2014): Environmental & social reports comprising:
  - Inception Report;
  - Baseline Assessment Report;
  - Stakeholder Consultation Report; and
  - Draft ESIA report.

- Studio Pietrangeli (2014-2015), *Inception Report for Detailed Design of Diamphwe Multipurpose Dam & associated structures*: Design report comprising:
  - Topographical Report;
  - Hydrological Report;
  - Geological Report;
  - Spillway Physical Model;
  - Water Supply Technical report;
  - Water Supply Technical report;
  - Detailed Design Drawings;
  - Optimized Dam Design Report; and
  - Dam Design Technical Report.
- *SOGREAH* (2011): *Preliminary ESIA of the Feasibility Study and Preliminary Designs for Lilongwe's New Water Source* report;
- S*AFEGE* (2002): *Preliminary ESIA under Engineering Studies*; and
- Other sources of information include the Lilongwe Water Board (LWB), government departments and NGOs, various socio-economic and environmental databases, mapping information and relevant websites.

ii. ***Additional investigations***

SMEC has reviewed relevant information and identified information gaps. A review Report identifying issues requiring further investigations was submitted to the Client in October, 2015. Subsequently SMEC has undertaken a number of additional baseline investigations including:

- Stakeholder consultations;
- Terrestrial and aquatic surveys;
- Water quality and background noise monitoring;
- Traffic survey;
- Cultural survey;
- Health study; and
- Census, asset and socio-economic surveys.

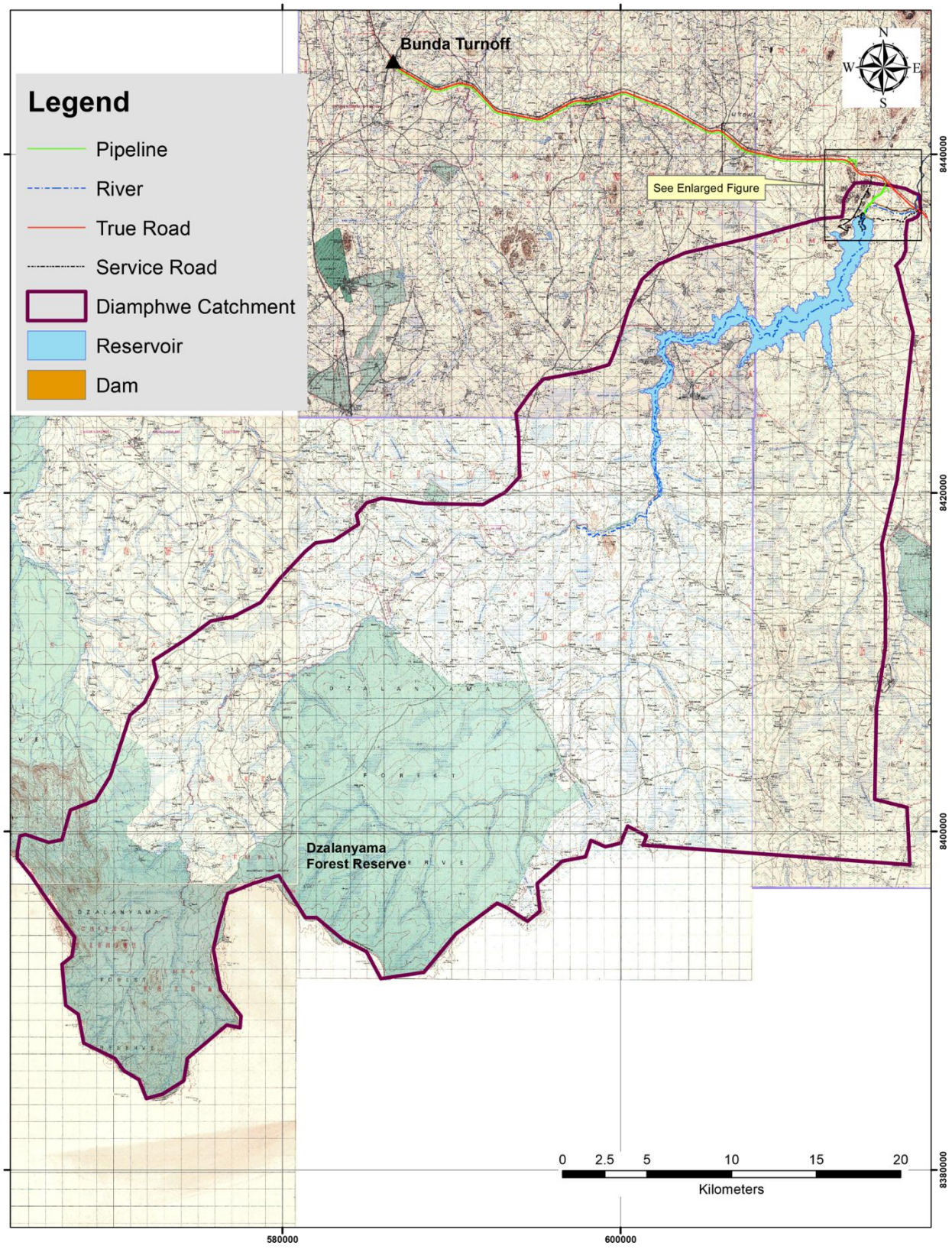


Figure 6.1: ESIA Study Area

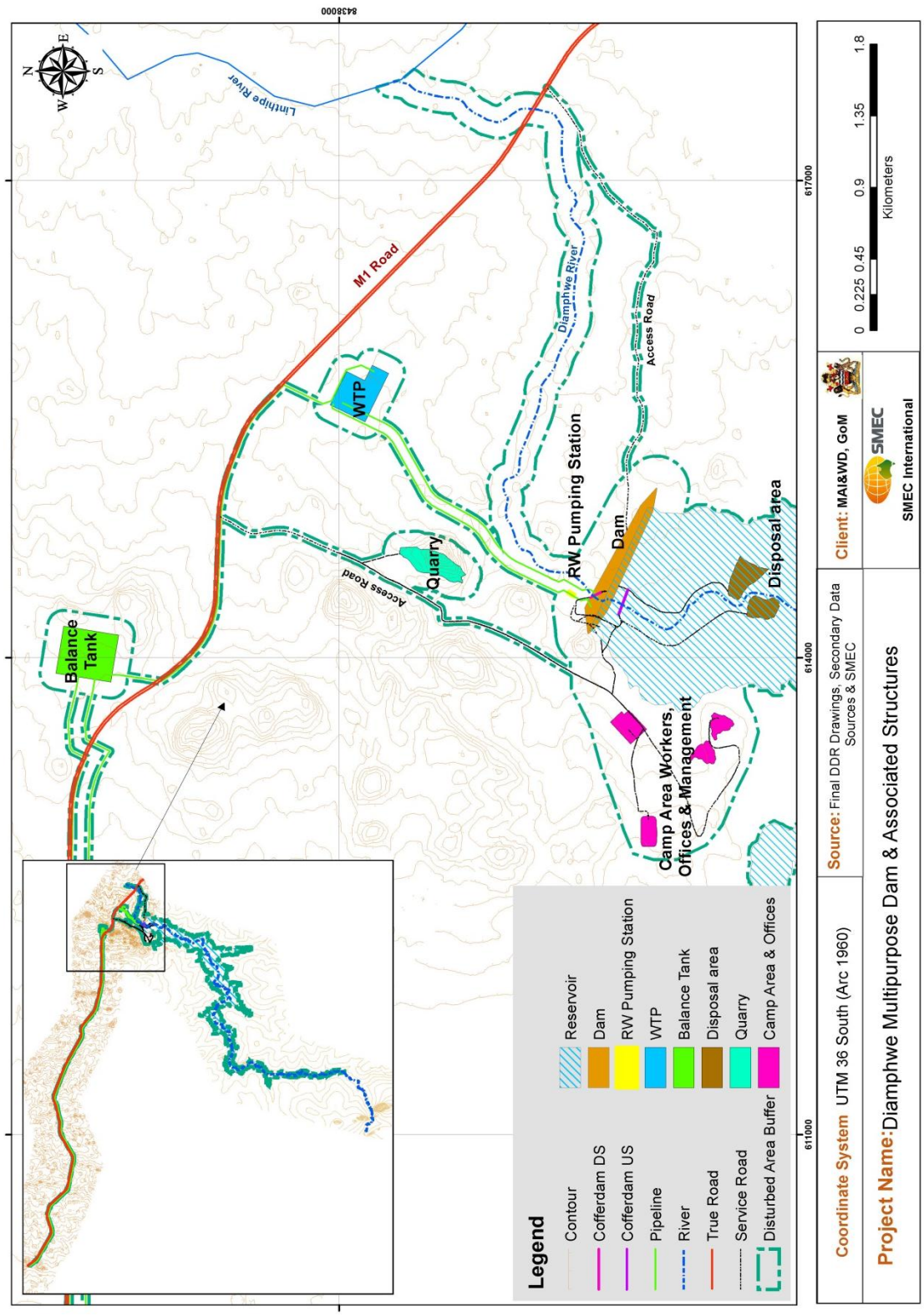


Figure 6.2: ESIA Study Area: Infrastructure

6.2. Geology and Seismicity

6.2.1. Information Sources

A general description of Geology within the Project region has been described by Sogreah, 2010. More specifically Studio Petrangeli (SP) undertook an extensive geological survey in 2014, which included analysis of the existing data and bibliographic research; photo interpretation of satellite images for morphostrucutral analysis; field mapping and investigation, geophysics and laboratory tests. Eight boreholes and 13 exploratory trenches were investigated in the Project area.

6.2.2. Regional and Local Geology

i. *Regional Geology*

The region is divided into various topographical units as shown on Figure 6.4 and listed below:

- Dzalanyama Range;
- South and North Lilongwe plain;
- Dissected remnant of Lilongwe-Dowa plain;
- Dedza hills;
- Rift Valley Fault Scarp Zone and
- Lakeshore plain.

The Dzananyama range (NW-SE axis) is located along the Mozambican boundary, which determines the catchment's line, and then the drainage system from west to east. A large North-South plain (Lilongwe plain) is occupied by tertiary deposit: the plain develops from North-west to South of Lilongwe city, forming part of the late cretaceous to early Miocene 'African' erosion surface. Some isolated prominent residuals of post-Gondwana erosion surface (Cretaceous) occur; they correspond to inselbergs of massive gneisses (Malingunde, Bunda).

Elevation ranges between 1000 and 1500 masl. From this relatively flat plain, the topography increases up to the NW-SE hills range including Dowa mountains and Dedza and Chongoni mountains. These hills correspond to post-Gondwana residual mountains, affected by African erosion surface and post-African dissection (late Miocene and Pliocene). The mountains correspond to ancient gneissic or granulitic mountains or group of inselbergs from a basement complex. Elevation can reach 1800 m. Some faults control the range, with NNE-SSW and NW-SE and a vergence in N-S and WNW-ESE in the northern part of Lilongwe In the eastern part, the Main valley faults scarp zone separate the central plateau from the lakeshore plain longing the Malawian lake. Main faults direction is NW-SE (normal fault), with downthrown site eastward (graben), and NE-SW (shearing fault). The gneissic lineation and foliation is varying depending on the area. In the west, main direction is NW-SE. In the north, it is variable, mainly N-S to NE-SW. In the south-east part, direction is mainly NE-SW.

Very few sheared zone exist in the study area and many normal and transverse faults and joints cross the basement complex. Normal faults determine down-lifted compartments to the east, towards the rift valley direction. The direction of these normal faults is mostly NW-SE and determines opened fractures.

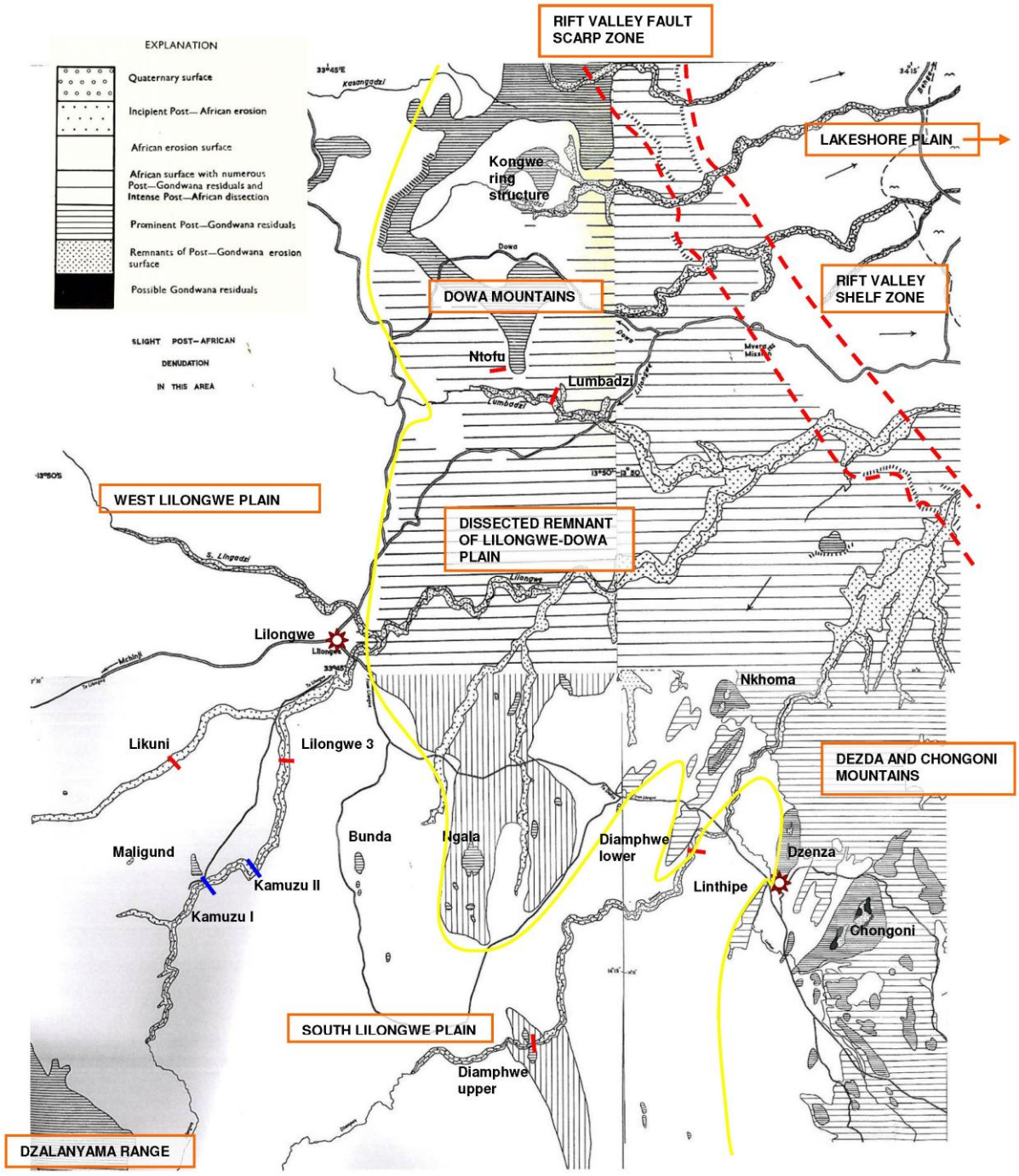
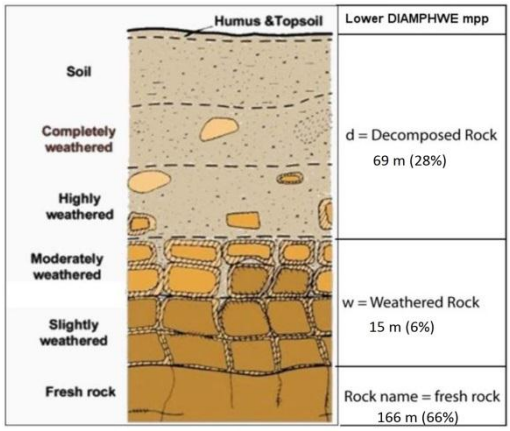


Figure 6.3: Regional Geology

ii. ***Project Site Geology***

The proposed Dam is situated in a gently undulating plain that extends from the Dzananyama range located along the Mozambique boundary, which determines the catchment's line, and the drainage system from west to east. The plain, built up mainly by loose deposits, is the result of extensive erosion cycles that followed several phases of uplift during the Cretaceous to Cenozoic periods. The Dam site lies entirely on the Precambrian basement metamorphic



rocks belonging to the Malawi Province of the Mozambique belt. The bedrock is covered by a variable thickness of soil of eluvial, colluvial and alluvial origin. The main rocks outcropping in the site are gneisses with sedimentary protolith (greywackes and sandstones). Investigations by Studio Petrangeli (2014) indicate that the boundaries between the various grades of weathered rock are sharply defined. In particular, there is a fixed frontier dividing rock and soil without gradual transition. Bedrock is covered by a variable thicknesses of loose material, with alluvial and residual deposits ranging from zero up to a thickness of 15 m (Figure 6.4).

According to Studio Petrangeli (2014) there are two broad geotechnical units:

1. SOIL UNIT (S): Made of loose deposits of built up river sediments and residual material that cover most of the ground surface. This level, with a variable thickness up to 15 m, is made mainly of silty and clayey sand with subordinate levels of clay.
2. GNEISS (G): Consisting of crystalline metamorphic rock.

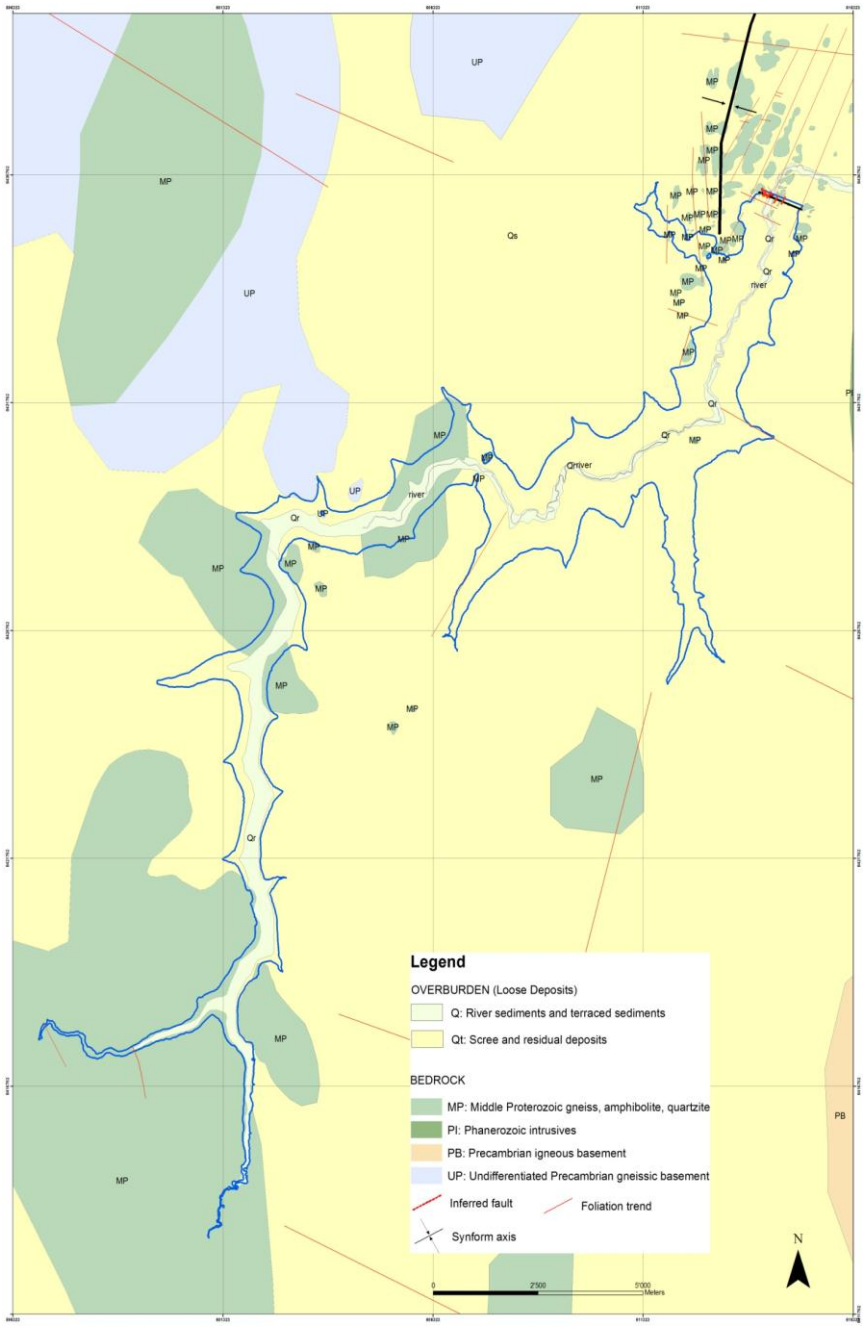


Figure 6.4: Geological map of the Dam site (SP, 2014)

6.2.3. **Seismicity**

The project area has been affected by considerable seismic activity in the past with frequent earthquakes of magnitude (M) 2.9 to 5.1 and having shallow epicentres of up to 35 km and exceptionally up to 46 km. Two earthquakes of M 5.8 and M 6.6 were recorded in 1989 at 60 to 95 km from the site. Seismic activity is generally related to active tectonic structures such as faults and monoclines of the Malawi rift.

Regional seismic events recorded over the last 30 years are shown on Figure 6.5, which shows that the majority of earthquakes are centred on Lake Malawi. Since 1973 approximately 10 earthquakes have occurred in and around Lilongwe and the Project site.

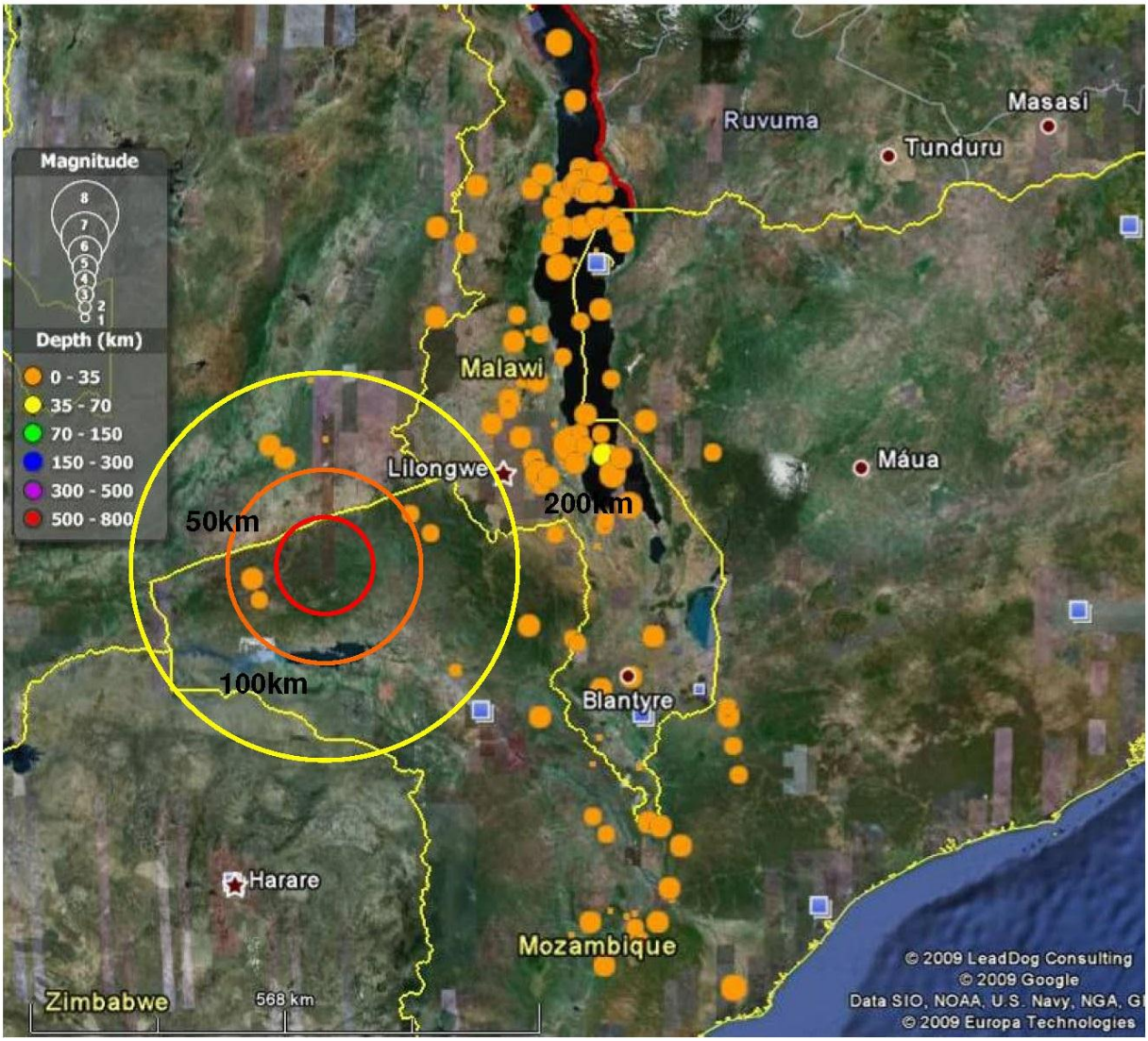


Figure 6.5: Distribution of Earthquakes in Malawi Since 1973 (Sogreah, 2010)

6.3. Topography

6.3.1. **Information Sources**

As part of Dam design a detailed topographical survey was undertaken by Studio Petrangeli (2014). The survey used a number of survey methodologies including Differential Global Positioning System (DGPS) with satellite differential correction, photogrammetric restitution of images acquired by the SPOT 5 satellite system and merging of the SRTM and ASTER data base.

6.3.2. **Regional Topography**

Lilongwe district is characterised by extensive plains lying at mid-altitudes (1000-1400 masl), interspersed with isolated inselbergs (rock hill or small mountain). Regional topography and landforms are shown on Figure 6.6. South of Lilongwe the Ngala hills (1,600 m) and Bunda hills (1,500 m) are prominent landmarks, soaring almost sheer from the plain. Similarly, Chiwamba, Nkuyu and Nguli hills rise to between 1,125 and 1,189 masl. To the east, the Lilongwe plains become increasingly dissected and merge with the Dedza hills and Dedza scarp zone. The Dzalanyama Forest lies to the south west of the Lilongwe plains, part of which is located in the upper Diamphwe river catchment.

Dedza district is divided into three topographic zones: the Lilongwe Plain, Dedza Highlands, and the Escarpments. The Lilongwe Plains are in the northern and western parts of the district and lie at an altitude of 1100-1300 masl. The Dedza Highlands (Kirk Range and Dzalanyama Range) occupy the western part of Dedza Escarpments. The highlands consist of uplands with an altitude varying between 1200 to 2200 masl. The topography is characterized by rolling slopes to hills varying between 13-55 degrees.

6.3.3. **Dam Catchment**

The Diamphwe river originates in the Dzalanyama Mountains at an altitude of 1,300 masl and drops approximately 149 m metres to around 1151 masl at the Dam site. The Project area is located between Ndomba Hill in Dedza District and Chinzili and Phili la Fisi Hills in Lilongwe District. The topography around the Project site is typically flat to undulating, with the occurrence of localized rock outcrops and inselbergs. Low lying dambos (seasonal wetlands) occur along the river banks, and are particularly prominent where tributaries join the river. Topographical information is shown on Figure 6.7 and Photograph 6.1.

Photograph 6.1: Topographical Landforms of the Project Area

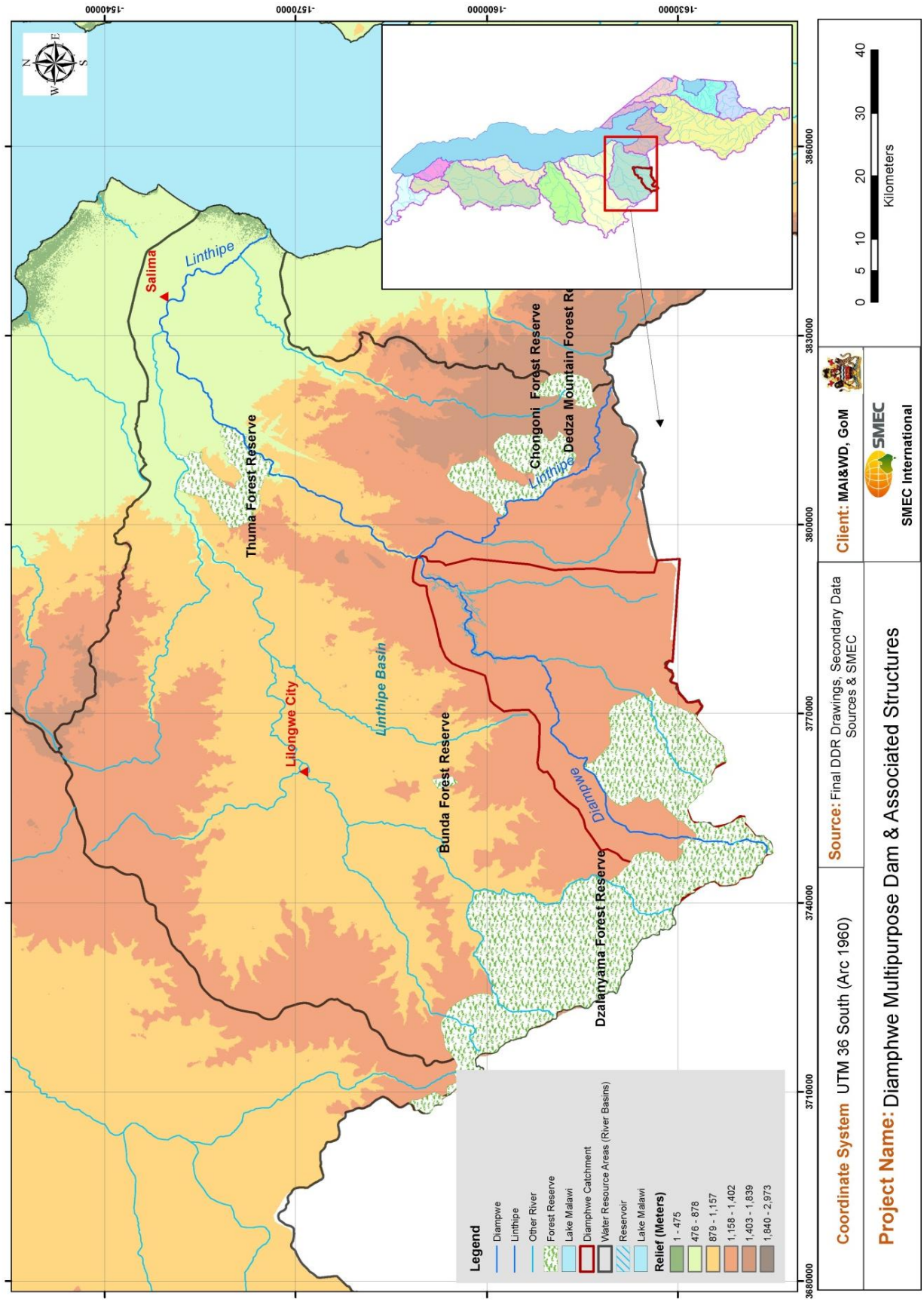


Figure 6.6: Regional Topography and Landforms

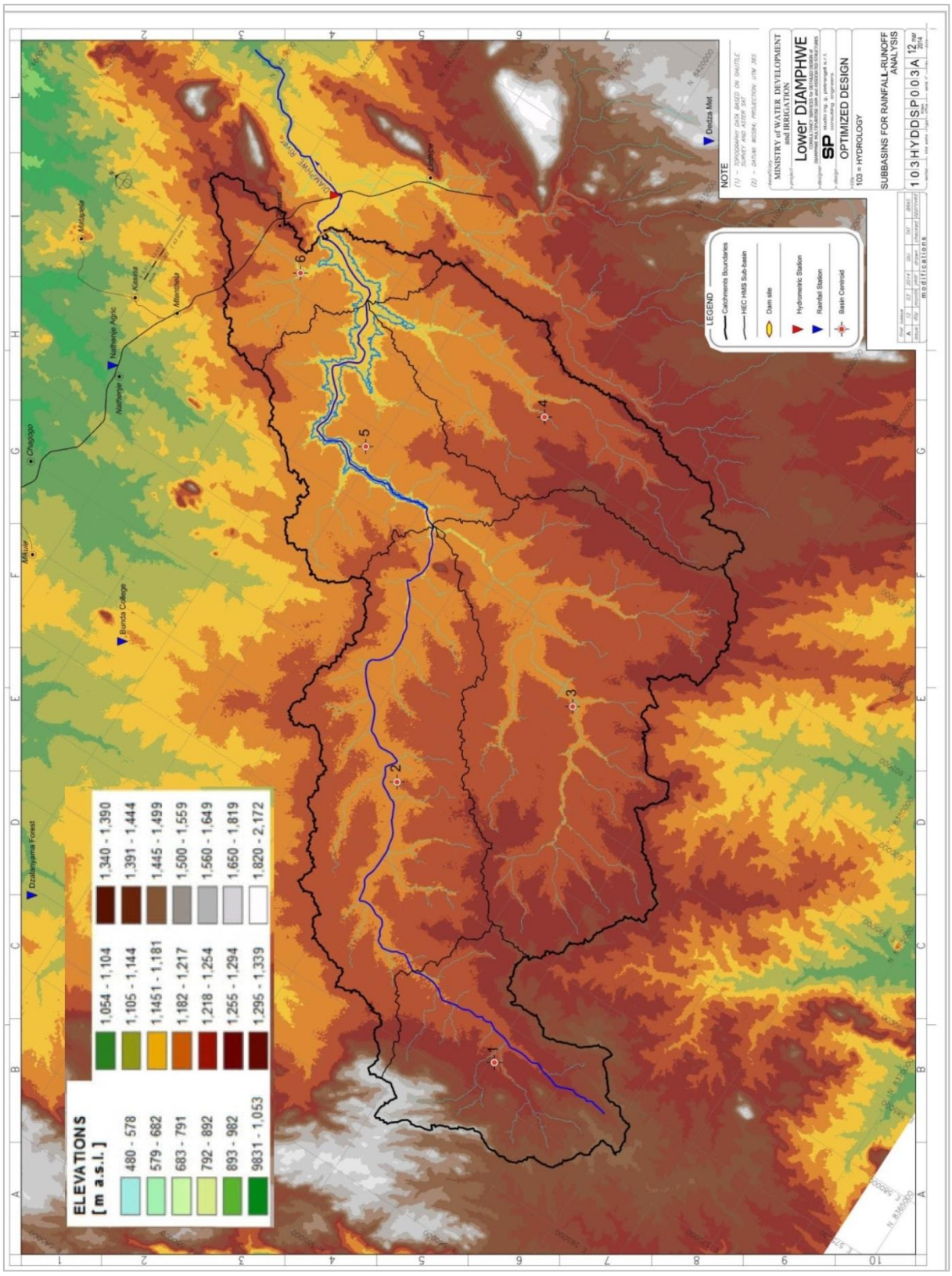


Figure 6.7: Topography and Meteorological Stations

6.3.4. **Water Pipeline to Bunda-Turn-off**

The Balance tanks will be located on an elevated knoll (elevation of 1252 masl) on the southern side of the M1 road at Mbuna. From here the pipeline will follow the topography, initially dipping and then rising to a high point at about 5 km, and then steadily declining to approximately 1050 masl at about the 16.5 km mark. Topography then gradually rises, with a few dips, to reach the Bunda Turn-off at an elevation of 1150 masl. The total vertical drop over the 30 km distance is 102 m (Figure 6.8).

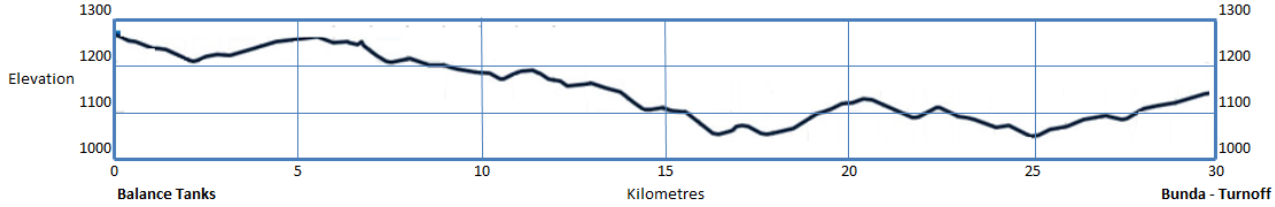


Figure 6.8: Service Pipeline Topography

6.4. Soils

6.4.1. **Information Sources**

A number of studies have been undertaken to describe Project area soils. These include:

- WAPCOS (2014) undertook soil sampling and testing within the Project area. Ten samples were collected in February 2014 and again in July 2014, and tested for physical and chemical properties.
- Studio Petrangeli (2014) undertook trench soil investigations and testing for physical and engineering characteristics. Investigations were done from around the proposed Dam wall and infrastructure area, as well as upstream within the inundation area. SP (2014) also prepared an irrigation report, which assessed soil type and productivity.
- Sogreah (2010) investigated and described soils around the proposed Dam wall and infrastructure area, inundation area and quarry site.
- The MoAIWD recently completed a *National Irrigation Master Plan and Investment Framework for Malawi* (SMEC 2015), which included soils capability mapping of the study area.

6.4.2. **Soil Description**

Soils in the project area have been described as moderately deep and well-drained, brown to reddish brown in colour and coarse to fine textured. The soils on the Lilongwe side are predominantly dark, dark red sandy clay or clay, possessing typical properties of ferruginous soil. Clay loam and sandy loam soils are predominant soils in various parts of the Dedza district (WAPCOS, 2014).

The soil erosion risk map obtained from the Department of Land Resources and Conservation indicates that Soil in the catchment has a slight to moderate soil erosion risk (Department of Land Resources and Conservation: Soil Erosion Risk Map).

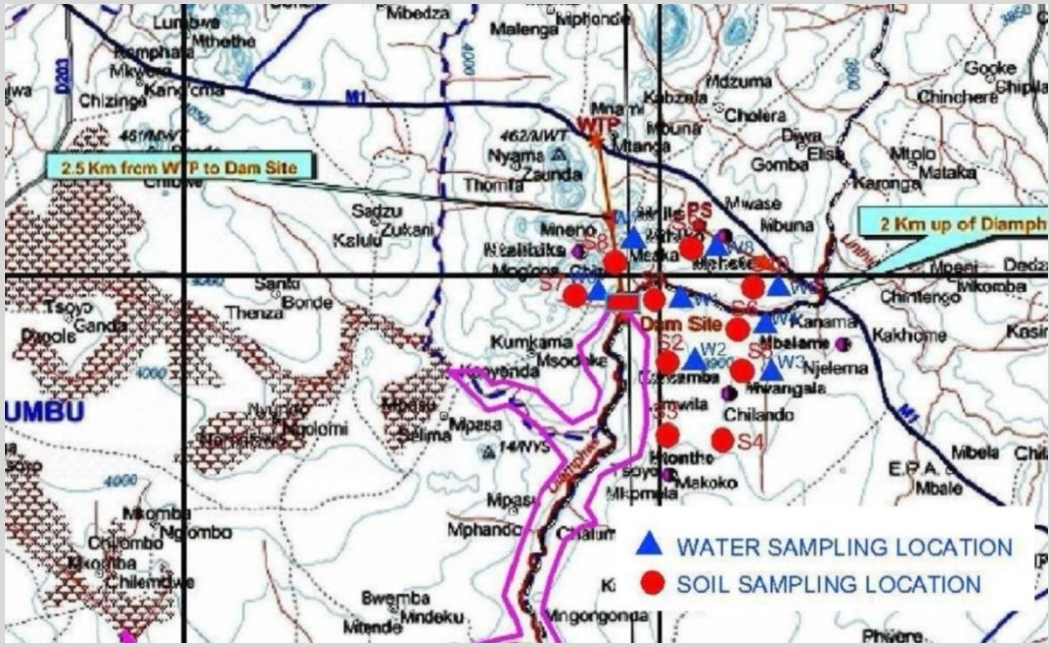
6.4.3. **Soil Sampling and Testing**

WAPCOS, 2014 completed soil field investigations in the Project area, including undertaking a sampling and testing program. A total of 10 samples (S1 – S10) were analysed in February 2014 and samples from the same locations further analysed in July. Samples were analysed by Central Water Laboratory at Lilongwe and results are reproduced in Figure 6.9.

WAPCOS concluded that pH of the soil was in the acidic to neutral range, with pH ranging between 6.63 to 7.23 in February and 4.5 to 5.0 in July. The Electrical Conductivity (EC) values were low

indicating low salt content. The level of nitrogen, phosphorus and potassium indicated moderate soil productivity and based on the level of organic matter, the productivity was categorized as moderate to high.

These findings were generally confirmed by Studio Petrangeli (2014) and Sogreah (2010) irrigation studies, which classified soils immediately downstream of the proposed Dam as suitable for a range of agricultural uses.



Results of analysis of soil sampling conducted in February 2014

Sampling Locations	Parameter				
	pH	EC	NO_3	PO_4	K^+
S1	7.23	16	0.010	<0.001	0.1
S2	7.09	10	0.020	0.128	0.1
S3	6.98	13	0.001	0.126	0.2
S4	6.80	19	0.063	<0.001	0.1
S5	6.68	12	0.016	<0.001	0.5
S6	6.82	14	0.074	0.156	0.8
S7	6.78	28	0.001	0.012	0.7
S8	6.72	22	0.050	0.552	0.6
S9	6.71	18	0.017	<0.001	0.6
S10	6.63	15	0.052	0.246	0.3

S1–Near proposed Dam Site
S2–500 m downstream of proposed Dam
S3–500 m upstream of proposed Dam
S4- upstream of proposed Dam site- Agriculture land
S5-Near upstream school site
S6-upstream of Dam site near village Chinthuli
S7-Near village Chinthuli
S8-Near village Kampheta
S-9- village Kampheta
S-10 Near village Nathenje

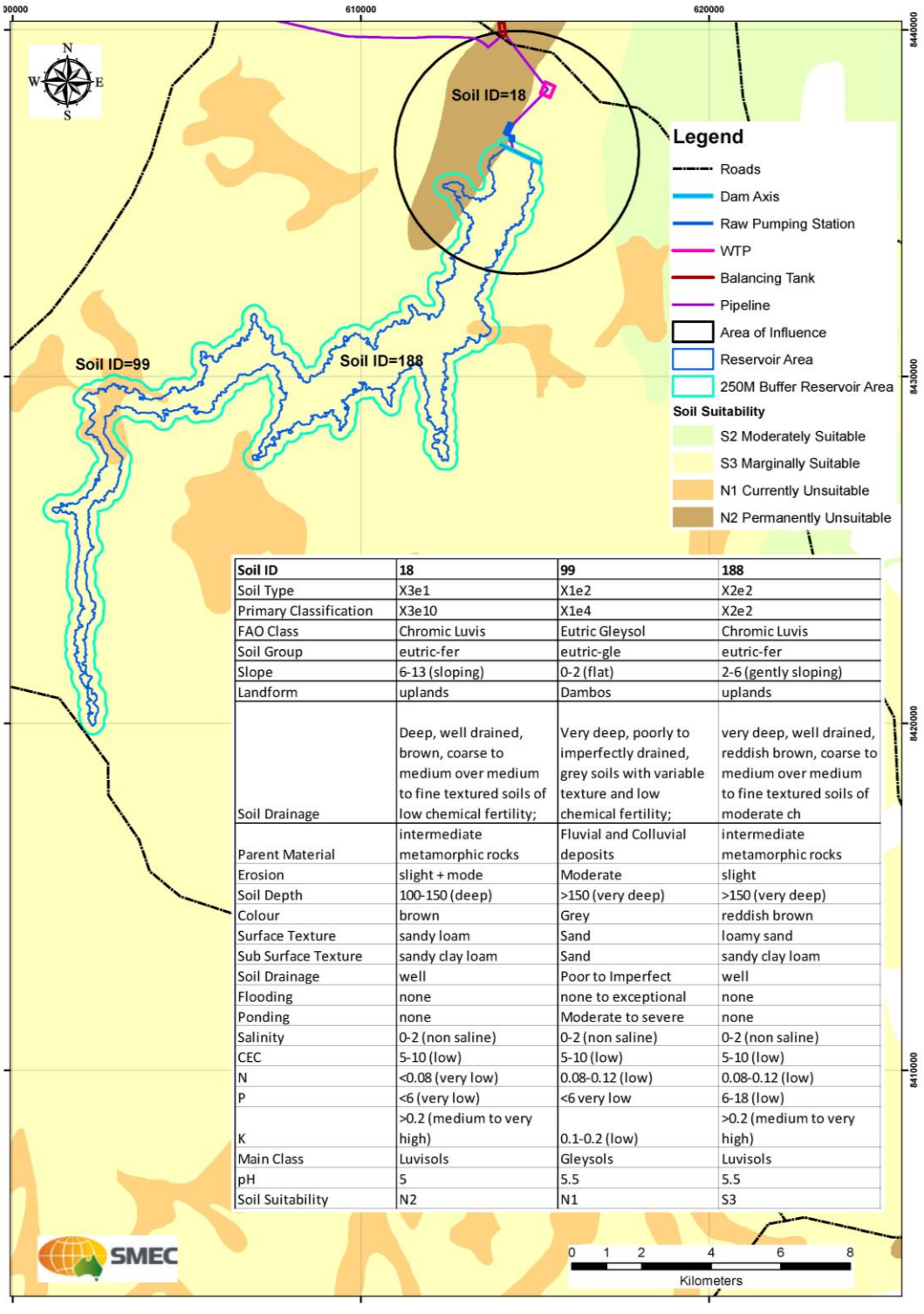
Results of analysis of soil sampling conducted in July 2014

Sample Locations	Parameter				
	pH	% N	P (mg/kg)	K (mg/kg)	% OM
S1	4.9	0.252	16.4	Trace	0.3
S2	5.0	0.391	18.6	Trace	2.2
S3	4.6	0.319	19.9	112	1.6
S4	4.3	0.328	85.0	53	1.9
S5	4.4	0.435	19.9	119	3.5
S6	4.0	0.265	17.0	26	2.7
S7	4.4	0.411	16.4	397	2.5
S8	4.7	0.466	13.6	81	4.1
S9	4.5	0.542	16.2	15	4.1
S10	4.6	0.453	35.0	171	3.1

Figure 6.9: Soil Sampling Results (WAPCOS, 2014)

6.4.4. **Landuse Suitability Study**

The MoAIWD recently completed a National Irrigation Master Plan and Investment Framework for Malawi (SMEC 2015), which included soils capability mapping of the study area (Figure 6.10). The study identifies the majority of the soil in the study area as Class S3, which is marginally suited for agriculture, but has significant limitations with potential yields being only 40 to 60% of the maximum. Small areas in the upper part of the catchment and around the western side of the Dam wall were described as being unsuitable for agricultural use.



Soil ID	18	99	188
Soil Type	X3e1	X1e2	X2e2
Primary Classification	X3e10	X1e4	X2e2
FAO Class	Chromic Luvis	Eutric Gleysol	Chromic Luvis
Soil Group	eutric-fer	eutric-gle	eutric-fer
Slope	6-13 (sloping)	0-2 (flat)	2-6 (gently sloping)
Landform	uplands	Dambos	uplands
Soil Drainage	Deep, well drained, brown, coarse to medium over medium to fine textured soils of low chemical fertility;	Very deep, poorly to imperfectly drained, grey soils with variable texture and low chemical fertility;	very deep, well drained, reddish brown, coarse to medium over medium to fine textured soils of moderate ch
Parent Material	intermediate metamorphic rocks	Fluvial and Colluvial deposits	intermediate metamorphic rocks
Erosion	slight + mode	Moderate	slight
Soil Depth	100-150 (deep)	>150 (very deep)	>150 (very deep)
Colour	brown	Grey	reddish brown
Surface Texture	sandy loam	Sand	loamy sand
Sub Surface Texture	sandy clay loam	Sand	sandy clay loam
Soil Drainage	well	Poor to Imperfect	well
Flooding	none	none to exceptional	none
Ponding	none	Moderate to severe	none
Salinity	0-2 (non saline)	0-2 (non saline)	0-2 (non saline)
CEC	5-10 (low)	5-10 (low)	5-10 (low)
N	<0.08 (very low)	0.08-0.12 (low)	0.08-0.12 (low)
P	<6 (very low)	<6 very low	6-18 (low)
K	>0.2 (medium to very high)	0.1-0.2 (low)	>0.2 (medium to very high)
Main Class	Luvisols	Gleysols	Luvisols
pH	5	5.5	5.5
Soil Suitability	N2	N1	S3

Figure 6.10: Project Area Soils Distribution (SMEC 2015)

6.4.5. Soil Mechanical Properties

Studio Petrangeli's design studies included investigating ground conditions from eight boreholes and 13 exploratory trenches within the Project area. A range of mechanical properties were assessed, including undertaking Sieve Analysis to determine soil properties (particle size, Liquid Limit, Plastic Limit) and Soil Classification in accordance with the United Soil Classification (USCS) System.

Soils were found to mostly comprise of sand and clay, with little or no gravel, and classified as follows:

- *S1 Unit*: This unit corresponds to a lean sandy clay (CL) with thickness ranging from 0.5 to 3 metres and occurs mostly in the upper part of the ground surface.
- *S2 Unit*: This unit corresponds to a fat sandy clay (CH) with thickness ranging from 1 to 3 metres and occurs mostly near the ground.
- *S3 Unit*: This unit is built-up by a coarse grained deposit made by clayey and silty sand (SM & SC) and is found at depths greater than 2.5 m.

These soils are slight to moderately prone to erosion.

6.4.6. Water Pipeline to Bunda-Turn-off

Soils along the proposed pipeline alignment are predominantly dark, dark red sandy clay or clay, possessing typical properties of ferruginous soil. These soils are slight to moderately prone to erosion.

6.5. Climate

6.5.1. Information Sources

Climate has been described by WAPCOS (2014). More detailed rainfall and evaporation information is provided by Studio Petrangeli (2014) and Sogreah (2010) as part of detailed hydrological and irrigation investigations. Rainfall gauging stations are located at four sites near the Project area as shown in Figure 6.7 and described in Table 6.1. Other data is available from stations at Dedza and Lilongwe.

Table 6.1 Rainfall Stations (Ref. SP, 2014)

Station Name	Coordinates UTM-WGS 84		Elevation [masl]	Data Period	Years	Data resolution	Mean Annual Rainfall [mm]
	East	South					
LUANAR	583090	8432230	1175	1961-2013	53	867	867
Dedza Met	634811	8416884	1620	1967-2013	47	937	937
Dzalanyama Forest	564733	8427859	1130	1954-1989 1995-1997	39	1024	1024
Nathenje Agric.	598961	8443233	1070	1955-1976 1978-1994 1997-2013	56	932	932

6.5.2. Rainfall and Temperature

i. *Rainfall*

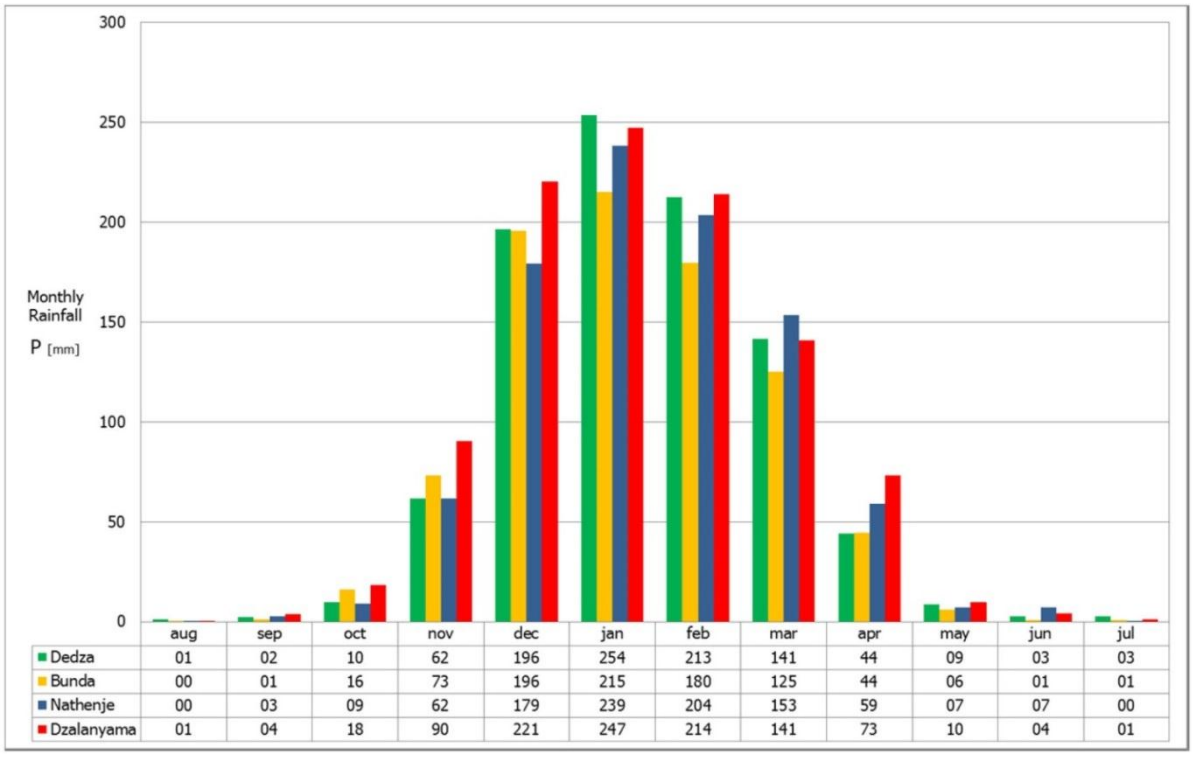
The Project area has a warm tropical climate and distinct wet and dry seasons:

- Dry season: August to October; and

- Wet season: November to mid-April.

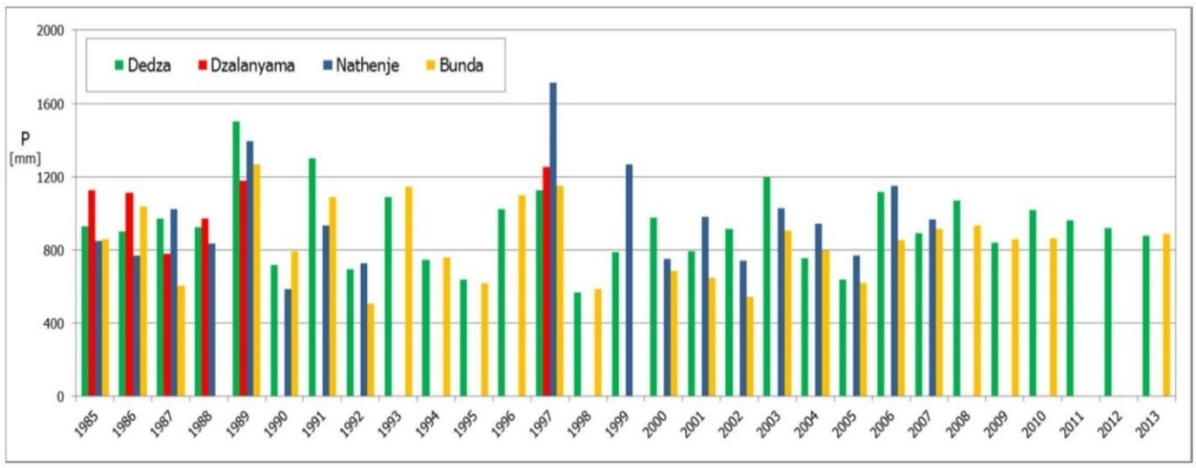
There are two distinct types of rainfall events, these being intense and short duration tropical storms; and cyclones that last over one or two days and extend over large areas. Cyclones events are relatively infrequent; however they have a significant influence on large floods.

There is noticeable variability between meteorological stations, with the mean annual average rainfall ranging from 867 mm (LUANAR) up to 1024 mm (Dzalanyama Forest). The combined annual average rainfall is 940 mm and ranges from less than 10 mm during the dry season, up to around 239 mm in December. Monthly average rainfall and variability for each station is shown on Figure 6.11.



	aug	sep	oct	nov	dec	jan	feb	mar	apr	may	jun	jul
Dedza	01	02	10	62	196	254	213	141	44	09	03	03
Bunda	00	01	16	73	196	215	180	125	44	06	01	01
Nathenje	00	03	09	62	179	239	204	153	59	07	07	00
Dzalanyama	01	04	18	90	221	247	214	141	73	10	04	01

Average rainfall



Rainfall variability

Figure 6.11: Average Annual Rainfall and Variability Between Stations (Ref. SP, 2014)

Rainfall variability is likely a result of characteristic orographic effects, which is a phenomena related to windward slopes receiving more rainfall than the leeward slopes of hills or mountains; and high elevations receiving more rainfall than low lying areas. The passage of the inter-tropical convergence zone, experienced between December and June, also influences local rainfall variability.

Consequently, higher elevation stations at Dedza and Dzalanyama Forest have relatively higher rainfalls during the wet season. The strong seasonal influence on rainfall patterns results in a restricted length of growing season of between 135 and 150 days.

Studio Pietrangeli (2014) spatially distributed the data using Thiessen polygons and rainfall at the proposed Dam site is shown in Table 6.2.

Table 6.2 Monthly Average Rainfall at Diamphwe Dam Site

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Year
Monthly Average Rainfall (mm)	248	205	151	45	5	1	1	1	2	11	63	194	927

ii. ***Temperature, evapotranspiration and humidity***

Monthly average temperatures and evapotranspiration are presented in Table 6.3. A cool and dry winter season is evident from May to August with mean temperatures varying between 14 and 16 degrees Celsius (^{o}C). A mild and dry season lasts from September to October with average temperatures varying between about 17 ^{o}C and 20 ^{o}C. The lowest temperatures are experienced in July at about 13^{o}C; and the highest temperatures of around 20 ^{o}C experienced in October to November.

The annual Potential Evapotranspiration (PET) was available from Dedza and adjusted using the Hamon method to reflect regional spatial distributions (Studio Pietrangeli, 2014). PET ranges from 57 mm in June and July, up to 70 mm in October.

Table 6.3 Average monthly Temperature and Evaporation

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Year
Monthly Average Temperature (°c) (Dedza)	18.7	19.0	18.5	17.6	15.9	14.0	13.6	15.2	17.8	19.7	20.0	19.1	17.4
Monthly Average PET(mm) (Dedza and adjusted by Hamon)	61	59	67	67	65	57	57	60	64	70	65	62	756
Monthly Average Humidity (%) (Dedza)	84	86	83	81	72	67	66	60	55	57	65	80	

6.5.3. **Wind**

Wind data related to average monthly wind speed and direction are shown on Figure 6.12.

Average wind speeds of around 3 to 4 m/s are lowest during the wet season, with prevailing winds trending generally in an arc from the north east to north west and west during January and February.

From March to about July prevailing winds orientate to the east and south east, however average speeds remain relatively unchanged.

From September prevailing winds trend dominantly to the east and north east, with average wind speeds increasing up to 6.5 m/s in October, before declining in strength over November and December.

Beaufort Wind Force Scale

Up to 1.5 m/s:	Light air
1.6 to 3.3 m/s:	Light breeze
3.4 to 5.5 m/s:	Gentle breeze
5.5 to 7.9 m/s:	Moderate breeze
8 to 10.7 m/s:	Fresh breeze
10.8 to 13.8 m/s:	Strong breeze

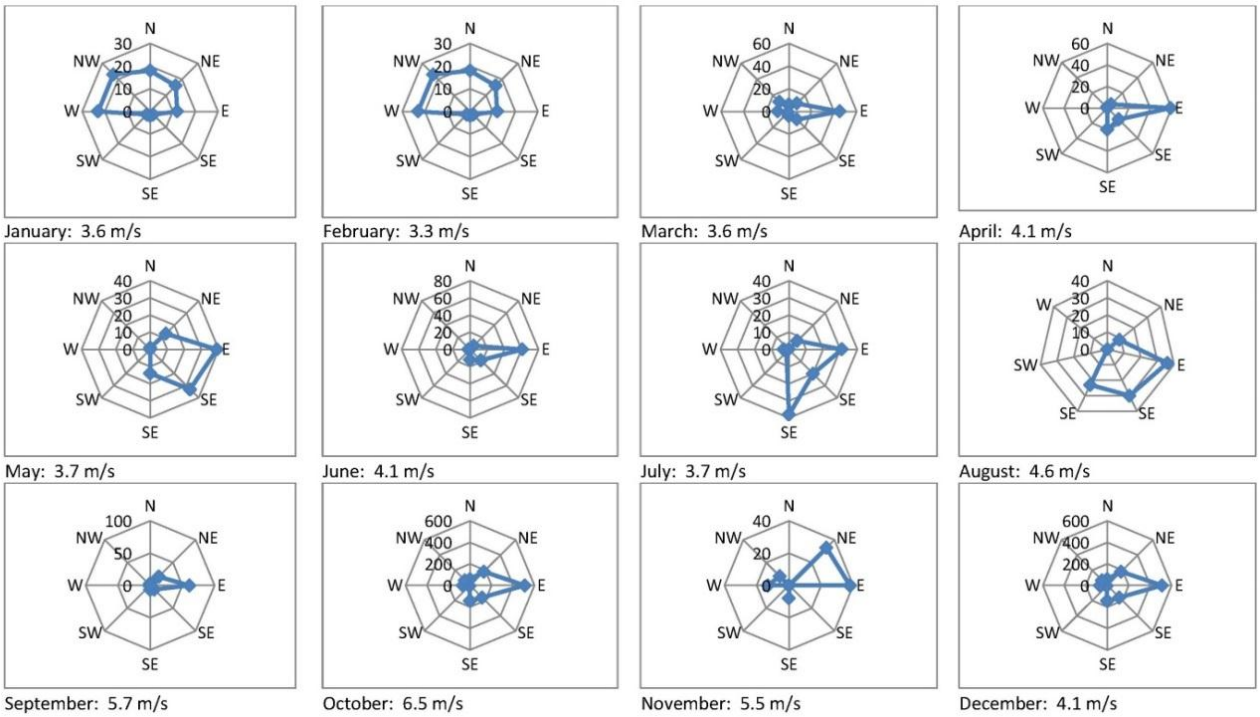


Figure 6.12: Monthly Average Wind Speed and Direction (Lilongwe)

6.6. Water Resources

6.6.1. Information Sources

Extensive water resources studies have been undertaken as part of Dam options assessment and design studies. Important studies include:

- Sogreah (2010) undertook water resources studies as part of feasibility studies and preliminary design of the proposed Diamphwe Dam. The studies assessed water yields, flood discharge, water quality, sedimentation of the reservoir and environmental flows.
- Studio Pietrangeli 2015) reviewed all relevant hydrological information and undertook additional studies to fully assess catchment run-off and flood information. Studies focused on:
    - **Runoff:** Runoff characteristics of the Dam catchment were investigated, which included assessment of monthly and seasonal runoff variations. This was then used to determine availability of water resources to meet demands.
    - **Floods**: Flood return periods were assessed, which is important for the safe design of the hydraulic and civil structures, as well as Dam operational efficiencies and minimising potential for downstream flood hazards.
- WAPCOS (2014) undertook water quality monitoring as part of ESIA studies.
- SMEC undertook supplementary water quality monitoring as part of this ESIA, which is attached at **Appendix 4**.

6.6.2. Regional Catchment Characteristics

The Diamphwe River is a tributary of the Linthipe River, which has a total catchment area of 8,641 km^2 and flows generally north-east to join Lake Malawi near Salima, as shown on Figure 6.13.

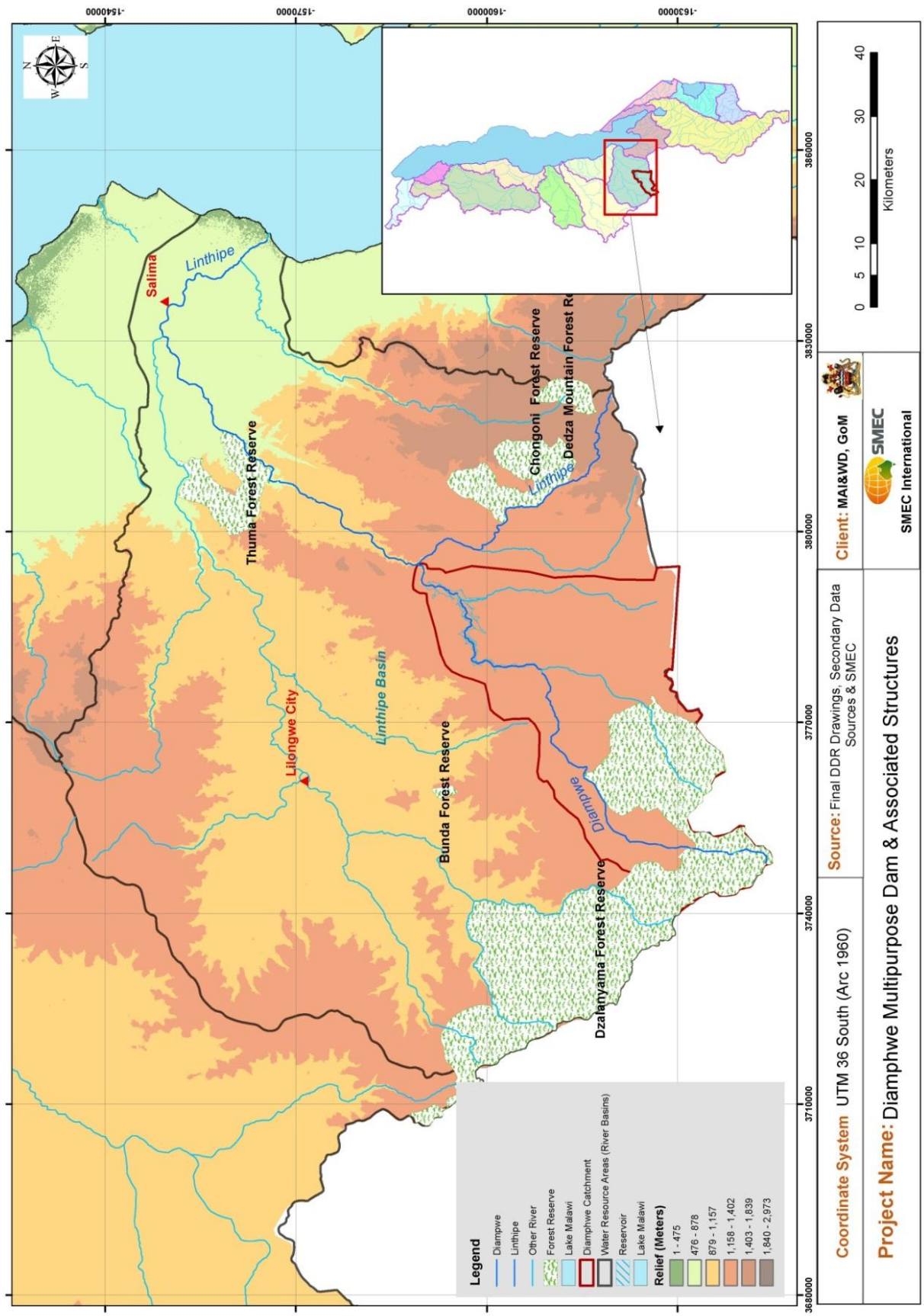


Figure 6.13: Linthipe River Catchment

The Linthipe river is one of Malawi's major water courses and encompasses the districts of Dedza, Lilongwe, Dowa and Salima. The river originates in the central high plateau and extends to Vipya Hills to the north and Dedza Hills and the Kirk range of hills to the south. Elevations range from 900 masl on the plateau up to 1650 masl in the Dzalanyama Range in the west of the catchment. The long rivers in the catchment, the Lilongwe and Linthipe, incise the highland area, and drop steeply down to around 500 masl at the lakeshore.

Recent catchment management studies (aurecon, 2014) identified a range of important environmental issues within the Linthipe catchment, which are summarised in Table 6.4.

Table 6.4 Linthipe Catchment: Environmental Issues

Environmental Issues
Water Quantity
▪ Increase in population and changes in land use in the catchment; contributing to many people using rivers and catchment areas for different purposes. ▪ Increasing droughts and floods, seriously disrupting water availability and quality. ▪ Increase in sand and soil (brick moulding) mining: – Contributing to the decrease in water quantity. – Transforming the riverbeds into large and deep pits and lowering the groundwater table, – Lowering the stream bed; exacerbating bank erosion. ▪ Climate change and changing rainfall patterns.
Environmental and Social
▪ Deforestation and degradation of the riparian banks leading to increased erosion and sedimentation of the rivers. ▪ Direct discharge of liquid and solid wastes from informal villages and settlements along catchment areas that are not provided with basic sanitary facilities. (Lilongwe Water Board Report, 2014) ▪ Disposal of agrochemicals and wastes in the rivers, emanating from river bank cultivation. ▪ Reduction of fish stocks in the rivers due to overfishing, which can also lead to reduced stream flow, increased turbidity levels and impaired water quality. ▪ Loss of soil fertility due to river bank cultivation and flooding. ▪ Increase in food insecurity and poverty due to climate change.

6.6.3. Diamphwe River Hydrology

i. *Catchment characteristics*

The Diamphwe river originates in the Dzalanyama Mountains at an altitude of 1,300 meters above sea level (masl) and then flows 95 km north-east to join the main Linthipe river, immediately downstream of the Blantyre – Lilongwe M1 Road (Figure 6.14). Catchment elevations range from 1151 masl at the Dam site to a maximum of approximately 1639 masl in the higher mountain areas. The Dam has a catchment of 1403 km^2 and a relatively flat average river gradient of 1.8 m per km or 0.2 percent. Catchment characteristics are shown on Figure 6.15.

As seen on Figure 6.15 the catchment is characterised by flat grades and extensive flood plain areas (dambos) at the bottom of valleys and most noticeably at the confluence of tributaries. Dambos support grassland and reed vegetation and are mostly flooded during the rainy season, during which time they provide important fish resources. Due to clayey soils and high water retention capacity, the

dambos accumulate water during the rainy season and maintain the moisture throughout the dry season, thereby supporting productive pasture lands and vegetable gardens. Agricultural viability is therefore heavily reliant on the hydrological regime and the function of Dambos to regulate moisture during the dry season. Typical dambos are shown on Photograph 6.2.

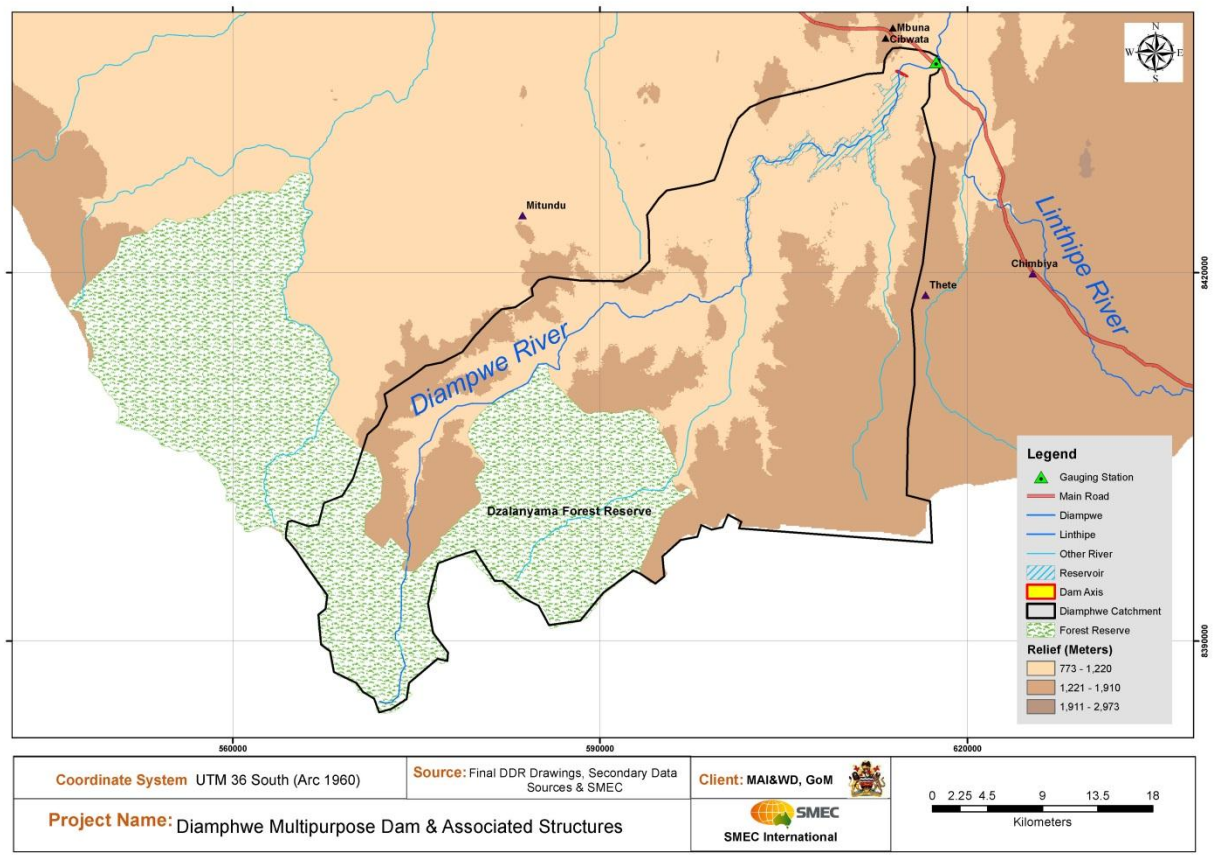
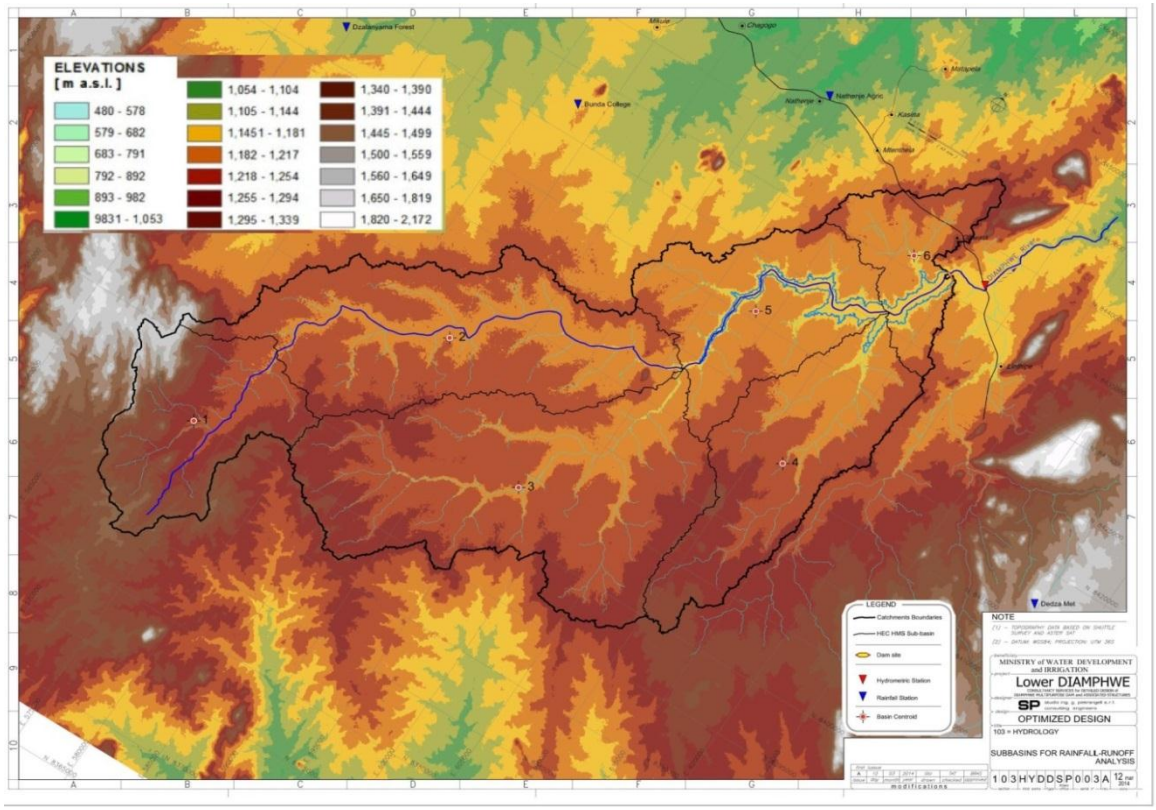
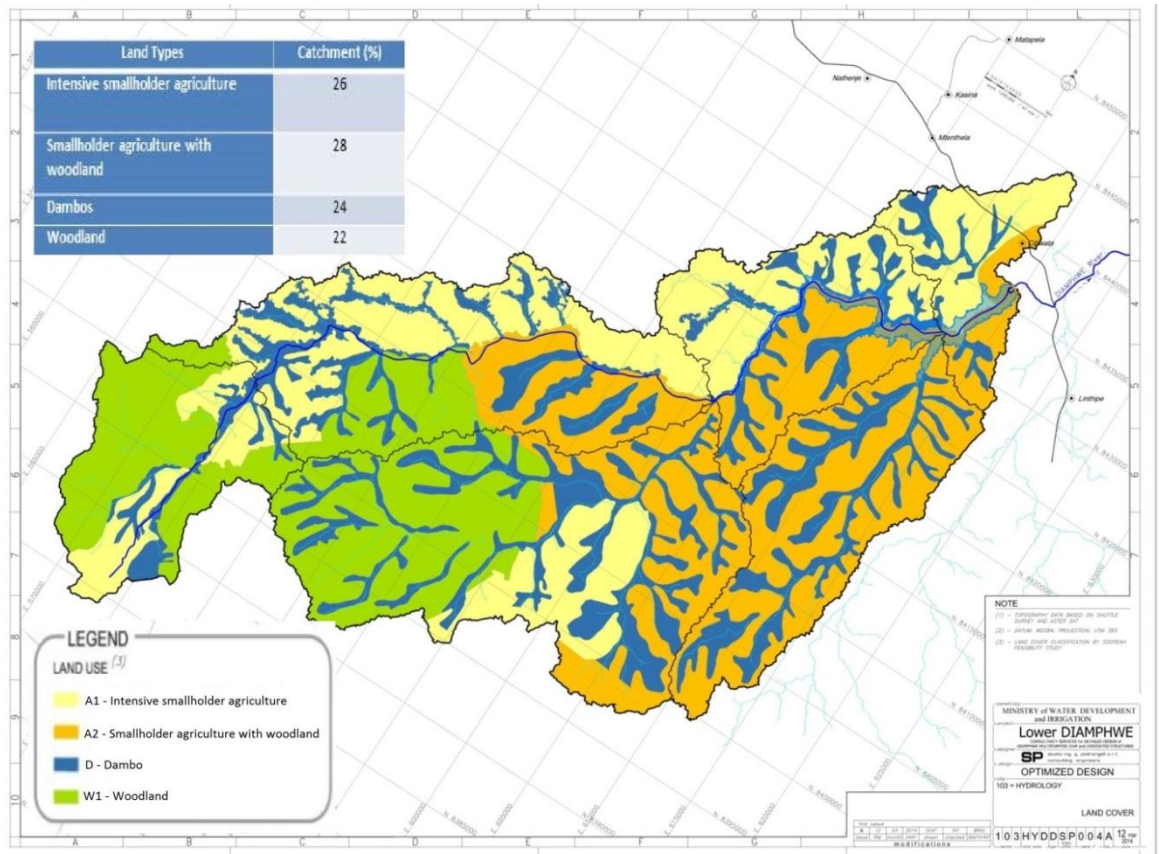


Figure 6.14: Diamphwe River Catchment

Photograph 6.2: Dambo Areas



Catchment Elevations



Catchment Land types used in runoff modelling

Figure 6.15: Diamphwe River Catchment Characteristics (SP 2015)

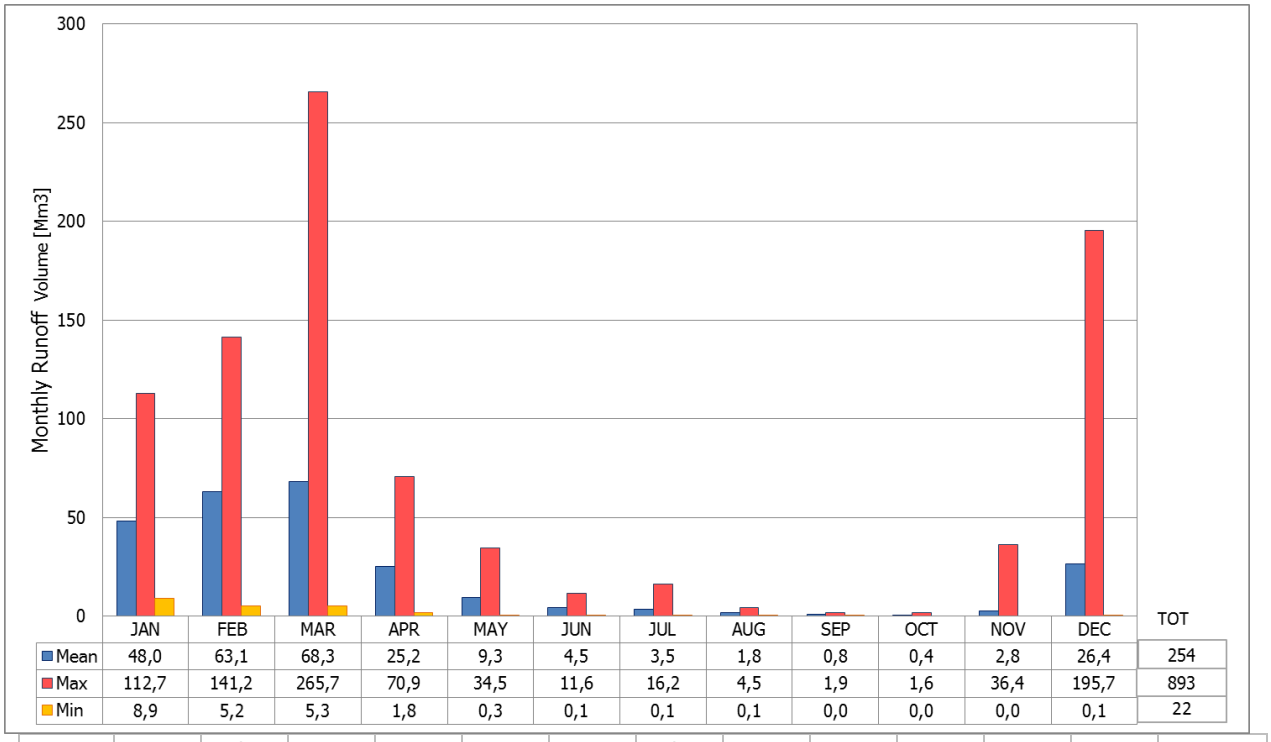
ii. *Hydrological investigations*

Hydrological studies were undertaken in 2010 (Sogreath) and updated in 2015 (Studio Pietrangeli). Studies reviewed river flow data and catchment information, which were then used to model various flood scenarios.

a. Catchment runoff

Runoff characteristics of the Dam catchment were investigated, which included assessment of monthly and seasonal runoff variations. Runoff estimates were based on 35 years of flow data obtained from the Chilowa New Bridge station, which is located on the M1 road immediately downstream of the proposed Dam wall, and historical precipitation data from four rainfall stations located close to the Project area (See Section 4.5).

Monthly average flows are shown on Figure 6.16, which show distinct wet (November to April) and dry (May to October) seasons. The highest average flow of 68.3 Mm^3 occurs in March and then rapidly declines to just 0.4 Mm^3 in October. For the available data set yearly flows ranged from 22 Mm^3 to 893 Mm^3, with an average of 254 Mm^3.



	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOT
Mean	48,0	63,1	68,3	25,2	9,3	4,5	3,5	1,8	0,8	0,4	2,8	26,4	254
Max	112,7	141,2	265,7	70,9	34,5	11,6	16,2	4,5	1,9	1,6	36,4	195,7	893
Min	8,9	5,2	5,3	1,8	0,3	0,1	0,1	0,1	0,0	0,0	0,0	0,1	22

Mean	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	
m^3/s	17.9	26.1	25.5	9.7	3.5	1.7	1.3	0.7	0.3	0.1	1.1	9.9	8.1

Figure 6.16: Average Monthly Flows at Chilowa New Bridge (Ref. SP, 2015)

Most of the river flow occurs during the rainy season. During the dry season flows can be limited to just a few litres per second, which is mostly a result of percolated water draining from the water retaining dambo areas. During below average rainfall conditions the river can have zero flow and cease to flow completely, thereby creating a series of isolated pools along the river (Photograph 6.3). Available data shows that very low or zero flows have occurred during 7 months (June to December).

Diamphwe River at M1 Bridge – Near Zero Flow Typical River pool during low flow conditions

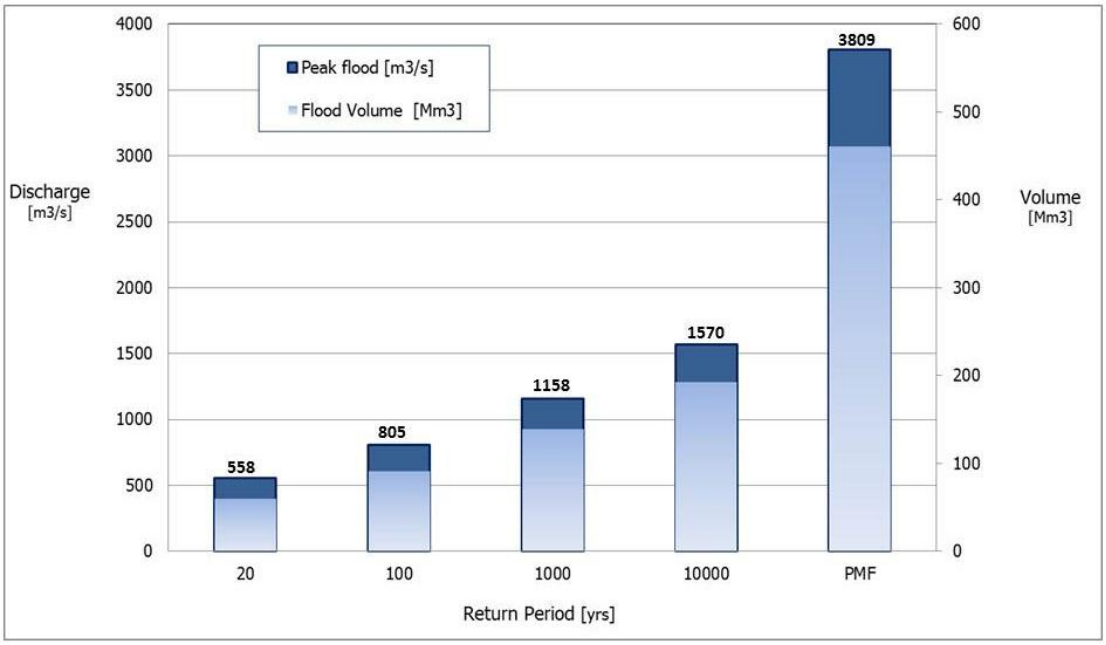
Photograph 6.3: Diamphwe River Low Flow Conditions

b. Flood estimates

Studio Pietrangeli identified six sub-basins, which were used to investigate catchment flows using the HEC-HMS hydrological model. These sub-basins reflect the relationship between run-off coefficients and landuse types (Figure 6.15).

Rainfall runoff analysis and catchment characteristics formed the basis for modelling storm events. Flood flows and hydrographs for 20, 100, 1000, 10000 year and Probable Maximum Flood (PMF) events are shown on Figure 6.17.

Hydrographs show that a flood event will last for around four days with the estimated peak occurring after approximately 30 hours.



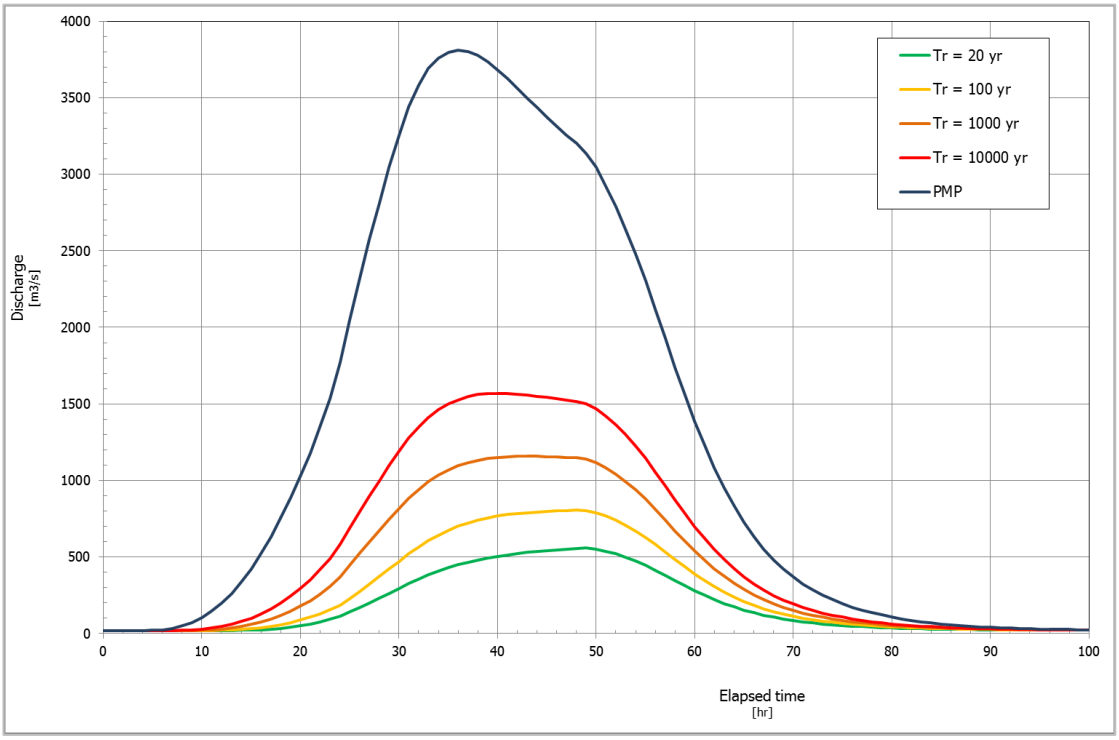


Figure 6.17: Flood Hydrographs and Flows (Ref. SP, 2015)

6.6.4. **Water Quality**

i. ***Information sources***

A number of water quality investigations have been undertaken in the Project area, which include:

- WAPCOS (2014) undertook water sampling and testing at eight water sample points located between the proposed Dam wall and the M1 road. Of these sample points three were from the river near the proposed Dam and five were from groundwater wells. Two rounds of sampling were done during February and July, 2014. As well as in-situ monitoring, the Central Water Laboratory at Lilongwe analysed samples for a wide range of organic and inorganic parameters.
- The LWB in conjunction with the Central Water Laboratory undertook water sampling and testing at the M1 road Diamphwe River bridge as well as in the upper Diamphwe river catchment (at Chankwatha) during November 2008 (wet season), and October 2009 (dry season). Results were reported by Sogreah (2010).
- Studio Petrangeli (2014) reviewed available water quality data, which was used to determine design parameters for the WTP.
- SMEC undertook supplementary water quality monitoring as part of this ESIA. Samples were taken at four locations, which correspond to sample points selected for the Aquatic survey. Sampling and testing was undertaken by the Central Water Laboratory and the Technical report is provided in **Appendix 4**.

i. ***Water Quality Standards***

Relevant water quality standards are:

- Malawi Standards:

- **MS733:2005**: The Malawi Standard for borehole and shallow well water quality specifies the requirements for untreated or raw ground water in boreholes and shallow wells suitable for human consumption and all usual domestic purposes.
- **MS214:2005**: Malawi Standards for drinking water quality, specifies the physical, biological organoleptic and chemical requirements for drinking water.
- **MS 691:2005**: Tolerance limits for domestic / sewage effluents discharged into inland surface waters
- IFC EHS Guidelines: Environmental 1.3 Wastewater and Ambient Water Quality
- WHO standards relevant to the New Water intake works on Shire River Project include:
- Standards for drinking water;
- Standards for wastewater; and
- Standards for water quality parameters.
- European Directive 75/440/EEC guidelines for water treatment

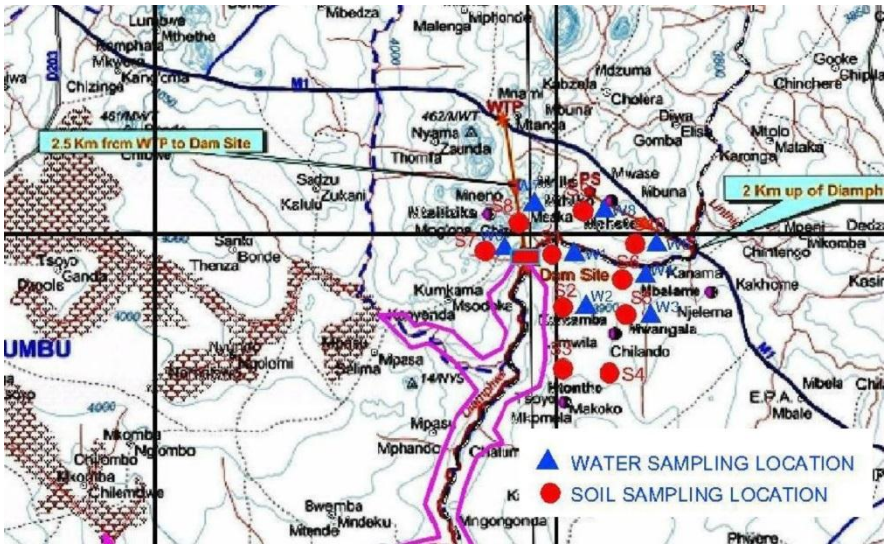
ii. ***Baseline water quality monitoring results***

Results of water quality monitoring are summarised as follows:

a. WAPCOS (2014)

Monitoring results are shown on Figure 6.18. WAPCOS assessed monitoring results with reference to the WHO Drinking Water Standards and concluded the following:

- Faecal coliform counts during dry season monitoring ranged from 100 to 240 counts/100 ml indicating low level sewage pollution.
- pH levels were similar for both wet and dry months and ranged from 6.43 to 7.54, indicating neutral to moderately alkaline conditions.
- Turbidity levels for the wet month were approximately twice that recorded for the dry month, however all readings were low (4 to 20 NTU).
- The TDS was relatively low at around 50 mg/l during wet season sampling, however this increased to around 115 mg/l during the dry season. This is indicative of the very low flows and increased salt concentration during the dry season. However overall the salt concentrations were relatively low and water is suitable for irrigation and stock watering.
- Hardness was generally low, however higher levels were recorded during the dry season monitoring. All other parameters were relatively low and well within guideline limits for irrigation use.



W1: Diamphwe River-Near Dam site (Right bank)

W2: Downstream of Dam Site -(Right bank)

W3: Upstream of Dam Site-(Right bank)

W4: Kuntamba Village –Handpump

W5: Handpump near school

W6: Near Chinthuli Village- Handpump

W7: Chinthuli village–Handpump

W8: Kampheta village-Handpump

FEBRUARY·2014¤	W···1¤	W···2¤	W···3¤	W···4¤	W···5¤	W···6¤	W···7¤	W–8¤
pH·Value¤	7.33¤	7.44¤	7.45¤	7.00¤	7.02¤	6.99¤	6.91¤	6.43¤
Conductivity·(µS/cm·at·25°C)¤	95¤	86¤	91¤	249¤	353¤	356¤	277¤	280¤
Total·Dissolved·Solids,·mg/l¤	50¤	51¤	47¤	124¤	180¤	180¤	142¤	140¤
Chloride·(as·Cl^-),·mg/l¤	7.7¤	3.7¤	7.0¤	24¤	24¤	49.8¤	29.5¤	45.6¤
Sulphate·(as·SO_4),·mg/l¤	2.23¤	2.91¤	0.11¤	2.16¤	14.6¤	3.48¤	0.67¤	0.60¤
Nitrate·(as·NO_3),·mg/l¤	0.650¤	0.010¤	0.080¤	0.340¤	0.950¤	0.62¤	0.12¤	0.10¤
Fluoride·(as·F^-),·mg/l¤	<0.01¤	<0.01¤	<0.01¤	0.03¤	<0.01¤	<0.01¤	<0.01¤	<0.01¤
Potassium·(as·K^+),·mg/l¤	1.9¤	1.5¤	1.3¤	1.0¤	1.1¤	0.7¤	0.5¤	1.5¤
Calcium·(as·Ca^{++}),·mg/l¤	6.4¤	7.0¤	7.3¤	20.2¤	47¤	41¤	28.1¤	25¤
Magnesium·(as·Mg^{++}),·mg/l¤	3.0¤	3.0¤	3.4¤	7.7¤	8.5¤	8.8¤	10¤	10¤
Manganese·(as·Mn^{++})¤	ND¤	ND¤	ND¤	ND¤	ND¤	ND¤	ND¤	ND¤
Iron·(as·Fe^{++})¤	ND¤	ND¤	ND¤	ND¤	ND¤	ND¤	ND¤	ND¤
Total·Hardness·(as·$CaCO_3$),·mg/l¤	28¤	27¤	32¤	82¤	152¤	139¤	111¤	103¤
Total·Alkalinity·(as·$CaCO_3$),·mg/l¤	33¤	34¤	35¤	84¤	121¤	90¤	91¤	62¤
Turbidity,·NTU¤	20¤	10¤	7.0¤	<0.01¤	<0.01¤	<0.01¤	<0.01¤	<0.01¤
Phosphate·(as·PO4),·mg/l¤	<0.001¤	<0.001¤	<0.001¤	<0.001¤	<0.001¤	<0.001¤	<0.001¤	<0.001¤

JULY:·2014¤	W···1¤	W···2¤	W···3¤	W···4¤	W···5¤	W···6¤	W···7¤	W–8¤
pH·Value¤	7.54¤	7.43¤	7.53¤	6.75¤	7.02¤	7.14¤	7.16¤	6.98¤
Conductivity·(µS/cm·at·25°C)¤	209¤	208¤	208¤	259¤	330¤	362¤	805¤	296¤
Total·Dissolved·Solids,·mg/l¤	115¤	114¤	115¤	143¤	182¤	199¤	442¤	166¤
Chloride·(as·Cl^-),·mg/l¤	5.50¤	9.17¤	3.67¤	21.9¤	10.8¤	7.35¤	22.2¤	14.7¤
Sulphate·(as·SO_4),·mg/l¤	4.374¤	2.837¤	5.468¤	13.0¤	13.08¤	43.5¤	13.9¤	2.09¤
Nitrate·(as·NO_3),·mg/l¤	0.087¤	0.006¤	0.067¤	1.283¤	0.388¤	0.305¤	1.56¤	0.013¤
Fluoride·(as·F^-),·mg/l¤	0.25¤	0.42¤	0.27¤	0.49¤	0.60¤	0.65¤	0.76¤	0.50¤
Potassium·(as·K^+),·mg/l¤	0.5¤	0.4¤	0.4¤	0.6¤	0.8¤	0.8¤	0.9¤	0.5¤
Calcium·(as·Ca^{++}),·mg/l¤	18¤	19.2¤	17.2¤	24.8¤	41.1¤	38.1¤	145¤	30.1¤
Magnesium·(as·Mg^{++}),·mg/l¤	9.6¤	10.0¤	8.0¤	9.2¤	11.7¤	12¤	23¤	13¤
Manganese·(as·Mn^{++})¤	ND¤	ND¤	ND¤	ND¤	ND¤	ND¤	ND¤	ND¤
Iron·(as·Fe^{++})¤	ND¤	ND¤	ND¤	ND¤	ND¤	ND¤	ND¤	ND¤
Total·Hardness·(as·$CaCO_3$),·mg/l¤	84¤	89¤	76¤	100¤	157¤	144¤	459¤	131¤
Total·Alkalinity·(as·$CaCO_3$),·mg/l¤	87¤	89¤	86¤	78¤	136¤	118¤	256¤	127¤
Turbidity,·NTU¤	4.0¤	4.0¤	4.5¤	12.0¤	17¤	2.0¤	17¤	4.0¤
Silica·(as·SiO_2)¤	10¤	8.0¤	7.0¤	25¤	20¤	43¤	35¤	32¤
Faecal·Coliform,·(Counts/100ml)¤	240¤	300¤	100¤	0¤	0¤	0¤	0¤	0¤
Faecal·Steptococci¶ (Counts/100ml)¤	40¤	60¤	20¤	0¤	0¤	0¤	0¤	0¤

Figure 6.18: WAPCOS (2014) - Water Quality Monitoring Results

b. SOGREAH (2010)

Monitoring results are shown on Figure 6.19. Sogreah assessed monitoring results with reference to the European Directive 75/440/EEC guidelines for water treatment and concluded the following:

- Suspended solids and turbidity levels are low, however it is expected that levels would increase during higher rainfall conditions.
- Total dissolved solids concentration is low and well within guideline limits.
- Faecal coliforms concentrations were high to very high, ranging from 320 to 1,360 counts/ ml. This is a strong indicator of domestic sewage pollution.
- Sogreah generally concluded that the Diamphwe River was favourable as a domestic water supply.
- Studio Petrangeli (2014) reviewed these data and also concluded that water from the Diamphwe River was suitable for a domestic supply with conventional treatment.

Date and site	**19/11/2008 Diamphwe River**	**13/10/2009 Diamphwe River**	**19/11/2008 Diamphwe River**	**13/10/2009 Diamphwe River**	**Direttiva Europea 75/440/EEC**	**OMS Guide line for drinking water**	**Direttiva Europea CEE N°83/199**
Site	**Lower site**	**Lower site**	**Upper site**	**Upper site**			
Parametro ppm (*1)							
pH	8.23	7.91	8.04	7.27	5.5-9.0		6.5-9.5
Total dissolved solids	140	90	82	56			1500 (*)2
Chloride ppm	16	10	12	5.54	200	250	250
Sulphate	12.4	0.156	7.9	0.856	150	500	250
Nitrate (as NO3-)	0.1	0.545	0.23	0.42		50 as Total Nitrogen NO3+N02	
Fluoride (As F-)	0.5	0.55	0.3	0.31	0.7-1.7	1.5	
Sodium	14.4	7	8	6		200	200
Calcium	22	16	14	9.6			
Magnesium	10	6.7	5.74	3.9			
Iron	0.07	0.36	0.21	0.1	1.0		0.2
Manganese	<0.001	<0.001	0<.001	<0.001	0.1	0.5	0.05
Turbidity NTU	0.7	2	0.6	2			
Suspended solids	<0.1	<0.01	0 <.10	2			
Faecal coliform count /100 ml	320	1360	450	1400	2000		0.0
Durezza totale							15-20° F
Disinfettante residuo							0.2
Ammonio NH4							0.5

Figure 6.19: Water Quality Monitoring Results (SOGREAH 2010) -

c. SMEC (2015) ESIA studies

Monitoring results are shown on Figure 6.18 and the technical report provided in **Appendix 4**. A summary of results is as follows:

- Results indicated river samples to be slightly alkaline and soft, with pH in the range 8.12 to 8.60 and Total Hardness (as CaCO3) between 43 to 82 mg/l.
- Low suspended solids (<0.10-25.0 mg/l)and turbidity (3.0-28.0 NTU) levels.
- Low nutrient levels for Phosphates (0.024 to 0.029 mg/l) and nitrates (0.110 to 0.243 mg/l).
- Generally low levels of BOD (10.0 to 19.45 mg/l) and COD (20.38 to 79.9 mg/l), however the upper range COD result is above the Malawi Standards for Effluent Quality.
- DO levels are below optimum levels for ecological health, which is indicative of the low flow and possibly stagnation during the sampling period.

Table 6.5 SMEC (2015): Water Quality Monitoring Results (See Figure 6.26 for sample points)

LAB No.		920	921	922	923	924
DATE SAMPLED		02/10/2015	02/10/2015	02/10/2015	02/10/2015	02/10/2015
MAP SHEET/GRID REF.	UTME	0602343/0602321		0611183/0611239	0583869/0614389	0617450/0617486
	UTMN	8420410/8420396		8430968/8430996	8457032/8435736	8437474/8437512
SOURCE TYPE/LOCATION		SITE 1A. NYAMAZAANI VILLAGE, T/A CHADZA, LILONGWE DISTRICT	SITE 1B. NYAMAZAANI VILLAGE, T/A CHADZA, LILONGWE DISTRICT	SITE 2. MALENYA VILLAGE, T/A KALUMBU, LILONGWE DISTRICT	SITE 3. CHIMBOWA VILLAGE, T/A MAZENGERA, LILONGWE DISTRICT	SITE 4. MBALAME VILLAGE, T/A MAZENGERA, LILONGWE
pH Value		8.12	8.57	8.60	8.56	8.58
CONDUCTIVITY (µS/cm at 25^{0}C)		182	145	233	197	232
TOTAL DISSOLVED SOLIDS, mg/l		101	80	128	108	128
CARBONATE (as CO_3^{2-}), mg/l		10.0	10.0	14	11	16
BICARBONATE (as HCO_3^{2-}), mg/l		39	37	60	53	56
CHLORIDE (as Cl^-), mg/l		17.8	8.1	15.2	12.2	14.3
SULPHATE (as SO_4^{2-}), mg/l		6.3	6.3	9.77	9.16	7.63
NITRATE (as NO_3^-), mg/l		0.144	0.169	0.110	0.243	0.230
FLUORIDE (as F^-), mg/l		-9	-9	-9	-9	-9
SODIUM (as Na^+), mg/l		14	9.1	13	8	9
POTASSIUM (as K^+), mg/l		0.7	1.9	0.9	1.0	1.0
CALCIUM (as Ca^{++}), mg/l		10.1	9.5	16.3	14.4	18.8
MAGNESIUM (as Mg^{++}), mg/l		5.6	4.2	8.2	8.2	8.5
SOLUBLE IRON (Fe $^{++}$), mg/l		0.1	1.2	0.2	0.045	0.3
MANGANESE (as Mn^{++}) mg/l		-9	-9	-9	-9	-9
TOTAL HARDNESS (as $CaCO_3$), mg/l		48	43	75	70	82
TOTAL ALKALINITY (as $CaCO_3$), mg/l		49	47	72	62	75
SILICA (as SiO_2) mg/l		-9	-9	-9	-9	-9
TURBIDITY, NTU		3.0	28	10	5.0	6.0
SUSPENDED SOLIDS, mg/l		<0.10	25	8.0	4.0	5.0
PHOSPHATE (PO_4^{3-}), mg/l		0.027	0.028	0.029	0.024	0.027
DISSOLVED OXYGEN (DO), mg/l		4.24	3.64	4.68	4.64	5.15
BIOLOGICAL OXGEN DEMAND (BOD_5), mg/l		10.0	16.0	15.6	19.45	14.2
CHEMICAL OXYGEN DEMAND (COD_{cr}), mg/l		79.9	58.8	21.17	33.71	20.38

***-9= Not Determined Analysis conducted by Central Water Laboratory

d. Summary of Diamphwe River Water Quality

Water quality in the Diamphwe River is summarised as follows:

- River water quality is slightly alkaline and soft, with low nutrient and TDS levels.
- Suspended solids and turbidity are generally low, however higher levels are expected during the wet season.
- DO levels may be below optimum levels during low flow conditions.
- Sewage pollution is evident, which is a consequence of a large number of people living in the catchment and no suitable sewerage reticulation and treatment system.
- River water is suited for domestic supply with conventional treatment.

Water quality monitoring indicates that overall water quality is good, with no evidence of persistent gross pollution or ecological stress. This is further evidenced by a healthy aquatic ecosystem (see Fisheries Section 4.11). However water quality can deteriorate during low flow conditions due to reduced flushing and mixing, and attendant increase in TDS and reduction in DO levels. During wet weather conditions water quality can be affected by increased erosion in the catchment, while sewage contamination remains an ongoing problem due to poor sewerage infrastructure and a growing population.

6.6.5. Environmental Flows

Under the Water Resources Management Component of the NWDP, the Water Resources Investment Strategy (WRIS, 2011) identified specific water resources development and infrastructure needs for the 17 Water Resources Areas (WRAs) across the country. WRIS allocated a habitat integrity rating of C (moderately modified) to the Linthipe-Lilongwe catchment, with more than half of the catchment area having a medium or high risk of sediment ingress to water courses and a medium risk of invasive aquatic plants. According to the WRIS (Atkins, 2011) the environmental flow requirement for the catchment is 10% of the river-flow in the dry season, 32% in the wet season and 21% annually.

6.6.6. Groundwater

Presently there are approximately 30,000 boreholes and about 8,000 protected hand-dug wells in Malawi. Current estimates show that 65% of the human population in Malawi depends on groundwater for domestic water supply (auricon, 2014).); about 82.3% of the rural population depends on groundwater whereas the figure for the urban population is 19.8%.

The aquifer system in Malawi's plateau area is described as low- yielding weathered Precambrian Basement Complex Aquifer (BCA). Information sourced from the MoAIWD is summarised below:

- There are 125 recorded wells in the Lilongwe / Dedza region.
- Well depth ranges from 20.0 to 76.3 m, with an average depth of 41.4 m.
- Groundwater levels below ground level range from 0.61 -54.9 m, with an average of 10.8 m.
- Groundwater yields range from 0.01 to 0.92 litres/second (l/s), with an average of 0.19 l/s.

On a national scale, groundwater quality is generally acceptable for human consumption and in the BCA aquifer groundwater resources are characterised by the dominance of alkaline earths in the cation group and by the carbonates in the anion group. Total dissolved solids content values are generally less than 1000 mg/L and typically around 350 mg/L (auricon, 2014). Groundwater monitoring undertaken by Wapcos (see Section 6.6.4) showed relatively high average harness levels of 117 mg/l during the wet season and increasing to 198 mg/l during the dry season. Salinity levels

were relatively low with average TDS levels ranging from 153 and 226 mg/l for respective wet and dry seasons. Bacterial contamination was not detected.

6.7. Landuse

6.7.1. **Regional Landuse**

The Linthipe catchment contains natural and cultivated forests; however the majority of the catchment consists of cleared land in previously forested areas, large and expanding population centres such as Lilongwe and Dedza, and numerous small villages and related community infrastructure. A wide range of agricultural activities occur in the catchment, which are mostly related to subsistence farming of crops such as maze, dry bean, groundnut, sweet potato, tomato, dry onion and cabbage. Fruit trees are important community assets and tobacco is grown as a cash crop.

There are a number of important regionally protected areas, as shown on Table 6.6 and Figure 6.20.

Table 6.6 Regional Protected Natural Areas

Protected Forest	Size (ha)	Location
Dedza Mountain Forest Reserve	3,022	7.5 km E of Dam
Chongoni Forest Reserve	12,616	15 km S-E of Dam
Thuma Forest Reserve	188,700	27 km N-E of Dam
Dzalanyama Forest Reserve	97,695	35 km S-W of Dam
Bunda Forest Reserve	471	33 km west of Dam

There are significant catchment pressures, which include:

- Much of the natural 'miombo' woodland (*Brachystegia*) has been cleared for agricultural land, as well as being harvested for furniture making, burning of bricks and charcoal making. Efforts are being made to develop a more sustainable tree harvesting industry by replanting, mostly of exotic trees such as pine and eucalyptus.
- Wetland areas (dambos) along watercourses were once common, however due to their moisture retaining characteristics these have also been extensively modified due to the activities of subsistence farming or small commercial agricultural operations.
- Protected forests, especially Dzalanyama and Chingoni, face problems of deforestation, illegal farming and charcoal making.

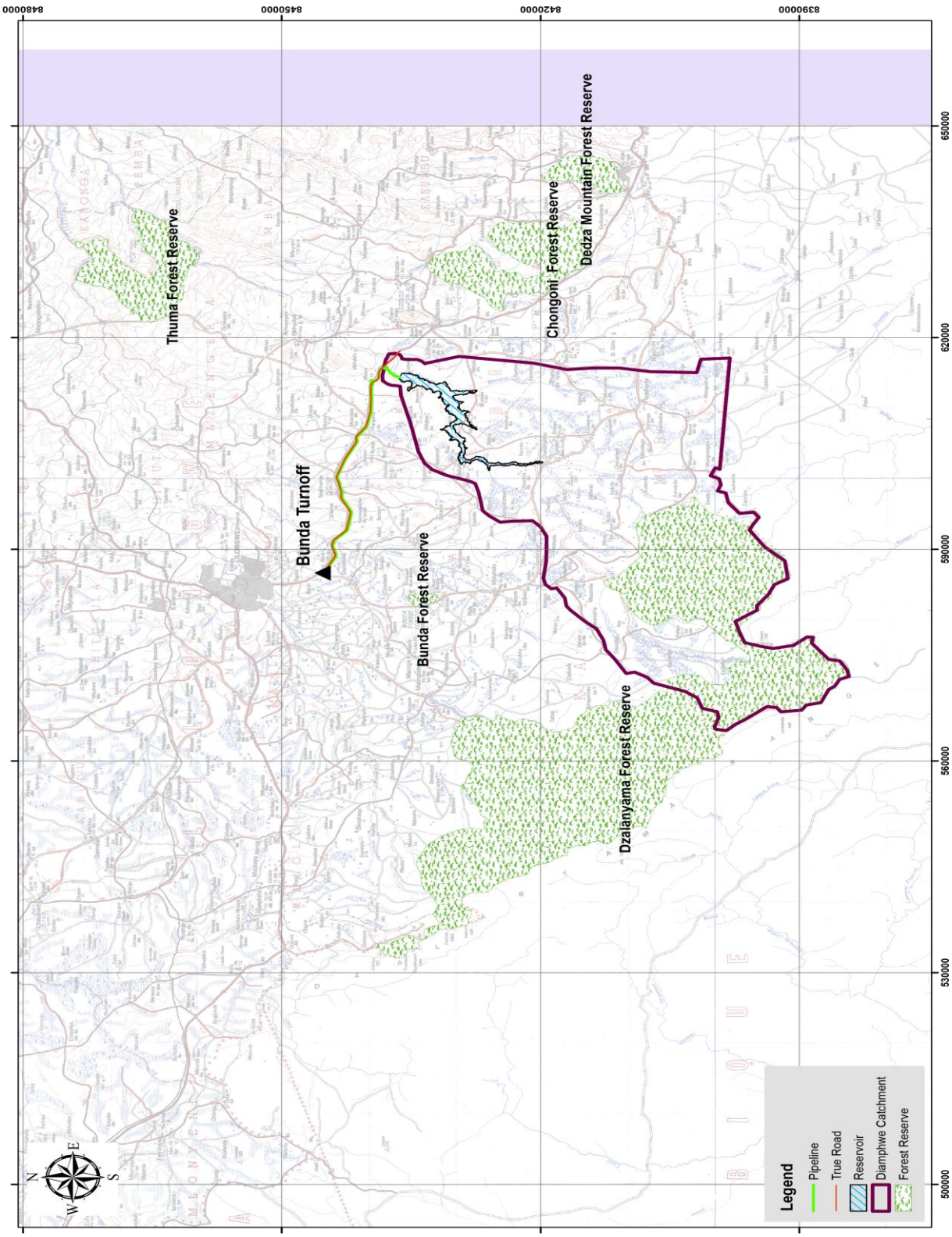


Figure 6.20: Regional Forest Reserves

6.7.2. **Diamphwe River Catchment**

The upper Diamphwe catchment is characterised by natural wooded forest, which forms part of the protected Dzalanyama Forest Reserve. The remainder of the catchment has been substantially cleared of native woodland and developed for intensive agricultural use. Remnant woodland patches

are commonly associated with graveyards while natural riparian grassland and reed vegetation remain on some stretches of the river.

Catchment landuse within the broader Diamphwe catchment upstream of the proposed Dam is shown on Figure 6.21. Four broad main landuses are described, which are summarised in Table 6.7.

Table 6.7 Diamphwe River Catchment Landuse

Landuse	Area (ha)	Area (%)
Cultivated Dambo	20,374	15
Dambo Herbaceous Vegetation	9,886	7
Rainfed Herbaceous Crop	73,021	54
Woodland	33,303	24
TOTAL	**136,584**	**100**

As noted in Section 6.6 (Water Resources) the catchment is characterised by flat grades and extensive flood plain areas (dambos) at the bottom of valleys and most noticeably at the confluence of tributaries. Dambos cover approximately 22 % of the catchment and support a variety of riparian vegetation and agricultural landuses, including providing fish resources during the wet season. Due to clayey soils and high water retention capacity, the dambos accumulate water during the rainy season and maintain the moisture throughout the dry season, thereby supporting productive pasture lands and vegetable gardens throughout the year. Agricultural viability is therefore heavily reliant on the hydrological regime and the function of Dambos to regulate moisture during the dry season.

Photograph 6.4: Cultivated Dambo and Shallow Well (Dry season)

Rainfed Herbaceous Vegetation (Cropland) and Cultivated Dambo collectively account for up to 69 % of agricultural landuse, which characterises the extensive anthropogenic impact on the natural environment. Only about 31% of the catchment remains in a natural state, mostly as woodland (24%) in the Dzalanyama Forest Reserve and isolated pockets such as graveyards, and a smaller representation of undeveloped Dambo (7%). However, increasing threats from illegal activities has resulted in significant degradation of these natural areas.

Numerous villages are scattered throughout the catchment and there is significant degradation of natural resources through intensive agricultural practices, illegal cutting of trees for charcoal production and population pressures. This, coupled with a lack of infrastructure, has resulted in significant environmental stress on the river's resources and function.

A selection of some of these landuses is shown in Photograph 6.5.

Dzalanyama Forest - River Headwaters

Illegal Tree Cutting and Charcoal Burning in Dzalanyama Forest (Nov. 2015)

Typical Village Settlement and Rainfed Cropland

Photograph 6.5: Diamphwe River Catchment Landuse

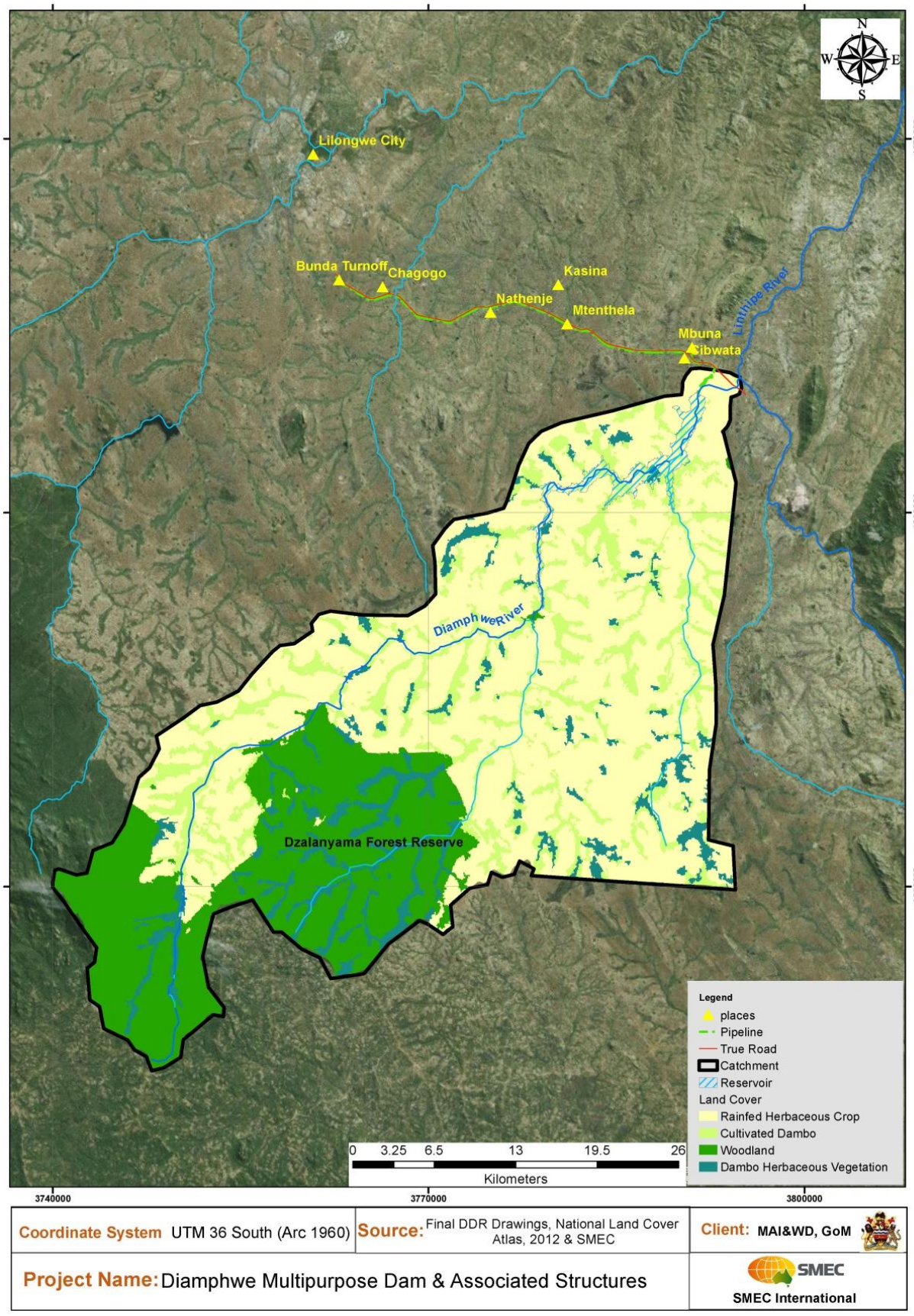


Figure 6.21: Diamphwe River Catchment Landuse

6.7.3. **Reservoir Area Landuse**

The proposed Dam inundation area and 15 meter wide buffer will directly impact on approximately 2,484 ha of land. Landuse and settlements within the affected area are shown on Figure 6.22. Six main landuses have been classified in accordance with the National Land Cover Atlas, 2012 (Food and Agricultural Organisation: Land Resource Conservation Department). Landuse types are summarised in Table 6.8 and described below. A Photolog of the various landuses is presented in **Appendix 11**.

Table 6.8 Landuse in Project Reservoir Area

Landuse category	Area (ha)	Area (%)
Cropland	1,563	63
Cultivated dambo	496	20
Dambo Grassland with patches of cultivated land	378	15
Forest / Natural vegetation	10	0.5
Settlement	37	1.5
TOTAL	**2,482**	**100**

i. ***Cropland***

Cultivated cropland accounts for approximately 63% of the proposed reservoir and covers the major part of the Dam extending approximately 12 km from the Dam wall to Kuchilara village. Cropping activities are dependent on rainfall and soil moisture, and these areas are mostly used during the wet season covering a period of between 120 to 150 days. Typical crops grown include maize, soya, beans, groundnuts, tobacco, pigeon peas, sweet potatoes and Irish potatoes (Photograph 6.6).


Photograph 6.6: Cropland Landuse

ii. ***Cultivated dambo***

Cultivated dambo covers approximately 26 % of the proposed Dam and is widely distributed along the river banks for a distance of approximately 16 km from the Dam wall to about Chilikumwendo village. Dambos are highly productive, with good fertility and year around water, which is sourced from shallow wells. Typical crops grown include vegetables (tomatoes, onion, and pumpkins), sweet potatoes, Irish potatoes, maize and beans Sugarcane is generally cultivated during the cool periods of the dry season. (Photograph 6.7).

Photograph 6.7: Cultivated Dambo Landuse

iii. ***Dambo Grassland with patches of cultivated land***

Dambo grassland comprises of expansive areas of short grassland, which is distinguished by a relatively high clay content, low fertility and characteristic cracking during the dry period. Landuse is predominantly grassland and stock grazing, with some small cultivated patches (cool dry season). During the wet period these areas become flooded and are commonly used for fishing. Dambo grassland accounts for approximately 15 % of the study area and is common in the top one third of the proposed Dam, extending approximately 11 km from around Chilikumwendo village to the upper extremity of the Dam near the S124 road bridge at Khomani village (Photograph 6.8).

Dambo grassland also includes natural riparian vegetation along the river banks and is found along the length of the river. Riparian vegetation consists of long grasses and reeds, and provides important animal habitat, as well as being used as a building material (Photograph 6.8).

Photograph 6.8: Dambo Grassland and Natural Riparian Vegetation Landuse

iv. ***Forest / Natural vegetation***

Forested areas and mature trees are typically found in graveyards, which occur throughout the Dam catchment in isolated patches Ten graveyards will be affected by the proposed Dam, covering a combined area of approximately 0.5 % (Photograph 6.9).

Photograph 6.9: Forest / Natural Vegetation Landuse

v. ***Settlement***

Villages in and around the immediate vicinity of the proposed Dam are shown in **Appendix 9**. A total of 223 villages are associated with land and / or structures within the Project area. Settlements cover approximately 1.5 % of the proposed reservoir. A list of villages and number of households is provided in *Table* 9.3 (Section 9.3.3).

Villages are scattered throughout the study area and cover approximately 1.5 % of the proposed Dam. Villages range in size from just a few to more than 100 houses. Smaller villages are typically made of mud brick and natural grasses, while more substantial brick and tin roof buildings are found in the larger villages. Community facilities such as health centres, schools, churches and public buildings are generally found in the larger villages (Photograph 6.10).

Photograph 6.10: Settlement Landuse

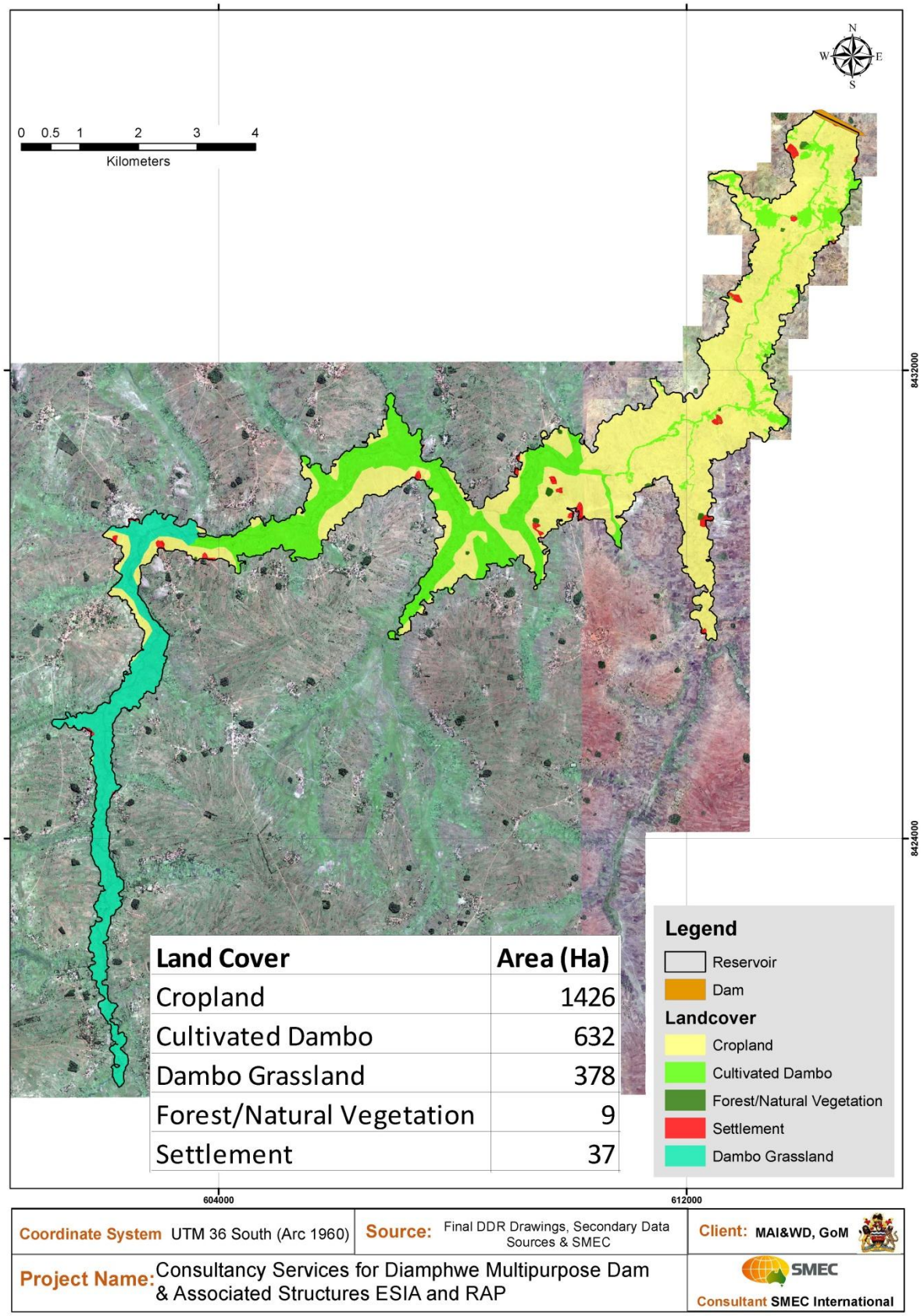


Figure 6.22: Landuse in Reservoir Area

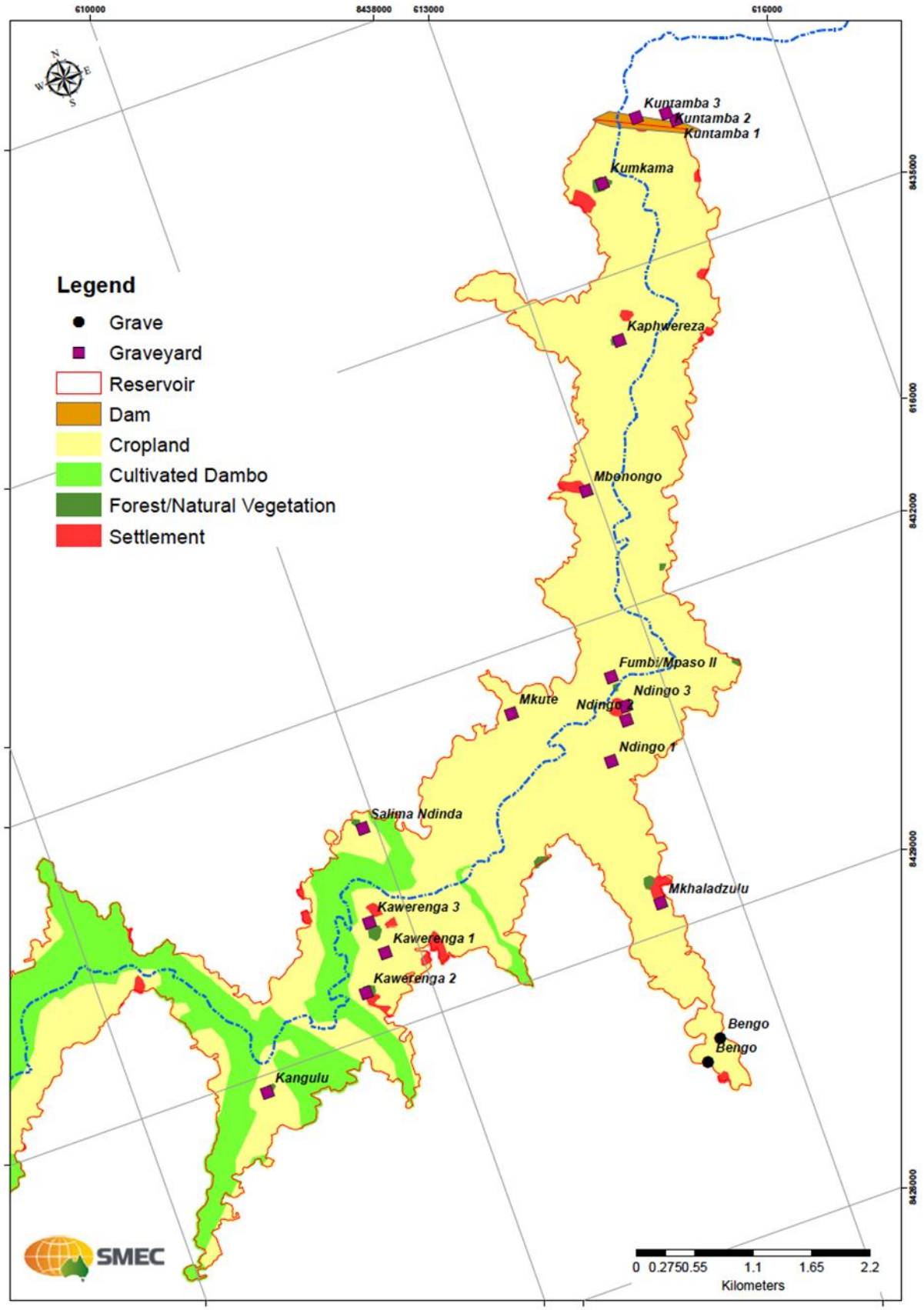


Figure 6.23: Graveyard Sites (Natural forest)

6.7.4. **Infrastructure and Downstreram Area Landuse**

i. ***Infrastructure Area***

The infrastructure area will directly affect approximately 162 ha of land comprising of the Dam wall and spillway structures, raw water pump station and pipeline, WTP and pipeline, treated water balance tanks, office and accommodation, access roads, and temporary construction areas including a quarry. Existing landuse and settlements are shown on Figure 6.24 and summarised in Table 6.9. It should be noted that these areas are approximations and actual disturbed land will be subject to detailed design.

Table 6.9 Landuse in Project Infrastructure Area

Heading	Area (ha)
Cropland	160
Cultivated dambo	1
Forest / Natural vegetation	1
TOTAL	**162**

Landuse mostly affected by the Dam is cropland (160 ha) with a relatively small area of cultivated dambo (1 ha) and forest graveyard (1 ha) near the proposed Dam wall. Settlements mainly occur around the proposed office and accommodation area (Photograph 6.11 – See locations on Figure 6.24).

P1. Dam Wall and associated structures (looking north - panorama)

P2 Raw water pump (looking south)

P3 Raw water pipeline (looking east)

P4 WTP & Pipeline (looking north)

P5 Quarry (looking south)

P6 Office / Accommodation (looking west)

P7 Balance Tanks (looking north)

Photograph 6.11: Infrastructure Area

iii. ***Downstream Area***

Landuse within a 100 meter strip of land along the Diamphwe River downstream of the proposed Dam wall to its junction with the Linthipe River is shown on Figure 6.24 and summarised in Table 6.10.

Table 6.10 Downstream Area Landuse

Landuse	Area (ha)	Area (%)
Cropland	74.00	80
Cultivated dambo	6.93	7
Dambo Grassland with patches of cultivated land	10.48	11
Forest / Natural vegetation	1.12	1
Settlement	0.27	0
TOTAL	**92.79**	100

Downstream landuse is typically a narrow fringe of dambo (18 %) and cropland (80%). A small area of settlement is located near the M1 road and pedestrian bridges (Photograph 6.12).

P8 Diamphwe river immideatly downstream of proposed Dam wall (looking south east)

P9 Diamphwe river immediately upstream of M1 bridge

P10 Diamphwe river immediately downstream of M1 bridge

P10 Diamphwe River downstream M1 bridge

P11 Diamphwe - Linthipe River Junction

Photograph 6.12: Downstream Area Landuse

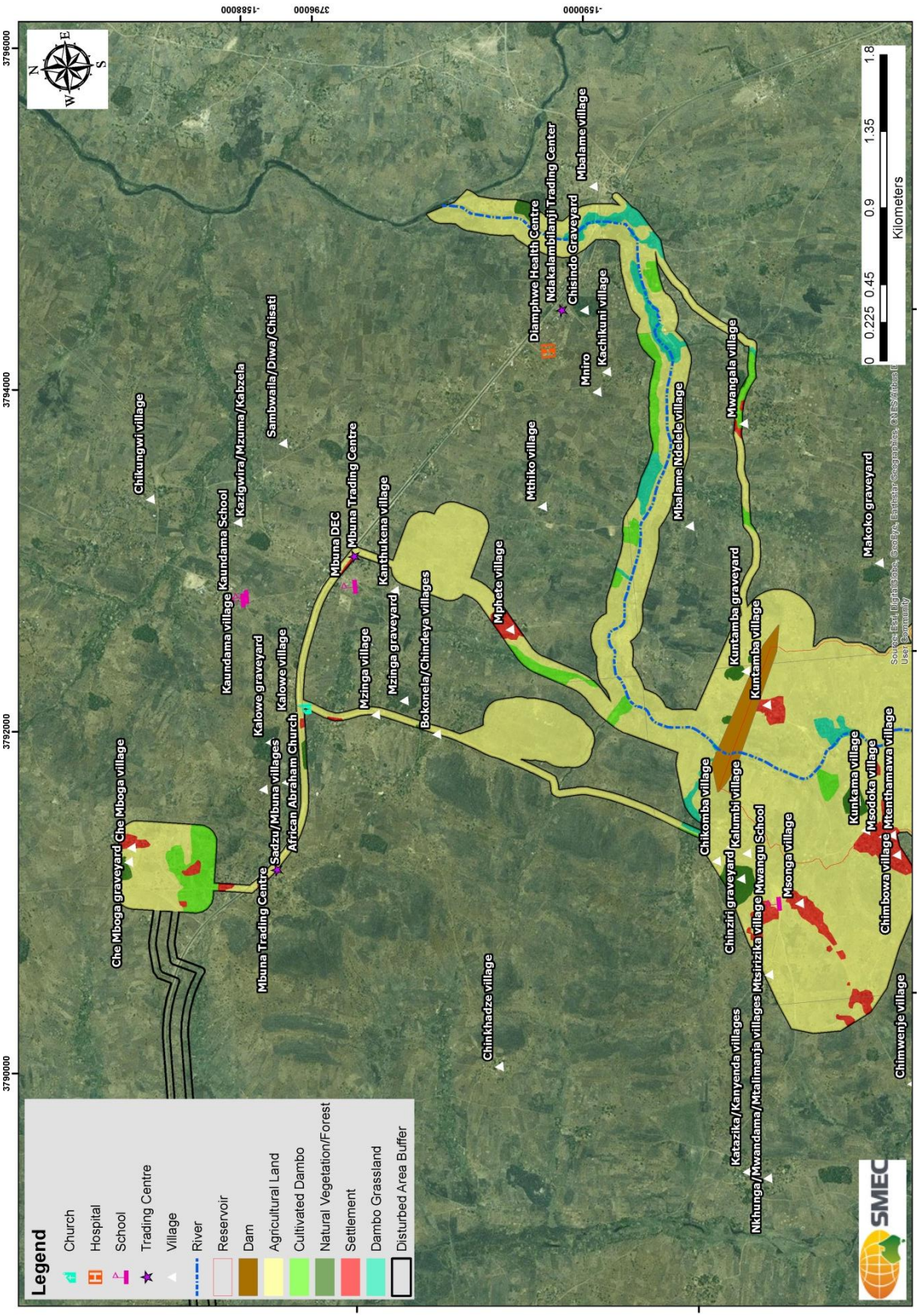


Figure 6.24: Infrastructure Area Landuse (UPDATE AND SHOW PHOTO LOCATIONS)

6.7.5. **Water pipeline to Bunda-Turn-off Landuse**

The dual water pipeline to Bunda Turnoff will be aligned within a 20 metre wide easement from the road centre-line, and extending mostly along the western side of the M1 road. Approximately 60 ha of land will be temporarily disturbed during construction and then rehabilitated. Landuse is summarised in Table 6.11 and shown on Figure 6.25 (larger scale maps provided in **Appendix 8**).

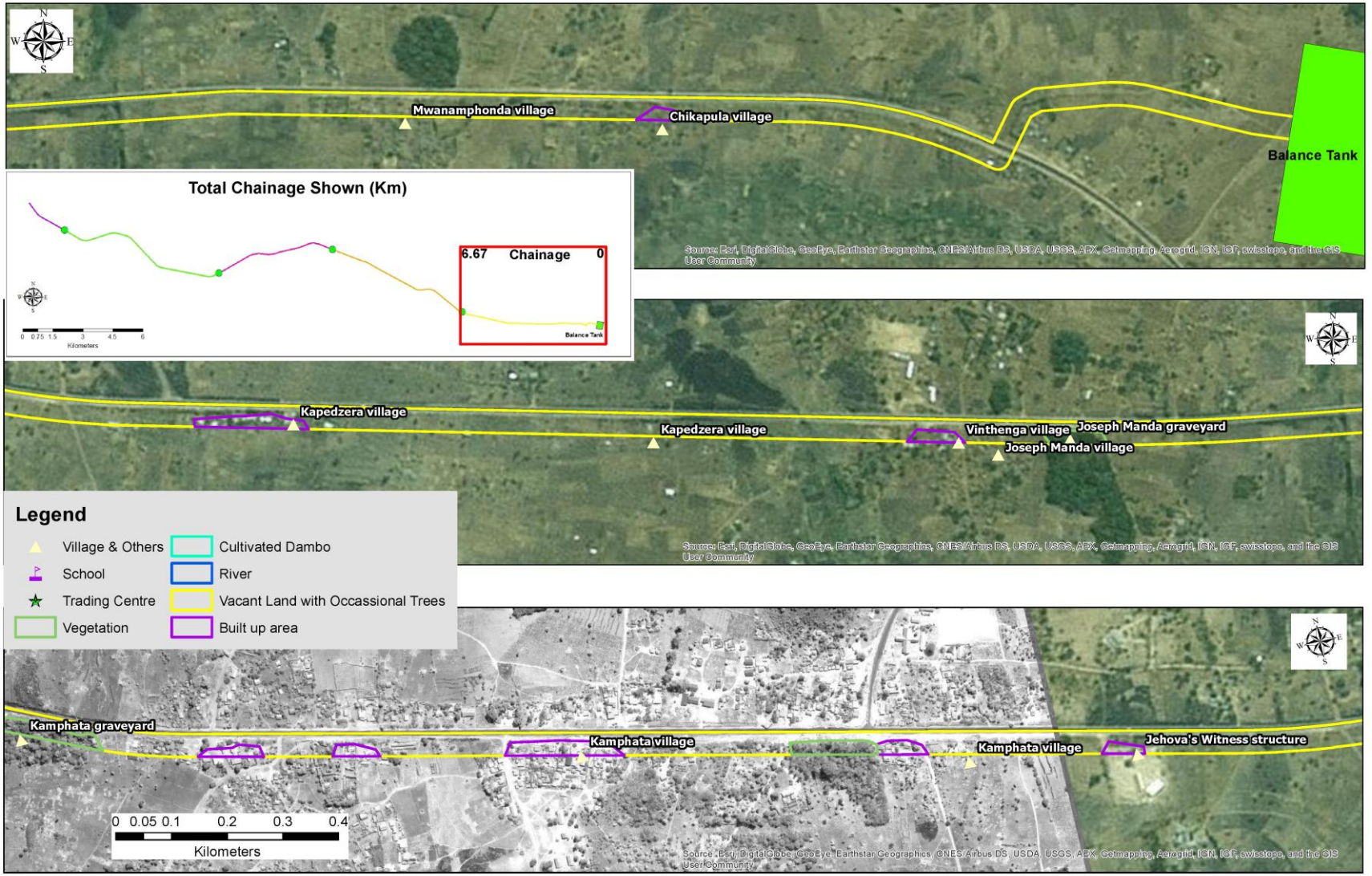
Table 6.11 Landuse Along Main Pipeline Route

Landuse	Area (ha)	Area (%)
Built up area	3.5	6
Cultivated dambo	1.2	2
Vacant land with occasional trees	54.0	90
Vegetation	1.3	2
TOTAL	**60**	**100**

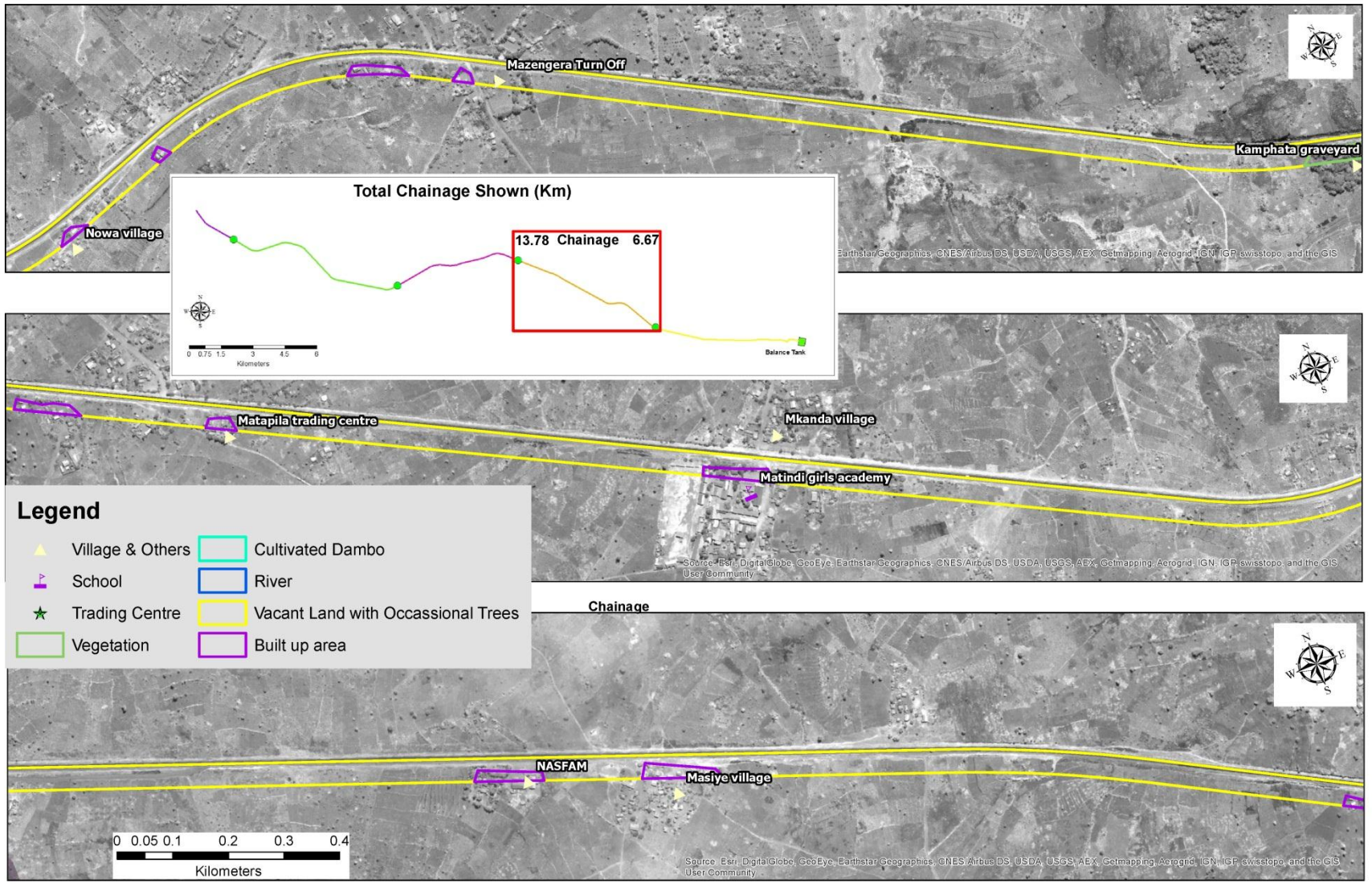
The pipeline route is within a designated road reserve and the majority of its length is characterised by vacant land with occasional trees (54 ha). Approximately 1.2 ha of agricultural use has spread into the easement and there are isolated fruit trees along the route. A further 1.3 ha is represented by natural vegetation, including a portion of a forested graveyard. Build-up areas including market and commercial activities and various buildings including schools and churches account for approximately 3.5 ha (Photograph 6.13).

Photograph 6.13: Pipeline Route Landuse

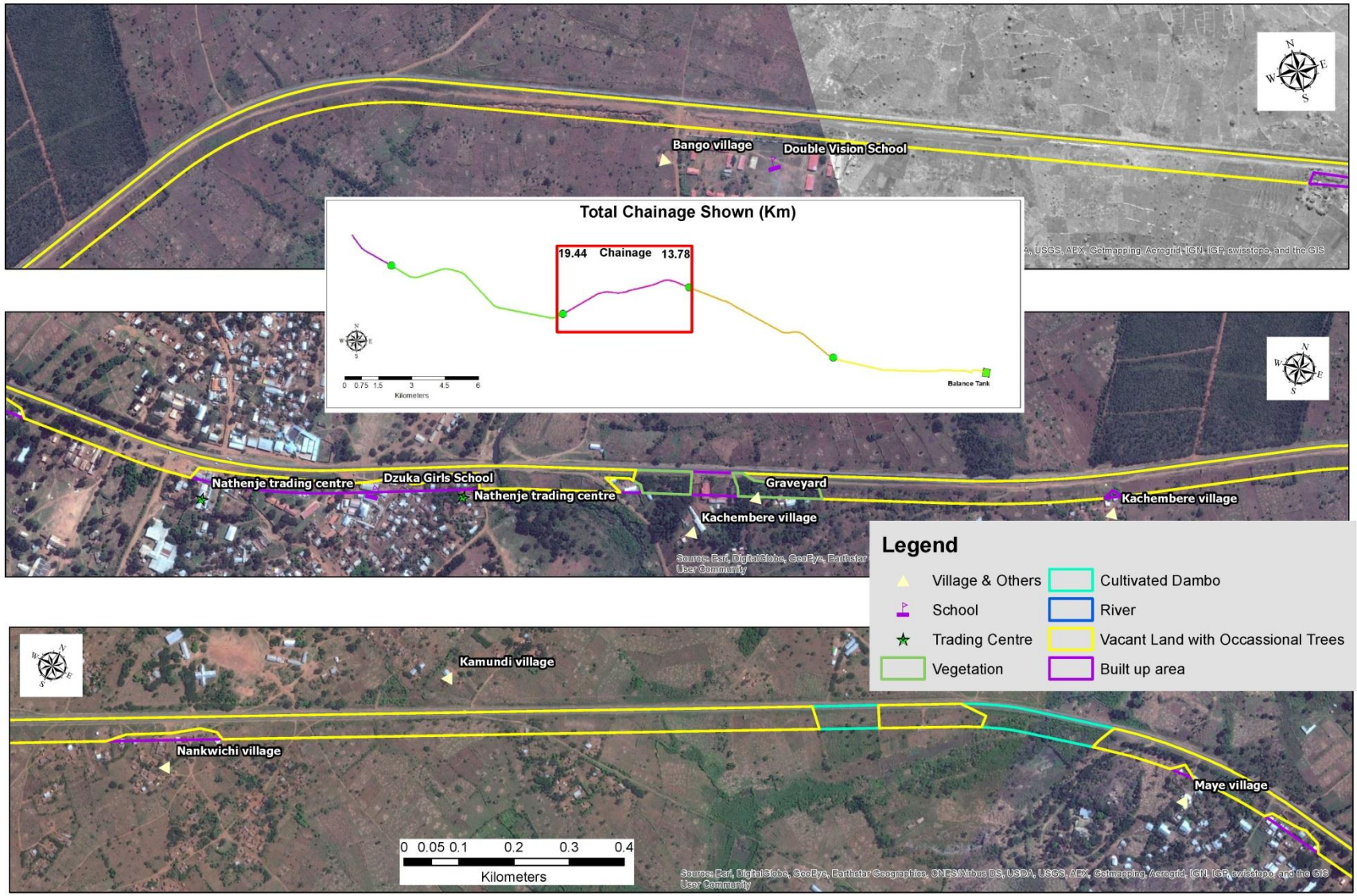
Layout 1 starting from Balance Tank



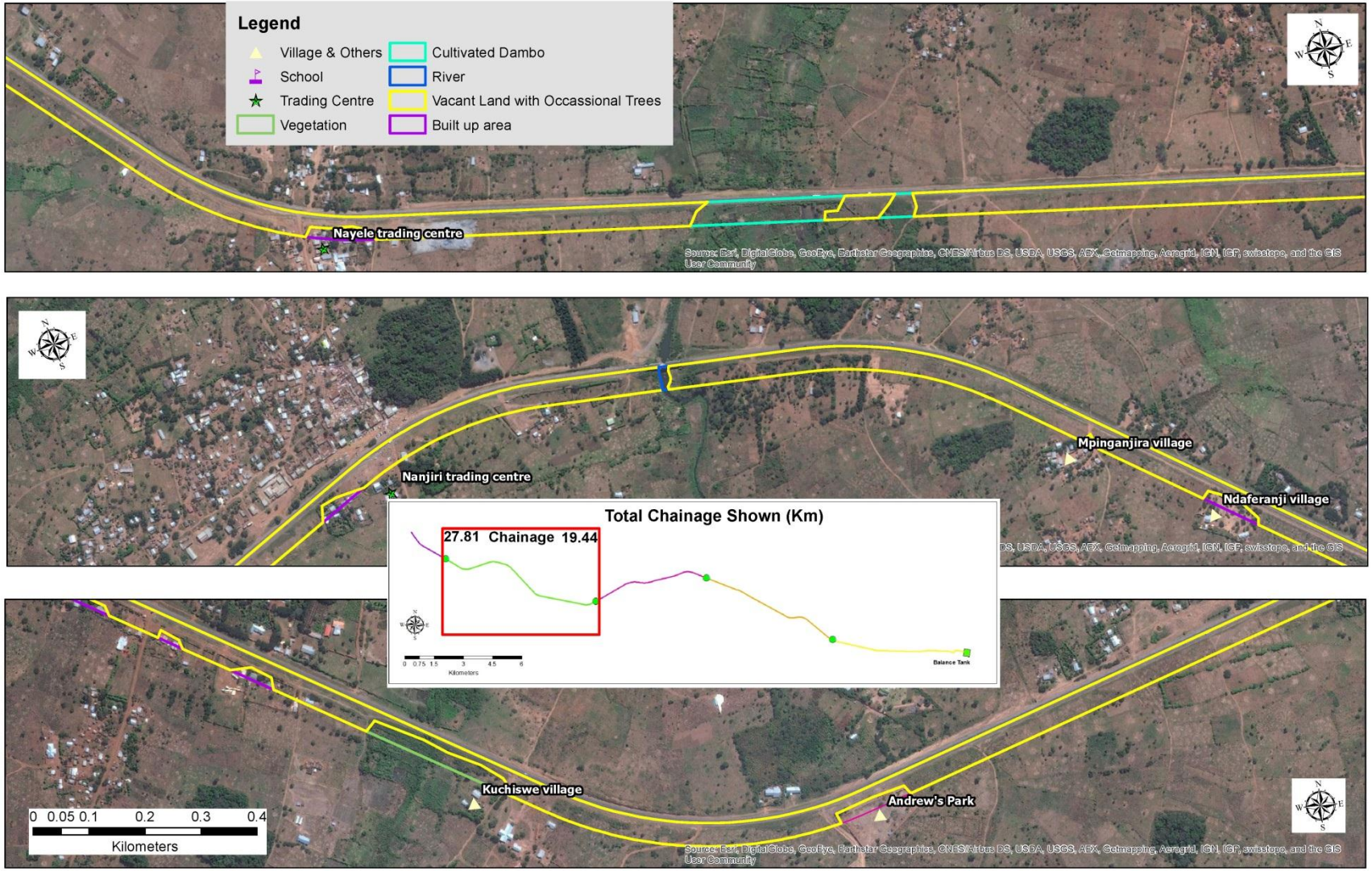
Layout 2


Mazengera Turn Off
Kamphata graveyard
Nowa village
Total Chainage Shown (Km)
13.78 Chainage 6.67
Balance Tank
Kilometers
Matapila trading centre
Mkanda village
Matindi girls academy
Legend
Village & Others
School
Trading Centre
Vegetation
Cultivated Dambo
River
Vacant Land with Occassional Trees
Built up area
Chainage
NASFAM
Masiye village
0 0.05 0.1 0.2 0.3 0.4
Kilometers
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Layout 3


Bango village
Double Vision School
Total Chainage Shown (Km)
19.44 Chainage 13.78
Balance Tank
Nathenje trading centre
Dzuka Girls School
Nathenje trading centre
Graveyard
Kachembere village
Kachembere village
Legend
Village & Others
School
Trading Centre
Vegetation
Cultivated Dambo
River
Vacant Land with Occassional Trees
Built up area
Kamundi village
Nankwichi village
Maye village
0 0.05 0.1 0.2 0.3 0.4
Kilometers

Layout 4


Legend
Village & Others
School
Trading Centre
Vegetation
Cultivated Dambo
River
Vacant Land with Occassional Trees
Built up area
Nayele trading centre
Nanjiri trading centre
Mpinganjira village
Ndaferanji village
Kuchiswe village
Andrew's Park
Total Chainage Shown (Km)
27.81 Chainage 19.44
Balance Tank
0 0.05 0.1 0.2 0.3 0.4
Kilometers
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

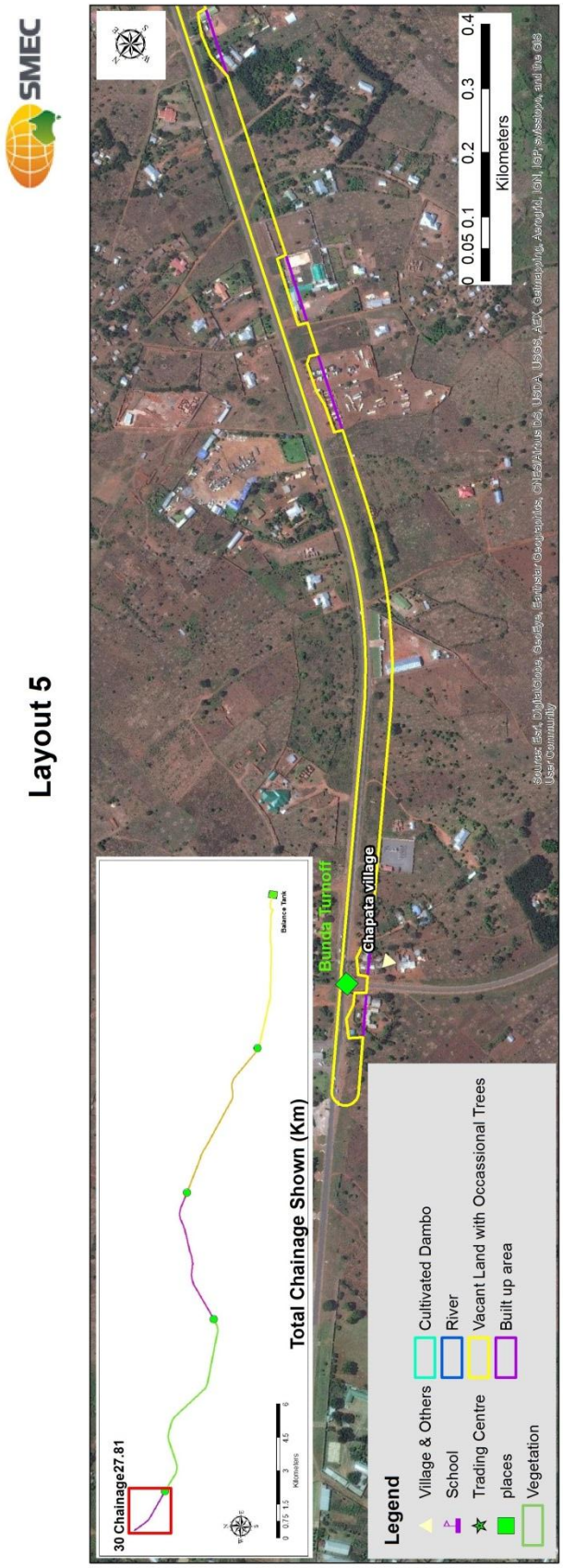


Figure 6.25: Land Use in pipeline buffer area

6.8. Biodiversity

6.8.1. Information Sources

Biodiversity studies have been undertaken to assess potential impacts on the Project area, as well as on the wider catchment. Regional implications relating to animal movements and species diversity and representation are also addressed. As part of this ESIA, SMEC reviewed available baseline data, conducted formal site surveys and undertook consultations with local villages and other relevant stakeholders. Relevant information sources are noted below:

- The most pertinent biodiversity studies were undertaken by WAPCOS (2014) as part of their Draft ESIA studies. Other preliminary studies were done by Sogreah (2010) and Safege (2001) as part of Dam options assessment studies. Investigations were mainly based on assessing available secondary data, consultation with local villages and some government departments, and informal site visits.
- Legislation and policies relating to environment, forestry, fisheries and parks and wildlife of the Government of Malawi.
- International policies and standards and guidance notes from the World Bank, IFC and African Development bank.
- Other documents of interest such as the Lilongwe District State of Environment Report and the Lilongwe and Dedza Socio-economic Profile.
- Stakeholders consulted as part of the biodiversity studies include:
- Lilongwe Water Board.
- Community members during site surveys
- Technical government officers and field assistants in Departments of Forestry, Fisheries, Wildlife and Environment in Lilongwe and Dedza Districts and the Lilongwe Headquarters.

Detailed specialist reports are presented in the following Appendices:

- **Appendix 5**: Specialist Biodiversity Report (Dr Chimwemwe Mawaya), which is summarised in Section 4.9.
- **Appendix 6**: Specialist Fisheries Report (Dr Bosco Rusuwa), which is summarised in Section 4.10.

6.8.2. Regional Flora and Fauna Biodiversity

i. *Species diversity*

Malawi has diverse habitats and ecosystems, which are rich in species diversity and abundance. The biodiversity includes forestry, fisheries, and wildlife resources. These are summarised below:

- **Flora**: Vegetation in Malawi is extensively miombo woodland, deciduous forests, and thickets, evergreen and semi-evergreen forests and montane grassland. Malawi has about 5,500 to 6,000 flowering plants, and 250 species of bryophytes, 200 of which are mosses. Out of the documented more than 6,000 plant species, 253 are considered threatened, vulnerable, rare or endangered (SOER 2010).
- **Invertebrates**: Over 8,770 invertebrate species have been documented in Malawi with insects dominating (SOER 2010). Dominant are the nematodes, crustacean and insects, while less represented species include earthworms, myriapods, and arachnids. Non-insect aquatic invertebrates include 280 species; 93 lacustrine (lake), and 187 associated with water (NABSAP 2006), and include: mollusks, nematodes, crustaceans (copepod, cladoceran, crabs,

ostracods, isopods and small prawns), rotifers, annelids, and acarins. Chironomids, water mites and nymphs of various insects are most common (NABSAP 2006).

i. **Amphibians**: There are 83 amphibian species in Malawi and 6 species are listed in the IUCN Red Data List. Most of the amphibian species are frogs and toads, with two species being caecilians. Eleven species of amphibians are currently listed on the IUCN Red Data List.

- **Reptiles**: There are 140 reptilian species recorded in Malawi from 22 families, but very little is known about their conservation status (NABSAP 2010). Twelve reptilian species are endemic to Malawi and 6 species are considered to be rare (SOER 2010).

- **Birds**: The number of bird species is 648 from 78 families (NABSAP 2006; SOER 2010). Over a third of these bird species are considered to be uncommon or rare and of long-term conservation concern. Eighteen bird species continue to be listed on the IUCN Red Data List (Pullanikkatil and Chilambo 2010). Ninety four birds in Malawi are restricted range species found only in one or a few biomes (NABSAP 2006) and these could be under threat because most of their habitats are degraded especially those outside protected areas (SOER 2010).

- **Mammals**: About 192 mammalian species have been recorded in Malawi, 125 species of which are small mammals. Most large mammals such as elephants (Loxodonta africana) occur in the national parks and wildlife reserves. Eight mammal species are listed on the IUCN Red Data List. Hippopotamus and otters are the only large mammals using aquatic habitats. The hippopotamus populations show a declining trend due to habitat loss and conflict with human activities (SOER 2010). Hippopotamus populations are protected within Liwonde National Park, Kasungu National Park, and Vwaza Wildlife Reserve.

- **Fish**: Fish and aquatic investigations are presented in Section 4.11. There are over 1,000 fish species in the country's water bodies, which represents approximately 15% of the global total of fresh water fish and approximately 4% of the world's fish species. Lake Malawi alone contains over 800 fish species, which is more than any other lake in the world and its fishes represent an evolutionary and biologically spectacle of global importance. Fish fauna of Lake Malawi is dominated by cichlids, while cyprinids dominate in the rivers that drain directly into the lake (Likongwe 2005 Kadye et al. 2008). Most of the large cyprinids (such as *Barbus*, *Labeo*, and the salmon-like *Opsaridium)* undertake seasonal breeding migration runs up tributary rivers of the lake. TheIUCN Red List data for Malawi lists 9 species as endangered, 93 as vulnerable and 3 as near threatened (IUCN, 2014).

ii. ***Biodiversity status and threats***

Biodiversity in Malawi has been significantly impacted by the Country's high population growth rate and extreme poverty causing habitat loss and land degradation, and influx of invasive alien species (NBSAP 2006). Nearly 90% of the Malawi population is forced by their low economic base to depend on natural resources for energy (fuel wood), food, construction material, medicine, and fodder. Specific stressors are:

- *Deforestation*: Currently between 50,000 and 70,000 hectares of natural forests are being destroyed annually and over the past 25 years the national forest cover has declined from 47% to 28%, (SOER 2010).

  Lilongwe and Dedza Districts are experiencing high deforestation and degradation of forest resources, primarily due to agricultural expansion and clearing tress for fuel and charcoal production. Miombo woodland was once common on the Lilongwe plain but it is now mostly restricted to customary protected graveyards, communal and individual woodlots, and protected areas such as Dzalanyama, Chongoni, Thuma, Bunda and Dzedza Forest Reserves.

Alarmingly even forest reserves, and in particular Dzalanyama and Chongoni forests, continue to experience significant illegal tree cutting (Photo).

- *Wildlife destruction*: Habitat destruction and poaching have significantly impacted on wildlife distributions and abundance, and many species are threatened by land clearing and draining of wetland areas. Most large animals are now only found in protected areas.

  In the Lilongwe/Dedza region the Dzalanyama and Chongoni forests support a number of endemic species including velvet monkey, baboon, duiker, sable antelope, leopard and hyena. These forests are also important bird sanctuaries with more than 300 species recorded. Rivers support important fisheries, with cyprinids species being the most common fish.

6.8.3. **Previous Studies**

Landuse in the Linthipe river catchment is discussed in Section 4.7. The catchment contains natural and cultivated forests; however cleared land, agricultural activities and population centers now dominate catchment landuses. There are a number of important regionally protected areas near the Project area including Dzalanyama, Chongoni, Dedza and Thuma Forest reserves (Figure 6.20). The southern part of the Dzalanyama Forest Reserve extends into the upper Diamphwe River catchment.

i. ***Flora***

WAPCOS described a range of tree species that occur in Forest Reserves, as shown in Table 6.12.

Table 6.12 Tree Species in Forest Reserves (WAPCOS, 2014)

Dzalanyama Forest Reserve	Chongoni Forest Reserve	Thuma Forest Reserve,
- *Julbenadia paniculata* - *Parinari curatellifolia* - *Brachystegia spiciformis* - *Terminaria sericea* - *Brachystegia floribunda* - *Colophospermum mopane* - *Combretum zeheri* - *Bauhemia thonningii* - *Uapaka kirkiana* - *Syzigium guinesee*	- *Adima microcephala* - *Burkea Africana* - *Pterocarpus angolensis* - *Sclerocarya caffra* - *Bauhimia thonningii* - *Terminaria sericea* - *Brachystegia floribunda* - *Syzygium cordatusm*	- Brachystegia bohemii - Julbenadia globiflora - Combretum sp. - Diplorhus sp. - Diospyrus sp - Acacia spp.

WAPCOS also described indigenous vegetation within the Dam inundation area as Miombo woodland type dominated by various Brachystegia and Julbenadia tree species, as shown in Table 6.13. WAPCOS states that most of these trees are in the regeneration stage except for a few large standing trees located in graveyards.

Table 6.13 Tree Species in Dam Inundation Area (WAPCOS)

Tree Species
- *Brachystegia floribunda (Tsamba)*
- *Julbernadia paniculata (Mtondo)*
- *Parinari curatellifolia (Muula)*
- *Brachystegia spiciformis (Mvukwe)*
- *Terminarea sericea (Naphini)*
- *Piliostigma thonningii*
- *Combretum sp.*

During this study, only *Terminarea sericea* (one tree), *Piliostigma thonningii* and *Combretum* species were recorded from the species listed above. The reason could be that most of these species have been cleared from the area and only a few, if any, now exist. *Piliostigma thonniingii* was only recorded in the riverine vegetation (9 trees) *and combretum* sp. was recorded only in forest woodland (graveyards).

Exotic fruit trees are scattered on farmland and gardens, graveyards and homesteads, and include mango (Mangifera indica) and guava (Psidium guajava). Other exotic trees used primarily for timber include *Acacia polyacantha*, *Eucalyptus sp*. and Gmelina arborea.

WAPCOS categorised vegetation as cultivated area; bushland with grassland patches; dense woodland patches (graveyards); and riparian.

ii. ***Fauna***

WAPCOS described the Project area as having poor wildlife representation due to loss of habitats resulting from land clearing, settlement, agriculture, firewood and brick making. No large mammals were observed during previous surveys, with wildlife restricted to small mammals, birds, snakes, frogs and insects.

Fauna species listed by WAPCOS (2014) as occurring in the area are shown on Table 6.14.

Table 6.14 Fauna Species in Direct Affected Project Area (WAPCOS, 2014)

Mammal species	Birds
- *Mus sp*. - Common duiker[1] (*Sylvicapra grimmia)* - Hyaena (*Crocuta crocuta)* - Otter (*Aonyx capensis)* - Monkey (*Chlorocebus pygerythrus)* - Hare (*Lepus sp.)* - Villages reported that rats are common. [1] WAPCOS reported Thomson's Gazelle, however this is likely an error and should have been listed as Common duiker.	- Noted that birds exist in the project area with Pied Kingfisher as the most common species. - Birds mainly found in graveyards and only a few birds found in open areas.
Reptiles, Amphibians & Insects	**Fish**
- Crocodile (*Crocodylus niloticus*) - Green mamba (*Dendroaspis angusticeps*) - Python (*Python sebae*) - The reptiles injure livestock and pose a threat to humans. - There were no amphibians recorded. - Insects recorded include mosquitoes, grasshoppers, Tsetse flies, Ticks, bees, wasps and scorpions.	- *Tilapia rendalli* - *Clarius gariepinus (Mlamba)* - *Lephrunops sp.* - *Oreochromis shiranus (Makumba)* - *Opsaridium microlepis (Mpasa)*-Endangered, - *Opsaridium microcephalum* - Vulnerable - *Labeo sp,* - WAPCOS did not record *Mpasa* (Lake Salmon) in the field and local people indicated that this fish does not reach the Dam site because of a natural barrier (water fall) located downstream of the Dam.

6.8.4. **Further Studies**

Following a review of relevant information, and in particular data obtained in the Draft ESIA studies (WAPCOS, 2014), a gap analysis was undertaken to determine what additional studies may be required to fully document baseline conditions in the study area. Important biodiversity data gaps

are listed in Table 6.15. Further investigations, including field surveys, were undertaken to address these gaps.

Table 6.15 Biodiversity Data Gaps

DATA GAPS
Vegetation
▪ Plant species list is incomplete and vegetation has not been classified into appropriate categories. ▪ Potential habitat types have not been identified in accordance with OP/BP 4.04 or IFC requirements. ▪ Appropriate landuse and vegetation / habitat mapping has not been completed.
Wildlife
▪ There are data gaps in animal species lists and identification of threatened/endangered species. ▪ A habitat assessment and ecological mapping of regionally identified species has not been done. ▪ The importance of biodiverse important habitats such as woodland graveyard sites to act as 'animal refuges' has not been assessed. ▪ The importance of the study area as a wildlife corridor has not been investigated, particularly with regard to animals potentially transiting between protected forests. ▪ There are data gaps in use of ecological resources by the local communities.

Information from the data review and site surveys was then used to describe baseline biodiversity characteristics of the Project area. This includes fully describing the vegetation and wildlife found in the project area; their species abundance and richness, assessment of diversity and conservation status, critical habitat and the use of ecological resources by local communities.

Specialist studies are included in Appendices and include:

Appendix 5: Terrestrial Vegetation and Wildlife Report (Dr Chimwemwe Mawaya).

Appendix 6: Fisheries Report (Dr Bosco Rusuwa).

A summary of these reports is provided below in Sections 4.9 and 4.10.

6.9. Terrestrial Vegetation and Wildlife

6.9.1. **Study Methodology**

The vegetation study focused mainly on the Project Dam and infrastructure area. Vegetation along the water pipeline to Bunda Turn-off is separately discussed at the end of this section.

The vegetation study was designed to identify vegetation categories, habitat types, plant species and conservation status. Survey methodology includes the following:

- Review of all available baseline information and assessment of information gaps.
- Consult with local villages and relevant stakeholders.
- Satellite imagery was initially used to identify important landuse areas within the project area and classified in accordance with the National Land Cover Atlas, 2012 (Food and Agricultural Organisation: Land Resource Conservation Department). Distributions of these landuses within the Project affected area are provided in Section 4.7 (Landuse) and shown on

Figure 6.26. Based on data review and known occurrence of vegetation species within the Project area these landuses were slightly modified to describe habitat types, these being:

- Dambo grassland / wetlands;
- Cultivated land (dambo and cropland);
- Riverine / riparian;
- Forest woodlands; and
- Tree plantations.
- A field survey plan was designed to include survey transects within all identified habitats and at representative sites throughout the Project affected area. A total of eight transects were surveyed, which were typically 100 meters long and aligned across the Diamphwe river, as well as parallel to the river (Figure 6.26).
- Vegetation surveys were undertaken during the period 8 to 12 October, 2015 and included walking each transect, recording vegetation types and species, and verifying satellite imagery. The survey team was accompanied by local villagers.

Data collected was compiled into species lists and inventories. The national and international species conservation status of species was also determined. Statistical tools were used to determine biological diversity in the different habitats and project impact areas.

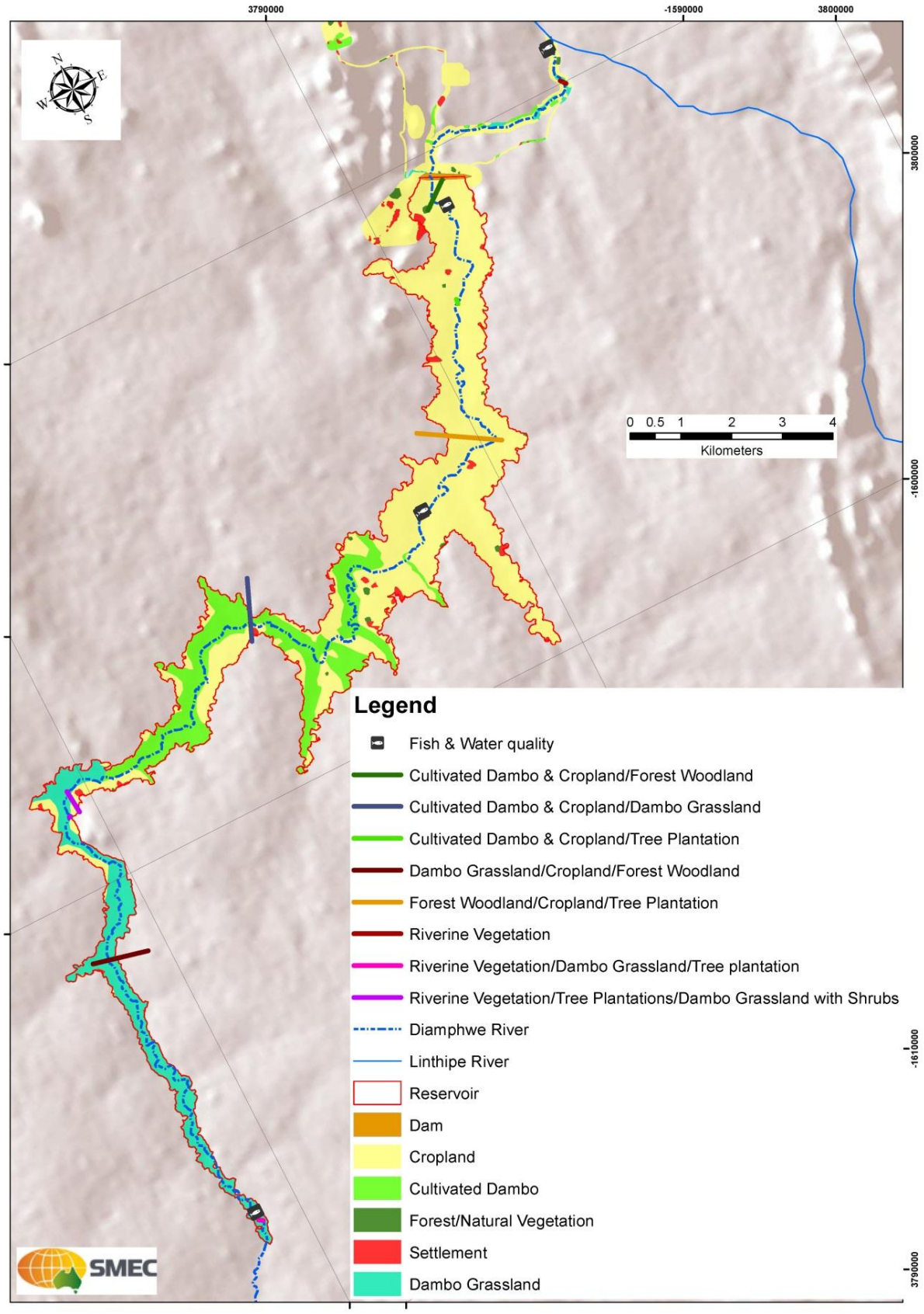


Figure 6.26: Habitat Distribution and Survey Transects

6.9.2. **Habitat Types in Project Area**

The distribution of Habitat types is shown on Figure 6.26. The ecological status of each of these habitats is summarised below.

i. ***Dambo grassland / wetlands***

Dambo grassland is located in the flood plain area of the upper reaches of the proposed reservoir and extends down the catchment for approximately 10 km to Chilikumwendo village. This habitat is mainly composed of grasses, typically *Setaria grandis, setaria sphacelata* and *Leersia hexandra*, sometimes with scattered shrubs. Shrubs recorded included: *Flueggea virosa, Diospiros heterophylla, Asparagus terrisfolias, and Senna sengueana*. The few cultivated parcels of Dambo grassland are typically used as tobacco nurseries, while some areas had plantings of *Eucalyptus saligna* and *Gmelina arborea* trees.

Photograph 6.14: Dambo Grassland

ii. ***Cultivated Land (Cultivated Dambo & Cropland)***

Cultivated land consists of cultivated dambo and cropland, and covers approximately two thirds of the lower part of the proposed reservoir, extending approximately 20 km from the Dam wall area to Chilikumwendo village.

Cultivated dambo is floodplain area that is used to grow crops such as vegetables, tomatoes, Irish potatoes, maize and sugarcane. During the dry season some of these areas are irrigated from shallow groundwater wells or the river. Scattered trees or private plantations are also present with the most common tree species being Eucalyptus sp. especially *Eucalyptus saligna*, *Gmelina arborea* and fruit trees such as *Mangifera indica* and *Psidium guajava*.

Cropland is cultivated agricultural land that is mainly used for growing crops during the wet season. Characteristic of this habitat are scattered trees, mostly mangoes, *Faldebia albida* and *Bauhinia sp.*

Photograph 6.15: Cultivated Land (Cultivated Dambo and Cropland)

iii. ***Riverine/Riparian Vegetation***

Riverine or riparian vegetation occurs along the river banks and comprises of reeds (*Phragmites mauritiana*) and a range of tree species including *Rauvoflia caffra , Mwimbi*; Toona *ciliata* or *cinderella*; *Acacia albida, Albizia versicolor, Oncoba spinosa* and *Parkia filicoedia or mkundi*. Other common plants include Lantana camara (invasive species); *Syzygium cordatus; Psidium guajava; Phragmites mauritiana; Vernonia glabla; Maytenus heterophyla; Flueggea virosa, Diasyroa lycidoides; Tithonnia diversifolia;* and *Sida acuta*. Riverine vegetation has high ecological importance such as filtering sediments and contributing to healthy water quality, supplying food and nutrients to aquatic organisms, providing habitat to a wide range animals and functioning as wildlife corridors for migrating and dispersing organisms.

Photograph 6.16: Riverine/Riparian Vegetation

iv. ***Forest woodland***

Forest Woodland is found mostly in graveyards with smaller patches in cultivated dambo grassland. This habitat has a good representation of older and larger trees, typically with large canopy cover, and includes indigenous trees such as *Rauvolfia caffra, Toona cilliata and Euphorbia tirucalli.* Forest woodland in the project area is restricted to isolated stands of vegetation with minimal connection with more expansive regional forests found within the region, such as Dzalanyama, Dedza, Chongoni, Thuma, and Bunda forest reserves.

6.9.3. **Species Richness and Abundance**

Seventy two (72) plant species were recorded in the project area representing 28 families. A comprehensive species list including relevant habitat type, abundance, uses and conservation significance is included in **Appendix 5**. The most abundant species are summarised in Table 6.16 and comparative abundance shown on Figure 6.27.

Table 6.16 Most Abundant Vegetation Species

Species	%	Habitat	Uses
Woody species			
Rauvolfia caffra	23	Mostly in forest woodland (graveyards)	Timber
Toona cilliata	16	Mostly in forest woodland (graveyards)	Timber & firewood
Euphorbia tirucalli	9	Mostly in forest woodland (graveyards)	
Eucalyptus saligna	11	Exotic trees mostly in dambo grassland	Firewood
Gmelina arborea		Exotic trees mostly in dambo grassland	Timber & firewood
Shrubs			
Flueggea virosa		Mostly in riverine and dambo grassland	Medicinal
Diospiros heterophylla		Mostly in riverine and dambo grassland	Medicinal
Asparagus terrisfolias		Mostly in riverine and dambo grassland	Medicinal
Senna sengueana		Mostly in riverine and dambo grassland	Medicinal
Phragmites mauritiana		Mostly in riparian areas and covers most of river banks.	Mat making

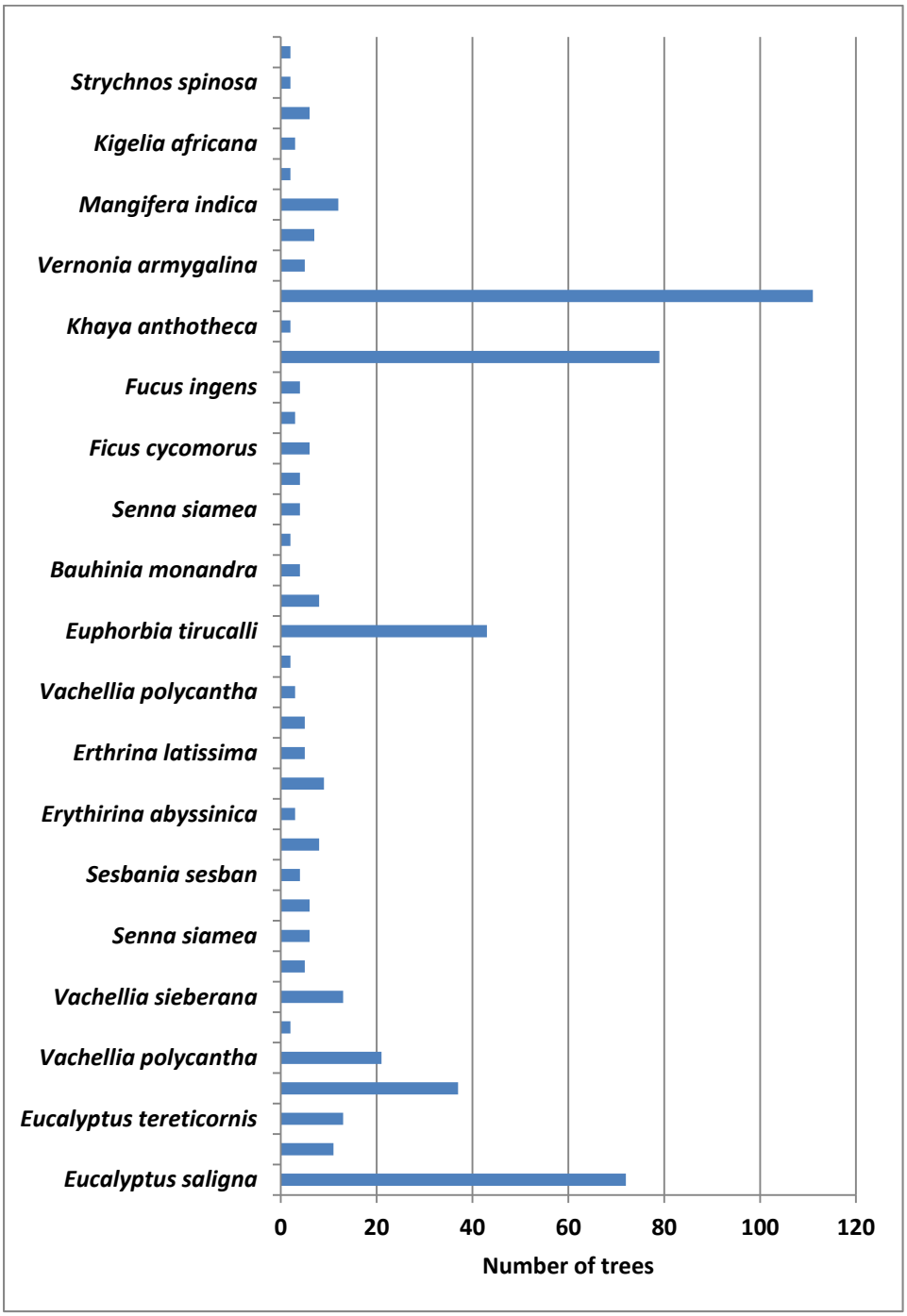
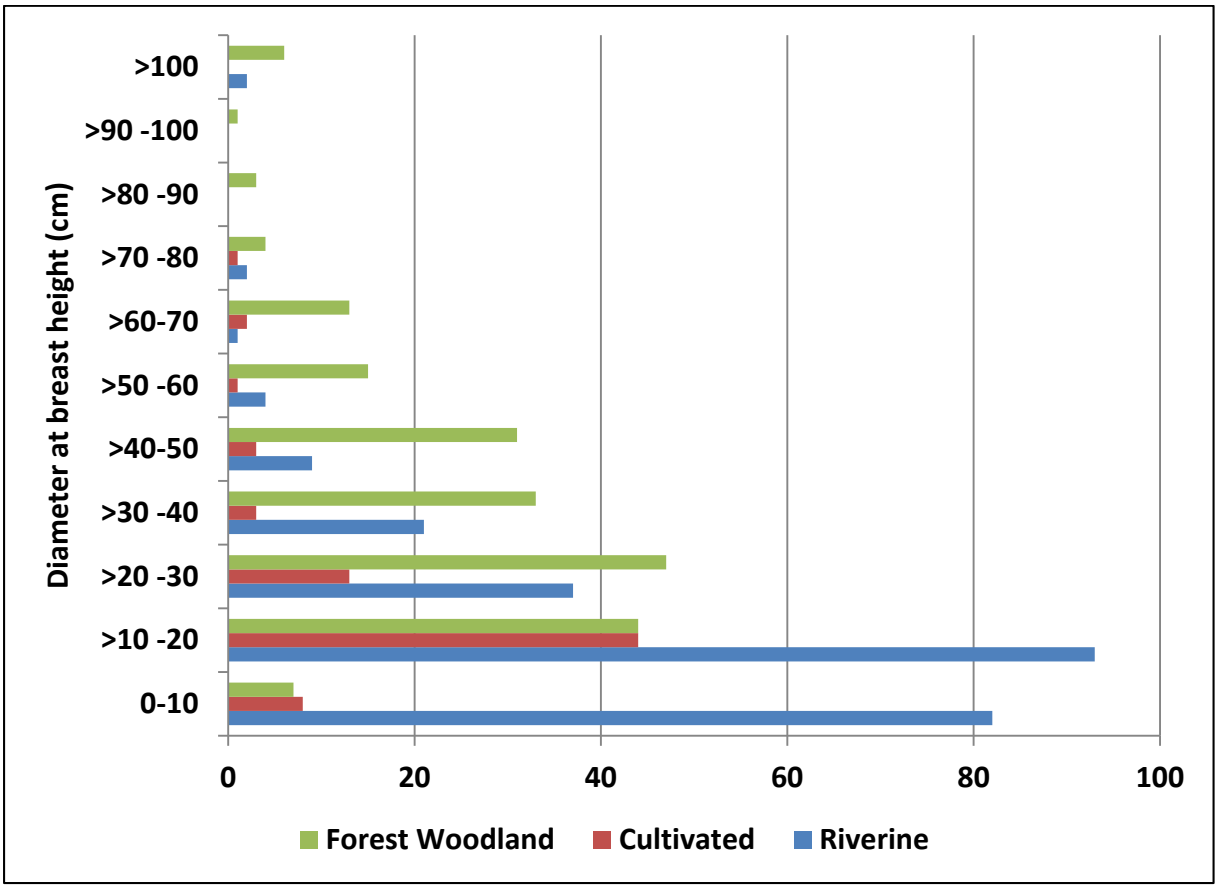


Figure 6.27: Abundance of Woody Tree Species Recorded In the Project Impact Area

6.9.4. **Vegetation Structure**

There is variation in age structure of trees found in different habitats. The Diameter at Breast Height (DBH) was used to classify age of trees, which is summarised below and shown on Figure 6.28.

- Riverine vegetation recorded the largest population of young trees (63%),
- Forest woodlands (graveyards) have a good representation of all trees in different age groups, as well has having the greatest number of older trees (76%). It was noted that large trees are harvested by villagers to make coffins.
- Cultivated areas had the least number of trees with most being young trees.



Note: DBH <10 cm = young age; DBH>20 – 50 cm = medium age; DBH>50 cm = old age

Figure 6.28: Age structure of woody plant species in different habitats

6.9.5. **Habitat Value**

Habitat value is summarised below:

- Optimum vegetation habitats were mostly found in forest woodland (graveyards), which contain high numbers of large and indigenous tree species, typically with more than 90% canopy cover.
- Riverine vegetation habitats were found to be most diverse with 62% of the recorded species; followed by forest woodland containing 31% of the recorded species.
- Cultivated areas are the most degraded habitats with low numbers of trees and tree species (15%) recorded.

Numerous plant species are used for medicinal purposes, firewood, and as a food source (mainly fruits). Many of these plants are found in riverine vegetation followed by forest woodland, and are an important ecological resource in supporting local livelihoods and health. A breakdown of ecological resources is shown in Figure 6.29.

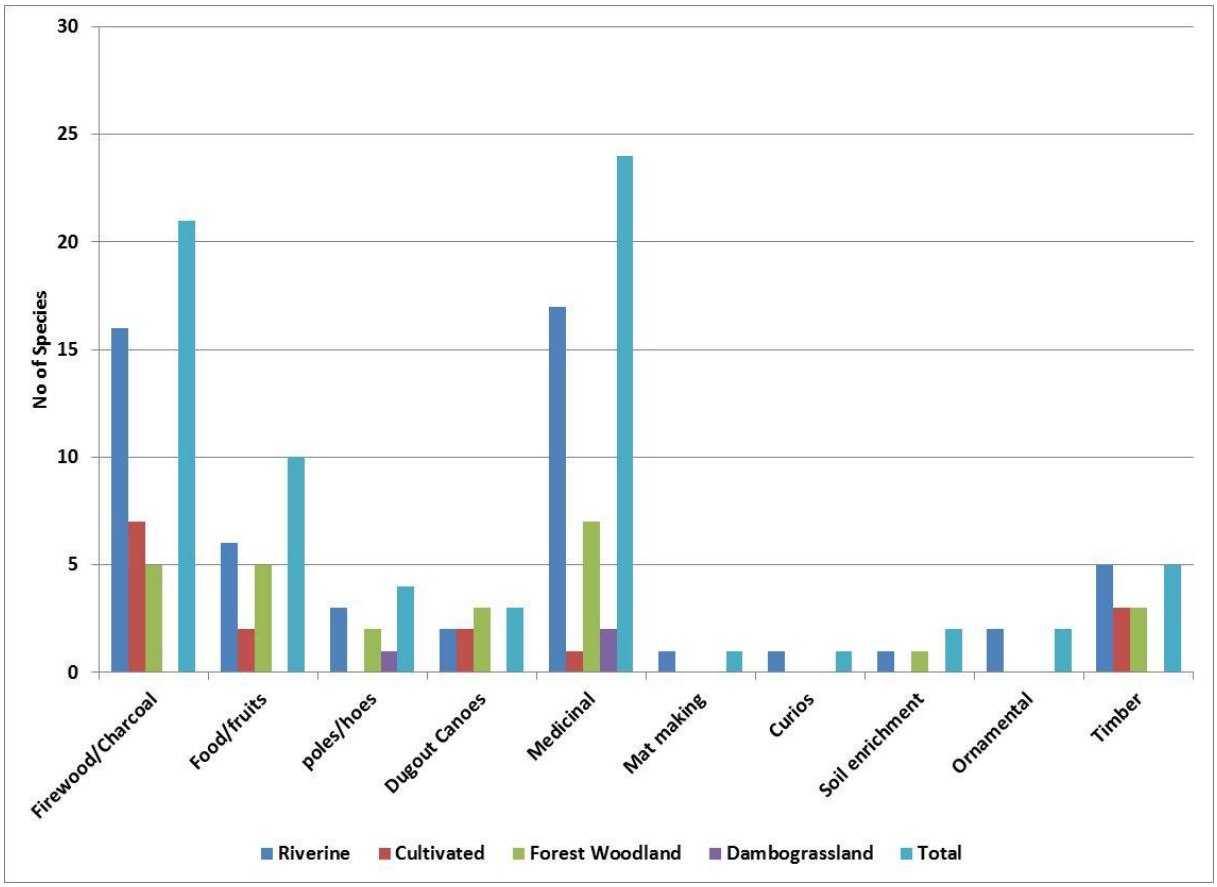


Figure 6.29: Use by local people of plant species from different habitats in project impact area

6.9.6. **Conservation Status of Vegetation in the Project Area**

Plant species with conservation significance are presented in Table 6.17 and summarised below:

- 17 International and National conservation significance;
- 10 International conservation significance; and
- 11 National conservation significance

Table 6.17 Plant Species of Conservation Significance in the Project Impact Area

Common name/Chichewa name	Scientific Name	Conservation Significance		
		National	CITES	IUCN
Poison pod albizia	*Albizia versicolor*	EN		-
	Piliostigma thoningii	EN		-
	Rauvoifia caffra	EN		NT
African Sausage tree (Mbvunguti)	*Kigelia africana*	EN		-
	Oncoba spinosa	EN		EN
Bleedwood teak (Mlombwa)	*Pterocarpus angolensis*	Protected		V
African mahogany *(*Mbawa*)*	*Khaya anthotheca*	Protected/T		V
Red hot poker tree	*Erythrina abyssinica*	NT		-
- (Makoma)	*Bridelia micratha*	Protected/NT		-
Cinderella	*Toona cilliata*	NT		-
- (Naphini)	*Terminaria sericea*	Protected		-

Common name/Chichewa name	Scientific Name	Conservation Significance		
		National	CITES	IUCN
Blue gum	*Eucalyptus tereticornis*	-		V
Guava	*Psidium guajava*	-		NE
	Faidherbia albida	-		V
	Azanza garkeana	-		R
	Ficus Cycomorus	-		V
	Markhamia obstuforlia	-		V

The number of species with conservation status and their habitats are shown on Figure 6.30 and summarised below:

- Riverine vegetation was found to contain 13 of the 17 species recorded with conservation value, with species in almost all categories. Common species include *Psidium guajava* and *Oncoba spinosa*.
- Forest Woodland found mostly in graveyards and cultivated dambo grassland recorded low numbers of species with conservation significance. Common species include *Toona cilliata* and *Rauvolfia caffra*.

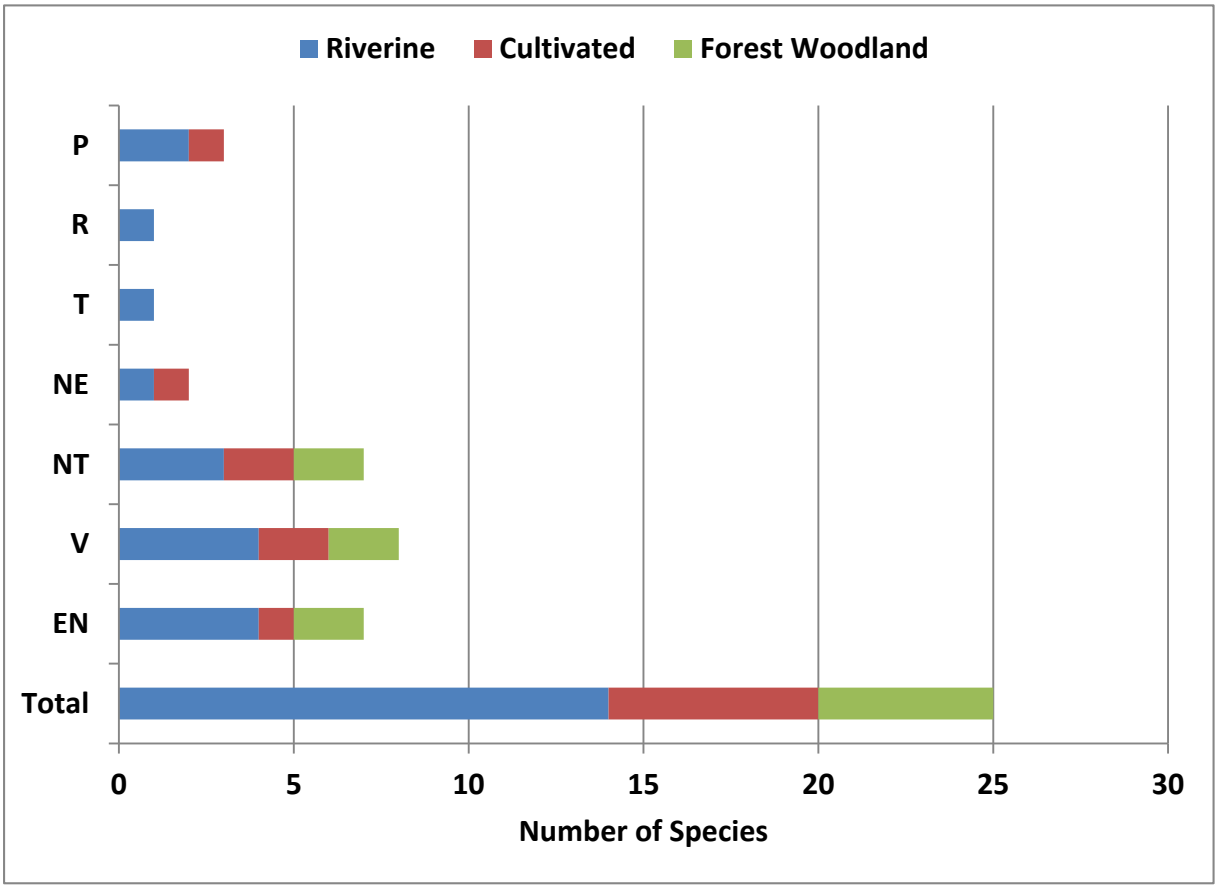


Figure 6.30: Number of Species with Conservation Status and their habitats

6.9.7. **Water pipeline to Bunda-Turn-off**

The pipeline route is within a designated road reserve and the majority of its length is characterised by vacant land with occasional trees. Approximately 1.3 ha is represented by natural vegetation, including a portion of a forested graveyard. Tree species are similar to those described in Section 6.9.2, including *Rauvolfia caffra, Toona cilliata and Euphorbia tirucalli.*

6.10. Wildlife

6.10.1. **Study methodology**

The wildlife study focused mainly on the Project Dam and infrastructure area. Wildlife along the water pipeline to Bunda Turn-off is separately discussed at the end of this section.

The wildlife study was designed to identify wildlife habitats and species, local and regional representation and conservation status. Survey methodology includes the following:

- Review of all available baseline information and assessment of information gaps.
- Consult with local villages and relevant stakeholders.
- Identify wildlife species found in each habitat type and assess their conservation status.
- Assess the regional and local importance of different habitat types, including the use of habitats as wildlife refuges (such as graveyards) and as part of wildlife corridors for transient wildlife, such as bird movements between Forest Reserves.
- Wildlife surveys were undertaken along vegetation survey transects identified above (Section 4.9) and shown on Figure 6.26. Surveys included recording fauna species during the vegetation survey, as well as using traplines and pit traps to identify small animals. A total of 830 trap-monitoring events were recorded. The survey team was accompanied by local villagers.

Data collected was compiled into species lists and inventories. The national and international species conservation status of species was also determined. Statistical tools were used to determine biological diversity in the different habitats and project areas.

Photograph 6.17: Survey Photos

6.10.2. **Mammals**

i. ***Species Richness and Abundance***

A total of 21 mammal species are known to occur in the project area, of which the field survey recorded 13 species. A species list is given in Table 6.18.

Table 6.18 Mammal Species List

Family	Common Name	Scientific Name	Habitat[1]				Record
			W	C	R	D	
Muridae	Multimammate rats	*Mastomys natalensis*	X	X	X	X	Survey
	Bush Rats	*Aethomys kaiseri*	X			X	Survey
	Woodland mouse	*Grammomys dolichurus*	X		X		Survey
	Shaggy swamp rats	*Dasymys incomptus*		X		X	Survey
Soricidae	Pygmy mouse	*Mus minutoides*			X	X	Survey
	Climbing Shrew	*Sylvisorex megalura*					Survey
	White toothed shrews	*Crocidura hirta*	X				Survey
Dendromurinae	Brant's climbing mouse	*Dendromus mesomelas*	X			X	Survey
Gergilidae	Gerbil's tatera	*Tatera branstii*					Survey
Gliridae	Woodland dormouse	*Graphiurus murinus*	X				Survey
Sciuridae	Squirrel	*Paraxerus sp.*			X		Survey
Thryonomyidae	Cane rat	*Thryonomys sp.*			X		Survey
Leporidae	Hare	*Lepus sp.*				X	Survey
Bovidae	Common Duiker	*Sylvicapra grimmia*	X		X		Reported
Mustelidae	Clawless Otter	*Aonyx capensis*			X		Reported
Canidae	Jackal	*Canis mesomelas*	X				Reported
Hyaenidae	Spotted Hyaena	*Crocuta crocuta*					Reported
Nesomyidae	Giant Pouched Rat	*Cricetomys sp.*			X		Reported
	Creek rat	*Pelomys fallax*					Reported
	Water rat	*Dasymys incomtus*					Reported
	Red veld rat	*Aethomys crysophilus*					Reported

Note [1]: W: Woodland/grave yard; C: Cultivated land/gardens; R: Rivers/riverine; D: Dambo grassland

The most abundant mammal species recorded during the field survey was multimmamate rats (*Mastomys natalensis),* which was found in all habitat types. Woodland mice *(Grammomys dolichurus*) were also common and were mostly found in woodland graveyards and a few from riverine.

Local villages indicated that the common duiker and Jackal are usually found in forested areas such as graveyards and private plantations, and would move to riverine vegetation to drink water and hide during the day. This information was also collaborated by the Department of National Parks and Wildlife (DNPW). Clawless otters were reported by villages to be present in the Diamphwe River and are commonly seen during the rainy season and hide in deep pools during the dry season. Otters often attack fishermen's traps to steal fish caught and crabs. DNPW also noted that otters are likely be the clawless otter and not the spot necked otter.

ii. ***Optimum Habitats***

Mammals were mostly found or known to occur in graveyards and riverine vegetation areas, followed by dambo grassland. Only 2 species of mammals were recorded in cultivated areas.

Habitat type and mammal species distribution are shown on Figure 6.31.

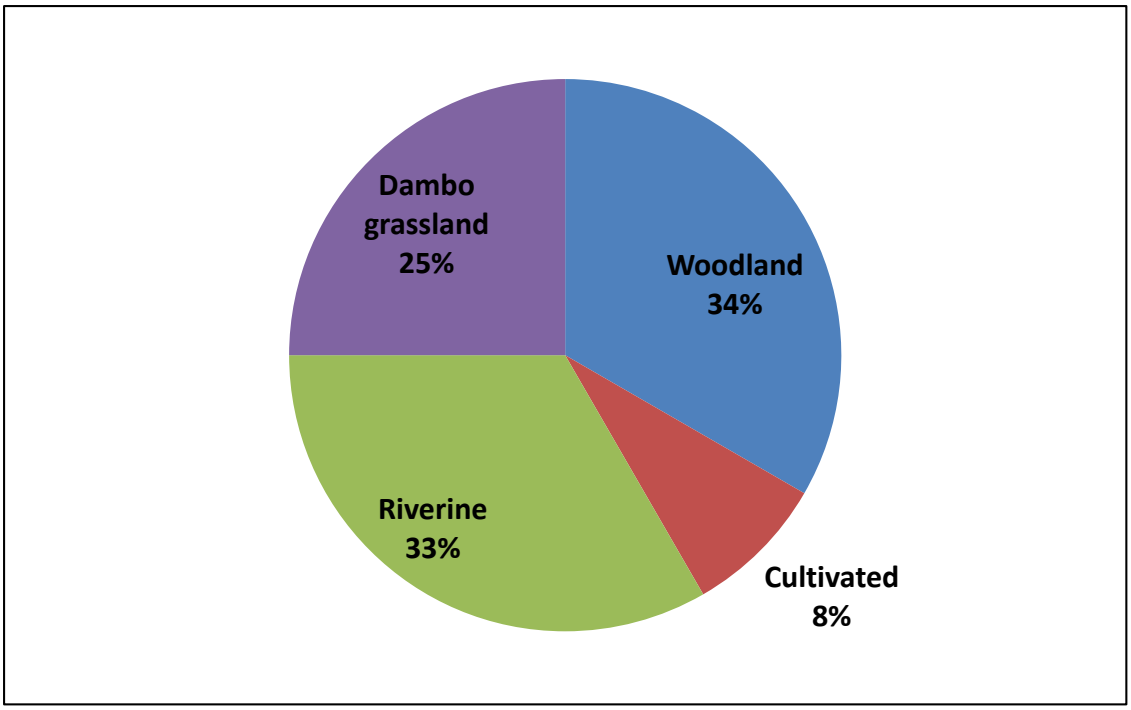


Figure 6.31: Percentage of Mammal Species and Habitat Type

iii. ***Dzalanyama Forest Reserve***

Part of the Dzalanyama Forest Reserve is located in the upper reaches of the project area catchment, approximately 35 km from the proposed reservoir. Large animals that are now restricted to the Dzalanyama Forest Reserve include Reed buck, Impala, Bush buck, Warthog, Bush pig, Ant bear and Spotted Hyeana, and Leopard (Consultation with DNPW 2015). Other than the Spotted Hyena, there is no evidence to indicate that any of these animals use or transit the Project site.

6.10.3. **Avifauna**

i. ***Regional distribution***

Malawi has about 653 bird species and 18 are near endemic (Pullanikkatil and Chilambo 2010). The project area is located approximately 35 km from the Dzalanyama Forest Reserve, which is one of Malawi's 22 recognised Important Bird Areas (MW011). Some 296 bird species have been recorded in Dzalanyama Forest Reserve, of which 28 species have been classified as being biome restricted and have conservation significance. However, none of these threatened bird species have been recorded in the Project area and none were observed or reported during the field survey.

ii. ***Species Richness and Abundance***

During this survey a total of 57 bird species belonging to 28 families were recorded. The dominant families include:

- *Estrildidae* (finches, blue waxbill and manikin): nine species;
- *Ploceidae* (weavers, bishops and quelea): four species;

- *Columbidae* (doves): three species
- *Alcedinidae* (kingfisher) three species
- Malaconotidae (Bush Shrike): three species

A full species list is provided in **Appendix 5** and summarised in Figure 6.32.

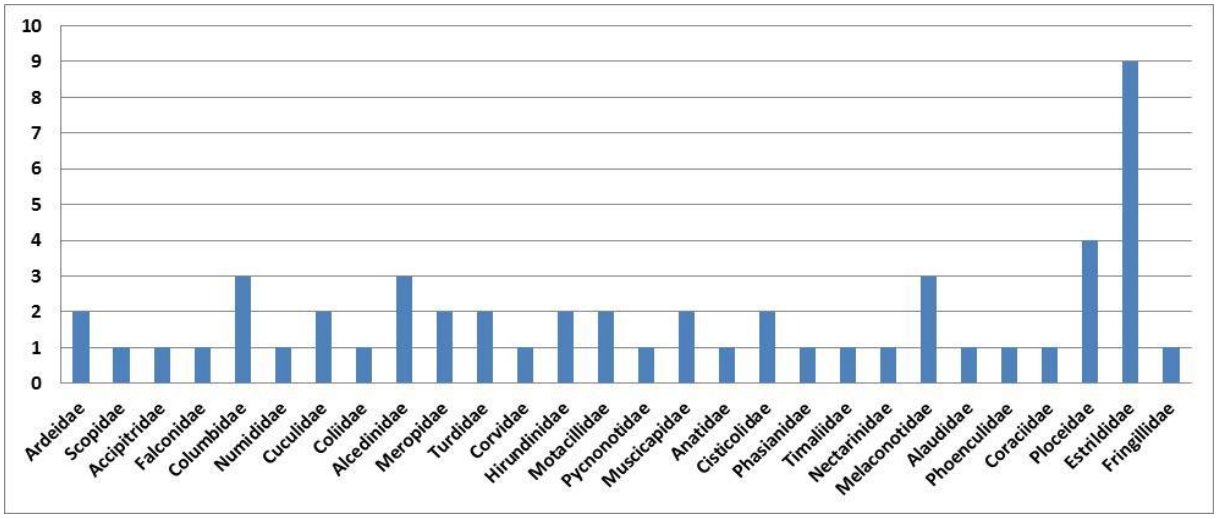


Figure 6.32: Avifauna Families and number of species recorded

iii. ***Optimum Bird Habitats***

The field survey established that birds were mostly found in the riverine vegetation especially where there were reeds and trees. Almost half of the species recorded inhabited river/riverine vegetation. Forest woodland in graveyards also acted as important bird habitats for forest dwelling bird species.

Bird nesting sites were observed in the riverine vegetation mostly in reeds and trees close to the water. Local villages also indicated that the riverine vegetation is used by nesting water ducks.

Species distribution in the different habitats is shown on Figure 6.33.

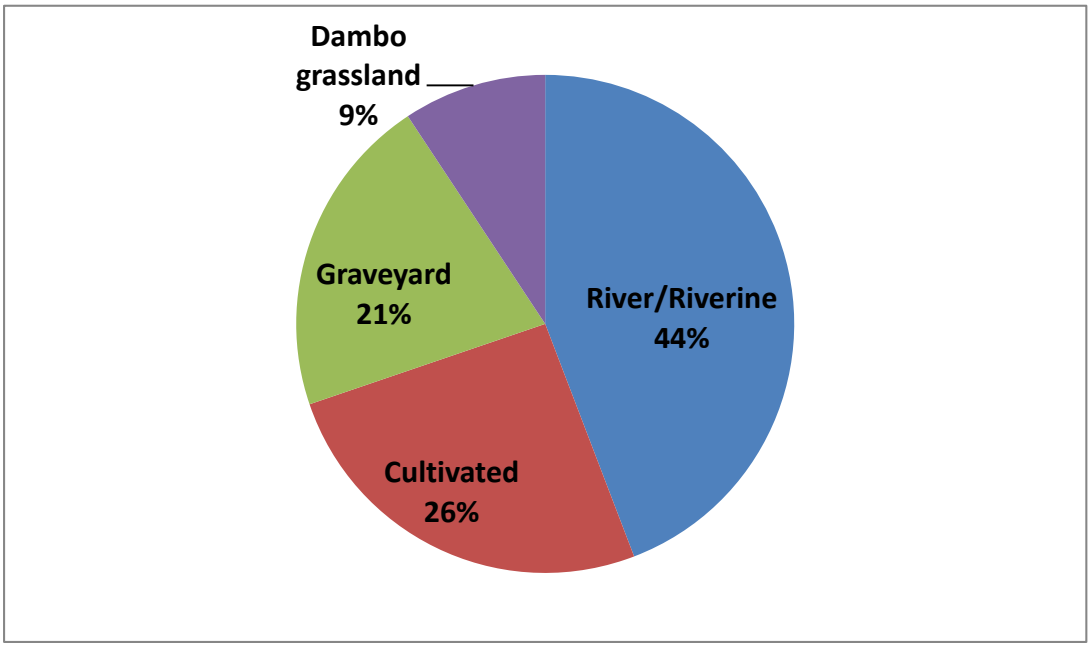


Figure 6.33: Percentage of Avifauna Species and Habitat Type

iv. ***Conservation Status of Birds in the Project Area***

There were no globally threatened or near endemic species recorded in the project area. However some species are protected under the National Parks and Wildlife Act of 2004.

However, local villages reported that the red winged francolin and guinea fowl are present along the riverine vegetation and are hunted for food. Owls were also reported to use graveyards and different types of owls may be present as different types of songs have been heard at night. Owls are also hunted. The red winged francolin is a protected bird species under the National Parks and Wildlife Act (2004). In addition the act protects all species of owls and rollers.

Bird species of conservation significance are shown on Table 6.19.

Table 6.19 Bird Species of Conservation Significance in the Project Impact Area

Common Name	Scientific Name	Conservation Significance		
		National	CITES	IUCN (2014)
Little sparrow hawk	*Accipiter minullus*	-	II	-
Pelegrine Falcon	*Falco peregrinus*	-	II	-
Broadbilled Roller	*Eurystomus glaucurus*	Protected		LC
Red Winged Francolin*		Protected		LC
Guinea fowls		Protected		LC
Owls	*Different types*	Protected		LC

* Although this species was assessed to be the Red Winged Francolin, a review expert suggests that it is more likely to be be Shelley's (which also has red wings), Hildebrandt's, or Red-necked francolins.

6.10.4. **Reptiles**

i. ***Species Richness and Abundance***

There are 140 reptilian species recorded in Malawi from 22 families, however little is known about their conservation status (NABSAP 2010).

Eight families and 13 reptilian species are known to occur in the project area. Of these six species were identified during the field survey and seven were reported by local villages. These are listed in Table 6.20.

Table 6.20 Reptiles in Project Area

Survey Species		Reported Species	
Nile crocodile	*(Crocodylus niloticus*	Python	*(Python sebae)*
Agama lizard	*Agama sp*.)	Mamba	*(Dendroaspis sp*.)
Three tined grass snake	*(Psammophis phillipsii)*	Green water snake	*(Philothamnus hoplogaster)*
Monitor lizard	*(Varanus niloticus)*	Brown water snake	*(Lycodonomorphus rufulus)*
Rainbow Rock Skink	*(Trachylepis margaritifer)*	Common puff adder	*(Bitis arietans arietans)*
African Striped Skink	*(Trachylepis striata)*	Wolf snake	*(Lycophidion sp.)*;
		Tortoise	

ii. ***Optimum Habitats***

Observed and reported reptile species were mostly found in river/riverine habitats. Crocodiles are found in deep pools and snakes are common in reeds and riverine vegetation along the river bank.

iii. ***Conservation Status of Reptiles recorded in the Project Area***

Twelve reptilian species are endemic to Malawi and six species are considered to be rare (SOER 2010). Species of conservation significance recorded or known to occur in the project area are presented in Table 6.21.

Table 6.21 Reptilian Species of Conservation Significance in the Project Area

Common Name	Scientific Name	Conservation Significance		
		National	CITES	IUCN (2014)
Nile Crocodile	*Crocodylus niloticus*	Protected	II	LC
Nile Monitor Lizard	*Varanus niloticus*	Protected	II	LC
Python	*Python sebae*	Protected		LC
Mamba	*Dendroaspis sp.*	Protected		LC

6.10.5. **Amphibians**

i. ***Species Richness and Abundance***

There are 83 amphibian species in Malawi. Most of the amphibian species are frogs and toads, with two species being caecilians.

Only four amphibian species from four families were recorded during this survey and these included frogs and toads. No further species were reported by local villagers. Recorded amphibians are listed in Table 6.22.

The most abundant species was Mullers or common plantana (Xenopus muelleri), which was very common in Diamphwe River. This species is fully aquatic and is able to survive for long periods under water.

Table 6.22 Amphibians in Project Area

Family	Common Name	Scientific Name
Pipidae	Mullers or common plantana	*Xenopus muelleri*
Bufonidae	Flat backed toad	*Amietophrynus maculatus*
Ptychanidae	Mascarene ridged frog	*Ptychadena mascareniensis*
Hemisotidae	Mabled snout burrower	*Hemisus marmoratus*

The number of species recorded during this study may not be a true representative of amphibians in the project area since amphibians are best studied during the rainy season when they come out to breed and their habitats are created, e.g. temporary pools and wetlands.

ii. ***Optimum Habitats***

Optimum amphibian habitat for amphibians is riverine with shrubs; pools and reeds. Numerous Mullers or common plantana (Xenopus muelleri) were observed in stagnant pools with rocks where the Diamphwe River was flowing slowly and there were a lot of algae.

iii. ***Conservation Status of Amphibians in the Project Impact Area***

Eleven species of amphibian species that occur in Malawi are currently listed on the IUCN Red Data List, however none observed during the survey are listed. However, since amphibian surveys are best

carried out in the rainy season when they come out to breed, this data may not be a true representation of the area.

6.10.6. **Water pipeline to Bunda-Turn-off**

As noted above the pipeline route is within a designated road reserve and the majority of its length is characterised by vacant land with occasional trees. Approximately 1.3 ha is represented by natural vegetation, including a portion of a forested graveyard. However vegetation is relatively dispersed and is not expected to be important fauna habitat.

6.11. Fisheries

6.11.1. **Study Methodology**

The Fisheries study was designed to identify fish habitats and species, local and regional representation and conservation status. Survey methodology includes the following:

- Review of all available baseline information and assessment of information gaps.
- Consult with local villages and relevant stakeholders.
- Identify fish species found in the project area and assess their conservation status.
- Assess the regional and local importance of fish species.
- A field survey plan was designed to include representative fish sample points along the full stretch of river within the Project area, as well as immediately downstream. Four sample points were selected, as shown on Photograph 6.18. Sample collection for fish and macro-invertebrates was done in a diversity of habitat types including riffles, runs and pools. Water quality was also monitored at each site (See Section 4.6.4).
- The survey was undertaken during the period 28 September to 1 October 2015, during which time there was low to zero flow in the river. Water monitoring indicated good water quality within standards set by the Malawi Bureau of Standards. The survey team was accompanied by local villagers.
- Fish diversity was assessed using the Shannon diversity index while the conservation status of each species was assessed using the most current Fish Base data and IUCN Red list data base. Key interviews with local people resident along these the river provided information relevant to fish, fisheries and fishing activities in the river system.

6.11.2. **Fish Survey Findings**

Sampling resulted in the capture of 179 fish, which represented five families and 10 species. Sampled fish, preferred habitat and conservation status are presented in Table 6.23. Catch examples are shown in Photograph 6.18.

Table 6.23 Fish Species – Survey

Family	Scientific Name	Habitat	IUCN Red List Status
Amphiliidae (Loach catfishes)	Amphilius uranoscopus (Pfeffer, 1889)	Demersal: Prefers clear, flowing water in rocky habitats.	Least Concern (LC)

Family	Scientific Name	Habitat	IUCN Red List Status
Cichlidae	Tilapia rendalli	Benthopelagic species; prefers quiet, well-vegetated water along river littorals or backwaters, floodplains and swamps. It is has a wide range of temperature tolerance and salinity.	Least Concern (LC)
	Oreochromis shiranus Boulenger, 1897	Benthopelagic/demersal: Found mainly in densely vegetated shallow waters.	Not yet assessed for the IUCN Red list
	Astatotilapia callipter a (Günther, 1894)	Benthopelagic: Occurs in vegetated areas in shallow water, but also found in rivers and streams.	Least Concern (LC)
Cyprinidae	Labeo cylindricus Peters, 1852	Benthopelagic: potamodromous, sediment-free and sediment-rich rocky biotopes; favours clear, running waters in rocky habitats of small and large rivers, lakes and dams.	Least Concern (LC)
	Labeobarbus johnsto nii (Boulenger, 1907)	Benthopelagic, potamodromous. Found in all types of habitat, inhabits inshore areas of the lake, but ascends rivers to breed	Least Concern (LC)
	Barbus paludinosus Peters, 1852	Benthopelagic: prefers quiet, well-vegetated waters in lakes, swamps, and marshes or marginal areas of larger rivers and slow-flowing streams.	Least Concern (LC)
	Barbus trimaculatus Peters, 1852	Freshwater; benthopelagic; potamodromous Found in shallow water near river outlets or close to swampy areas Hardy, commonly occurs in a wide variety of habitats, especially where there is vegetation	Least Concern (LC)
Clariidae	Clarias gariepinus (Burchell, 1822)	Freshwater benthopelagic occur mainly in quiet waters, lakes and pools and prefer shallow and swampy areas with a soft muddy substrate and calmer water. They may also occur in fast flowing rivers and in rapids	Least Concern (LC)
Mormyridae	Petrocephalus catostoma (Gunther, 1866)	Occurs in shallow and muddy waters, sheltered bays, in lagoons, and swampy areas. Prefers quiet parts of rivers where there is abundant vegetation.	Not yet Evaluated

	
Oreochromis shiranus,	Astatotilapia calliptera
	
Labeobarbus johnstonii	Labeo cylindricus
	
Petrocephalus catostoma,	Amphilius uranoscopus

Photograph 6.18: Example Fish Species

Key findings are:

- Of the ten fish reported to occur in the river, none is documented as endangered under the IUCN; eight are of least concern while two are not yet evaluated.
- Two species made up approximately 94% of the fish sampled, *Astatotilapia calliptera* (69 % of catch) and by *Barbus palludinosus* (25% of catch).
- Fish diversity as measured by the Shannon Diversity Index (SDI) was generally low (1.5) for all sample sites. Comparatively the SDI was higher in the lower section of the river at Mbalame Village (SDI = 1.12) but was significantly lower upstream at Chimbowa village (SDI = 0.31), Malenya village (SDI= 0.36) and at Nyamazaani village (SDI= 0.47).

Shannon Diversity Index (SDI): Typical values are generally between 1.5 and 3.5 in most ecological studies, and the index is rarely greater than 4. The Shannon index increases as both the richness and the evenness of the community increase.

- Species richness correspondingly declined from seven species in the lower stretches of the river at Mbalame Village to only two species at the upper sampling points at Malenya and Nyamazaani villages.
- It was reported by villagers and the Department of Fisheries that a natural five metre high waterfall is situated approximately 50 km downstream of the M1 road on the Linthipe River close to its confluence with Lilongwe River near Mayani in Dedza. This fall is reportedly vertically steep, making it very unlikely that fish can migrate upstream of this point. Consequently the large number of fish species inhabiting Lake Malawi, including the threatened Mpasa or Lake Salmon (Opsaridium microlepis), are unlikely to migrate upstream into the Diamphwe river.

6.11.3. **Fishing Activities**

There is widespread fishing taking place in the river, which supports livelihoods for a large number of people. Local fishermen estimated that up to 1800 fishermen could be utilising this part of the river. Local fishermen reported that the main species in the fishery comprise of ten groups, as shown on Table 6.24.

Table 6.24 Main Fishery Species

Local Name	Scientific name	Recorded in Survey
Kambuzi	*A. calliptera*	Yes
Matemba	*B. palludinosus*	Yes
	B. trimaculatus	Yes
Mphondo or Mbalawala	*Labeobarbus johnstonii*	Yes
Ningwe	*Labeo cylindricus*	Yes
Nkholokolo	*A. uranoscopus*	Yes
Mphuta or Kanenere	*Petrocaphalus catostoma*	Yes
Nkhunga	*Anguilla nebulosa labiata*	No
Chambo	*O. shiranus* and *T. rendalli*	Yes
Mlamba, ntcheka or mphindira	*Clarias gariepinus*	Yes

Nkhunga was reported to be common in the past but is now rare and no longer a significant part of fish catches. Of note is that the survey recorded all these species (with the exception of Nkhunga) during the dry season with almost none or zero river flow. This may indicate that seasonal species variation is not significant, however this would need to be verified by undertaking further seasonal surveys.

Fishers mainly use hook and line (mbeza), mosquito net seines, gill nets (Ukonde) and fish traps (Mono). Also used is a locally sourced poisonous plant known as *Katupe,* which is pounded and used indiscriminately to kill fish. Katupe is mostly used by women fishers. Almost all the fish caught from the river are consumed at household level or sold directly at local markets.

Local fishers reported that fish catches were more abundant in the past, and declining catches were likely a result of the harmful *Katupe* and other non-selective gear such as mosquito-net seine. They also think that there are now significantly more people fishing than in the past. In terms of seasonal catches, fishers indicated that more fish are caught in the dry season due to relative ease of access to the river compared to the flooded swollen river flow in the wet season.

6.11.4. **Invertebrates**

A total of 718 individual aquatic macro-invertebrates belonging to 45 families and 68 species were sampled during the survey. A listing is given in Table 6.25.

Table 6.25 Invertebrate Species - Survey

Family	Species	Family	Species
Actiidae	*Utethesia pulchella*	Lestidae	*Lestes uncifer*
Aeshnidae	*Anax imperator*	Lestidae	*Lestes virgatus*
	Anax speratus	Libellulidae	*Aethriamanta rezia*
	Anax tritis		*Crocothemis erythraea*
Anthopholidae	*Xylocopa caffra*		*Nesciothemis farinosa*
Argulidae	unidentified		*Orthetrum caffrum*
Baetidae	unidentified		*Orthetrum abbotti*
Belestomatidae	*Appassus* sp		*Orthetrum crysostigma*
Chaoboridae	*Chaoborus* sp		*Orthetrum crysostigma*
Chironomidae	*Chironomus formosipennis*		*Orthetrum* sp
	Chironomus sp		*Rhyothemis semihyalina*
Clorocyphidae	*Platycypha caligata*		*Trithemis arteriosa*
Coenagrionidae	*Ceriagrion glabrum*		*Trithemis furva*
Corbiculidae	*Corbicula* sp		*Trithemis kirbyi*
Corduliidae	*Phyllomacromia contumax*		*Trithemis stictica*
Corduliidae	*Phyllomacromia* sp		*Urothemis edwardsi*
Culicidae	*Culex* sp		*Orthetrum* sp
Daphniidae	*Daphnia* sp		*Orthetrum julia*
Dytiscidae	*Acilius* sp	Lymnaeidae	*Lymnaea* sp
Ephemeridae		Mantidae	unidentified
Gerridae	unidentified	Nepidae	*Laccotresphes* sp
Gomphidae	*Ictinogomphus ferox*	Nepidae	*Ranatra* sp
Gomphidae	*Paragomphus genei*	Nepidae	unidentified
Gryllotapidae	*Gryllotalpa africana*	Nymphalidae	*Charaxes varanes*
Gyrinidae	*Dineutes aereus*		*Hamanumida daeddalas*
Heptageniidae	unidentified		*Protogoniomorpha parhassus*
Hirudinidae	*Hirudo medicinalis*	Perlidae	*Catopsilia florella*
Hydrophilidae	*Berosus* sp	Pieridae	*Eurema brigitta*
Hygrobiidae	unidentified	Planorbidae	*Biomphalaria pfeifferi*
Iridinidae	*Asphatharia* sp	Simuliidae	*Simulium* sp
Leptophlebiidae	unidentified	Tipulidae	*Tipula* sp
Lestidae	*Lestes plagiatus*	Veliidae	unidentified

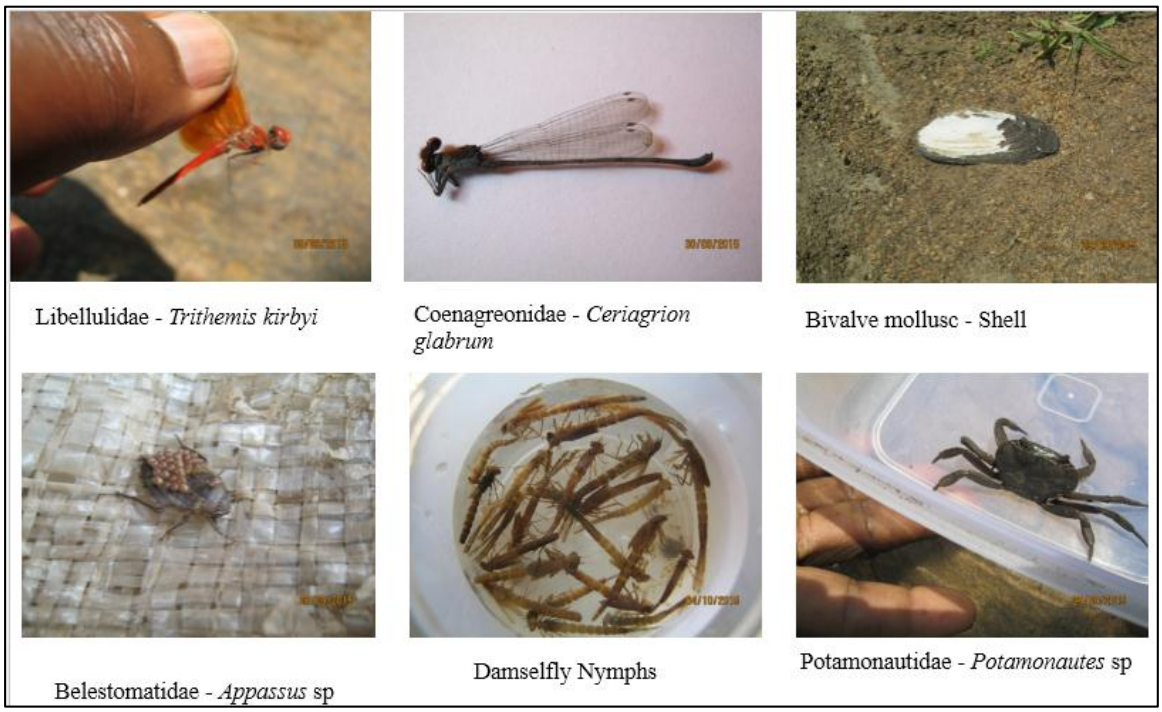


Figure 6.34: Example Macro-invertebrate Species

Key findings are:

- The number of species sampled at each of the four sample points was not statistically different, ranging from 19 to 27 species.
- Aquatic macro-invertebrate diversity measured by the Shannon Diversity Index (SDI) ranged from 2.53 in the lowest reaches of the river (site 1, Mbalame village) to 2.84 in the upper reaches (site 2, Chimbowa village). These values indicate good diversity in all parts of the survey area, indicating good ecological health with no obvious environmental impairment.
- Seven of the 45 families contain 64 % of sample species, as shown on Table 6.26.

Table 6.26 Dominate Invertebrate Species

Family	Species
– Lestidae	'Spreadwings' damselflies
– Lymnaeidae	Small air-breathing freshwater snails
– Libellulidae	Skimmer dragonflies
– Aeshnidae	Hawkers or darners
– Culicidae	Mosquitoes
– Planorbidae	Ramshorn snails
– Ephemeridae	May flies

- Most of the sample species were either not evaluated by IUCN or were under least concern. The medical leach *(Hirudo medicinalis*) is the only species of conservation significance, as it is under the red list category of near threatened species (IUCN 2015-3 red list).

In summary:

- The dominant invertebrate families of the Diamphwe River ecosystem comprises of damselflies (Lestidae), dragonflies (Libellulidae), darners (Aeshnidae), may flies (Ephemeridae), skimmer mosquitoes (Culicidae), small freshwater snails (Lymnaeidae) and

ramshorn snails (Planorbidae). The Lestidae (damselflies) Libellulidae (dragonflies) and Aeshnidae (darners) all belong to the insect order odonata.

- The odonata are very dependent on ecological conditions of the environment and are thus an important indicator of ecological balance; and their abundance in an area is a good indication of the good quality of its freshwater. In particular Ephemeropteran insects have a strong negative response to anthropogenic disturbances in aquatic ecosystems and their absence is an indication of pollution and low biological water quality. The Diamphwe River therefore has a rich diversity of odonates and ephemeropteran, which is an indicator of consistently good water quality.

6.12. Noise Environment

6.12.1. **Methodology**

Noise monitoring was undertaken to assess ambient noise levels in the Project area. Monitoring points are shown on Figure 6.35 and were selected at proposed construction and operational component sites including access roads, quarry, Dam wall, raw water pump, WTP, Balance Tank and water pipeline to Bunda Turn-off. Monitoring methodology and results are provided below.

Noise monitoring was undertaken using an Integrated Sound Level Meter (ISLM) model Castle GA 215, which was operated by a technician from the Malawi Bureau of Standards. At each monitoring point the background noise levels were measured for 15 minute intervals over an eight period. Measurements were recorded for L_{eq}, L_{ex} and L_{mx}. The meter was calibrated before and after to check for any variations.

Monitoring was undertaken over a two day period from 2 to 3 November 2015.

Photograph 6.19: Noise Monitoring

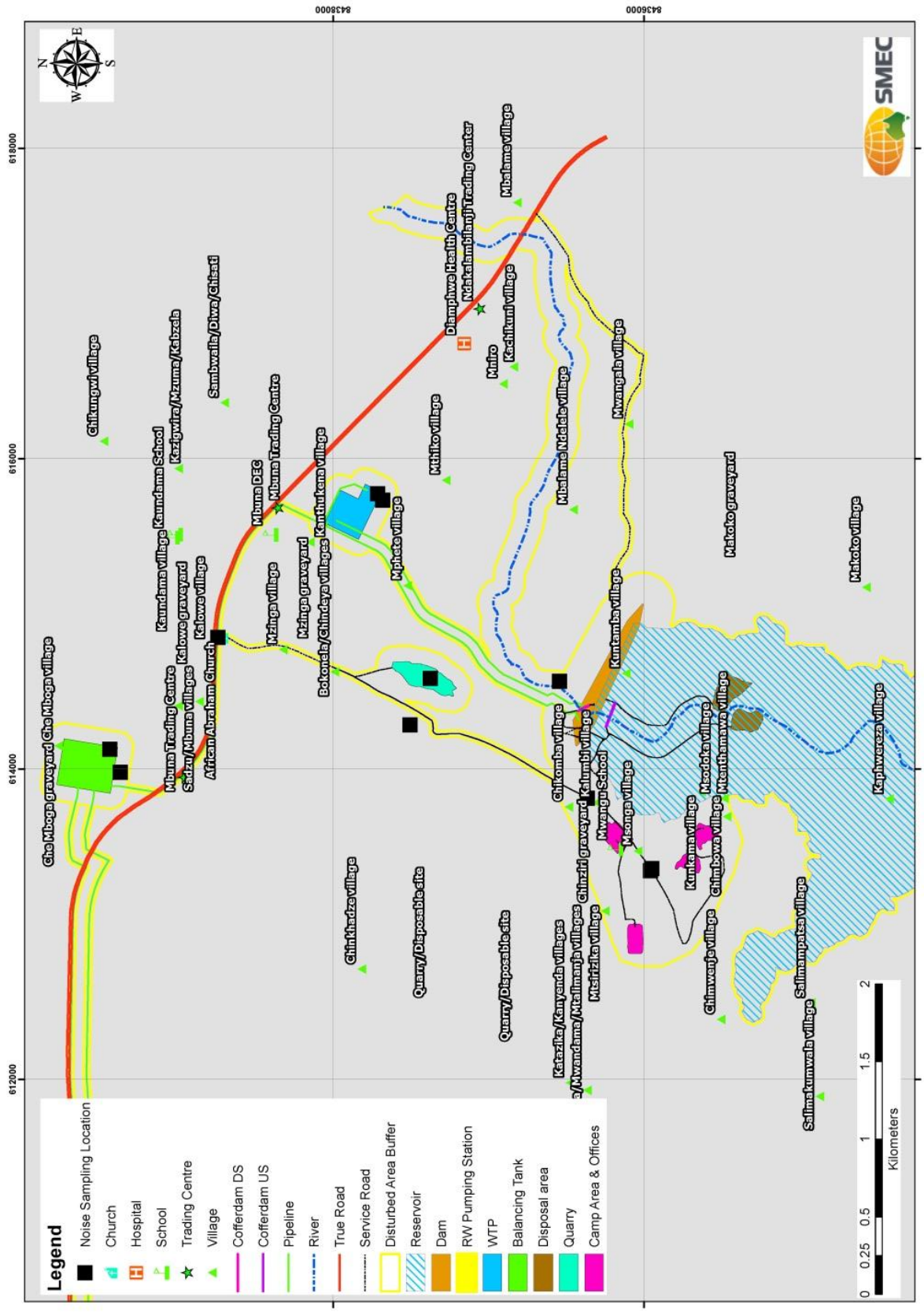


Figure 6.35: Noise Monitoring

6.12.2. **Monitoring Results**

Monitoring results are presented in Table 6.27. Results show ambient noise levels are relatively high with Leq levels higher than would be expected of a rural environment. This is likely a result of various types of activities associated with a relatively dense population, such as large groups of children playing, constant traffic and community related activities.

Table 6.27 Noise Monitoring Results

Site	Time	Duration (Mins)	Noise reading (dBA)			Comments
			Leq	Lmx	Lex	
Day 1						
1	09:40	15	57.7	78.3	42.7	Cock roosting, Person cutting and splitting wood
2	10:06	15	64.3	80.8	45.1	More windy with hissing sounds
3	11:15	15	53.9	72.4	36.8	Persons cutting, internment winds
4	11:45	15	56.9	73.4	36.3	Persons cutting, internment winds
5	12:15	15	55.3	75.3	40.1	Children Playing: shouting / chatting.
6	12:38	15	51.4	74.2	36.4	Children Playing: shouting / chatting.
7	13:04	15	58	76.5	43.0	People chatting, children playing / shouting.
8	13:34	15	63.7	81.6	48.4	Near main road. Cars passing
9	14:18	15	59.7	73.0	44.7	Near main road. Cars passing
10	15:11	15	59.6	76.0	44.6	Close to the road. Cars, trucks, busses passing
11	15:37	15	63.9	84.1	48.9	Very busy: close to bus stop and filling station
Day 2						
12	08:25	15	46.1	64.7	31.1	Day was calm and there were few noises by children
13	08:57	15	49.6	68.7	34.5	Moderately windy, people passing / chatting.
14	09:18	15	56.7	69.4	38.0	Windy hissing sounds
15	09:45	15	66.0	84.8	51.1	More than 150 vehicles passing at speed.

Note: Day 1 was windy with hissing sounds.

L_{ex} (L_{A90}) is the sound exposure averaged over 8 hour.

L_{eq} is the sound pressure level in dBA equivalent continuous sound level

L_{mx} (L_{A10}) is the maximum sound pressure level

6.13. Traffic

The Project site is predominantly located immediately south of the M1 Main Road, which is aligned south east between Lilongwe to Dedza, and then south to Blantyre, Malawi's second largest City. Access to the site is from the M1 road, approximately 3.5 km north of the Diamphwe river bridge. Approximately one kilometre further north is the access to the proposed Balancing Tanks, which is located on the northern side of the M1 road.

The proposed accss road is unsealed and poorly formed, and is currently used by pedestrians, bikes, ox carts and just a few small vehicles to access villages on the Lilongwe side of the Diamphwe River. The Dedza side of the river is accessed from a similar road approximately 3 km south of the Diamphwe River bridge.

The M1 road is a sealed two lane road and is the main road transport link between Lilongwe and Blantyre, and for international freight travelling to and from Mozambique in the south and Zambia in

the north. The road has a speed limit of 100 km/hr and a standard design lane capacity of approximately 5,000 vehicles per day.

As part of ESIA studies a 5-day weekday traffic count was undertaken at the intersection of the M1 road and the Project site access road. Daily average traffic for heavy and light vehicles for both morning (AM) and afternoon (PM) periods are shown on Table

Table 6.28 Average Daily Traffic Counts on M1 at Site Access – Mi Road intersection

	Heavy vehicles			Light vehicles		
	AM (6 - 12)	**PM (12 - 6)**	***Total***	**AM (6 - 12)**	**PM (12 - 6)**	***Total***
Lilongwe to Blantyre	86	139	*225*	339	500	*839*
Blantyre to Lilongwe	84	114	*198*	299	394	*663*
Total	**170**	**253**	***423***	**638**	**894**	***1,502***

As shown on the above table, traffic numbers are considerably less than the dsign capacity of the road, with approximately 10 to20 percent more traffic occurring in the afternoon period.

Chapter 7
Existing Socio Economic Environment

Environmental and Social Impact Assessment

February 2016

7. BASELINE SOCIO-ECONOMIC ENVIRONMENT

7.1. Administrative context

The Project is situated within the Central region of Malawi, in the Lilongwe and Dedza Districts, comprising of Mazengela, Kalumbu and Chadza Traditional Authorities (TAs) in Lilongwe District (west), and Kaphuka and Chilikumwendo TAs in Dedza District (east).

The Lilongwe and Dedza District Councils (DCs) are two of the 35 local authorities in Malawi established under the Local Government Act (1998).

The administrative structures and committees operating at the local District level are detailed in Chapter 2. Importantly, at TA and community level there are Chiefs, Group Village Heads (GVHs) and Village Heads (VHs) responsible for the development of the villages, and for administering justice other than cases referred to the national judicial system through the police. The village meeting place or headquarters for each village serves as the location for the court.

7.2. Demography

7.2.1. Population and Settlement Patterns

The 2008 national Census recorded the population of Malawi as 13,077,160 with an annual average growth rate of 2.8 %.[13]

According to the Census, the population of the TAs affected by the Project were:

- Lilongwe District: TA Mazengera, 95,958; TA Kalumbu, 57,997; TA Chadza 112,230; and
- Dedza District: TA Kaphuka, 133,778; TA Chilikumwendo 60,707.

The national population density of the country was 139 in 2008, with an average of 155 in the Central Region. The Districts affected by the Project have slightly higher figures, with Lilongwe (Rural) at 216 and Dedza at 172 (Table 7.1).

Table 7.1 Population Density of Impacted Districts

Area	Population density
Malawi	139
Lilongwe (rural)	216
Dedza	172

Source: *NSO Census, 2008*

Except for people living in towns straddling the M1 affected by the Pipeline, the majority of people potentially affected by the Project live in rural households, whose livelihoods depend directly on the availability of land, water and other natural resources. Resource availability, and particular water, plays a vital role in population distribution in the area, with village settlements close to the Diamphwe River and its tributaries. People thus live near to their fields and small gardens along the riverbanks.

7.2.2. Historical Context

As part of the SGDs, a PRA exercise on Historical Mapping was used in which participants were asked to contribute to a Timeline by outlining the most significant past events that have occurred in their communities. This provided an understanding of past events, how they affected local people, and

[13] National Statistical Office (NSO). 2008. *2008 Population and Housing Census Main Report*.

how communities have successfully responded to and solved the problems/challenges. A synopsis of the findings from all groups showed the following results:

Table 7.2 Historical time line of major events

YEAR	EVENT
1914	Hunger in the area due to locusts; government donated/provided relief food items.
1949	Hunger in the area.
1974	Cholera outbreak; Government provided medication to those affected.
1984	Hunger in the area; Government provided free food items to the communities
1985	Hunger; people went to towns for work (ganyu); Government provided maize to those affected
1987	An earthquake; Chiefs reported this to the TA and district officials; those whose houses were affected repaired them themselves.
1989	Another earthquake; Chiefs reported the incident to the TA and District officials; houses cracked while others collapsed; damaged houses were maintained independently.
	Cholera outbreak; Government provided medication.
1991, 1992	Dysentery outbreak; more men died than women; people went to hospitals for treatment; Government, through the Ministry of Health, provided extension messages on health issues delivered by Health and Sanitation Assistants.
1993	War speculation in the area; at the time Malawi Young Pioneers were being disarmed; “those that were courageous remained while others left and have not returned”.
1994	Outbreak of Armyworms; reported to Government and they sprayed chemicals.
1995	Hunger as the rains stopped early; people ate roots and tubers; others went to buy maize from Mozambique in exchange for labour and some weaving products.
	Measles outbreak; Government vaccinated children under five years of age.
1998	Dysentery outbreak; more men died than women; people went to hospitals for treatment; Government, through the Ministry of Health, provided extension messages on health issues.
1999	Cholera outbreak; Government provided medication to those affected.
2001	Again there was hunger, due to heavy rains and the rainy season ending prematurely; people ate roots and tubers; villagers were selling mats and exchanging dogs and chickens for maize flour in Mozambique; the community relied on roots (e.g. banana) and tubers, along with cassava, while others ate only vegetables; some used cassava flour for nsima, rice and maize husk flour; winter cropping assisted in relief.
	There was a cholera outbreak; Government provided medication to those that were affected.
2005	One night a hyena terrorised the area by killing nine people; this was reported to police, who killed the animal.
2009	A crocodile killed three people; fishing has been minimised greatly due to fears.
2010	Heavy winds destroyed some houses; the community called for relief support from the Government, but it did not materialize; those affected had to repair their houses themselves.
2013	Heavy hailstorm and strong lightening: this resulted in the death of fish and crocodiles in Diamphwe River; it was reported to the District Commissioners office; people ate the fish.
2014	Heavy winds destroyed some houses; no assistance given to repair damaged houses.
2014/5	There is an expectation/worry of hunger due to the rainy season ending prematurely (a prolonged dry spell); in preparation for this people have grown maize in their dambos.

Source: RAP SGDs, SMEC 2015

The history table shows the environmental- and health- related difficulties faced by communities in the area, and the level of dependence on nature and natural resources and exposure to the elements. Their vulnerability, and limited resources to cope in times of crises, is an indication of the possible challenges they might face with the loss of their homes, land, and crops and trees on that land as a result of the Project.

7.3. Socio-Economic Profile

7.3.1. Socio economic survey

Most of the Socio economic information was derived from the Census of 5,178 PAP. The Census form includes questions on a range of socio economic issues related to the person's family, assets and livelihood. In addition a more comprehensive census survey was used for about 10% of those surveyed. Additional questions related to a broder range of socio economic issues such as health, education, etc. Questionnaires are included I the RAP.

7.3.2. Ethnicity

Although several tribes are found in the area, the Chewa are dominant, comprising 79.9 % of the sample of surveyed PAP affected by the Reservoir and BZ, with the Ngoni making up a further twenty percent, and only a few Yao (less than one percent) resident in the area.

The Chewa is the largest ethnic group in Malawi, predominantly concentrated within the Central Region, surrounding the capital city of Lilongwe. Their language is Chichewa, Malawi's national language. The Chewa is closely related to people in surrounding regions such as the Tumbuka and Nsenga, and to Chewa in neighbouring Tanzania and Zambia. A considerable part of Chewa territory came under the influence of the Ngoni, who originally migrated from South Africa.

As a matrilineal society, property and land rights are inherited through the mother. Women are recognised as reproducers of the lineage (*Bele*), which is an extended family of people related to the same ancestor. Children of the same mother or female (*Lubele la achite*) make up a family of dependents or *Mbumba*. Elder brothers of the mothers, *Nkhoswe*, are the guardians of the lineage, and are mentors to their sisters' sons.[14]

The Chewa believes that living things were created by God. '*Gule wamkulu'*, Big Dances associated with masks, has become a title for secret societies of traditional Chewa religious practices, the '*Nyau*'. The *Gule wamkulu* ceremonies consist of formally organised dances for the Nyau. Masks worn include many different representations, generally each developed historically by unique tribes, accented with their own individual touch.[15] Despite mission influence, *Nyau* societies are still common. This tradition is included on the UNESCO Representative List as a masterpiece of intangible cultural heritage under the 2003 Intangible Cultural Heritage Convention, and thus is of global significance.

7.3.3. Age and Gender Distribution

Table 7.3 below indicates that there are more women (51.27 %) than men (48.72 %) in the sample of households of PAP affected by the Reservoir and BZ. According to the national Census, the gender ratio was 95 for the whole country, 95 for the District of Lilongwe (rural), and 91 for Dedza District.[16]

Table 7.3 Gender by age distribution

Gender	Age Composition (%)				Total %
	1 - 14	15 - 45	46 - 60	61+	
Female	51.95	51.65	46.40	52.50	51.27
Male	48.05	48.35	53.60	47.50	48.72
Total	100	100	100	100	100

Source: RAP Census, SMEC January, 2016

[14] https://en.wikipedia.org

[15] www.earth-cultures.com

[16] The gender ratio is defined as the number of men per 100 women.

In terms of age composition, 87.4 % of household members (both men and women) included in the sample RAP Census survey for the Reservoir and BZ were 45 years and younger, with over half (52.7%) of these being 14 years old or younger. This supports the trend towards a youthful population. The 2008 national Census showed that almost seven percent of the total population comprised infants aged less than one year, 22 % were aged under five, about 46 % were aged 18 years or older, while a further 4 % were aged 65 years or older. The median age of the population was 17 years.

The demographic profile is characterised by high fertility and mortality rates. The projected Infant Mortality Rate (IMR) per 1,000 live births in 2015 for the country as a whole was 61.78; 65.75 for boys and 57.68 for girls. The Total Fertility Rate (TFR) was projected to 5.96 for 2015. The projected life expectancy at birth in 2016 is given as 5.66; 53.99 for women, and 51.38 for men.17

7.3.4. **Religion**

The religion of the PAP was asked in the Project's Census and Socio-Economic Survey. Initial results for PAP affected by the Reservoir and BZ indicate that there are a number of varied religions in the area; however, most have a Christian base, with only 16% of PAP following animism and Gule wamkulu, and 0.2% being Muslim.

Information relating to religion is given in Table 7.4. The main religion is Catholicism with one fifth of the PAP being Catholic; 18.2% attended the African Abraham church; 18.0% the Church of Central African Presbyterian (CCAP); and 8.8% the Apostolic church. Other churches, include: Assemblies of God, Seventh Day Adventist, Jehovah's Witness, African International, African Isaac, Zion, Pillar of Fire, Anglican, Baptist, New Jerusalem, New Apostolic, Bible Believer, Church of Christ, Evangelical Lutheran, Rainbow Covenant, Province Industrial Ministry (PIM). Figure 7.1 below indicates the location of some of these churches.

Table 7.4 Religion of PAP

Religion	Total %
None	1,1
Gule wamkulu	16.0
Catholic	20.5
African Abraham	18.2
CCAP	18,0
Apostolic	8.8
Assemblies of God	4.1
Jehovah's Witness	3.3
African International	3.0
Zion/Zion Spirit	1.6
Pillar of Fire	1.3
Muslim	0.2
Other	4.0
Total	**100.0**

Source: RAP Census, SMEC January, 2016

[17] NSO. 2008. *Op cit*.

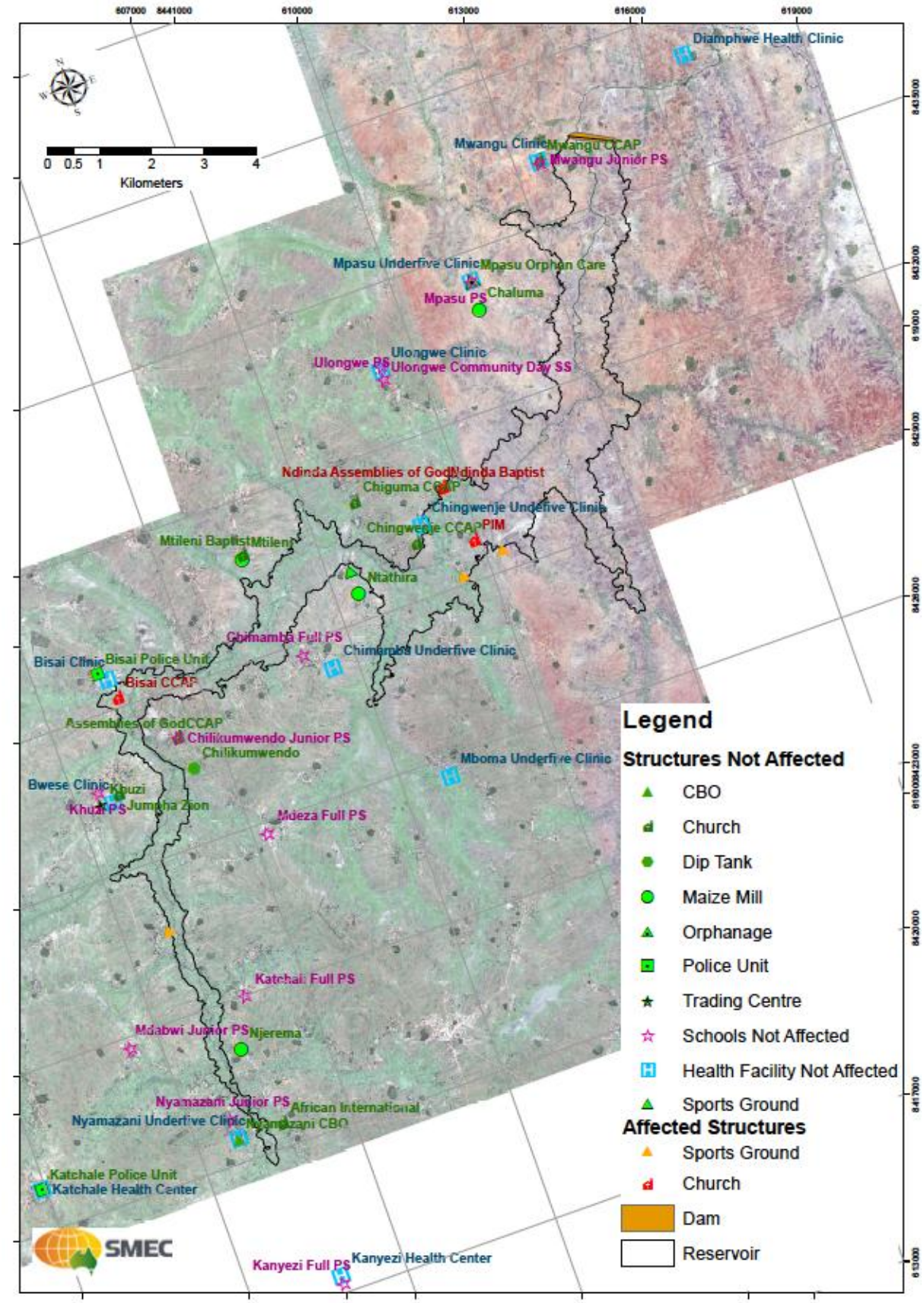


Figure 7.1: *Service Facilities in and near Reservoir Area*

7.3.5. **Education**

Educational facilities available to residents of the Project Impacted Area include:

- Primary Schools in Mwango, Kanama, Ulongwe, Mpaso, Mlodzenzi, Luwani, Niuchi, Kanyezi, Bua, Mkomela, Mdedza, Kaundama, Bango and Chilembwe;
- Mkomela Day Secondary School, Chingwenje Night Secondary School, and Kaundama Secondary School, with night classes offered for Secondary School students in Kawelama;
- A nursery school at Malenya and Chingwenje villages, and Community Based Childcare (CBCC) in Kawelama; and
- Adult literacy classes offered in Chingwenje.

Some of these schools are situated close to the Reservoir as shown on *Figure 7.1*.

In the analysis by WAPCOS of the household survey conducted amongst Project Affected Villages in August 2014, 29% of the surveyed population had no education, 63% had completed primary education, seven percent secondary level schooling, one percent a tertiary level education, and 0.4% a university degree.

As evidenced in the sample RAP Census survey for the Reservoir and BZ, nearly seventy percent of children up to 14 years of age in the households of the PAP were at primary school. Adult education levels for household members were low, with twelve percent of the age group of 15 years or older having no formal education, and a further eighty percent having only attained primary school level. Educational attainment declined in relation to higher education levels: only eight percent had attained a secondary education, only a few had any vocational training, and none had a university education.

According to UNESCO, 2008 national figures showed a literacy rate of 72.8% for people 15 years or older, with an average of 3.2 years of schooling per person.[18]

There was no clear evidence of gender discrepancies in educational attainment from the RAP Census and Socio-Economic Survey, other than more men attaining secondary school (Table 7.5). Whilst males may have marginally higher education levels than females in this category, the split is more equalised across all education attainment levels. This may be associated with the strengthening of women's rights – in line with the principle of equality within the legal system and institutions, and in line with the Millennium Development Goals.

These results are in line with national figures. According to statistics produced by UNICEF, in 2012 the net enrolment ratio for primary school was 86.2 for females and 84.3 for males, and for secondary school 28.8 for females and 29.7 for males.[19]

Table 7.5 Highest completed education by gender: adults (15+ years)

Education	% Female	% Male	% Total
None	36.8	63.2	12.0
Primary	51.0	49.0	79.9
Secondary	42.0	58.0	8.0
Total			**100.0**

Source: RAP Census, SMEC January, 2016

[18] The adult literacy rate is defined as "*the percentage of people ages 15 and above who can, with understanding, read and write a short, simple statement on their everyday life*" (www.nationmaster.com)

[19] www.unicef.org

7.3.6. **Employment Status and Livelihood Activities**

For those affected by the Reservoir and BZ, the employment status of household members of the sampled Census indicated the following:

- Nearly 60% were children, either scholars/students, or not at school; a few children up to fourteen years of age were employed, mostly as seasonal workers;
- 38.3% were self-employed, primarily farmers, mostly in the 15 to 45 age group (62.8%), and mostly women (53.9%);
- 0.2% had formal employment, with a contract or formal agreement and regular wages (two women and six men);
- 1.0% had informal employment, or were seasonal workers, mostly in the younger age group;
- 0.8% were unemployed at home, with only one member of a household seeking work; and
- 0.2 % were disabled and not employed.

The dependency ratio was particularly high at 61.3:1.
Since the Project area is considered primarily an agricultural society, the majority of the population in the working age group are involved in farming activities. While men are mostly fully involved in farming, or combine farming with off-farm employment, women tend to combine their domestic activities with farming (assisting with hoeing, weeding and harvesting, and growing vegetables). The results of the sampled Census supported this (Table 7.6); the majority of working household members were farmers or farm workers (90.1%), of whom most were self-employed (97.9%), farming around their homes or village (96.4%). In contrast there were no professionals; the highest level of formal skilled occupation was represented by skilled labourers, working around the village or in the district.

Table 7.6 Occupation of household members

Occupation	% Total
Farmer/Farm worker	90.1
Domestic work	4.2
Trader	2.8
Fishing	1.1
Unskilled labourer	1.3
Skilled labourer	0.5
Total	**100.0**

Source: RAP Census, SMEC January, 2016

7.3.7. **Household Income**

Income levels for the PAP households affected by the Reservoir and BZ were low, with nearly three-quarters of those in the sampled Census earning on average less than 20,000 Kwacha per month; most farmers were in this income bracket. Less than ten percent earned on average more than 50,000 Kwacha as a household (Table 7.7).

Table 7.7 Average monthly household income

Average monthly income (Kwacha) %			
< 5,000	5,000 – 20,000	20,000 – 50,000	> 50,000
27,2	50,3	13,9	8,5

Source: RAP Census, SMEC January, 2016

Although local livelihoods are mostly based on subsistence farming, nearly half (47,7%) of household income for PAP of the sampled Census affected by Reservoir and BZ was through the sale of crops, vegetables and fruit, with a further 11,9% through the sale of animals and animal products. Other income sources included: salaries and wages (19,2%); migrant remittances (6,7%); sale of firewood and charcoal (4,6%); and operating a shop, store or informal stall (3%). The sale of fish did not play a significant role in household income, with less than one percent mentioning it as an income source. Five percent of income came through savings.

7.3.8. **Land Use and Agricultural Activities**

The upper Diamphwe catchment is characterised by natural wooded forest, which forms part of the protected Dzalanyama Forest Reserve. The remainder of the catchment has been substantially cleared of native woodland and developed for intensive agricultural use. Remnant woodland patches are commonly associated with graveyards, while natural riparian grassland and reed vegetation remain on some stretches of the river.

Four broad main landuses within the broader Diamphwe catchment upstream of the proposed Dam are summarised in Table 7.8.

Table 7.8 Diamphwe River catchment landuse

Land use cover	Area (Ha)	Area (%)
Rainfed herbaceous crop	73.021	53.5
Cultivated dambo	20.374	14.9
Dambo herbaceous vegetation	9.886	7.2
Woodland	33.303	24.4
Total	**136.584**	**100.0**

Source: Mapping of Dam Project Area, SMEC 2015

Dambos cover approximately 22 % of the catchment area. Rainfed herbaceous vegetation (cropland) and cultivated dambo collectively account for nearly 69% of agricultural landuse, which characterises the extensive anthropogenic impact on the natural environment. Only about 31% of the catchment remains in a natural state, mostly as woodland (24.4%) in the Dzalanyama Forest Reserve and isolated pockets such as graveyards, and a smaller representation of undeveloped dambo (7.2%).

Numerous villages are scattered throughout the catchment and there is significant degradation of natural resources through intensive agricultural practices, illegal cutting of trees for charcoal production, and population pressure. This, coupled with a lack of infrastructure, has resulted in significant environmental stress on the river's resources and function.

The Reservoir inundation area and 15 meter wide BZ will directly impact on approximately 2.484 ha of land. The main land uses have been classified in accordance with the National Land Cover Atlas[20], as shown in Table *7.9*. The major land use categories are cropland and cultivated dambo, accounting for 2.059 ha (82.9%) of the total area, with cropland dependent on rainfall and soil moisture accounting for approximately 63% alone. Settlements only take up 37.4 ha (1.5%) of the area, and forest/natural vegetation just over nine hectares (0.4%). In confirmation of land use, the Asset

[20] Food and Agricultural Organisation (FAO). 2012. *National Land Cover Atlas*. Land Resource Conservation Department.

surveyors found, and surveyed, 2,259.48 ha of productive land in the Reservoir and BZ, including land used for cultivation, grazing and graveyards, and residential plots (see RAP APPENDIX J).

Table 7.9 Land use pattern of Reservoir area and Buffer Zone

Land use cover	Area (Ha)	Area (%)
Cropland	1,562.47	62.9
Cultivated dambo	496.29	20.0
Dambo grassland with patches of cultivated land	378.42	15.2
Forest/natural vegetation	9.48	0.4
Settlement	37.41	1.5
Total	**2,484**	**100.0**

Source: Mapping of Dam Project Area, SMEC 2015

Dambo grassland comprises of expansive areas of short grassland, which is distinguished by a relatively high clay content, low fertility and characteristic cracking during the dry period. Landuse is predominantly grassland and stock grazing, with some small cultivated patches (in the cool dry season). During the wet period these areas become flooded and are commonly used for fishing. Dambo grassland accounts for approximately 15 % of the study area and is common in the top one third of the proposed Dam, extending approximately 11 km from around Chilikumwendo village to the upper extremity of the Dam near the S124 road bridge at Khomani village.

Dambo grassland also includes natural riparian vegetation along the riverbanks and is found along the length of the river. Riparian vegetation consists of long grasses and reeds, and provides important animal habitat and material for construction and other domestic uses.

Photograph 7.1: Tobacco seedlings planted in dambo ready for replanting

With agriculture as the main livelihood, the fertile land adjacent to the Diamphwe River and its tributaries, and particularly in the dambos, is essential to the lives of the residents of the area.

The rainy season, beginning in November and ending in mid-April, is the main agricultural season, covering a period of between 120 to 150 days. The primary crop grown by households impacted by the Reservoir and BZ for the sampled Census was maize (comprising 87.1% of crops grown), with over 88,6% of those growing it having produced more than five 50 kg bags in the last season. Other crops and vegetables grown were beans (3.9%), ground nuts (3.8%), and potatoes (2.2%), and to a

lesser extent cabbages, sugar cane, cassava, rice, sorghum and onions. Particular crops grown in the dambo areas over the drier times include Irish potatoes, sweet potatoes and sugar cane, and seedlings are cultivated for tobacco and maize, for replanting in time for the rainy season.

When asked details of all the land owned and used by the household, the Census survey results showed the following:

- The PAP interviewed stated that 83.2% of the land they own and/or use lies within the Dam inundation area and is therefore affected by the Project[21];
- Land was mostly owned by household heads (85.7%) or other household members (13.4%);
- 98.8% of the land was being used directly by the household, rather than through some rental/leasing or sharecropping arrangement;
- The average number of land parcels owned or used by PAP households was three, with the average land parcel size being 1.22 acres (Table 7.10). Few had large cultivation areas, indicating that farming has little commercial value on a large scale; and
- 86.0% of those with land relied on rainfed rather than irrigated agriculture. Some farmers had dug their own shallow wells, and used watering cans or buckets for watering their crops; a small percentage (1.3%) used pumped irrigation from the river.

Photograph 7.2: Homemade shallow well

Giving detail to the above, the number of land parcels owned or used by the PAP households, and the approximate size of all land owned or used, are shown in Table 7.10.

Table 7.10 Land Parcels Per Household, and Land Size

Number land parcels	% Households	Acreage of land parcel	% Land parcels
1	3.5	<1	38.7
2-3	70.9	1-2	45.8
4-5	23.2	3-4	11.4
6+	2.5	>4	4.2

[21] This figure will be validated by the results of the Census survey.

Land utilised by the community at village level includes school grounds, dambo land or communal spaces used for meetings and local courts, for Gule Wamkulu dancing, and for sports such as football and netball.

There is an Agricultural Department at District level with District Extension Officers. However, agricultural extension activities in the Project area seem to be limited by a lack of resources.

A Seasonal Events Calendar was developed with the SGDs (Table 7.11), to learn about changes in livelihoods over the year and to show the seasonality of agricultural and non-agricultural workload, food availability, income and expenditure, water, forage and credit. Generally, the participants linked the activities on the calendar; for instance, food availability and rainfall, livestock forage to health status of animals, income and expenditure to the rainy season. Many of the activities were associated with agriculture, such as the busiest time of the year, food lean periods, the income-earning period and related expenditure and access to credit facilities. Interestingly the non-agricultural activities take place out of the agricultural season.

Table 7.11 Seasonal events calendar

ACTIVITY	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Comments
Busiest month													Busy for school except over holidays August and September; farming months mostly coincide with rainy season (below)
Rainfall season													
Food lean period													Crops in the field are not mature
Income earning period													Income from selling agricultural produce; in December people collect granite stones to sell
Expenditure													
Water availability													Boreholes and Diamphwe River have water all year; shallow wells dry up in dry season
Livestock forage availability													Livestock have more forage in rainy season, although not available due to tethering
Credit availability													Easy to get loans; there are Village Savings and Loans (VSL) which run for the whole year
Non-agricultural activities													

7.3.9. **Tree Ownership**

Trees classified as fruit and nut bearing, indigenous, and exotic are owned by PAP. These have economic value in that they can be used, and sold: for food production, such as for fruit and nuts; as timber, for house construction and for making furniture; as firewood and thus fuel, for cooking, heating and light, including for burning bricks; for medicinal purposes; and for making charcoal. Although there are ready markets for such products, in both Lilongwe city and Dedza town, trees in the Project area are mostly grown and kept for domestic use, including for shade, at the residential sites and in the agricultural fields.

Fruit and nut trees that belonged to the sampled households surveyed for the Census are listed in the Table 7.12 below.

Table 7.12 Fruit and Nut Bearing Trees

Tree type	Average number owned[22]
Banana	34.3
Mango	7.8
Tangerine	7.7
Cashew Nut	7.0
Orange	4.3
Pawpaw/Papaya	4.1
Lemon	3.2
Cocoa	2.2

Source: RAP Census, SMEC November 2015

Photograph 7.3: Mango Fruit-Bearing Tree

[22] The average number of trees owned by all households owning such trees.

7.3.10. Livestock Ownership and Grazing Patterns

Livestock does not play a significant role in farming activities in the Project area. Households affected by the Reservoir and BZ and sampled in the Census kept an average of 4.3 animals, mostly chickens (owned by 59.1% of households), followed by goats (25.7%) and pigs (11.7%). Only a few households had cattle (2.2%). The average number of animals kept by households owning each animal type was: chicken - 8.8; goats - 3.7; cattle - 4.3; pigs - 4.3; and donkeys - 1.8. A few households kept sheep and ducks.

Animal sales and animal products were reported as an income source for 11.9% of the households. Livestock is sold as cash in hand to cover expenses; to buy basic household goods, including food; to pay for medical expenses; to cover school fees; for agricultural needs; for building construction; and for ceremonial purposes. In addition, livestock products supply households with meat and dairy products.

Households use land within the Project Area of Impact for grazing their animals; 91.1% of households with cattle, and 95.0 % of households with goats. When asked where their animals graze, participants of the SGDs cited the surrounding hills, and at village dambos along the rivers, over the wet season (November to March), and in the harvested agricultural land and uncropped hills (such as Maye hill near Chinzili) over the dry season (March to October). Livestock grazing is controlled; animals, including goats, get tethered in the rainy season, to protect the crops, and thus become lean. For the remainder of the year they 'become plumper' as they are let out to graze more freely.

7.3.11. Homesteads and Household Composition

Settlements are typically scattered. A cluster of families form a village, situated near to the Diamphwe River and its tributaries and as close as possible to the areas they cultivate.

Seven percent of the sampled PAP for the Census survey had more than one homestead, with over ninety percent situated in the same TA as where they currently reside.

Homesteads surveyed mostly comprised two to four structures (Photograph 7.4).

Table 7.13 Number of structures per homestead

Number of structures	% households
<2	2.2
2 to 4	74.3
>4	23.5
Total	**100.0**

Source: RAP Census, SMEC November 2015

Photograph 7.4: Typical rural homestead structure

The national Census in 2008 found that most people (42.9 %) were living in traditional dwelling units, 34.1 % in semi-permanent dwellings, and 22.9 % in permanent dwelling units.[23]

Most structures of the homesteads of PAP for the sampled Census were similar, having: no foundations (97.7%); mud/earth floors (91.1%); clay/burnt bricks (60.0%) or mud (30.5%) for inside walls, with no plastering (97.0%); no material used for windows, other than wood or wood and glass windows (26.7%); and no roof (16.1%), or roofing made of wood and wooden poles (65.6%), iron/tin (10.0%), and thatching grass (7.6%). Most, if not all, of these construction materials are sourced directly from the Diamphwe River or surrounds. Foundations of concrete or stone, concrete or brick floors, concrete blocks for walls, and plastic windows are materials used in house construction in the area, but are not common (*Figure 7.2*).

Homesteads comprised of family units of the PAP, their spouse and children, extended to additional family members such as parents, siblings and grandchildren, with some non-relatives. Residential status showed that 98.7% of members of the household lived at the homestead, with a small percentage away studying (1.0%) or away working (0.3%). Of those working away, only a few were migrant workers, and mostly men.

Household size was generally large, with an average of 4.9 members (Table 7.14). This is larger than the average household size recorded by the national Census in 2008, at 4.6 for the country, and at 4.7 in the Central Region.[24]

Table 7.14 Household size

Number of Household Members	%
<= 2	11.7
3 – 5	50.1
6 – 8	38.2
Total	**100.0**

Source: RAP Census, SMEC November 2015

[23] NSO. 2008. *Op cit*.

[24] NSO. 2008. *Op cit.*

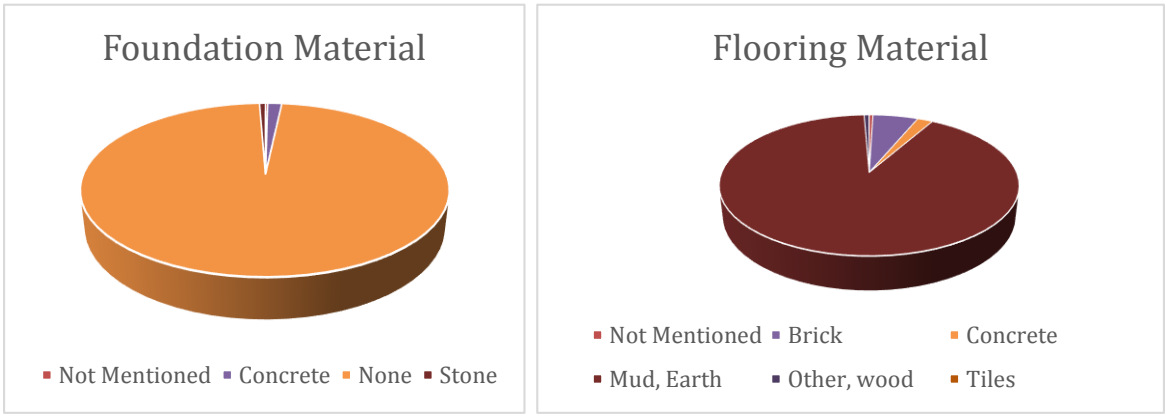


Figure 7.2: Construction Materials

According to the results from the WAPCOS household surveys, 89.9% of the heads of the surveyed households were married, of which 74.9% had one wife and 15% more than one wife; 7.1% of the heads were widows, 2.5% were divorced and 0.8% were single.

Most household members of 18 years of age or older of the sampled Census affected by the Reservoir and BZ were married (61.1%); of these 78.0% were married through traditional means, with less through a formal civil ceremony (18.5%), or both traditional and civil (3.6%). A further 10.9% of the adult household members were living together but not married; 19.1% were single; 4.6% were separated or divorced; and 4.3% were widowed.

Nearly all households (97.5%) had been living on the site for longer than five years. Structures have developed to accommodate the familial relationships, gender and age differences, consisting of a general living area, the women's sleeping huts, a kitchen (sometimes inside and outside), a bathroom, a toilet, a livestock shelter or enclosure, a storage facility, mostly for crops, and sometimes a business.

7.3.12. Service Provision and Resource Use

i. *Energy and fuel source*

Most households from the sampled Census affected by the Reservoir and BZ indicated that they use wood as the primary energy and fuel source (98.8%), again demonstrating dependency on the natural resource base. Wood is sourced locally in the neighbourhood, from private trees and communal woodlots, and from Dzalanyama Forest Reserve. The army is now patrolling the Reserve, to enforce regulations on the felling of trees. This, and increasing deforestation, will impact on access to the resource.

Photograph 7.5: Dzalanyama forest

While 23,3% used wood alone, it is mostly used in combination with other energy sources, such as flashlights (72,0%), paraffin and/or candles. The popularity of flashlights has come in tandem with access to affordable mobile phones, and to a Chinese-produced radio with a torch.

Less than one percent of households sampled used generators or had access to an electrical connection. Those with electricity have it through living close to a town on the national grid as there is no power supply from Eskom in the Reservoir inundation area.

Although only just over one percent used solar power, it is becoming an increasingly popular form of accessing energy.

Charcoal is not used by many households for private use; rather, it is regarded as a valuable income source, as a commodity to be sold to markets outside of the area. With the price of electricity rising, and regular power outages, there is a high demand for charcoal in Lilongwe city and Dedza town. Charcoal has mostly been produced in Dzalanyama forest, an activity that will diminish as restrictions on access become enforced.

ii. ***Water source and resource***

Only five households of the sampled Census affected by the Reservoir and BZ had piped water to their homesteads. Rather, wells/boreholes were the most common domestic water source. While one-third of households used unprotected wells or boreholes situated in their yards, accessing the water with buckets and ropes, over sixty percent used public facilities with pumps.

Less than two percent of the households used the river alone as a main water source; six percent used it in combination with wells/boreholes. It is often used as a domestic source if communal wells are some distance away, or if water pumps are not operational.

Photograph 7.6: Local borehole and pump

The river and its resources are used for a number of activities, for domestic and commercial use:

- Water, for bathing, washing clothes, small-scale irrigation, and watering animals;
- Reeds, for fencing of small gardens and residential sites, for ceiling and roofing material, and for basket-making for catching fish and storing maize flour;
- Grasses, for sleeping mats and mats on which to dry ground corn; for roof thatching; and for cattle feed;
- Sand for house construction, clay for pot making; and
- Natural edible and medicinal plants.

iii. ***Sanitation facilities***

Most of the households of the sampled Census reported using a pit latrine toilet system in their yard (97,0% their own, and 1,6% belonging to another household). Few had a bathroom and toilet inside their house. Only one household indicated that they use the open fields or bushes for sanitation.

7.3.13. **Movement and Access**

With the exception of the M1 main road between Lilongwe and Dedza, roads in the area are unsealed and in relatively poor condition, being particularly inaccessible over the wet season.

Apart from on the M1 there is little to no public transport offered on the road network in and around the reservoir area, and people mostly walk, or use motor bikes and bicycles.

Photograph 7.7: Bicycles are the most popular form of transport

There is considerable movement across the river, particularly for people visiting friends and families, accessing their land, and utilising service provision such as health and educational facilities. Mostly, people cross the river at informal crossing points; the only bridges in the area are over the M1 downstream of the Dam, and at the furthest point upstream of the Dam, between Kakhosi village in Dedza District and the villages of Kamsapha, Mizaleki, Mdangwe, Izeki and Galanganda in Lilongwe District. The latter is likely to be inundated.

7.3.14. **Health**

i. ***Health resources***

a) Facility based resources

Communities in the Project study area receive health services from Chitowo, Mdedza, Kasina, Diamphwe, Kamphata, Katchale, Kanyezi and Nathenje Health Centres. In addition there are Under-Five clinics in Mwango, Chaponda, Ulongwe, Mpaso, and in Chingwenji at the nursery school. Nyamanzi also has a clinic used by communities in the area. Health Centres are used interchangeably by residents; that is, people go to the one closest, or has the best facilities, which could mean crossing between the two Districts.

Patients with severe illnesses and complications are referred to Dedza District Hospital, and Bwaila, Nkhoma and Kasina Hospitals, all some distance away. Nkhoma is approximately 30 km from the Dam wall site, and Kasina some 20 km away.

Health facilities offer treatment for common diseases, including malaria and tuberculosis (TB), family planning services, under-five clinic services, antenatal and maternity services, psychiatry, nutrition rehabilitation, HIV/AIDS counseling and treatment, and treatment of other Sexually Transmitted Infections (STIs).

b) Community based resources

The community health services are targeted to deal with poverty, under-nutrition, safe water provision, family planning, and providing access to health services to under-five children. Services are offered by CARE (village savings loans), NASFAM (food production), Kasina Health Centre (food production and nutrition education), Feed The Children (nutrition) and Nkhoma Hospital.

Health Surveillance Assistants (HSAs) support communities in dealing with problems of poor sanitation, poor access to health services, unsafe drinking water, and malaria, by conducting health

promotion activities relating to sanitation and hygiene, water chlorination and health education on common diseases, and by offering outreach clinics and distributing mosquito nets.

There are also several local healers and traditional herbalists in the area.

ii. ***Health Issues***

The common health-related problems in the Project area that were highlighted by communities and stakeholders during the health studies include:

- Illnesses and disease such as malnutrition, malaria, diarrhea, bilharzia, Acute Respiratory Infection (ARI), HIV/AIDS and STIs.
- Early marriages and teenage pregnancies.
- Not all villages have clinics, and for those that do HSAs do not always have drugs and other supplies to provide to the communities. Most villages are far from the nearest health facilities, and access to health services is difficult due to poor road networks and a lack of transport. For example, there is no bridge for people in some villages to cross the Diamphwe River to get to Chitowo and Diamphwe Health Centres. In addition, local health centres have no ambulance service for referral cases, and patients with complications find it difficult to get to the nearest hospital.
- Local health services lack drugs, space, equipment and adequate personnel, making it difficult for communities to "*get the right services they need*". Chitowo and Mdeza Health Centres do not have electricity, making it difficult to offer some services, especially at night. Inadequate and old infrastructure was generally named as inhibiting health centres from coping with emerging health issues in the area.
- Most outreach clinics do not take place due to transport problems and inadequate HSAs in the communities to provide health promotion activities such as water chlorination and sanitation; water chlorination is usually only provided in the rainy season despite water challenges during other periods of the year.

Concerns were also expressed about overpopulation, and poor access to safe drinking water and sanitation facilities affecting health.

7.4. Cultural Heritage

As stated, the Linthipe – Chongoni area in Central Region has yielded rare and important pre-historic, historic and cultural heritage resources, documenting human evolution in terms of Middle, Later Stone Age and Early, Middle and Later Iron Age sites.

A total of 21 heritage sites were identified during the field surveys in the Project area, including 16 archaeological sites of variable ages. The archaeological sites include eight evident settlements dating back to the Iron Age. The presence of such sites in the area is 'not surprising' as riverbanks have always been the preferred place of settlement given the need for drinking water. Moreover, rivers provide a source of food, means of transport, and line of defense.

Given the short history of writing in the country, Malawi needs to rely on archaeology for most of its historiography. Even relatively recent sites (19th century) are thus likely to have a scientific value. The actual value will depend on the size, age, function and integrity of the sites. As little archaeology has been done in Lilongwe and Dedza Districts, any site will have some value.

The original and predominant population of the area is Chewa. Despite mission influence, *Nyau* societies are still quite common. This tradition is included on the UNESCO Representative List as a 'masterpiece' of intangible cultural heritage under the 2003 Intangible Cultural Heritage Convention,

and thus is of global significance. These secret societies have *Dambwes,* or activity areas within the Project area. These forest patches also serve as graveyards.

Photograph 7.8: Local burial ground

SMEC

Local People. Global Experience.

Chapter 8
Environmental Impact Assessment

Environmental and Social Impact Assessment

February 2016

8. ENVIRONMENTAL IMPACT ASSESSMENT

8.1. Environmental Impact Assessment

8.1.1 Extent of Potential impacts

This section identifies potential impacts that the various elements of the Project may have on the physical, biological and socio-economic environment. Assessment of potential impacts requires a multi-disciplinary approach and consideration of a range of aspects, including:

- Sensitivity of the receiving environment;
- Direct and indirect impacts;
- Cumulative impacts;
- Duration of impacts (short, medium, long term);
- Whether impacts are temporary or permanent;
- Areal extent of the impact (including any transboundary aspects); and
- Legislative and policy implications.

Potential impacts may be both positive and negative. Positive impacts relate to the accrued benefits that the project will have as a result of the Project's planning, construction and operation. Negative impacts may directly or indirectly have an impact on environmental and social qualities.

8.1.2 Impact Assessment Methodology

Impact assessment and mitigation were undertaken in accordance with the ESIA objectives presented in Chapter 2. The general process includes:

- *Impact assessment*: Identification and assessment of potential environmental and social impacts with reference to applicable country and international regulations, standards and guidelines. Impact assessment also includes identifying opportunities to enhance beneficial impacts of the Project and to improve social development opportunities.
- *Mitigation measures*: Mitigation measures have been developed with consideration of baseline conditions; identified constraints; concerns and suggestions raised by the community; GoM, WB, IFC and other relevant requirements, and the level of design information available at the time of preparation of this ESIA. Mitigation may include:
    - Environmental controls (eg. measures for minimising harmful noise, air, water and waste emissions);
    - Design optimisation (eg. relocation of dam wall to avoid graveyard);
    - Procedural measures (eg. setting up catchment management committee);
    - Avoidance/reduction (eg. waste minimisation process management to conserve water);
    - Compensatory measures (eg. biodiversity offsets); and
    - Timing measures (eg. no construction at night).
- *Risk assessment*: Risk assessment has been undertaken to gauge the level of 'Residual' impact after mitigation and acceptability against international criteria and sustainability principles. Further opportunities for reducing identified 'high' risk residual impacts are then canvassed.

8.1.3 Project Footprint and Extent of Potential Impacts

The Project's area of influence includes direct disturbance of land due to the Project's footprint, as well as construction and operational impacts on the surrounding environment.

The Project Footprint is shown on Figure 8.1 and *Figure 8.2* and summarised in *Table 8.1*. A total of **2,682 ha** will be permanently or temporarily affected by the Project as follows:

- Permanent sterilisation of land: 2,342 ha;
- Permanent exclusion zones (buffer): 258 ha; and
- Temporary construction areas: 82 ha.

Table 8.1 Project Footprint

Project component	Permanent (ha)	Permanent Buffer (ha)	Temporary (ha)	Total Disturbed (ha)	Description
Reservoir	2,328	156		2,484	▪ This includes the dam inundation area up to a FSL of 1180.3 masl. ▪ A 15 metre wide buffer zone to be situated around the dam. This zone will be planted with endemic forest woodland species.
Dam Infrastructure	16	124	22	162	▪ Structures will include the dam wall and associated structures, raw water pump station and pipeline, WTP and pipeline, balancing tanks, access roads and office / accommodation buildings. ▪ Exclusion zones will be maintained around dam components. ▪ Temporary construction areas will include some access roads, laydown areas and quarry. These areas include directly impacted and buffer areas and will be subsequently rehabilitated.
Service Pipeline			60	60	The 30 km pipeline will be constructed within the road easement. On completion the area will be rehabilitated and unrestricted access permitted.
TOTAL	**2,342**	**258**	**82**	**2,682**	

Other potential impacts not directly related to the Project footprint include:

- Construction activities on the surrounding environment may potentially result from noise, air, water and waste emissions, changed traffic conditions, influx of workers and socio-economic changes.
- Dam operations may directly impact on catchment and downstream areas, as well as adjoining sensitive receptors such as houses, community facilities and important natural and cultural areas.
- The Project may indirectly impact on the broader catchment, as well as on socio-economic aspects, both locally and regionally.

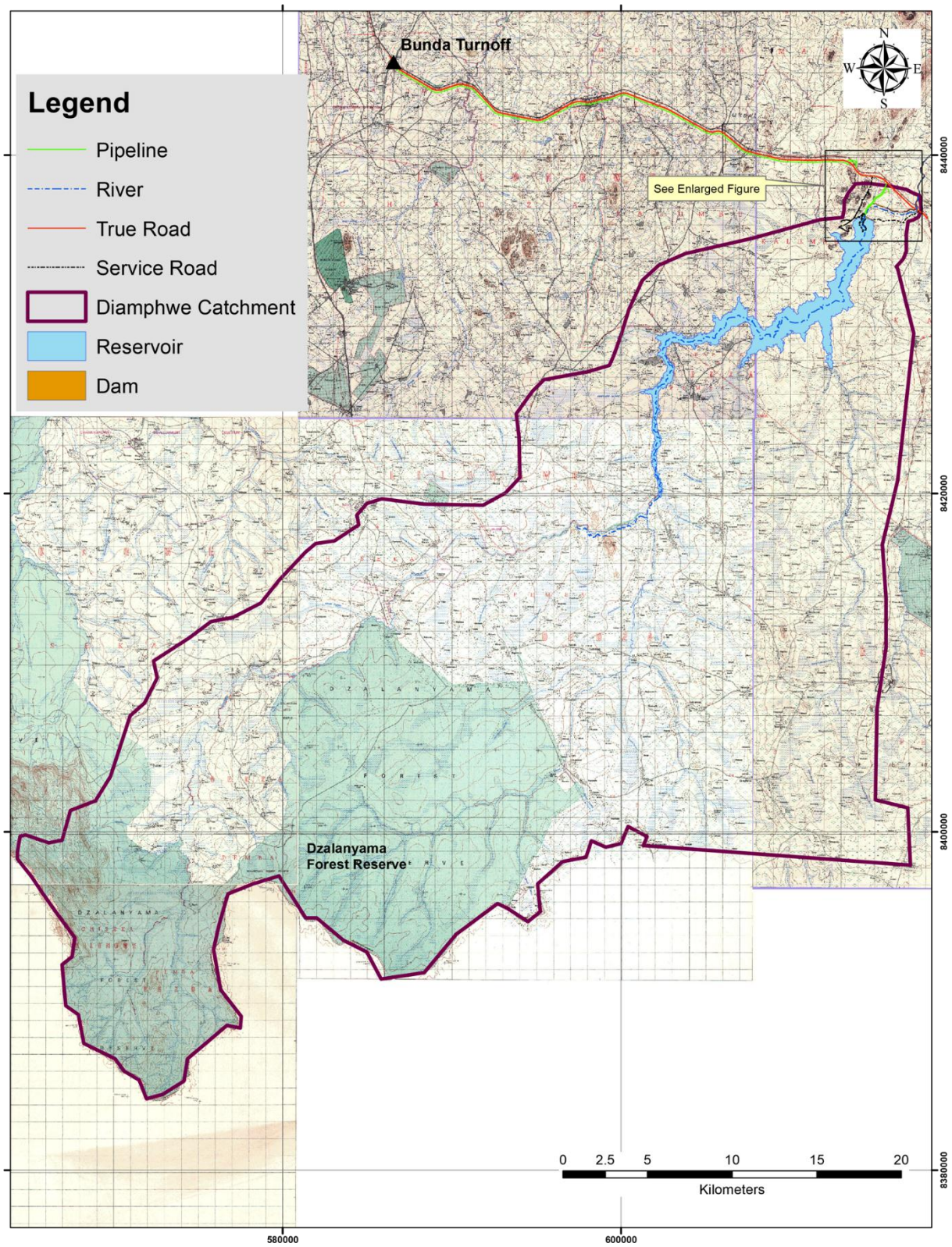


Figure 8.1: Project Footprint

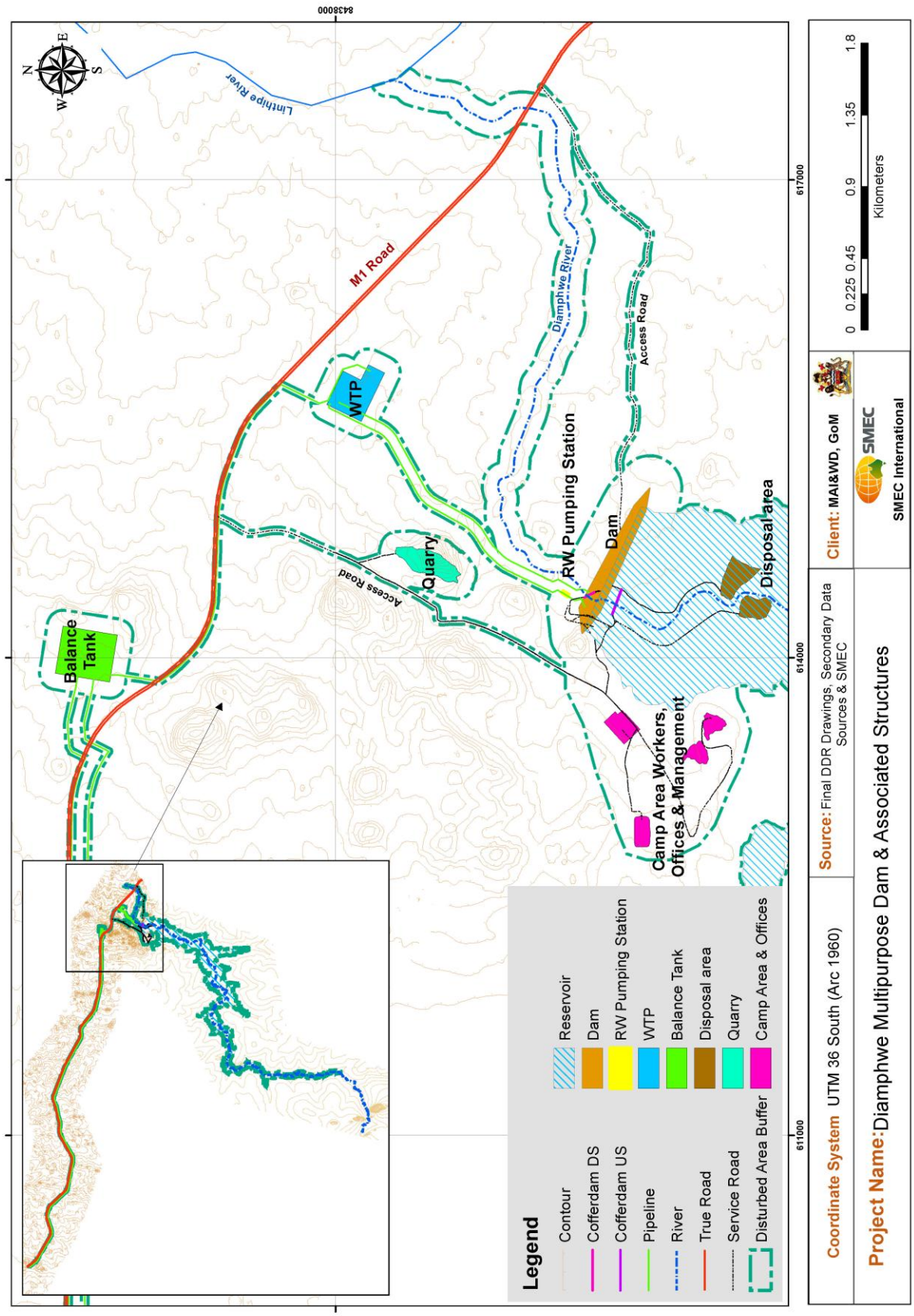


Figure 8.2: Infrastructure Footprint (Enlargement)

8.2. Project Benefits

8.2.1 Introduction

The Project will generate significant benefits during planning, construction and operational stages. These include increased water supply security to Lilongwe, agricultural expansion and improved livelihoods, local and regional economic development through enhanced employment and commerce opportunities, improved community infrastructure and services, more effective catchment management and increased biodiversity.

8.2.2 Water supply security

Lilongwe is currently suffering severe water shortages, with a supply deficit of approximately 47 ML/d. Planned upgrade works will cater for the city's demands up to year 2020, after which an additional bulk water supply will be needed.

Development of the Diamphwe Multipurpose Dam and associated water treatment and transmission infrastructure will secure Lilongwe's water supply to 2045. Further, the development will provide significant opportunities to supply water to rural villages, irrigating up to 1,000 ha of agricultural land and promoting development of fish farms.

As part of feasibility studies Sogreah (2010) undertook a detailed economic analysis of the project, which included consideration of direct costs and benefits. The analysis considered security of supply, multipurpose use and environmental & social, financial and economic criteria. Overall the Project showed a Benefit to Cost ratio of 1.69 and an internal rate of return of 12 %. This is indicative of the sustainability of the project to meet future water demands, as well as providing irrigation and fisheries opportunities.

Significant project benefits will therefore accrue by substantially improving water resources sustainability, food security and livelihoods.

8.2.3 Employment Opportunities

Employment and training opportunities will be created during Project planning, construction and operation. Increased economic activity generated by the proposal will create additional employment opportunities.

i. ***Project planning***

Prior to construction significant work is required to implement the Resettlement Action Plan (RAP), including undertaking verification of the census survey, finalising compensation, relocating Project Affected Persons (PAP) and assisting with the identification and assessment of land requirements for replacement agricultural losses and community assets, such as graveyards and community centres. It is anticipated that most of this work will be undertaken by Malawian resettlement specialists, surveyors, valuers and engineers. Over 6000 PAP and 7000 defined assets have been identified and work is expected to be undertaken over a two to three year period.

ii. ***Construction***

It is envisaged that there will be between 200 and 300 workers on the Project during the various stages of the 3.5 year construction period. The workforce will be accommodated in an onsite construction camp and is expected to comprise of approximately:

- 150 unskilled workers who will most likely come from the local area;
- 100 skilled workers (technicians and artisans, drivers, plant operators etc.) who will be Malawian and may come from other areas of the country. It is anticipated that many of these workers will be accompanied by family members, who may be accommodated in the wider community.

- 50 expatriate from elsewhere (i.e. the region or abroad) whose special skills will be required from time to time. About 10 expatriate employees (for the Consultant and the Contractor) will be on site for most of the time.

iii. ***Operation***

There will be a smaller operational workforce of approximately 50 personnel comprising of the site manager, hydrologist, water quality specialist, laboratory technicians, WTP and Dam operators, and maintenance staff. It is anticipated that these positions will be filled by Malawian nationals.

iv. ***Catchment management***

It is also anticipated that direct employment will be generated through catchment management activities, such as riparian and re-afforestation work to be undertaken around the reservoir perimeter, as well as more general land management activities within the broader catchment, such as erosion control works and better monitoring and protection of the upper woodland catchment.

A catchment management committee will be set up and a specialist team employed to plan and manage activities. It is envisaged that local people will be trained and contracted to undertake these works. Assistance will also be provided to local community groups to establish plant nurseries for propagating suitable plants. It is anticipated that approximately 200 people could be involved in catchment management activities. Much of this work would be undertaken over a five year period, after which a smaller workforce would be engaged in monitoring and maintenance activities.

8.2.4 Improved infrastructure and development

Improved infrastructure will primarily be associated with provision of treated water to villages around the Dam, as well as adjoining the pipeline alignment to Lilongwe. This will mainly consist of locating water kiosks near villages (*Photograph 8.1*), which will substantially improve water accessibility and reduce reliance on groundwater resources. A reliable water source will also provide scope for improved sanitary services and attendant reduction in diseases such as diarrhoea and cholera.

During construction the MoAIWD will provide financial assistance for the expansion of local educational, health and welfare services to cater for the construction workforce and their families. These investments will also benefit local communities in the longer term.

The influx of construction workers and their families will stimulate commercial opportunities such as accommodation rentals, market activities and growth of service industries such as restaurants and shops. Economic stimulus as a direct result of construction will decline following completion of the works and departure of workers and their families, however investments made during the construction period are expected to have longer term benefits due to improved community services and new business and employment opportunities generated by improved infrastructure.

Photograph 8.1: Examples of Water Kiosk

8.2.5 Agriculture

The proposed multipurpose dam will have capacity to irrigate up to 1,000 ha of land and supply a pilot fish farm (2 ha), and up to 50 community fish farms (approximately 500 m^2 each). This will extend the cropping season into the dry season and improve livelihoods as a result of increased food security, employment and commercial opportunities (*Photograph 8.2*).

Photograph 8.2: Example Malawi Irrigation & Fish Farm

8.2.6 Catchment management and biodiversity

Management of the Diamphwe river catchment will be enhanced by establishing a catchment management committee with appropriate funding to improve and maintain the water catchment. This will include re-vegetation and erosion control works, as well as providing additional resources to monitor and protect the upper wooded forest that forms part of the Dzalanyama Forest Reserve.

The Project will have positive benefits on biodiversity as a result of catchment management initiatives, as well as establishment of extensive riparian and woodland habitats around the perimeter of the Dam. It is estimated that based on current landuse characteristics the Project will result in a net increase of up to approximately 10 km of riparian dambo grassland around the reservoir's perimeter, and an additional 156 ha of woodland forest, which will form the reservoir's 15 m exclusion zone. It is also anticipated that the reservoir will provide habitat to significant numbers of native animals including birds and fish.

Planted Woodland Forest around Kamuz Dam-1 Plant Nursery at Kamuz Dam-2

Photograph 8.3: Kamuzu Dam Catchment Management

8.2.7 Dam management

The proposed Dam will assist in delaying and lowering flood peaks, which will reduce the potential for downstream flooding. During the dry months the Dam will regulate more consistent base flows

and improve yearly availability of water to downstream users. This will be a substantial benefit compared to the current situation whereby the river can cease to flow altogether.

8.2.8 Improvement in status of women

Provision of a sustainable water resource will generate business and employment opportunities, and provide a stimulus for women to become more active in employment generation activities, such as in irrigated agriculture and service industries. Clean water and improved sanitation will significantly improve the health of women and children, thereby substantially improving quality of life and capacity to pursue employment opportunities.

8.3. Water Resources

8.3.1. Hydrology

i. *Dam design and operation*

The Linthipe River is one of Malawi's major rivers with a catchment area of approximately 8,641 km^2. The Project will directly impact on the Diamphwe River catchment, which covers approximately 1,403 km^2 or 16% of the upper Linthipe River catchment.

During the 3.5 year construction period a diversion channel will divert the river around the construction area, allowing unrestricted downstream flows. Water will be required during construction, mainly for concrete production and dust suppression.

Once the dam wall is completed the diversion channel will be sealed and downstream flows will be impeded by the Dam wall. Detailed hydrological studies were undertaken by Studio Pietrangeli (2014) to estimate the minimum reservoir capacity required to satisfy the water demand. Based on hydrological modelling the minimum operating level was set to 1161.9 masl, corresponding to a dead volume of 5.6 Mm^3 to accommodate silting of the Dam. The Full Supply Level required to satisfy water demands (including environmental flows) and non-emptying of the reservoir after the second year is 1175.7 masl. A summary of model results is shown in Figure 5.4.

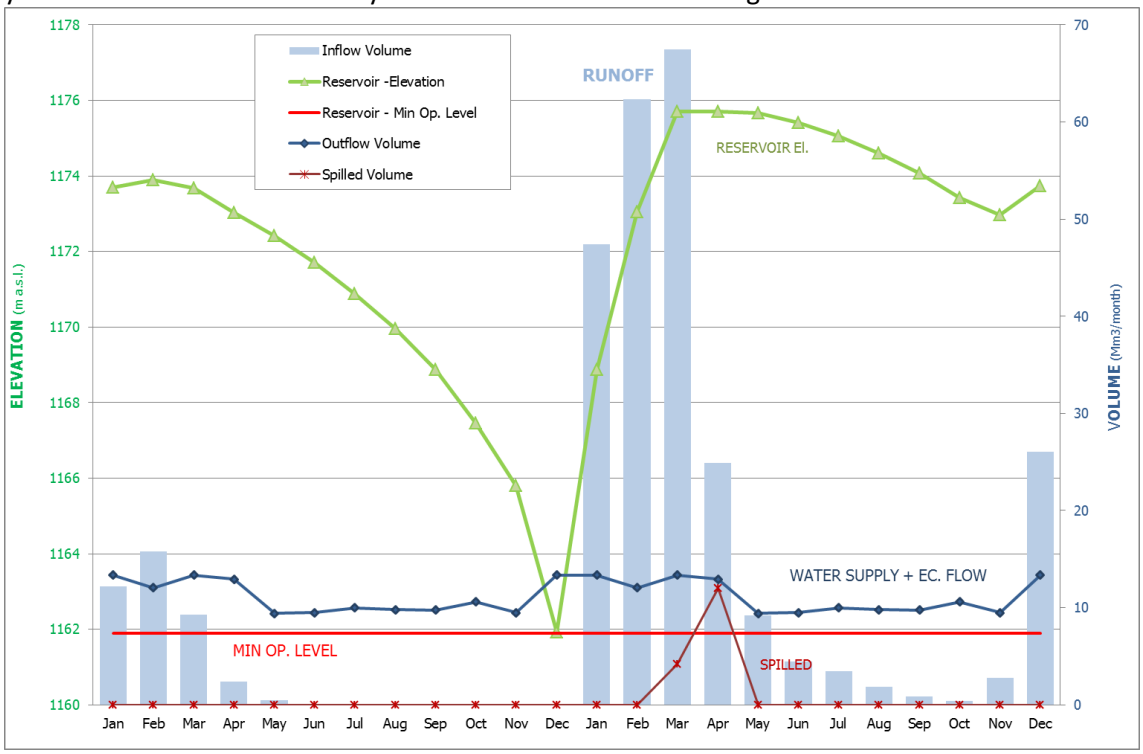


Figure 8.3: Diamphwe Dam Reservoir Routing Results (Studio Pietrangeli, 2014)

The above model shows that for average conditions the dam will spill for approximately two to three months between February and May, while for the remainder of the year there will potentially be no downstream flows for approximately nine months of the year.

ii. ***Impact on water resources***

During construction a diversion channel will redirect river flow around the dam wall construction area, allowing unimpeded downstream flows. Once construction is completed river flow will be directed into the dam. Potential changes to river flows are discussed below.

- It is estimated that up to 2,000 m^3/d of non potable water will be required for dust suppression, washdown and concrete production. This could potentially negatively impact on the Diamphwe River is extraction is done during below average flow conditions.
- Downstream river flows will be adversely affected immediately following construction of the Dam wall and during filling of the reservoir. During this time there will be near zero downstream flow. The Diamphwe River regularly experiences low flows and sometimes zero flow during the dry season. Consequently downstream impacts are not expected to be significant for the initial period of dam filling. However, extending a zero flow regime for an extended time would significantly impair the section of river between the Dam and the Linthipe River confluence. Impacts will diminish further downstream as the contributing catchment becomes larger.
- Once the dam reaches its operating level it was predicted that the Dam would spill for two to three months of the year, meaning that for approximately nine months there would be no flow in the Diamphwe River to its confluence with the Linthipe River. This would significantly degrade this section of the river and reduce flows to Lake Malawi by approximately 18 %.

iii. ***Mitigation during Dam construction and commissioning***

- **Water extraction**: During construction site water demands will generally be sourced from the Diamphwe River, however this will be subject to prevailing conditions and maintaining average flows. If necessary water can be sourced from the larger Linthipie River further downstream and trucked to the site. Construction activities and scheduling will be carefully managed to ensure water extraction does not significantly affect water resources.
- **Dam filling**: Downstream river flows will be impacted upon immediately following construction of the Dam wall and during the initial period of reservoir filling from ground level (1160 masl) up to the operating level of 1161.9 masl. Once the operation level is reached the bottom outlet will be able to regulate a discharge flow as the dam continues to fill to its maximum level of 1175.7 masl. To minimise the time taken for the Dam to fill up to the operational level it is recommended that the diversion channel be decommissioned at the commencement of the rainy season. It is anticipated that zero downstream flow would still occur for one to two months, however the Diamphwe River immediately downstream of the proposed Dam has regularly experienced low and zero flow conditions and any impact will be relatively short term and not inconsistent with existing low and zero flow conditions.

iv. ***Mitigation during Dam operation***

To minimise downstream impacts during operations it is proposed to maintain an environmental flow. There have been extensive investigations undertaken to determie an appropriate environmental flow, which is summarised as follows:

- Under the Water Resources Management Component of the NWDP, the Water Resources Investment Strategy (WRIS, 2011) identified specific water resources development and infrastructure needs for the 17 Water Resources Areas (WRAs) across the country. WRIS allocated a habitat integrity rating of C (moderately modified) to the Linthipe-Lilongwe

catchment, with more than half of the catchment area having a medium or high risk of sediment ingress to water courses and a medium risk of invasive aquatic plants. According to the WRIS (Atkins, 2011) the environmental flow requirement for the catchment is 10% of the river-flow in the dry season, 32% in the wet season and 21% annually.

- Studio Pietrangeli (2014) assessed environmental flow requirements as 10% and 30% of the annual flow for dry and wet seasons respectively. This was based on detailed hydrological analysis and maintenance of downstream river ecosystems.
- The MoAIWD has reviewed relevant information provided by Studio Pietrangeli and relevant correspondence is provided in **Appendix 7**. MoAIWD stated the following:

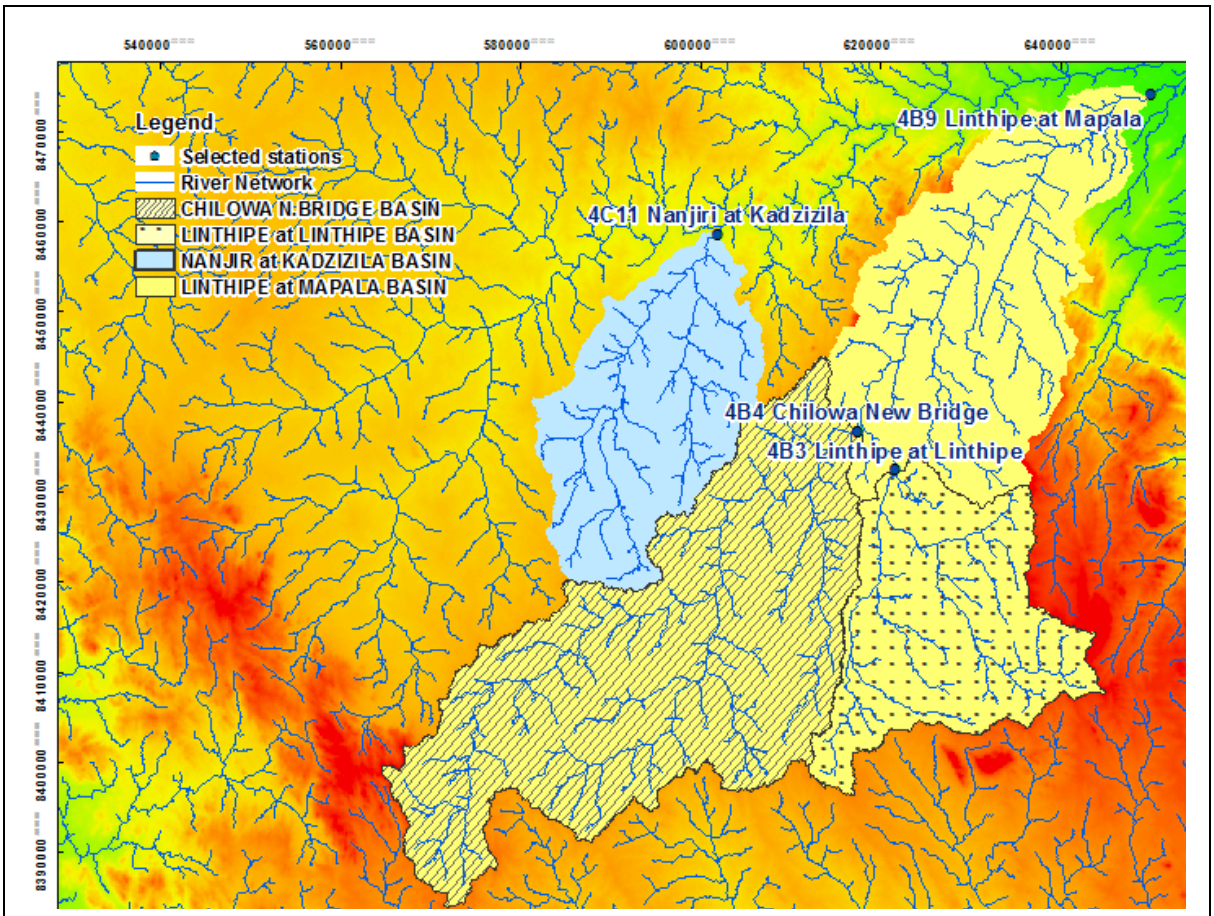
  1) In assessing the environmental flow the consultant has considered all the relevant issues that are required in the riverine ecosystem;

  2) The Consultant has looked at the different flow assessment techniques ranging from hydrological index, natural habitat, discharge methods, habitant inundation methods to holistic approaches; and

  3) The Consultant has also looked at the required or recommended environmental flows for different objectives and has recommended environmental releases for different months which is equivalent to 10% of the annual average flows in the dry season and 20% of annual average flow in the rainy season,

  However, the ministry would like to advise that the policy on ascertaining the environmental flow has been that of the hydrological index using the flow duration curve, that is to say that all designs are to allow a 90% percentile compensation flow i.e Q90 which is interpreted as "the flow which is available 90 percent of the time" should be released as environmental flow. This agrees partially with the consultant recommendation though the difference has been that consultant's recommendation uses the Annual Average Flow (AAF) which varies with time.

The proposed dam will therefore be operated to ensure a 90% percentile compensation flow (Q90), which is the flow that is available 90% of the time. In assessing potential downstream impacts consideration was given to the contribution of the Diamphwe catchment to the larger Linthipe catchment. Contributory average flows from various sub catchments are shown in Figure 8.4.



Mean annual runoff and specific discharge at selected stations:

Station name	Station code	River	Area [km2]	Mean Runoff [m3/s]	Specific Discharge [l/km2/s]
Chilowa New Bridge	4B4	Diamphwe	1420	8.2	5.8
Linthipe At Linthipe	4B3	Linthipe	635	4.9	7.7
Linthipe at Mapala	4B9	Linthipe	2970	15.8	5.3
Nanjiri at Kadzizila	4C11	Nanjiri	600	4.8	8.0

Figure 8.4: Average Sub catchment Flows (Studio Pietrangeli, 2014)

Average downstream flows in the 3 km section of Diamphwe River between the Dam wall and its confluence with the Linthipe River would be potentially reduced by 10%. Immediately downstream of the Diamphwe / Linthipe confluence the percentile of normal flows would increase to approximately 94%, which would further increase to approximately 97% at Mapala, approximately 30 km further downstream. Further downstream at Lake Malawi it is expected that there would be negligible change to current flows. The proposed environmental flow regime will therefore significantly mitigate a potential significant reduction in downstream flows as a result of the Dam.

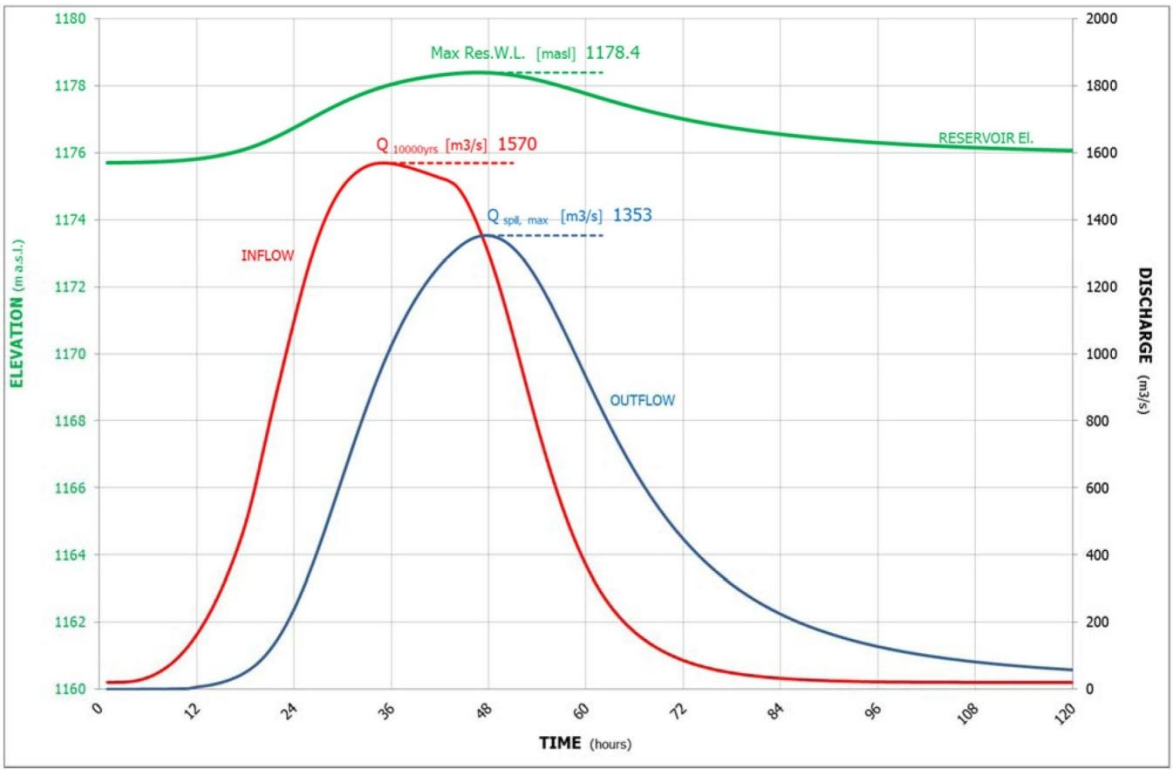
During below average flows there would likely be a positive impact, as the minimum flow will be maintained at the 90% percentile, thereby potentially limiting periods of below average or zero flow.

Following environmental flow mitigation the overall impact to downstream flows is not expected to significantly impact on downstream users or biodiversity.

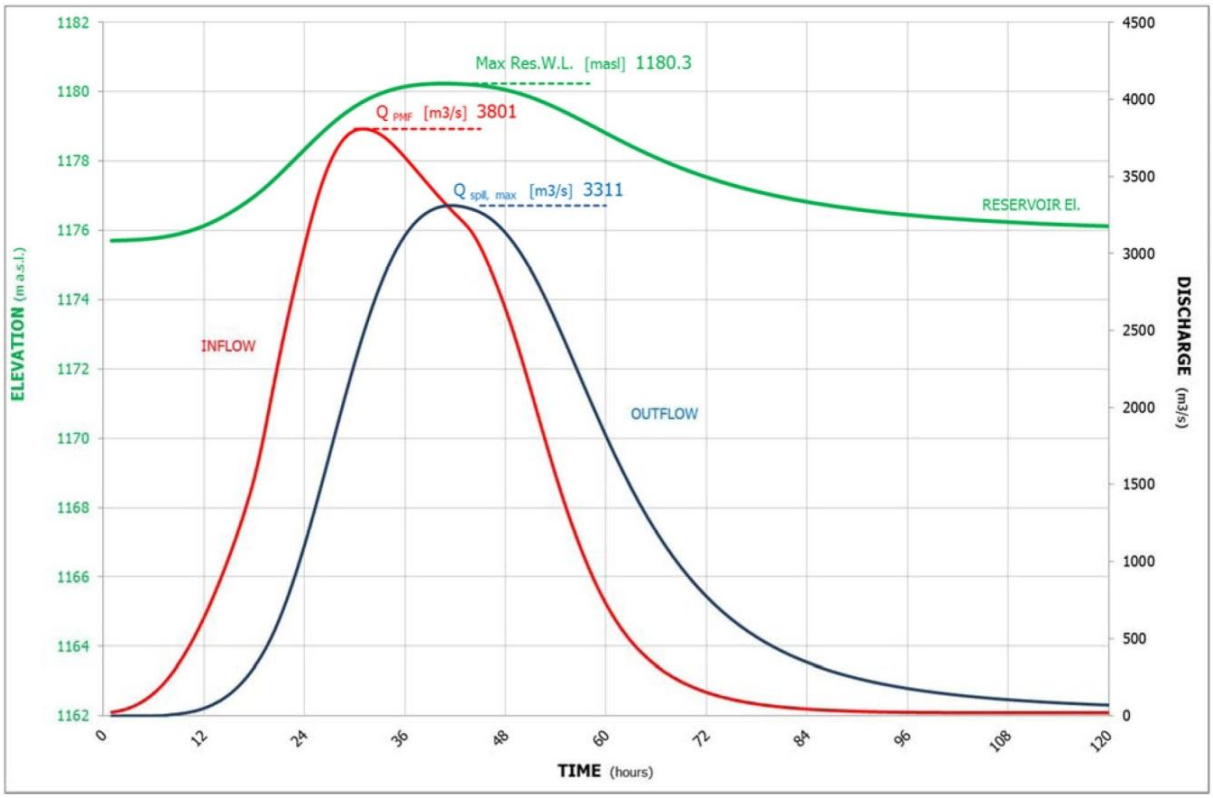
v. ***Flooding***

Regulating flows would decrease the extent of downstream flooding, however current flood patterns would be less affected during periods of spill, which are most likely to occur between February and

May. Flood routing modelling undertaking by Studio Pietrangeli (2014) showed that flood peaks for major floods are reduced by up to 16 % for a 1 in 1,000 year flood event, and 12 5% for a Probable Maximum Flood (PMF) event. Flood peaks are also delayed by approximately 12 hours, which would increase time of flood peaks from approximately 30 hours to 42 hours. Routing results are shown on Figure 8.5.



Reservoir routing for Q1,000 year flood



Reservoir routing for PMF flood

Figure 8.5: Dam Flood Routing (Studio Pietrangeli (2014)

8.3.2. **Water Quality**

Existing water quality is generally good, with no evidence of persistent gross pollution or ecological stress. However water quality can deteriorate during low flow conditions due to reduced flushing and mixing, and attendant increase in TDS and reduction in DO levels. During wet weather conditions water quality can be affected by increased erosion in the catchment, while sewage contamination remains an ongoing problem due to poor sewerage infrastructure and a growing population.

i. ***Construction***

Construction activities may affect river water quality due to:

- Erosion and sedimentation.
- Contaminated stormwater from operational areas containing potential pollutants such as oils, solvents, paints, fuels and waste materials.
- Uncontrolled liquid spills of contaminants such as fuel and oils.
- Sewage and wastewater discharges.

A range of management controls will be implemented to minimise the potential for contaminants to enter receiving waters, and to ensure any site discharges meet water quality objectives identified in:

- **MS733:2005**: The Malawi Standard for borehole and shallow well water quality specifies the requirements for untreated or raw ground water in boreholes and shallow wells suitable for human consumption and all usual domestic purposes.
- **MS 691:2005**: Tolerance limits for domestic / sewage effluents discharged into inland surface waters
- **IFC EHS Guidelines**: Environmental 1.3 Wastewater and Ambient Water Quality

Management measures will include careful containment and management of potential pollutants, separation of clean and 'dirty' stormwater runoff, drainage and sedimentation controls and onsite treatment and disposal of sewage and site generated wastewater. A monitoring program will be implemented to confirm that water quality meets relevant water quality objectives and, if necessary, remedial measures undertaken and / or site activities modified. Specific water quality mitigation measures are provided in the ESMP (Chapter 12).

ii. ***Operation***

Water quality is expected to significantly change within the dam impoundment, particularly during the early period of dam filling and operation. Physical-chemical changes are likely to include:

- Low dissolved oxygen levels as a result of decaying vegetation and enhanced active organic decomposition in bottom sediments, as well as reduced flow-induced turbulence that would normally promote the dissolution of oxygen in the water body. Landuse within the reservoir is predominantly agricultural land with only about 16 % comprising of natural vegetation, of which less than 0.5% is wooded forest. Consequently the amount of vegetation subject to decay will be relatively low.
- Release of organically-bound elements from flooded vegetation, organic waste and soil nutrients, resulting in an upsurge of nutrient enrichment and high productivity, and possible eutrophication. Fertilizers are not commonly used within the catchment and there are no significant sources of nutrient accumulation. It is expected that nutrient levels will temporarily rise during the early stages of dam development, however not to levels that would trigger eutrophication.
- Thermal stratification and the formation of anoxic conditions in the deeper parts of the reservoir. This may result in the release of sulphur dioxide gas, lowering water pH and

further reduction in oxygen levels. Rapid temperature change can result in water 'turnover', whereby the bottom water layer potentially affected by anoxic conditions can become more mobilised and adversely affect the upper surface layer.

- Dam siltation and entrapment of metals such as lead, Copper, Zinc, Manganese and Iron. In low pH conditions metals can dissolve into the water column causing elevated levels of potential toxins.

Downstream water quality could be impacted by lower flows and dam discharges of poor quality water with low pH and oxygen, and high nutrient and metal concentrations. In the longer term ambient nutrient and metal levels may decline due to upstream entrapment of nutrients in Dam bottom sediments.

Mitigation measures will include the following:

- Clearing large vegetation stands within the reservoir area and restricting agricultural activities for at least six months prior to inundation.
- Implementation of a comprehensive water quality monitoring system for the reservoir, and upstream and downstream areas. Real time monitoring will ensure that any water quality issues are quickly responded to.
- The Dam water intake has been designed to divert water with the best quality characteristics according to the levels present in the reservoir. Two outlets have been designed at 1162 masl and 1170 masl. In addition the Dam has been designed to release environmental flows in open air, thereby increasing the opportunity for mixing and oxygenation of the water.
- Catchment management initiatives will reduce potential for catchment erosion and siltation of the Dam. These include substantial revegetation around the dam perimeter, erosion control management within the catchment and improved management of the Diamphwe River headwaters within the Dzalanyama Forest Reserve.

8.3.3. **Dam siltation**

Studio Pietrangeli (2014) assessed catchment sediment yields and estimated the rate of Dam siltation. The analysis considered flow records and suspended solids concentrations, catchment erosion studies undertaken by Sogreah (2010), evaluation of sediment loading to Kamuzu Dam by Safege (2001) and more recent sediment yield data assessed by Aurecon (2013).

The estimated sediment volume entering the proposed reservoir was estimated to be 120,000 m^3/year. As noted above Dam design includes provision of a dead volume of 5.6 Mm^3 to accommodate silting of the Dam. This would therefore accommodate sediment for approximately 47 years of Dam operations.

Catchment management measures noted above will effectively reduce sediment loads from the catchment and it is anticipated that the rate of sediment accumulation would be less than 120,000 m^3/year. Consequently it is anticipated that sufficient sediment storage volume would be available to operate the dam for more than 47 years.

8.3.4. **Groundwater**

Groundwater depth ranges from 20.0 to 76.3 m, with an average depth of 41.4 m. Geology comprises of alluvial and weathered rock to approximately 15 m depth, underlaid by relatively impermeable rock. Groundwater resources are of generally good quality and are extensively used by regional populations, including all of the villages within the study area. Potential Project impacts are summarised below:

- The proposed Dam will not significantly impact on groundwater recharge areas, although groundwater levels immediately around the Dam may increase due to impoundment of a large body of water. However due to groundwater depth and impermeable overlying rock any increase is expected to be minimal with no discernible negative impact.
- Potable water will be required for the construction and operational workforce. The maximum water demand is estimated to be 45 m^3/d during peak construction, reducing to approximately 5 m^3/d during Dam operations. Groundwater will be used however this will be closely monitored and potable water would be trucked in from Lilongwe if necessary. Groundwater will not be used for construction purposes. The Project will not result in significant drawdown of groundwater levels.
- There is potential for pollutants such as fuel, oil, sewage and contaminated stormwater from Dam construction and operations to affect groundwater, however there is a low potential of this occurring due to groundwater depth and impermeable overlying rock. Implementation of site management measures discussed in Section 8.3.2 would further reduce any potential risk of contamination.
- The Project includes providing treated water to villages around the Dam, as well as adjoining the pipeline alignment to Lilongwe. This will mainly consist of locating water kiosks near villages, which will substantially improve water accessibility and reduce reliance on groundwater resources. Consequently groundwater drawdown will be reduced, which will have a positive benefit in protecting groundwater as a more sustainable resource.

8.3.5. **Summary of impacts and mitigation: Water Resources**

Table 8.2 Water Resources Impacts and Mitigation

Positive Impacts	Negative Imapcts
▪ The dam will be operated to reduce flood peaks for major flood events, thereby reducing downstream flood hazard. ▪ Minimum environmental flow will be maintained at 90% of normal flows, thereby limiting periods of below average or zero flow. ▪ Providing a sustainable water supply to communities around the dam would reduce the dependency on groundwater resources.	▪ **Hydrology** - Change downstream flow regime resulting in reduced flows and water availability to communities and impact on biodiversity values. - Impact on river as a result of water extraction during construction. - Dam failure due to earthquake or security breach. ▪ **Water quality** - Water quality impacts during construction due to erosion and sedimentation, and potential stormwater entrainment of contaminants such as fuel from spills. - Sewage and wastewater discharges. - Deteriorating water quality in the Dam due to physio-chemical changes and downstream discharge of poor quality water. ▪ **Dam siltation** - Resulting in poor Dam water quality and operational issues ▪ **Groundwater** - Reduce GW recharge - Water extraction and unsustainable GW drawdown
Mitigation	
▪ **Design** - Design for 10,000 year event earthquake and PMF events. - Adequate dam storage capacity for trapped sediment.	

- **Construction**
  - ESMP and Construction management plan addressing management of soil and water runoff, wastewater, solid and hazardous waste and materials handling.
  - Clear large stands of vegetation within the reservoir area and restricting agricultural activities for at least six months prior to inundation
  - Minimise GW extraction during construction
- **Operation**
  - Dam will be operated to ensure a 90% percentile compensation flow (Q90), which is the flow that is available 90% of the time.
  - Dam operational procedures to include management of environmental flow discharges to ensure poor quality dam water is not released.
  - Management of the Diamphwe river catchment will include establishing a catchment management committee with appropriate funding to improve and maintain the Dam water catchment. The Committee will comprise of members from relevant government agencies and community representatives.
  - Catchment management will include re-vegetation and erosion control works, rehabilitating degraded dambo wetland, as well as providing additional resources to monitor and protect the upper wooded forest that forms part of the Dzalanyama Forest Reserve.Implementation of catchment –wide water quality and flow monitoring system, including real time monitoring of key water quality parameters.

8.4. Climate Change

8.4.1. Introduction

The importance of Climate Change in shaping and determining how populations function into the future has been scientifically addressed in the United Nations Intergovernmental Panel on Climate Change (IPCC). The IPCC's Fifth Assessment Report (2014) has confirmed that as climate change progresses, the intensity, duration, frequency and geographical extent of extreme weather events will increase, and the risk of disasters will rise as a consequence. The impacts of these changes can lead to freshwater resources being degraded, coastal zones and settlements being increasingly put in danger, drought phenomena intensifying, fertile soils being denuded, forest fires occurring more frequently, epidemics spreading and biodiversity being reduced.

The effects of Climate Change are particularly evident throughout Africa, with predicted higher temperatures and changing rainfall patterns resulting in lower agricultural production, greater prevalence of diseases and pests, increased desertification, floods and erosion, deforestation and biodiversity changes. These stressors will result in widespread social dislocation, increased poverty and trans-boundary tensions. Significantly existing problems are exacerbated, above all in areas where people's everyday lives are already defined by the need to secure their livelihoods and by a lack of water, food, health care and education. African Nations are developing strategic responses to Climate Change, which include implementing strategies to reduce greenhouse gas emissions and measures to manage current and future impacts.

Studio Pietrangeli (2014) reviewed relevant data and assessed the impact of Climate Change on the proposed Dam under different climatic scenarios. Relevant data sources include:

- Previous studies regarding the regional hydrological trend in Malawi;
- Numerical calculation of the Global Circulation Model (GCM);
- The A2 and B1 EMISSION SCENARIOS of the Intergovernmental Panel on Climate Change (IPCC), whose projected temperature and precipitation data are derived from several global circulation models (GCMs);
- Eleven (11) Global Circulation Models (GCM); and

- The U.S. Geological Survey (Thornthwaite, C.W., 1948*, An approach toward a rational classification of climate: Geographical Review*) water balance model on monthly step, calibrated on the historical hydrological data, has been adopted to simulate runoff under varied monthly mean temperature and areal precipitation patterns.

A summary Studio Pietrangel's analysis is provided below.

8.4.2. **Regional Hydrological Studies**

A review of relevant studies showed that that most rainfall stations revealed statistically non-significant decreasing rainfall trends for annual, seasonal, monthly and the individual months from March to December at the 5% significance level. The months of January and February (the highest rainfall months), however, had overall positive but statistically non-significant trends countrywide, suggesting more concentration of the seasonal rainfall around these months.

8.4.3. **Global Circulation Model**

i. ***Hydrological Data***

Runoff and evapotranspiration data at the dam site have been described in Section 6.5 and summarised in Table 8.3. This data is considered to be representative of the actual climate in the Diamphwe catchment and was adopted as baseline conditions.

Table 8.3 Baseline Climate for the Diamphwe Catachment

Hydrological data (mm)	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	**Year**
Rainfall	248	205	151	45	5	1	1	1	2	11	63	194	927
Temperature (°C)	18.7	19.0	18.5	17.6	15.9	14.0	13.6	15.2	17.8	19.7	20.0	19.1	17.4
Evapotranspiration	61	59	67	67	65	57	57	60	64	70	65	62	756
Runoff	84	86	83	81	72	67	66	60	55	57	65	80	

ii. ***Water Balance Model***

The hydrological model selected in this study is based on the Thornthwaite monthly water balance model, which was developed by the U.S. Geological Survey. The conceptual model is widely used in projecting runoff under changed climate scenarios (Figure 8.6)

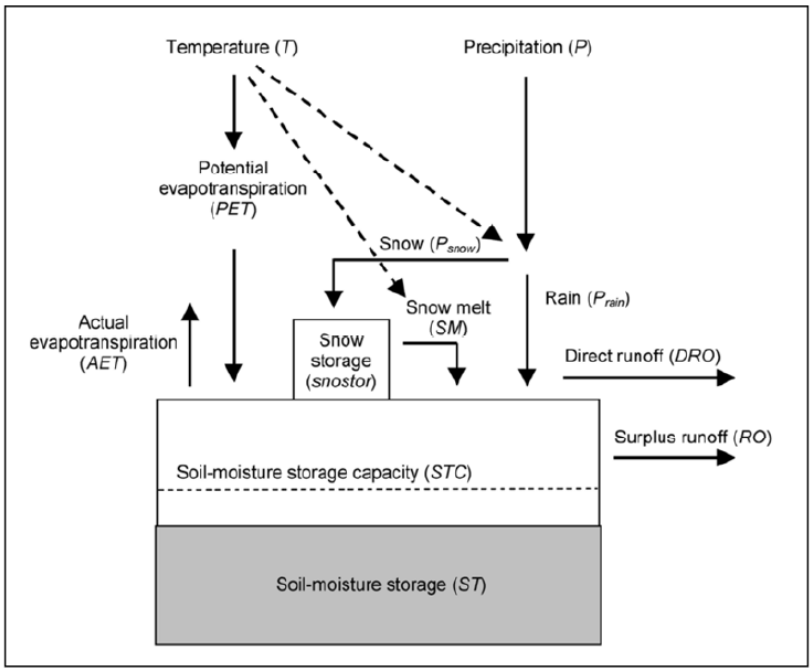


*Figure 8.6: Thornthwaite Water Balance Conceptual Model (**Studio Pietrangeli, 2014**)*

8.4.4. **Emission Scenarios**

The A2 and B1 EMISSION SCENARIOS (spanning 2010 to 2099) used by the Intergovernmental Panel on Climate Change (IPCC) was used for estimating hydrological changes in the Diamphwe watershed. Of note:

- The A2 scenario envisions a heterogeneous world with continuously increasing global population and regionally oriented economic growth that is more fragmented and slower than in other scenarios. Population grows to 15 billion by the year 2100. CO_2 concentrations would vary from 367 ppm in year 2000 to 857 ppm in year2100.
- The B1 scenario envisions a convergent world with global population that peaks in mid-century and declines thereafter, with rapid changes in economic structures toward a service and information economy, with reductions in materials intensity, and the introduction of clean and resource efficient technologies. Population grows to 7 billion by the year 2100. CO_2 concentrations would vary from 367 ppm in year 2000 to 538 ppm in year 2100.
- A2 and B1 scenarios of future climate are obtained by adjusting the baseline observations by the difference (or ratio) between period-averaged results from the GCM simulations. Change fields of the 30-year periods 2010-2039, 2040-2069, and 2070-2099 were considered in this analysis. Monthly outputs of all GCM simulations were collected from the Data Distribution Centre. Only those models that have the outputs for both scenarios A2 and B1 were adopted for this analysis. GCMs chosen are summarised in Figure 8.7.

Center	Center acronym	Model name
National Centre for Atmospheric Research	NCAR	CCSM3
Australia's Commonwealth Scientific and Industrial Research Organisation	CSIRO	Mk3.0
Max-Planck-Institut for Meteorology	MPI-M	ECHAM5
Geophysical Fluid Dynamics Laboratory	GFLD	CM2.0
		CM2.1
UK Met. Office	UKMO	HadCM3
Institute for Numerical Mathematics	INM	CM3.0
Institut Pierre Simon Laplace	IPLS	CM4
Meteorological Research Institute	MRI	CGCM2.3.2
Goddard Institute for Space Studies	GISS	E-R
National Institute for Environmental Studies	NIES	MIRO3.2 medres

*Figure 8.7: Global Circulation Models used in Analysis (GCMs) (**Studio Pietrangeli, 2014**)*

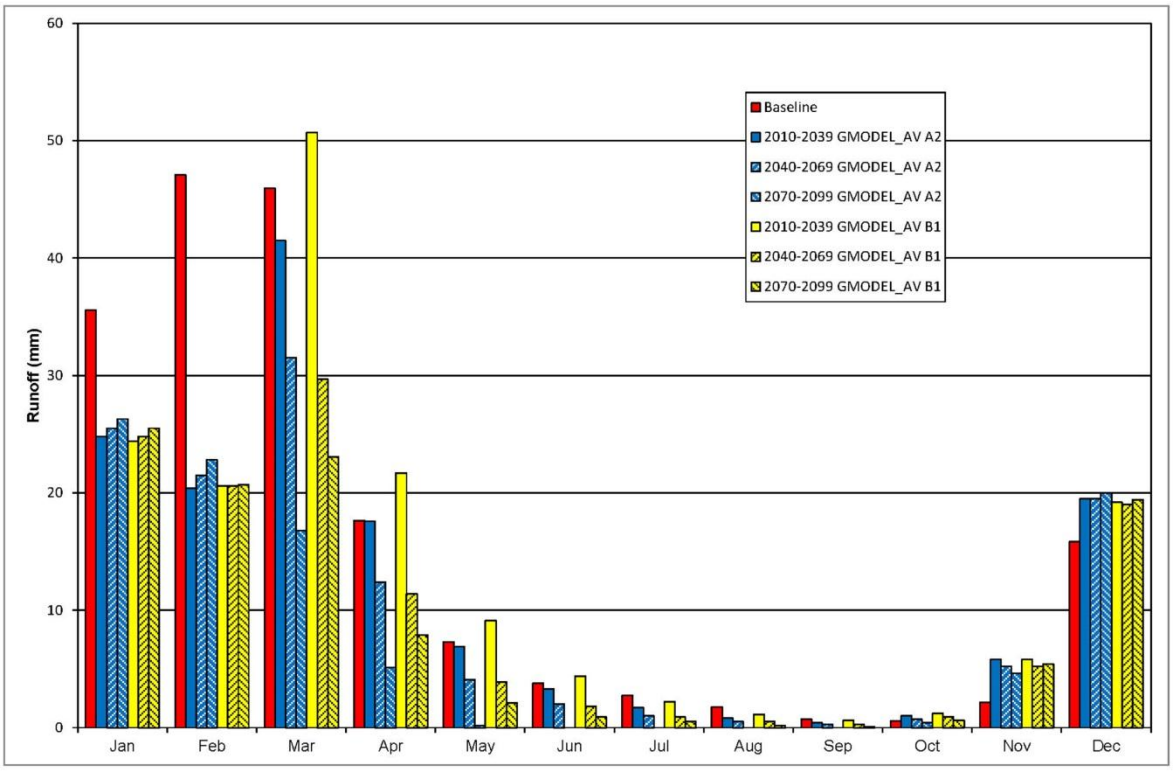
For each scenario the values of the temperature and precipitation anomalies were deduced for each analysed period by means of the selected models. As a representative value the anomalies were averaged among the 11 model results.

The average temperature and precipitation anomalies were used as input data for Thornthwaite's monthly water balance model to estimate runoff into the Diamphwe watershed.

8.4.5. **Study Conclusions**

The projected runoffs over the Diamphwe catchment due to Climate Change as predicted by the GCM models under A2 and B2 EMISSION SCENARIOS are presented in Figure 8.8. Key findings are:

- Analysis of the hydrological data from 1960 to 2006 shows consistent rainfall patterns with no negative trends.
- Over the next 25 years there could be a reduction in average rainfall of between 0.5% and 1.2%. However the worst case scenario of a 7°C temperature rise could result in a reduction in average runoff of between 10 and 20%.



Diamphwe Catchment Monthly Mean Runoff: A1 and A2 Scenarios

Month	Baseline	A2 SCENARIO			B1 SCENARIO		
		2010-2039	2040-2069	2070-2099	2010-2039	2040-2069	2070-2099
Jan	35,6	24,8	25,5	26,3	24,4	24,8	25,5
Feb	47,1	20,4	21,5	22,8	20,6	20,6	20,7
Mar	45,9	41,5	31,5	16,8	50,7	29,7	23,1
Apr	17,6	17,6	12,4	5,1	21,7	11,4	7,9
May	7,3	6,9	4,1	0,2	9,1	3,9	2,1
Jun	3,8	3,3	2,0	0,0	4,4	1,8	0,9
Jul	2,7	1,7	1,0	0,0	2,2	0,9	0,5
Aug	1,8	0,8	0,5	0,0	1,1	0,5	0,2
Sep	0,7	0,4	0,3	0,0	0,6	0,3	0,1
Oct	0,6	1,0	0,7	0,4	1,2	0,9	0,6
Nov	2,2	5,8	5,2	4,6	5,8	5,2	5,4
Dec	15,8	19,5	19,5	20,0	19,2	19,0	19,4
TOT	181	144	124	96	161	119	106
Δ (%)		-21	-31	-47	-11	-34	-41

Projected Runoff (mm) and annual runoff change (%)under A2 and B1 Scenario

*Figure 8.8: Diamphwe Catchment Runoff for A2 and B1 Climate Change Scenarios (**Studio Pietrangeli, 2014)***

Although Climate Change is now widely recognised as being critical to future infrastructure planning, there is uncertainty in predicting the extent of future changes, particularly at a local level. The Studio Pietrangeli study demonstrates that there will most likely be a reduction in rainfall in the Dianphwe catchment, however the predicted magnitude of this reduction ranges from a low 0.5% up to 20%.

Due to the current status of water shortages and threat to food security the proposed Dam will provide significant security of water supply, which would otherwise become more critical if the Project did not proceed. Further, the proposed Dam will better regulate downstream flows during

below average flows, which will become more important as average flows decline due to Climate Change. The Project will therefore have an overall positive impact by providing an adaptive mechanism to protect against reduced rainfall and river flow.

An important aspect of Climate Change is to respond to changes that may affect Dam operations, particularly with regard to envrionemntal flows. A monitoring and assessment program is needed to confirm that the proposed flow requirements can satisfactory maintain downstream health.
Summary of impacts and mitigation: Climate Chage

Table 8.4 Climate Change Impacts and Mitigation

Positive Impacts	Negative impacts
▪ Dam will provide security of water supply and contribute to river health as natural flows decline.	▪ Concentrate rainfall over a shorter period resulting in changes to flow regimes. This can lead to Dam operational issues. ▪ Increase temperatures resulting in increased prevalence of pest species such as Red fern and disease vector mosquitoes. ▪ Changes to environmental flow requirements due to reduced water enterin ghte dam or a long term reduction in average flows.
Mitigation	
▪ The Project will mitigate declining river flows and increase security of supply to Lilongwe and surroiunding communities. ▪ Operational management to manage pest species. ▪ A monitoring and assessment program is needed to confirm that the proposed environmental flow requirements can satisfactory maintain downstream health.	

8.5. Landuse

8.5.1. Reservoir and infrastructure area

Over a period of approximately three years PAP and community facilities (such as graveyards) will be relocated from the Project area, structures removed or made safe, and large trees removed. The Development of the reservoir and infrastructure area will result in disturbance of approximately 2,644 ha, which includes sterilising from further use an estimated 2,342 ha of land. A 15 m wide buffer covering approximately 156 ha will be established around the reservoir perimeter and vegetated with woodland trees and scrubs. Landscape buffers totalling approximately 124 ha will be established around key infrastructure components, while the remaining of the disturbed area will be rehabilitated to pre-construction landuse.

The extent of direct Project impacts on landuse categories is shown in *Table 8.5*.

Table 8.5 Reservoir and Infrastructure Area Landuse Loss

Landuse category	Project affected area				Total catchment	
	ha			%	ha	% Project affected landuse
	R	***IA***	**Total**			
Cropland	1,562	160	1,586	60	73,021	2
Cultivated dambo	496	1	633	24	20,374	3
Dambo Grassland with patches of cultivated land (includes 15 ha of riverine vegetation)	378		378	14	9,886	4

Landuse category	Project affected area				Total catchment	
	ha			%	ha	% Project affected landuse
Forest woodland	10	1	11	0.5	33,303	<0.1
Settlement	37		37	1.5		<0.1
Total	**2,983**	**162**	**2,645**		**136,584**	
Area planted as forest woodland buffer (reservoir)			156			
Area rehabilitated as landscaped buffer (infrastructure)			124			
Area rehabilitated to previous landuse			22			
Total rehabilitation			**302**			
Net Land loss			**2342**			

Approximately 97 % of the reservoir and infrastructure area is currently used for agricultural use. Potential impacts resulting from the Proposed Dam and associated infrastructure are discussed below:

i. ***Cropland loss (1,562 ha)***

Cropland represents the majority of landuse in the Project affected area, however its use is generally restricted to one crop during the wet growing season of between 120 to 150 days.

On a catchment wide basis the loss of cropland (1,586 ha) will be approximately 2 % of the total cropland available, which is not expected to significantly affect overall catchment characteristics.

Overall agricultural productivity in Malawi is estimated to support 4.4 people per hectare per year (World Bank, 2013), so loss of the Project affected cropland would be equivalent to reducing available food security for 6,978 people during the growing season, that is for about one third of the year. This is equivalent to reducing food security, on an annual basis, for 2326 people. However, taking into account realistic landuse suitability (see S6.4.4), yields may be 40 to 60% lower, which would reduce this estimate to around 1,500.

The proposed Dam will provide irrigation water to approximately 1,000 ha of existing downstream cropping land. This will allow for year-round cropping and increase current productivity by about 60%, which is equivalent to supporting approximately 2,650 people.

ii. ***Cultivated dambo loss (496 ha)***

Cultivated dambo is used intensively year round and provides the most valuable contribution to food production. As noted in Chapter 6 (S6.7.2), dambo plays an important role in regulating water availability throughout the catchment and contributing to river base flows during the dry season.

On a catchment wide basis the loss of cultivated dambo (633 ha) will be approximately 3 % of total cultivated dambo available, which is not expected to significantly affect overall catchment characteristics. However, due to catchment threats such as deforestation and catchment degradation, the contribution to cumulative loss of dambo will have a much larger long term impact on the hydrological regime of the catchment.

Applying a similar productivity estimate of 4 people per hectare per year (World Bank, 2013) the loss of the Project affected cultivated dambo would be equivalent to reducing available food security for 2,785 people over a one-year period.

As noted above compensatory irrigation will partly offset loss of productivity, however combined with cropland loss (see above) the Proposal will result in a net production loss equivalent to supporting approximately 1,350 people.

iii. ***Dambo grassland loss (378 ha)***

Dambo grassland is mainly used for stock grazing during the dry season with small patches used for cultivation. During the wet season these areas are mostly water-logged and used for fishing. This dambo also includes natural riparian grasses and reeds, which are found along the river banks.

On a catchment wide basis the loss of dambo grassland (378 ha) will be approximately 4 % of total dambo grassland available, which is not expected to significantly affect overall catchment characteristics. However, as noted above, the cumulative impacts of dambo loss is likely to negatively affect natural hydrological characteristics of the catchment.

Only about 2 % of the PAP own stock (SMEC census), so stock grazing is not a significant agricultural activity. Local villages indicated that fishing is also not a significant activity during the wet season due to access and safety issues (See Chapter 6, S6.11.3). The loss of riparian natural grassland (approximately 45 ha) will impact on native plant animal species, however this is expected to be localised with minimal adverse impact (See S8.4).

Mitigation includes proving water for a pilot fish farm (2 ha), and up to 50 community fish farms (approximately 500 m2 each). The proposed Dam will also provide significant fisheries opportunities and there will be an overall net benefit as a result of the Project. Mitigation also includes establishing riparian natural grassland around the Dam shoreline. There is potential to establish approximately 50 ha of riparian grassland, which would adequately replace the estimated loss.

Following mitigation the loss of dambo grassland will have minimal potential impact on people's livelihoods or biodiversity.

iv. ***Forest Woodland loss (10 ha)***

Forest woodland represents just 0.5 % of landuses in the Project area, and is found as isolated graveyards and small wood lots. Almost all of the forest woodland found in the Diamphwe River catchment is located in the Dzalanyama Forest Reserve. Loss of forest woodland (10 ha) within the Project area will have minimal impact on the status of forest woodland within the broader catchment. However forest woodland within the Project area serves as important animal habitat and from this perspective is locally important (See S8.4).

Mitigation includes relocating woodland graveyards and establishing a minimum 15 m wide buffer zone around the Dam perimeter, extending from the full supply level of the reservoir, which is above the 100 year flood contour level (See MoAIWD buffer zone requirement, Appendix 7). This will result in a net increase in forest woodland of approximately 156 ha, which will result in positive biodiversity benefits. During detailed design of the Dam the possibly of extending the buffer further will be investigated. Some parts of the buffer zone may be extended further than 15 metres, subject to the availability of land and potential impacts on surrounding communities.

Establishment of the buffer zone will require careful planning and sufficient resources to successfully vegetate and manage. The buffer wil be supervised by the PIU, with oversight from a Catchment Management committee, and specialist advice and assistance from the Department of Forestry. Types of activites allowed within the buffer zone will also be established by the Catchment management committee. More details are provided in the ESMP (Chapter 12, Biodiversity Plan).

v. ***Settlement loss (37 ha)***

The census undertaken as part of this ESIA identified 733 homesteads within the proposed reservoir The main potential impact of the proposal will be loss of homes and disruption of the affected population, which is comprehensively addressed in the Resettlement Action Plan (RAP). The loss of structures and relocation of people will have no impact on catchment landuse.

8.5.2. **Service pipeline to Bunda Turnoff**

The dual water pipeline to Bunda Turnoff will be aligned within a 20 metre wide easement from the road centre-line, and extending mostly along the western side of the M1 road. Most of this easement will be impacted due to trench excavation, materials handling and associated plant and equipment activities.

Over a period of approximately three years it is estimated that up to 60 ha of land will be temporarily disturbed during construction and then rehabilitated. Most of this land (54 ha) is vacant land with occasional trees. At any one time the active construction area will be restricted to a length of approximately 500 metres, during which time pedestrian access will be restricted. Following pipe laying and backfilling the affected area will be rehabilitated and pedestrian access restored. Alternative pedestrian thoroughfare will be provided as construction progresses. Potential impacts will therefore be temporary and will not significantly affect people's livelihoods or health.

Pipeline construction will result in the removal of approximately 1.2 ha of agricultural land and 1.3 ha of wooded vegetation. Affected people will be suitably compensated as described in the RAP. Up to 3.5 ha of built up areas that include commercial activities and various buildings will also be affected. Affected persons will be suitably compensated as described in the RAP and any impacts can be appropriately mitigated and managed.

8.5.3. **Downstream impacts**

The proposed dam will be operated to ensure a 90% percentile compensation flow (Q90), which is the flow that is available 90% of the time (See S8.3.1) During dam operation various downstream landuses along approximately a three kilometre stretch of river to the confluence with the Linthipie River may be impacted due to flows being more regulated during the wet season, resulting in reduced inundation of areas previously prone to unregulated flood flows. Conversely water is likely to become more available during the dry season, in particular during below average flow conditions. Any impacts will be significantly reduced downstream of the Diamphwe / Linthipe confluence as catchment runoff contribution increases and flows become more normalised.

As noted in S6.7.4 (Table 6.10) the potentially affected cropland and cultivated dambo within about 50 metres either side of the river accounts for approximately 81 ha. Any change to moisture regimes due to dam operation can be adequately made up with irrigation water, thereby effectively minimising potential impacts. Riverine vegetation comprising of dambo grassland covers approximately 11 ha of the study area, while forest / natural vegetation incorporates approximately 1 ha. These landuses provide important habitat to a variety of animal species and potential impacts are discussed in Section 8.4.1 below.

8.5.4. **Cumulative impacts**

As noted in Chapter 4 (S 4.7.2) the Diamphwe River catchment has undergone significant anthropogenic change related mainly to land clearing and intensive agricultural activities. Ongoing threats remain due to illegal land clearing and poor catchment management. Consequently there has been a significant decline in natural resources and biodiversity, particularly with regard to forest woodland and dambo wetlands.

The project will result in additional loss of forest wetland and dambo. While forest woodland and some riparian grassland dambo will be replaced, there will be a net loss of dambo from the catchment, equivalent to approximately 1000 ha or about 3 % of dambo remaining in the catchment. Consequently the cumulative effects of Project induced loss of dambo combined with threats to catchment wide dambo is of significant concern.

8.5.5. **Summary of Landuse Impacts and Mitigation**

The project will significantly impact on landuse, with an estimated 2,342 ha of land to be permanently sterilised from further use. This includes agricultural land that currently supports an estimated 26,149 people. There will therefore be potential for widespread disruption and significant diminution of livelihoods. In addition there will be some loss of natural habitat and ecological resources due to the removal of forest woodland (mostly graveyards) and riparian dambo grassland (riverine habitat).

Table 8.6 Landuse Imapcts and Mitigation

Positive Impacts	Negative Impacts
▪ **Forest Woodland**: will increase from 10 to 156 ha. ▪ **Irrigation**: The Project will provide water for irrigating up to 1,000 ha of cropland downstream of the dam. This will allow existing downstream cropland to be used throughout the year, which will effectively increase current production by approximately 75%. ▪ **Fish farms**: Up to 20 community fish farms ▪ **Dam fisheries**: Improved fishing opportunities in the Dam.	▪ **Impacted Area:** - Project affected land (2,682 ha) - Permanent affected land (2,342 ha) - Buffer & Temporary affected land (340 ha) ▪ **Losses:** - Agricultural cropland & cultivated dambo (2,219 ha); reduction in food security - Dambo Grassland (378 ha) - Forest woodland (10 ha) - Settlements (37 ha)

Mitigation

- **Compensatory landuse:** A 15 m wide buffer zone covering approximately 156 ha will be established around the reservoir perimeter and vegetated with woodland trees and scrubs. In addition approximately 10 ha of forest woodland will be established on relocated graveyard sites.
  - Rehabilitation specialist with appropriate qualifications will be employed to oversee the planning and implementation of a buffer rehabilitation plan. The Plan will carefully consider species selection to ensure the optimum mix of endemic species and densities.
  - Consultation with Lilongwe District Forestry Office and Dedza Forestry Office.
  - Seeds will be harvested from existing vegetation for later propagation and planting in the rehabilitation areas.
  - Community plant nurseries will be established to propagate suitable plants. Nurseries will be established immediately following Project approval.
  - The reservoir buffer area will initially be surveyed and clearly delineated with appropriate fencing. Establishment of the buffer area will begin as early as possible.
  - Stripped topsoil from the dam inundation area will be initially stockpiled and then reused on areas to be rehabilitated.
  - A staged planting program will be prepared with the aim of completing plantings within a five year period.
  - Vegetation cleared from the proposed inundation area will be used to mulch areas to be planted with forest woodland species.
  - A monitoring and maintenance plan will be prepared and implemented.
- **Infrastructure and pipeline Area rehabilitation**: Approximately 146 ha of project disturbed land will be rehabilitated as cropland or landscape buffer areas.
  - Rehabilitation will be staged as soon as possible following construction activities.
  - Wherever possible landscape areas will incorporate fruit trees and other plants than can be used by the local community.
  - Stripped topsoil will be initially stockpiled and then reused on areas to be rehabilitated.

- A monitoring and maintenance plan will be prepared and implemented.

- **Provide compensatory irrigation (1,000 ha)**
  - Based on previous feasibility studies (Sogreah, 2010) identify and delineate irrigation area.
  - Prepare irrigation system design and construction program, as well as relevant planning documents.
  - Obtain planning approval and tender construction.
  - Construct and commission irrigation system.
  - Manage and monitor irrigation system.
- **Fish Farms:** The Project will provide water for a pilot fish farm (2 ha), and up to 50 community fish farms (approximately 500 m^2 each). Further, current fish stocks will markedly increase in the Dam, which will also be available to fishers. These initiatives will likely result in a greatly expanded fisheries resource compared to the current situation.

8.6. Biodiversity Impacts

8.6.1. **Terrestrial habitat**

i. ***Habitat removal***

As presented in S8.4 the Project will directly affect 2,644 ha of land. Of this 2,342 ha will be permanently sterilised from future use, while 302 ha will be rehabilitated. Approximately 98% of the affected area is used for agriculture and settlements, with the remaining 2 % (approximately 55 ha) consisting of natural riverine and woodland vegetation. Baseline studies identified riverine vegetation and forest woodland as the most important ecosystems, which are also used as important ecological resources by local populations. These habitats and potential impacts are discussed below:

- Riverine vegetation is found along the river banks and is the most diverse habitat in the Project area, with 62% of the recorded species. This habitat was found to contain 13 of the 17 species recorded with conservation value. Riverine vegetation has an important ecological function in maintaining healthy water quality and aquatic diversity, as well as habitat to a wide range of animals. Important ecological resources used by local people include building materials, food and medicines.

- Riverine vegetation is typically confined to a few metres either side of the river and it is estimated that approximately 45 ha will be lost as a result of the Project. This habitat is found along much of the length of the Diamphwe River and further downstream on the Linthipe River.

- Forest woodland is mostly found as isolated stands in graveyards. This habitat contains 31% of the recorded species and the highest number of large and indigenous tree species, typically with more than 90% canopy cover. This habitat recorded low numbers of species with conservation significance. Forest woodland is an important animal habitat and provides refuge to larger animals such as jackal, spotted hyena and common duiker, as well as being a source of food, wood and medicines to local people.

- Approximately 10 ha of forest woodland will be affected by the Project. Almost all of the forest woodland in the Diamphwe River catchment is found in the Dzalanyama Forest Reserve and loss of this habitat as a result of the Project will have minimal impact on the status of forest woodland within the broader catchment.

- Other: Cultivated areas were found to be the most degraded habitats recording very low numbers and species (15 %) of trees.

The removal of riverine and forest woodland habitat will reduce important vegetation by approximately 55 ha. A further 2,589 ha of mostly cultivated cropland and dambo land with low habitat value will also be affected by the project, most of which will be inundated by the proposed reservoir.

There are no plant species that are critically endangered and all species of conservation significance are represented elsewhere in the Lilongwe – Dedza region. However four species are protected under the National parks and Wildlife Act 1992 / Forestry Act and will require approval for their removal (Bleedwood teak (Pterocarpus angolensis), African mahogany (Khaya anthotheca), Coast Gold leaf (Bridelia micratha) and Yellow Wood (Terminaria sericea).

The Project includes establishing a 15 m wide buffer around the reservoir, which will be vegetated with predominantly forest woodland species covering an area of approximately 156 ha. It is anticipated that the buffer will be firmly established within 5 to 10 years of planting. Forest woodland will also be established on relocated graveyards. There will therefore be a net increase of approximately 156 ha of forest woodland habitat. A similar buffer has been successfully established around Kamuzu dams as shown on Photograph 8.4.

The District Forestry has been extensively involved in rehabilitation projects and has the capability to mobilise local communities through Forestry Assistants and Extension workers. Recent work included:

- Lilongwe District Forestry Office worked with the Lilongwe Water Board during rehabilitation of the Kamuzu Dam riverine vegetation and planting of indigenous trees along the buffer zone.
- Dedza Forestry Office is working with communities in TA Chilikumwendo in rehabilitation of riverine vegetation through planting of trees along Diamphwe River.

Trials will be undertaken to determine the optimum conditions for establishing riverine vegetation around the edge of the proposed reservoir. A more expansive planting program will then be developed and implemented.

Photograph 8.4: Forest Woodland Buffer - Kamuzu Dam (approximately 10 years old).

ii. ***Downstream impact***

Riverine vegetation downstream of the proposed dam may potentially be impacted by changes to natural flow regimes. In particular riverine vegetation is adapted to flood flows and may decline due to more regulated flows during the wet season. This in turn may alter riverine species composition and richness with the most affected being hydrophytic species, as well as fragmenting vegetation connectivity and dispersal characteristics. Dry weather base flows regulated by catchment dambo

wetlands may also be altered to the extent that riverine vegetation may be adversely affected by reduced water availability.

The proposed dam will be operated to ensure a 90% percentile compensation flow (Q90), which is the flow that is available 90% of the time (See section 8.3). Although the quantum of water may not significantly change, approximately 2.0 ha of downstream riverine vegetation may potentially suffer some change as a result of more regulated flows and reduced flood events. However any impacts are likely to be contained within the 3 km stretch of Diamphwe River between the dam wall and its confluence with the Linthipe River. Further downstream it is anticipated that potential impact will be substantially reduced as river flows increase due to an expanding catchment. For example immediately downstream of the Diamphwe / Linthipe confluence the percentile of normal flows would increase to approximately 94%, which would further increase to approximately 97% at Mapala, approximately 30 km further downstream.

During below average flows it is expected that the Project will benefit downstream riverine vegetation by ensuring a minimum 90% of normal flows, which will have a positive impact during below average rainfall. This will have the greatest benefit during zero flow conditions, which could become more frequent as a result of changing climatic conditions (see S8.5.3).

iii. ***Invasive species***

The invasive pest species red water fern (*Azolla filiculoides*) was recorded during baseline investigations at Kaphwereza Village, which is located at approximately the midsection of the proposed reservoir. This species proliferates in stagnant water and could potentially thrive in the proposed reservoir and be released to downstream areas. Where infestations persist, floating mats of the water fern can form a complete cover on the water surface and obstruct sunlight from entering habitats. The water fern is capable of doubling its biomass in a very short space of time and can out-compete native plants as a result. Thick mats form barriers to normal access and infestations can have negative implications for all aspects of water utilization. Physical control is difficult as the fern reproduces by fragmentation and are capable of regrowth into cleared areas within days.

Mitigation will include implementing a program to monitor and manage invasive vegetation species as follows:

- The best form of invasive management is prevention. If prevention is no longer possible, it is best to treat the weed infestations when they are small to prevent them from establishing (early detection and rapid response). Consistent follow-up work is required for sustainable management.
- People from the local community should be employed on a part time basis to patrol the dam and upstream areas and any detection of the weed immediately reported to the Dam environmental representative. Local community can also be employed to clear investations. Collecetd weed should be appropriately disposed of by burial or incineration.
- All boats and equipment used on the dam should be regularly inspected and cleared of fern fragments.
- Education of the local community about how risk of contaminating the dam can be reduced.
- In the event of extreme investations a herbicide (glyphosate) can be used, which is very effective, however a thorough risk assessment would need to be undertaken before any herbicides are used.

8.6.2. **Terrestrial Wildlife**

Mammals were mostly found or known to occur in graveyards and riverine vegetation areas, followed by dambo grassland. Only two species of mammals were recorded in cultivated areas. Birds are predominantly found in riverine vegetation followed by forest woodland in graveyards. Similarly reptiles are mainly found in riverine vegetation along the river bank. As noted above the proposal will remove approximately 15 ha of riverine vegetation and 10 ha of forest woodland.

iv. ***Mammals***

Of the 21 mammal species identified in the Project area, some 17 species are small mammals that are commonly found throughout the wider catchment. These species do not travel long distances and none are rare or of conservation significance. It is anticipated that small mammals will easily move to adjoining woodland graveyard and riverine vegetation areas due to the gradual rising of dam water levels. In the longer term the establishment of the riparian buffer will likely result in an increase in small mammal numbers.

Mammal species of conservation significance are the larger common duiker, jackal, spotted hyena and the clawless otter.

- Common duiker (*Sylvicapra grimmia*)

The common duiker is a solitary animal with a home range of up to 15 ha. According to local villagers, duiker are most active at night and travel up to 7 km/d between riverine vegetation and the forest woodlands in graveyards or nearby forest plantations. Riverine vegetation therefore serves as an important transient corridor between daytime woodland refuge areas. The loss of woodland habitat as a result of inundation will not significantly impact on the duiker as there are alternative woodland graveyards adjoining the project area. There may be some disruption to home ranges and in the short term affected animals may be adversely impacted until new transit routes are established between woodland sites. However the numbers of affected animals are expected to be relatively small, with just nine ha of forest woodland being affected by the Project.

- Jackal (*Canis mesomelas*) and Spotted Hyena (*Crocuta crocuta*)

These animals are similarly active at night but have a much larger home range of up to 25 km^2. They typically feed on small mammals, reptiles and small livestock, and take refuge in woodland forest during the day time. Jackals are also commonly seen scavenging around villages. It is not expected that these animals will be significantly affected by the proposal as the affected area forms only a relatively small part of their home range and they are less reliant on using riverine vegetation as a transit corridor.

- Clawless otter (*Aonyx capensis)*

The clawless otter is of conservation significance nationally and internationally. According to Laliviere (2001), the clawless otter makes extensive use of reed beds (*Phragmites* and *Typha*) and prefers shallow water. Optimal habitats are areas with good bankside vegetation cover with sandy soils for digging dens up to 15m deep. In addition, otters require flowing water during the dry season or warmest period of the year. Otter density in freshwater rivers may reach 1 otter per 3-4 km of stream and home range for an otter pair (1 male and 1 female) is typically between 14 and 19 km (Lariviere 2001).

Threats to otters include reduction of riverine vegetation and erosion of riverbanks. Phragmites is common in Diamphwe riverine vegetation and its loss due to dam inundation will directly impact on otters due to loss of habitat and reduction of the riverine transit corridor, resulting in fragmentation of home ranges. Potential impacts may also occur downstream of the dam due to more regulated flows.

Various studies (Laliviere 2001 and Pedrosso et. al. 2007) conclude that dams are generally beneficial to otters due to increased water availability and available food such as fish, frogs and crabs. However it is important that suitable available habitat is available around the dam perimeter and associated tributaries. This is consistent with study findings, whereby villagers reported that otters are common and easily seen during the rainy season when there are large amounts of water but rarely seen in the dry season when the river is characterised by a series of deep pools.

In the short term it is anticipated that less than 15 otters within the study area will be adversely affected due to home range fragmentation and destruction of habitat. In the longer term the dam perimeter will be rehabilitated with riverine vegetation, which will be mostly protected from human interference by the 15 m buffer zone. Consequently numbers of otters are likely to increase due to increased riverine habitat and food availability. Operation of the dam will ensure a 90% percentile compensation flow (Q90), which will likely provide more security of downstream dry weather flows than is currently the case, when flows may cease during below average flow conditions.

v. *Avifauna*

The Dzalanyama Forest Reserve is located in the upper Diamphwe River catchment approximately 35 kilometres from the Project area. The Reserve is designated as an important bird area (MW011) with more than 296 identified bird species, including 28 biome restricted species with high conservation significance. A total of 57 avifauna species, belonging to 28 families, were identified in the Project area, with the dominant families comprising of *Estrildidae* (finches, blue waxbill and manikin), *Ploceidae* (weavers, bishops and quelea), *Columbidae* (doves), *Alcedinidae* (kingfisher) and Malaconotidae (Bush Shrike). No biome restricted species were identified, however two species have international significance (Little Sparrow Hawk and Peregrine Falcon), while four species are protected under the National Parks and Wildlife Act, 2004 (Broadbilled Roller, Red Winged Francolin, Guinea fowls and Owls).

Approximately 44 % of species inhabit riverine vegetation, 26 % in cultivated land and 21% in woodland areas. Of these habitats riverine and woodland areas provide relatively high density and important nesting sites. Consequently potential impacts will occur across the Project footprint, however most affected will be ground dwelling (such as guinea fowls, red francolin and quails) and less mobile birds (Owls) inhabiting riverine and woodland habitats.

It is anticipated that most bird species will progressively relocate to adjoining habitats during construction activities and dam inundation.. A permit will be required to interfere with species listed under the National Parks and Wildlife Act of 2004.

Establishment of the dam, woodland buffer and riverine habitat along the dam perimeter will provide compensatory habitat as well as attracting additional species, including from the nearby Dzalanyama Forest Reserve. Other specific mitigation measures will monitoring, and longer term habitat development. This will include working with local communities to modify hunting activities and assist in monitoring and rehabilitation initiatives.

It is generally concluded that following implementation of proposed mitigation measures there will be initial disruption to some ground and less mobile birds, however following establishment of compensatory habitat and dam inundation there is likely to be a significant increase in avifauna diversity and abundance.

vi. *Reptiles and Amphibians*

Eight families and 13 reptilian species have been identified in the project area, which include crocodile, lizards, snakes, skinks and frogs. Most species recorded during the survey were found in and around deep pools (crocodiles and frogs) and adjoining riverine habitat (reptiles, lizards and skinks).

Construction, water inundation and dam operations will result in displacement of large numbers of reptiles and amphibians. Crocodiles, snakes, lizards and skinks are relatively mobile and it is anticipated that many of these animals will gradually relocate to adjoining riverine habitat up and downstream of the dam. However some species, including most frog species, will be unable to successfully relocate and their numbers may be significantly impacted by the Proposal.

Species of conservation significance include the Nile crocodile, Nile Monitor Lizard and two snakes: Python and Mamba. Of note is that the number of amphibian species recorded during the survey may not be a true representative of amphibians in the project area since amphibians are best studied during the rainy season when they come out to breed and their habitats are created, e.g. temporary pools and wetlands. Eleven species of amphibian species that occur in Malawi are currently listed on the IUCN Red Data List, however none were observed during the survey are listed. Further surveys will therefore be required to determine amphibian diversity and presence of any species of conservation significance.

- Nile Crocodile (Crocodylus niloticus)

The crocodile is protected under the National Parks and Wildlife and is listed under CITES II for Malawi. According to Kalowekamo (2005) the Nile crocodile reaches maturity at the age of about 12 to 15 years, weighs up to 100 kgs and has a length of between 2 and 3m. Courtship and mating takes place in the water between July and August, and females dig nests and lay their eggs at the beginning of the wet season in November. Life-long nests are typically located in sunny sandy banks above flood water level with good cover.

Villagers reported that crocodiles are common and inhabit deep pools with adjoining rocks or reeds on the river bank and sandy soils. Nests are located up to 50 metres from the water. Nile Crocodiles are not known to be territorial and have no particular home range. They are fairly mobile during the wet season and can travel up to 36km in a day. Crocodiles are a threat to stock and humans and are not used as an ecological resource. Consequently they are regarded as pests and nests and eggs are opportunistically destroyed.

The proposal will destroy crocodile habitat and fragment unimpeded movement along the affected part of the Diamphwe River. However crocodiles are common throughout the wider Linthipe River catchment and long term impacts on crocodile distribution and abundance will not be significant. It is expected that the crocodile population will increase as a result of the dam impoundment and greater availability of permanent deep water.

Although the crocodile population is expected to remain healthy and increase as a result of the proposal, there will likely be increased interactions and conflict with villagers residing near the dam. Potential for conflict will be minimised through catchment management initiatives including establishment of the 15 m exclusion zone and operational procedures, such as trapping and relocation.

- Monitor Lizard (Varanus niloticus)

The Monitor Lizard is protected under the National Parks and Wildlife and is listed under CITES II for Malawi. Monitor lizards can grow up to 1.8 m and weigh around 10 kg. These animals are excellent climbers and quick runners on land, and feed on fish, snails, frogs, crocodile eggs and young, snakes, birds, small mammals, insects and carrion. They have a home range and typically travel up to two kilometres during the night. Monitor lizards are usually found near water and riverine vegetation is a preferred habitat, however they often forage in wooded and cleared areas. They live in shallow sandy burrows, breed annually from June to November and lay eggs at the end of the rainy season. Villagers reported that monitor lizards scavenge around populated areas and are regarded as pests.

The proposal will destroy monitor lizard habitat, however these animals are mobile and adaptable, and Project impacts will not be significant. Monitor lizards are also well represented

throughout the region. It is expected that the monitor lizard population will increase as a result of the dam impoundment and related increase in riparian habitat and food supply. This will potentially increase human interaction and conflict, which will need to be carefully managed (see crocodile discussion above).

- Python (*Python sebae*), Mamba (*Dendroaspis sp*.)

Both the Python and Mamba are protected under the National Parks and Wildlife. Both these species inhabit a variety of habitats including riverine, woodland and rocky ground, although the Python is usually associated with areas of permanent water. They feed on a variety of small mammals, and occasionally larger prey such as small goats and monitor lizards.

Both species are mobile and readily adaptable to changing conditions, although the Python is less agile. Some relocation of animals may be required around construction areas, however in the medium to long term it is expected that both these snakes will migrate to nearby habitats and will increase in abundance as the buffer and riparian rehabilitation becomes established.

It is generally concluded that most reptiles will migrate to adjoining habitats without significant disruption. However less mobile frog species and possibly some reptiles, such as the Python, are likely to be adversely impacted and trapping and relocation will be required. Following establishment of compensatory habitat and dam inundation there is likely to be a significant increase in reptile and amphibian diversity and abundance.

8.6.3. **Fish and fisheries**

Ten fish species were identified in the study area, of which eight are classified under the IUCN as least concern and two are yet to be evaluated. All the fish species recorded are widely distributed across Malawi and Africa and most are hardy and tolerant of a wide range of ecological conditions. These species utilise a wide range of habitats including flowing water and rocky substrata, fast flowing streams, low flow with vegetation, densely vegetated shallow water, sediment free water, marsh conditions and muddy waters.

Important survey findings are:

- Fish diversity along the Diamphwe River was found to be relatively low. Two species made up approximately 94% of the fish sampled, *Astatotilapia calliptera (*Kambuzi, 69 % of catch) and *Barbus palludinosus* (Matemba, 25% of catch). One species (*Anguilla nebulosa labiate* – Nkhunga) was not recorded during the survey and was reported by villagers as being rare and no longer a significant part of fish catches.
- A natural five metre high waterfall is situated approximately 53 km downstream of the proposed dam near the confluence of the Linthipe and Lilongwe Rivers. This fall is reportedly vertically steep, making it very unlikely that fish can migrate upstream of this point. Consequently the large number of fish species inhabiting Lake Malawi, including the threatened Mpasa or Lake Salmon (Opsaridium microlepis), are unlikely to migrate upstream into the Diamphwe River.
- Up to 1800 fishers exploit this section of the Diamphye River, however it was reported that fish catches have significantly declined over the past few years. Fishing is mostly done during the dry season, as access is difficult during the wet season.

i. ***Potential impacts***

The Project will effectively dam an approximately 30 km stretch of the Diamphwe river, resulting in significant changes to habitat diversity, more regulated downstream flows and a barrier to fish migration. Resulting habitats will be less diverse, and will broadly be defined by deeper water, lower flows and dam induced temperature and water quality changes. Specific impacts and mitigation measures are discussed below:

- *Impedance to Fish migration*

  The proposed dam will interfere with upstream fish migration and negatively affect those species whose life cycles depend on longitudinal spawning movements along the river. Species associated with upstream migration for spawning are *Labeo cylindricus* (Ningwe), *Labeobarbus johnstonii* (Mphondo), *Barbus trimaculatus* and *Petrocephalus catostoma* (Mphuta). None of these species are listed as threatened and migratory fish do not include the two most abundant species of fish (*Astatotilapia calliptera* - Kambuzi and *Barbus palludinosus* - Matemba). Migratory fish populations will therefore be fragmented by the proposed dam, however since the dam will be located in the upper catchment it is expected that these populations will still be able to complete their migratory lifecycles in sections of river up and downstream of the dam.

- *Changes in river flows*

As previously noted in S8.3.3, the proposed dam will be operated to ensure a 90% percentile compensation flow (Q90) and it is anticipated that the three kilometre stretch of river to the Linthipe River confluence will experience more regulated and reduced flood flows. Further downstream the catchment runoff contribution increases and flows will become more normalised. Potential impacts on the aquatic environment include reduced prevalence of inundated areas and diminished sediment transport, which may affect habitat conditions for some downstream fish species. In particular, *Clarias gariepinus (*Mlamba) migrates laterally towards flooded plains to breed, where the juveniles remain until big enough to return to the adult population in the main river. It is likely that these species will still be able to complete their migratory lifecycles further downstream where flows will be more normalised.

- *Changes in water quality*

The proposed Dam will create a relatively wide and deep (up to 30 m) impoundment, which will significantly change thermal and chemical characteristics of this section of the Diamphwe River. Environmental flow releases may result in low oxygen anoxic water (deep release) or oxygen / nitrogen saturated water (surface release) to flow downstream, which may adversely affect downstream species. Downstream water quality may also be affected during construction as a result of high sediment loads and chemical / material spills such as cement, fuel, oil and poorly managed waste. For example *Amphilius uranoscopus* (Nkholokolo) and *Labeo cylindricus* (Ningwe) favour clear running waters and are sensitive to changes in temperature and water quality. However, *Tilapia rendalli* (Chambo) is more resilient and can tolerate a wide range of water quality conditions.

- *Changes in habitat*

The proposed dam will create new habitats along an approximately 30 km stretch of river. Significant changes include changes to water depths and flow rates, temperature and water quality, sediment transport, bathymetric conditions and riparian environment. New lacustrine-like micro-habitats will dominate riverine ones, favouring fish species that do well in slow-moving aquatic habitats at the expense of species favouring fast flowing water.

Strong adaptable species: Fish species likely to thrive in these conditions prefer still or low flowing water, muddy substrates and shallow waters around lake shores. Relevant species include:

  - *Barbus paludinosus* (Matemba) and *Barbus trimaculatus* (Matemba) are hardy species that prefers quiet waters in lakes, swamps and marshes or marginal areas of slow-flowing rivers;

- *Clarias gariepinus* (Mlamba) is widely tolerant of extreme environmental conditions and spends its life mainly in quiet waters, lakes and pools with soft muddy substrates;
- *Astatotilapia calliptera* (Kambuzi) and *Oreochromis shiranus* (Chambo) thrive in vegetated areas of shallow waters around lakes; and
- *Petrocephalus catostoma* (Mphuta) occurs in quiet muddy waters of sheltered bays.

It is anticipated that these species will initially flourish in the Dam environment, due to favourable habitat conditions and an abundance of nutrients and food. Over time fish abundance may decline to a more sustainable fish population due to reduced nutrient availability and food / habitat competition.

Less adaptable species: Fish species that favour clear and flowing waters in rocky habitats will be less adaptable to Dam conditions and include *Labeo cylindricus* (Ningwe), *Labeobarbus johnstonii* (Mphondo) and *Amphilius uranoscopu*s (Nkholokolo). It is anticipated that these species will migrate upstream to more favourable habitats.

- *Introduced species*

The Project could potentially attract unwanted fish species, resulting in competition and decline of native species. This may occur as a result of introducing fish either intentially directly into the Dam, or unintentially from fish escape from community fish farms, which will be promoted to improve food security. Introduced fish could also potentially migrate down the Linthipe into Lake Malawi, resulting in negative impacts on lake fish and macroinvertebtrate species.

ii. ***Mitigation***

Mitigation measures will include:

- Implementing procedures for monitoring and regulating environmental discharges from appropriate Dam depths and ensuring implementation of an effective Construction Management Plan.
- Implementing a monitoring progam to assess changes in species composition and abundance, and migration patterns during construction and operational phases of the Project. Suubject to monitoring findings response actions may include creating various habtat tpypes within specific sections of the Dam, as well as up and downstream. This could include localised riffle areas and offstream wetland areas to promote lateral migration.
- Implementing a plan to minimise the potential for invasive fish species to become established in the Dam and potential to enter Lake Malawi. A biodiversity management Plan is include in the ESMP (Chapter 12). Important controls are included in the ESMP (Biodiversity Management Plan) and include installing a screen on the dam intake to prevent fish from entring the downstream river, and educating the community about the dangers of introducing non enemic species. Fishers will also be encouraged to report their catches.

iii. ***Conclusions***

It is generally concluded that the proposed Dam will not significantly affect the distribution and abundance of the 10 recorded species. None of these species are endemic to the Project site and all are well represented regionally and throughout Malawi. Key findings are:

- Six species, which include 2 dominate species (*Astatotilapia calliptera* - Kambuzi and *Barbus palludinosus* - Matemba), are expected to thrive in the proposed Dam environment, while three species will likely remain well established in upstream and downstream river habitats.

One species (*Anguilla nebulosa labiata* - Nkhunga) was noted to be uncommon and may no longer inhabit the Diamphwe River.

- A natural waterfall barrier is located approximately 53 km downstream of the proposed dam. It is therefore unlikely that fish from the lower sections of the Linthipe River and Lake Malawi can migrate upstream of this point.

8.6.4. **macroinvertebrates**

A total of 45 families and 68 species of macroinvertebrates were identified during the survey. The only species of conservation significance is the medical leach *(Hirudo medicinalis*), which is listed under the red list category of near threatened species (IUCN 2015-3 red list). The survey found good species diversity along the Diamphwe River, indicating good water quality and a healthy river system. Dominant species are represented by four orders and seven families:

- Order **Odonata**: damselflies (*Lestidae*), dragonflies (*Libellulidae*), darners (*Aeshnidae*),
- Order **Ephemeroptera:** may flies (*Ephemeridae*),
- Order **Diptera**: skimmer mosquitoes (*Culicidae*),
- Order **Basommatophora**: small freshwater snails (*Lymnaeidae*) and ramshorn snails (*Planorbidae*).

Macro-invertebrates depend on adequate habitat and water quality for their survival and display different sensitivities to habitat disturbances. The proposed dam will create a predominantly homogenous lacustrine environment, which will result in changes to water quality and longitudinal distribution of macro-invertebrate species, particularly with regard to species abundance, community composition, structure, density and diversity.

The proposed Dam will likely reduce the diversity of macroinvertebrate species, both in the reservoir and immediately downstream. Hardy macro-invertebrates that favour slower currents and can exploit a variety of habitats will increase in numbers while the more sensitive ones will decline. Specific impacts are discussed below:

- Ephemeroptera species are adapted to clear substrates in runs and riffles, and are sensitive to sedimentation and water quality changes. These species are therefore expected to significantly decline within the inundation area as a result of dam sedimentation, increased nutrients and temperature changes. Downstream impacts can be minimised by ensuring an environmental flow regime that replicates as much as possible current flow and water quality conditions. The proposal to maintain a 90% percentile compensation flow (Q90) coupled with careful water quality management will minimise potential downstream impacts on these species.
- Odonata and Basommatophora species are sensitive to habitat and environmental changes, and will mainly be affected by the removal of riverine vegetation and destruction of preferred micro-climates. In the medium term these species will likely decline in species diversity and abundance, however this will be mitigated by the establishment of riverine vegetation around the Dam perimeter. Downstream impacts will be less evident, subject to maintaining the proposed environmental flow and water quality regime.
- Other species including Chironomidae, Tipullidae and Oligochaetae macro-invertebrates prefer sediment substrates and are more tolerant of change water quality conditions. These species are expected to thrive in the new Dam environment.

It is generally concluded that the proposal will result in an increase in macroinvertebrate abundance, however there will be a reduction in species diversity with the decline of sensitive species such as Odonata, Basommatophora and Ephemeroptera species. Potential downstream impacts will not be significant, subject to the successful implementation of water flow and quality mitigation measures.

8.6.5. **Summary of Biodiversity Impacts and Mitigation**

The proposed Dam will inundate approximately 2,328 ha of land, which will displace a large number of animals and significantly change local habitats. There will be loss of approximately 55 ha of important riverine and forest woodland vegetation. Of these, riverine habitat (45 ha) is the most diverse and has an important function in maintaining river health and ecological connectivity between upper and lower parts of the Diamphwe river. Forest woodland (10 ha) occurs in relatively small isolated graveyards and has a more localised function in providing a refuge for plants and animals. Operation of the dam will also regulate downstream flows, which may impact on downstream flora and fauna.

Table 8.7 Biodiversity Impacts and Mitigation

Positive Impacts

- Following establishment of compensatory forest woodland and riverine habitat, and dam inundation there is likely to be a significant increase in animal diversity and abundance. The main impact will be associated with changes to species dominance however this will not significantly impact on regional biodiversity and in the longer term there will be an overall positive Project impact.
- Increase in Dam fish stocks

Negative Impacts

- **Vegetation**

There will be loss of approximately 55 ha of important riverine and forest woodland habitats. Downstream riverine habitat (approximately 2 ha) may be impacted by regulated flows and reduced flooding events. Four tree species are protected and will require approval for their removal. These are:

- Bleedwood teak (Pterocarpus angolensis)
- African mahogany (*Khaya anthotheca)*
- Coast Gold leaf (*Bridelia micratha) and*
- Yellow Wood (*Terminaria sericea)*

As noted above under 'Landuse' (S8.4.5) mitigation for habitat loss includes establishing woodland forest and riverine habit around the perimeter of the proposed dam. There will be an overall net increase of approximately 156 ha of available natural forest woodland habitat and no net loss of riverine habitat. There will therefore be an overall positive Project impact.

- **Terrestrial Wildlife**

Wildlife will not be significantly impacted by the proposal. All species are regionally represented and it is anticipated that most animals will easily relocate to adjoining habitat during construction and gradual increase in dam water levels. Some animals such as otters, pythons, some ground dwelling birds and amphibians may require physical relocation. There are a number of species that will require approval for their removal. These are:

a) Mammals

- Common duiker (*Sylvicapra grimmia*)
- Jackal (*Canis mesomelas*)
- Spotted Hyena (*Crocuta crocuta*)
- Clawless otter (*Aonyx capensis*)

b) Birds

- Broadbilled Roller (*Eurystomus glaucurus*)
- Red Winged Francolin
- Owls (various)

c) Reptiles & Amphibians

- Nile Crocodile (*Crocodylus niloticus*)
- Monitor Lizard (*Varanus niloticus*)
- Python (*Python sebae*),
- Mamba (*Dendroaspis sp*.)

Mitigation measures include providing compensatory habitat and maintaining environmental flows equivalent to that occurring for 90% of the time. In the short term some animal species may decline in numbers, particularly those that are less mobile or are territorial. However following establishment of

compensatory habitat and dam inundation there is likely to be a significant increase in animal diversity and abundance. The main impact will be associated with changes to species dominance however this will not significantly impact on regional biodiversity and there will be overall positive Project impact.

- **Fish**

All fish species identified are widely distributed across Malawi and none are listed as protected. Potential impacts relate to changes to habitat diversity, more regulated downstream flows a barrier to fish migration and introduced species. It is anticipated that six fish species (including two dominate fish species targeted by fishers) will flourish within the proposed Dam, while three species will migrate to adjoining upstream and downstream habitats.

Provision of compensatory riverine habitat and maintaining environmental flows will minimise potential downstream impacts, while substantially increasing habitat value within the dam impoundment. The main potential residual impacts relate to the success of some of the more sensitive fish species to relocate to adjoining habitat and impact of the proposed Dam on fish migration. However these potential impacts are not expected to be significant and the anticipated increase in fish stocks will result in an overall positive Project impact.

- **Invertebrates**

The proposed dam may result in significant changes to species diversity. Current dominant species (Orders: Odonata, Ephemeroptera and Basommatophora) are sensitive to habitat and water quality changes, while other species are likely to flourish within the new habitat. One species has conservation significance (medical leach - *Hirudo medicinalis*), which will be adversely impacted by the reduction in riverine vegetation.

Compensatory riverine habitat will minimise potential impacts on some sensitive species (such as Odonta and Basommatophora species), while environmental flows will minimise downstream impacts. Although it is likely that species dominance will change, this will not significantly impact on catchment or regional biodiversity.

Mitigation

- **Terrestrial Habitat**

- Establish forest woodland/ riparian grassland buffer around reservoir (156 ha)
    - ***Seeds will be harvested from existing vegetation for later propagation and planting in suitable areas.***
    - ***Planting trials undertaken to determine optimum growing requirements.***
    - ***A monitoring and maintenance plan will be prepared and implemented.***
- Relocation of forest woodland graveyards (10 ha)
- Ensure approval for removing protected tree species
- Maintain environmental flows to minimise impact on downstream riverine habitat
- Implement program to monitor and manage invasive vegetation species
- Catchment management initiatives to include better management of natural habitat within the dam catchment, including the Dzalanyama Forest Reserve.

- **Terrestrial Wildlife**

- Ensure planting of forest woodland buffer and new graveyard sites reflect habitats of affected species
- Salvage appropriate vegetation (hollow logs, seedlings, seeds, etc) affected by the project and reuse in areas to be planted with forest woodland and riverine vegetation
- Ensure approval for removing protected animal species
- Undertake further site surveys during the wet season, particularly for amphibian species. Also reassess listing of Red Winged Francolin as a bird of conservation significance.Aa review expert suggests that it is more likely to be be Shelley's (which also has red wings), Hildebrandt's, or Red-necked francolins.
- Management plan to capture and relocate animals that cannot easily leave the affected area to a suitable habitat. Affected animals could include ground dwelling birds, sedentary owls, and small and less mobile animals such as python and frogs
- Management plan to minimise adverse crocodile / human interactions

- **Aquatic**
- Plant riparian vegetation around Dam perimeter
- Maintain environmental flows to minimise impact on downstream riparian habitat, river flows and water quality
- Construction management plan to minimise potential water quality impacts
- Dam operational procedures to include management of environmental flow discharges to ensure poor quality dam water is not released
- Do not allow introduction of non endemic species and ensure any pest species are quickly removed from the Dam.
- Implement system to manage pest species including:
    - Treat infestations as soon as they are noticed.
    - People from the local community should be employed on a part time basis to patrol the dam and upstream areas, and any detection of pest species immediately reported to the Dam environmental representative. Local community can also be employed to clear investations. Collecetd weed should be appropriately disposed of by burial or incineration.
    - All boats and equipment used on the dam should be regularly inspected and cleared of weed fragments.
    - Education of the local community about how risk of contaminating the dam can be reduced.
    - In the event of extreme investations a herbicide (glyphosate) can be used, which is very effective, however a thorough risk assessment would need to be undertaken before any herbicides are used.

8.7. Noise

8.7.1. **Ambient noise and noise criteria**

Background monitoring (Chapter 6, S6.12.2) show ambient noise levels are relatively high with Leq levels ranging from 46.1 to 66 dBA, which are significantly higher than would be expected of a rural environment. This is likely a result of various types of activities associated with a relatively dense population, such as large groups of children playing, constant traffic and community related activities.

The International Finance Corporation (IFC) provides guidelines for environmental noise, which are documented in the IFC's EHS Guidelines, *General EHS Guidelines: Environmental Noise Management (April 2007).* These guidelines are consistent with Malawian standards for noise pollution (MS 173:2005: Acoustics-Noise pollution-Tolerance limits). Daytime noise criteria are (7.00am-10.00pm):

- 55 $L_{Aeq,1hr}$ (dBA): Residential, institutional and educational
- 70 $L_{Aeq,1hr}$ (dBA): Industrial and commercial

In addition to the above criteria, the IFC EHS Guidelines state that noise impacts should not result in a maximum increase in background levels of 3 dBA at the nearest off-site receptor.

8.7.2. **Construction**

Construction will be undertaken over a period of 3.5 years. Major works, activities and plant & equipment are summarised in Table 8.8.

Table 8.8 Construction Woks, Activities and Plant & Equipment

Construction works	Construction activities	Plant & Equipment
▪ Mobilisation, site establishment,	▪ Vehicle movements	▪ Light vehicles

Construction works	Construction activities	Plant & Equipment
preclearing and access development ▪ Building works including Pump stations, WTP, Office / accommodation, balancing tanks and pipelines ▪ River coffer dams and river diversion works ▪ Dam structure and associated works	▪ Quarrying and rock crushing ▪ Concrete batching and placement ▪ Piling ▪ Excavation and earthworks ▪ Spoil disposal	▪ Trucks: materials delivery, concrete, fuel & water ▪ Dump trucks ▪ Scrapers ▪ Excavators, dozers, vibro rollers ▪ Rock breaker and crusher ▪ Cranes, power tools, etc.

Construction work hours will be from 7 am to 6 pm, Monday to Saturday. There will be no work on Sundays and public holidays.

Project Affected Persons (PAP) within the construction area and associated buffer areas will be relocated prior to site mobilisation. A layout of the construction area showing Project infrastructure and buffer areas is shown in Figure 8.2. A more precise layout will be prepared following detailed design, however a primary objective is that there will be no residential houses or community buildings within a minimum of 500 m of major construction activities such as the dam wall and quarry areas. A minimum distance of 200 m will be maintained around other components such as the accommodation / office area, WTP, pumping station and balancing tanks. A 50 meter wide buffer will be maintained on the northern side of the main access road.

i. ***Noise sources***

General construction: Significant noise sources will be associated with major earthworks around the dam wall, rock breaking, crushing and heavy vehicle movements. Other noise generating activities that may cause disturbance relate to concrete batching, pipe laying and general building works.

Potential impacts associated with elevated noise levels can include nuisance effects, sleep disturbance, and health impacts associated with exposure to low frequency noise and vibration. Sound power levels of significant noise generating plant and equipment are given in Table 8.9.

Table 8.9 Sound Power Levels

Plant & equipment	Sound Power level (dBA)
Dozer	117
Excavator	115
Dump truck	114
Rock crusher	119
Front end loader	113
Dust suppression water truck	103
Delivery truck	104

ii. ***Noise assessment and mitigation***

Noise generation will be most prominent around major excavations and earth moving activities, as well as quarry and rock crushing activities. The type, number and distribution of construction plant and equipment will be subject to detailed design and programming. Point source noise assessments for three assumed scenarios that represent high noise generation activities are summarised in Table 8.10.

Table 8.10 Noise generation scenarios

Plant & equipment	Estimated noise generation (dBA)	
	50 m buffer	500 m buffer
Scenario 1: Major earthworks 2 x Dozers, 2 x Excavators, 2 x dump trucks, water truck		68
Scenario 2: Quarrying & rock crushing 2 x Excavator, Rock crusher, 2 x dump truck		69
Scenario 2: Delivery truck along access road	70	

Based on this assessment and proposed buffer distances the estimated noise levels generally meet IFC guidelines for Industrial and commercial (70 $L_{Aeq,1hr}$ dBA) but not for residential, institutional and educational (55 $L_{Aeq,1hr}$ dBA). These noise estimates are consevatively high and do not consider available mitigation measures, topography and scheduling of the works. The quarry and most of the Dam construction area are well in excess of 500 metres from sensitive receptors, while intervening hills are located around the quarry site and at the northern and sourthern ends of the dam alignment.

It is recommended that the Contractor undertake detailed noise modelling assessments prior to major construction activities, such as quarrying and crushing, river diversion works and at various stages of dam construction. Modelling results would form the basis for implementing appropriate mitigation measures, including scheduling the works, selection of plant and equipment and temporary noise barriers. Mitigation measures included in the ESMP are summarised in Table 8.11.

8.7.3. **Operation**

Main operational noise sources include the Raw Water Pumping Station, Water Treatment Plant, accommodation / office buildings and Dam related operations. The operational goal will be to meet IFC noise limits at sensitive receptors.

The Dam and Pumping Station are well removed from sensitive receptors and no specific acoustic controls are envisaged, other than standard controls for acoustically treating components such as pumps, motors, etc. The Waste Water Treatment Plant and accommodation / office areas will be surrounded by a minimum 200 meter buffer, however this will be confirmed following detailed design. If necessary additional acoustic controls will be incorporated into the design, such as muffling systems, pump covers, noise barriers, etc.

8.7.4. **Summary of Noise impacts and mitigation**

Dam construction will be a signifiact undertaking over a period of 3.5 years. Noise generation will vary in accordance with the construction schedule, hence mitigation measures will require evaluation and modification on a regular basis.

The objective noise criteria at sensitive receptors will be in accordance with IFC standards, however it is expected that this criteria may be exceeded on occassion, which will prompt further mitigation response. In the event that noise excedences are consistently above criteria, then negotiations with the affected persons for temporary relocation or property modifications will be done.

Table 8.11 Noise Impact and Mitigation

Negative Impact	
▪ Noise levels consistently exceed IFC guidelines of: - 55 $L_{Aeq,1hr}$ (dBA): Residential, institutional and educational; and - 70 LAeq,1hr (dBA): Industrial and commercial	
Mitigation	
▪ Select low noise plant and equipment where feasible. ▪ Incorporate breaks into construction activities likely to generate high noise levels. ▪ Periodically test the sound power levels of mobile mining equipment in accordance with ISO 6395: 1998. ▪ Modify or limit audible signals such as horns, whistles and bells, as safety permits. ▪ Maintain equipment in good working order. ▪ Limit delivery of equipment and consumables to between 7 am and 6 pm. ▪ Further refinement of on-site noise mitigation measures and site operating procedures, where practicable, including investigation of temporary noise barriers on the northern side of the access road. ▪ Prompt response to any community issues of concern or complaints.	▪ Monitor noise levels at sensitive and implement additional mitigation measures if necessary. This may include: - modifying activities or providing acoustic shielding for high noise emitting plant to reduce noise emission impacts on sensitive receivers, if necessary; - implementing feasible and reasonable acoustical mitigation at receivers, if necessary; and - negotiating or relocating sensitive receivers if noise attenuation measures are not effective or feasible. ▪ Undertake regular consultation with local government officials and community members about upcoming Project activities. Providing community members with a phone number to contact in the event of excessive noise disturbance. ▪ Include noise control and awareness training programs for site personnel.

8.8. Air quality impact

8.8.1. **Dust emission objectives**

From a human health perspective, short-term exposure to dust in the coarse particulate range (greater than $PM_{2.5}$) may cause eye and respiratory track irritation, while longer term exposure can lead to worsening of chronic respiratory tract illnesses, such as asthma. The human respiratory system has in-built defensive systems that prevent particles larger than approximately 10 µm from reaching the more sensitive parts of the respiratory system. The majority of soil-derived dust generated from construction operations is comprised of particulates above PM_{10}.

IFC guideline for ambient air quality as documented in the IFC's Environmental, Health, and Safety (EHS) Guidelines, General EHS Guidelines: Environmental Air Emissions and Ambient Air Quality (IFC, 2007) recommend the following criteria levels for PM_{10} particulates:

- 50 g/m^3 for 24-hour average PM_{10} for the Project considered alone; and
- 20 g/m^3 for annual average PM_{10} due to the Project and other sources.

Air pollution may be caused by emissions from construction related traffic and machinery. Dust particulates will be generated from earth works related to land clearing, river diversion works, quarrying and rock crushing, dam and foundation excavations and spoil disposal, as well as from

traffic movements along unsealed roads. The extent and intensity of dust emissions is directly related to the level of activity, ambient weather conditions and local topography.

Emissions of carbon monoxide (CO), nitrogen dioxide (NO^2), and sulphur dioxide (SO^2) will occur from diesel-powered equipment however these emissions are typically minor and too widely dispersed to give rise to significant off-site concentrations.

8.8.2. **Weather conditions**

The extent and magnitude of dust generation are related to the type of activity being undertaken and climatic conditions, particularly with regard to wind strength and direction, and soil and air moisture. Climatic conditions are described in Chapter 6, S6.5 and summarised below.

- *Rainfall*: The Project area has a warm tropical climate and distinct wet and dry seasons:
    - Dry season: August to October; and
    - Wet season: November to mid-April.

  There are two distinct types of rainfall events, these being intense and short duration tropical storms; and cyclones that last over one or two days and extend over large areas.
- *Wind*: Wind is characterised by:
    - Wind speeds are lowest during the wet season, with prevailing winds trending generally in an arc from the north east to north west and west during January and February.
    - From March to about July prevailing winds orientate to the east and south east, however average speeds remain relatively unchanged.
    - From September prevailing winds trend dominantly to the east and north east, with average wind speeds increasing in October, before declining in strength over November and December.
- *Temperature and evapotranspiration*:
    - A cool and dry winter season is evident from May to August with mean temperatures varying between 14 and 16 degrees Celsius (^oC).
    - A hot and dry season lasts from September to October with average temperatures varying between 17 ^oC and 20 ^oC.
    - The lowest temperatures are experienced in July, ranging between 13 ^oC; and the highest temperatures of 20 ^oC experienced in October to November.
    - The annual evapotranspiration is relatively ranges from 57 mm in June up to 70 mm in October.

8.8.3. **Impact assessment**

During the 3.5 year construction period (42 months) the major sources of dust generation will occur for the following activities and Program durations (Table 8.12):

Table 8.12 Program of Dust Generating Construction Activities

Activity	Program Months	Months
Site clearing & road construction	1 to 6	6
River diversion works	5 to 26	21
Dam construction	12 to 20	8

Major dust generation activities will therefore be most pronounced for the first 26 months of construction.

Dust will be most problematic during the drier and warmer months, particularly for the two months between September and October. During this time dominate winds trend to the east and north east towards Lilongwe district. Dust generation will be less of a problem during the wetter months, when prevailing winds orientate towards the north-west.

To some extent dust dispersion will be restricted by topographical landforms, in particular the two dominating hills at either end of the Dam wall. Similarly the quarry is located within a small amphitheatre and protected from hills to the north, east and south.

Dust generation will be minimised by programming dust generation activities outside of hot and dry months (September and October) as much as possible. Other mitigation measures identified in the ESMP are summarised in Table. There will be no significant operational air emissions.

8.8.4. Summary of Air Quality Impacts and mitigation

The potential for significant dust generation will generally occur during the first 26 months of construction when major earthworks are being undertaken. Dust dispersion will be partially contained by surrounding topography, however there remains potential for dust to impact on sensitive receptors, which poses potential health risks. It is expectd that mitigation can significantly reduce potential for dust generated impacts, however this will require carefull programing to avoid adverse weather conditions and implementation of a range of site mitigation and monitoring measures.

The objective air quality criteria at sensitive receptors will be in accordance with IFC standards, however it is expected that this criteria may be exceeded on occassion, which will prompt further mitigation.

Table 8.13 Air Quality Impacts and Mitigation

Negative Impacts

- Air particulates levels consistently exceed IFC guidelines of:
  o 50 g/m^3 for 24-hour average PM10 for the Project considered alone; and
  o 20 g/m^3 for annual average PM10 due to the Project and other sources.
- Health related impacts on sensitive receptors

Mitigation
▪ Program construction activities to avoid hot, dry and windy weather conditions. ▪ The main access road will be sealed. ▪ Internal construction roads will be regularly maintained and kept compacted to minimise dust mobilisation. ▪ Enforce vehicle speed limit on unsealed roads to 20 km/hr. ▪ Two watering trucks will be available full time on the project. Each truck will have a capacity of around 10,000 l and a spray rate of approximately 2,500 l per minute. ▪ A water tank and fixed water sprays will be located at the quarry and crushing area. ▪ Fit vehicles with appropriate exhaust systems and emission control devices. Maintain these devices in good working condition. ▪ Operate the vehicles in a fuel efficient manner. ▪ Cover hauling vehicles carrying dusty materials moving outside the construction site. ▪ Provide dust collectors and/or watering systems to the concrete batching and mixing plant to control the particle emissions in all stages, including unloading, collection, aggregate handling, cement application, circulation of trucks and machinery inside the installations. ▪ Minimize the extent and period of exposure of the bare surfaces.

- Restore disturbed areas as soon as practicable by vegetation/grass-turfing.
- Store the cement in silos and minimize the emissions from silos by equipping them with filters.
- Establish adequate locations for storage, mixing and loading of construction materials, in a way that dust generation is minimized during such operations.
- Not use water as dust suppression on potentially contaminated areas, to prevent generation of liquid waste stream.
- Crushing of rock and aggregate materials shall be wet-crushed, or performed with particle emission control systems.
- Not permit the burning of solid waste.
- Provide medical assistance to workers and community who may suffer from dust exposure.

8.9. Waste

8.9.1. **Construction**

Construction activities will generate a range of waste types such as surplus unsuitable fill materials, general construction rubbish, domestic and sanitation waste from construction camps and potentially hazardous wastes such as oils and solvents.

The objective will be to minimise waste generation as much as possible, but when this is unavoidable then to reuse and recycle either on site or through local businesses. Waste to be disposed of will be removed from the site by an appropriate and approved waste contractor.

A breakdown of waste types is summarised in Table 8.14.

Table 8.14 Waste Types

Waste Category	Potential Waste Generated	Disposal
Vegetation and topsoil	Greenwaste and topsoil from Pre-construction activities.	This will be offered to local villagers or temporarily stockpiled for use on rehabilitation areas such as the 15 m wide buffer zone around the dam perimeter.
Soil material	Earthworks and foundation construction will generate surplus soil and rock material.	To be disposed of immediately upstream of the dam wall in designated 'dumps'. The spoil will be spread over the land surface to minimise steep slopes and the potential for erosion and mobilisation during filling of the reservoir.
General Solid Non – Putrescible Waste from on-site maintenance and servicing of plant and equipment – note minor servicing only. Major servicing to be completed off site (non-liquid).	▪ Drained and crushed oil filters and grease tubes ▪ Used and defective parts ▪ Oil soaked rags ▪ Used oil absorbent materials ▪ Tyres	• Recycle, reuse Removed from site by appropriate waste contractor
General Solid Putrescible Waste from accommodation and office areas	Food scraps, waste wrappers, paper.	Removed from site by appropriate waste contractor.

Waste Category	Potential Waste Generated	Disposal
General Solid Non-Putricible Waste from construction activities (non-liquid)	Waste that is not contaminated or mixed with any other type of waste: ▪ Concrete pour residues ▪ Aggregates ▪ Damaged & offcuts of PVC pipes ▪ Rejected or defective precast concrete ▪ Steel waste ▪ Used Geotextile ▪ Timber waste	▪ Recycle, reuse ▪ Removed from site by appropriate waste contractor
Potentially hazardous solid waste Waste from on-site maintenance and servicing of plant and equipment – note minor servicing only. Major servicing to be completed off site. (non-liquid)	▪ Drained and crushed oil filters and grease tubes ▪ Used and defective parts ▪ Oil soaked rags ▪ Used oil absorbent materials ▪ batteries ▪ Tyres	Removed from site by appropriate waste contractor.
Potentially hazardous liquid waste	Relatively small quantities of: ▪ Paints ▪ Solvents ▪ Spilt oil and fuel	Removed from site by appropriate waste contractor.
Sewage waste	Sanitary and wastewater	Onsite treatment and disposal via engineered and approved septic disposal system.

A variety of wastes will be generated during construction. Wastes will be suitably classified and managed in accordance with the ESMP. The principal objectives are to minimise waste generation, reuse, recycle and finally to dispose of waste in an approved fashion. All potentially hazardous materials, such as diesel fuel, will be stored in approved containers and suitably bunded to contain a minimum 110% of the container volume. Spill kits will be located around the site and a spill prevention, containment and clean-up plan implemented.

Implementation of these measures will minimise the risk for waste to be discharged to the environment and the overall potential impact is low.

8.9.2. **Operation**

Operational waste will mainly include general office and accommodation waste, sewerage and non-waste generated from dam maintenance activities. These wastes will be managed in a similar fashion to that described above.

8.9.3. **Summary of waste impact and mitigation**

Table 8.15 Waste Impact and Mitigation

Negative Impacts	
▪ Uncontrolled disposal of liquid and solid wastes on site ▪ Soil and water pollution	▪ Improper storage and handling of fuels, lubricants, chemicals, hazardous goods/materials on-site, wash down of plant and equipment, and

▪ Health hazards and environmental impacts due to improper waste management practices ▪ Putrscible waste and stagnant water attracting vermn and disease carrying insects such as mosquitoes.	potential spills may harm the environment or health of construction workers.
Mitigation	
▪ Segregate and manage types of waste in appropriate areas around the site ▪ Vehicles carring waste to be covered ▪ Staff training in waste management ▪ Request suppliers to reduce packaging ▪ Maintain construction site and ensure no unsecure waste ▪ Collect chemical wastes in 200 liter drums (or similar sealed container), appropriately labeled for safe transport to an approved chemical waste depot. ▪ Store, transport and handle all chemicals avoiding potential environmental pollution.	▪ Store all hazardous wastes appropriately in bunded areas away from water courses. ▪ Make available all Material Safety Data Sheets (MSDS) for hazardous materials on-site during construction. ▪ Collect hydrocarbon wastes, including lube oils, for safer transport off-site to reuse, recycle, treatment or disposal at approved locations. ▪ Construct concrete or other impermeable hard-stand to prevent seepage in case of spills. ▪ Keep sufficient stock of absorbents for generally used chemicals or for petrochemicals (e.g., dirt, sawdust, etc.) within the storage area to contain accidental spills.

8.10. Occupational Health and Safety

8.10.1. **Occupational, Health & Safety requirements (OH&S)**

All personnel working or visitng the construction site must pay close attention to the increased risk of accidents, unsafe working conditions and health risks. Safety requirements will relate to the types of activities being undertaken. High hazard activities include working with heavy plant & equipment, excavation and quarrying, working at height/below ground/electricity, handling hazardous materials such as fuel and driving trucks. During Dam operations safety will be mainly concerned with maintenance activities and being in proximity to major plant and equipment. All staff will be exposed to potential health risks from vector bourne diseases such as malaria, poor sanitation and HIV/Aids. Health and Safety will be addressed as follows:

8.10.2. **Summary of OH&S Impacts and Mitigation**

Table 8.16 Occupational Health & Safety Impacts and Mitigation

Negative Impacts	Positive Impacts
▪ Poor worker safety systems ▪ Safety threats to workers and the community ▪ Poor health management, including lack of HIV/AIDS awareness. ▪ Unacceptable Worker Lost Time	▪ Improved health facilities to surrounding communities
Mitigation	
▪ Occupational health and safety procedures will be enforced at site. Each contractor will be required to prepare, obtain approval of, and implement an occupational health and safety (OHS) plan. These plans will be prepared in compliance with the ESMP (ECP 18): Workers Health and Safety and World Bank Group's Environment, Health, and Safety (EHS) Guidelines.	

- All workers will be adequately trained and provided with proper personal protection equipment (PPE).Frequent supervision will be carried out by supervision consultants to ensure they are wearing proper PPE at all times.
- Contractor OHS plan to describe the tasks and methods to be used by workers associated with construction and diving operations, and how to perform them safely and state how potential hazards are identified and handled. Contractors will ensure that construction workers are adequately informed about the OHS plan.
- Contractors will train workers to deal with safety from hazards such as crocodile attack and snake bite.
- Special attention will be focused on safety training for workers to prevent and restrict accidents and deal with emergencies.
- Road signage will be fixed at appropriate locations to reduce safety hazard associated with project-related traffic.
- Liaison with traffic police will be maintained
- Project drivers will be trained on defensive driving.
- Vehicle speeds near / within the communities will be kept low, to avoid safety hazards.
- The communication strategy complements awareness raising and information dissemination.

8.11. Security risks, theft, and vandalism for construction workers and materials

Inadequate construction site security poses a significant risk to assets, construction materials and property. Theft/vandalism of assets, materials and property would increase construction costs and cause delays in project completion. Improper security measures may also pose a security risk for construction workers and particularly foreign staff on construction sites. This issue will be addressed by:

- Continued consultations with the village and group village head and security personnel.
- Provide Security at the work sites and camps. Employ night watchman.
- Ensure there is proper fencing around construction areas, which should be chain-link at least 2.4 m high and secured with a steel chain and lock.
- Employ appropriate security personnel at job sites. Pre-employment screening investigations should be used to verify the applicants relating to their employment, education and criminal history background.
- Provide identification cards to workers.
- Maintain register to keep track of number of persons present in the camp at any given time.
- Ensure job sites are properly lighted at night.

8.12. Traffic

8.12.1. **Existing and Project traffic generation**

Construction traffic will vary over the course of construction. In the early stages of construction large trailer trucks will be required to move heavy plant and equipment. Water carts will also regularly use public roads to fill from offsite locations. Following excavation works deliveries will mainly relate to delivery of construction components, cement and other construction materials. Small vehicle movements including private cars and mini vans will be generated from personnel living offsite. The main potential impact is related to traffic congestion at the M1 road intersection and safety issues.

A traffic survey undertaken as part of ESIA studies (Chapter 6.13) showed average weekday traffic volumes were relatively low, with 423 trucks and 1,502 light vehicles. Approximately 10 to20 percent more traffic occurs during the afternoon period.

It is estimated that up to 30 large trucks and 100 vans and small vehicles would access the site during working hours from 7am to 6pm. Trucks would mostly access the site during the morning period from 7am to noon, giving an estimated rate of arrival of about 5 truks per hour. However this may increase subject to specific activities, such as concrete production for the dam structure.

8.12.2. **Impact assessment**

The Project will result in an increase in current truck movements on the M1 Main Road from about 5 trucks per hour to 10 trucks per hour during the morning period. A lower number of trucks are expected during the afternoon period. Light vehicles would increase from about 125 to 133 per hour over the course of the day. These relatively low numbers are not expected to cause significant queuing or interference at the M1 Road/site access turnoff and there would be minimal impact on existing traffic flows along the M1 road. However larger trucks turning into the access road could result in some disruption to vehicles travelling along the M1 Road.

There will likely be a significant increase of heavy and light vehicles using the access road, which is currently used by pedestrians, non-powered modes of transport and a few light vehicles. This will have significant safety issues. Other potential impacts from Project traffic include noise, vibration and dust, which are addresseed under the relevant sections.

Mitigation will include implementing a Road Transport and Road Traffic Management Plan. A Plan outline is provided in the ESMP (Chapter 12), which will be updated by the contractor to include detailed drawings of traffic arrangements showing all detours, temporary road, temporary bridges, temporary diversions, necessary barricades, warning signs / lights, road signs, construction schedule etc. More detailed measures are given in Section 8.12.

8.12.3. **Summary Impacts and Mitigation**

Table 8.17 Traffic Impacts and Mitigation

Negative Impacts	
▪ Increased Traffic on the access road at the M1 Road intersection and access road to the construction area could interfere with public traffic and deteriorate safety (especially the school children and elderly people), ▪ Spillage of fuels and chemicals, and damage to infrastructures and properties due to vibration.	
Mitigation	
▪ Implement ECP 15: Road Transport and Road Traffic Management ▪ Include in the contractor's traffic management plan to ensure uninterrupted traffic movement during construction: detailed drawings of traffic arrangements showing all detours, temporary road, temporary bridges, temporary diversions, necessary barricades, warning signs/lights, road signs, construction schedule etc. ▪ Provide signs at strategic locations of the roads complying with the schedules of signs contained in the National Traffic Regulations. ▪ Safety and security actions and procedures to protect local community.	▪ Restrict truck deliveries to working hours. ▪ Manage traffic queuing at the Main Road intersection. ▪ Restrict the transport of oversize loads. ▪ Operate vehicles, if possible, to non-peak periods to minimize traffic disruptions. ▪ Enforce on-site speed limit, especially close to the sensitive receptors, schools, health centers, etc. Inspect structures within the close proximity of construction site and ensure that all affected persons are evacuated from the property before construction commences.

8.12.4. **Management Plans**

Project impacts will be managed through implementation of an ESMP (Chapter 12) and accompanying RAP, which are summarised in Table 8.18.

Table 8.18 Management Plans

Environmental & Social Management Plan (ESMP)

An ESMP has been prepared, which provides guidance for the management of social and environmental aspects during the Project's construction and operation. The ESMP will form the basis for preparing and implementing detailed Construction and Operational Plans.

- The ESMP will be included in Contractor and Operator approval and tender documents.
- Contractor to prepare a Construction Environmental & Social Management Plan (CESMP). The plan should provide specific details for monitoring and management of:
  - Approval & regulatory compliance
  - Stakeholders
  - Clearing and demolition
  - Waste and recycling
  - Water supply
  - Materials handling
  - Soil erosion
  - Water quality
  - Hazardous materials
  - Flora and fauna
  - Air quality
  - Noise and vibration
  - Cultural heritage
  - Traffic
- Dam operator to prepare a detailed Operational, Environmental & Social Management Plan (OESMP). The plan should provide specific details for monitoring and management of:
  - Approval & regulatory compliance
  - Stakeholders
  - Dam catchment
  - Water resources and quality
  - Rehabilitation works
  - Environmental flows
  - Dam and downstream water quality
  - Hazardous materials
  - Waste and recycling
  - Flora and fauna
  - Air quality
  - Noise and vibration
  - Cultural heritage
  - Traffic

Resettlement Action Plan (RAP)

A total of 5,178 PAP have land and other assets that will be directly affected by the Project. Of these 733 homesteads will be need to be relocated to new areas. Community assets such as graveyards will also need to be relocated to new sites.

- Following Project Approval the RAP will need to be verified and compensation finalised.
- Relocation areas for PAP, compensatory land and community assets (such as graveyards) need to be identified and appropriately assessed, including undertaking adequate environmental & social impact assessment.
- Develop and implement RAP program.
- Instigate grievance and monitoring mechanism.

8.13. Quarry operations

The impact from quarry operations are generally addressed under the various impact assssments provided above. Extractive industries such as quarry operations are an intensive activity and further assessment information is provided below.

The proposed quarry is located just off the site access road and a layout of the quarry site is shown on Figure 8.9. Quarry operations will occur on the southern side of a large hill, which is generally

aligned south to north. Large hills are located immediately to the east and south, with cropland extending to the Diamphwe River to the west. Surrounding receptors include Bonkoneia/Chindeya village located approximately 600 metres to the north and T/A Mazengera village approximately 700 metres to the south. Both these villages are protected from the quarry site by large hills. Site landuse is mainly rocky outcrops with some cropland.

Quarrying activities will be generally contained within a naturally occurring amphitheatre and noise emissions will be effectively mitigated by the surrounding hills. Blasting is not proposed, as the rock can be mined using an excavator. However, should blasting be deemed necessary a separate blasting plan would be prepared. Dust will also be contained to a large extent, although mitigation will be required to minimise dispersion over the hills and towards sensitive receptors. A small tributary is located immediately south of the quarry and site controls will include installing clean water cut off drains around the active area. Rain falling onto active areas will drain to a sedimentation pond that will be positioned according to the progress of quarry development towards the north.

In summary quarry operations will be adequately contained by natural landforms and mitigation controls described in preceeding sections. No additional mitigation controls are anticipated beyond those already described for managing noise emissions, air quality, water quality, biodiversity, traffic and OH&S.

Figure 8.9: Quarry Site

Chapter 9
Social Impact Assessment

Environmental and Social Impact Assessment

February 2016

9. SOCIAL IMPACT ASSESSMENT

9.1. Introduction

Project development will have a range of positive and negative socio-economic impacts, experienced at both micro and macro levels. These may include:

- Demographic impacts (population numbers, distribution);
- Resource impacts (natural resource usage, ownership and access);
- Economic impacts (standard of living, poverty levels);
- Socio-psychological impacts (quality of life, health, well-being);
- Development impacts (social and human capital);
- Service and infrastructure impacts (service provision, leisure and tourism);
- Institutional impacts (organisational make-up);
- Community impacts (cohesion, relationships, social support)
- Cultural impacts (gender, customs, traditions, values);
- Archaeological and cultural heritage impacts (grave sites, spiritual sites, religious buildings);
- Aesthetic impacts; and
- Political impacts (human rights, governance).

It is recognised that social, economic and biophysical impacts are inherently and inextricably interconnected. A change in one domain may trigger impacts across other domains, and there are iterative or flow-on consequences within each domain.

The ESIA report and related ESMP cover the range of potential impacts. Involuntary resettlement in itself does not incorporate all; however, it will have a significant impact on individuals, households, businesses and groups, and on communities hosting those being relocated. This section assesses the key socio-economic impacts of the Project relating to resettlement; however, completion of the Asset and Census surveys for the Infrastructure and Pipeline will give further detail to specific impacts.

9.2. Positive Impacts

Positive impacts for those affected by resettlement may include the following:

i. ***Tourism Opportunities***

The Dam is close to Lilongwe and is easily accessible from the M1 Main road, and has the potential to attract local as well as international tourists.

ii. ***Employment Opportunities***

Short term benefits will be presented through Project developments, particularly employment opportunities offered during the construction phase of the Project works, and economic opportunities to provide services to supply the needs of contractors and workforce over such times.

In addition it is recommended, for example, that house construction at the resettlement sites preferably use local labour, for skilled and unskilled tasks. Using locally sourced materials for house construction will also financially assist local business enterprises.

In the long term, employment will be created through the operation and maintenance of the Dam and Pipeline, and through associated projects, such as irrigation development.

iii. ***Economic Development***

The Project provides great potential for long-term economic benefits, through the creation, diversification and growth of income-generating activities, to increase food security and reduce poverty in the area. This potential will present itself through the following:

- **An improved, regular water supply** to urban areas in Lilongwe, reducing the reliance on Kamuzu Dams as the current sole providers of water to the city. The risk of low flows and water shortages, and by implication, electricity load shedding, will decrease. This will encourage investment in the city, facilitate all-round economic growth, create employment opportunities, and thereby increase income levels and reduce poverty.

- **Easy access to a potable water source** for households affected by the Project, which will relieve domestic tasks in the collection of water. This could present women, not only with more leisure time, but opportunities to spend time in farming and income-generating activities.

- **Improved agricultural production** realised through: irrigation development, with opportunities for the diversification of agricultural activities; a steady flow of water, over all seasonal periods, including downstream of the Dam wall; and implementation of livelihood restoration measures. A more modern market- and cash-orientated agriculture will be introduced, leading to increased production and improvement in the general standard of living and welfare of the PAP. Irrigated agriculture by relocated famers will lead to an increase in food production, including for external markets; food security will thus be enhanced, not only locally but on a broader regional level.

- **Potential for creating new economic opportunities**, such as through support to fish farming and other non-agricultural livelihood restoration/improvement (LRI) income-generating activities.

- **Emigrants** with higher incomes and improved employment opportunities may be attracted to return to their families, re-introducing skills into the area, and establishing a more settled home environment.

- **Economic benefits** will become evident through in-migrants creating a buyer's market for local goods and services; sale of land to those affected; and the potential for other opportunities presented by the Project, such as the creation of a tourist industry.

iv. ***Improved Infrastructure and Service Provision***

Benefits relating to infrastructure development and service provision will include:

- **New and improved housing** at the resettlement sites, provided that housing principles are adhered to in house construction.

- **Improved physical and social infrastructure**, including roads, water supply, health care, education and other social services.

- **Improved downstream regulation of water**, with the monitoring of water flows and discharges, water quality and sediment loads etc. will benefit water users (for irrigation and

drinking water). The control and regulation of water levels and in-stream flow requirements of the Diamphwe River by the LWB will provide a more reliable steady source of water, particularly over the dry season.

- **Improved transport and communication** - The upgraded roads on site will provide both motorists and pedestrians an easier, safer and quicker access to health clinics, trading centres, markets and other places where they access goods and services, and aid in the movements of such goods and services. In addition, this **increased accessibility and mobility** will enable access to new income generating and marketing opportunities, and encourage investment by outsiders. It will also enable the creation of a public transport system, and a reduction in transport-operating costs.

- **Community skills development** - The many activities to be undertaken during the Project construction works will likely require the contractor to train local people. The acquired skills will benefit the individuals as well as communities in the Project area during and after the life of the Project.

Consulted stakeholders, including PAP, viewed the Project as an agent of development in the area, particularly as a 'mulitpurpose' dam, providing opportunities for irrigation, and potentially enabling people access to the reservoir, to fish as an income-generating activity, and to use the water for household consumption and for animal watering. They also believed that through the Project they would have a constant potable water supply for domestic use.

9.3. Negative Impacts

9.3.1. Introduction

Negative impacts relating to resettlement may include the following:

- The loss of land-holding, and privately owned assets on that land, resulting in the possible need to relocate. Land loss incorporates:
  - Cultivation land, residential/homestead sites;
  - Productive resources on the land, such as crops and trees;
  - Household structures, such as homesteads, sheds, boreholes/water wells/pumps, animal shelters and animal kraals, fencing, stores/shops and other privately owned business enterprises; and
  - Assets owned by organisations, such as non-governmental organisations (NGOs) and religious bodies, such as buildings and other related infrastructure.
- The loss of communal resources and assets. This includes:
  - Land, such as grazing land;
  - Productive resources on the land, such as natural plants used for culinary/medicinal purposes;
  - Usage of the river resources, for domestic and commercial purposes; and
  - Structures, such as community halls, water supply points/tanks/pumps, and burial grounds.
- The loss of government property. This includes:
  - Land used by government bodies, such as for schools, for clinics, and for outreach centers;
  - Structures, such as government buildings, water supply points/tanks/pumps, bridges, and archaeological sites.

- Disturbances to livelihoods, subsistence levels and income-earning capacity, primarily through the loss of economic assets/resources and the need to relocate. This may in itself lead to an increase in poverty levels, and cause a decline in household nutritional and health standards.
- Loss of access to agricultural land, and to services and facilities, through the creation of the reservoir and other construction works.
- Impeded access and the relocation of large numbers of people may increase pressure on existing services in host areas, particularly on educational and health facilities.
- Environmental spin-off effects from resettlement; for example, pressure on water and sanitation facilities may affect water quality, or an increase in livestock grazing may cause soil erosion.
- Loss of access to natural resource bases, and particularly the river system, currently used extensively for domestic, agricultural and commercial purposes. This is particularly important where local people depend to a large extent on the physical environment for survival. The dam will lead to the loss of river and floodplain habitats, diverse ecosystems home to numerous plants, animals and fish used by the communities. The devastation is compounded by other factors: for example, farmers displaced by the reservoir may clear forests in other areas to grow their crops and build new homes; and access to previously remote areas allowed by new roads may lead to further deforestation and other ecological impact.
- A changed hydrological regime in the Diamphwe River downstream of the dam, affecting users with the impact of the unnatural pattern of flow variation, of water loss, and possible erosion of riverbanks. A lower water table level will impact on crop production, and other water-related activities. As stated by International Rivers Organisation: "the floodplain is just as much a part of the river as the main channel itself".[25] Instream flow requirements give little consideration to natural seasonal flow variations; this will impact on agricultural practices dependent on seasonal changes in river flows and flood recession cropping, particularly in the dambo areas.
- Less quantifiable impacts on social groups; such as a breakdown in neighbourliness and support and coping strategies; potential community strife as a result of pressure on remaining resources, and socially destabilising effects; and changes in local movement patterns.
- Health may be affected in that reservoirs can become breeding grounds for disease vectors; for example, mosquitoes (as vectors for malaria) and snails (as vectors for bilharzia – Schistosomiasis) can take advantage of slow flowing water. In addition, a potential increase in Sexually Transmitted Diseases (STDs) in the area through in-migration, compounded by an increase in commercial sex work.
- Impacts on the aesthetic value of living conditions and scenery, particularly with the creation of the dam infrastructure.
- Collective adverse impacts on vulnerable groups/social categories who, because of their social position, may be vulnerable to changes brought about by project activities, or who may be excluded from its associated benefits.

[25] www.internationalrivers.org

The negative impacts are reiterated by the World Bank in OP 4.12: "*Bank experience indicates that involuntary resettlement under development projects, if unmitigated, often gives rise to severe economic, social, and environmental risks: production systems are dismantled; people face impoverishment when their productive assets or income sources are lost; people are relocated to environments where their productive skills may be less applicable and the competition for resources greater; community institutions and social networks are weakened; kin groups are dispersed; and cultural identity, traditional authority, and the potential for mutual help are diminished or lost*"[26].

9.3.2. **Land Acquisition Requirements**

The Area of Project Impact can be identified as falling into three areas:

- Dam inundation area, including a 15m buffer zone;
- Dam infrastructure area; and
- Pipeline to Bunda turnoff.

The Project will require both permanent and temporary occupation of land.

Permanent land acquisition will occur for:

- The construction of the Dam wall;
- The creation of the Reservoir;
- Other permanent infrastructure, such as the raw water pump station and pipeline, WTP and pipeline, balancing tanks, access roads, and buildings for office and accommodation; and
- Resettlement sites.

Temporary land occupation will be required for aspects of the Dam infrastructure development, such as for the quarry, the pipeline from the Reservoir to the WTP, and for the construction of the Pipeline to Bunda Turnoff.

The following Table 9.1gives detail to the proposed land take by the Project for the Reservoir inundation and BZ, the Dam infrastructure, and the construction of the Pipeline. These figures will be confirmed through the Land Asset Survey, particularly regarding land use.

Table 9.1 Land acquisition

Project Area of Impact	Land acquisition impact
Reservoir	▪ Permanent acquisition of an inundation area of 2,328 ha at FSL of 1,180.3 masl, and an additional 15m Buffer Zone (BZ) of 156 ha, comprising of 2,484 ha (24.8 km²) in total. From land use mapping this amounted to: – ***Cropland: 1,562.47 ha (62.9% of the total area);*** – ***Cultivated Dambo: 496.3 ha (20.0%);*** – ***Dambo Grassland: 378.4 ha (15.2%);*** – ***Forest/Natural Vegetation: 9.5 ha (0.4%); and*** – ***Settlement: 0.4 km²/37 ha (1.5%).*** ▪ 2,259.48 ha of productive land, used for cultivation, grazing and graveyards, and residential plots, was surveyed by the Asset Surveyors. ▪ The acquisition will lead to: – Permanent loss of cultivated crops, primarily for subsistence. – Permanent loss of individual productive trees, primarily for domestic use. – Loss of produce supplying local markets, Lilongwe city and Dedza town.

[26] World Bank. 2013a. *Op cit*.

Project Area of Impact	Land acquisition impact
Dam infrastructure development	▪ Permanent acquisition of an estimated 37.3 ha, with an additional 161.2 ha as a buffer zone, comprising 198.5 ha in total, for: the dam wall and auxiliary works, WTP, Balancing Tanks, access road, and buildings for office/accommodation, leading to: – Permanent loss of cultivated crops, primarily for subsistence. – Permanent loss of individual productive trees, primarily for domestic use. – Loss of produce supplying domestic markets in Lilongwe city and Dedza town ▪ Temporary acquisition of an estimated 8.8 ha for raw water pipeline from the Reservoir to WTP, and quarry with a 100m BZ.
Pipeline	▪ Temporary loss of 60 ha of land along the stretch of pipeline 33.4 km long to Bunda Turnoff. ▪ Clearance for the road easement where construction will take place, leading to: – ***Permanent loss of cultivated crops, primarily for subsistence.*** – ***Permanent loss of individual productive trees, for private use.*** – ***Loss of produce supplying domestic markets.***

An estimate of land loss per TA for the Reservoir inundation area is presented in Table 9.2 below.

Table 9.2 Land loss per Traditional Authority

Traditional Authority	Area (Ha)	%
Lilongwe District		
Mazengera	93.8	4.0
Kalumbu	613.7	26.4
Chadza	197.9	8.5
Dedza District		
Kaphuka	1263.8	54.3
Chilikumwendo	158.7	6.8
TOTAL	2327.9	100

9.3.3. Project Affected People and Associated Villages

i. *Reservoir and Buffer Zone*

A total of 5,178 people were identified in the Asset, Census and Socio-Economic surveys as affected by the Reservoir and Buffer Zone through loss of land and/or assets on that land (structures, crops and/or trees). With an average household size given at 4.9 members per household, assuming the PAP came from different households, an estimated 25,372 people will be directly affected.

A total of 223 villages will be affected through loss of land (residential, agricultural, communal) as detailed in *Table 9.3*; 76 in Lilongwe District and 147 in Dedza District. Names of villages given are those recognised by the community, in addition to those being formally named by District Councils.

The positioning of the affected villages can be seen in Appendix 9, which gives the location of all 223 of the villages affected by the Reservoir and BZ.

Information from the Asset survey indicates that a total of 644 residential homesteads will be affected by the inundation of the Reservoir including the BZ, and would thus require resettlement; at an average of 4.9 people per household, an estimated 3,156 people will be affected. These

homesteads are situated in 41 villages, as detailed in Table 9.4; 17 villages (with 358 homesteads) in Lilongwe District, and 24 villages (with 286 homesteads) in Dedza District.

In addition to this, 89 businesses will be affected, mostly in the trading centre of Bisayi, in Kalumbu TA, Lilongwe District. These businesses are permanent structures, made of brick. They sell a range of goods from bicycle parts to general merchandise (such as soap, oil, sugar, tea, 'chitenje' cloth, plastic plates and plastic shoes). Some offer alcoholic drink and cooked food on the premises. Eight PAP are more affected in that they are losing two business structures.

See **Appendix 8** to refer to A3 size maps showing affected villages and structures in reservoir area.

Table 9.3 Villages directly affected by inundation of the Reservoir and Buffer Zone

TA Name	villages	GVH	Village name
Lilongwe District			
Chadza	3	Nyamazani	Chibweya, Naymazani
		Mkute	Mkute
Kalumbu	61	Mwachilolo	Binwell, Chaluma, Chapota, Kaphwereza, Kapiza, Kudziwe, Kumfela, Kuthambala, Mbonongo, Mkanda, Mnjolo, Molosoni, Mpasu, Mposa, Mwachilolo, Namilaza, Ndalekana, Salimakhoza, Salimakumwala, Salimakunsi, Salimampatsa, Salimamtanda, Sikadzi
		Bisayi	Bisayi
		Thondolo	Biwi, Kantema, Tchete, Thondolo
		Malenya	Bwemba, Chaponda, Chilembwe, Chithumba, Doko, Filimoni, Kantukule, Makokola, Malenya, Mkombero, Mlombwa, Mphaleidyani, Mtende, Mwatchipitsa, Mzingwa
		Kalumbi	Chidampamba, Kadzakatha
		Chilembwe	Chilombo
		Chingwenje	Chingwenje, Chiononga, Kaluchi, Savala, Salimandinda
		Chiphazi	Chiphazi, Mtengo, Chikhuwa
		Chikanda	Bowa, Chikanda, Mtileni, Kasonda
		Khuzi	Khuzi, Mwamtsindo
		Mkomba	Mchiteni
Mazengera	12	Thofa	Chimwenje, Mdandu, Thebulo
		Chinziri	Chimbowa, Kalumbi, Kamakhala, Kumkama, Kunkaika, Msodoka, Msonga, Mtenthamawa, Mtsirizika
Subtotal	***76***		
Dedza District			
Chilikumwendo	15	Kawelama	Wilinda, Chinkhalamba, Kawelama, Machimaza
		Chilikumwendo	Chilikumwendo
		Kuthambala	Kanyumbu
		Dulampingo	Chibede, Chingonda, Dulampingo, Kamanula, Khomani, Mkoka, Mofati, Njelema
		Chamangwana	Kakhosi
Kaphuka	132	Bonya	Bonya
		Chaponda	Benati, Bikinosi, Chagwira, Chapala, Chaponda, Chikadza, Chimunthu, Fred, Kaguka, Kankodo, Kuchigawe, Mkomba, Mnomo, Ngongonda, Njati, Samison
		Chimamba	Bezayi, Chawanje, Chidzade, Chimamba, Jason, Kalonga, Kamuziyamo, Kathuvu, Kuchilala, Kumbuyo, Kupinda, Mfuti, Mkhukuzalira, Mlezo, Mnezo, Mtapasa, Musuliya, Myanga, Siliya, Tera
		Chiothera	Chidzamwela, Chiothera, Chitanda, Gakhi, Kan'gong'o, Kawerenga, Msindiza, Napulu II, Napulu Nswaswa, Ngwaditsa, Nyankhwi, Tsakulire, Tsalakunja, Zikiyere
		Chisela	Chinkhuthi, Mjondo
		Chisomba	Chisomba

TA Name	villages	GVH	Village name
		Galanga	Galanga
		Kangulu	Chakukhonde, Lunda, Kangulu, Kangulunjande, Kuchipata, Kukambala, Kwananda, Magawa, Maguza, Mangulenje, M'maso, Sitima
		Khuthe	Khuthe
		Kwendekeza	Chikumba, Galanga Msunduzi, January, Khumbiza, Kathewera, Khasu, Kwendekeza, Lumbe, Malikebu, Masininga, Mbendela, Mkhaladzulu, M'manga, Mphete, Ndingo
		Makoko	Chaimedi, Chisaka, Kumtamba, Makoko, Mbalame, Mkanda, Mkuthiwa, Msakambewa, Tsoyo
		Manondo	Chagala, Manondo
		Mbalira	Chiboli, Chimangiro, Chimtenga, Mbalira, M'bang'ombe, Notisi, Kamwala, Kasompho, Kathumba
		Mbwadzulu	Kasauka, Mbwadzulu, Njiwa, Sunga
		Mthontho	Chidothi, Chipanangwe, Kambwata, Malika, Mtontho
		Muothera I	Andrea, Bongololo, Chaola, Chidzondo, Jalikeni, Mambala, Mchaka, Muothera I, Muothera II, Mkusa, Masula, Ndaleya, Yobe
		Ntanthira I	Kajinya, Kapinda, Kutsolo, Mkwata, Ngombengo, Ntanthira I, Thengo
Subtotal	***147***		
TOTAL	**223**		

Table 9.4 Villages and number structures affected by Reservoir and Buffer Zone

Traditional Authority	VIllage	Number of residential structures	Number of businesses	Total number structures
Lilongwe District (17 villages)				
Mazengera	Kumkama	21		21
	Kalumbi	10		10
	Msodoka	17		17
	Mtenthamawa	18		18
	Mtsirizika	41	1	42
	Salima Ndinda	23		23
Kalumbu	Bisayi	15	87	102
	Chikhuwa	12		12
	Chingwenje	95	1	96
	Kadzakatha	10		10
	Kaphwereza	23		23
	Mbonongo	26		26
	Mchiteni	6		6
	Mpasu	10		10
	Mpasu I	10		10
	Mposa	5		5
	Chiphazi	15		15
Subtotal		***358***	***89***	***447***
Dedza District (24 villages)				
Kaphuka	Bonya	1		1
	Ngongonda	1		1
	Kawerenga	107		107
	Nabulu Nswaswa	16		16

Traditional Authority	VIllage	Number of residential structures	Number of businesses	Total number structures
	Mjondo	1		1
	Galanga Msunduzi	1		1
	Khumbiza	9		9
	Kwendekeza	1		1
	Lumbe	1		1
	Mkhaladzulu	23		23
	Chaimedi	7		7
	Kuntamba	10		10
	Makoko	6		6
	Mdalame	20		20
	Chidothi	1		1
	Kambwata	12		12
	Malika	11		11
	Mtontho	2		2
	Ntanthira 1	5		5
	Fred	8		8
	Njati	6		6
	Bikinosi	4		4
	Ndingo	24		24
Chilikumwendo	Chilikumwendo	9		9
Subtotal		***286***	***0***	***286***
TOTAL		**644**	**89**	**733**

Source: SMEC groundtruthing exercise, September/October 2015

ii. ***Dam infrastructure***

Additional villages may be affected by construction and ancillary works for the Project (Figure 9.1), including:

- Chimbowa, Msonga, Mtsirizika, Kalumbi, Chikomba and Samalina villages, for the construction camp and offices;
- Mzinga and Bokonela/Chindeya, for the access road from the M1 to the Dam site and construction camp/offices;
- Mphete village, for the pipes from the Reservoir to the WTP; and
- Kanthukena village, for the WTP.

Adjustments were made to siting of the Water Treatment site. It was relocated to the west of its original position after it was found to have affected some structures in Kanthukena village, TA Mazengera in Lilongwe district (Figure 17).

Photograph 9.1: Current WTP site

The Balancing Tank site is in Che Mboga village of TA Mazengera in Lilongwe district. As shown by the map image (Photograph 9.2) about five households and a graveyard for the village will be affected if the site is confirmed.

Photograph 9.2: Balancing Tank site

The proposed quarry site is situated near Mtsirizika village of TA Mazengera in Lilongwe District. There is no settlement on the designated site (Photograph 9.3); however, the area would be affected by heavy machinery and construction activities, and thus affect villages on the access road.

Photograph 9.3: Quarry site

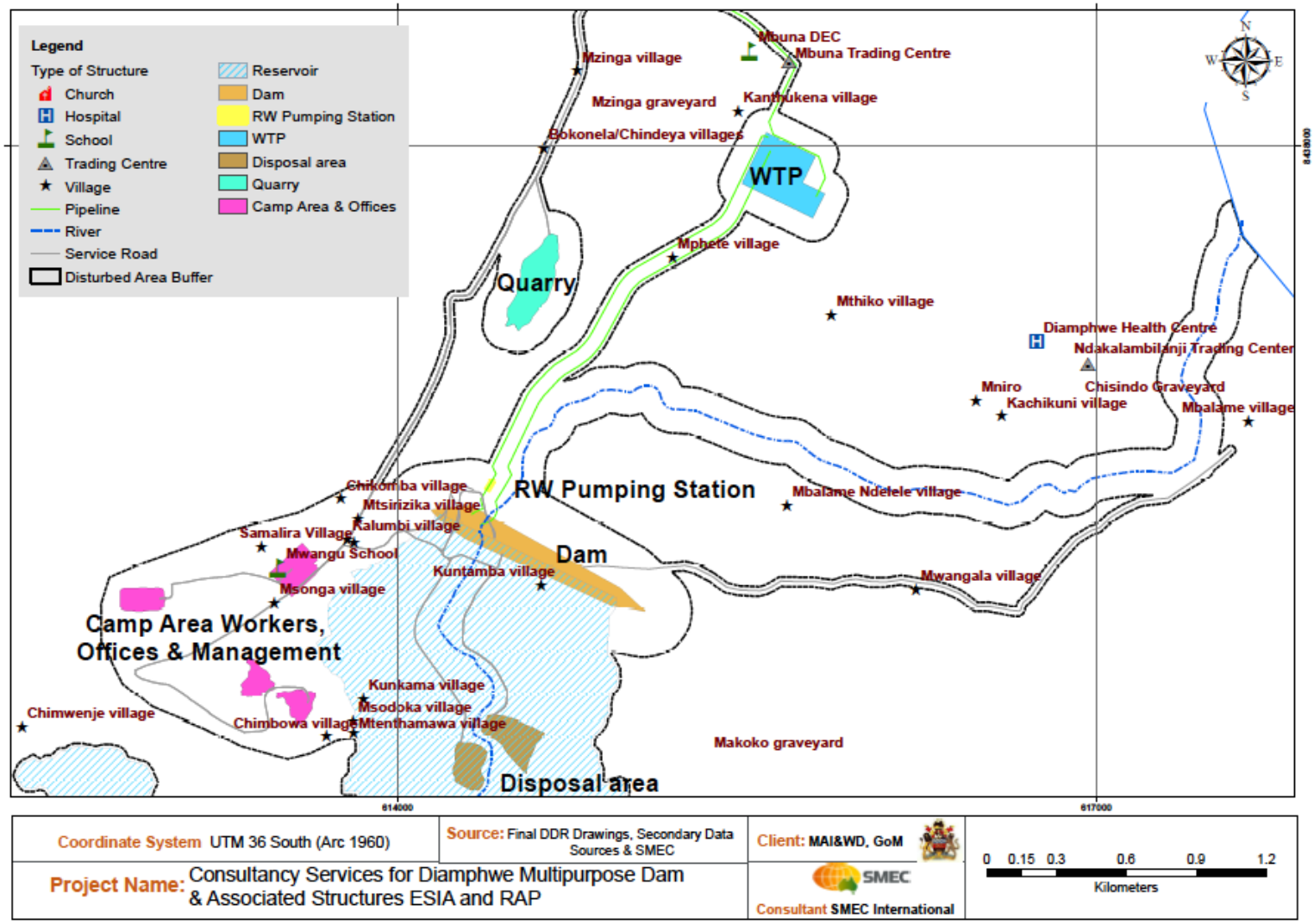


Figure 9.1: Potential impact on villages by Dam infrastructure

Source: SMEC groundtruthing exercise, October 2015

iii. ***Pipeline***

Villages potentially affected by the Pipeline are shown in Figure 9.2 below:

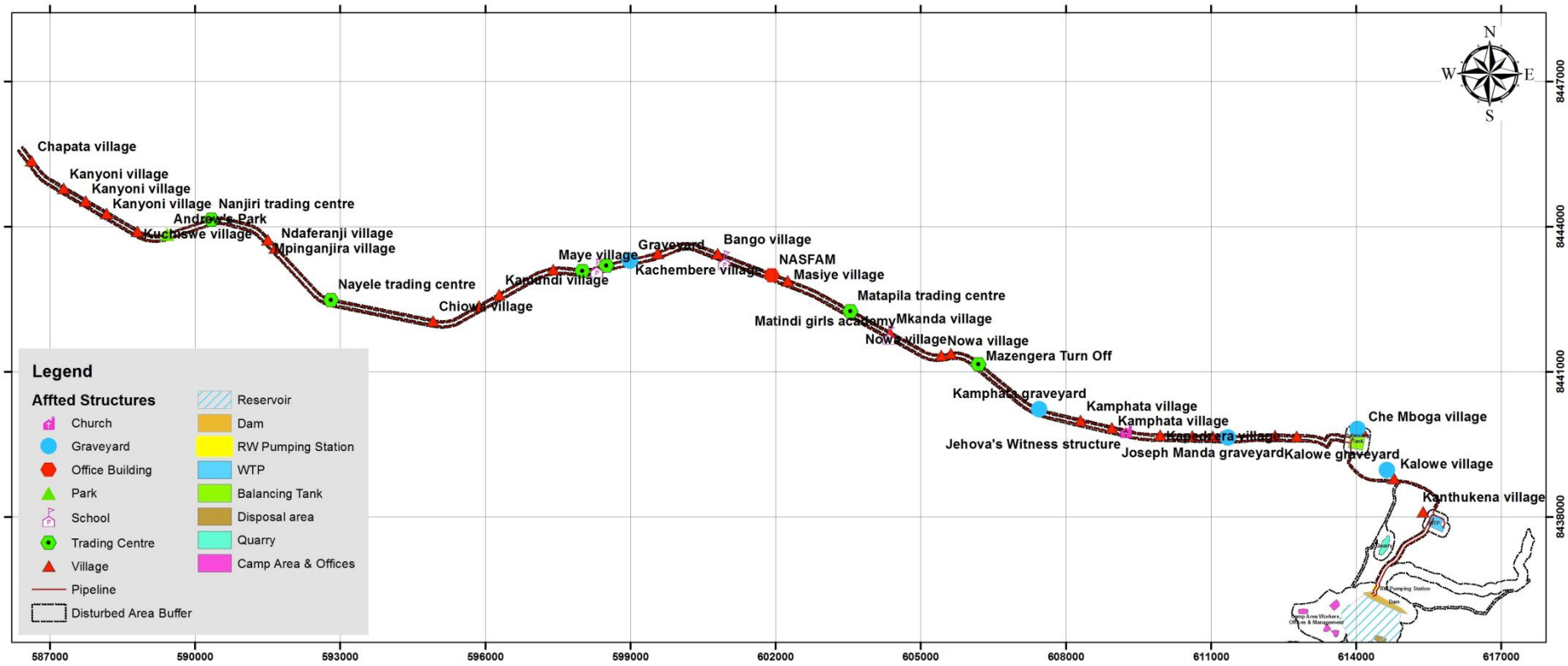


Figure 9.2: Potential impact on villages by Pipeline

Source: SMEC groundtruthing exercise, September/October 2015

The total number of villages affected by the Project for the Infrastructure and Pipeline, through total or partial loss of structures and/or cultivated land, and associated PAP and household population, including those requiring resettlement, will be calculated on completion of the Asset and Census surveys of those villages.

9.3.4. Loss of Service Provision

Loss of structures is not limited to private ownership. There may be a loss of structures owned by the government and NGOs/CSOs. Other service provision, such as sports grounds, may also be affected.

i. ***Governmental and non-governmental structures***

There does not seem to be a major impact on government and NGO structures. Only Mwangu Junior Preparatory School seems to be affected by the Dam infrastructure, and Matindi Girls Academy by the Pipeline.

ii. ***Religious buildings***

The Reservoir is likely to inundate four churches, as positioned in Figure 9.3:

- In Lilongwe District, in Kalumbu TA:
  - Assemblies of God and Baptist Churches in Salima Ndinda village; and
  - CCAP Church in Bisai village.
- In Dedza District, the PIM Church, Zerela village in Kaphuka TA.

iii. ***Sports grounds***

At least three sports grounds will be inundated by the Reservoir:

- In Lilongwe District, Kalumbu TA, Botomani sports ground; and
- In Dedza District, Kaphuka TA, Tsalakunja and Kawerenga sports grounds.

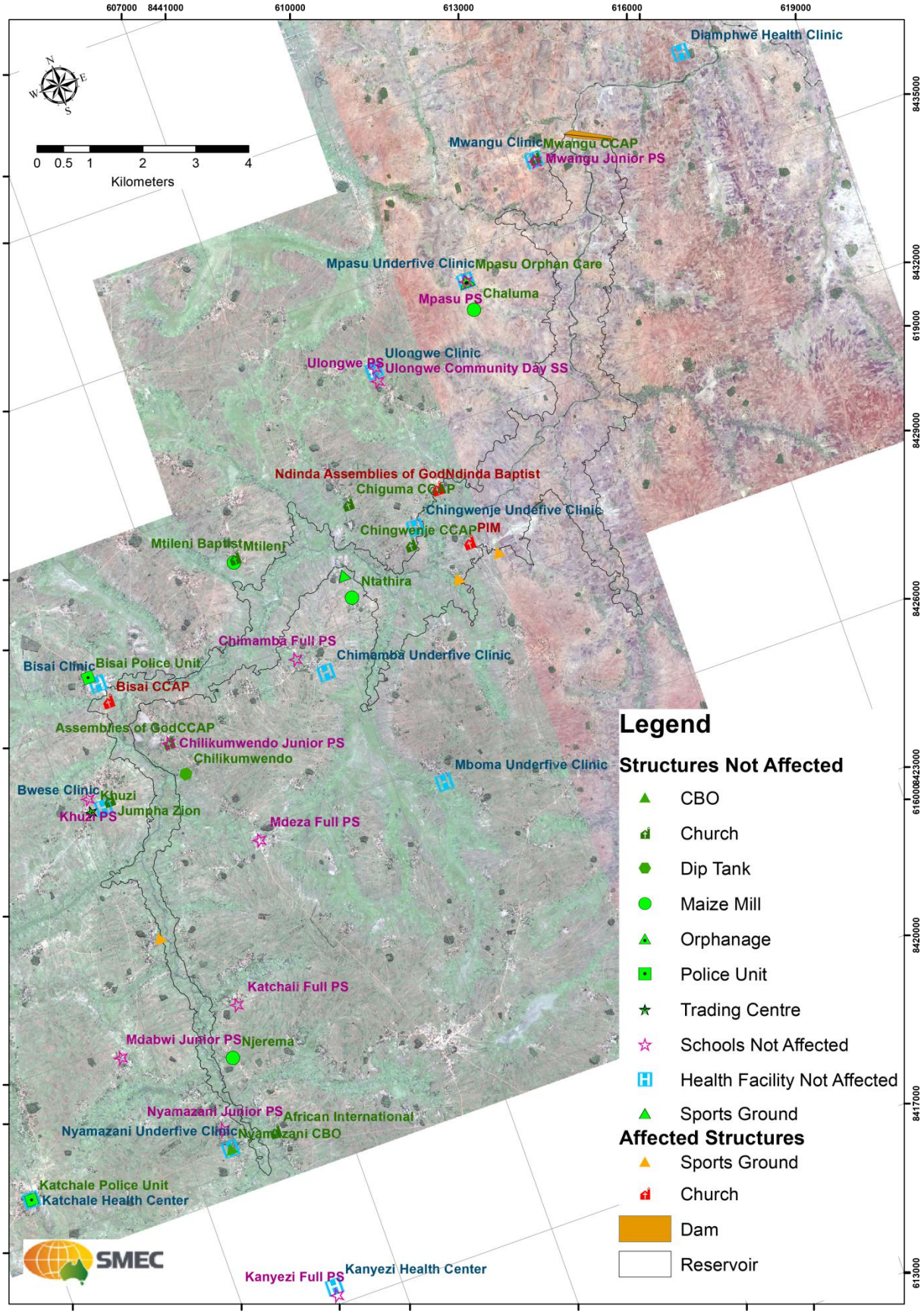


Figure 9.3: Service provision in the Diamphwe Reservoir area

9.3.5. **Crop and Tree Loss**

Of particular concern is the extent of agricultural loss, given the dependence of local communities on subsistence farming and the amount of cropland that will need to be acquired for the Project.

The acquisition of land will lead to:

- Permanent loss of cultivated crops, primarily for subsistence;
- Permanent loss of individual productive trees, primarily for domestic use; and
- Loss of produce supplying domestic markets in Lilongwe city and Dedza town.

Dambo gardening (flood recession agriculture) is an important economic activity in the Project area, and the main preoccupation for households residing close to the Diamphwe River and its tributaries:

- For winter cropping it as an important source of income and food for households where produce from dambo land is either consumed or sold. Main crops planted include maize and horticultural crops such as tomato and various cabbages. When sold, the money is used to meet other household needs such as school fees for children, clothes and farm inputs for upland farming;
- Dambo land is rented out to other households who also use it for winter cropping;
- Some households depend on buying and reselling produce, mainly at District headquarters (Lilongwe and Dedza). Many vegetables such as cabbage and tomato that are consumed in Dedza and Lilongwe come from the Project area; and
- During times of drought the bulk of the population depends on dambo gardening as it becomes the only source of food and income.

The extent and details of crop and tree loss will be calculated once the Crop and Tree Asset Survey has been completed.

9.3.6. **Depletion of Natural Resource Base**

A range of natural resources that are useful to local communities will be inundated by the creation of Diamphwe Reservoir. These resources play an important role in the livelihoods of households and other resource user groups.

i. ***River usage***

Of particular importance is the usage of the Diamphwe River, not only for its water, but for other resources and activities.

Water is one of the most important factors for the development of different life aspects – economic, social and health – and is essential to sustain life, development and the environment. As an important water source for affected people, the loss of access to the use of water of the Diamphwe River is one of the most significant negative impacts of the Project: for agricultural irrigation, domestic usage (drinking water, washing of clothes and other household items, and bathing), recreation (swimming), and the watering of animals.

Apart from the water, the river is used for many purposes, including:

- Fishing, as a food source, a recreational activity, and an economic activity;
- Sand and clay, for brick-making;
- Clay for pottery, for domestic purposes, or as an income source; and

- Reeds and grasses, for house construction and/or basket-making.

ii. ***Land-based natural resources***

Land loss will impact on forms of livelihood and income-generating activities that rely on land-related natural resources, such as medicinal and culinary plants and trees. The loss of these will particularly affect households who depend on these resources as income-generating activities; such as the sale of herbal plants, and of firewood. The harvesting of resources in other areas will create an added economic burden, and lead to increased pressure on those resources.

Figure 9.4: Homestead stockpile of wood

9.3.7. Livelihood Impacts

i. ***Income sources of affected households***

The results of the surveys for the Reservoir and BZ indicate that the local economy is primarily based on subsistence agriculture, however the majority of people earn an income from farming.

Some households are also affected through the loss of businesses, either run from the homestead or independently – as in village market places. As mentioned, Bisayi Trading Centre was particularly affected through the loss of 87 permanent business structures, with Chingwenje and Mtsirikiza villages losing one business structure each. Businesses are of varying sizes, and mostly sell basic general household goods required in the rural areas.

ii. ***Loss of produce***

It is estimated that the cropped area in the Reservoir inundation area and BZ comprises the following:

- Cropland: 1,562.47 ha; and
- Cultivated dambo: 496.29 ha;

This totals just over 2,000 hectares, with additional patches of cultivated land in dambo grassland.

As stated, this, in addition to acquisition of land for Dam infrastructure and the Pipeline, will result in considerable loss to the agricultural base and produce of many households.

The loss of produce will not only directly impact on the livelihoods of affected households, but also have a number of spin-off affects. For example:

- Local services and infrastructure supporting the agricultural industry will be negatively affected; and
- The receiving markets will be substantially affected by a loss of produce. Local markets are not only in the immediate vicinity, but reach further regionally and nationally.

iii. ***Livestock farming***

Although livestock husbandry does not form a significant component of local economic and social activities, most households affected by the Reservoir had some livestock, comprising of mostly goats, with a few cattle and other animals.

Affected households may lose their stock through relocation; they and those remaining may also lose considerable areas of grazing land.

9.3.8. **Severed/Constrained Access**

As a natural feature, the Diamphwe River has constrained the movement of people to some degree, although it is crossed on a regular basis; by footpaths and bridges over the dry season, and by bridges and boats in the wet season.

The Reservoir will, nevertheless, further impede access to services and facilities (such as transport, health facilities, schools, businesses, and market places for the sale/purchase of goods), and kinship, social and support networks. Two bridges currently used, from Bisai to Chimpaze and from Nyamazani to Kakhosi, and a concrete causeway at Katete, will be flooded, as will two new bridges being constructed, at Kawerenga and from Salima Ndinda to Zalera (see Figure 9.5).

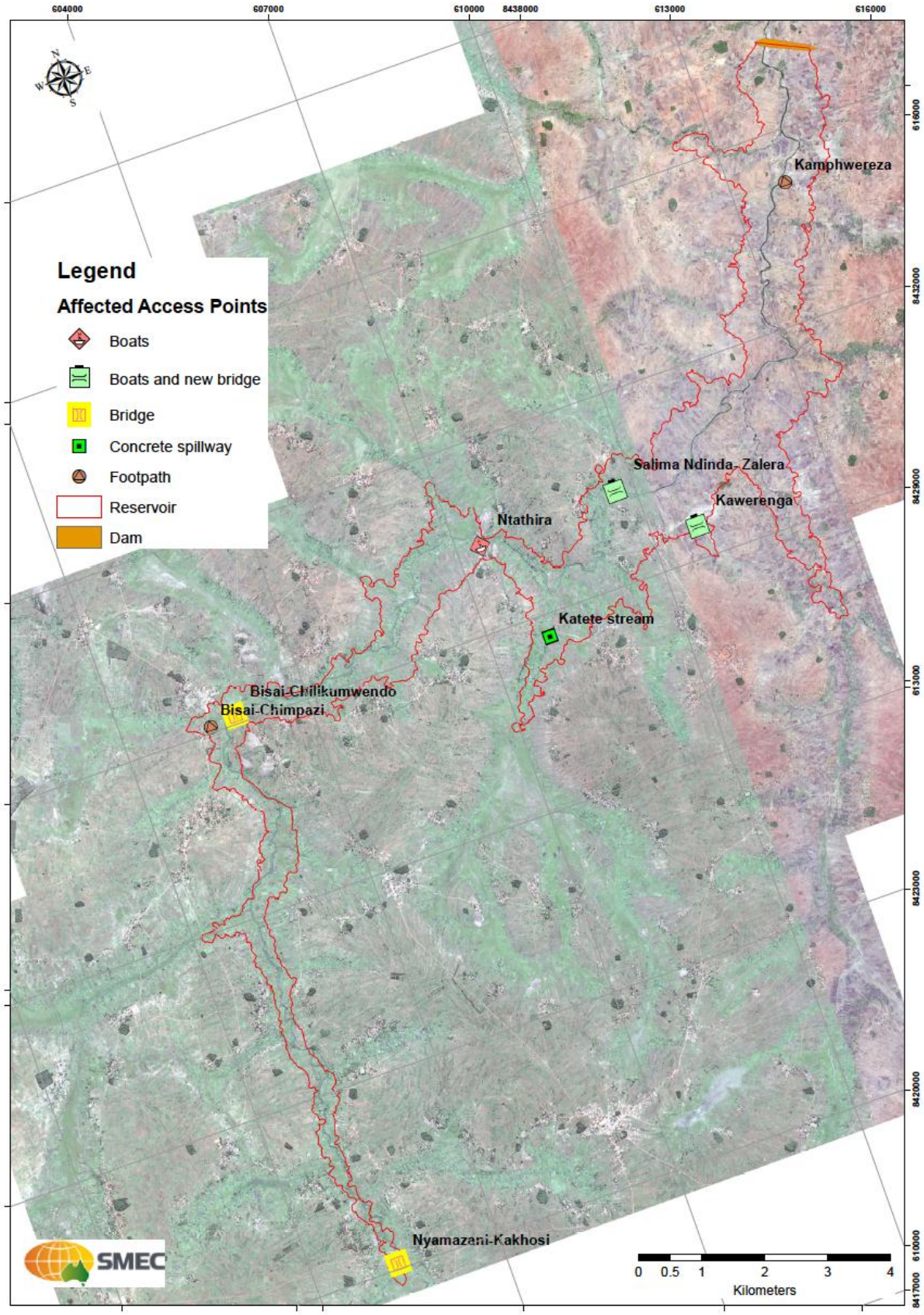


Figure 9.5: Access points across Diamphwe River

9.3.9. **Downstream/Upstream Impacts**

A changed water flow regime in the Diamphwe River will impact on the operations of farmers downstream of the Dam through changes to seasonal flooding, particularly for those dependent on flooding for agricultural production.

Backwater affects from the Reservoir may also lead to flooding of agricultural lands immediately upstream of the Reservoir.

9.3.10. **Host Communities**

Depending on where resettlement sites are situated, resettlement will have an impact on host communities. This will include, for example, the loss of assets, and particularly land; pressure on existing infrastructure, services and resources; disruption to social cohesion; and conflict with those relocated.

9.4. Vulnerable Groups

In the context of resettlement planning, vulnerability has come to refer to two socio-economic dynamics. At a general level it refers to the insecurity experienced by all PAP because of the loss of private and communal property, loss of access to the Diamphwe River as a resource, severed/ constrained access to social services, etc. At a more specific level it refers to those social categories whose livelihoods may be particularly vulnerable to disturbances created by the Project, for which special provisions need be made so that they are better equipped to deal with Project-induced changes.

Households classified as 'vulnerable' are affected households who may, by virtue of gender, ethnicity, age, physical or mental disability, economic disadvantage or social status, be particularly vulnerable to Project implementation, and changes induced by the Project.

These may include:

- Women-headed households;
- Households with an aged household head older than 65 years;
- Child-headed households (headed by children under the age of 18);
- Households where the household head has a physical or mental disability;
- Households with no or limited access to cash income, and have high levels of unemployment amongst the household members; and
- Households with a low nutritional base, measured through current nutritional intake and requirements, agricultural and/or livestock farming activities, employment and other off-farm activities, support networks, and a medical examination (where required).

Vulnerability is not a given or static condition. A household may become vulnerable when the head becomes aged, falls ill or becomes disabled, destitute or poverty stricken; and hopefully less vulnerable as their health and economic circumstances improve. Because vulnerability is a dynamic concept, the identification, assessment (and monitoring) of vulnerable households will be an ongoing process throughout the compensation/livelihood restoration programme.

9.5. Health

9.5.1. Stakeholder Comment and Concern

Through the community consultations, DPCs, women chiefs and village members considered how the proposed activities of the Project may impact on community health in a direct or indirect manner, positive and negative, including the vulnerability of sectors of the community to these potential health impacts.

Positive health impacts

Participants named direct positive impacts; however, most will be dependent on the multi-functional nature of the Dam, and mitigation measures undertaken to improve the conditions of PACs. For example, the Project has the potential to:

- Improve the health of people through potable water provision, in Lilongwe City as well as locally for communities surrounding the Dam. In particular, there will be a reduction in waterborne diseases, such as diarrhea; and
- Improved nutritional status, if irrigation farming and nutrition education programmes are integrated into Project implementation.

Negative health impacts

The following potential negative health impacts were identified as resulting from the Project:

- Early marriages and teenage pregnancies, HIV/AIDS and other STIs, through the in-migration – and influence – of people coming into the area, and a possible increase in commercial sex work;
- The Reservoir may become a breeding ground for disease vectors; for example, mosquitoes (as vectors for malaria) and snails (as vectors for bilharzia – Schistosomiasis) can take advantage of slow flowing water, causing an increase in the prevalence of the diseases; and
- Concern over the possibility of drowning, particularly of children.

Community members believed that involving key stakeholders throughout the Project cycle will help the Project achieve its full potential while minimising the negative health impacts; for example, government departments such as health, agriculture, education, internal affairs and community development, and relevant NGOs operating in the Project area.

9.5.2. Potential Health Impact Areas

Giving more detail to potential health-related impacts, areas of concern include[27]:

- **Physical resettlement and economic displacement**: This may impact on local livelihoods and increase the vulnerability of PAP, with the following potential health impacts:
  - Loss of housing and available land to support livelihoods, with impacts on nutrition and ability to afford services;
  - Reduced access to available basic social services, including health;

[27] Richards Bay Minerals. September 2014. *Zulti South Project: Health Impact Assessment Scoping Study*. Prepared by JM Consulting.

- **Vector-related illnesses**: The environment in and around the Project is conducive to the breeding of mosquitoes, with the river holding such a dominant position, yet an altered physical environment with an expanse of water from the Reservoir may increase the number of breeding sites and thus vector densities. In-migration of people from areas where malaria is endemic may also carry the parasite into the area, increasing the risk of localised transmission of malaria.

  The Reservoir will also provide a breeding ground for bilharzia. At risk are individuals contracting bilharzia swimming and washing clothes in the Reservoir.

- **Project-induced influx with associated communicable disease transmission and social discord**: There is potential that the development of the Project will result in the in-migration of returning residents, speculative migrants, and some movement closer to the Project from residents in the District. This is most likely to occur during the construction period, but may extend into operations.

  The risk of in-migration will have extensive social concerns, including:

  - The potential for makeshift, unplanned, unserviced housing settlements developing in proximity or along transport routes to the Project. Limited financial and human capital to plan and support the infrastructure requirements related to sudden expansion in settlements, especially if makeshift in nature, without basic sanitation and garbage disposal, may lead to poor environmental hygiene;

  - Challenges in providing equitable basic and social services to the current community, and with increased demand this ability will be further reduced;

  - Supply and demand pressure on housing and basic supplies such as food may increase costs, with vulnerable people of the PAC especially susceptible to inflation; and

  - Less land available for subsistence farming and natural resource use to satisfy household needs, including nutrition.

  The risk of additional health impacts related to in-migration includes:

  - Competition for scarce resources, leading to possible social discord and associated violence;

  - Overcrowding and poor environmental health conditions, leading to an increase in communicable respiratory diseases such as TB;

  - Changes in the lifestyles of people, increased affluence, and the mix of different cultures may lead to an increase in the incidence of promiscuity and transactional sex, and thus to communicable diseases such as HIV/AIDS and other STIs (compounded by the creation of a market for commercial sex workers), to the possible rise in substance (drug and alcohol) abuse, and to gender-based violence;

  - The introduction of other communicable diseases or different strains of communicable disease, such as TB and MDR-TB, measles or influenza;

  - Food insecurity due to pressure on natural resources, lack of access to arable land, and inflation in the price of food;

- Increase in WASH-related disorders, due to polluted environments and lack of services, causing diarrhoeal disease outbreaks; and
- Community safety issues, including increased levels of crime/violence, and fires in the informal settlements.

- **Noise, vibrations and dust:** The construction and operation activities of the Project will include blasting, crushing and transportation of materials and personnel using heavy vehicles. As a result there are a number of environmental health determinants that may influence human health. These are discussed in detail as part of the various biophysical studies performed as part of the ESIA, with the following relevant to human health:
  - Air quality: dust is the biggest potential risk for health impacts in proximity to construction activities and along unsealed roads, particularly during the dry season;
  - Reduced water quantity and quality, from abstraction of local surface and ground resources, altered ground water tables and pollution of surface and ground water; and
  - Noise and vibration, with vibration especially a risk due to movement of heavy vehicles and potential damage to structures.
- **Traffic hazards**: Increased vehicle movements, especially heavy vehicles, leading to a temporary increased risk of accidents during the construction period. Temporary road development, and road upgrade, will also increase the likelihood of traffic accidents.

9.6. Cultural Heritage

9.6.1. **Cultural Heritage Sites**

The development of the Reservoir will have destructive effects on the cultural heritage sites identified within the Project Area of Impact.

A total of 21 heritage sites were identified as being impacted by the Reservoir during the field surveys, as described in Table 9.5 below and illustrated in Figure 9.6. These include 16 archaeological sites of variable ages, with eight being evident settlements of the Iron Age. The severity of the impact depends on the size and nature of the site.

As no subsurface testing was conducted at this stage of the assessment of the Project, these impacts are preliminary.

Table 9.5 Location of identified heritage sites and significance of impact

Site number	Description	Nature of Impact	Significance	Severity of the Impact
DZ01	Decorated pottery in the maize fields on the lower bank of the Diamphwe River over a distance of more than 100m. Pottery densities are generally low (<5/m^2) with some concentration areas. The pottery is with few exceptions undecorated and highly fragmented as a result of cultivation. The exceptions include some curved moulded ribs and some incised fragments.	Completely inundated by Dam water. Direct loss of archaeological sites due to permanent submerging through flooding.	High. This is possible late 19th century to early 20th century extensive settlement site.	Moderate to severe
DZ02	Historic traditional water well located approximately 200m east of Diamphwe River. The outer lining of the well is made of stones and is still used today.	Completely submerged in Dam water.	High. Important source of drinking water since historic times.	Severe
DZ03	Traditional ancient cattle Kraal, made of an outline of stones piled up on each other in a circular form. It is located approximately 250m east of the Diamphwe River.	Completely destroyed by the Dam.	High. No longer used by the local communities, but has commemorative and symbolic value to locals as a monument of importance.	Severe
DZ04	A scatter of decorated and undecorated pottery on a small hilltop. Also presence of beads. Samples collected to be further analysed.	Completely inundated in Dam water. Direct loss of archaeological sites due to permanent submerging through flooding.	High. An interface of iron age settlements and historic settlements.	Severe
DZ05	Clusters of embedded potsherds along a walkway (>10/m^2). Some decorated, with rims. Samples collected for further analysis.	Inundated by Dam water. Direct loss of archaeological sites due to permanent submerging through flooding.	High. Possible late 19th to early 20th century settlement.	Very severe
DZ06	An Iron Age Site in a maize field was detected with clusters of decorated and undecorated pottery (>5/m^2). Samples collected for further analysis.	Potential inundation by Dam water. Direct loss of archaeological sites due to permanent submerging through flooding.	High. Possible late 19th to early 20th century settlement.	Moderate to severe
DZ07	An exposure of lithics and cluster of decorated and undecorated pottery site, located in an undisturbed extensive area of approximately 50m x 50m. Samples collected for further analysis.	Potential inundation by Dam water. Direct loss of archaeological sites due to permanent submerging through flooding.	High. Possible late 19th to early 20th century settlement.	Moderate to severe

Site number	Description	Nature of Impact	Significance	Severity of the Impact
DZ08	Traditional water well located along a footpath.	Completely submerged in dam water.	High. Important source of drinking water since historic times.	Severe
DZ09	An Iron Age Site in a maize field with clusters of decorated and undecorated pottery, (>5/m^2). Samples collected for further analysis.	Completely submerged in Dam water.	High. Possible late 19th to early 20th century settlement.	Severe
DZ10	An Iron Age Site located in a maize field with clusters of decorated and undecorated pottery and daga, >10/m^2.	Completely inundated by Dam water. Direct loss of archaeological sites due to permanent submerging through flooding.	High. Historic settlement.	Severe
DZ11	An Iron Age Site located in intact ground with possible Maudzu potsherds embedded on the ground. Presence of metals (iron) fragments. Situated in 50m x 50m area, about 200m east of Diamphwe River	Completely inundated by Dam water. Direct loss of archaeological sites due to permanent submerging through flooding.	High. Possible late 19th to early 20th century settlement.	Very severe
DZ12	Iron Age Site located in a maize field with clusters of decorated and undecorated pottery and daga, >10/m^2, of total area approximately 50m x 50m.	Inundated by Dam water. Direct loss of archaeological sites due to permanent submerging through flooding.	High. Historic settlement.	Moderate to severe
LL13	Rock shelter, possible settlement of the Afakula; no traces of rock paintings, scatters of potsherds and glass.	Completely destroyed in Dam construction. Direct loss of archaeological deposits due to sediments being removed from archaeological areas.	High. Possible late 19th to early 20th century settlement.	Moderate to severe
LL14	Historic and Iron Age Site located in a maize field with clusters of decorated and undecorated pottery with intact rims, >10/m^2, of total area approximately 20m x 20m. Samples collected for further analysis.	Permanent change of cultural landscape around the heritage sites that indirectly reduces the associated cultural landscape value.	High. Possible late 19th to early 20th century settlement.	Severe
LL15	Historic site located in a maize field with scatters of decorated and undecorated pottery and dagga, >15/m^2, of total area approximately 30 m x 30 m.	Completely inundated by Dam water. Direct loss of archaeological sites due to	High. Possible late 19th to early 20th century settlement.	Moderate to severe

Site number	Description	Nature of Impact	Significance	Severity of the Impact
		permanent submerging through flooding.		
LL16	An Iron Age Site located in a maize field with clusters of thick decorated and undecorated pottery mostly eroded, >10/m^2, of total area approximately 50m x 50m. A few potsherds with comb dragging, incisions and comb stamping.	Inundated by Dam water. Direct loss of archaeological sites due to permanent submerging of the site through flooding.	High. Possible late 19th to early 20th century settlement.	Severe
LL17	*Bwalo*: A sacred meeting place for 8 chieftaincies within the 3 Traditional Authorities and *Gule Wamkulu* performing arena.	Partially submerged in Dam water during flooding.	High. Historic and socio-cultural.	Moderate to severe
LL18	Historic and Iron Age Site located in Nyamazani village, in a maize field with clusters of decorated and undecorated pottery and pieces of reed impressed dagga, >5/m^2, of total area approximately 50m x 50m. Samples collected for further analysis and site interpretations.	Completely inundated by Dam water. Direct loss of archaeological sites due to permanent submerging of the site through flooding.	High. Possible late 19th to early 20th century settlement.	Severe
LL19	An Iron Age Site with a high concentration of pottery in a disturbed maize field (>20/m^2), in an area of approximately 50m x 50m. Samples collected for further analysis.	Completely submerged by Dam inundation.	High. Possible late 19th to early 20th century settlement.	Very severe
LL20	Scatters of embedded potsherds on an undisturbed landscape (>10/m^2) in Chimkuteni Village. Some decorated and other undecorated with rims intact. Samples collected for further analysis.	Completely destroyed during Dam construction and inundation. Direct loss of archaeological sites due to permanent submerging through flooding.	High. Possible late 19th to early 20th century settlement.	Very severe
LL21	An Iron Age Site located in an undisturbed landscape surrounded by maize fields, with clusters of potsherds (>10/m^2), in total area approximately 30m x 30m. Samples collected for further analysis.	Completely destroyed in dam construction.	High. Possible late 19th to early 20th century settlement.	Very severe

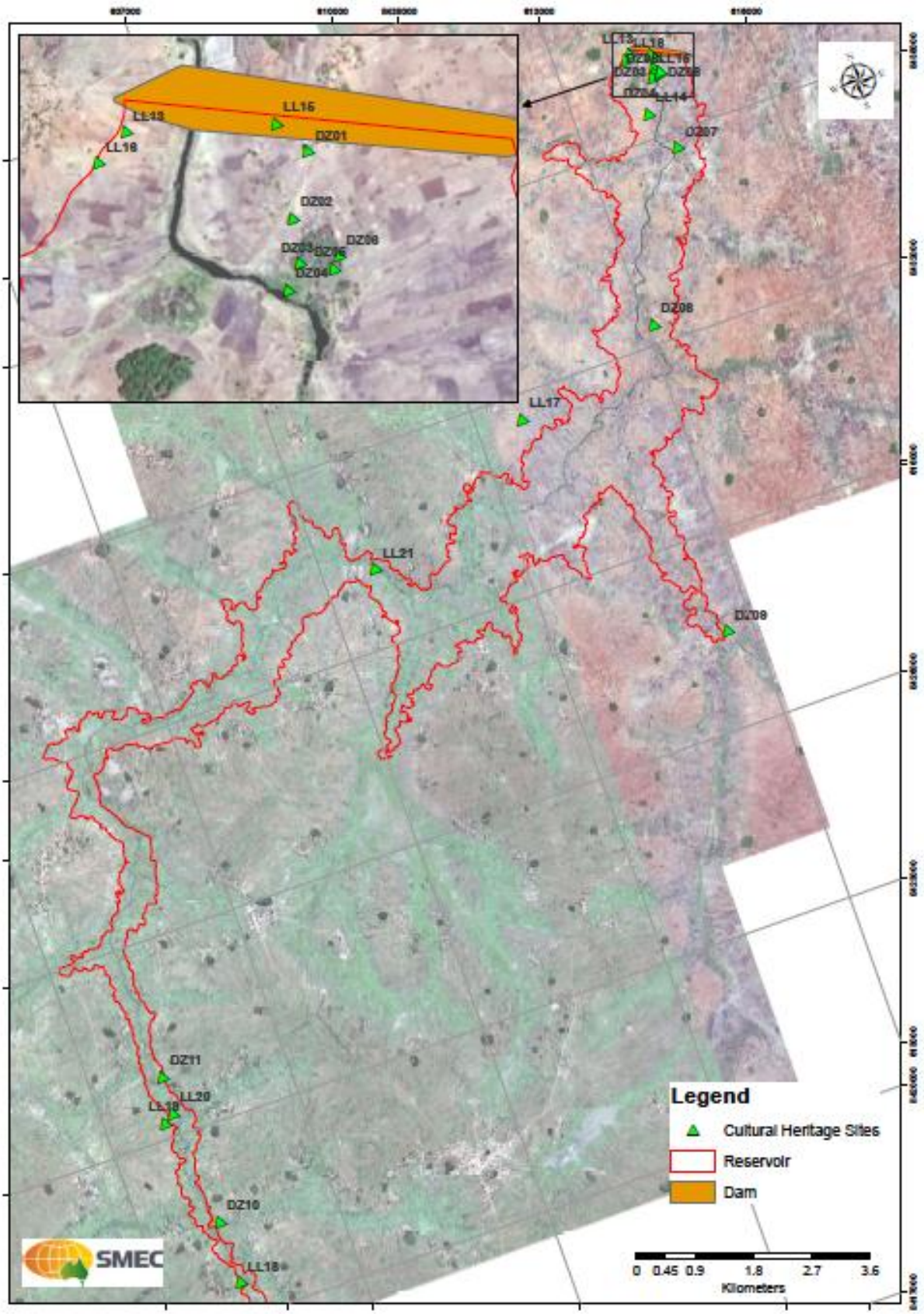


Figure 9.6: Cultural heritage sites in the Diampwhe Reservoir area

Figure 9.7: Iron Age Site located in undisturbed landscape with potsherds

Figure 9.8: Clusters of embedded potsherds on intact sediments

Figure 9.9: Intact decorated pottery on western side of Diamphwe River

9.6.2. **Graves and Graveyards**

Through ground-truthing undertaken at the time of the Asset, Census and Socio-Economic Surveys, the SMEC Social Team has identified that the Dam construction will lead to the inundation of at least 14 graveyards and two isolated grave sites lying within the Project Reservoir and Buffer Zone area, as identified in Table 9.6 and Figure 9.10. An additional three graveyards will potentially be affected near Kuntamba village, Dedza District, over the construction of the Dam, and one graveyard near Che Mboga village, Lilongwe District, as a result of the positioning of the Balancing Tank.

Table 9.6 Impact on identified graveyards in Reservoir Area and Buffer Zone

TA	GVH	Village/Graveyard	Status
LILONGWE DISTRICT			
Kalumbu	Chingwenje	Salima Ndinda	Affected by Reservoir/BZ
	Nyamazani	Mkute	Affected by Reservoir/BZ
	Mwachilolo	Fumbi/Mpaso II	Affected by Reservoir/BZ
		Mbonongo	Affected by Reservoir/BZ
		Kaphwereza	Affected by Reservoir/BZ
Mazengera	Chinzili	Kumkama	Affected by Reservoir/BZ
	Che Mboga	Che Mboga	Affected by Balancing Tank
DEDZA DISTRICT			
Kaphuka	Kangulu	Kangulu	Affected by Reservoir/BZ
	Kawerenga	Kawerenga (graveyard 1)	Affected by Reservoir/BZ
		Kawerenga (2)	Affected by Reservoir/BZ
		Kawerenga (3)	Affected by Reservoir/BZ
	Makoko	Kuntamba (1)	Affected during construction
		Kuntamba (2)	Affected during construction
		Kuntamba (3)	Affected during construction
	Kwendekeza	Mkhaladzulu	Affected by Reservoir/BZ
	Chisela	Bengo (isolated grave with tombstone)	Affected by Reservoir/BZ
		Bengo (isolated grave)	Affected by Reservoir/BZ
	Ndingo	Ndingo (1)	Affected by Reservoir/BZ
		Ndingo (2)	Affected by Reservoir/BZ
		Ndingo (3)	Affected by Reservoir/BZ

The DoA has identified the number of graves in each of the graveyards that they have studied in the Reservoir inundation area, as detailed in Table 9.7.

Table 9.7 Number of graves in each graveyard

	Name of graveyard	Villages that use graveyard	Total number of graves
LILONGWE DISTRICT			
1	Name: Kumkama graveyard GVH Chinzili, TA Mazengera	Kumkama (96 graves) Msodoka (72 graves) Chibowa (28 graves) Kamakhala (56 graves) Msonga (52 graves) Mtenthamawa (34 graves)	338
2	Name: Kaphwereza graveyard GVH Mwachilolo, TA Mazengera	Kaphwereza	17
3	Name: Mbonongo graveyard GVH: Mwachilolo	Mbonongo	15

	Name of graveyard	Villages that use graveyard	Total number of graves
	TA: Mazengera		
4	Name: Salimandinda graveyard GVH Chingwenje, TA Kalumbu	Chilundwe (17 graves) Ankhwazomba (9 graves) Salimandinda (40 graves) Lukiyo (23 graves) Mwambo (35 graves)	124
5	Name: Mpasu underage graveyard (still born) GVH Mwachilolo TA Mazengera	Mpasu, Mlombwa, Mphaleyidyani	Unknown still-born babies
6	Name: Mpasu Leprosy graveyard *(Manda aanthu akhate)* GVH Chingwenje, TA Mazengera	All people from Mwachilolo villages	2
7	Name: Mkute Leprosy graveyard *(Manda aanthu akhate)* GVH Mkute, TA Mazengera	Kalumbi, Nankhombo, Mbalame, Gwengwe, Ndakuyanja, Chatupa	15
Subtotal number of graves in Lilongwe District			***511***
1	Name: Ndingo graveyard GVH Chinzili, TA Kaphuka	Ndingo	84
2	Name: Kanguru Mkhonde graveyard GVH Mbalila, TA Kaphuka	Kanguru-mkhonde	31
3	Name: Bonya graveyard GVH Chiwothera, TA Kaphuka	Old closed graveyard (no longer used)	38
4	Name: Kawerenga graveyard GVH Chiwothera, TA Kaphuka	Kawerenga (69 graves) Kubwaila (35 graves) Mnthawanji (36 graves) Mzelera (50 graves) Nyalubwe (8 graves) Zingalume (25 graves) Chigwira (6 graves)	229
5	Name: Tsakunja graveyard GVH Chiwothera, TA Kaphuka	Tsakunja	38
6	Name: Mkhaladzulu graveyard GVH Kwendekeza, TA Kaphuka	Khumbiza (14 graves) Mkhaladzulu (45 graves)	59
7	Name: Bengo Isolated graveyard 1 tombstone, 1 unmarked grave GVH Chisela, TA Mazengera	Mjondo village	2
8	Name: Mtanthila 1 graveyard GVH Chimamba, TA Kaphuka	Mthanthila	3
Subtotal number of graves in Dedza District			***484***
TOTAL NUMBER GRAVES			**995**

The DoA advises that the details of individual bodies buried in these graves will be provided once the processing and analysis of the information collected is finalised.

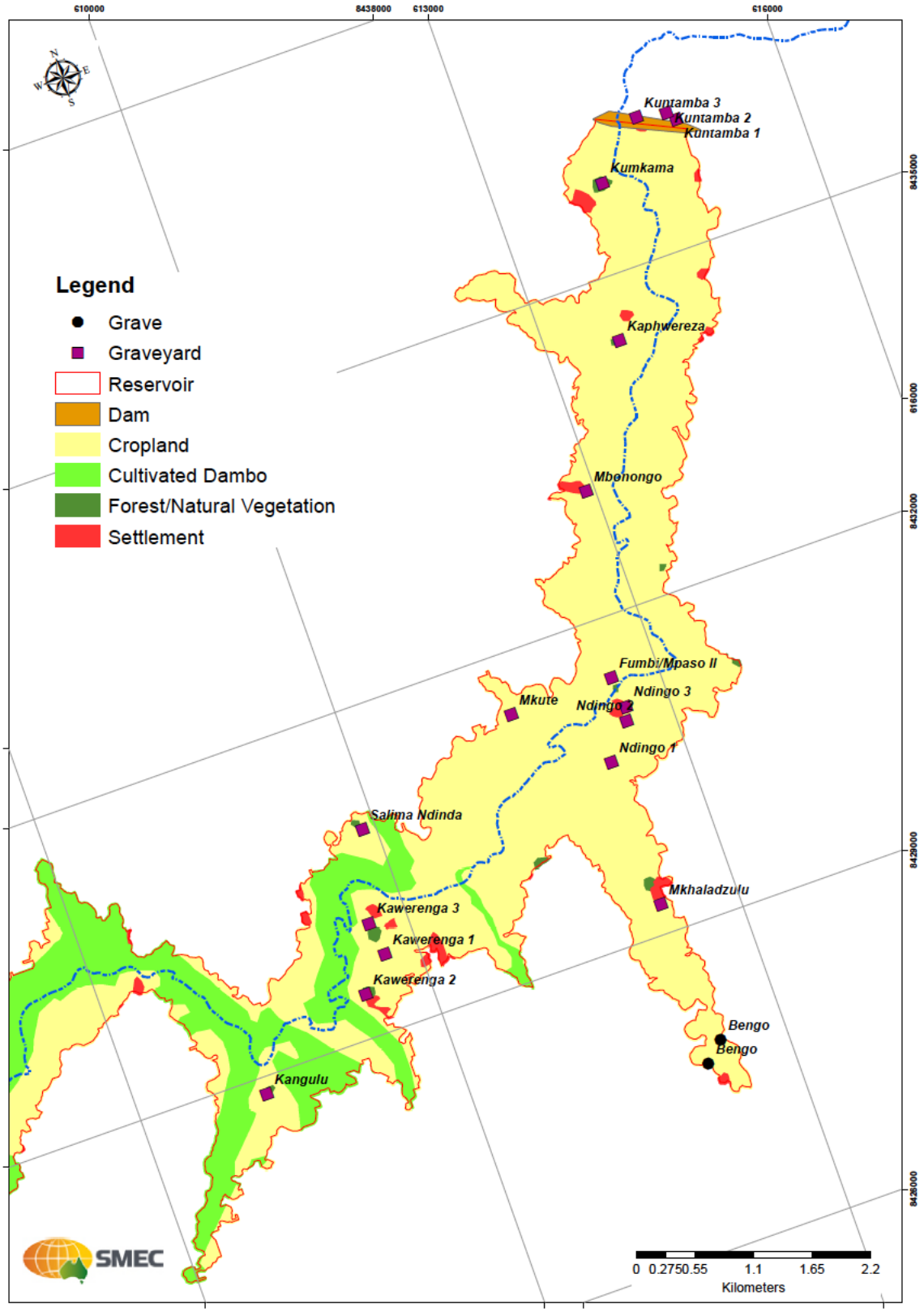


Figure 9.10: Graveyards and grave sites graveyards and individual graves in Reservoir area and Buffer Zone (Source: SMEC ground-truthing, October – December 2015)

SMEC

Local People. Global Experience.

Chapter 10
Risk Assessment

Environmental and Social Impact Assessment

February 2016

10. RISK ASSESSMENT

10.1. Risk Assessment Methodology

The IFC's Performance Standard 1 requires assessment of the risks to the environment and people / the community associated with Project development. Accordingly, this section assesses the risks associated with identified impacts generally in accordance with the guidance of AS/NZS ISO 31000:2009 – Risk Management – Principles and Guidelines. A Project risk matrix was developed and risk ranking was evaluated by considering:

- The likelihood of impact occurrence; and
- The severity or consequence of the impact in the biophysical and/or socio-economic context (including whether impacts will breach GoM legislation or Project objectives).

The risk matrix is presented in Figure 10.1.

Specialists from each discipline developed the consequence rankings to reflect the consequence or severity of impacts specific to that discipline. The rankings were developed based on consideration of:

- Whether the impact will breach legislative or policy requirements;
- The sensitivity of receptors;
- Duration of impact, i.e. whether the impact is permanent or temporary; and
- The areal extent of the impact and/or the magnitude of the impact on receptors.

There is inherent variability in the significance of impacts that is introduced by the human factor. This variability can arise as a result of such matters as:

- The range of ways in which the individuals making up a group/community/population may respond to a particular impact;
- Preconceived opinions or perceptions of the existing conditions or nature of an impact and how it will affect them; and
- The range of degrees of vulnerability to the consequence of an impact within a community (e.g., due to age, gender, economic status, level of education).

It is recognised that evaluation of the likelihood of impact occurrence is largely subjective and based upon the expert judgement of disciplined specialists.

Once the consequence and likelihood of an impact is assessed, the risk matrix provides an associated ranking of risk significance: low; moderate; high or very high. Each ranking has a definition relating to the overall risk and level of mitigation recommended for the impact.

Once mitigation measures have been applied, significance of residual risks is defined in Table 10.1.

Table 10.1 Residual Risk Definition

21 – 25 Extreme	Widespread and diverse primary and secondary impacts with significant long-term effects on the Widespread and diverse primary and secondary impacts with significant long-term effects on the environment, livelihood and quality of life. Those affected will have irreparable impacts on livelihoods and quality of life.
15 – 20 High	Significant resources and/or Project modification would be required to manage potential environmental damage. These risks can be accommodated in a project of this size, however comprehensive and effective monitoring measures would need to be employed such that Project activities are halted and/or appropriately moderated. Those impacted may be able to adapt to change and regain their livelihoods and quality of life with a degree of difficulty.
9 – 14 Medium	Risk is tolerable if mitigation measures are in place, however management procedures will need to ensure necessary actions are quickly taken in response to perceived or actual environmental damage. Those impacted will be able to adapt to changes.
1 – 8 Low	On-going monitoring is required, however resources allocation and responses would have low priority with regard to higher ranked risks. Those impacted will be able to adapt to change with relative ease.

Where residual risk was assessed as high or very high, mitigation options were reviewed to ascertain whether any further mitigation could be employed to further reduce impacts.

			CONSEQUENCE				
			Negligible	Minor	Moderate	Major	Catastrophic
		LEGAL	No legal consequences	No legal consequences	Incident potentially causing breach of licence conditions	Breach of licence conditions	Breach of licence conditions resulting in shutdown of Project operations.
		SOCIO-ECONOMIC	Impacts that are practically indistinguishable from the social baseline, or consist of solely localised or temporary/short-term effects with no consequences on livelihoods and quality of life.	Short-term or temporary impacts with limited consequences on livelihoods and quality of life. Those affected will be able to adapt to the changes with relative ease and regain their pre-impact livelihoods and quality of life.	Primary and secondary impacts with moderate effects on livelihoods and quality of life. Will be able to adapt to the changes with some difficulty and regain their pre-impact livelihoods and quality of life.	Widespread and diverse primary and secondary impacts with significant long-term effects on livelihoods and quality of life. Those affected may be able to adapt to changes with a degree of difficulty and regain their pre-impact livelihoods and quality of life.	Widespread and diverse primary and secondary impacts with irreparable impacts on livelihoods and quality of life and no possibility to restore livelihoods.
		HEALTH	No health consequences	Accident or illness with little or no impact on ability to function. Medical treatment required is limited or unnecessary.	Accident or illness leading to mild to moderate functional impairment requiring medical treatment.	Accident or illness leading to permanent disability or requiring a high level of medical treatment or management..	Accident, serious illness or chronic exposure resulting in fatality.
		ENVIRONMENT	Localised (on-site), short-term impact on habitat, species or environmental media	Localised or widespread medium-term impact to habitat, species or environmental media	Localised degradation of sensitive habitat or widespread long-term impacts on habitat, species or environmental media. Possible contribution to cumulative impacts.	Widespread and long-term changes to sensitive habitat, species diversity or abundance or environmental media. Temporary loss of ecosystem function at landscape scale. Moderate contribution to cumulative impacts.	Loss of a nationally or internationally recognised threatened species or vegetation community. Permanent loss of ecosystem function on a landscape scale. Major contribution to cumulative effects
			A	B	C	D	E
LIKELIHOOD	Expected to occur during the project or beyond the project	a	13	14	20	24	25
	May occur during the project or beyond the project	b	8	12	19	22	23
	Possible under exceptional circumstances	c	6	7	11	18	21
	Unlikely to occur during the project	d	4	5	10	16	17
	Rare or previously unknown to occur	e	1	2	3	9	15

Risk Definition	LOW No further mitigation is necessary	MEDIUM Risk is tolerable if mitigation measures are in place.	HIGH Further mitigation measures should be considered	EXTREME Further mitigation measures should be applied and/or reconsider Project design & scale.

Figure 10.1: Risk Matrix

10.2. Risk Assessment

An assessment of risks before and after proposed mitigation is presented in Table 10.3. Key residual risks are summarised below in Table 10.2.

Table 10.2 Summary of Key Project Residual Risks

RISK CATEGORIES	
Extreme 21 - 25	*Widespread and diverse primary and secondary impacts with significant long-term effects on the environment, livelihood and quality of life. Those affected will have irreparable impacts on livelihoods and quality of life.*
There are no residual risks rated as Extreme.	
High 15 - 20	*Significant resources and/or Project modification would be required to manage potential environmental damage. These risks can be accommodated in a project of this size, however comprehensive and effective monitoring measures would need to be employed such that Project activities are halted and/or appropriately moderated. Those impacted may be able to adapt to change and regain their livelihoods and quality of life with a degree of difficulty.*

Landuse (20)

The project will significantly impact on landuse, with approximately 2,342 ha predicted to be permanently sterilised from further use. This includes an extensive area of agricultural land that currently supports an estimated 25,372 people. There will therefore be widespread disruption and significant diminution of food security and livelihoods. With mitigation this impact can be reduced from Extreme to High risk, however this will depend on allocation of significant mitigation resources to relocate and compensate PAP, and appropriately offset agricultural and natural resources.

An extensive census survey has been undertaken and a comprehensive RAP prepared in accordance with applicable Malawian and World Bank requirements. Compensatory land resources include development of 1,000 ha of downstream irrigation cropland, up to 50 community based fish farms and extensive forest woodland propagation around the dam. However, due the significant level of resources required to successfully implement these measures this risk remains at the upper Medium range (20).

Air Quality (19)

The potential for significant dust generation will generally occur during the first 26 months of construction when major earthworks are being undertaken. Dust dispersion will be partially contained by surrounding topography, however there remains potential for dust to impact on sensitive receptors. This poses potential health risks, which categorises air quality as an Extreme risk.

The objective air quality criteria at sensitive receptors will be in accordance with IFC standards, however it is expected that this criteria may be exceeded on occasion, which will prompt further mitigation. It is expected that mitigation can significantly reduce potential for dust generated impacts, reducing this Risk to High. However this will require careful programing to avoid adverse weather conditions and successful implementation of a range of site mitigation and monitoring measures.

Dam Failure (17)

Dam failure is unlikely to occur during the life of the Project however the consequences of it happening could be catastrophic with the loss of life and widespread and potentially irreparable impacts on livelihoods and quality of life. Without mitigation the assessed risk is Extreme however this can be effectively mitigated by incorporating appropriate design measures and implementing effective monitoring, maintenance and security procedures. An

RISK CATEGORIES	
Emergency Response and Preparedness Plan would mitigate consequences should a dam break occur.	
Medium 9 - 14	*Risk is tolerable if mitigation measures are in place, however management procedures will need to ensure necessary actions are quickly taken in response to perceived or actual environmental damage. Those impacted will be able to adapt to changes.*

Traffic (18)

Construction traffic will vary over the course of construction. In the early stages of construction large trailer trucks will be required to move heavy plant and equipment. Water carts will also regularly use public roads to fill from offsite locations. Following excavation works deliveries will mainly relate to delivery of construction components, cement and other construction materials. Small vehicle movements including private cars and mini vans will be generated from personnel living offsite. The main potential impact is related to traffic congestion at the M1 road intersection and safety issues. Due to the possibly of accident this is rated as an Extreme risk with the possibility of death. Traffic mitigation will include a wide range of measures and their implementation will significantly reduce the likelihood that serious accidents would occur. However this risk is at the upper medium end and mitigation requires diligence and ongoing monitoring to ensure risk does not escalate.

Occupational health and Safety (OH&S) (18)

OH&S issues will be significant on a project of this scale, with significant potential for accidents includiong fatalities. In addition the influx of workers significantly increases the potential for spreading infectous diseases, including HIV/Aids. Due to the potential loss of life and impact on surrounding communities this risk is assessed as Extereme. OH&S are well established and implementing appropriate systems will significantly decrease the liklehood of accidents or health problems. However this takes a great deal of effort, including ongoing monitoring, training and ensuring a safe worksite. This risk is therefore manageable, however significant effort is required to mange any escalation of the risk.

Terrestrial Habitat (14)

Important terrestrial habitat includes forest woodland and riverine (grassland dambo) vegetation. These habitats comprise of approximately 2 % (55 ha) of the permanently affected Project area, with the remainder (2287 ha) comprising of agricultural land. The majority of affected animals use these habitats to varying extent, including to transit to areas outside of the Project area. Further, woodland and riverine grassland provide important ecological resources to local communities and four tree species have conservation significance. At a catchment level the loss of these habitats will contribute to ongoing cumulative loss due to clearing and illegal landuses.

Consequently this risk is rated as High, however proposed offset planting of compensatory habitat around the Dam and catchment management initiatives will substantially mitigate this to a Medium risk. However this remains at the higher end of the Medium range (14) due to the significant level of effort required to implement mitigation measures.

Terrestrial Wildlife (14)

Terrestrial wildlife is represented by 21 mammal, 57 avifauna and 13 reptile/amphibian species, of which 14 species have conservation significance. All species are regionally represented and none are classified as endangered. Most of these species will be capable of relocating to nearby habitats, however some will require capture and release into suitable areas. Without mitigation there will be a net loss of animals, which will contribute to the catchment wide cumulative loss of biodiversity, hence giving this a High risk ranking.

RISK CATEGORIES	
Replacement of woodland and riverine habitat around the Dam will likely increase species diversity and abundance and, in combination with other mitigation measures, would reduce the assessed risk to Medium. However effective and prolonged mitigation is required to successfully ensure habitats are fully established. **Aquatic fauna (14)** Ten fish and 68 macroinvertebrate species use the project area, with one macroinvertebrate having conversation significance. There is also a high diversity of macroinvertebrates, indicating a healthy river system. Fisheries are also an important ecological resource. The project will mainly affect three species of fish that are unlikely to readily adapt to an impoundment and changed habitat conditions, however none of the identified species are expected to be regionally impacted. Macroinvertebrates will likely increase in abundance, however species diversity within the dam and immediately downstream is expected to decline. Mitigation will include restoration of riparian habitat around the dam perimeter and careful management of downstream environmental flows, however these measures will need to be successfully implemented to effectively manage longer term risk. **Hydrology (11) and Water quality (11)** The proposed dam will change river flows and affect water availability to downstream users and riparian habitats. The Diamphwe catchment comprises of approximately 16% of the major Linthipe River catchment and the Dam would result in a corresponding reduction in water flowing into Lake Malawi. However potential impacts would be significantly higher in the section of river between the proposed Dam and the first major tributary, approximately 3 km downstream, making this a High risk. There would also be attendant impacts on water quality due to reduced downstream flows and physical-chemical changes resulting from the Dam impoundment. Proposed mitigation measures include maintaining a 90% percentile compensation flow, combined with careful regulation of water quality in water releases and catchment management initiatives. These measures will substantially lower environmental risk, as well as providing positive benefits during periods of below average flow conditions and by reducing flood peaks for major flood events. **Noise (11)** Dam construction will be a significant undertaking over a period of 3.5 years. Noise generation will vary in accordance with the construction schedule, hence mitigation measures will require evaluation and modification on a regular basis. The objective noise criteria at sensitive receptors will be in accordance with IFC standards, however it is expected that this criteria may be exceeded on occasion, which will prompt further mitigation response. Consequently this risk is rated as Moderate, whereby risks are tolerable but quick response is required. **Groundwater (11)** It is unlikely that the Project will adversely affect groundwater resources. Mitigation measures can be easily applied and in the longer term there is likely to be a positive benefit as local villages rely less on groundwater as a potable water source. However this remains a moderate risk due to the high importance of groundwater and the attendant consequences in the event of significant drawdown or pollution.	
Low **1 - 8**	*On-going monitoring is required; however resources allocation and responses would have low priority with regard to higher ranked risks. Those impacted will be able to adapt to change with relative ease.*
Other environmental issues are of low risk.	

Table 10.3 Risk Matrix

Ref.	ISSUE	RISK WITHOUT MITIGATION			MITIGATION	RISK WITH MITIGATION		
		Likelihood	Consequence	Risk		Likelihood	Consequence	Residual Risk
8.2	**WATER RESOURCES**							
1	*Hydrology* - Significant reduction in downstream flows and changes to current flow regimes - Impact on river as a result of water extraction during construction - Increased flooding	**a**	**C**	**20**	- Maintain environmental Flows equivalent to 90% percentile compensation flow (Q90), which is the flow that is available 90% of the time - Decommission diversion channel at beginning of wet season to minimise time required for dam to reach operational level (1161.9 masl) and commencement of environmental flow discharges - Dam operated to reduce flood peaks for major floods - Water extraction during construction will only be undertaken during suitable flow conditions - Emergency Response and Preparedness Plan - Implementation of weather and flow monitoring system	**c**	**C**	**11**
2	*Dam failure* - The dam is located in a seismic active area and damage due to earthquake or other unforeseen event (eg. security breach or explosion) could result in uncontrolled water discharge and potential loss of life	**c**	**E**	**21**	- Dam design has thoroughly assessed and incorporated design elements to mitigate potential damaging scenarios such as seismic events - Inspection & Maintenance Plan - Security Management Plan - Emergency Response and Preparedness Plan	**d**	**E**	**17**
3	*Water Quality* - Erosion and sedimentation - Contaminated stormwater from operational areas containing potential pollutants such as oils, solvents, paints, fuels & waste materials. - Uncontrolled liquid spills of contaminants such as fuel and oils	**b**	**C**	**19**	- Construction management plan addressing management of soil and water runoff, wastewater, solid and hazardous waste and materials handling - Clearing large vegetation stands of vegetation within the reservoir area and restricting agricultural activities for at least six months prior to inundation - Dam operational procedures to include management of environmental flow discharges to ensure poor quality dam water is not released	**c**	**C**	**11**

Ref.	ISSUE	RISK WITHOUT MITIGATION			MITIGATION	RISK WITH MITIGATION		
		Likelihood	Consequence	Risk		Likelihood	Consequence	Residual Risk
	- Sewage and wastewater discharges. - Dam impacts on water quality including deterioration of water quality due to physio-chemical changes and downstream discharge of poor quality water - Non compliance with IFC and Malawian water quality requirements				- Set up Catchment Management Committee. Catchment management initiatives to include substantial revegetation around the dam perimeter, erosion control management within the catchment and improved management of the Diamphwe River headwaters within the Dzalanyama Forest Reserve - Implementation of water quality monitoring system, including real time monitoring of key water quality parameters			
	Dam siltation - Potential to reduce operational efficiency of the dam resulting in the release of sediment into downstream waters. - Potential to accumulate nutrients and metals, which can be released into the water column under adverse conditions, such as low pH and temperature driven upwelling of cold water ('Dam-turnover').	**a**	**C**	**20**	- Dam design includes provision of 5.6 Mm^3 to store accumulated sediment below the dam water outlet infrastructure. This is sufficient to provide for approximately 47 years of accumulating sediment - Management of Dam outlet to avoid release of poor quality water	**c**	**B**	**7**
4	*Groundwater* - Groundwater recharge may be affected. - Groundwater drawdown due to water extraction during construction - Groundwater pollution from uncontrolled waste water discharges and spills of hazardous materials	**c**	**C**	**18**	- Groundwater will not be used for non-potable water use during construction. - Groundwater will be used for potable use during construction, however this will be closely monitored and potable water would be trucked in from Lilongwe if necessary. - Construction management Plan to reduce potential for offsite pollution - Implementation of groundwater level and quality monitoring system	**c**	**C**	**11**
8.2	**LANDUSE**							
5	*Impacted Area:* - Project affected land (2,682 ha) - Permanent affected land (2,342 ha) - Buffer & Temporary affected land (340 ha) *Losses:*	**a**	**D**	**24**	- RAP implementation - Plant forest woodland buffer around reservoir - Relocation of forest woodland graveyards - Rehabilitation disturbed areas - Plant Riparian dambo grassland	**a**	**C**	**20**

Ref.	ISSUE	RISK WITHOUT MITIGATION			MITIGATION	RISK WITH MITIGATION		
		Likelihood	Consequence	Risk		Likelihood	Consequence	Residual Risk
	- Agricultural cropland & cultivated dambo (2,219 ha) - Dambo Grassland (378 ha) - Forest woodland (10 ha) - Settlements (37 ha)				- Irrigation downstream (1,000 ha) - Fisheries (Pilot + 20 ponds)			
8.3	**BIODIVERSITY**							
6	*Terrestrial habitat* - Loss of important forest woodland - Loss of riparian dambo grassland (riverine vegetation) habitat (55 ha). - Removal of protected tree species without approval: Bleedwood teak, African mahogany, Coast Gold leaf and Yellow Wood - Reduced water flow to downstream riverine vegetation causing vegetation stress and loss of habitat connectivity. - Proliferation of invasive species (Azolla filiculoides) - Loss of ecological resources to local communities - Cumulative impact due to continuing loss of habitat in the wider catchment	**a**	**C**	**20**	- Plant forest woodland buffer around reservoir (156 ha) - Relocation of forest woodland graveyards (10 ha) - Plant Riparian dambo grassland around dam shoreline - Ensure approval for removing protected tree species - Maintain environmental flows to minimise impact on downstream riverine habitat - Implement program to monitor and manage invasive vegetation species - Catchment management initiatives to include better management of natural habitat within the dam catchment, including the Dzalanyama Forest Reserve.	**a**	**B**	**14**
7	*Terrestrial Wildlife* - 1. Mammals: 21 identified species will be displaced by the Dam, most of which use riverine and forest woodland habitat. - Mammal species of conservation significance are the larger common duiker, jackal, spotted hyena and the clawless otter. Approval will be required to interfere with their habitats.	**a**	**C**	**20**	- Ensure planting of forest woodland buffer and new graveyard sites reflect habitats of affected species - Salvage appropriate vegetation (hollow logs, seedlings, seeds, etc) affected by the project and reuse in areas to be planted with forest woodland and riverine vegetation - Ensure approval for removing protected animal species - Undertake further site surveys during the wet season, particularly for amphibian species	**a**	**B**	**14**

Ref.	ISSUE	RISK WITHOUT MITIGATION			MITIGATION	RISK WITH MITIGATION		
		Likelihood	Consequence	Risk		Likelihood	Consequence	Residual Risk
	- 2. Avifauna: 57 identified species use the Project area, including two of international significance (Little Sparrow Hawk and Peregrine Falcon), while four species are protected under the National Parks and Wildlife Act, 2004 (Broadbilled Roller, Red Winged Francolin, Guinea fowls and Owls). - Approval will be required to interfere with their habitats. Riverine and forest woodland are the most important habitats. Most affected will be ground dwelling birds (such as guinea fowls, red francolin and quails) and less mobile birds (Owls) inhabiting riverine and woodland habitats. - 3. Reptiles & Amphibians: 13 identified species use the Project area. Species of conservation significance include the Nile Crocodile, Nile Monitor Lizard and two snakes: Python and Mamba. Small and less mobile animals such as frogs may require physical relocation. - Surveys were undertaken over a 4 week period during the dry season, which may not reflect the status of frog populations.				- Management plan to capture and relocate animals that cannot easily leave the affected area to a suitable habitat. Affected animals could include ground dwelling birds, sedentary owls, and small and less mobile animals such as python and frogs - Management plan to minimise adverse crocodile / human interactions			
8	*Aquatic Fauna* - 1. Fish: 10 identified fish species use the study area. None are listed as having conservation significance. - Some species will readily adapt to Dam conditions, although some will rely on establishment of riparian vegetation around the Dam. It is expected that 3 species - *Labeo cylindricus* (Ningwe), *Labeobarbus johnstonii* (Mphondo) and *Amphilius uranoscopus*	**a**	**C**	**20**	- Plant riparian vegetation around Dam perimeter - Maintain environmental flows to minimise impact on downstream riparian habitat, river flows and water quality - Construction management plan to minimise potential water quality impacts - Dam operational procedures to include management of environmental flow discharges to ensure poor quality dam water is not released	**a**	**B**	**14**

Ref.	ISSUE	RISK WITHOUT MITIGATION			MITIGATION	RISK WITH MITIGATION		
		Likelihood	Consequence	Risk		Likelihood	Consequence	Residual Risk
	(Nkholokolo) -will be affected by changes to habitat and flow conditions and will relocate upstream of the dam. - Downstream fish populations could be affected by changes to flow regimes and poor water quality. - Introduced fish species adversely affecting local populations and potentially entering and impacting on Lake Malawi. - *2.* Macro invertebrates*:* 68 identified species use the study area. One species (medical leach, *Hirudo medicinalis*) has conservation significance. - Dam will impact on species diversity, however this will be localised and species abundance will likely increase. - Introduction of pest fish species competing with endemic species. - Proliferation of aquatic weed such as Red Fern				- Do not allow introduction of non endemic species and ensure any pest species are quickly removed from the Dam. iv. ***Implement system to manage pest species including treating infestations as soon as they are noticed.*** ○ ***People from the local community should be employed on a part time basis to patrol the dam and upstream areas, and any detection of pest species immediately reported to the Dam environmental representative. Local community can also be employed to clear weed infestations. Collected weed should be appropriately disposed of by burial or incineration.*** ○ ***All boats and equipment used on the dam should be regularly inspected and cleared of weed fragments.*** ○ ***Education of the local community about how risk of contaminating the dam can be reduced, including the the risk and consequences of introducing pest flora and fauna species.*** ○ ***In the event of extreme infestations of aquatic weed a herbicide (glyphosate) can be used, which is very effective, however a thorough risk assessment would need to be undertaken before any herbicides are used.*** ○ ***Fishers to be trained in identifying potential pest species and encouraged to report their catches.***			

Ref.	ISSUE	RISK WITHOUT MITIGATION			MITIGATION	RISK WITH MITIGATION		
		Likelihood	Consequence	Risk		Likelihood	Consequence	Residual Risk
8.7	**NOISE AND AIR QUALITY**							
	Noise - Noise levels consistently exceed IFC guidelines of: ○ ***55 $L_{Aeq,1hr}$ (dBA): Residential, institutional and educational; and*** ○ ***70 $L_{Aeq,1hr}$ (dBA): Industrial and commercial***	b	C	19	- Contractor to undertake detailed noise modelling assessments prior to major construction activities, such as quarrying and crushing, river diversion works and at various stages of dam construction. Modelling results would form the basis for implementing appropriate mitigation measures, including scheduling the works, selection of plant and equipment and temporary noise barriers. - Construction Management Plan detailing monitoring and mitigation requirements	c	C	11
	Air Quality - Air particulates levels consistently exceed IFC guidelines of: ○ ***50 g/m3 for 24-hour average PM10 for the Project considered alone; and*** ○ ***20 g/m3 for annual average PM10 due to the Project and other sources.*** - Health related impacts on sensitive receptors	b	D	22	- Program dust generation activities outside of hot and dry months (September and October) as much as possible. - Construction Management Plan detailing monitoring and mitigation requirements, including sealing access road, water spraying active areas and replanning activities during adverse weather conditions.	b	C	19
8.8	**WASTE**							
	Uncontrolled disposal of liquid and solid wastes on site	**b**	**D**	**19**	ESMP implementation to minimise, reuse, recycle and appropriately dispose of liquid and solid waste	**c**	**C**	**11**
8.9	**TRAFFIC**							
	- Increased Traffic on the access road at the M1 Road intersection and access road to the construction area could interfere with public traffic and deteriorate safety (especially the school children	b		D	- Implement ECP 15: Road Transport and Road Traffic Management. - Include in the contractor's traffic management plan to ensure uninterrupted traffic movement during construction: detailed drawings of traffic arrangements showing all detours, temporary road, temporary	**c**	**D**	18

Ref.	ISSUE	RISK WITHOUT MITIGATION			MITIGATION	RISK WITH MITIGATION		
		Likelihood	Consequence	Risk		Likelihood	Consequence	Residual Risk
	and elderly people), spillage of fuels and chemicals, and damage to infrastructures and properties due to vibration.				bridges, temporary diversions, necessary barricades, warning signs / lights, road signs, construction schedule etc.			
	OCCUPATIONAL HEALTH & SAFETY							
	- Poor worker safety systems - Safety threats to workers and the community - Poor health management, including lack of HIV/AIDS awareness. - Unacceptable Worker Lost Time	b		E	- Occupational health and safety procedures will be enforced at site. Each contractor will be required to prepare, obtain approval of, and implement an occupational health and safety (OHS) plan. These plans will be prepared in compliance with the ECP 18: Workers Health and Safety and World Bank Group's Environment, Health, and Safety (EHS) Guidelines. - All workers will be adequately trained and provided with proper personal protection equipment (PPE).Frequent supervision will be carried out by supervision consultants to ensure they are wearing proper PPE at all times. - Contractor OHS plan to describe the tasks and methods to be used by workers associated with construction and diving operations, and how to perform them safely and state how potential hazards are identified and handled. Contractors will ensure that construction workers are adequately informed about the OHS plan. - Contractors will train workers to deal with safety from hazards such as crocodile attack and snake bite. - Special attention will be focused on safety training for workers to prevent and restrict accidents and deal with emergencies.	**c**	**D**	18

Chapter 11
Public Consultation

Environmental and Social Impact Assessment

February 2016

11. PUBLIC CONSULTATION

11.1. Consultation Process

Historically there has been an extensive consultation process for the Project, including through the former Consultants, WAPCOS. Consultation has continued with this study, over the period from 21 August 2015 to date, including the following:

- Formal meetings, report backs and presentations to the Client, represented by the MoAIWD, the NWDP, the LWB, the World Bank (WB) and the International Finance Corporation (IFC);
- Direct interviews with stakeholders, and particularly representatives of national and district level governmental institutions, service providers and NGOs/CSOs;
- Formal meetings with representatives of TAs and DCs, organised by the Client;
- Community meetings on site, with village members, TA representatives, and DPC members, organised by the Client;
- Small focus group discussions with special interest groups; and
- Organising and undertaking the ground-truthing exercise, the Asset, Census and Socio-Economic surveys, the health and cultural heritage studies, and other RAP-related activities.

Stakeholders consulted during the course of this study are summarised in Table 11.1.

Table 11.1 Stakeholder Consultation

ORGANISATION	DATE/TYPE OF CONSULTATION
GOVERNMENT OFFICES AND DEPARTMENTS	
NATIONAL	
Department of Forestry	28/08/2015 Personal interview, Assistant Officer to JICA
Department of Antiquities (DoA)	- 23/10/15 Personal interview, Archaeologists and Geo-archaeologists - 23/10 and 26/10/15 Meetings with Consultant and Client - 17 and 18/11, 02/12/15 Formal meetings
Department of National Parks and Wildlife (DNPW)	23/11/15 Personal interview, Assistant Director Research and Development, Deputy Director Research
LILONGWE DISTRICT COUNCIL	
District Commissioner	03/11 and 18/11/15 Formal meetings
District Planning and Development Office	13/11/15 Personal interview, Director of Planning and Development (DPD)
Community Development Office	13/11/15 Personal interview, District Community Development Officer (DCDO)
District Forestry Office	28/08/2015 Personal interview, District Forestry Officer (DFO)
District Fisheries Office	28/08/2015 Personal interview, Assistant Director of Fisheries (ADOF)
District Environmental Health Office	13/11/15 Personal interview, District Environmental Health Officer (DEHO), Assistant Environmental Health Officer (ADEHO)
LILONGWE DISTRICT TRADITIONAL AUTHORITIES (TAS)	
Chadza, Kalumbu, Mazengera TAs	Ongoing, including: - 16-22/09/15 Meetings on site - 03/11 and 18/11/15 Formal meetings

ORGANISATION	DATE/TYPE OF CONSULTATION
DEDZA DISTRICT COUNCIL	
District Commissioner	03/11 and 18/11/15 Formal meetings
District Council Administration Office	04/11/15 Personal interview, District Council Administrator (DCA)
District Agriculture Office	21/09 and 19/11/15 Personal interviews, District Agriculture Development Officer (DADO), District Land Officer (DLO), District Housing Officer (DHO) and Agricultural Extension Development Coordinator (AEDC),
District Irrigation Office	06/11/15 Personal interview, District Irrigation Officer (DIO)
District Water Development Office	05/11/15 Personal interview, District Water Officer (DWO)
District Fisheries Office	06/11/15 Personal interview, District Fisheries Officer (DFO)
District Animal Health and Livestock Development Office	05/11/15 Personal interview, District Animal Health and Livestock Development Officer (DAHLDO), Assistant Vetinary Officer (AVO)
District Health Office	04/11/15 Personal interview, Chief Preventive Health Officer (CPHO)
Environmental District Office	06/11/15 Personal interview, Environmental District Officer (EDO), Secretariat for DESC, and acting Monitoring and Evaluation Officer
District Gender, Child and Community Development Office	- 08/09/15 Community meeting - 14/09/15 Workshop - 04/11/15 Personal interview
District Social Welfare Office	04/11/15 Personal interview, Social Welfare Assistant (SWA) and Child Protection Worker (CPW)
DEDZA DISTRICT TRADITIONAL AUTHORITIES	
Kaphuka, Chilikumwendo,	Ongoing, including: - 16-22/09/15 Meetings on site - 03/11 and 18/11/15 Formal meetings
HEALTH CENTRES	
Mdeza Health Centre	04/11/15 Personal interview, Medical Assistant
Chitowo Health Centre	09/11/15 Personal interview, Nurse in Charge/Midwife Technician
Diamphwe Health Centre	09/11/15 Personal interview, Medical Assistant, Assistant EHO, Health Surveillance Assistants (HSAs)
Kamphata Health Centre	11/11/15 Personal interview, Nurse/Midwife Technician
Kasina Health Centre	12/11/15 Group meeting, village leaders; personal interview, Team Leader of Community Programmes, Extension Worker
NGOs/CSOs	
NGO/CSO representative organisations	17/11/15 Formal meeting
Catholic Development Commission in Malawi (CADECOM), Dedza	05/11/15 Personal interview, Coordinator
Centre for Children Aid, Dedza	05/11/15 Personal interview, Executive Director
Church and Society, of CCAP Church of Central Africa Presbyterian (CCAP), Dedza and Nkhoma	17/11/15 Personal interview, CCAP Church elder
Catholic Commission for Justice and Peace (CCJP), Dedza	19/11/15 Personal interview, Coordinator
Concern Universal, Dedza	04/11/15 Personal interview, Health Manager
Kasusu Community Based Orphan Care Organisation (KACO), Dedza	04/11/15 Personal interview, Coordinator

ORGANISATION	DATE/TYPE OF CONSULTATION
National Smallholder Farmers Association of Malawi (NASFAM), Nathenje	12/11/14 Personal interview, Centre Manager
National Initiative for Civic Educaiton (NICE), Dedza	19/11/15 Personal interview, Assistant District Civic Education Officer (ADCEO)
Rights Advice Centre (RAC), Dedza	05/11/15 Personal interview, Finance and Administration Officer, and Paralegal
WaterAid, Lilongwe	02/10/15 Personal interview
World Vision, Dedza	05/11/15 Personal interview, Health and Food Security Development Facilitators
PROJECT STRUCTURES – DAM PROJECT COMMITTEE (DPC)	
Lilongwe and Dedza DPCs	Ongoing, for Asset, Census and Socio-Economic Surveys. Additional consultation includes: - 08/09/15 Community meeting - 14/09/15 Workshop - 16-22/09/15 TA meetings and ground-truthing exercises - 28-30/09, 01-02/10 and 06-10/10/15 Small Group Discussions - 04/11/15 Public Health introductory meeting on site - 13/11/15 Health meeting, Lilongwe
PROJECT AFFECTED PEOPLE AND COMMUNITIES	
Lilongwe and Dedza communities	Ongoing, for Asset, Census and Socio-Economic Surveys. Additional consultation includes: - 08/09/15 Community meeting - 14/09/15 Workshop - 28-30/09, 01-02/10 and 06-10/10/15 Small Group Discussions - 05/11/15 Health meetings, Chinkhuti and Kumkama Villages - 10/11/15 Health meetings, Chidothi, Njiwa and Kangong'o Villages - 13/11/15 Health meeting, Makoko Village

11.2. Consultation Outcomes

Details of consultation undertaken by SMEC, including the people consulted – their names, positions and contact numbers – and the issues discussed, are presented in **Appendix 9**.

There is strong community support for the proposed dam and high expectations that livelihoods would be improved by better access to a clean and sustainable water source, as well as opportunities afforded by irrigation, fisheries and new businesses. However there remains significant apprehension about the impact the dam could have on people's homes and livelihoods.

The majority of those consulted would prefer to remain in the immediate area. People were unhappy about the prospect of relocating, losing their agricultural land, and leaving their cultural attachments to their villages and graveyards. Some were concerned about not being able to cross the river, however most queries related to what restrictions there might be on accessing the reservoir for fishing, washing and watering their animals. A number of people were interested in opportunities for setting up businesses and supplying seedlings for use in rehabilitation areas.

The NWDP and the LWB have continued to consult over issues relating to graves and graveyards, with input from the DoA and local authorities.

12. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

12.1. Introduction

The ESMP will guide the actions necessary for implementation of commitments and mitigation measures identified in the ESIA and RAP, and facilitate proactive management of the environmental and socio-economic aspects of Project construction, operation and closure.
The Plan sets out the '*what, who, how, and when*' measures will be achieved, and identifies the resources required for implementation. The Plan includes:

- Provision of a schedule for implementation of key commitments and/or activities;
- Details of monitoring activities required to verify implementation and effectiveness of mitigation measures; identification of institutional capacity requirements; and
- A process and timeframe for reporting, auditing and review.

The Plan has been prepared in accordance with the following:

- The Project ESIA and RAP;
- Government of Malawi regulatory requirements and standards; and
- World Bank and IFC Performance Standards on Environmental and Social Sustainability.

In order to apply the principles of adaptive management, the ESMP will be subject to periodic review, update, and external audit with the aim of facilitating compliance with regulatory requirements and driving continual improvement of the Project's environmental performance and stakeholder relationships.

Key Acronyms used in this ESMP are defined in *Table 12.1*.

Table 12.1 ESMP Acronyms

CEAP	Construction environmental action plan	LWB	Lilongwe Water Board
CPLO	Community Liaison and Participation Officer	GO	Grievance Officer
CSC	Construction Supervision Consultants	MEC	Monitoring and Evaluation Consultant
DC	District Council	MoAIWD	Ministry of Agriculture, Irrigation and Water Development
DCCMA	Department of Climate Change and Meteorological Services	NRWA	National Water Resources Authority
DOH	Department of Heritage	PAP	Project Affected Person
DWR	Department of Water Resources	PIU	Project Implementation Unit
DoF	Department of Forestry	PCC	Program Coordination Committee
ECP	Environmental Codes of Practices	PCC	Program Coordination Committee
ESHS	Environmental, Social and Health & Safety	RAP	Resettlement Action Plan
ESMP	Environmental and Social Management Plan	RWC	Resettlement Working Committee
FRIM	Forest Research Institute of Malawi	VNRMCs	Village Natural Resources Management Committees
GOM	Government of Malawi		

12.2. ESMP Objectives and Performance Indicators

The ESMP addresses mitigation measures, monitoring and institutional arrangements for the environmental management of the Project. It provides the basis for evaluating the efficiency of mitigation and enhancement measures and suggests further actions that need to be taken to achieve the desired Project outcomes.

Objectives for the Project are to:

- Ensure compliance with the ESIA and RAP, including minimising pollution and waste generation, minimising environmental and social impacts and ensuring support and integration with the local communities.
- Describe in detail mitigation measures to be carried out, including costing, scheduling and assigning responsibility for such measures.
- Provide a detailed monitoring process and schedule, and a description of any training support that may be required.
- Maximize potential project benefits and control negative impacts.

Key indicators and targets for the environmental and social performance of the Project are presented in Table 12.2.

Table 12.2 Aspects and Objectives

Performance Indicator	Target
Legislative Compliance	No breach of environmental or social legislative or regulatory requirements, including all commitment documentation.
Stakeholder Relations	Prompt and effective response to any community complaints.
Employee Training	Appropriate training and resources to all employees to meet their environmental and community relations responsibilities.
Environmental Performance	No environmental incidents resulting in irreversible damage or adverse off-site impacts to the environment or community.

12.3. Various Categories of Mitigation Measures

The ESMP includes various categories of mitigation measures and plans:

(a) General and non-site-specific measures in the form of environmental codes of practices (ECPs) presented in **Appendix 10** to address general construction and operation matters.

(b) Project specific and to the extent possible, site-specific mitigation measures discussed in Chapters 8 and 9, and summarised in Section 10;

(c) Construction environmental action plan (CEAP) with site-specific and contract-specific management plans to be prepared by the contractor;

(d) Entitlement framework; and

(e) Proposed ESMP Sub-plans to address cumulative impacts.

12.4. Inclusion of ESMP in Contract Documents

In order to make the Contractors fully aware of the implications of the ESMP and responsible for ensuring compliance, technical specifications in the tender documents will include compliance with mitigation measures proposed in the ESIA as well as IFC's General EHS Guidelines. The Contractor must

be made accountable through contract documents for the obligations regarding the environmental and social components of the project.

Contractors need to prepare site specific construction management plans to address various environmental issues, and to demonstrate the manner in which the Contractor will comply with the requirements of ECPs and ESMP. It will be reviewed and approved by Construction Supervision Consultants (CSC), Environmental, Social, Health and Safety (ESHS) Unit, and Project Implementation Unit (PIU) before implementation of construction works.

12.5. Implementation and Institutional Arrangements

12.5.1. **Project Implementation**

The project will be implemented through GoM's existing institutional arrangements for water service delivery and water resources management, with minor adjustments to mitigate implementation risks. Lilongwe Water Board (LWB) will be the lead implementing agency for the project, through its existing Project Implementation Unit (PIU). The PIU is responsible for delivering LWB's capital projects and is staffed with qualified Engineers, procurement specialists and accountants. However, the unit will require strengthening in the areas of project/contract management, environmental and social safeguards through recruitment of additional staff and consultants as needed.

In addition to the PIU, LWB will form a small Taskforce drawn from its different departments to coordinate implementation of institutional strengthening activities related to LWB scope. Institutional strengthening activities related to catchment management will initially be coordinated by the Department of Water Resources (DWR) of MoAIWD, and later be the National Water Resources Authority (NRWA) once it is fully established and operational. The Ministry of Natural Resources, Energy and Mining, through the Department of Forestry (DoF) and Department of Climate Change and Meteorological Services (DCCMA), will provide support and technical advice as needed on catchment management issues.

The PIU will be responsible for overall project management, including procurement and financial management. The PIU will also be responsible for:

(a) Managing the project's designated account and ensuring proper and timely project accounting and reporting of project expenditures, and

(b) Preparing consolidated progress reports.

The PIU Manager will be the focal point for the World Bank, and will work closely with focal point officers from other participating entities.

The LWB Organogram and Implementation Flow Chart are provided in *Figure 12.1* and *Figure 12.2*.

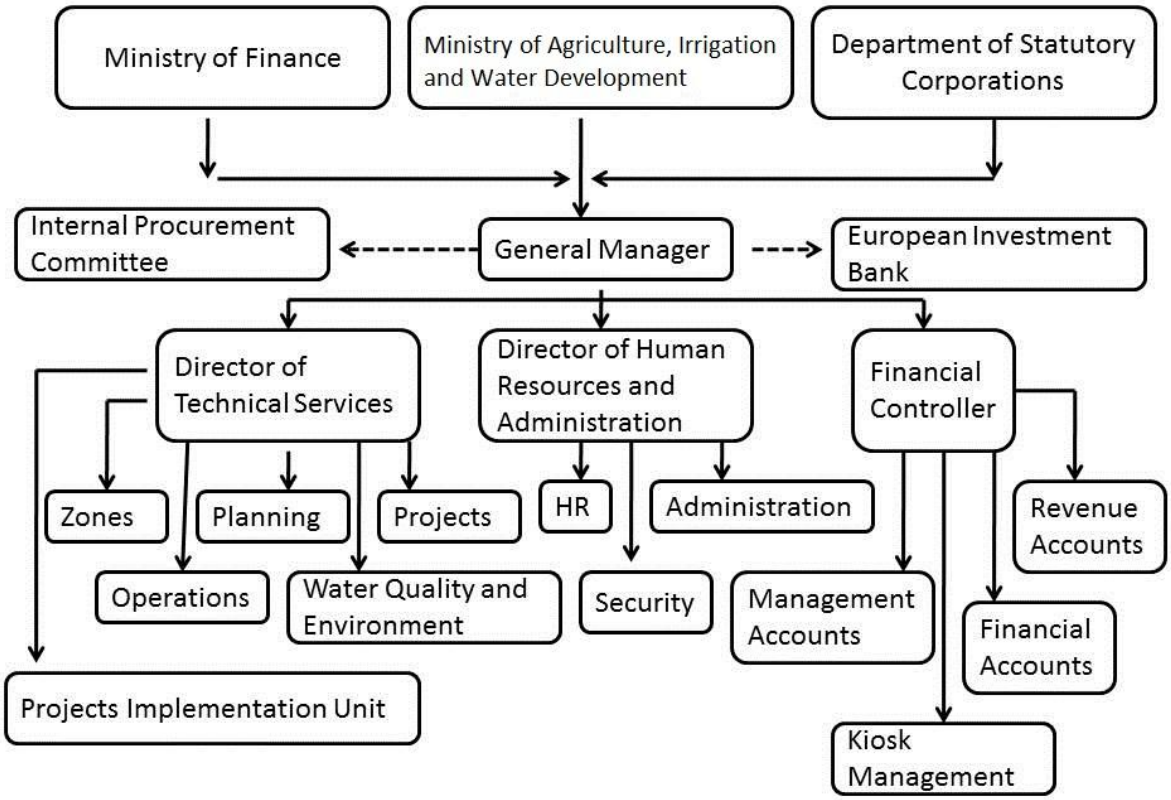


Figure 12.1: LWB Organogram (LWB, 2016)

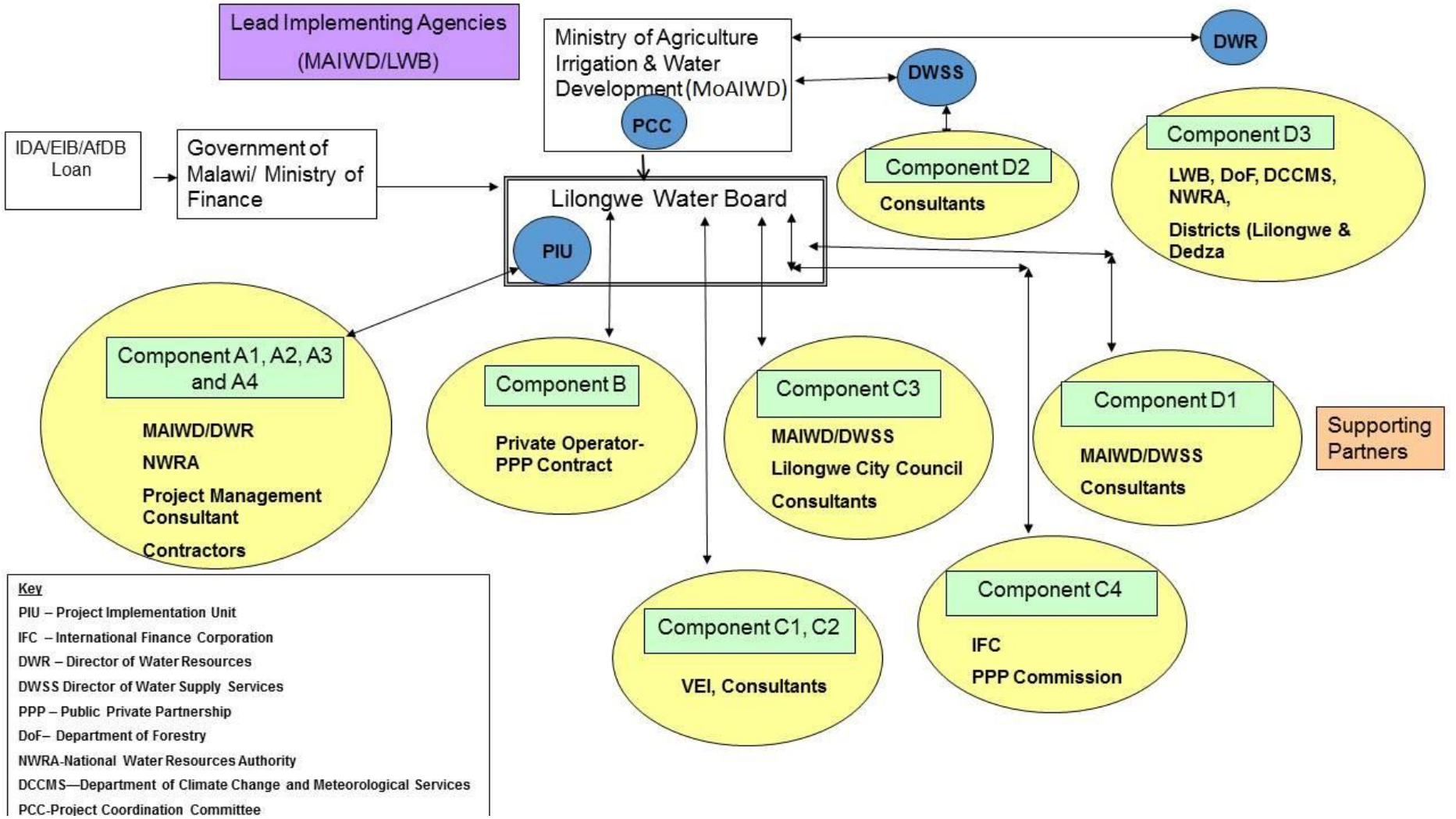


Figure 12.2: Implementation Flow Chart (LWB, 2016)

12.5.2. **Program oversight and coordination**

Overall Program oversight and coordination will be at the Ministry level through the Program Coordination Committee (PCC), to be established within MoAIWD and chaired by the Chief Director, Irrigation and Water Development. The PCC will consist of

(i) CEO of Lilongwe Water Board and PIU Manager,

(ii) Directors of Water Resources, MoAIWD;

(iii) Director of Water Supply and Sanitation, MAOWD;

(iv) Director of Irrigation, MAIWD;

(v) CEO of NRWA;

(vi) Representative from the PPP commission;

(vii) Representative from Lilongwe City/District councils and Dedza District Council;

(viii) Representative from Diamphwe Dam Committees; and

(ix) Representative from other ministries/agencies with some involvement in the Program.

The PCC's responsibilities will include

(i) Advocacy and oversight of the overall Lilongwe Water Program;

(ii) Providing strategic guidance and facilitating inter-agency coordination;

(iii) Monitoring and evaluation of progress and impact of the Programme on the sector and national economy;

(iv) Coordination and integration of program activities to maximize impact;

(v) Acting as a collective policy and decision making body for the whole Program;

(vi) Ensuring that the program and project adheres to agreed environmental social safeguard measures.

The PCC will be supported by a small secretarial housed within MAIWD/LWB and staffed with a Program Coordinator, a Communications Specialist and a Monitoring and Evaluation Specialist. MoAIWD will also retain the existing Dam Safety Panel that has been reviewing and providing advice on dam safety and other aspects of dam operations in Malawi. Further details on implementation arrangements will be provided in the Program Operations Manual.

12.5.3. **Legal Structure**

The legal structure for World Bank/IDA financing will consist of three agreements;

1) MoFEPD, representing the Government of the Republic of Malawi will sign a Financing Agreement with the Bank.

2) A Subsidiary Agreement between MoFEPD and LWB through which funds and responsibility for project implementation will be passed on to LWB under terms acceptable to the Bank.

3) A Project Agreement between LWB and the Bank, which will define eligible activities and implementation modalities.

12.5.4. **Institutional strengthening**

Institutional strengthening will include:

- Strengthening the PIU in the areas of project/contract management, environmental and social safeguards through recruitment of additional staff and consultants as needed.
- Formation of the Programme Coordination Committee.

12.5.5. **Technical Services and Project Implementation Unit (PIU)**

LWB's PIU will monitor and coordinate all project implementation activities and be responsible for all aspects of project implementation including technical, operational, and financial management, and overseeing the implementation of the ESMP. It is proposed to have an Environmental, Social, Health, and Safety Unit (ESHSU) consisting of the following staffs:

- Environmental, Social, Health, and Safety Officer
- Assistant Water Quality and Environmental Officer;
- Social Safeguard Officer
- Environmental, Health and Safety Officer and
- Laboratory Technicians.

The job descriptions of the positions above are presented in **Appendix 10.1**. The responsibilities of the ESHSU are:

(i) Supervising, facilitating and coordinating implementation of environmental and social plans including the ESMP and RAP;

(ii) Ensuring that contractors follow Malawi-EAD regulations, World Bank Safeguard Policies, and other requirements mentioned in the ESMP and RAP,

(iii) Identifying any issues of non-compliance and report them,

(iv) Suggesting mechanisms to link contractor performance in relation to the ESMP to the timing of financial payments, incentives or penalties, and

(v) Interacting with other stakeholders (especially EDO, HIV/AIDS Coordinator in DC Office) for their concerns about the construction activities.

12.5.6. **Construction Supervision Consultants (CSC)**

The CSC will be responsible for supervising the contractors responsible for implementing the ESMP and RAP. For this purpose, the CSC will appoint dedicated environment, social, Health and Safety and HIV/AIDS personnel to ensure the implementation of environmental and social management plans during the project. They will supervise the contractor for the ESMP implementation, particularly the mitigation measures. They will also be responsible for implementing the monitoring of effects of these measures. CSC Terms of Reference are given in **Appendix 10.2**.

CSC will have the following environmental staff:

- Unit Leader/Environmental specialist;
- Environmental, Occupational Health and Safety Specialist;
- Social Specialist;
- Ecologist;
- HIV/AIDS Specialist; and

- Field Surveyors.

Environmental staff will closely supervise the construction team to ensure that all environmental and social commitments are incorporated into the construction activities and work processes. The Terms of Reference (TOR) of the CSC is presented in Volume 10. Specific responsibilities include:

- Supervising and supporting contractors in achieving their responsibilities as outlined in the ESMP;
- Issuing non-compliance notices to the contractors;
- Providing input, advice, and approval on activity specific work plans relating to ESMP;
- Supervising the implementation of activity specific work plans;
- Regularly reviewing and assessing environmental risks throughout the construction phase;
- Identifying and preparing environmental induction and training materials;
- Conducting environmental and social trainings and building awareness on HIV/AIDs and STDs;
- Assist ESHSU in addressing and resolving environment-related complaints and grievances;
- Responding to occupational, health, and safety incidents as required;
- Managing compliance reporting as it relates to the Project, and preparing monthly ESMP compliance reports;
- Liaise with ESHSU for effective environmental management at site;
- Liaise with the Public Affairs and Health Clinics, and other relevant Project entities; and
- Reviewing ESMP and revising it if required on six-monthly basis.

12.5.7. **Monitoring and Evaluation Consultant (MEC)**

MEC will be recruited by PIU to carry out independent monitoring of the ESMP implementation. The MEC will have environmental and social experts and will carry out intermittent third party monitoring of the project. MEC will also carry out annual third party auditing of the ESMP and make further modifications if required. MEC Terms of Reference are given in **Appendix 10.3**.

12.5.8. **Contractors**

Contractors are also required to appoint the following environmental staff:

- Environmental, Health, and Safety coordinator;
- Ecologist (manages biodiversity issues, including animal relocations);
- Rehabilitation Specialist (responsible for site rehabilitation, as well as working with Dam Catchment Management Committee);
- Environmental Scientist (responsible for environmental monitoring);
- HIV/AIDS Program Coordinator, Field Program Coordinating Officers, and Unit Support Staffs;

- Social/Community Liaison Officer; and
- Human Resources Officer.

The contractor will develop various plans addressing health, safety, the environment and social issues (discussed in Section 8.9), and get them approved by the CSC. The contractor will also be responsible for communicating with and training of its staff in the environmental/social aspects before commencement of site works. Appropriate numbers (in braces) of the following personnel are required in the contractor's environmental team are given in *Table 12.3*.

Table 12.3 Contractor Personnel

Personnel	Number
EHS coordinator	1
Ecologist	1
Rehabilitation specialist	1
Environmental Scientist	3
HIV/AIDS Program Coordinator	1
HIV/AIDS Field Program Coordinating Officers	3
HIV/AIDS Unit Support Staffs	3
Social/Community Liaison Officer	1
Human Resources Officer	1

The construction contract will have appropriate clauses to bind the contractor for the above obligations.

12.5.9. **Resettlement Working Committee (RWC)**

Since the Project will deal with a range of different communities and complex socio-economic systems and issues, a representative organisational structure will be required to ensure that all Project activities relating to resettlement are properly planned, implemented and monitored.

It is recommended that a Resettlement Working Committee (RWC), dedicated to the Project, be created at to fulfil this 'managerial' function, to ensure proper coordination of compensation, mitigation (and, where required, relocation) activities.

The RWC will work parallel to, and in close co-operation with, the MoAIWD, NWDP and LWB, recognising that these ministerial bodies are ultimately responsible for co-ordination of Project activities. It will also work in close collaboration with the Project's existing DPCs.

A draft Terms of Reference for the RWC is included in the RAP (Appendix I), providing detail to the composition of the RWC, its responsibilities, and how it will operate.

The RWC will have representation from:

- The MoAIWD, the NWDP and the LWB;
- Concerned government departments and agencies, in particular at District level, and those providing required services in support of the Project;
- Representatives of the DPCs, including Ward Councillors and Chiefs, GVHs and VHs;
- Other agencies that may be involved in resettlement issues, such as NGOs/CSOs; and
- Other key stakeholders as required.

The RWC will have the following key functions:

- Advising on the implementation of aspects relating to this RAP;
- Acting as a mechanism for information exchange, complementary planning and coordination of implementation activities;
- Ensuring adherence to the Project's compensation and relocation policies;
- Assessing the progress and efficacy of the Project's programme, and suggesting modifications where necessary;
- Identifying issues/areas of concern and suggesting corrective measures;
- Assisting with the identification of socio-economic development and livelihood restoration opportunities in the resettlement areas; and
- Disseminating information on Project developments, reporting back to the organisations or people they represent, including the DPCs, PAC and PAP.

Specific issues requiring assessment and discussion may occur during implementation of the Project. Where necessary, special Sub-Committees will be established within the RWC; for example, a Compensation Sub-Committee (CSC), focusing on compensation rates and payment procedures; and a Grievance Sub-Committee (GSC) focusing on grievances and dispute resolution. The Sub-Committees will make recommendations to the RWC on resolutions for further action required.

12.5.10. **Community Liaison and Participation Officer (CPLO)**

A Community Liaison and Participation Officer (CPLO) would have sufficient personnel and resources to ensure that the consultation activities are effectively implemented and managed, including a number of Consultation Officers (COs) from the PAC with extensive experience in community consultation issues. All would be based at a Project Information Office and work directly with the local authorities, DPCs, the RWC and its Sub-Committees, PAP, other locally-based stakeholders, and any bodies involved in the Project at field level.

12.5.11. **Grievance Officer (GO)**

It is necessary to establish a defined institutional base to implement and manage the Grievance Mechanism (GM), with input from all relevant stakeholders, including the PAC and PAP. Responsibility for matters relating to grievance and dispute resolution lies with the MoAIWD, working in close collaboration with the NWDP and the LWB. However, it is recommended that, for this Project, a Grievance Officer (GO) be appointed within the PMU of the NDWP to co-ordinate all functions relating to grievances. The GO need be based primarily at the Project Information Centre, working in close consultation with the COs.

The GO would liaise closely with a **Grievance Sub-Committee** (GSC) of the RWC. As part of the proposed organisational framework, a specific GSC of the RWG would be best placed to address grievances and disputes that are not resolved by the GO. The Terms of Reference (ToR) of this Task Group would include the definition of membership, roles and responsibilities, powers and *modus operandi*, and the process for further action if required. A draft ToR of the GSC is presented in the RAP (Appendix I).

12.5.12. Dam Catchment Committee

A dam Catchment Committee will be set up with responsibility for coordinating rehabilitation of the Dam buffer zone and catchment management activities within the Dam catchment. The committee will have an annual budget to coordinate the following activities:

- Special advice to contractors and dam operator;
- Plant nursery operations; and
- Coordination of catchment management activities under the direction of the LWB.

The Committee will comprise of representatives from MoAIWD, LWB, Lilongwe and Dedza DCs, Department of Forestry, Department of National Parks and Department of Fisheries.

12.5.13. Dam Operations

ESHS for Dam operations will be managed by LWB. Site personnel will include an EHS coordinator and environmental scientist, who will report to the LWB EHS Officer.

12.6. Environmental Management

12.6.1. Environmental Project Plans

Frameworks for Project Operational Plans are provided in **Appendix 10.4**. They have been prepared on the basis of the detailed impact and risk assessments covered under Chapters 8, 9 and 10 and include:

- *ESMP Subplans*: Two Plans address cumulative impacts related to Soil erosion and biodiversity management.
- *Mitigation plan*: This Plan is organized around various project activities and defines responsibilities for implementation as well as monitoring of each action, and also indicates the timing of these actions.
- *HIV/AIDS Management Plan:* This will be required to manage health risks associated with the influx of construction workers.

These plans are project-specific, and to the extent possible, site-specific, however contractors will be required to carry out further detailing of the key aspects, to prepare site-specific construction environmental management plans discussed below.

12.6.2. Environmental Codes of Practice

A set of environmental codes of practice (ECPs) has been prepared for various environmental and social management aspects. Contractors will be contractually obligated to comply with these ECPs. These are summarized in *Table 12.4*and provided in **Appendix 10.5**.

Table 12.4 Environmental Codes of Practice

Environmental Codes of Practice	
ECP 1: Waste Management	ECP 10: Air Quality Management
ECP 2: Fuels and Hazardous Goods Management	ECP 11: Noise and Vibration Management
ECP 3: Water Resources Management	ECP 12: Protection of Flora
ECP 4: Drainage Management	ECP 13: Protection of Fauna

Environmental Codes of Practice	
ECP 5: Soil Quality Management	ECP 14: Protection of Fisheries
ECP 6: Erosion and Sediment Control	ECP 15: Road Transport and Road Traffic Management;
ECP 7: Top Soil Management	ECP 16: Construction Camp Management
ECP 8: Topography and Landscaping	ECP 17: Cultural and Religious Issues
ECP 9: Quarry Areas Development and Operation	ECP 18: Workers Health and Safety
	ECP 19: Construction and Operation Phase Security

12.6.3. Site-specific Construction Environmental Management Plans

These plans are site-specific and where applicable, contract-specific and will be prepared by various contractors prior to the commencement of construction activities. The Plans to be prepared by the contractors for various aspects of the environmental management will mostly include the detailing of the measures included in the ECPs and Mitigation Plans providing where applicable, location details, layouts and drawings, timelines, roles and responsibilities, methodologies and procedures, and key performance indicators. A brief description of each of these plans is provided Table 12.5.

Table 12.5 Site-Specific Construction Environmental Management Plans

	Construction Environmental Management Plans
1	**Erosion, sediment and drainage control plan** Prepared by each contractor on the basis of ECP 4 and 6, and the mitigation measures given in ESA and ESIA. The Plan will be submitted to the CSC for review and approval before contractor mobilization.
2	**Pollution Prevention Plan** Prepared and implemented by the Contractor on the basis of ECP 1, ECP 2, ECP 11, and WBG EHS Guidelines (2007), as well as the mitigation plans given in ESIA. The Plan will be submitted to the CSC for review and approval before contractor mobilization.
3	**Waste Disposal and Effluent Management Plan** Prepared and implemented by the Contractor on the basis of ECP 1, ECP 4, and WBG EHS Guidelines (2007), as well as the mitigation plans given in this ESIA. The Plan will be submitted to the CSC for review and approval before contractor mobilization.
4	**Traffic Management Plan** Prepared by each Contractor on the basis of ECP 15 and also the mitigation plans given in this ESIA, after discussion with PIU and authorities responsible for roads and traffic. The Plan will be submitted to the CSC for their review and approval before contractor mobilization. CSC will facilitate the integration and coordination of the plans prepared by various contractors to prepare an overall Plan.
5 6	**Borrow Area Management and Restoration Plan** Prepared for management and restoration of borrow areas will be prepared by the Contractor on the basis of ECPs 8 and 9 and other requirements described in the mitigation plans. This Plan will aim at minimizing the environmental and social impacts during borrowing activities and restoring as much as possible the original natural situation of these sites by various measures (refill, levelling or smoothening). Restoration methodologies will be included in the Plan. The Plan will be approved by the CSC and PO.
6	**Occupational Health and Safety Plan**

	Construction Environmental Management Plans
	Prepared and implemented by each Contractor on the basis of the WBG EHS Guidelines (2007), ECP 18, and other relevant standards. The Plan will be submitted to the CSC for review and approval before contractor mobilization.
7	**Drinking Water Supply and Sanitation Plan** Separate water supply and sanitation provisions will be needed for the temporary facilities, labour camp and workshops, in order not to cause shortages and/or contamination. A Plan will be prepared by the Contractor on basis of ECP 3. The Plan will be submitted to the CSC for review and approval before contractor mobilization.
8	**Construction Camp Management Plan** Prepared by each Contractor on the basis of ECP 16 and also the mitigation plans given in this ESIA. The Plan will include the camp layout, details of various facilities including supplies, storage, and disposal. The Plan will be submitted to the CSC for review and approval before camp establishment.
9	**Fuel and Hazardous Substances Management Plan** Prepared by each Contractor on the basis of ECP 2 as well as the mitigation plans given in this ESIA and in accordance with the standard operating procedures, relevant guidelines, and where applicable, material safety data sheets. The Plan will include the procedures for handling oils and chemical spills. The Plan will be submitted to the CSC for review and approval before contractor mobilization.
10	**Emergency Preparedness Plan** Prepared by each Contractor after assessing potential risks and hazards that could be encountered during construction in the Diamphwe and Linthipe Rivers. The Plan will be submitted to the CSC for review and approval before contractor mobilization.
11	**Communication Plan** Prepared by each contractor to demonstrate how they will communicate with local community leaders, provide details regarding employment opportunities at mobilization, HIV/AIDS management, construction schedule, and traffic management throughout the construction period. The contractor's communication strategy should define a process for receiving, recording and responding to complaints and also monitoring of the success of any responsive action taken to prevent the escalation of any conflicts.

12.6.4. **Monitoring Plan**

Monitoring plan will be carried during implementation of the project to ensure contractors compliance. CSC will be responsible for supervision of implementation of the monitoring plan. A monitoring Plan framework is provided in Table 12.6.

Table 12.6 Monitoring Plan Framework

Parameter	Means of Monitoring	Frequency	Responsible Agency	
			Implementation	Supervision
Surface water quality	Sampling and analysis of river water quality and waste water discharges for the parameters given in MS691:2005	Quarterly	Contractor	CSC, ESHSU
		Annually	MEC (PO through a nationally recognized laboratory)	CSC, ESHSU
	Spot measurements of pH, conductivity, turbidity; visual inspection of presence of petroleum products	Daily	CSC	CSC, ESHSU

Parameter	Means of Monitoring	Frequency	Responsible Agency	
			Implementation	Supervision
Groundwater quality	Sampling and analysis of groundwater quality for drinking water for the parameters required by MS733:2005.	Quarterly	Contractor	CSC, ESHSU
		Annually	MEC (through a nationally recognized laboratory)	CSC, ESHSU
Air Quality (dust, smoke)	Visual inspection to ensure good standard equipment is in use and dust suppression measures are in place.	Daily	Contractor	CSC, ESHSU
	High volume dust gauges	Continuous		
	Visual inspection to ensure dust suppression work plan is being implemented	Daily	Contractor	CSC, ESHSU
Emissions from plant and equipment	Visual inspection	Monthly	Contractor	CSC, ESHSU
Noise and vibration	24 hour noise monitoring	Weekly	Contractor	CSC, ESHSU
	24 hour noise monitoring	Monthly	MEC (through a nationally recognized laboratory)	CSC, ESHSU
	Spot measurements	Daily	CSC	CSC, ESHSU
Waste Management	Visual inspection that solid waste is disposed of at designated sites	Monthly	Contractor	CSC, ESHSU
Spills from hydrocarbon and chemical storage	Visual inspection for leaks and spills	Monthly	Contractor	CSC, ESHSU
Operation of borrow sites	Visual inspection of quarry sites	Monthly	Contractor	CSC, ESHSU
Biodiversity monitoring	Collection of information on presence, seasonal behaviour and biotope characteristics of dolphin, fish and migratory birds selected locations;	Half yearly	PO through nationally recognized institute	CSC, ESHSU
Traffic safety	Visual inspection to ensure Traffic Management Plan is implemented	Monthly	Contractor	CSC, ESHSU
Local access roads	Visual inspection to ensure local roads are not damaged	Monthly	Contractor	CSC, ESHSU
	Visual inspection to ensure local roads are not damaged	Annually	MEC (through a nationally recognized laboratory)	CSC, ESHSU
Drinking water and sanitation	Ensuring construction workers are provided with safe water and sanitation facilities on site	Weekly	Contractor	CSC, ESHSU
Safety of workers	Usage of personal protective equipment	Monthly	Contractor	CSC, ESHSU
Reinstatement of work sites	Visual Inspection	After completion of all works	Contractor	CSC, ESHSU
Plantation	Visual inspection to ensure plantations are growing well	Monthly	Plantation Contractor	CSC, ESHSU
	Visual inspection to ensure plantations are growing well. Number of trees survived and rate of growth	Annual	MEC	CSC, ESHSU

Parameter	Means of Monitoring	Frequency	Responsible Agency	
			Implementation	Supervision
HIV/AIDS	Status reports on HIV/AIDS by the CSC taking input from the Contractor	Monthly during construction	Contractor	CSC, ESHSU
	Statistics from health facilities	Annually	MEC	CSC, ESHSU
Sediment contents in Shire River	Silt contents and turbidity in Shire River during the wet season	Monthly during wet season (November-March) 3 years of construction	LWB WF Laboratory	CSC, ESHSU
	Silt contents and turbidity in Shire River during the wet season	Monthly during wet season (November-March) 3 years of construction	LWB WF Laboratory and MEC	ESHSU
Water quality of Tap water	Sampling and analysis of supply water quality for drinking water for the parameters required by MS214:2013.	Monthly during the 3 years of operation	LWB and MEC	ESHSU
Potable drinking water to the communities	Number of working water points	Annually during the 3 years of operation	MEC	ESHSU

12.7. Social Management

12.7.1. **Implementation of RAP**

Social management will be undertaken in conformance with the RAP, which includes the following main components:

- Entitlement Framework
- Relocation Framework
- Institutional and Organisational Framework
- Public Consultation and Disclosure Of Information
- Grievance Procedures
- Gender Mainstreaming
- Monitoring and Evaluation

12.7.2. **Entitlement Framework**

The Project will acquire a range of privately owned assets and communal resources for which appropriate compensation and/or mitigation measures are required. The RAP proposes the types and levels of compensation and other resettlement and supplementary measures that will assist each category of eligible-affected people, and at the same time achieve the objectives of national legislation and policies, and international best practice. Key components include:

- *Eligibility criteria*: Those who will be affected directly by resettlement and are eligible for compensation and other assistance require definition and identification, with criteria set for determining their eligibility.

- *Compensation Entitlement Framework*: The objective of relocation, compensation and other rehabilitation measures is to mitigate for, and manage, the negative impacts of the involuntary resettlement aspects of the Project.
- *Livelihood Restoration/Improvement (LRI) Programme*: A detailed LRP is required, separate to this RAP, that establishes the means to implement, monitor and guide the Project in livelihood restoration, describing how, when and by whom outcomes are to be achieved, and the activities and resources required to achieve these, and related timescales. A framework LRI is provided in **Appendix 10.4**.

12.7.3. **Relocation Framework**

The relocation programme will entail assistance with the identification of new residential/business sites in preferred villages, provision of replacement housing/businesses or cash compensation, physical preparation of sites for residential/business occupation, assistance in the act of relocation, provision of appropriate infrastructure and facilities and services on site, and payment of Shifting and Displacement Allowances. In determining a relocation site, the following factors need be considered:

- Proximity to services, facilities and amenities, including administrative, educational, health, financial, commercial (offices/shops/markets) and religious;
- Proximity of potential residential areas to agricultural base;
- Access to the area, through road networks and transport;
- Land potential, that is suitable in terms of quality and topography for agriculture development;
- Land productivity and land capability, linked to a full soil survey of potential areas;
- Available land size, with the area not only being sufficient to hold the affected population (host and resettled), but allow for future development;
- Landholding and land status, including: current registration of the land, land users and land use; existing improvements to the land; planned developments (not be reserved for any other purpose); and regulations such as the right to pursue agricultural activities and/or establish a business on that land;
- Proximity to the same/potential markets/clientele/customers for farming and business enterprises;
- Social support networks, encompassing neighbourliness and organisational make-up; and
- Ability to maintain cultural heritage.

Selected sites should, as far as possible, be within the same physical and cultural environment. The new living area should offer an improved economic and social life to those affected, preserving their identity and their social and geographical unity.

12.7.4. **Institutional and Organisational Framework**

A number of agencies, governmental and non-governmental, will play a role in the implementation of resettlement activities and the restoration of livelihoods.

In particular, implementation of the RAP will be dependent on the development of a strong institutional base. Managed by the PMU of the NWDP within the MoAIWD, in cooperation with the

PIU of the LWB, this will require not only the co-ordination of activities between the Ministry and the LWB, but interaction with Project-related structures inclusive of the following organisations:

- The relevant bodies associated with the MoAIWD, and particularly the PMU of the NWDP and the PIU of the LWB;
- District Council Offices and Committees that will be involved in the Project;
- Statutory Corporations providing a relevant service to the Project;
- Traditional Authorities (TAs), including GVHs and VHs, of the PAC;
- Local-level structures set up specifically for the project, such as Project Development Committees (PDCs);
- Agencies identified as having a role in the implementation of resettlement activities, including Development Organisations and Non-Governmental Organisations (NGOs); and
- Other interested stakeholders, including religious bodies, private investors and political parties.

12.7.5. **Public Consultation and Disclosure of Information**

Public consultation and the disclosure of information are vital components for the success of any development project, to ensure two-way communication between the project developer and relevant stakeholders, and assure accountability and transparency in the development process. An intense public consultation and disclosure programme was undertaken as part of ESIA and RAP studies.

As the Project proponent, the MoAIWD will take this process forward, with consideration given to all stakeholders, supportive institutional arrangements, and a programme of implementation. The success of the resettlement programme will largely depend on the ability of the MoAIWD, NWDP and LWB, and PAP and PAC, to maintain a collaborative (partnership) relationship, building on the trust that has developed, to contribute to the quality of decisions, and to move forward with Project developments.

The major activities to be undertaken by NWDP and LWB to take the resettlement process forward are:

- A review of the current consultation and disclosure process, including a review of each organisation's roles and responsibilities in the process – their separation of tasks – and their internal institutional make-up appropriate to the tasks required. This would be facilitated by the Community Liaison and Participation Officer (CPLO).
- A review of the identification of stakeholders appropriate to contributing to the tasks required in the implementation stage. Stakeholders would include institutions outlined in the RAP (Section 9).

Consultation will continue as appropriate to the stages of the Project, with particular reference given to the involvement of those being relocated and host communities, to obtain their views, concerns and suggestions in relocation implementation activities.

Running parallel to this process will be the continual dissemination of information about the Project. This includes the immediate development of materials about the Project for distribution to the public, such as brochures, information sheets and news updates, with a view to opening a Project Information Office to the public. A framework Consultation Plan is provided in **Appendix 10.4**.

12.7.6. **Grievance Procedures**

Appropriate grievance and dispute resolution procedures and mechanisms will be established by which PAC and PAP can bring grievances and complaints on any Project-related aspect of land acquisition, compensation and resettlement to the Project for consideration and redress. These are essential tools for allowing affected individuals to voice concerns as they arise and, where appropriate, for corrective action to be taken expediently and in a satisfactory manner.

It is in the interest of all concerned that Project-related grievances are resolved from the start in a standardised procedure, through Project-related mechanisms with representation from the MoAIWD, the NWDP, the LWB and other relevant stakeholders, the DCs and TAs, and particularly the PAC and PAP. The RAP provides a GM framework, which addresses:

- Grievance Procedure Methodology;
- Timeframes;
- Public Awareness program; and
- GM Management System.

12.7.7. **Gender Mainstreaming**

Given the potential impact of the Project on women, it is important that the Project proactively implements gender mainstreaming[28], on a conceptual level – bringing gender towards the centre of the Project – and on an operational level – responding to the impact of gender on the Project, and responding to the impact of the Project on gender. Successful gender mainstreaming begins at the concept, planning stage and continues through design, implementation, monitoring and evaluation, integrating gender sensitive initiatives into all elements of the Project.

In order to implement a gender-based project, the following actions will be applied:

- Incorporation of legislative requirements of gender equality in all aspects of the Project. Equal opportunity for all men and women land holders (including unmarried/married women);
- Awareness raising among relevant stakeholders, and engaging in advocacy to ensure that gender issues are identified and addressed;
- Creating partnerships with gender-sensitive NGOs on implementation of aspects of the RAP, to address gender at the grassroots level;
- Working with local organisations that have an interest in/insight into gender issues, such as groups with women membership, particularly Women's Associations at village level. This will not only ensure participation of women but also provide required gender-based knowledge for the project;
- Including gender issues into all ToR and contracts for RAP implementation;
- Actively including women in the consultation process, and ensuring that their participation is sought, from planning, through to implementation and monitoring;

[28] Gender mainstreaming can be defined as "the process of identifying gender gaps and making women's, men's, girls' and boys' concerns and experiences integral to the design, implementation, monitoring and evaluation of policies and programmes in all spheres so that they benefit equally". SADC. 2008. *SADC Protocol on Gender and Development*.

- Gender sensitive social analysis; and
- Gender-sensitive project monitoring and evaluation, using gender indicators.

Women as a vulnerable group, and especially women-headed households, should obtain not only equal benefit to men in the Project, but also be placed at an added advantage over some migratory measures, to enhance their economic and social wellbeing.

12.7.8. **Monitoring and Evaluation**

In order to check whether or not the Project is meeting relevant national and international principles, standards and guidelines, the resettlement implementation programme of the Project needs to be monitored and evaluated on a regular basis against agreed upon qualitative and quantitative targets.

The overall objective of a monitoring and evaluation (M+E) programme is thus to monitor, assess and report on the effectiveness of the implementation of resettlement, and particularly the application of mitigation measures. This includes asset acquisition, disbursement of compensation, physical progress with land resettlement and rehabilitation activities, effectiveness of consultation and participation, and the sustainability of livelihood restoration efforts.

M+E will form an integral part of Project implementation, providing the necessary information about the involuntary resettlement aspects of the Project, measuring the extent to which the goals of the RAP have been achieved and the effectiveness of mitigation measures. The RAP outlines the methods to be employed, frequency of measurement, reporting procedures, and the organisational arrangements to be made to undertake the activities, including the involvement of those affected in the process.

12.7.9. **Data Management**

All information collected for the RAP is to be stored in an information system. Databases will be linked to a Geographic Information System (GIS), which will build upon the Census data compiled during preparation of the ESIA and RAP.

12.7.10. **Resettlement Schedule**

A full schedule covering all resettlement activities, from preparation through implementation, including monitoring and evaluation in the long term, is to be linked to the overall Project plan, and particularly to the implementation of civil works included in the Construction Programme.

12.8. Training and Capacity Building

Contractor training is summarised in Table 12.7. The primary responsibility of providing training will be the contractor, Supervision Consultants, and a designated training consultant.

Capacity building will also be provided to LWB staff as summarized in **Appendix 10.6**.

Table 12.7 Contractors Training Plan

Training Subject	Target Audience
Handling, use & disposal of hazardous material	Construction workers with authorised access to hazardous material storage areas and required to use hazardous material during their works
Waste Management	All staff (construction and camp staff)
Efficient& safe driving practices, including road & vehicle restrictions	Drivers & mobile plant operators
Actions to be taken in the event of major or minor pollution event on land	All construction staff

Training Subject	Target Audience
Use of flexible booms and surface skimmers in event of pollution event in water	All construction staff working on intake area
Pollution prevention: Best practice	All staff
Refuelling of water borne plant – pollution prevention	Operators of water borne plant & vehicles
Health & Safety: Safe way to work & hazard awareness	All construction staff
Health & Safety: Safe use of plant & equipment	Operators of plant & equipment
Health & Safety: Working at height	Intake, WTW expansion, pumping stations, and reservoir construction staff
Health & Safety: Working near/on water	All construction staff working on intake and river bank protection
Health & Safety: Use of PPE	All construction staff
Emergency procedures and evacuation	All staff
Fire fighting	All staff
Site inductions, including requirements under the Environmental Management Plan & details of environmentally sensitive areas of the site	All staff
Culturally sensitive awareness rising on HIV/AIDS and the spread of sexually transmitted diseases. Awareness raising on risks, prevention and available treatment of vector-borne diseases	All staff
Cultural sensitivities of the local population	On induction of all non-local staff

12.9. Audits and Annual Review of ESMP

Internal environmental audits will be held with an objective to review the effectiveness of environmental and social management of the project. CSC under the supervision of ESHSU will carry out monthly reviews of compliance against the ESMP and RAP.

External third party environmental and social audits will be held with an objective to review the effectiveness of environmental and social management of the project. It is proposed that MEC carry out these audits on a six monthly basis. These audits would be used to re-examine the continued appropriateness of the ESMP and to provide advice on any updates required.

12.10. Reporting

The CSC will prepare monthly reports covering various aspects of the ESMP implementation including compliance monitoring, capacity building, and grievance redressal. A list of reports to be prepared is given in Table 12.8.

Table 12.8 Reporting

Report	Contents	Prepared by	Distribution
Monthly	Non-Compliances observed on sites and actions required	Environmental/Social team of the Engineer (CSC)	ESHSU – PIU; MEC, Contractor
Monthly	Actions taken on site in response to CSC Monthly report Project progress and works to be undertaken in the coming three months Details of training delivered Details of accidents reported and actions taken	Contractor	CSC ESHSU – PIU; MEC
Quarterly	Quarterly review on implementation of ESMP	ESHSU – PIU, CPLO, GO	PIU, World Bank, CSC, Contractor

Report	Contents	Prepared by	Distribution
	including compliance and effects monitoring, capacity building, HV/AIDS program monitoring, biodiversity management monitoring, plantation program monitoring, and grievance redressal		
Half yearly	Results of effects monitoring Independent review of environmental and social performance on site Recommended actions required by all parties.	CSC, MEC, CPLO, GO ESHSU – PIU	PO, World Bank, Contractor

12.11. ESMP Budget

The cost of implementing the ESMP during construction is USD 7.666 million. A summary is shown in Table 12.9.

Table 12.9 ESMP Preliminary Construction Budget

	Item	Cost (USD)
1	Staff and Consultancy Costs	5,064,000
2	Rehabilitation Works	734,000
3	Development of Plans	130,000
4	Implementation of Plans	1,085,000
5	Other Operational & Capacity Building Costs	653,000
	Total	**7,666,000**

The cost of implementing the ESMP during operation is USD 0.767 million /year. A summary is shown in Table 12.10.

Table 12.10 ESMP Preliminary Operation Budget

	Item	Cost (USD)
1	Staff and Consultancy Costs	256,000
2	Rehabilitation Works	60,000
3	Development of Plans	0
4	Implementation of Plans	155,000
5	Other Operational & Capacity Building Costs	296,400
	Total	**767,400**

Costing details are provided in **Appendix 10.7**.

13. CONCLUSION AND RECOMMENDATIONS

The ESIA demonstrates that the Project can be successfully developed and implemented to meet relevant GoM regulatory and policy requirements, and World Bank Operational procedures.

The Project will secure Lilongwe's water supply to 2045 and provide significant opportunities to supply water to rural villages and for irrigation and fish farming, thereby substantially improving food security and livelihoods. The ESIA highlights a number of potential beneficial impacts likely to accrue as a result of Project development, including stimulating employment opportunities and economic development, improved infrastructure and service provision, enhanced biodiversity opportunities and management of downstream river flows to reduce large flood peaks and improve water flow during below average flow conditions.

The Project will directly affect 26,149 people, including 5,178 PAP who have land or assets within the reservoir area. A total of 644 homesteads with approximately 3,050 people will need to be relocated to new areas. The RAP provides details on compensation and relocation requirements, which will require careful planning and diligence for successful implementation.

Mitigation and management measures have been developed, which will mitigate, minimise and/or manage potential impacts to Malawi and World Bank standards. These measures have been formalised into an Environmental and Social Management Plan and accompanying RAP that address environmental and social monitoring, implementation of mitigation measures and management of risks, and an Entitlement Framework.

Despite the application of mitigation measures and management plans, a range of potential 'residual' impacts remain and existing social and physical environments in the Project area will change. These issues will require proactive, dedicated and culturally sensitive leadership on behalf of MoAIWD to minimise the risk of harm to the environment or people affected by Project development, and maintain productive, friendly relationships with local communities.

In summary, while there are impacts associated with development of the Project, this report demonstrates that with commitment and strong leadership these impacts can be managed to conform to Malawi legal requirements and World Bank standards. In this regard the following recommendations are made:

7. *RAP Implementaion:* This should commence as soon as possible, including advising on a cut-off-date, establishing institutional arrangements and commemncing compensation activities.
8. *Project design:* The ESIA was based on feasibility level design. Detailed design should consider opportunities to further minimise environmental and social impacts by avoiding, where possible, sensitive areas or increasing positive biodiversity outcomes. For example minor relocation of the proposed balancing tank would avoid a wooded cemetery in Che Mbonga village, Traditional Authority Mazengera in Lilongwe District. Some parts of the proposed 15 m wide buffer zone may also be extended, subject to the availability of land and potential impacts on surrounding communities.
9. *Management measures*: This ESIA report and RAP have recommended a series of management measures, mitigation strategies and actions for the various environmental and social impacts created by the Project. These measures should be actively implemented and with committed intent to ensure that environmental and social impacts are managed appropriately.
10. *Residual risks*: There are three potentially high environmental risk areas; The loss of 2,342 ha of predominantly agricultural land will be a significant loss to a community that is heavily reliant on cropping for sustaining livelihoods. This is likely to have long term effects as compensatory irrigation, fish farming and forest woodland propagation become firmly established. Reduced air quality resulting from dust emissions during construction will require

a high level of mitigation and vigilance to ensure compliance limits are achieved at sensitive receptors and that health of the community is not compromised. The third high residual risk relates to Dam failure and although this is unlikely to occur, the potential consequences could cause severe and hazardous downstream flooding. Appropriate resources should be allocated to monitor and manage successful implementation of proposed mitigation measures and immediate steps taken to resolve any escalation of these risks.

11. *Project verification:* There are a number of areas where early consultation, ongoing monitoring, evaluation and research is required for the verification of environmental and social management approaches. This consultation, monitoring, evaluation and research must also be undertaken in a timely manner and with commitment.
12. *Management Plans:* The key commitments to environmental and social impact management and mitigation are set out in the ESIA, ESMP and RAP. Prior to Project development these plans will need to be reviewed and updated to reflect specific development consent conditions and management details.