MASTER PLAN

GENERAL

ACKNOWLEDGEMENTS

The Government of Malawi would like to thank all the people who with all concerted efforts participated in the course of producing this National Water Resources Master Plan.

Special thanks go to the Japan International Cooperation Agency (JICA), for the financial and technical support and commitment without which this Master Plan would not have been produced. Our appreciation also goes to the Consultant CTI Engineering International Co., Ltd Oriental Consultants Co., Ltd. Newjec Inc for the technical expertise and for the capacity development to local counterparts during the Master Plan preparation.

Sincere thanks to the Ministerial Task Team, for their guidance and untiring assistance in various aspects of the preparation of the Master Plan report.

Appreciation also goes to all the Government officials from the various line Ministries and organisations who provided data and information for production of the Master Plan, for their cooperation and assistance rendered.

The National Water Resources Master Plan report is in 9 volumes as follows:

1. Main Report: Existing Situation
2. Annex 1 Surface Water Resources
3. Annex 2 Groundwater Resources
4. Annex 3 Water Quality
5. Annex 4 Water Resources General
6. Annex 5 Water Supply and Sanitation
7. Annex 6 Irrigation
8. Annex 7 Capacity Development
9. Master Plan: General

The contents of this Annex on Master Plan General are indicated below:

Chapter 1 Issues on Water Resources Management and Development
Chapter 2 Summarised Plans
Chapter 3 Integrated Water Resources Management in Malawi
Chapter 4 Institutional Setup for Integrated Water Resources Management
Chapter 5 Monitoring and Information System
Chapter 6 Water Related Disasters
Chapter 7 Soil Erosion Measures and Watershed Conservation Plan
Chapter 8 Improvement of Management Plan for Water Development Facilities
Chapter 9 Projects Implementation Program

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Acronyms and Abbreviations

AIDS	:	Acquired Immuno Deficiency Syndrome
B/C	:	Benefit Cost Ratio
CBA	:	Cost-Benefit Analysis
CBO	:	Community Based Organization
CBR	:	Crude Birth Rate
CCO	:	Central Control Office
CEO	:	Chief Executive Officer
CMC	:	Catchment Management Committee
COVAMS	:	Community Vitalization and Afforestation in Middle Shire
CVM	:	Contingent Valuation Method
DEM	:	Digital Elevation Model
DoDMA	:	Department of Disaster Management
DoI	:	Department of Irrigation Services
DRM	:	Disaster Risk Management
EIA	:	Environmental Impact Assessment
EIRR	:	Economic Internal Rate of Return
ESCOM	:	Electricity Supply Corporation of Malawi Limited
FAO	:	Food and Agriculture Organization
F/S	:	Feasibility Study
GBI	:	Green Belt Initiative
GDP	:	Gross Domestic Product
GIS	:	Geographic Information System
GIZ	:	Deutsche Gesellschaft für Internationale Zusammenarbeit
HFA	:	Hyogo Framework for Action
HIV	:	Human Immunodeficiency Virus
ICT	:	Information and Communication Technology
IEE	:	Initial Environmental Examination
IFM	:	Integrated Flood Management
IRR	:	Internal Rate of Return
ISD	:	Irrigation Service Division
IWRM	:	Integrated Water Resources Management
JICA	:	Japan International Cooperation Agency
JSR	:	Joint Sector Review
LDF	:	Local Development Funds
MACRA	:	Malawi Communication Regulation Authority
MBS	:	Malawi Bureau of Standard
MC	:	Market Center
MDGs	:	Millennium Development Goals
M&E	:	Monitoring and Evaluation
MEPD	:	Ministry of Economic Planning and Development
MERA	:	Malawi Energy Regulation Authority
MGDS	:	Malawi Growth and Development Strategy
MK	:	Malawi Kwacha
MoAFS	:	Ministry of Agriculture and Food Security
MoAIWD	:	Ministry of Agriculture, Irrigation and Water Development
MoE	:	Ministry of Energy and Mine
MoF	:	Ministry of Finance
MoLPPS	:	Ministry of Land and Physical Planning and Survey
MoNREE	:	Ministry of Natural Resources, Energy and Environment
MoU	:	Memorandum of Understanding
M/P	:	Master Plan
NGO	:	Non Governmental Organization
NPV	:	Net Present Value
NSO	:	National Statistical Office

NWDP	:	National Water Development Project or National Water Development Programme
NWRA	:	National Water Resources Authority
ODA	:	Official Development Aid
ODSS	:	Operation Decision Support System
O&M	:	Operation and Maintenance
PAP	:	Project Affected Person
PDCA	:	Plan Do Check Action
SCF	:	Standard Conversion Factor
SRBMP	:	Shire River Basin Management Program
SRTM	:	Shuttle Radar Topography Mission
SS	:	Suspended Solid
SWAp	:	Sector Wide Approach
SWG	:	Sector Working Group
TWG	:	Technical Working Group
UNDP	:	United Nations Development Plan
UNISDR	:	United Nations Office for Disaster Risk Reduction
USD	:	United States Dollar
VFA	:	Village Forest Area
WB	:	World Bank
WRA	:	Water Resources Area
WRB	:	Water Resources Board
WRIS	:	Water Resources Investment Strategy
WRM	:	Water Resources Management
WRU	:	Water Resources Unit
WS	:	Water Supply
WTP	:	Water Treatment Plant
WTP	:	Willingness-to-pay
WUA	:	Water Users Association

CHAPTER 1. ISSUES ON WATER RESOURCES MANAGEMENT AND DEVELOPMENT

1.1 Issues on Water Resources Management and Development in Malawi

Investigations and analyses of the present condition in Malawi (see **Main Report: Existing Situation and Annexes 1 to 5**) have revealed a number of issues related to water resources management and development. The issues are summarized and identified for each sub-sector, namely, hydrology/Surface water, groundwater, water quality, irrigation, forestry, water supply, hydropower, and international rivers in **Table 1.1.1**. Institutional issues are also discussed. Some interventions have been proposed in the Master Plan (M/P) to mitigate or resolve the issues in line with IWRM or SWAp concepts.

Table 1.1.1 Issues on Water Resources Management and Development in Malawi

No.	Themes	Issues
1	Institution	The new Water Resources Act (2013) is in place. This Act will contribute to the improvement of institutions related to water resources. However, there are still institutional issues as listed below. - Some water-related agencies still have ambiguities in function, role and coverage area. - Some information such as water rights and water rentals has not been managed properly. - There has been no proper coordinated management between the hydropower sector and other water-use sectors from the viewpoint of regulation of water use. - Chronic budgetary deficit and manpower shortage which has led to inadequate functioning of some water-related organizations - Conflicting regulations - Lack of enforcement of the existing water related regulations
2	Hydrology/Surface water	Basic systems and tools to manage hydrological information do exist; however, some systems are not being properly managed. - The number of operational hydrological stations is decreasing. The density of rainfall stations is very low. There is need to rationalise the gauging stations for water resources monitoring. - Data collection and transmission systems in some river basins are inadequate. - Data validation is not undertaken. In addition, some of the information is not updated appropriately (for example, discharge rating curves). - Data on floods and drought is not shared properly among the related agencies.
3	Groundwater	The establishment of monitoring systems and training on monitoring and analysis have been progressing with the assistance of ODA development partners; however, proper monitoring is not still carried out due to shortage of materials/measurements, standards and budget. Information is not satisfactorily organised and managed properly for assessment and dissemination.- Borehole construction data is not shared adequately among stakeholders -Coordination among stakeholders on groundwater developments is inadequate
4	Water Quality	-Water quality and pollution monitoring is carried out on an adhoc basis. - Measurement facilities in laboratories including laboratory consumables (e.g. reagents) are not enough/adequate and the maintenance condition of facilities is not good. -Water quality standards for aqueous environment are not established. -There is no Laboratory building in the Northern Region part of the country for water quality and pollution monitoring -Data in all the water quality laboratories (Regions and headquarters) is not organized and managed properly for retrieval, analysis, interpretation and dissemination. -Some of the equipment is not operational due to lack of accessories and adequate training to operate.
5	Irrigation	Although studies and research on agricultural facilities and development are being carried out, investigations and understanding in terms of water distribution to users and their water use requirement have not been implemented. - Activities to crystallize GBI are ongoing in terms of availability of water resources in quantity and location of source. - Cadastral information especially regarding location of crop areas is not arranged. - Present condition of water usage has not been fully determined. For example, water rights on agricultural use (0.7 mil m^3/day) is obviously less than agricultural water demand (2.5 mil m^3/day). - Studies to establish the impact of the quality of water on crop growth and yield are not taken seriously
6	Forestry	-So far, deforestation which may cause topsoil erosion is progressing. - Studies to determine the survival rate of planted seedlings and establish its causes are hardly carried or if carried out, information disseminated in not conducted adequately. -Protection of the sources of water in the forestry reserves is inadequately carried out hence concerns on the dwindling water resources country wide.
7	Water Supply	Development of water supply systems is being undertaken as planned in the MDG/MDGS. Related agencies should however address some issues in order to supply sufficient water in a sustainable way. - Rate of non-revenue water is still very high. - There are many problems related to water use facilities such as aging, lack of performance

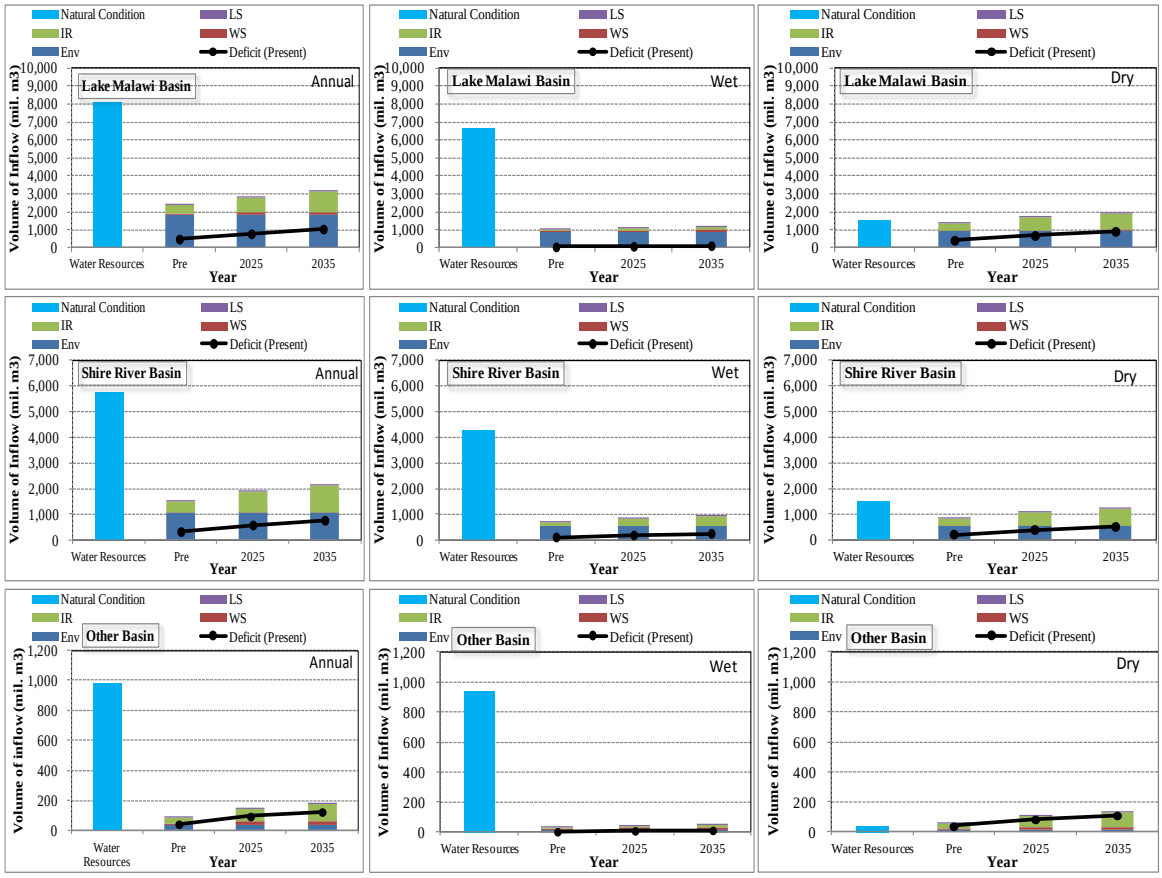
No.	Themes	Issues
		capacity due to increase of water users, usage of inappropriate materials for water pipes, and siltation. - Reports on the quality of water distributed to the consumers are hardly disseminated or information made available to the public - Encroachment of the water catchment areas leading the pollution of water sources
6	Hydropower	Although the Ministry responsible for energy has a strategy to develop electric power supply and distribution, inadequate studies have been conducted on the water budget with respect to different uses among the water sectors. - Construction of dams for hydropower generation has been planned and undertaken without consultations with related agencies on the water balance. - Currently, the electricity shortage influences operating rate of water use facilities. - Studies to establish sediment loads in the major rivers and their sources are not taken seriously and this include aquatic weeds
7	International Rivers	There is no critical problem with surrounding countries in water use; however, preparations and predictions are necessary to confirm future impact on neighboring countries.

1.1.1 Water Scarcity in Malawi

The basic analysis of water resources indicates that annual water resources availability is more than the water demands, even in year 2035. However, biased water resource conditions in season and location would significantly affect future water resources development.

The amount of water deficit can be seen as very low compared with the natural flow (See **Figure 1.1.1**). Particularly, water sufficiency in Malawi is very high with abundant surface water in the rainy season. However, the deficit water increases in the dry season with the increment of agricultural water requirement from surface flows. These mechanisms can be explained by the relationship between cropping patterns and effective rainfall as described in **Annex 6**.

To fulfill the water demand in the dry season, measures have been proposed to distribute the available water resources to drier areas and reserve it for the dry season.



Annual Wet Season Dry Season

Figure 1.1.1 Water Balance

1.1.2 Basic Policy for Water Resources Development and Management

The general water resources balance in Malawi is evaluated in the Project by using the simulation model with 30 years hydro-meteorological data as shown in **Figure 1.1.2**. On average, out of the 980 mm annual water on the surface obtained from precipitation, 23 percent (225 mm) and 5 percent (53 mm) runs off to the ground and surface and penetrates into the ground, respectively, while the evaporative loss is estimated at 72 percent of the water supplied by precipitation. With regard to surface water, 63 percent of the surface water in Malawi flows into Lake Malawi and 28 percent flows directly to the Shire River. The catchment water of Lake Malawi flows into the Shire River with restricted conditions by the geography at outlet of the lake and the operation of Liwonde barrage. Due to the effect of the large storage function of Lake Malawi, the water flow of the Shire River is abundant throughout the year and fluctuates within a relatively narrow range compared with the other rivers. Furthermore, due to the steep slope (average slope is 1/240), 98 percent of hydropower in Malawi is generated using this characteristic of the Shire River.

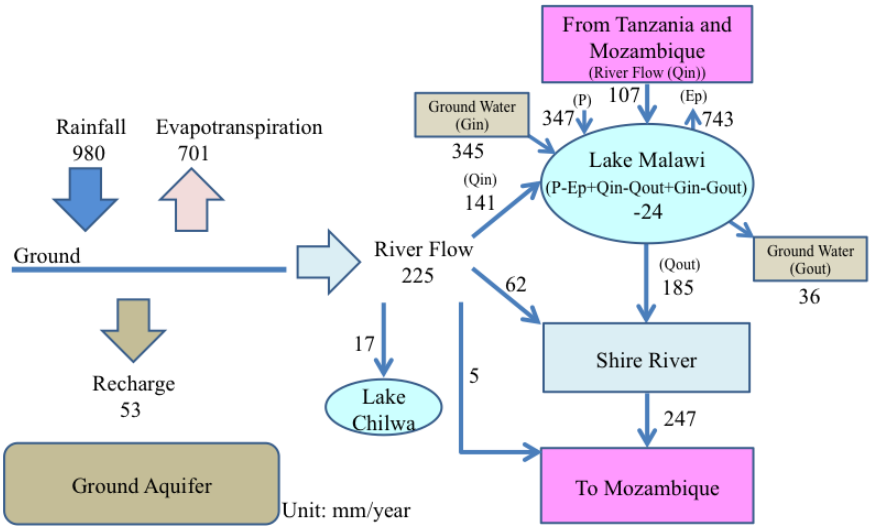


Figure 1.1.2 Natural Water Balance in Malawi

Water demand on the other hand is estimated at 1.1 billion m^3 per year (as of 2012)[1], as shown in **Figure 1.1.3** (left figure). The irrigation and domestic water demand is 87 and 13 percent, respectively. This demand may increase by 2.5 times by the year 2035. Compared with the annual average water resources (excluding water resources in Lake Malawi) and annual water demand, the water resources are 20 times (at present) and 10 times (in the future) of water demand as shown in **Figure 1.1.3** (right figure). That is to say, the annual water resource is predominant against annual water demand; however, the water shortage in dry season is prominent by seasonal fluctuation as shown in **Figure 1.1.3** and **Figure 1.1.4**.

[1] This is the result of our demand calculation result by sector. Please see the Master Plan Reports for each sector

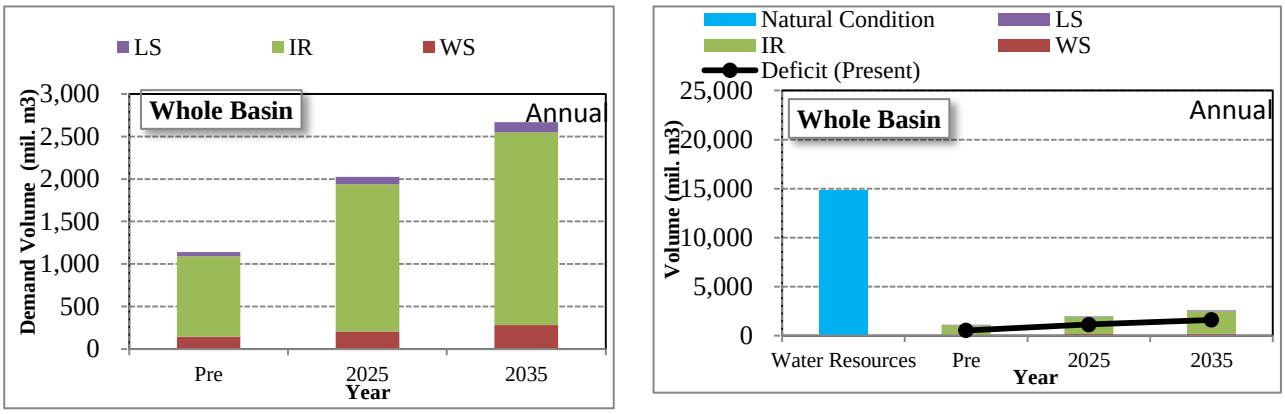
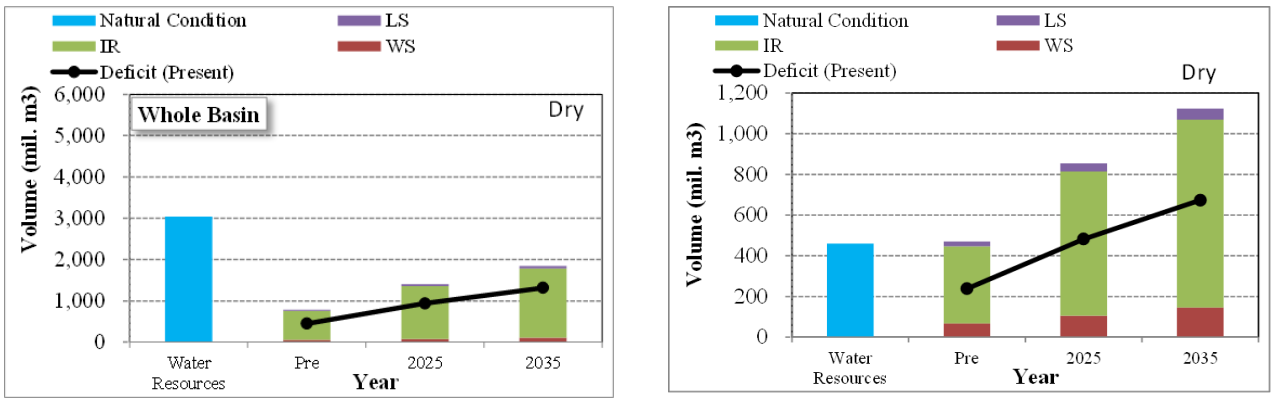


Figure 1.1.3 Transition of Water Demand (Left) and Comparison between Annual Water Demand and Water Resources (Right)



LS: Livestock, IR: Irrigation, WS: Water supply
Right Figure is sum total of WRA2, 4, 5, 6, 9, 10, 11, 17

Figure 1.1.4 Comparison between Water Demand and Water Resources (Left: Dry Season, Right: Driest Month)

1.1.3 Challenges to the Formulation of Master Plan for Water Resources Development and Management

(1) Potential for Water Resources Development

The total volume of water resources per year is predominantly larger than the water demand in Malawi. However, 95 percent of rainfall occurs in the rainy season, resulting in prominent water shortage in the dry season. Since the water demand will quadruple in total volume per year in the target year 2035, the water shortage will become more severe than that for the present condition. This situation is predicted based on the water balance simulation in **Annex 4: Section 3**, in consideration of the results of projection of major social elements. As a matter of fact, the water demand may increase corresponding to natural water distribution in the future. However, it is difficult to implement nationwide water resources development, management and allocation along various Government policies unless a Master Plan is in place.

Based on the study results so far obtained, it is apparent that the utilization of abundant water resources in rainy season is most important. There are methods that can be used to adapt seasonal fluctuations of water resources in terms of balance between water resources and locations of irrigable area (which is the dominant water user in Malawi), so that water resources developments should be implemented in consideration of the limited budgetary conditions and the natural and social environments.

The balance between the water resources and irrigation demands[2] by WRA is presented in **Figure 1.1.5.** The water resources abound in WRA 4, 7, 14 and 16 compared with the vested irrigation water demand (which is total amount of "Present Water Demand" and "Water Supply for irrigation Development") In case of water resources development, the balance should be considered to save water and construction cost for water use facilities as well as their maintenance.

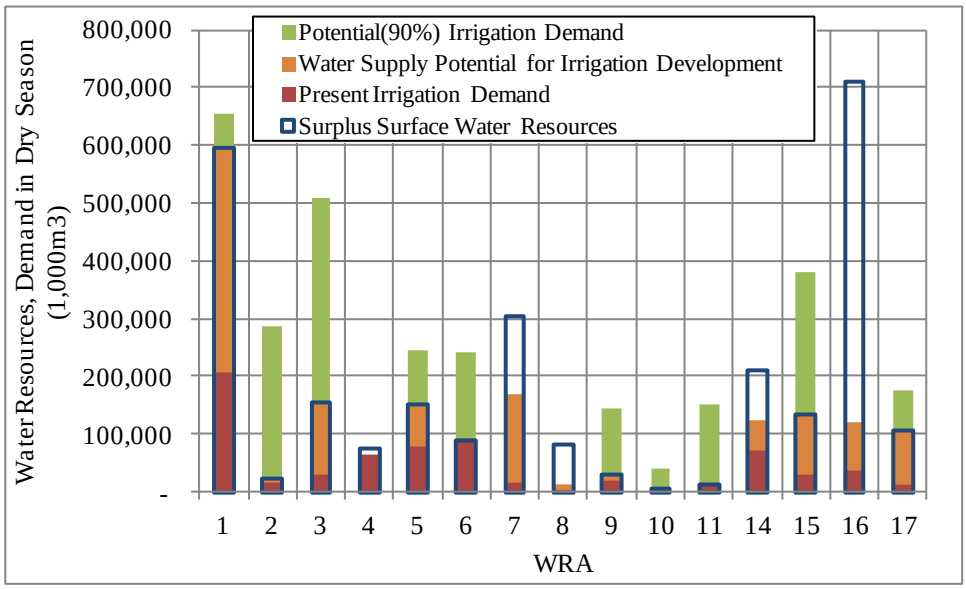


Figure 1.1.5 Comparison between Water Resources and Irrigable Area by WRA

(2) Establishment of Appropriate Organizational Framework

The integrated water resources development and management shall be implemented by the National Water Resources Authority and Catchment Management Committees in accordance with the Water Resources Act 2013 and other relevant legislations. In the Master Plan, the framework and functions of the above organizations are proposed in order to implement the integrated water resources development and management properly corresponding to the characteristics of each river basin in Malawi.

(3) Low Data Reliability and Inadequate Monitoring System

Along time was spent in collection and validation of hydrological data due to the organization of hydrological data as well as hydrogeological and water quality data in the data office. In addition, the hydrometric network has been shrinking and, currently, some primary stations are not operated even at the important control points for monitoring water resources.

(4) Poor Data Management

Information on water allocations is essential for sustainable water resources development and management. However, the database on water rights is currently not in good state. In addition, there is need to improve the management of data on water facilities such as dams, reservoirs and irrigation facilities.

(5) Lack of Consideration in Terms of Water Balance

In Malawi, the feasibility of water resources management projects is examined without due consideration of impacts to other hydrological components. For example, a groundwater development project may be implemented without assessing the possible impacts on surface water resources. This is because there are no efforts to examine the water budget between the water subsectors at the WRU level. In the Master Plan, a water balance method is used and this can also be implemented in the future. A follow-up on capacity building and organizational enhancement

[2] Focus is on irrigation water only because domestic water supply is very small compared to that of irrigation. Also, the ratio of incremental irrigational water demand is much higher than domestic one.

is necessary after the formulation of the Master Plan.

1.1.4 Basic Policy for Formulation of the Master Plan (M/P)

(1) Target Year of Water Resources Development and Management

The long-term target year for the M/P of water resources development and management is the year 2035, and the short and middle term target years were set as 2020 and 2025, respectively. The components of water resources development and management plans in water sectors shall be formulated using these time frames.

(2) Basic Policy for Water Resources Development and Management

To satisfy the growing demand in Malawi, the key considerations for water resources development in Malawi are:

(a) the effective demand management in dry season,
(b) effective usage of the abundant water resources in rainy season; and
(c) effective usage of the constantly abundant water resources of Lake Malawi and the Shire River.

The water source except for the purpose of rural domestic water supply in Malawi is mainly surface water which has better cost performance than groundwater; however, to meet the water requirement in the future, the usage of groundwater and rationalization of water use through water-saving measures and control of cropping patterns will be needed for appropriate water resources development with no conflict between the sectors.

In addition, the recommended measures for improved water resources management in Malawi are:

(a) appropriate monitoring of hydrological data and water quality and pollution;
(b) enhancement of system and capacity of relevant agencies; and
(c) strengthening of basin management system based on the basin characteristics (depicted in Table 3.3.2) studied in the Project such as infiltration pond, water conservation forests, etc.

(3) Priority in Water Supply

The priority order of consumptive water use in Malawi is domestic water, irrigation, and livestock. Regarding environmental flow in Malawi, there is insufficient information about its uses such as existence of species to be protected. In addition, there is no guideline to estimate environmental flow. Therefore, in the Master Plan, the hydrological index methodology (Q90: the flow that is exceeded 90% of the time) was applied to estimate environmental flow for the planning of measures to ensure outflow for downstream water utilization and environment.

As a result of calculation of the environmental flow, it was found out that the environmental flow is so huge that the volume is comparable to the irrigation water demand in a year. Therefore, if the priority of environmental flow is first, large-scale development of water use facilities will be needed everywhere to meet the domestic and irrigation water demands. Considering the situation and the financial condition of Malawi where about 40 percent of the revenue is the financial assistance from other countries, this is not suitable from the viewpoint of sustainable development.

In the circumstances, the influence to river discharge by water resources development has been examined, compared with the environmental flow, and the methodology of management of environmental flow has been finally suggested in the Master Plan. It is recommended that monitoring and detailed investigation for the environmental flow and clarification of precious species should be done in Malawi to properly determine the environmental flows by river basin.

(4) Safety Level of Water Usage

The safety level of water resources development has been set as in the **Table 1.1.2**. This resulted from discussions and consultations with Government Officials and a study of previous

investigation results[3][4][5][6][7], planning guidelines[8] and past domestic water supply plans[9].

Table 1.1.2 Safety Levels for the Master Plan

Sector	Level	Drought Year	Target Year	Setting Method
Irrigation and Livestock	Large and small scale	5-year drought	2035	- Consultations with DoI
Domestic	Major 4 cities (Lilongwe, Blantyre, Mzuzu and Zomba)	20-year drought	2035	- Consultation with MoAIWD - WB report (2012) - F/S reports for Cities
	Towns and Market centers	10-year drought	2035	- Consultation with MoAIWD - WB report (2012) - F/S reports for Market Centers
	Rural areas	5-year drought	2035	- Consultation with MoAIWD - Guideline of MoAIWD
Hydropower	Capacity Factor (Annual average energy/Installed capacity)		2035	- Consultation with MoE

(5) Water Demand Estimation

Water Demand has been estimated by the methods described in **Annex 4, Water Resources General**.

[3] Feasibility Study and Preliminary Design for Lilongwe's new water source, April 2010 (SOGREAH Consultants)
[4] Feasibility Study and Preliminary Design for Blantyre's New Raw Water Source and Other Purposes, August 2010 (SOGREAH Consultants)
[5] Feasibility Study and Preliminary Design of Multi-Purpose Water Source Development for Mzuzu & Mzimba and Surrounds, September 2010 (SOGREAH Consultants)
[6] Preliminary and Detailed Design and Construction Supervision for Zomba and Mangochi Water Supplies, June 2010 (SSI Engineers Environmental Consultants)
[7] Draft Report "Water Resources Investigations For Selected Market Centres In Lilongwe, Machinga, Zomba And Mulanje Districts", Centre For Development Research And Information In Southern Africa, May 2011
[8] Ministry of Irrigation and Water Development 2000, Technical Manual for Gravity fed Rural Piped water schemes.
[9] Malawi Water Sector Investment Plan, Vol. I, World Bank, April 2012

CHAPTER 2. SUMMARISED MASTER PLANS

This chapter contains summarized plans for the water resources themes as well as subsectors of irrigation, water supply and sanitation. These plans are important as part of implementation of water resources management, as such, they are presented herein to form part of this Annex which discusses some general plans for water resources management including integrated water resources management and soil conservation and water related disaster reduction.

Target Year

The target year of the Master Plan for water resources development and management was set at 2020 as a short-term target, 2025 as a middle-term target and 2035 as a long-term target.

Basic Policy for Water Resources Development and Management

To satisfy growing demand in Malawi, the key considerations for water resources development in Malawi are 1) effective water demand management in dry season, 2) abundant water resources in rainy season, 3) constantly abundant water resources of Lake Malawi and the Shire River.

The main recommendations for improving water resources management are;

1) appropriate monitoring for hydrological and water quality data,
2) enhancement of system and capacity of relevant agencies, and
3) strengthening of basin management system based on the basin characteristics studied in the Project.

2.1 Plan for Hydrometric Network

Plans for enhancement of the rainfall and surface water monitoring network are presented below.

2.1.1 Rainfall

The following is a summary of the plans for rainfall monitoring network

(1) Short term Plan

- Reliable gauging stations shall be increased in series aiming at development of a reliable and well-distributed observation network consisting of at least 100 stations. The ideal condition is: (i) at least one station exists in each WRU for basin-based water resources management; and/or (ii) coverage area of each station is about 1,000 km^2.
- Develop operation and maintenance structure
- A framework for data sharing shall be developed

Activities

- Provision of training to gauge readers
- Preparation of manual for validating monitoring data
- Strengthening of the structure/system of collection, input and management of the data (setting guidelines for verifying the gauge reader's proficiency, condition of monitoring station and equipment, keeping proper number of staff)

(2) Middle and Long Term Plan

- Maintaining reliable and stable rainfall observation system and its operation and maintenance structure
- Stations shall be upgraded as required with the aim of improving reliability

Activities

- Installation of automatic rainfall gauge to existing rainfall gauging stations.
- telemeter system for stations of which observation data can be used for flood forecasting and warning

2.1.2 Hydrology

(1) Short term Plan

Prioritized gauging stations should be targeted for activities such as improvement and

rehabilitation, and redevelopment of the system for proper observation and proper collection and management of the observed data. Then, it will be important to establish a reliable and stable water level observation system

Activities

- Reinstallation of staff gauges and benchmarks and facilities for high flow measurement
- Development of a system for carrying out regular discharge measurement including cross sectional surveys will be done.
- Discharge measurement restarted, and verification of availability of existing rating
- Ensure that accurate data is reliably recorded at least by a gauge reader, and that the data is transmitted to the office without undue delay, and validated and input to database (HYDSTRA) in prioritized stations.
- Allocation of proper remuneration to gauge readers
- Training to gauge readers engaged in prioritized stations
- Setting guidelines for verifying the gauge reader's proficiency, condition of the monitoring station
- Filling of vacant positions, training of staff,
- Strengthening the data management system by for example developing a proper operational structure of HYDSTRA at the Head office.
- Development of a framework for data sharing and information dissemination

(2) Middle & Long term Plan

- Prioritization of stations should be revised as required, based on the change of local circumstances and data requirements
- Maintenance and rehabilitation of prioritized stations, and redevelopment of the system for proper observation
- Operation and maintenance of existing observation stations should be prioritized rather than installation of new automatic gauges

Activities

Development of a system for proper O&M for automated stations. Regional offices and district offices may need to manage them.

2.2 Groundwater

One of the study findings is that catchments 5D and 5E, which include parts of Mchinji, Dowa, Ntchisi and Lilongwe districts will experience shortage of groundwater by approx. 5 million m^3 in 2035. These areas generally consist of flat lands on a series of plateaus and have the lowest recharge (4 mm/year) in Malawi. Thus, the Malawi Government has to manage carefully to exploit groundwater resources not depending on the considerations of localized groundwater in these areas.

Water supply schemes for rural areas are essentially not designed uniformly since considerations of local and social conditions. Thus, the Master Plan has limitations to consider planning individual localized areas and uses design water use of 36 liters/person/day borehole serves 250 people

Conceptual Schemes of Groundwater Development for Market Centers have been developed. However, the detailed plan of water supply to an individual market center requires site investigation including social conditions, topographic and geological conditions, etc., by feasibility studies. The continuous discharge with a large amount water volume by power pump will cause a fall of groundwater table in the long term and abstraction which exceeds discharge capacity of an aquifer will lead to drying-up of boreholes. Therefore, the long term conditions of groundwater should be predicted in order to sustain it.

2.2.1 Road Map and Activities for Groundwater Management

(1) Short Term

- Framework of a groundwater management system which routinizes administrative procedures, data processing, maintenance, and other activities related to groundwater development will be established.
- Executive capacity of groundwater management will be strengthened.
- Technical capacity for groundwater management and development shall be enhanced.
- All existing boreholes shall be identified in Malawi up to 2020
- Monitoring wells will be added up to approx. 90 wells in total
- Routine works of the automatic leveling will be strengthened

Activities

- Establishment of borehole database
- Establishment of comprehensive guidelines for groundwater management system, which consists of basic/technical knowledge of groundwater and routine manual for administrative procedures, procurement, data processing, data format, maintenance of database)
- Preparation of manual for collecting data from data loggers and from borehole construction, tidying up data in computer, extracting data error, and maintaining data loggers.
- Capacity building and staffing of hydro-geological experts for data management, evaluation and planning groundwater development
- Inventory surveys for groundwater sources (boreholes and shallow wells) including springs and artesian wells.
- Strengthen the personnel and technological capacity to implement the surveys
- Establish procedures and codes of newly constructed monitoring wells, as well as of ordinary borehole drillings. Well logs including geological profile, well structures and pumping test records are also essential to interpret the hydro-geological environment. In addition, some advance investigations such as extracting soil/rock samples, soil laboratory test (soil or rock physical and mechanical properties), detailed pumping tests with several observation wells, etc., should be done as well.

(2) Middle and Long Term

Systems of aquifer recharge enhancement shall be identified up to 2025

Activities

- Identifying and implementation of sustainable technologies with regard to groundwater recharge enhancement
- Review and enhancement of technological capacity to keep up with new advances in groundwater management and development
- Capacity building in groundwater recharge enhancement
- Development of artesian wells, springs and deep boreholes

2.3 Water Quality & and Pollution Control

The summarised Master Planning for Water Quality & and pollution Control is given below.

(1) Short & Middle Term Plan

- Water quality database will be developed by 2018
- The functions of the three (3) existing water quality laboratories in the Water Quality Services Division will be strengthened through upgrading of facilities, staffing and capacity building
- Environmental water quality standards and guidelines will be developed by 2025 to describe how water quality and pollution monitoring control system will be operating

Activities

- Preparation of manual for routine works such as the sampling procedure, tidying up data in computer, Quality control management and procedures etc.
- Procurement of analytical and measurement instruments for pesticide, organic solvent and heavy metals, such as Gas Chromatograph & Mass Spectrometer (GC/MS), Inductively Coupled Plasma Mass Spectrometry (ICP-MS), radiation measurement etc.
- Assigning the watershed class for environmental conservation to all rivers, marshes and lakes in Malawi
  - Water Quality Standard for Human Health- existing standards for drinking water (MS214), boreholes and protected shallow wells
  - Water Quality Standard for Conservation of Aqueous Environments (in accordance with several grades of watershed which correspond to the water usage or degrees of water pollution)
  - Water Quality Standard for Effluent Control

This Annex has also outlined some plans relating to integrated water resources management and development.

2.4 Water Supply

The roadmap in the short, middle and long-term includes some strategies and recommendations for Urban Water Supply as follows:

(1) Strategies

- To step up access rate
- To reduce production losses (to 5%) and NRW to less than 20- 25%. This is to be done through technical management, regulatory approach or administrative approach.
- To develop new raw water sources and rehabilitate existing ones
- To strengthen financial soundness of water supply and optimize water tariff through Asset and Accounting Management Database, improvement of Operation ratio, appropriate staffing and organization, etc

Recommendations are provided for human resource development and capacity building in formulating policies and strategies, both at the technical and professional levels. Adequate financial and human capacity is also important to promote the efficiency of the organization and at the same time the efficiency of the facility. Another recommendation is for Maintenance Programs of Waterworks Facilities to be carried out adequately, effectively and rationally since this influences the safety and stability of drinking water.

Urban water supply programs that are already planned are picked out based on feasibility and weighted against degree of emergency, importance and aging. The program, projects and activities except the priority of "Low" are formulated as concrete action plans or implementation schedules. The report has also highlighted what other reports presented on dam sites for cities, for example, the Sogreah report on New Raw Water Sources.

2.5 Development Plan for Regional Water Boards

Development concept of the Water Supply Master Plan for the towns will be as follows:

- Securing stable and safe water sources. A number of water supply schemes experience shortage of water source from rivers and boreholes since water demand had increased due to population growth. Hence, the potential of river discharge should be examined in detail, and when river flow does not have enough supply capacity, there shall be alternatives for new/additional groundwater development or dam construction based on detailed surveys conducted in consideration of demand projection. The potential of groundwater was reviewed in this Project; however, evaluation of the potential requires more detailed investigation including test drillings for actual implementation, especially, the boreholes to

be operated by power pump for urban areas. On the other hand, it is necessary to monitor water quality.

- Improve efficiency of operation. This is on economic and efficient operation and includes reduction of NRW
- Protect the catchment area. This needs to be approached through the control of deforestation and reforestation

The Water Demand in 2020-2035 is estimated for towns managed by three (3) regional water boards and development plans are prioritized using the ratio of the existing water intake capacity in 2012 against water demand projection and using population in the water supply schemes.

The action plan for implementation in towns is that a review and monitoring of target towns shall firstly be conducted to investigate and modify priority settings. Then Feasibility Study for the target towns shall be conducted for the towns on short-term plan, and Second Study for the middle and long-term plan. Part of the towns will be selected as emergency, and Basic Design will be conducted antecedently in 2015. Implementation of the Project will be started in 2016.

Recommendations are also made for capacity development Operation of the water treatment plant and reduction of Non-Revenue Water

2.6 Rural Water Supply

The development concept of the Water Supply for Rural Areas is as follows:

- The Market Centre Project is given high priority considering that population growth is high in market centers due to migration from rural areas. This is on rehabilitation/ expansion and construction of new facilities to meet future water demand in the Market Centres.
- The Project for rehabilitation/expansion of gravity fed piped schemes in rural areas, many of which are aged
- Improvement in monitoring and evaluation of existing boreholes and protected shallow wells
- New borehole drilling where feasible

Development concept of the Water Supply Master Plan for the towns will be as follows:

- Secure the stable and safety water source
- Improve service level
- Sustainable operation by RWB/WUA

Prioritization of market centres is made, by population in 2035 and using the priority list provided by MoLGRD.

In order to facilitate the project for gravity-fed piped water supply, the following approach is recommended:

- Outline of the water demand and challenges of the scheme should be grasped by MoAIWD, Local Government and District Water Office.
- Preliminary survey of the water supply schemes by MoAIWD and the local government.
- Drawing up of the Priority List.
- Coordination to implement the program with financial issues.

An action plan and implementation list is provided

For those communities served by a borehole, the recommended plan is to promote rehabilitation, strengthen the operation and maintenance capacity of the water supply committees and construct new boreholes for areas with few boreholes with no possibility of gravity-fed water supply.

2.7 Sanitation

Outstanding conclusions and recommendations for Sanitation are:

- There is need to establish an institutional framework and guidelines for sewage management in the urban areas in Malawi. The National Sanitation Policy 2008 and the and the Water Works Act (1995) mandates that the Water Boards be in charge of the management of Water borne sanitation.
- There is need to strengthen coordination for rural on-site treatment
- Maintenance of existing facilities need to be improved to fulfill the Malawian standard on effluent discharges. A National Urban and Rural Sewage Development and Management Master Plan is highly recommended
- Prioritization of solid waste management especially for market centres where there is poor solid waste management

2.8 Irrigation Water Supply Development Plan

The development plan for irrigation water supply depicts the irrigation development area under the agreed development scenarios to 2035. It also proposes structural and non-structural measures (replacement of normal crops to earlier growing crops or introduction of water saving cultivation) as well as development priorities and depicts an area and cost based implementation plan, formulated according to the irrigation development scenarios. The irrigation development schemes will be arranged in accordance with the parameters of irrigation development effects which are: (1) cost efficiency; (2) availability of water resources; and (3) high development effectiveness.

The two agreed development scenarios are:

- The realistic development at 2,500 ha/year, and
- The quite ambitious development at 5,000 ha/year. This is nearly equal to the standard development rate of SADC countries

The total irrigation areas in 2035 are 150,000 ha in the lower scenario with an annual area increase of 2,500 ha and 210,000 ha in the higher scenario with an annual area increase of 5,000 ha.

The irrigation potential area, as presented in the Irrigation Master Plan and Investment Framework is around 407,862 ha. A water balance simulation is conducted using the potential area as an upper limit for irrigation development by Water Resources Area (WRA). Based on the results of initial water balance analysis, it is proven that water is still available at the early stage of the dry season. Therefore, the possibility of crop diversification, such as shifting crop cultivation and application of early maturing crops, are proposed for saving available water as a non-structural application. As a result, Green Maize Cultivation and Early Maturing Rice are adopted as the non-structural applications.

2.8.1 Irrigation Development Area

Following the two development scenarios of 2,500 ha/year and 5,000 ha/year, the irrigation development areas are allocated in consideration of a suitable balance between water demands from irrigation development areas and water development potentials from surface water simulation. After some trial and error approach, the irrigation development area by WRA is determined in the two scenarios. Based on the irrigation development areas in the two development scenarios, water demand is estimated including livestock demand.

Using the monthly cropping pattern and its demand for irrigation and water supply and livestock demands, water balance analysis is made by the Water Resources Unit. The results of water balance analysis in the dry season, from May to October done. Out of 66 WRUs, some water deficit occurs in 7 and 11 WRUs in the dry season under 2,500 ha/year and 5,000 ha/year of the development scenarios, respectively. In other words, irrigation water development can be made without large storage facilities in 59 WRUs which is equivalent to 89% of all WRUs, in the 2,500 ha/year development scenario.

Some structural works including weirs on tributaries and pipe/ canal works, taking into account topography, river features, advantageous location of intake facilities, and suppleness of structural component are considered applicable for irrigation development.

CHAPTER 3. INTEGRATED WATER RESOURCES MANAGEMENT IN MALAWI

Water resources management which follows the principles of Integrated Water Resources Management (IWRM) has been recognized and adopted by key players who utilize water for various social and/or economic activities in a very wide cross-section of sectors. IWRM for instance has been adopted for its importance in relation to the efficient production of food crops in irrigation agriculture, for its significance in reducing water-related health risks, and its important role in reducing the risks of floods and droughts.

The key principles in IWRM agreed in the international conference on water and the environment in Dublin in 1992, known as "The Dublin Principles", are as follows:

- Freshwater is a finite and vulnerable resource, essential to sustain life, development and the environment;
- Water development and management should be based on a participatory approach involving users, planners and policy makers at all levels;
- Women play a central part in the provision, management and safeguarding of water; and
- Water has an economic value in all its competing uses and should be recognized as an economic good.

Furthermore, the widely accepted Global Water Partnership's definition of IWRM is as follows:

"IWRM is a process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems".

3.1 Specific Features in Malawi's Water Resources

IWRM has proven to be a flexible approach to water resources management that can adapt to diverse local and national contexts. The details in planning and implementation should reflect local water issues and management conditions. In order to improve IWRM in Malawi, the following features of Malawi should be considered:

- There are 17 Water Resources Areas (WRAs) dividing the national territory by their drainage areas, and their areas range widely from the 3.3 km2 of Chizumulu Island to the 18,910.6 km2 of the Shire River Basin. Thus, there are big differences in importance from socio-economic activities and development effects to national economy so that it is not practicable to deal with them equally.
- Development needs in domestic water supply, hydropower generation, and agriculture, as well as flood risk, extend over the entire WRAs. Thus, IWRM shall identify the specific demands and risks of each WRA and address their issues in the process of plan formulation.

Based on the above considerations, key development issues are identified from the present situation of water resources development and management in Malawi, as shown in **Table 3.2.1.**

It is notable that the Water Resources Act 2013 is in place. The Act stipulates the establishment of the National Water Resources Authority and Catchment Management Committees, which closely relate to IWRM. The following are some notable points on the Authority, the Committees and the National Water Resources Master Plan stipulated in the Act, which will contribute to progress and back-support for the realization of IWRM.

(1) National Water Resources Authority

The National Water Resources Authority (NWRA) consists of representatives of government ministries responsible for water development, health, tourism, agriculture, irrigation, land management, natural resources, environment and transport as well as representatives of catchment management committees to be established, water user associations and NGOs engaged in the water sector. Thus, while performing the regulatory functions under its mandate, the NWRA shall

greatly contribute to the advancement of IWRM in Malawi.

The National Water Resources Authority has the following major powers and functions related to IWRM:

- To develop principles, guidelines and procedures for the allocation of water resources;
- To monitor, and from time to time reassess, the National Water Policy and the National Water Resources Master Plan;
- to receive and determine applications for permits for water use;
- to regulate and protect water resources quality from adverse impacts;
- To manage and protect water catchments;
- To gather and maintain information on water resources and from time to time to publish forecasts, projections and information on water resources;
- To liaise with the relevant stakeholders for the better regulation and management of water resources;
- To assist the Minister in the coordination of hydrological and hydrogeological investigations;
- To coordinate the preparation, implementation and amendment of a water action plan and to recommend the water action plan to the Minister; and
- To advise the responsible Minister, as the case may require, on any dispute between agencies involved in water management that may be referred to it.

Based on the power and functions stipulated by the Act as described in **Subsection 2.1.1 of the Water Resources Act, 2013**, the NWRA shall provide for:

(1) The collection, collation and analysis of data concerning the occurrence, flow, characteristics, quality and use of any water or waste;
(2) The systematic gauging and recording of rainfall and of the volume, flow and quality of other water or waste;
(3) The construction, operation and removal of gauging, recording and monitoring stations and investigation and monitoring boreholes; or
(4) The sampling and analysis of any water or waste.

The NWRA shall meet at least four times every year, and shall produce and publish the progress of its activities annually at the end of each financial year.

(2) Catchment Management Committees

Regarding the Catchment Management Committees, the Authority may by notice publish in the gazette, designate a defined area from which rainwater flows or drains into a watercourse, to be a catchment area for the purpose of the Act. The Authority may establish a catchment management committee for a specific catchment area after public consultations on the proposal of the community and stakeholders concerned, or the Authority may establish a catchment management committee on its own initiative. A catchment management committee shall consist of the representatives of government agencies related to water resources in the catchment area and representatives of various stakeholders within the catchment area concerned.

The Catchment Management Committee shall advise officers of the Authority on:

(a) water resources conservation, use and allocation;
(b) the grant, adjustment, cancellation or variation of any license and permit under the Act; and
(c) any other matters pertinent to the proper management of water resources.

(3) National Water Resources Master Plan

The Act stipulates the following items to be addressed in the National Water Resources Master Plan:

- Water balance for each catchment area that compares forecasted water demand with data and information regarding water availability;

- Proposed options for meeting forecasted demand for each catchment area in which forecasted water demands exceed available supply, and such options may include:
  (a) water demand management programs;
  (b) necessary infrastructure construction; and
  (c) any other measure, including appropriate legal reforms considered necessary in achieving the objectives of the National Water Resources Master Plan;
- The protection of water resources from over-exploitation and pollution; and
- Conservation of water resources, including the recycling and re-use of wastewater, the harvesting of rainwater, and any other suitable conservation practice and technique.

3.2 Overall Approach for Integrated Water Resources Management

Taking the discussion in the preceding sections into consideration, the approach for proper water resources management, which contains clarification of specific features of WRAs and their

classification for easy ways to manage the basins or WRAs, shall start with basin analysis. The chart in

1. Comparative analysis of WRAs
   (1) Physical features
      - Area of WRA
      - Major rivers in the WRA
   (2) Socio-economic features
      - Population (urban and rural) in WRA
      - Major cities and towns in WRA
   (3) Major water resources development structures
      - Reservoirs for multi-purposes or single-purpose
      - Irrigation Intake
2. Classification of WRAs
   - Class A: important and socio-economically active WRAs, urgent development/management target put at these WRAs by the M/P
   - Class B: intermediate level of WRAs, long-term development/management target put at these WRAs by the M/P
   - Class C: small and socio-economically inactive WRAs

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3. Review of Legal Background for Strengthening on Water Resources Management
   - New Water Resources Act
   - Environment Management Act
4. Proposition of Proper Management Organization
   (1) Review for proper management in central government levels
      - Human resources potential
      - Budgetary back-up
   (2) Proposition of management structure

↓

WRA/Catchment Area Analysis: Class A

5. Proposition of Proper Monitoring System
   (1) Evaluation of hydrological/meteorological monitoring system
      - Monitored period
      - Monitored parameters (water level, stream flow, rainfall)
      - Representativeness of WRA
   (2) Proposition of the proper monitoring system
      - Representative hydrological/meteorological monitoring network
      - Data collecting and archiving system
6. Proposition of Water Resources Management Measures (by Class A WRAs)
   - Water resources demand (current and future) for domestic, industrial and agricultural uses
   - Water supply potential and water balance
   - Necessary measures: structural and non-structural development/management measures

Figure 3.2.1 presents the basic approach.

Table 3.2.1 Key Development Issues in the Water Resources Management of Malawi

No	Key Development Issues	Actual Conditions	Way to Address the Issues
1	Securing food production	To increase agriculture productivity and diversification, promoting irrigation farming is one of key strategies in MGDS I & II. The Malawi Government is carrying out a national-scale project 'Green Belt Irrigation and Water Development'. But total irrigation area of 90,563 ha is equivalent to only 2.3 % of arable area of 3,994,000 ha in 2011.	To assess the water supply potential from the relevant river system and propose proper supply capacity and system to the subject area
2	Ensuring sustainable water infrastructures	To improve access to water through an integrated water management system, increasing number of people connected to piped water supply systems in both urban and rural areas. Through the continuous effort to increase the access, significant improvement shows up to 75 % to total population in service coverage of improved water supply.	To prioritize the necessary demand areas and assess the suitable water sources and supply capacity
3	Managing the water-energy relationship	To generate and distribute sufficient amount of energy to meet national socio-economic demands, construction of hydropower stations along the major river courses shall be necessary. In 2010, the access rate of electricity is still low, only 9 %.	To evaluate hydrological potential to the proposed hydropower generation plants and downstream effects in river hydrology
4	Collaboration in the management of land and water	In relation to low energy supply rate, most people rely on biomass energy produced by logged woods. As a result, forest areas have reduced for a long period. In 2010, forest-covered area remains at 35 % to the total land.	To assess the deforestation effects in hydrology, in particular increase of drought vulnerability and sediment runoff, and to propose the well-functioning collaboration between water and watershed conservation
5	Adapting to climate change	Monitoring system on climate changes is not sufficient. In particular, early warning, preparedness and response is strongly necessary for agricultural practices.	To assess the actual effects of climate changes in the typical selected model area and to demonstrate the monitoring and warning system
6	Mitigating disaster risks, floods and droughts	Habitual flooding occurs mainly along the Songwe and North Rukuru rivers in the northern region and along the Shire River in the southern region. The severe drought occurred over the country, so that agricultural products were severely damaged due to mainly relying on rainfed cultivation.	To assess the actual flooding and drought effects over the country, and to propose the appropriate countermeasures coping with natural disasters
7	Planning transboundary collaboration	Malawi is a member state of Zambezi Watercourse Commission, and future collaboration becomes much important for Nsanje World Inland Port project opening up navigable river course to the Indian Ocean.	To review the effective cooperation directions, and to propose strengthening transboundary collaboration

1. Comparative analysis of WRAs
   (1) Physical features
      - Area of WRA
      - Major rivers in the WRA
   (2) Socio-economic features
      - Population (urban and rural) in WRA
      - Major cities and towns in WRA
   (3) Major water resources development structures
      - Reservoirs for multi-purposes or single-purpose
      - Irrigation Intake
2. Classification of WRAs
      - Class A: important and socio-economically active WRAs, urgent development/management target put at these WRAs by the M/P
      - Class B: intermediate level of WRAs, long-term development/management target put at these WRAs by the M/P
      - Class C: small and socio-economically inactive WRAs

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3. Review of Legal Background for Strengthening on Water Resources Management
      - New Water Resources Act
      - Environment Management Act
4. Proposition of Proper Management Organization
   (1) Review for proper management in central government levels
      - Human resources potential
      - Budgetary back-up
   (2) Proposition of management structure

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WRA/Catchment Area Analysis: Class A

5. Proposition of Proper Monitoring System
   (1) Evaluation of hydrological/meteorological monitoring system
      - Monitored period
      - Monitored parameters (water level, stream flow, rainfall)
      - Representativeness of WRA
   (2) Proposition of the proper monitoring system
      - Representative hydrological/meteorological monitoring network
      - Data collecting and archiving system
6. Proposition of Water Resources Management Measures (by Class A WRAs)
      - Water resources demand (current and future) for domestic, industrial and agricultural uses
      - Water supply potential and water balance
      - Necessary measures: structural and non-structural development/management measures

Figure 3.2.1 Overall Approach to Integrated Water Resources Management

3.3 Water Resources Area Classification

The land area of Malawi is divided into 17 water resources areas (WRAs) based on the catchment area of the major rivers. Each WRA consists of one river basin or in some cases consist of a number of small river basins. Furthermore, the relatively large WRAs have been sub-divided into Water Resources Units (WRUs). The **Table 3.3.1** summarizes the salient features of WRAs at present.

Table 3.3.1 Water Resources Area (WRA) and Major Indices

WRA	Region	Area[1] (km^2)	Number of WRUs	Major Rivers	Population in 2010[2] (thousand)	Major Cities and Towns[3]
1. Shire	Southern & Central	18,911	16	Shire, Rivirivi, Lisungwe, Mwanza	3,327	Blantyre, Mangochi, Balaka, Ngabu, Nsanje
2. Lake Chilwa	Southern	4,567	4	Phalombe, Domasi, Thondwe	1,254	Zomba
3. South West Lakeshore	Southern & Central	4,998	6	Bwanje, Livulezi	746	Dedza
4. Linthipe	Central	8,885	6	Linthipe, Lilongwe, Diamphwe	2,496	Lilongwe, Salima
5. Bua	Central	10,658	4	Bua	1,513	Mchinji
6. Dwangwa	Northern & Central	7,751	4	Dwangwa, Mpasadzi, Rupase, Lingadzi	616	Kasungu
7. South Rukuru, North Rumphi	Northern	12,719	7	South Rukuru, Kasitu, Mzimba	925	Mzuzu, Mzimba, Rumphi
8. North Rukuru	Northern	2,088	-	North Rukuru	123	Karonga
9. Songwe, Lufira	Northern	3,730	2	Songwe, Lufira	204	-
10. South East Lakeshore	Southern	1,659	-	-	209	-
11. Lake Chiuta	Southern	2,443	-	-	317	-
12. Likoma Island	Northern	17	-	-	11 (12 & 13)	
13. Chizumulu Island	Northern	3	-	-		
14. Ruo	Southern	3,519	4	Ruo	1,117	Mulanje
15. Nkhota-kota Lakeshore	Central	4,819	3	-	608	Khonbedza, Nkhotakota
16. Nkhata-Bay Lakeshore	Northern & Central	5,533	3	Luweya, Dwambazi	308	-
17. Karonga Lakeshore	Northern	1,945	3	-	154	-

[1] Refer to Table 4.1.1 in the Part I report; [2] Refer to the report "Water Resources Investment Strategy" prepared by ATKINS, 2011;
[3] Major cities and towns are highly populated areas having more than 10,000 population.

Based on the present situation, area extent and population of WRA could be divided into the following three classes. Their histograms are presented in the figure below.

Area

Large: larger than 7,000 km^2

Medium: 3,000 km^2 to 7,000 km^2

Small: smaller than 3,000 km^2

Population

Large: more than 1,000,000

Medium: 400,000 to 1,000,000

Small: less than 400,000

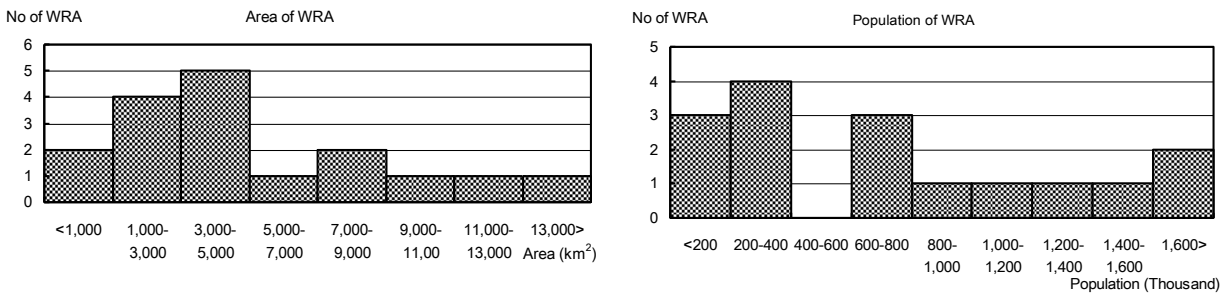


Figure 3.3.1 Histograms of Area and Population of WRA

Principal features of each WRA, including the above-mentioned classification of area and population, major existing and planned water resources structures, flood vulnerability and areas under trans-boundary issues are shown in **Table 3.3.2**. Considering the importance of WRA and the existing and future water resources development structures, WRAs are classified into the following three classes:

(1) Class A: High national importance (8 WRAs)
(2) Class B: Medium national importance (4 WRAs)
(3) Class C: Low national importance (5 WRAs)

In Class A, the major rivers flow through the areas so that water resources management should be over the catchment area from the national level viewpoint. In Class B, the rivers are not large so that water resources management should be concentrated in areas where water resources development structures are planned. On the other hand, in Class C, major waterworks may be limited to rural water supply. **Table 3.3.2** gives a list of water development facilities while **Figure 3.3.2** shows the location of water resources development facilities in the WRAs.

Table 3.3.2 Principal Features of Water Resources Area (WRA) and its Classification (1/2)

WRA / Parameter	1	2	3	4	5	6	7	8
	Shire	Lake Chirwa	South West Lakeshore	Linthipe	Bua	Dwangwa	South Rukuru/ North Rumphi	North Rukuru
Area Extent	Large	Medium	Medium	Large	Large	Large	Large	Small
Major River System	Shire	Phalombe	Many small rivers	Linthipe, Lilongwe	Bua	Dwangwa, Rupashe	South Rukuru, Mzimba	North Rukuru
Population	Large	Large	Medium	Large	Large	Large	Large	Small
Major Cities/ Towns	Blantyre, Mangochi	Zomba	Detza	Lilongwe	Mchinji	Kasungu	Mzuzu, Rumphi, Mzimba	Karonga
Irrigation Existing Medium & Large Dams	Gala in Ntcheu			Chilembwe, Mchoka, Thyola in Lilongwe	Chinomwe, Mkuwira in Dowa	Estate 81, Estate 88 in Kasungu	Mawowo, Njorwa/Dolola in Mzimba	
Large Irrigation Scheme			Bwanje Valley					
Green Belt Initiative	Malombe, Chilengo							
Urban Water Supply Existing Dams	Mpira in Ntcheu, Mudi in Blantyre	Mulunguchi in Zomba		Kamuzu I & II in Lilongwe		Chitete in Kasungu	Lunyangwa in Mzuzu	
Planning Large Dams				Diamphwe Lower (multi) in Lilongwe			Lambilambi in Muzuzu, Mzimba (multi) in Muzimba	
Hydropower Plants Existing Plants	Nkula, Tedzani, Kapichira							Wovwe
Planning Plants	Nkula A upgrade, Kholombidzo, Tezani IV, Mpatamanga, Kapichira II & III				Mbongozi, Malenga, Chasombo, Chizuma		Lower Fufu, Rumphi, Henga Valley	
Flood Vulnerability	High			High				High
Transboundary Issues	Outflow	Inflow						
Classification	**A**	**A**	**B**	**A**	**A**	**A**	**A**	**B**

Note: Medium dams are defined as dam hight of 10 m to 15 m, while large dams are defined as dam height of higher than 15 m.

Table 3.3.2 Principal Features of Water Resources Area (WRA) and its Classification (2/2)

WRA / Parameter	9	10	11	12 & 13	14	15	16	17
	Songwe, Lufira	South East Lakeshore	Lake Chiuta	Likoma Is. & Chizumulu Is.	Ruo	Nkkhota-kota Lakeshore	Nkhata-Bay Lakeshore	Karonga Lakeshore
Area Extent	Medium	Small	Small	Small	Medium	Medium	Medium	Small
Major River System	Songwe, Lufira	Many small rivers	Many small rivers	Small Islands	Ruo	Many small rivers	Many small rivers	Many small rivers
Population	Small	Small	Small	Small	Large	Medium	Small	Small
Major Cities/ Towns	-	-	-	-	Mulanje	Nkhotakota	-	-
Irrigation								
Existing Medium & Large Dams					Thunga, Tswane in Thyolo			
Large-scale Irrigation Scheme								
Green Belt Initiative	Nithola-Ilora-Ngosi							Nithola-Ilora-Ngosi
Urban Water Supply								
Existing Large Dams								
Planning Large Dams	Manolo (multi)				Mombezi in Thyolo for Blantyre			
Hydropower Plants								
Existing Plants								
Planning Plants	Bupigu, Sofwe, Manolo				Zoa Falls		Chimgonda	
Flood Vulnerability	High				High			
Transboundary Issues	Inflow	Small inflow	Outflow					
Classification	**A**	**C**	**C**	**C**	**A**	**C**	**B**	**B**

Note: Medium dams are defined as dam hight of 10 m to 15 m, while large dams are defined as dam height of higher than 15 m.

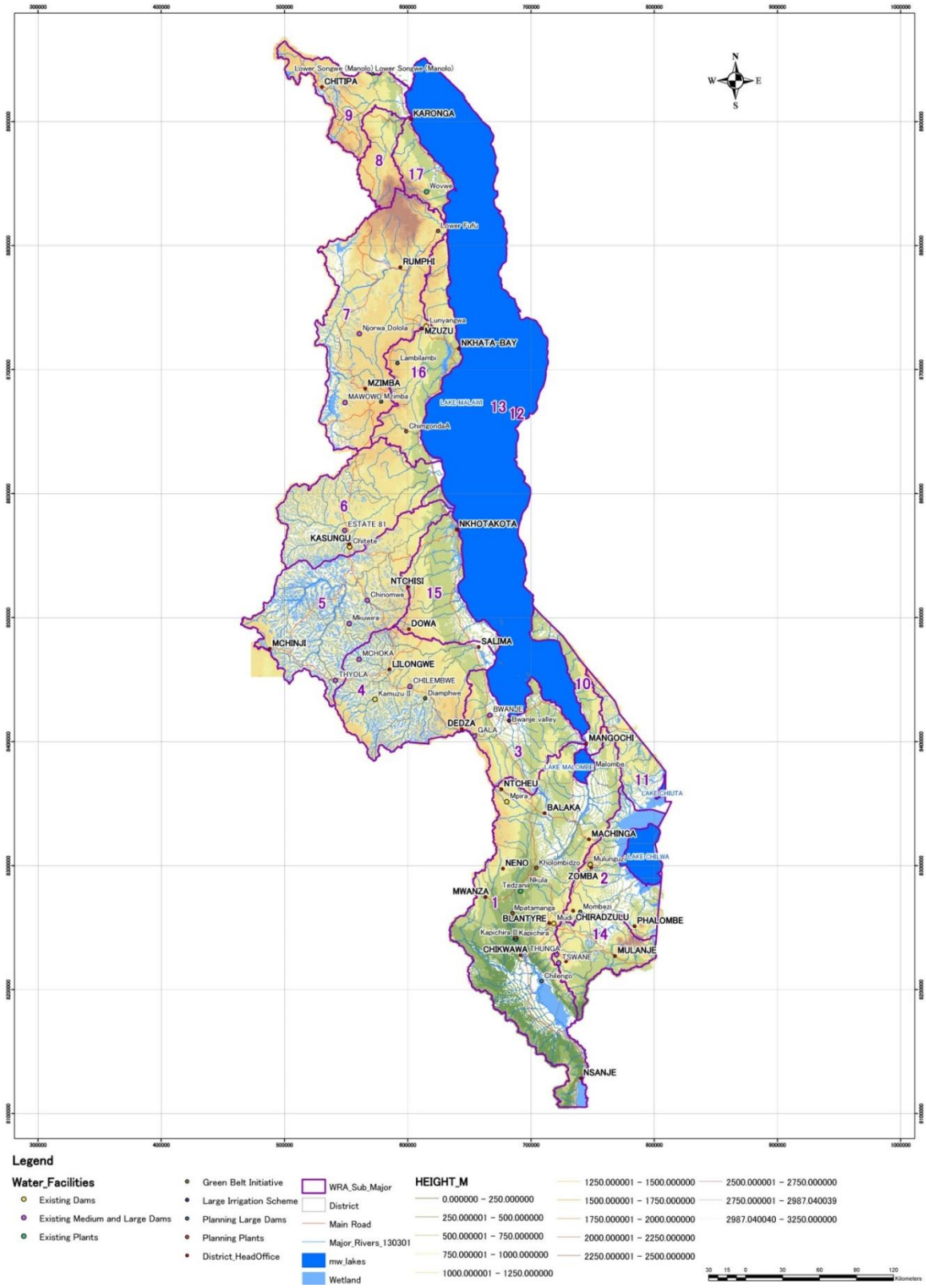


Figure 3.3.2 Location Map of Water Resources Development Facilities in the WRAs

CHAPTER 4. INSTITUTIONAL SETUP FOR INTEGRATED WATER RESOURCES MANAGEMENT

As described in **Chapter 3**, establishment of the National Water Resources Authority and the Catchment Management Committees will greatly contribute to the realization of IWRM in Malawi.

4.1 Managerial Coordination of the Organizations

(1) Overview for IWRM Coordination

Based on the implication of the Water Resources Act and the IWRM policy, coordination of all relevant stakeholders may be a great challenge in realizing the IWRM in Malawi.

Since the NWRA is organized with the representatives from relevant governmental agencies, the following coordination shall be made in the central organization of the NWRA:

(a) Data and information monitored or planned/developed by the departments shall be shared with the NWRA, and their stored data/information shall be updated on regular basis.
(b) Coordination works to mitigate adverse effects by some projects shall be necessary by both sides, if some projects with significant effects will induce to water resources or other factors operated/maintained by the relevant agencies.
(c) In case of occurrence of some problems in water resources, both sides shall collaborate for reasonable and equitable solution.

The following figure depicts the mechanism of coordination works to realize the IWRM.

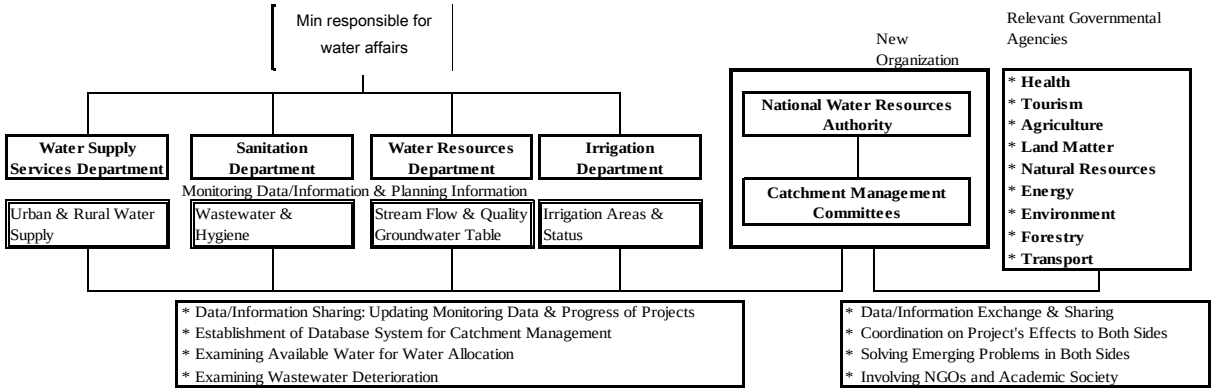


Figure 4.1.1 Organizational Relationship and Necessary Coordination Works

(2) Issues that should be addressed for Strengthening the Institutional Capacity of the Water Resources Management

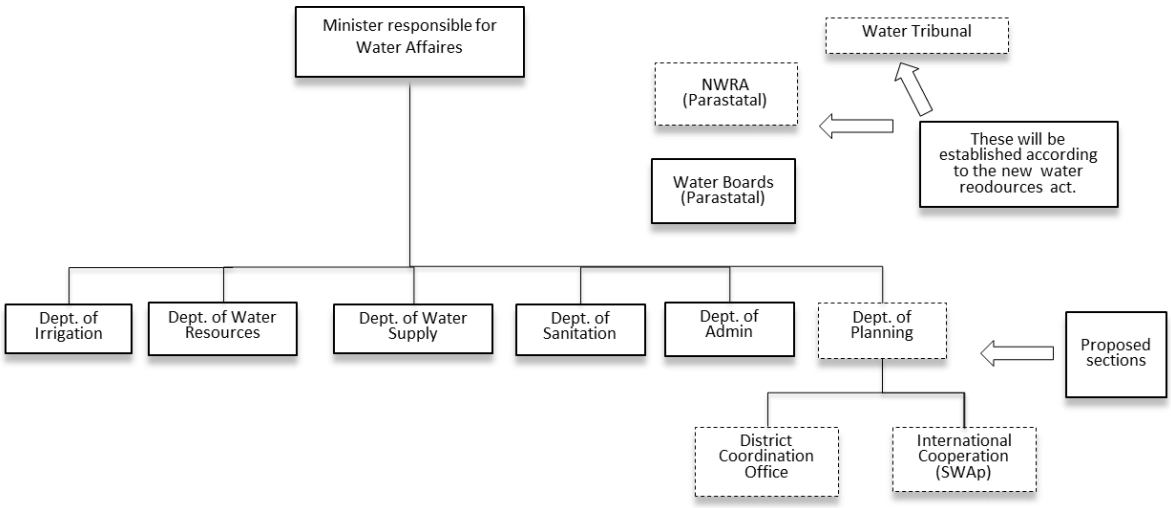
The Master Plan has identified the following issues which need interventions for improved water resources management and development:

- The mandates of the water sector have been partly devolved to the district councils, but the process was not fully completed.
- The roles and functions of the regional offices are not well articulated. Government interventions and projects are implemented without the involvement of regional offices. The health sector, for example, has no regional office and the functions are all performed by the district councils, district offices and health institutions. It is important that the role of Regional Offices should be spelt out clearly when implementing projects so that there is adequate technical supervision and information sharing at the Regional level.
- An institutional structure for the National Water Resources Authority should be developed and implemented for the new organization to facilitate the IWRM.
- The collection rate of water licensing fees and water abstraction rentals is roughly 40%. The database is not well structured to monitor a good track record of the clients. Stakeholders are also not well sensitized about the water abstraction rentals/fees. Therefore,

many boreholes and facilities are not recorded. This will make it difficult to estimate the volume of water abstraction at each catchment. There is need for an improved database and sensitization on the need to pay for water abstraction.

- The Ministerial library does not function as a central archive. Information and reports are scattered and the books are not registered. The room is disorganized. There is need for reorganization of the library so that it functions properly and there is proper tracking of all reports and books kept there.
- The capacity of policy guidance and planning is weak. The Planning Section is short of human resources capacity and is heavily loaded with the SWAp coordination and M&E projects as well as the other activities.

The Integrated Water Resources Management System has become a common conceptual framework for management and utilization of water resources. In Malawi the high level government officials are well sensitized about the concept; however, the institutional structure is still in the transitional process. In the following paragraphs, proposals are made to improve the issues identified as above, for upgrading the institutional activities of the Ministry towards the IWRM, including a proposal of setting a new department with operational teams for district coordination and Projects activities. These new units will serve as the focal points for navigating the water sector policy, upgrading the district office activities around the country and international interventions. **Figure 4.1.2** illustrates a proposed structure of the Ministry responsible for Water Affairs and NWRA. The sections indicated by the dotted squares are the new institutional units that are proposed in this Master Plan.



Note: Water Tribunal will be set up according to the National Water Resources Act of 2013

Figure 4.1.2 Proposed Organizational Structure for IWRM

1) Institutional Framework for the National Resources Authority

The concept of the National Water Resources Authority (NWRA) was made out of proposals to revise the institutional management of water resources towards a more integrated management for the national water resources. The management by river basin is a step towards IWRM. The concepts were initially outlined in the Water Resources Policy of 1994 and further analysis was undertaken during the project "Strengthening of the Water Resources Board, January 2003". The National Water Policy 2005 was formulated to address the issues of water resources management, water resources development and water provision. Furthermore, the water resources developments would be aimed at achieving the UN Millennium Development Goals (MDGs) and the World Summit on Sustainable Development targets of 2015, and management of trans-boundary water resources would have to conform to the regional and international agreements and protocols. The aspect of water resources was further taken up in the National Water Resources Act 2013 which had been long discussed before its enactment. The Water Resources Act 2013 details mandates of the Authority and how it is to be

established and composed. Public sector regulatory entities have in a similar manner already been operationalized for the telecommunication and energy sectors in Malawi to control public goods and resources for the benefit of the public at large. Two regulatory authorities are taken as examples to propose an organogram for the NWRA.

- Malawi Energy Regulation Authority (MERA)
- Malawi Communication Regulation Authority (MACRA)

Taking these examples of other entities as a reference as well as considering the organizations' powers and functions that the NWRA is expected to perform, an organizational structure for NWRA is illustrated in **Figure 4.1.3**. This proposed structure is an initial organogram and needs to be developed further as required.

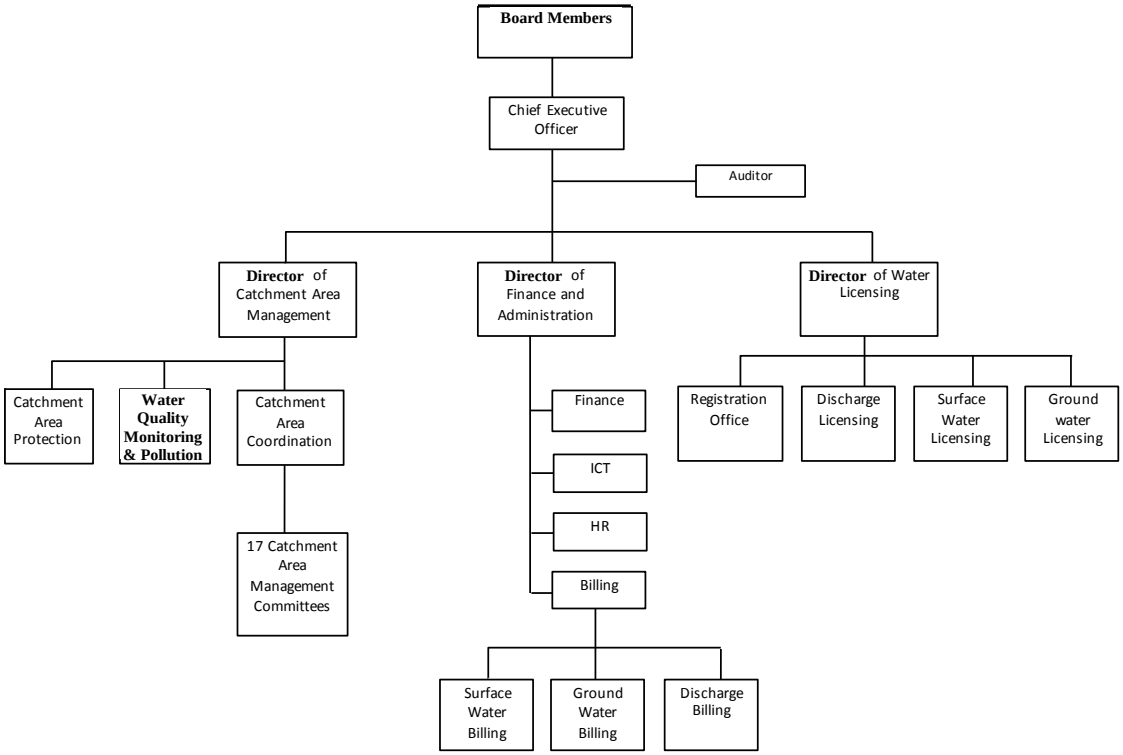


Figure 4.1.3 Proposed Initial Organizational Structure of NWRA

Table 4.1.1 shows the proposed staffing plan for the NWRA. The proposal is made only for minimum core competencies. Other posts with general skills shall be recruited according to the requirements.

Table 4.1.1 Proposed Staffing Plan of NWRA

Post	Specialization	No. of Posts
CEO	Management/water resources	1
Auditor	Management/Finance	1
Director of Catchment Area Management	Management of Catchment Management Committee	1
Catchment Area Protection	Environmental science, water resources, civil engineering	2
Water Quality and Pollution Control	Water Quality, Environmental science	2
Catchment Area Coordination	Water resources/environment/forestry Hydrogeology Civil Engineering Planner	3
Director of Finance and Administration	Finance Administration Organizational Management	1
Finance	Financial Administration	2
ICT	Computer Science, Programming	1
Human Resource Management	Human Resource Management	1
Billing	Billing, Accounting	2
Director of Water Licensing	Hydrology, Water Resources	1
Registration Officer	Hydrology, Water resources	2
Discharge Licensing	Water Quality, Environmental Sciences	2
Surface Water Licensing	Hydrology, Water Resources	2
Groundwater Licensing	Hydrology, Groundwater	2
Principal Office Manager	Administration/Human Resources	1
Community Relations Officer	Public Relations/Media/Journalism	1
Total		27

The transitional process of establishment of the NWRA requires gradual transfer of certain mandates which the Ministry is currently in charge of. Since the NWRA is in the process of establishment with a business plan, concrete project contents have to be prepared once the organizational structure of the NWRA is set up and officers recruited. Projects that are needed for enhancing IWRM under NWRA are outlined in **Table 4.1.2**.

Table 4.1.2 Projects Recommended for enhancing IWRM under NWRA

Project Theme and Background	Project Components	Target Stakeholders
1.Classification of Rivers		
For the purpose of river water management there needs to be a classification system of rivers with regulations covering – water quality standards, conservation rules, management system by classifications among others.	**1.** Draw a set of classification criteria **2.** Draw rules and regulations according to the classification of rivers **3.** Inform stakeholders of the protocols who undertake any activities related to the rivers	**1.** NWRA officials **2.** Surface water section **3.** River water users
2.Buffer Zones Management of Rivers		
To facilitate riparian management, such as river and lake waters, buffer zones need to be set in place to avoid siltation and contamination of water by cultivation activities at riversides. However, in practice there need to be alternative ways of gardening as people are gaining food and income from such practices.	**1.** Draw a set of classification criteria **2.** Draw rules and regulations according to the classification of rivers **3.** Assist raising awareness and other means of gardening by providing water through pipes or something.	**1.** NWRA officials **2.** Ministry responsible for water affairs **3.** River water users
3. Catchment Area Management		
Catchment Area Management is a key to manage and supervise 17 Water Resources Areas (WRA) also indicated catchments across Malawi. A catchment area management committee will care for 1 or more catchment areas.	**1.** Draw guidelines for catchment area management **2.** Establish catchment area committee **3.** Implement activities concerning water allocation, conservation and control of water usage.	**1.** NWRA officials **2.** Min of Water officials **3.** District councils **4.** Water users
4. Registration of Associations of Water Users		
Many water users associations have been established to monitor and manage water usage. However, those entities are currently not registered or regulated by any legal constitutions. Many farmers associations created WUAs under Department of Irrigation as well as Blantyre Water Board and Lilongwe Water Board but there is no supervising entity to regulate and support WUAs at the operational level.	**1.** List and register all AWUs in Malawi **2.** Facilitate AWUs to create and agree on constitutions **3.** Sensitize to pay water license charges to NWRA	**1.** AWUs **2.** District Councils **3.** NWRA officials 4. Ministry responsible for water affairs

2) Catchment Management Committee

Water resources management by river basin is an effective institutional establishment for the integrated water resources management. Malawi has 17 River Basins. The Water Resources Act of 2013 stipulates the establishment of catchment management committees. Based on the law, each catchment area is to have a Catchment Management Committee either by public demand or by the initiative of the NWRA. However, from the viewpoint of water resources engineering, the basin-based division as a managerial unit is more rational than creating new area divisions for the Catchment Management Committee (CMC), since there may be conflicts of interest upstream and downstream. The rivers need to be coordinated as a whole in the river basin. Therefore, the Catchment Management Committee can use 17 river basins as divisional scheme for managerial purposes. Further, considering the scarcity of human resources well qualified in water resources, hydrogeology, environment and other relevant disciplines, it is recommended to initially establish one (1) committee. In the future, more committees can be established for the river basins.

Should needs arise, sub-catchment committees can be established. It is recommended that the establishment of such committees undergoes the process outlined in **Table 4.1.3**. A Secretariat that will look after all of the 17 river basins has to be placed at the headquarters of the NWRA.

Table 4.1.3 Proposal for Catchment Management Committee Establishment Process

Process	Activities
1. Selection of members	Select members
2. Establishment of Secretariat	Establish a Secretariat
3. Strategic plan for management	Draw a business management plan/management strategy either by the Authority or CMC
4. Consideration of funding sources	Draw a financial plan
5. Catchment Area Coordination	Coordinate stakeholders in relation to the catchment area management
6. Water Quality and Pollution Control	Monitor and analyze the data and decide actions if needed
7. Manage abstraction and discharge activities	Licensing in collaboration with the central NWRA office
8. Conduct or initiate water resources conservation activities and works	Find funding sources to undertake water resources conservation activities and works and implement the activities

The NWRA will coordinate the production of the catchment management strategy for the 17 basins. These plans may be implemented with support from the district councils, the Ministry responsible for Water Affairs and other ministries, NGO/CBOs and the Private Sector.

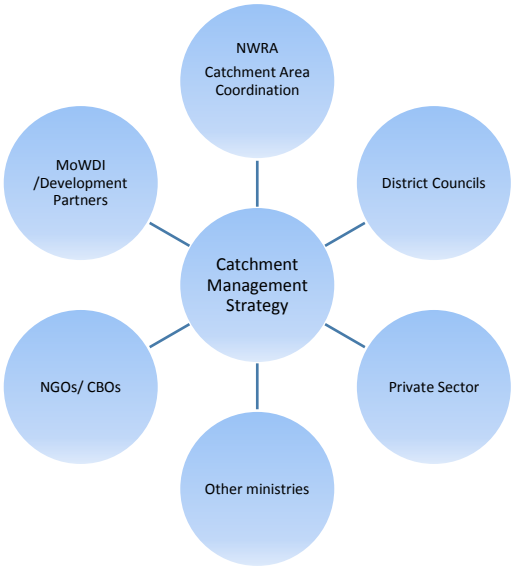


Figure 4.1.4 Potential Partners for Catchment Area Management

3) Water Sector Wide Approach

The structure of Sector-Wide Approach (SWAp) is established in order to strengthen a management system with participation of relevant stakeholders in the water sector. The management concept was sought in accordance with the guidelines from the Ministry of Finance (MoF) and the Ministry responsible for Economic Planning and Development in 2008 and elaborated water pillars outlined in the Water Sector Investment Plan (2012). The current institutional structure is shown in **Figure 4.1.5**.

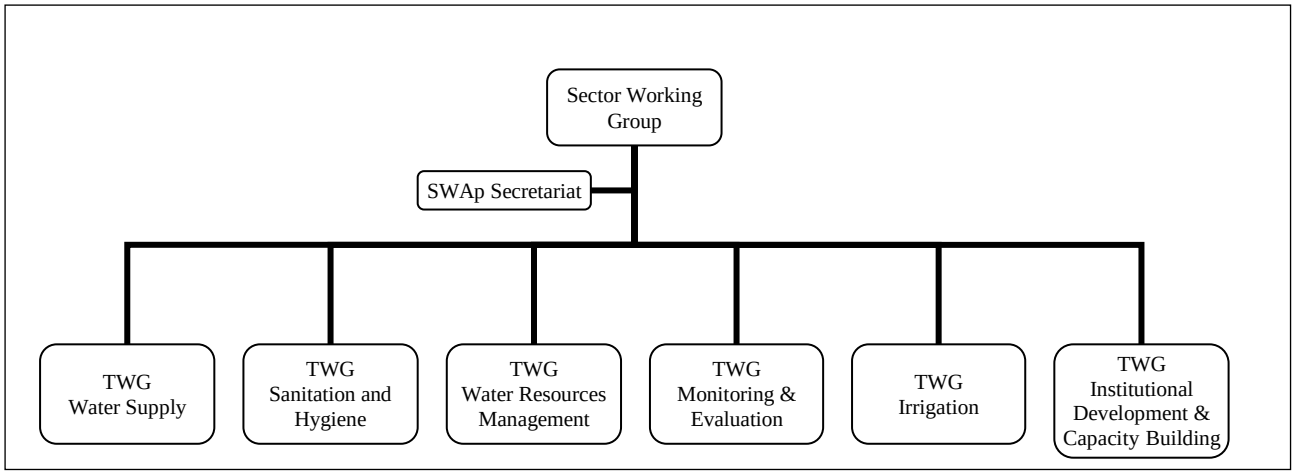


Figure 4.1.5 Organizational Structure of Water Sector Technical Working Group

Challenges in the coordination and implementation of the SWAp structure are as follows:

- TWG reports dwell much on detailed progress on activities that the implementing agencies in the sector are undertaking, rather than presenting specific recommendations on strategic issues requiring direction from the SWGs'.

Another challenge is the weak coordination and management capacity of the Ministry responsible for Water Affairs as the Secretariat of SWAp. As noted that the technical working groups are only reporting individual projects and progress of interventions, the SWG is unable to identify strategic challenges, and make appropriate policy interventions and plan adequate projects or programs. Thus, there needs to be a function of synthesizing the common issues and proposing recommendations at TWG levels for policy and strategic decision making by the SWGs. The lead facilitator is currently selected among the members of TWGs. However, this facilitator should come from the departments of the Ministry as a permanent focal person to reserve constant communications with the SWG Secretariat, since the Ministry should play a managerial and leading role to facilitate this SWAp process. Therefore, for the functionality of TWGs and SWGs to be coordinated to focus more on the strategic interventions and policy formulation, the government officials of the departments from the Ministry have to be involved in the respective TWGs to coordinate, report the planning activities of TWGs and liaise with the Secretariat for the overall coordination.

Figure 4.1.6 proposes the structure of SWAp with Ministry officials attached to TWGs.

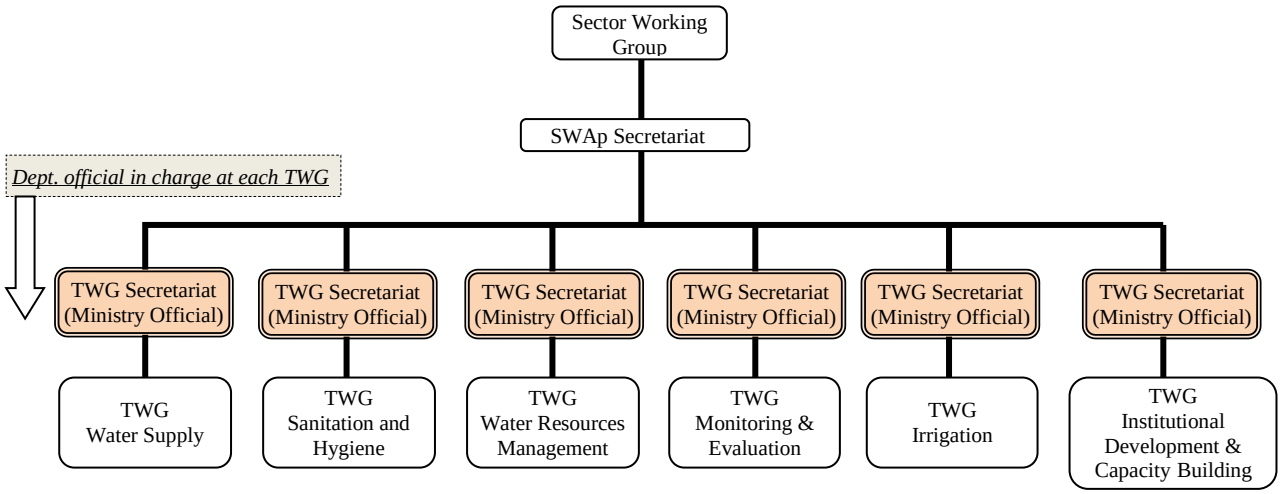


Figure 4.1.6 Proposed Organizational Structure for the Water Sector Technical Working Group

As for the progress of the activities in 2014 for the full institutionalization of SWAp, the

following was done. Activities remaining to be done are also identified.

The following has been done by 2014:

- Broad Sector Policy with Clearly Defined Subsector Themes
- Sector Policy Investment Plan
- Sector Strategic Plan
- Sector Monitoring and Evaluation Framework
- SWAP Governance Structures: SWG, TWG, JSR
- Sector Medium Term Budget
- Sector Medium Term Program of Works

The following needs to be done:

- Fiduciary Framework: combination of Bilateral, Multilateral, Basket funds
- SWAP Institutional Framework (full implementation)
- Program of Works implementation and supervision
- Sector Monitoring and Evaluation Implementation

Road Map

- 2015-2020: Improvement of Program of Work Implementation

  Sector M&E Implementation

- 2020: Fiduciary Framework consolidated

  SWAp Institutional Framework implemented

Table 4.1.4 Road Map of National Water Resources Authority and Sector Wide Approach

WRA / Time Frame / Program / Project / Activities	Time Frame																							Responsible Organ	
	Short Term									Middle Term					Long Term									Main	Associate
	2012-2020									2021-2025					2026-2035										
	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	
National Water Resources Authority																									
Business Plan/Operational Plan			■	■																					MoAIWD / MoAIWD
Financial Plan			■	■																					MoAIWD / MoAIWD
Catchment Area Management				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	NWRA / MoAIWD
Water Abstraction and Use				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	NWRA / MoAIWD
Control and Protection of Groundwater				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	NWRA / MoAIWD
Control and Protection of Water Government Waterworks					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	NWRA / MoAIWD
Dams and Flood Management							■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	NWRA / MoAIWD
Water Charges and Financial Provisions							■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	NWRA / MoAIWD
Water Trust Fund							■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	NWRA / MoAIWD
Associations of Water Users					■	■	■	■	■																NWRA / MoAIWD
National Water Resources Master Plan																									
Master Plan formulation	■	■	■	■																					MoAIWD / NWRA
Implementation of Works				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	MoAIWD / NWRA
Master Plan update																						■	■	■	NWRA / NWRA
Sector Wide Approach																									
Fiduciary Framework				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	MoAIWD / NWRA
Institutional Framework						■	■	■	■																MoAIWD / NWRA
Sector Monitoring and Evaluation						■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	MoAIWD / NWRA
Programe of works				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	MoAIWD / NWRA
Establishment of Water Tribunal																									
Staff appointment							■	■	■																MoAIWD / NWRA
Determination of rules and procedures								■	■	■															MoAIWD / NWRA

(3) Development of Planning

The Ministry needs to develop its capacity to formulate a strategic policy and navigate the activities of national water resources management. The current Planning Section is placed under the Department of Administration. The capacity of this section should be enhanced to the level of the Department that can coordinate the policy proposals from different technical departments within the Ministry and play the leading role to formulate strategic planning of the water sector. Under the Department of Planning, two relevant sections are included; namely, the District

Coordination Section and the International Cooperation (SWAp) Section. It is recommended that the District Cordination section should be a combination of Technical officers with the Economists or just made up of officer from respective technical departments.

1) District Coordination Section

This section will be in charge of coordinating activities of the district offices. The District coordination section in the Ministry should be able to coordinate a standardized administrative communication system and activity monitoring with all district offices throughout the country. The section will be in charge of monitoring and giving guidance to district offices in carrying out their duties, assist in data gathering and filing as well as records keeping. At present, communications are made directly through the concerned department for projects or government interventions. A standardized administration system guided by the central level will help update the district capacity and monitor the district office activities. In particular, there are projects implemented without informing the Ministry and this results in inadequate supervision and monitoring of water resources management. The District Coordination Section will thus help facilitate the functions of district offices.

Under this reform, the roles and responsibilities of the three regional offices will be integrated with those of district coordination offices and the central government, paving the way for the dissolution of regional offices.

Table 4.1.5 Proposed Mandates of District Coordination Section

Function	Activities	Purpose
To coordinate the district office activities and standardize the procedures throughout the country	• Provide districts with standardized information filing framework. • Standardized reporting of the monthly activities to the water sector. • File and keep track records of district information.	To keep track records of policy implementation within the district • Administrative procedures • Information about development projects • Water resources monitoring •

2) Project Management Section

This new unit in charge of projects and interventions through international cooperation will manage the international cooperation procedures and administration concerning the projects supported by the international partners. This unit will eventually coordinate the SWAp and other projects once the SWAp is fully launched for the water sector. This setup will streamline international assistances with different approaches, either the international partners wishing to participate in the SWAp or to hold an agreement of bilateral cooperation. According to the Sector Working Group Guidelines, MoF and MEPD 2008, the following principles guide the SWAp to improve the overall sectoral performance:

- Ownership: Sectoral governance and implementation of strategies, programs and projects by the Government of Malawi
- Alignment: Support of development partners for National Policies and Procedures, National Program of Work, Sector Budget, Public Finance Management, National Monitoring and Evaluation Framework
- Harmonization: All stakeholders' intervention and process in the sector
- Managing for sector results: Implementation and M&E Framework and reporting
- Mutual accountability: Review and monitor the progress of activities through Joint Sector Review (JSR)

The Human resources required for the Project Management Section is proposed and shown in **Figure 4.1.6**.

Table 4.1.6 Human Resources Capacity Required for the Project Management Section

Competencies	Personnel	Mandate	Job Description	Tools
SWAp Secretariat	3	To coordinate related sectors	• Prepare and coordinate production of Sector Performance Review • Database control and supervision • Prepare and coordinate Joint Sector Review	• Sector strategic and investment plan • Fiduciary Framework • Program of Work • M&E Framework
International Liaison Officer	1	To coordinate international cooperation projects	• Coordinate all necessary government procedures for international cooperation works	• MoU, Record of Discussion
Procurement Officer	1	To manage procurement for projects	• Procurement administration for projects	• Budget and Procurement Plan • Terms of Reference, procurement documents
Documentation Officer	1	To maintain related documents	• Record and administer documentations	• Documentation • Database

CHAPTER 5. MONITORING AND INFORMATION SYSTEM

5.1 Overview

It was clear during period of the Master Plan formulation that the hydrological data sets in the country are fragmented and inconsistent. In addition, hydrological information and knowledge systems and monitoring and evaluation systems were inadequate and most of the time these aspects were neglected. There is often inconsistent and unreliable data collection. This situation has led to a serious lack of vital data required for planning, designing and management of sustainable water resource programmes and projects. Two projects namely "Strengthening Water Sector Monitoring and Evaluation Project" and "Establishment of Water Resources Monitoring System" through NWDP-II were implemented to improve the data collection system and data quality. A central databank was developed under the M & E Project to provide information for policy decision making. In accordance with the WRA 2013, NWRA will be responsible for monitoring and management of hydrological data in the near future when it is operationalized.

A schematic diagram of the data management system is shown in **Figure 5.1.1**.

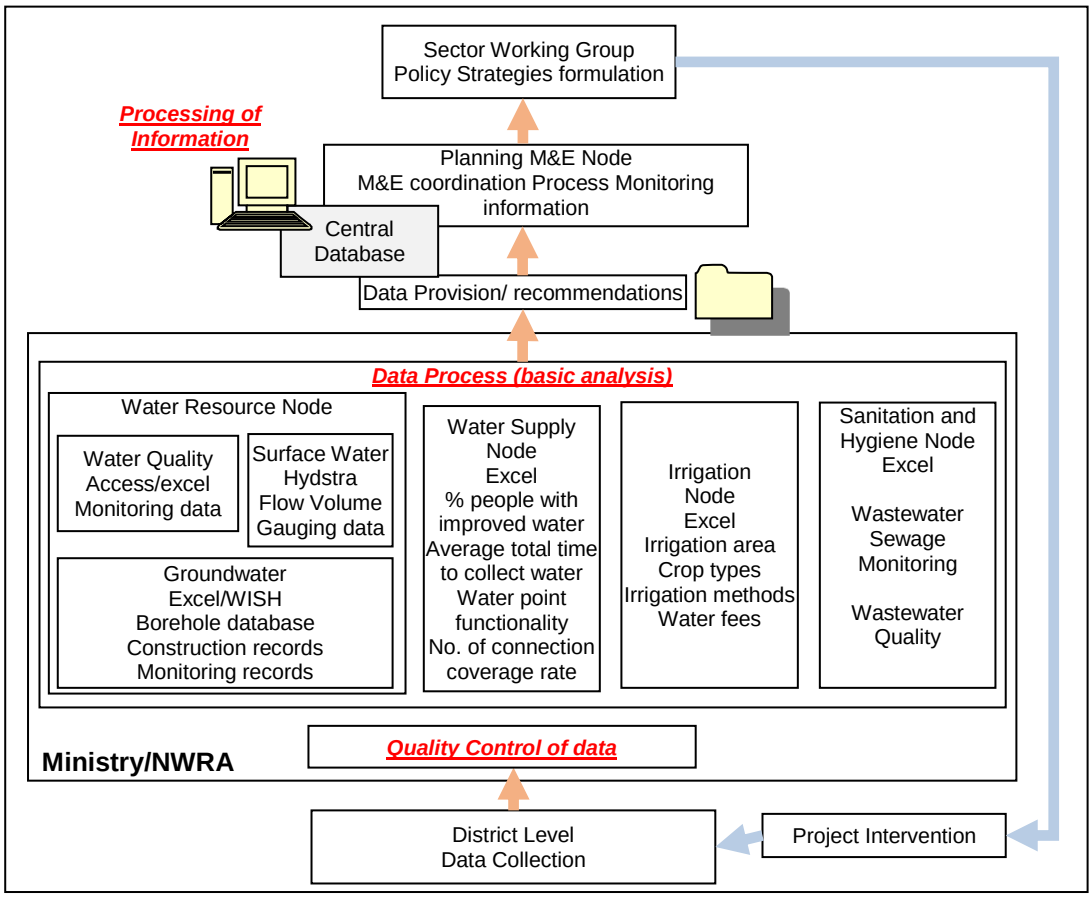


Figure 5.1.1 Schematic Flow of Data Management

A situation analysis revealed, however, that the capacity for data collection, recording, data tracking and processing is not sufficient to provide reliable data to the central databank which will be installed at the Department of Planning. Some equipment for water resources data collection and analysis is also lacking, even though some past Projects procured some monitoring equipment. For instance, the Water quality laboratories are lacking equipment for radionuclides and pesticides analysis, just to mention a few. However, considerable equipment has been procured for hydrological monitoring by 2015.

It is important that equipment for monitoring is adequate for all aspects of water resources monitoring. Laboratory equipment such as spectrophotometers for heavy metals, radionuclides as well as radiation

detection. and equipment for hydrogeological survey should be procured in the short term so that data collection is not affected in these fields.

The Water Resources databases need to be well established and data archiving improved. The information should not be personalized at the Ministry, but should be treated as a public utility asset. The archival activity needs to be enhanced by producing publications.

Consistency is required in policy formulation and implementation of undertakings to attain tangible achievements of short-term and long-term objectives for the water resources management including the water supply sector. Such undertakings and projects need to be planned based on analytical results of data directed by long-term policy guidance. It is vital to reflect scientific data into planning of undertakings and policy formulation so that they are physically, economically and environmentally viable, sustainable and manageable. In this section, project recommendations are outlined for capacity development to facilitate logically viable strategic policies formulation as well as project undertakings based on scientific data. The areas of recommendations include surface water, groundwater and water resources management.

A challenge at the institutional level is to make use of monitoring data to plan undertakings and formulate policy. A systematic review and incorporation of real time water resources data into the planning process will be of a great use for projects and policy formulation. There should also be a strategy developed on regular dissemination of water resources information to stakeholders, to assist in the planning of water resources development/ management in the country. Furthermore, there should be modalities of sharing/ linking databases between the different themes under water resources.

The central database that was developed under the M & E Project is not fully operationalized. Further interventions are necessary in the form of training and technical assistance to make use of the system and the information stored in the database. **Table 5.1.1** presents the M & E capacity needs.

Table 5.1.1 Monitoring and Information System Capacity Development Needs

Project Theme and Background	Project Components	Target Stakeholders
1. Technical assistance for database control and operation		
The central database has been developed and installed however, the database is not in operation due to lack of knowledge on operation of the system.	・ Assistance to the planning division to acquire full knowledge on the operation of the system ・ Training sessions ・ Input: Engagement of technical experts for a year (possibly part-time basis)	Department of Planning
2. Roll out of database operation		
Some districts have been included in the project as pilot sites to use the database; however, there is need for all districts to have been trained on the already developed database and provided with the necessary equipment.	・ Training on data collection and demonstration of the system ・ Training sessions on the collection of data and use of database ・ Input: Engagement of technical experts	District Councils NWRA officials Departments eg Water Resources, Irrigation and others

5.2 Surface Water

The section to be in charge of surface water management in the NWRA will be responsible for quantity and quality monitoring of surface water resources as well as conservation, and catchment area management.

Apart from data management, institutional strengthening is also a key to improving management of surface water resources in Malawi. The capacity needs in relation to data management for personnel at different institutional levels are identified to formulate an institutional framework on surface water management.

Table 5.2.1 summarizes the capacity needs.

Table 5.2.1 Capacity Needs for Surface Water Management in the Short-, Medium- and Long-Terms

Institutional Levels	Short-Term Targets	Mid-Term Targets	Long-Term Targets
Policy level	- Plan governmental undertakings using surface water data ・ Water supply ・ Irrigation ・ Water resources conservation and management ・ Drought/flood control protocols	-Formulate policy and undertakings based on monitored data and analysis results -Review policy and regulations to protect and conserve surface water	-Plan the Sector Performance Review. -Formulate Long-Term Plan such as Master Plan of Water Resources Management.
Technical and Professional level	-Properly check information and data quality -Proper storage of collected surface water data into database -Develop and maintain a flood warning system	-Identify and report the data analysis results that are relevant to policies -Plan and develop catchment areas -Publish year books	-Produce optional recommendations for surface water usage to policy makers for discussion.
District and monitoring station level	- Properly record and report collected data -Properly read monitoring gauges at hydrometric stations -Properly maintain and rehabilitate gauzing stations	-Consolidate reporting system from monitoring points to the database system - Properly conduct discharge measurements	-Sustainable technical knowledge transfer

5.2.1 Groundwater

Various efforts have been made to improve groundwater data collection, recording, processing and monitoring. Trainings on groundwater monitoring and use of database software have taken place. There is need to continuously carry out these activities to ensure a reliable data management system. Although two database software for groundwater data management, that is WISH and HYDSTRA, were introduced to the Ministry responsible for Water Affairs, there is latter database requires more regular training due to the nature of its functions. It is however good for storage of large datasets while WISH is more specialized Groundwater analysis software.

Groundwater information has to be a common property of the sector and not institutionalized hence it should be easily accessible.

There should be modalities developed on data sharing among Government, NGOs, Development Partners and all other organisations that are involved in borehole construction/ groundwater development.

Table 5.2.2 outlines important steps that should be followed in groundwater data management.

Table 5.2.2 Steps Needed for Groundwater Data Management

Phase	Activities
Data Collection	Collection of data from district levels, all catchment areas; Coordination of data collection activities with relevant stakeholders such as district offices
Data Entry	Data entry has to be done with care. Any unconvincing data should be noted and its credibility checked out.
Data Processing	Data cleaning, simple processing
Data Analysis	Analyze the data according to the needs.
Monitoring	Maintain database in good condition and always keep a back-up.
Information Production	Produce presentation material and provide information, processed analysis and policy recommendations to project planners, and policy-makers

5.2.2 Water Quality and Pollution Monitoring

To improve the capacity of the section responsible for water quality and pollution monitoring, various capacity development projects have been carried out to improve the data collection, recording, processing. A number of trainings have also been conducted on database system, use of database software, and measurement among others. In addition, the database software "Access" is proposed to replace "D-base III" that is currently used.

This Division also provides water quality sampling and analysis services for private customers. The data that are collected through such assignments should also be stored in the database and utilized as useful information sources. **Table 5.2.3** summarizes the capacity needs for water quality MIS at different institutional levels.

Table 5.2.3 Water Quality Monitoring Data Utilization in Projects and Policy Formulation

Institutional Levels	Short-term targets	Mid-term targets	Long-term targets
Policy Level	Promote water and wastewater quality standards update, development and monitor compliance Improve laboratory services and infrastructures in Northern, Southern and Central Regions	Develop and update, in collaboration with Environmental Affairs Department, MBS and others, national water quality standards and monitor compliance. Develop and maintain modern laboratory management	Maintain sustainable and quality laboratory services
Technical & Professional Level	Maintain the water quality and pollution database in a good condition. Produce reports on water quality and pollution. Maintain laboratorial equipment in a good condition and keep an inventory list	Provide analytical services to stakeholders who need water quality assessment	Identify and report on environmental constraints affecting water resources management and development. Identify and report on impacts of proposed development projects on water quality and pollution

5.2.3 Water Resources Board Database

The Water Resources Board (WRB) which upon enactment of the Water Resources Act (2013) becomes National Water Resources Authority (NWRA) is using a database system for water resources allocation called "Permit Processing and Tracking System". All water abstraction activities have to be registered at the Water Resources Board. The system is an effective tool for tracking records of registration and providing rough estimates of water abstraction volumes.

Water licensing is an effective strategic tool to control and monitor abstraction of raw water which greatly affects IWRM. Improvement of the current registration rates of water abstraction effluent discharge activities is to be a prerequisite for a sustainable water resources management. The volume and areas where water is abstracted need to be monitored and regulated throughout the country. The water balance has to be well monitored and regulated so that disastrous consequences of over-exploitation of water resources will be avoided.

Improvement of the database system at the WRB is a stepping stone for the establishment of the National Water Resources Authority. All the water abstraction activities in the country need to be registered and given a license number and all license fees and rentals should be paid by the clients.

Regular backup of the database is required to secure it from any loss, virus contamination and/or any other disturbances such as theft.

5.2.4 The Ministerial Library

The library located in the Ministry responsible for water Affairs needs significant upgrading so as to be functional as a national water sector archive. Very important documents, materials, past plans, designs, and project documents are scattered, personalized and often lost in the Ministry. This makes policy formulation and intervention programming more laborious than necessary. All stored materials have to be numbered and entered into the archive database. Upgrading of the library activities and transforming it to the "National Water Information Center" will help the country's water resources information management.

There is need for the officer in charge to get familiarized with standard librarian activities through training.

Table 5.2.4 Upgrading of the Library by Phase

Institutional Levels	Short-Term Targets	Mid-Term Targets	Long-Term Targets
Policy Level	Library becomes a useful, well managed information source	Improved quality of the library as a data source	.
Practical Level	-All books and documents are on the shelves; -A database is created for all the materials in the library; -All the materials are entered in the database; -Clean the library and keep a usable database; -The materials and information are easy to find. -Lending and returning regulations are set (days of lending, penalties if not returned, etc.); -A modernized data search system is installed, preferably a web-based system;	-The information is also available on the web where possible; -Data search system is well established. -Linkages are created with other libraries and search for materials available in the other libraries on water is possible ; -	

Table 5.2.5 Data System Required for the Library

Database System	Purpose
Database tool (eg Access)	Keep records of: ·Title ·Media of information ·Publishing year ·Author ·Summary ·Any other information that are in line with the standard library registration

5.2.5 District Water Office

As described in **Main Report: Section 4.5**, the district water offices have responsibility for water level and discharge measurement, groundwater monitoring and maintenance of gauging stations. In terms of Hydrology however, only two offices have a hydrologist and most offices have two or three staff members of the hydrological team as of September 2013 (see **Main Report: Section 4.5**). In addition, remuneration to Gauge readers is not enough to ensure their commitment; thus, many stations are not being properly maintained and many gauges are now not even being read. Furthermore, maintenance by district staff is also constrained by unavailability of staff, vehicles or fuel. As a result, about 70 stations are estimated to need reinstallation or replacement of gauge plates among the operational stations managed by the Ministry. Similarly, collection of groundwater monitoring data is in some cases constrained by lack of fuel to travel to long distance stations or unavailability/ lack of technical staff at the district.

The role of each office level is summarized in **Table 5.2.6**. The main role of district offices is supervision of observation of each station, and the regional office is responsible for supervision and coordination of district offices, while headquarters is responsible for supervision and coordination of regional offices and storing, utilizing and supervision of data for their decision-making. Quality control to find erroneous data should be carried out at each office level. At present, it is carried out based on experience using graphs, visually. District offices verify the hydrological data, regional offices and the head office check data from the hydrological aspect. However, the hydrogeological data from many of the districts goes straight to Headquarters mainly because there is no hydrogeological staff at the district level, although in recent times some DWDOs are increasingly checking the data.

Data input is carried out in the head office at present for both Surface water and Groundwater because there are few people who can operate HYDSTRA and few licenses. Ideally, data input is carried out in regional offices, and the head office compiles data from them, manages quality, processes the data and

disseminates information. The regional offices operate the observation station network in the districts within their jurisdiction and the head office manages the network from the national point of view.

At present, for Hydrology, the boundaries of hydrometric districts are different from basin boundaries. Therefore, the responsible areas of water offices should be reorganized in order to match them with the hydrometric network. The ideal staffing of district offices is that all posts such as two hydrologists and a hydrological team of five staff members of two assistant hydrological officers, one hydrological assistant and two gauging assistants are filled to undertake comprehensive maintenance of stations and access roads, flow measurement including high and low flow for rating curve and payment of gauge readers. The ideal staffing of regional offices shall include a hydrologist and a manager assigned for planning of observation station network. It is also important that the vacant posts in Hydrogeology, Groundwater Development and Drilling and Water Quality and pollution Control in the regional offices should be filled.

However, even at the head office, staffing is inadequate. Therefore, organization for observation should be developed in stages. First, the number of staff and capacity of the head office are enhanced, then those of regional and district offices are enhanced by staff of the head office.

Appropriate remuneration to gauge readers is needed because the observation would not be carried out if wages are not paid. There are some suggestions about increasing remuneration. Before increasing remuneration, it is recommended that gauge readers are trained on observation techniques and simple hydrological analysis. For gauge readers who travel a long time or distance to an observation station located at a remote area, bicycle allowance should be reintroduced depending on the importance of observation station. Definitely, capacity development of office staff is also needed.

Lack of promotions is also a challenging issue. When one person stays in the same position for a long term, and he or she leaves the office, no one possesses the previously accumulated knowledge. Therefore, appropriate promotion or rotation of positions is needed for providing motivation of staff to perform well and for knowledge transfer.

Table 5.2.6 Role of Each Office Level

	District Office	Regional Office	Headquarters
Responsibility (At Present)	-Maintenance of gauging stations -Maintenance of access routes to the stations -Discharge measurement (routine measurement of flows and measurement of high flow) -Collection of groundwater level data -Sending of data to regional office -Payment of and communication with gauge readers (data collection from gauge readers) -Quality Control of surface water data	-Sending of hydrological data to the head office -Supervision and assistance to district offices -Water quality sampling and analysis -Quality Control	-Quality control -Data processing -Storage of data -Retrieval and dissemination of data and information -Assistance to regional offices -supervision of field work -Management of automatic recorders
Responsibility (Proposed)	-The same as described above, plus -Collection of some water quality data -Quality Control of groundwater data	-The same as described above -Management of data -Planning of observation network in districts	-The same as described above -Decision making and planning in whole country with respect to water resources information management

There is currently little sharing of data among other institutions such as the water boards in Blantyre, Zomba, Lilongwe and Mzuzu, and among NGOs. Data exchange is needed for filling the network, improving quality of data and assurance of supply, etc. It is also needed for coordination purposes in times of drought.

5.2.6 Action Plan

Action plan including time schedule, responsible organization and budget is shown in **Table 5.2.7** .

Table 5.2.7 Action Plan of Building Water Resources Monitoring Systems by 2035

Program / Project / Activities	WRA / Time Frame / Organ/Budget	Prior WRA	Time Frame																					Responsible Organ	
			Short Term								Middle Term				Long Term									Main	Associate
			2012-2020								2021-2025				2026-2035										
			12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	
Groundwater Management System																										
	Establishment of guideline for groundwater management	All																							MoAIWD	NWRA
	Capacity building for data management, evaluation and planning of groundwater development	All																							ditto	ditto
	Inventory survey for groundwater resources	All																							ditto	ditto
	Implementation and Maintenance of groundwater management system	All																							ditto	ditto
Groundwater Monitoring																										
	Reinforcement and maintenance of automatic groundwater leveling	All																							MoAIWD	NWRA
	Establishment of new monitoring wells	4, 5																							ditto	ditto
	Upgrading of monitoring wells	All																							ditto	ditto
Water Quality Conservation																										
	Establishment of steering committee for water quality	All																							OPC	NWRA
	Establishment of environmental water quality standard and guideline	All																							NWRA	MoAIWD
	Establishment of water quality database	All																							MoAIWD	NWRA
	Strengthening of water laboratory functions	All																							ditto	ditto
	Implementation of water quality monitoring scheme	All																							NWRA	MoAIWD

Note: ditto means same as above

CHAPTER 6. WATER RELATED DISASTERS

6.1 Background on Disasters Related to Water

6.1.1 General Disaster Conditions

(1) Major Water Related Disasters in Malawi

Overall, records of disaster damage provided by Department of Disaster Management (DoDMA) and the Prevention Web (by UNISDR: The United Nations Office for Disaster Risk Reduction) give critical information related to human and economic losses resulting from the disasters that have occurred in Malawi during the past three decades (refer to Table 5.1.1). More than 47 natural disasters were recorded in the period and these range from droughts, earthquakes, epidemics, floods and storms. Floods were reported to have the highest frequency followed by droughts while storms were the least in occurrence.

A total of approximately 2,775 people were killed in the natural disasters, with an average of 90 people killed annually. Most of these (60%) died due to epidemics. In addition, at least 20 million people were affected with an average affected population of over 700,000 per annum.

Flood and Drought Conditions

EMDAT and Prevention Web indicate that the floods that occurred in 1991 recorded the second highest economic damage following the damage by earthquakes in 1989. In addition, it is reported that more people were affected by droughts than any other disaster from the year 1992 to 2007, with the highest affected population in 1992. The top 5 economic damages and populations affected by floods and droughts are summarized in **Table 6.1.1**.

For instance, a DoDMA (2008) report which the Project team managed to obtain indicates that Nsanje District had the highest number of households affected by floods (16,341) in the year 2008. This was followed by Chikhwawa District with 5,678 households affected. As overall for the year 2008, 27,758 households were affected, 9,851 had their households damaged while a total of 10,080 hectares of crops were damaged by natural disasters.

Table 6.1.1 Top Five Economic Damages (Left) and People Affected by Major Droughts and Floods (Right)

Order	Disaster Events	Year	Damage (1,000USD)
1	Earthquake	1989	28,000
2	Flood	1991	24,000
3	Flood	2001	6,700
4	Flood	2000	1,000
5	Flood	1998	89

Source: EMDAT and Prevention Web

Year	People Affected (Drought)	Year	People Affected (Flood)
1987	1,429,267	1991	268,000
1990	2,800,000	1997	400,000
1992	7,000,000	2001	500,000
2002	2,829,435	2002	246,340
2005	5,100,000	2003	81,604
2007	520,000	2007	180,246

According to the report "Malawi and Southern Africa: Climatic Variability and Economic Performance (2003, WB)", 6 districts; namely, Karonga, Salima, Machinga, Zomba, Chikwawa and Nsanje, are vulnerable to flood and drought events. In addition, areas remarkable and vulnerable to floods and drought are illustrated in **Figure 6.1.1** herein and in **Figure 4.1.1** in **Annex 4: Chapter 4**, which also indicates flood occurrence years and probable flood areas based on DoDMA's disaster record.

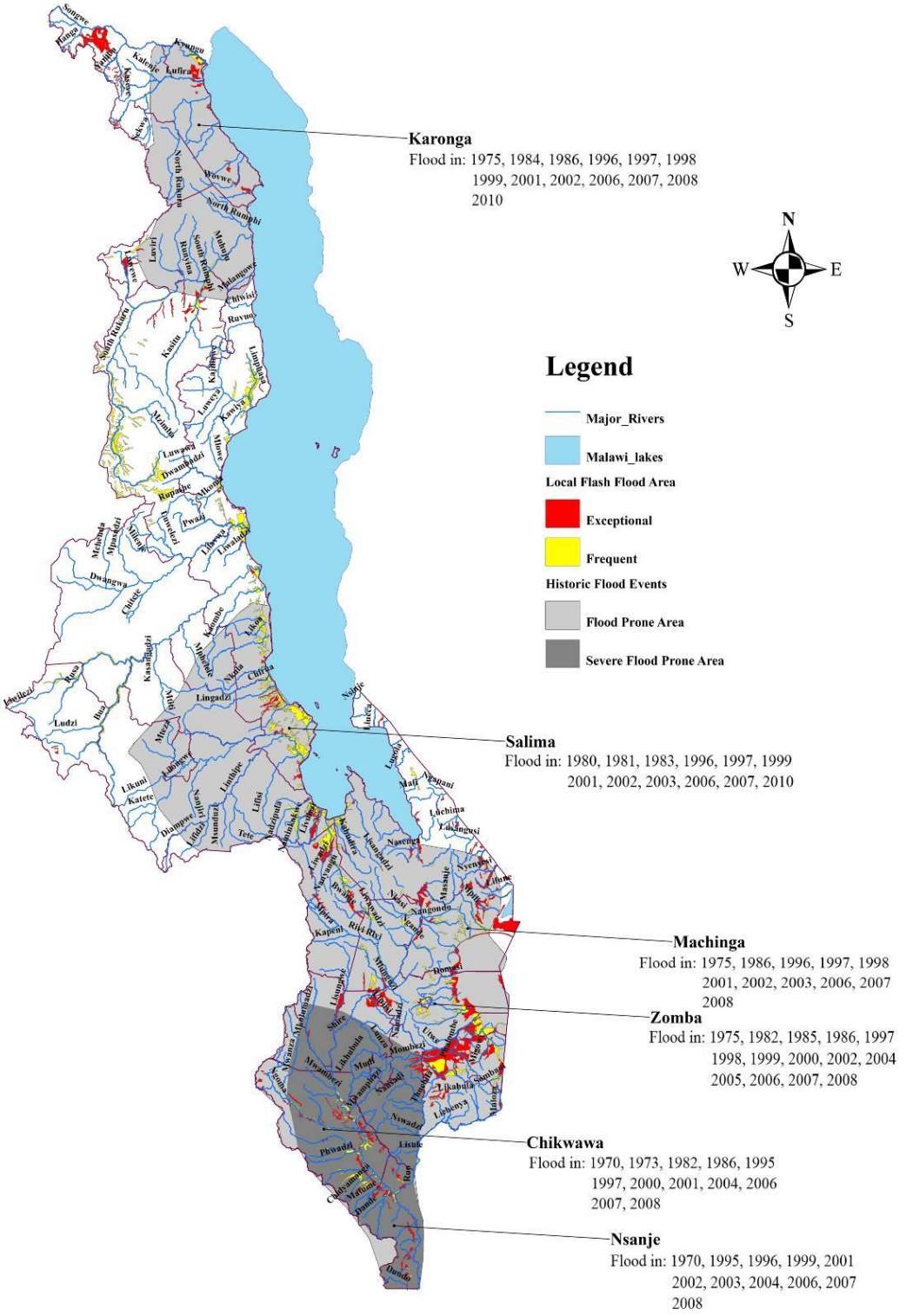


Figure 6.1.1 Map showing Areas Vulnerable to Flood and Drought Damage

The data provided in Error! Reference source not found. is based on (1) record of DoDMA, (2) GIS Information provided by Department of Land and Resources in the Ministry of Land and Physical Planning and Survey (1995 Photography and updated using 2012 Satellite Images) and (3) Linthipe and Lingadzi River System Study (GIZ, 2012)

6.1.2 Policy and Legislation for Disaster Management

(1) Disaster Risk Management

The Disaster Risk Management (DRM) should be strengthened by the spiral-up process under a series of activities for mitigation and preparation works in the precaution stage and for response and recovery works after occurrence of disasters. The spiral-up process will create a virtuous cycle to adapt to prevention and mitigation works against disaster damages. This cycle is referred to as the "Disaster Management Cycle".

In Malawi, activities for DRM just started for the first step of the cycle based on the "National Disaster Risk Management Policy (2013-2017)" which is aligned to "Hyogo Framework for Action (HFA 2005-2015)" adopted by the United Nations World Conference on Disaster Reduction in 2005 of which the Malawi Government is a signatory. The 6 linked legislations and strategies to the policy are summarized in the **Table 6.1.2.**

Table 6.1.2 Linked Legislations and Strategies

No.	Legislations and Strategies	Year of Enactment
1	The Forestry Act	1996
2	The Irrigation Act	2001
3	The Local Government Act	1998
4	The Town and Country Planning Act	1988
5	The Water Resources Act	2013
6	The Malawi Growth and Development Strategy 2012-2017	
7	The Malawi Constitution.	1995

The Policy consists of 6 priority areas toward achievement of the policy goal and ensuring that it meets commitments of HFA, the Africa Regional Strategy for Disaster Risk Reduction, MDGs and MGDS. The priority areas are itemized below.

- Mainstreaming disaster risk management into sustainable development,
- Establishment of a comprehensive system for disaster risk identification, assessment and monitoring.
- Development and streaming of a people-centered early warning system.
- Promotion of a culture of safety, and adoption of resilience enhancing interventions.
- Strengthening preparedness capacity for effective response and recovery.

(2) Flood Risk Management Strategy

The Flood Risk Management Strategy for Malawi was developed by the DoDMA in 2010 with assistance from UNDP. The strategy comprises a description of the existing situation; an account of challenges faced, issues, opportunities and options; the presentation of flood risk management strategies; and an implementation plan. However, according to the DoDMA, the activities are behind schedule to be re-arranged and it is necessary to harmonize them with the DRM activities and concept of the Water Resources Act (2013).

6.2 Integrated Flood Management (IFM)

6.2.1 Objectives and Policy of Flood Control

Flood disaster should be prevented and mitigated in consideration of activities for other disasters to effectively utilize systems, functions, human resources, budget related agencies as to DRM. In addition, the Malawi Government states that all stakeholders in the country shall align their activities towards this policy in order to ensure that resilience to disasters is built at national, local and community levels in the National Disaster Risk Management Policy. Therefore, flood disaster risk management should also be integrated with the National DRM and measures should be implemented involving all stakeholders from both the public and private institutions. In this context, an integrated

flood management (IFM) in Malawi should be recommended and supported by strategies outlined in item (2).

The integrated management of land and water is very important for the river basins in Malawi. The IFM plan should aim to mitigate flood damage for all the flood inundation areas. However, the flood damage area is too extensive and scattered to manage. Efficiency of large-scale structural measures that aim to deal with floods in Malawi may be very low because the flood damaged areas are less developed and less populated. Therefore, appropriate flood management made of the best mix of structural and non-structural measures should be applied to build a society resilient to floods.

6.2.2 Flood Conditions and Strategies for Flood Management

(1) Flood Prevention and Mitigation in Habitual Flood Damage Area

Investigations and analyses to find out vulnerable areas have been previously carried out by the Malawi Government. They were also conducted during the Master Plan Formulation. It is however recommended that, a more detailed analytical study and implementation of measures should be carried out to mitigate and prevent flood damage in habitual flood areas. The measures should consist of structural and non-structural measures in consideration of climate change impacts and cost-benefit. The characteristics of habitual flood areas is described below.

The main flood prone districts in Malawi are Karonga, Salima and Nsanje. The flood disasters in Karonga district are due to flooding of rivers, rising of water level in the lake, water stagnation in low lying areas, and ground saturation especially on wetlands (Karonga Contingency Plan 2010), whereas in Salima and Nsanje districts, floods are reported to be due to the swelling of rivers that come from upland areas as was reported during the interview survey conducted for the Project. The frequency of flood is presented in Figure 6.2.1.

Most of the floods that have caused damage are the flash floods which normally come along with no warning sign and even cause severe damage when experienced at night. In Karonga district, floods tend to occur more often in the northern and southern parts of the district while floods that are experienced in Salima district are due to the swelling of the Linthipe and Lifidzi rivers. On the other hand, floods experienced in Nsanje district are either due to over-topping of the banks of the Ruo or Shire rivers or due to backwater effects. Flood disaster damages and frequency have increased in the recent years due to effects of human activity, catchment destruction and river-line cultivation. The frequency is shown in years. Average return period in such floodplains has been reported to have decreased to almost less than half in the past three decades; for example, according to the hydrological observation data of MoAIWD, the return period of Songwe River flows has decreased from 5-years in the 1980's to 2-years in the recent years. Discharges in several rivers in Malawi have also tremendously increased in recent years; for example, Songwe River flows which increased from 500 cubic meters per second in 1986 to 2000 cubic meters in 2006.

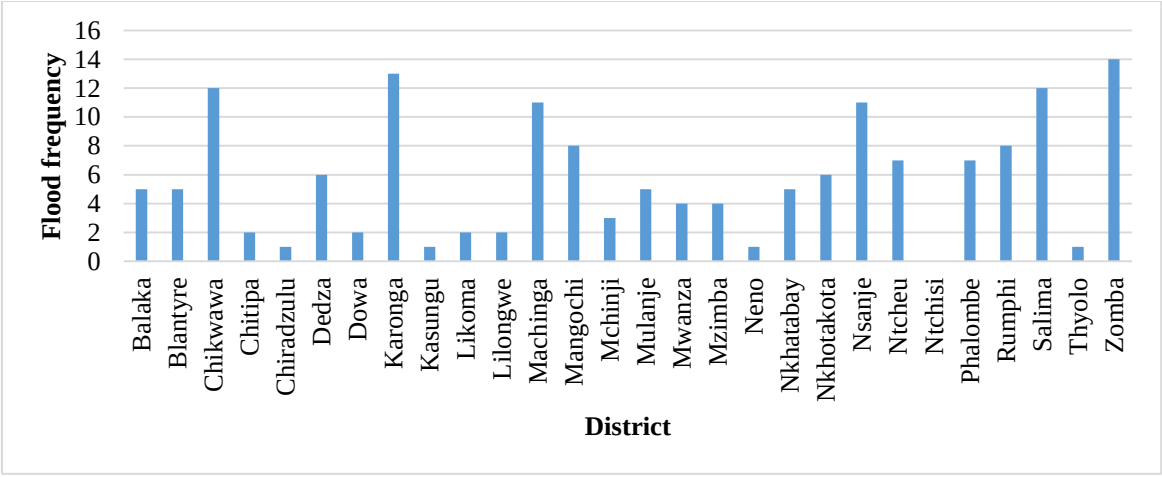


Figure 6.2.1 Flood Frequency of Over 40-Year Return Period in Districts

(2) Creation of Flood Resilience Land Use

Disorderly land development in flood prone areas increases the flood damage potential as well as flood discharges (risk). In Malawi, the definition of river area and cadastral area are not well-determined to develop backlands and riverine areas properly. Laws and policies have been formulated to regulate cultivation in the riverine areas so as not to increase sedimentation and results occurrence of floods. But there is need for enforcement of the policies.

Land degradation and poor farming practices have led to heavy siltation in most of the rivers, consequently reducing their depths and capacities. This simply means that the same amount of water that did not flood a few years ago when the rivers were deep is currently flooding. There are some rivers, which have been completely filled up with silt e.g. Lifidzi in places close to where it joins Linthipe River. There is no trace of river course since any drop of water that finds its way into the river spreads and floods into villages and fields that are below it.

In addition, people living in flood prone areas are also a problem to protect from direct and in-direct flood damage. The measures should be examined and proposed circumstantially in consideration of non-structural and structural measures including implementation agencies and communities.

(3) Ensuring Safe Evacuation

The first priority of the IFM plan is to save human lives . Appropriate response to floods is also important to minimize flood damages. Flood forecasting and warning system as well as evacuation system with community-based flood management is a tool to lead people to safe places during floods. As of September 2014, an automatic flood forecasting and warning system was about to be introduced in the Shire River Basin, with technical assistance from World Bank. Similar activities and projects should be implemented in the other flood prone areas.

6.2.3 Objectives and Roadmap for IFM

The objective of the IFM plan is to provide a roadmap for building a resilient society to floods in Malawi. The roadmap for IFM is modified based on the flooding conditions, present framework of related agencies, policies and strategies The outline of short, middle and long-term plans was proposed in the “Flood Risk Management Strategy (2010)”; however, the strategy was formulated before DoDMA started implementing DRM activities, before the enactment of the Water Resources Bill in 2013, and occurrence of the largest flood (2011). Therefore, the strategy has been re-organised in the study.

6.2.4 Action Plans for IFM Roadmap

Based on the conditions described in items (1) to (3), action plans proposed for the IMF are given in **Table 6.2.1** and explained thereafter.

Table 6.2.1 Action Plan for the IFM

Program	Project / Activities	Prior WRA	Time Frame: Short Term 2012-2020 (12 13 14 15 16 17 18 19 20)	Time Frame: Middle Term 2021-2025 (21 22 23 24 25)	Time Frame: Long Term 2026-2035 (26 27 28 29 30 31 32 33 34 35)	Responsible Organ: Main	Responsible Organ: Major Associate
Policy and Strategy							
F-1	Establishment of Flood Disaster Management Cycle	All				MoAIWD and DoDMA	DRM members
F-2	Formulation of River zoning , code and protocols	All				ditto	ditto
Preparation & Studies							
F-2	Risk Assessment for Malawi	All				DoDMA	DRM members
F-3	Strenghening of information management system	All				MoAIWD	RBA
F-4	Feasibility Study for major vulnerable areas	1, 15, 17				MoAIWD	RBA and DoDMA
F-5	Investigation for flash flood damage for tributaries of main rivers	All				MoAIWD	RBA and DoDMA
F-6	Preparation of technical guidelines for flood protection works	All				MoAIWD	RBA
F-7	Capacity building for flood protection works and plannning	All				MoAIWD	DoDMA and RBA
Implementation of Flood Mitigation Works							
F-9	Implementation of flood warning system	All				MoAIWD and DoDMA	-
F-10	Implementation of flood protection works	1, 15, 17				MoAIWD	DoDMA and LG
F-11	Implementation of community-based flood protection	All				DoDMA and LG	MoAIWD
Response and Recovery							
F-11	The response and recovery should be done by line ministries in accordance with DRM	All				DoDMA	MoAIWD and RBA

RBA:River Basin Authority, or NWRA LG: Local government
Source: The schedule and action plans proposed in the Flood Risk Management Strategy by UNDP, 2011

(1) Improvement of Strategy in Consideration of DRM Preparation (F-1)

The flood risk management strategy by UNDP should be modified to harmonize with recent activities related to DRM because the Strategy was formulated before DoDMA commenced the DRM activities and before the enactment of the Water Resources Bill, and before the occurrence of the largest flood (2011). The flood is one of disaster risks which should be effectively managed by integrated approach using limited human resources, budget and functions of related agencies.

(2) Formulation of River Zoning, Hazard Maps and Protocols (F-2)

Zoning and regulations in the rivers and flood prone areas are essential for prevention of disorderly development activities which will increase flood damage. Especially, river areas[10] should be confirmed, regulated and managed by government agencies. It is better to define the river area in consultation with the Ministry responsible for water resources and the National Water Resources Authority (NWRA). In addition, authorization and gazettement of the area by the Malawi Government are necessary through the formal protocol by the line ministries headed by the Ministry of Lands and Physical Planning and Survey.

After the confirmation of river area, line ministries and local governments should refer to the river area to make flood maps/hazard maps which provides information to examine the flood mitigation measures and make flood management plans. In addition, all the environmentally and ecologically important and sensitive areas such as protected areas, wetlands, water catchment areas, wildlife corridors etc should be considered and demarcated when the flood mitigation and prevention plans are formulated.

Flood hazard maps which graphically indicate information on inundation areas as well as on evacuation areas are useful to reduce loss of human life and people's property and help smooth evacuation from home to relief areas before the occurrence of flood. Recently, the flood inundation area in the Shire River Basin has been analyzed. More detailed analyses and studies regarding the hazard areas are necessary to facilitate the smooth evacuation and regulation of land use in and around local areas vulnerable to flood damage. As a result of the activities, the flood hazard maps will be elaborated including the information for their use not only for recording flood inundation but also for raising flood-awareness of people, land use planning and evacuation activities.

[10] River Area should be delineated to keep the people safety. The is area close to flood prone but not actual prone area.

(3) Risk Assessment (F-3)

Flood risk assessments have been conducted by DoDMA based on exposure data and assumptions of damage. The results should be utilized to select priority areas and formulate flood mitigation plans in the future.

(4) Strengthening of Information Management System (F-4)

To make flood mitigation plans and hazard maps, the hydro-meteorological information is essential as well as flood damage information. Currently, the former information is managed by MoAIWD (hydrological data) and MoNREE (meteorological data), while the latter is recorded by DoDMA. This information should be organised properly and shared among related agencies. In the future, the NWRA may be a platform to share and manage the information; however, the ministries should have a proper management system individually to smoothly furnish the information to the authority and related agencies or water users for the purpose of integrated water resources management. A program to enhance capacities on information management is also suggested to introduce a proper information management system.

(5) Feasibility Study for Major Vulnerable Areas (F-5)

At present, flood prevention works such a construction of dykes or piling of sandbags are carried out based on requests from the Local Government. DoDMA and MoAIWD dispatch engineers/professionals to assists the Local Government or NGOs which directly conduct the works. However, MoAIWD should conduct feasibility studies to clarify necessary measures and interventions in the vulnerable areas classified in the Project before flood mitigation works are implemented on ad hoc basis by the Local Governments.

(6) Investigation for Flash Flood Conditions (F-6)

Several studies and analyses have been carried out by the Ministry of Land and Physical Planning and Survey (MoLPPS), DoDMA and development partners to outline and classify flood conditions. However, implementation of detailed investigation is necessary to build plans to mitigate flood damages in the local areas. It is recommended that Local Government should be involved from the planning stage to enable them understand the flood conditions and countermeasures to be put in place in future. The flashflood damaged areas can be seen in Figure 6.1.1.

(7) Preparation of Technical Guidelines for Flood Protection Works (F-7)

MoAIWD is responsible for flood forecasting and warning systems, and flood mitigation and protection works such as river training, dams, levees and dykes. However, technical guidelines and manuals, and design standards are not prepared in the Ministry. The guidelines and manuals should be developed/formulated and distributed in MoAIWD to implement flood protection and mitigation works and maintain river structures properly.

So far, flood protection works and design of structures are conducted by the Local Government as Local Development Funds (LDF) permit with the assistance of MoAIWD or Traditional Authority and Village Civil Protection Committees with the assistance of NGOs and DoDMA. However, the river structures for prevention of floods such as small dyke are easily flushed away or collapsed partially in the next flood due to the lack of proper guidance and directions for planning, designing and maintenance.

(8) Capacity Building for Flood Protection and Mitigation Activities (F-8)

MoAIWD, DoDMA and Local Government agencies are responsible for the security of the people at the national and local level. Actually, they shoulder activities of flood warning/forecasting, evacuation, flood fighting and rescue during floods. Moreover, they should be involved in land use planning to clarify the flood hazard area and river area. Therefore, strengthening of the capacity of the MoAIWD, DoDMA and local government agencies is key to building flood-resilient communities. Implementation of capacity building programs for flood protection and mitigation are proposed in terms of: (a) Information management and sharing (especially, hydro-meteorological information and disaster information); (b) Arrangement of technical guidelines;

(c) Flood hazard maps with flood evacuation drills; (d) Flood forecasting and warning; (e) Flood evacuation system: (f) Construction works; and (g) Definition of river area and regulation of land use in the area.

(9) Implementation of Flood Warning System (F-9 and F-11)

DoDMA states in the DRM Policy that it will establish community based early warning systems and national early warning roadmap with line ministries in the process of the policy priority area No. 2[11]. After the preparation, early warning systems and forecasting systems should be installed in the major vulnerable area and local flash flood areas based on the result of "F-5" and "F-6" in **Table 6.2.1**. Simultaneously, MoAIWD should rehabilitate and strengthen the hydrological monitoring system and information management system and the result of activities of "F-4" in **Table 6.2.1**.

The Project on "Shire Basin Operational Decision Support System (ODSS) through Enhanced Hydro-Meteorological Service" intends to install a real-time forecasting modelling framework and early warning system with automated alert system. Lessons learnt from the project should be disseminated and utilized in case of the implementation of warning and forecasting systems in other areas.

(10) Implementation of Flood Protection Works (F-10)

Flood prevention and mitigation works should be constructed in the selected area based on the result of "F-7". Scales and durability of structural measures to prevent and mitigate the flood damage should be planned and designed based on the hydrological information which is in "F-4" as well as cost-benefit conditions. The guidelines, manuals and standards, which are prepared in "F-6", should be utilized to plan, design, maintain and operate river structures.

(11) Response and Recovery (F-12)

In accordance with the DRM cycle, activities for response and recovery shall be executed in the future in case of the occurrences of flood disaster and learnings from the response and recovery works that will be utilized to renew the plans formulated in "F-5" and "F-6". The cycle should be spiraled up to improve the quality of all activities from "F-1" to "F-9".

[11] This is "policy priority area No.2 in National Disaster Risk Management Policy (2013-2017)

CHAPTER 7. SOIL EROSION CONTROL MEASURES AND WATERSHED CONSERVATION PLAN

7.1 Introduction

Deforestation and forest degradation have rapidly taken place in Malawi mainly due to augmentation of agricultural land and logging for charcoal production and utilization as firewood. The reasons are low electricity connection due to high electricity tariff, low coverage of electricity grid, high population growth, poverty and low literacy. Mismanagement of agricultural land through inappropriate cultivation methods and over-cultivation also causes soil erosion and results in deterioration of crop yields. Sediment runoff to rivers impacts on structures such as dam. In the Shire river basin, sedimentation in hydropower dams has occurred and is still taking place (see **Figure 7.1.1**) due to cutting of trees for firewood with population increase in Blantyre City resulting in the deterioration of storage capacity of reservoirs, instability of and decrease in power generation and degradation of structures such as intake facilities.

Sedimentation in rivers, furthermore, causes aggradation of river bed level and deterioration of flow capacity. The lowering of water retention capacity of land due to deforestation increases peak flow and rapid runoff of water resources. In the Songwe River floodplain, there is siltation problem leading to blocking of tributaries and causing flood damage to crops, houses etc. The Ruo River also has siltation problems at the confluence with the Shire River where the Ruo River has a steep slope and the Shire River has a gentle slope. This confluence is located downstream of the Elephant Marsh, and the sediment is thought to affect the river channel and floodplain of the Shire River.

There are many malfunctioning irrigation ponds due to sediment inflow and accumulation. The Bwanje Valley Irrigation System was damaged by the flood in 2001 and maintenance proved to be a problem due to sedimentation. Proper management is, therefore, necessary for sustainable utilization of irrigation ponds.

The load to water treatment plants increases sediment inflow to rivers. Sedimentation at intake results in failure of intakes and damage of facilities. which are valuable water resources for irrigation as well as habitat for a variety of species,. sedimentation also causes change in wetland environmentFloating aquatic weeds together with soil erosion cause a problem for reservoirs. ESCOM which manages hydropower dams on the Shire River experiences such a problem and has invested heavily in an effort to removing them on a regular basis. These are mainly from the tributaries of Shire River.

Based on the above-mentioned situations, there is strong relationship between soil erosion and water resources, in terms of quantity and quality etc.

Source: ESCOM

Sediment deposition near the intake (March 2010)

Source: ESCOM

Sediment deposition in the reservoir (March 2010)

Figure 7.1.1 Photos of Sediment Deposition

7.2 Present Condition

7.2.1 Existing Results of Study

There are existing results of studies on soil erosion risks such as the 1986 soil erosion hazard map and risk of sediment ingress to watercourses shown in **Figure 7.2.1** and **Figure 7.2.2**. The risk of sediment deposition at watercourses was studied in the Water Resources Investment Strategy and the risk for each WRA and WRU were estimated by considering land cover, rainfall, slope, soil erosion and distance from watercourse.

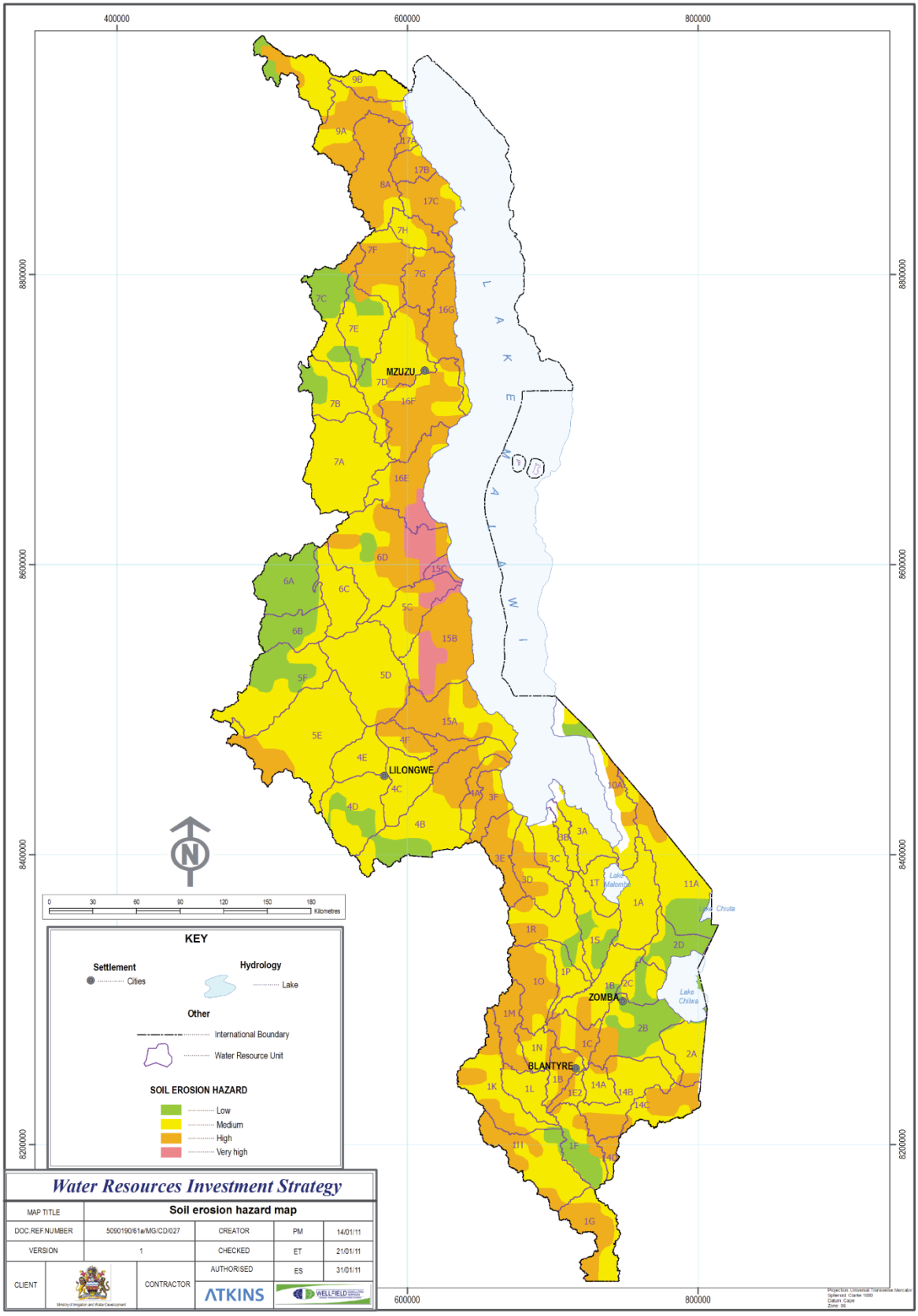
JICA implemented a project on Community Vitalization and Afforestation in Middle Shire (COVAMS) from 2007 to 2012 with the Department of Forestry to control soil erosion through community forestry. As of the present, the project, which aims at promoting catchment management activities in Middle Shire, is being conducted to expand the approach developed by COVAMS to other areas of Middle Shire Catchment.

The Shire River Basin Management Program (SRBMP) is a World Bank funded Program, is currently under implementation. It is aimed at generating sustainable social, economic and environmental benefits by effectively and collaboratively planning, developing and managing the Shire River Basin's natural resources. There are three components under the Program; namely, Shire Basin Planning (Component A), Catchment Management (Component B), and Water Related Infrastructure (Component C). Under each component, there are three or four sub-components. Soil and water conservation is under Component B. **Table 7.2.1** and **Figure 7.2.3** show soil loss of priority sub-catchment areas for the Component B project which are selected by consideration of reducing sedimentation impact on hydropower plants at lower stream and site characteristics.

Table 7.2.1 Overview of Priority Sub-Catchment for Project Component B of SRBMP

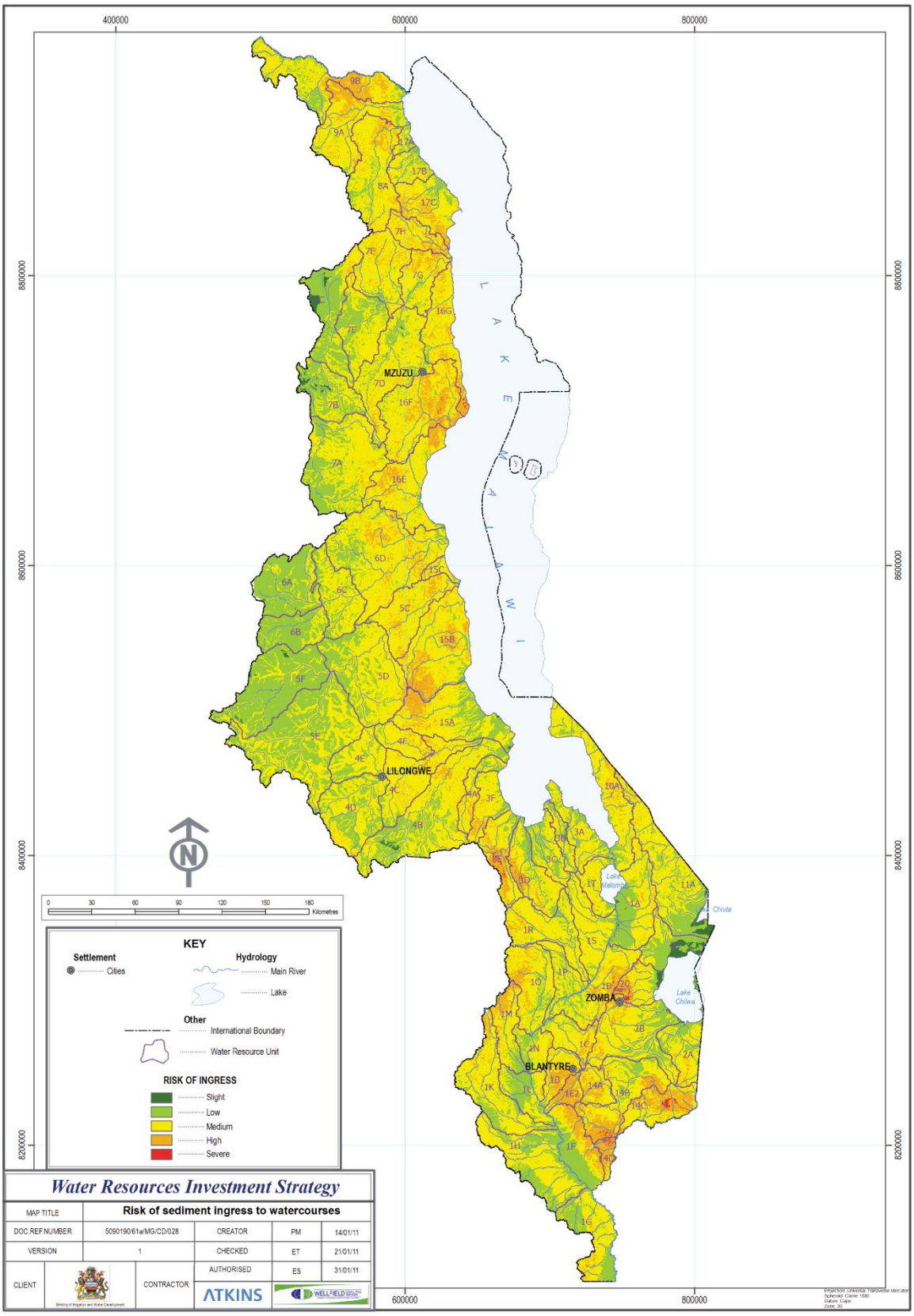
Sub-catchment Code	No of GV	No. of HH	Area (ha)	High Soil Loss (ha)	High Soil Loss (%)	Area/GVH (ha)	Ha/HH
Catchment 1 - Upper Lisungwe							
48	3	7,424	16,075	9,803	61.0	5,358	2.2
47	1	2,334	9,706	3,917	40.4	9,706	4.2
Sub-total	4	9,758	25,781	13,720	53.2	6,445	2.6
Catchment 2 - Upper Wamkulumadzu							
53	1	1,273	15,913	6,760	42.5	15,913	12.5
51	2	4,089	7,703	3,551	46.1	3,852	1.9
52	2	1,955	9,641	5,159	53.5	4,821	4.9
Sub-total	5	7,317	33,257	15,470	46.5	6,651	4.5
Catchment 3 - Escarpment Upstream from Kapichira Falls (Blantyre District)							
70	5	6,269	20,130	13,402	66.6	4,026	3.2
79	3	4,923	12,996	7,362	56.6	4,332	2.6
Sub-Total	8	11,192	33,126	20,764	62.7	4,141	3.0
Catchment 4 - Chingale							
39	6	9,600	17,578	7,700	43.8	2,930	1.8
40	4	5,110	9,829	3,321	33.8	2,457	1.9
42	1	2,618	13,345	5,138	38.5	13,345	5.1
Sub-Total	11	17,328	40,752	16,159	39.7	3,705	2.4
Total	**28**	**45,595**	**132,916**	**66,113**	**49.7**	**4,747**	**2.9**

GV: Group Village, HH: Households
Source: World Bank (2012)



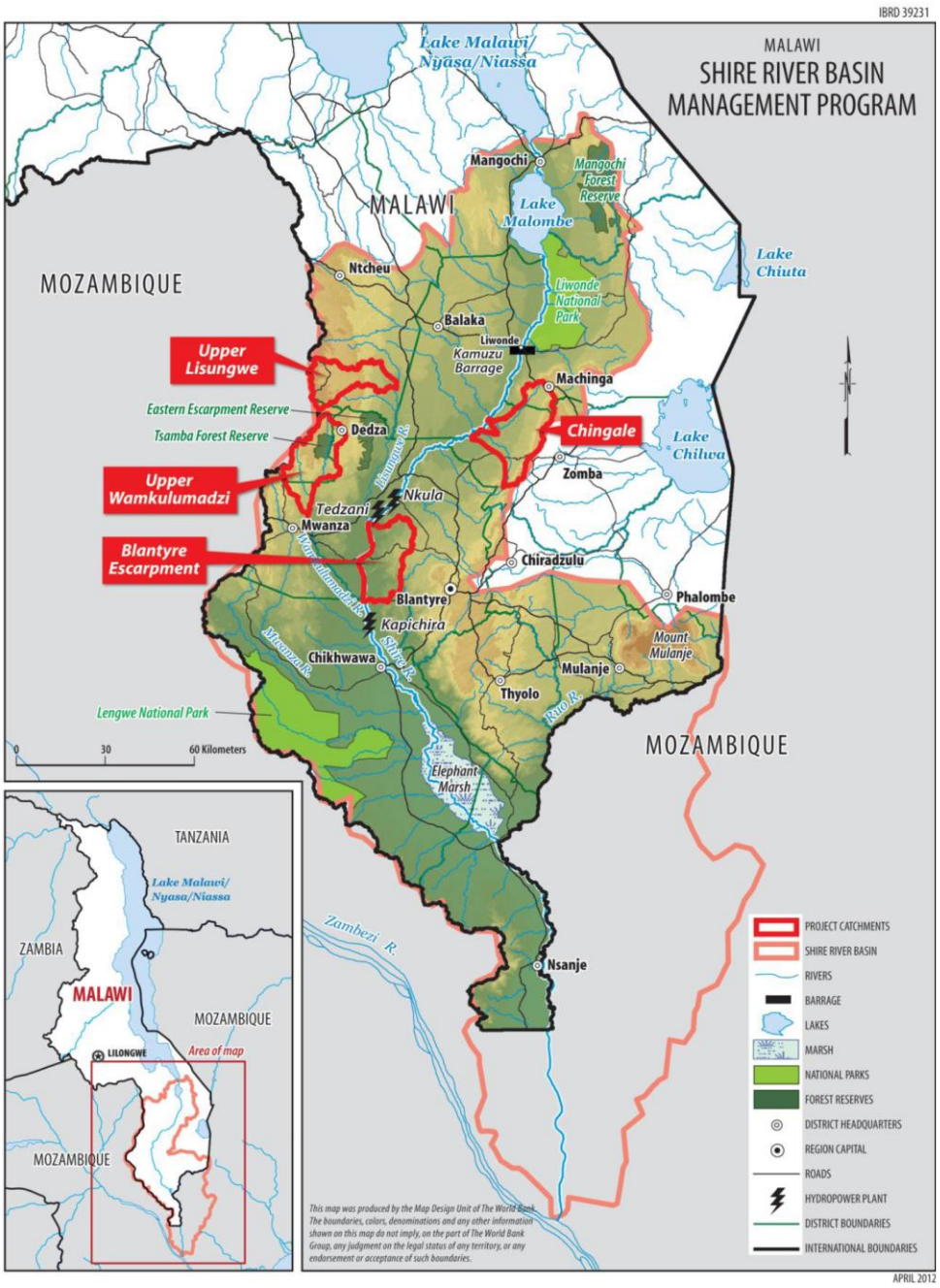
Source: WRIS (2011)

Figure 7.2.1 Soil Erosion Hazard Map, 1986



Source: WRIS (2011)

Figure 7.2.2 Risk of Sediment Ingress to Watercourses



Source: World Bank (2012)

Figure 7.2.3 Location Map of Project Component B of SRBMP

7.2.2 Policy on Soil Conservation

The guiding principles 5.2 (a) and (b) of the National Environmental Policy (2004) stipulates that deforestation is an important contributing factor to soil erosion, siltation of lakes, rivers, and reservoirs and other water bodies, loss of biodiversity and climate change and the participation of the private sector, NGOs and local communities in forestry is essential for sustainable management, conservation and utilization of forest resources. They also describe the promotion of plantation, monitoring and development forest management plan that incorporates the conservation and sustainable management of resources such as water and wildlife.

The guiding principles 5.5 (b) and (j) of the National Environmental Policy stipulates that all programs related to water should be implemented in such a manner that mitigates environmental degradation and at the same time promote enjoyment of the asset by all beneficiaries, and the construction of small dams and diversion of water in rivers for development of irrigation shall take into account catchment protection measures.

In line with this, water resources developments should consider watershed conservation for sustainable development to prevent catchment degradation. Forests are important for watershed conservation and they should be managed with the participation of communities.

7.2.3 Land Cover

Comparing land use in 1990 and 2010, the deforestation occurred in the northern region, along Lake Malawi and the Shire River basin. Forest land decreased from 28 percent to 26 percent in twenty years. On the other hand, cropland increased from 61percent to 63 percent as estimated from GIS data in the Project. Most of the land in Malawi is cropland and forest land is not large. With consideration of land use condition and deforestation, it is important to conserve forest land.

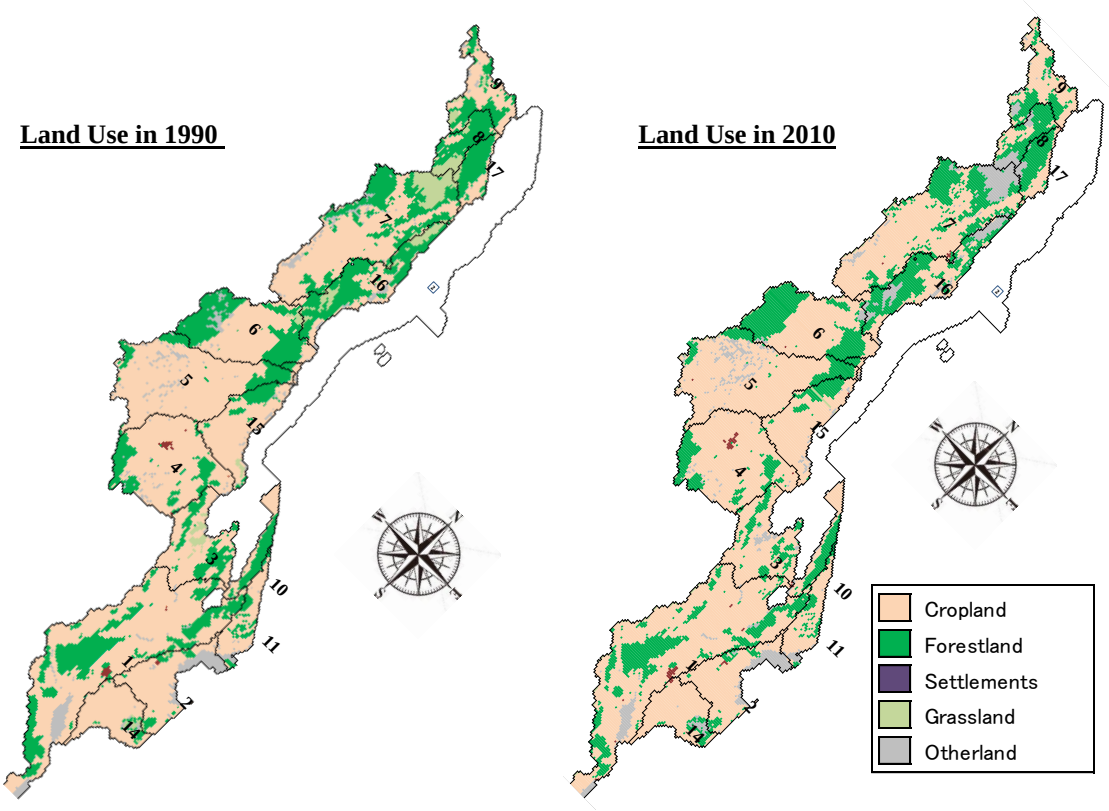
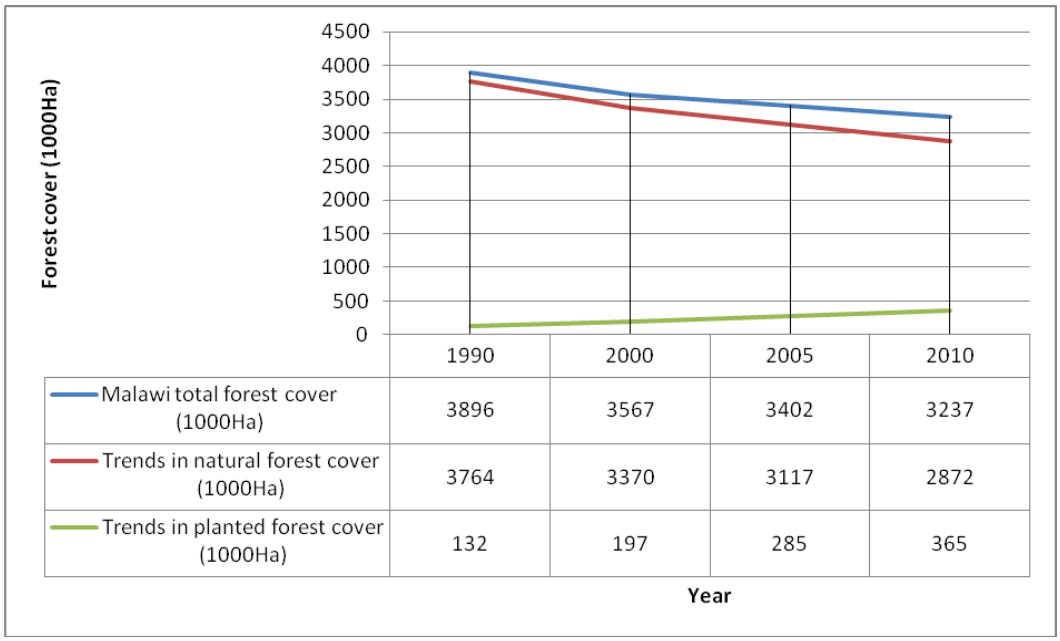


Figure 7.2.4 Land Use Change from 1990 to 2010

7.2.4 Assessment of Forest Reserves

Figure 7.2.5 shows that there has been a consistent depletion of forest cover in Malawi which has not been significantly addressed in recent years. Nevertheless, it indicates that there have been some notable efforts to build the forest cover although presumably not proportionate. The main issues contributing to forest cover loss include poverty, population growth, low literacy levels and agricultural expansion. Some of the forests where depletion is very eminent include the Michiru mountain forest reserve in Blantyre, the Marabvi forest reserve in Chiradzulu district, the Chimaliro forest reserve in Kasungu District and the Thyolo forest reserve in Thyolo District.



Source: Malawi Environmental Profile (2011)

Figure 7.2.5 Trends on Forest Cover from 1990 to 2010

7.2.5 Impact of Land Cover Change on Water Resources

The impact on water resources especially flow at the Kamuzu Dam has been studied in case of land cover change from forest land to cropland at the Dzalanyama forest reserve shown in **Figure 7.2.6.** The Dzalanyama forest reserve is located upstream of the Kamuzu Dam which supplies water to Lilongwe City. The area of the Dzalanyama forest reserve is 989 km^2 and it spreads to Lilongwe, Dedza, Mchinji.

The ratio of change is about ten percent decrease of forest land from when the Dzalanyama forest reserve changes to cropland between 1990 and 2010.

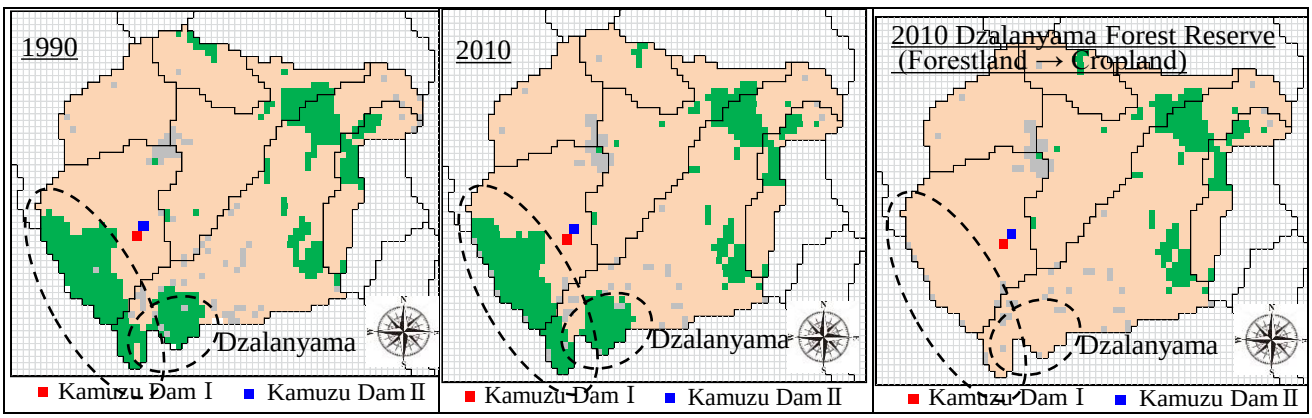


Figure 7.2.6 Land Use Change at the Dzalanyama Forest Reserve

Using the MIKE-SHE model developed in **Annex 4: Chapter 3**, the flow at the Kamuzu Dam is calculated to find the impact of deforestation on water resources. **Figure 7.2.7** shows the comparison of the flow in case of forest land and cropland at the Dzalanyama forest reserve. The peak flow at the dam has increased in this case by approximately ten percent. It is because of increasing direct flow during flood. It means that the water in rainy season runs off in a short time and this water is lost because surplus water at reservoir flows out if there is full storage capacity although the result is roughly estimated. It is recommended that further detailed studies be undertaken to ensure the impact of deforestation on water resources.

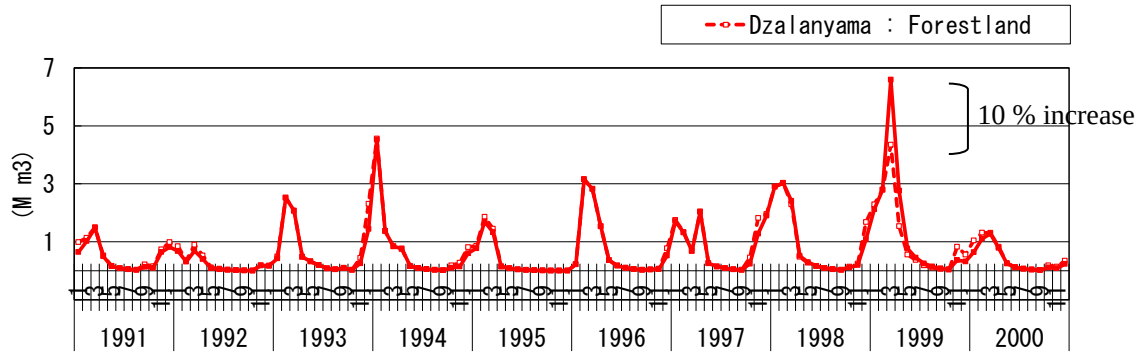


Figure 7.2.7 Inflow at Kamuzu Dam II (Monthly Maximum)

7.2.6 Sediment Survey in Pilot Basin

Present condition and issues on sediment runoff are investigated through survey and analysis targeting some pilot basins.

(1) Methodology of Survey

In the Project, sediment runoff survey was carried out in the following manner:

Objective: To investigate sediment runoff condition in selected target basins with various forest coverage ratio.

Survey Method: Actual sediment runoff volume is measured at the lower stream ends of several basins with various ratios of forest coverage, and the results are compared in order to confirm the effect of forest coverage on sediment runoff. The survey is carried out in the following procedure: (a) sampling river water in both rain and dry seasons at sites located at the lower stream ends in the selected target basins; (b) estimating volume of wash load and suspended sediment by analyzing SS (suspended solid) of samples; (c) measuring river discharge at the same time as sampling; (d) investigating relationship between sediment concentration and river discharge; and (e) comparing forest coverage with sediment concentration and river discharge.

Selecting target basins and sampling sites: The target basins were selected comparing forest coverage shown in **Figure 7.2.4**. Considering the deforestation and forest degradation, the target basins are narrowed down to the central region of WRA-3, 4, 5 and 6. In addition, sampling and discharge measurements are carried out at the sites, which are the existing operational gauging stations as well as water quality monitoring points, considering availability of existing data and repeatability of survey. Consequently, they are set as a prerequisite for selecting target basins where proper gauging station exists in and around lower stream end of relevant basins. Further, the following are also considered for selection: (a) existence of past discharge data; (b) existence of rating curve developed in recent years; and (c) availability of discharge measurement in both low and high flows. Finally, three stations (4E1, 5F1 and 6C1) and related basins are selected for investigating effects of forest coverage ratio on sediment runoff as shown in **Table 7.2.2**.

In addition, gauging station 4D21 is selected as a survey site since future detailed investigation including historical change of forest coverage may be available by working with Dzalanyama forest conservation project, an ongoing forest project by JICA. The upper stream area of 4D21 is a target area of the forest project and 4D21 also fits into most of the above-mentioned condition for the selection.

Table 7.2.2 Sampling Sites (Stations) and Target Basins

Target Area			Represented WRU
Station	Catchment Area (km^2)	Coverage Ratio of Forest	
4E1	943	0%	4E
5F1	2,347	18%	5F
6C1	2,866	67%	6A & 6B
4D21	180	64%	(4D)

(2) Result of Survey

The survey result is summarized in **Table 7.2.3**. From the result below, it can be said that volume of suspended sediment is inversely proportional to forest coverage ratio and its volume is bigger in rainy season than in dry season. In case that the above-mentioned finding is converted into annual soil erosion rate though the result only includes suspended sediment, converted soil erosion rate is very small in the order of 10-3 to 10-5 mm/year.

Table 7.2.3 Survey Result on Suspended Sediment

Target Area			Represented WRU	Survey Result			
Station	Catchment Area (km^2)	Coverage Ratio of Forest		Suspended Sediment (mg/l)	Discharge (m^3/sec.)	Estimated Volume of SS (g/sec/km^2)	Season/Date
4E1	943	0%	4E	32	4.92	0.167	Rain/8Mar2013
				30	0.64	0.020	Dry/12Jun2013
5F1	2,347	18%	5F	1	18.75	0.008	Rain/13Mar2013
				<0.10	0.89	N.A.	Dry/11 Jun2013
6C1	2,866	67%	6A & 6B	11	0.77	0.003	Rain/13Mar2013
				(4.7)	0	N.A.	Dry/11Jun2013
4D21	180	64%	4D	To be measured	ditto	To be estimated	Rain/2014
				<0.10	0.35	N.A.	Dry/12Jun2013

(3) Comparison with Past Survey

A survey regarding sediment runoff was conducted in the Feasibility Study for the Stabilization of the Course of the Songwe River, 2003. In the survey, just like in the Master Plan formulation, suspended sediment and discharge were measured in five sites in the Songwe river basin. One site is upstream along the Songwe River, three sites are downstream along the Songwe River, and one site is on the Kyungu River, a tributary of Songwe River. The measurement was conducted once or twice a month from December 2002 to June 2003.

From the above survey, the result of Mwandenga site, which is located in the lower stream of the Songwe River and is a site of existing gauging station of 9B7 with catchment area of 3,864km2 including area in Tanzania, is summarized in **Table 7.2.4**.

Table 7.2.4 Result of Suspended Sediment Survey in Past Study

Target Area		Represented WRU	Survey Result			
Station	Catchment Area (km^2)		Suspended Sediment (mg/l)	Discharge (m^3/sec.)	Estimated Volume of SS (g/sec/km^2)	Date
9B7	3,864	(9B)	2,855	68.5	50.613	31Dec2002
			2,650	165.1	113.229	14Feb2003
			1,089	37.7	10.625	28 Mar2003
			3,670	57.7	54.803	10 Apr2003
			346	32.7	2.928	24 Apr2003
			94	24.1	0.586	21May2003
			235	28.5	1.733	24May2003

Source: NORPLAN, Feasibility Study for the Stabilization of the Course of the Songwe River, 2003

Forest coverage ratio in WRU-9B is 18% though this value is assessed only using the area on the Malawi side. This ratio is almost at the same level as 5F1, but the volume of suspended sediment in **Table 7.2.4** is far more than 5F1 as well as the other target areas in the survey carried out in the Project. However, an order of annual soil erosion rate converting the volume is 10-3 to 100 mm/year and is judged to be within normal range that corresponds to the value of grassland/wood land to agricultural land in general.

(4) Findings

As investigated above, the following can be referred to as findings though these were observed from quite limited survey results:

- Volume of suspended sediment is fairly higher in rainy season than in dry season.
- The volume of suspended sediment is inversely proportional to forest coverage ratio.
- Sediment runoff in general, is not so high in Malawi though it may vary depending on catchment condition.

7.2.7 Assessment of Sediment Volume

The sediment volume is estimated by desktop analysis considering slope, slope length, precipitation, land use and soil factor which seem to be related to produce sediment volume. **Figure 7.2.8** shows slope, precipitation, ratio of forest land and fractured basement in Malawi. Slope is estimated from using SRTM DEM data. Precipitation data is one which is used in hydrological analysis. Ratio of forest land is estimated by land use in 2010 shown in **Figure 7.2.4** as the land use factor. Rate of fractured basement is estimated from geological map as soil factor. Slope length is not considered because it is estimated from the slope and there is similar feature with slope factor. The analysis is conducted by 2 km^2 mesh. Elevation-volume curves at the Kamuzu Dam I, the Nkula Dam and the Kapichira Dam were collected and are shown in **Figure 7.2.9** and the sediment volume is estimated from these data and existing survey. There is some degree of correlation between sediment volume and other factors shown in **Figure 7.2.10**. Considering the correlation, the sediment yield in Malawi is estimated by WRU and shown in **Figure 7.2.11**. There are relatively severe sediment volumes in the northern and southern regions and along the Lakeshores because of steep slope and severe precipitation. On the other hand, there are relatively slight sediment volumes in the central region because there is a gentle slope and sediment is considered to be caught in the dambo areas. Among the factors related to sediment volume, only the ratio of forest is changed mainly by human activities. Therefore, forest land should be conserved to control sediment in watershed. However, since this is only desktop analysis under the limited data, a field survey is required for more appropriate findings.

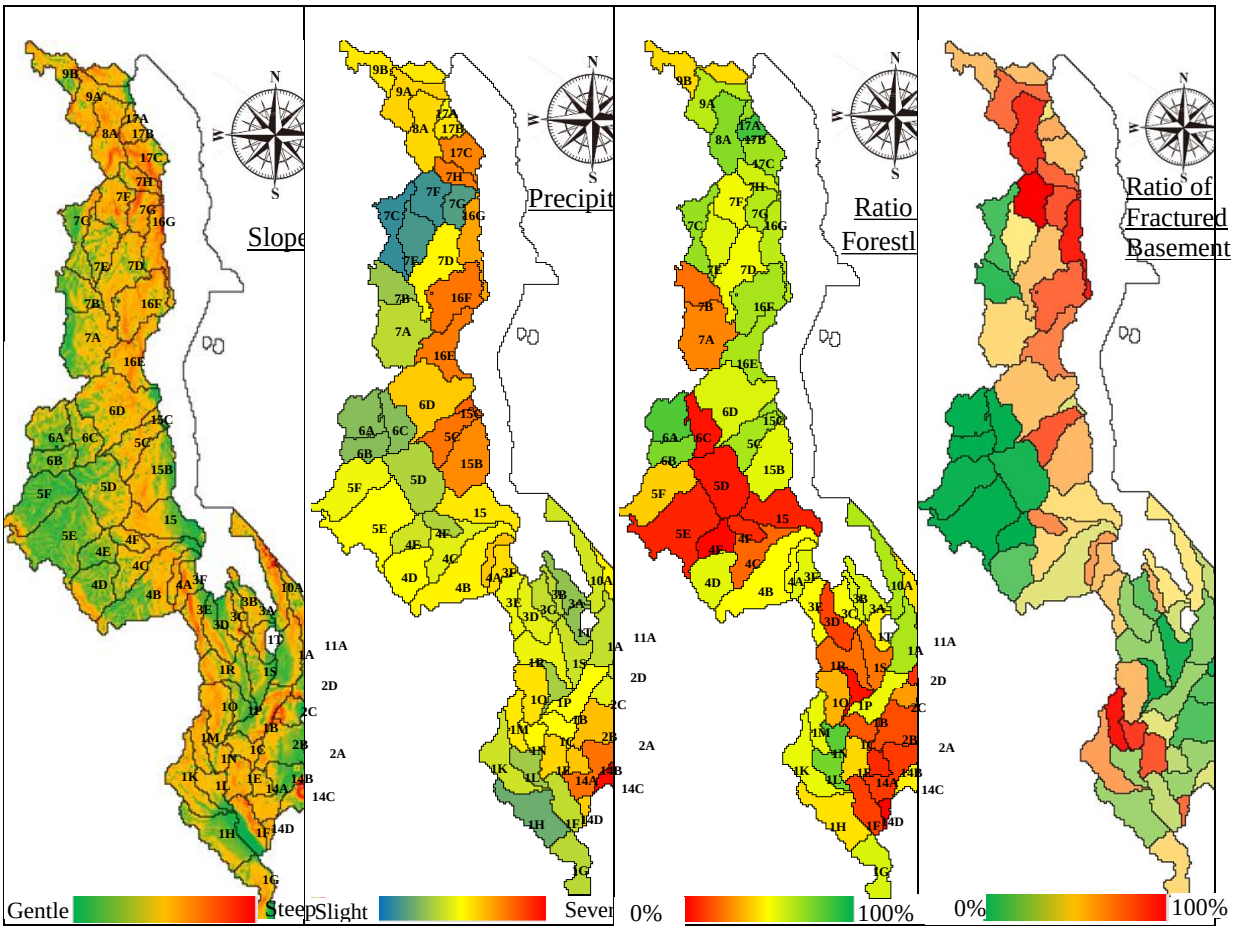


Figure 7.2.8 Slope, Precipitation and Ratio of Forest Land and Fractured Basement

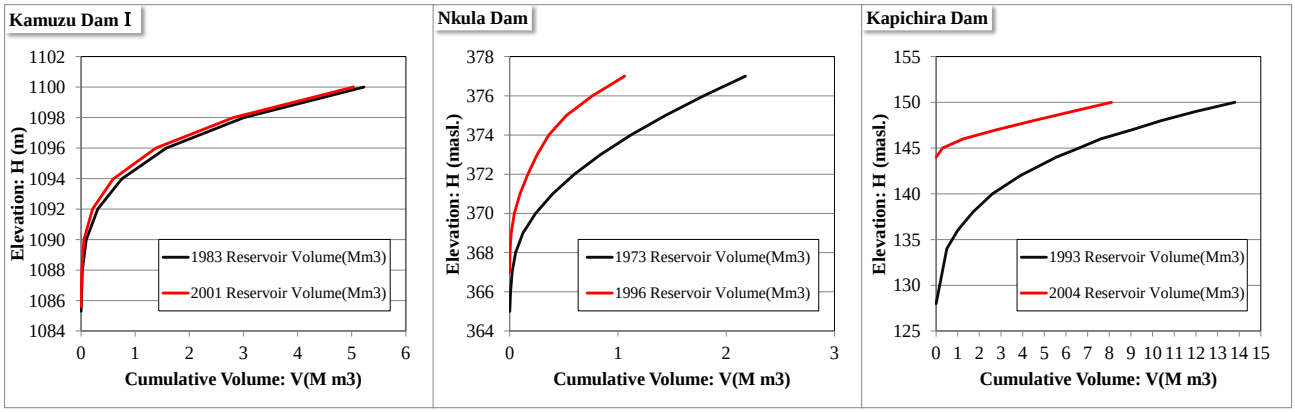


Figure 7.2.9 Elevation-Volume Curve at Kamuzu I, Nkula, Kapichira Dam

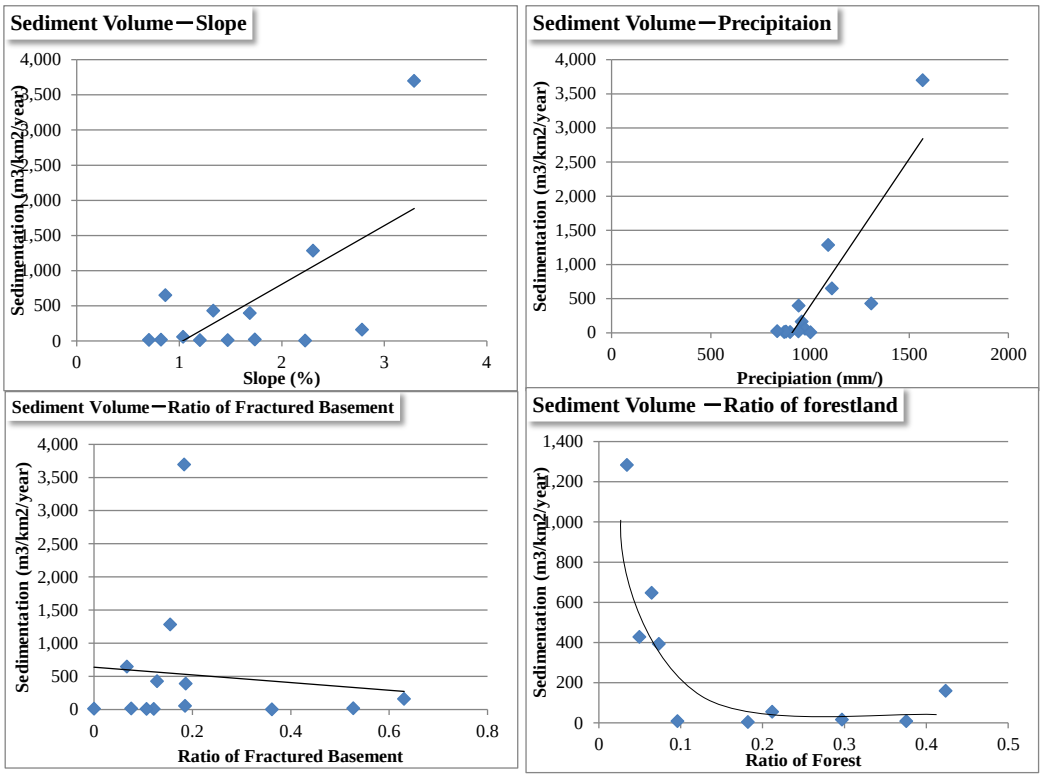


Figure 7.2.10 Relationship between Factors and Sediment Volume

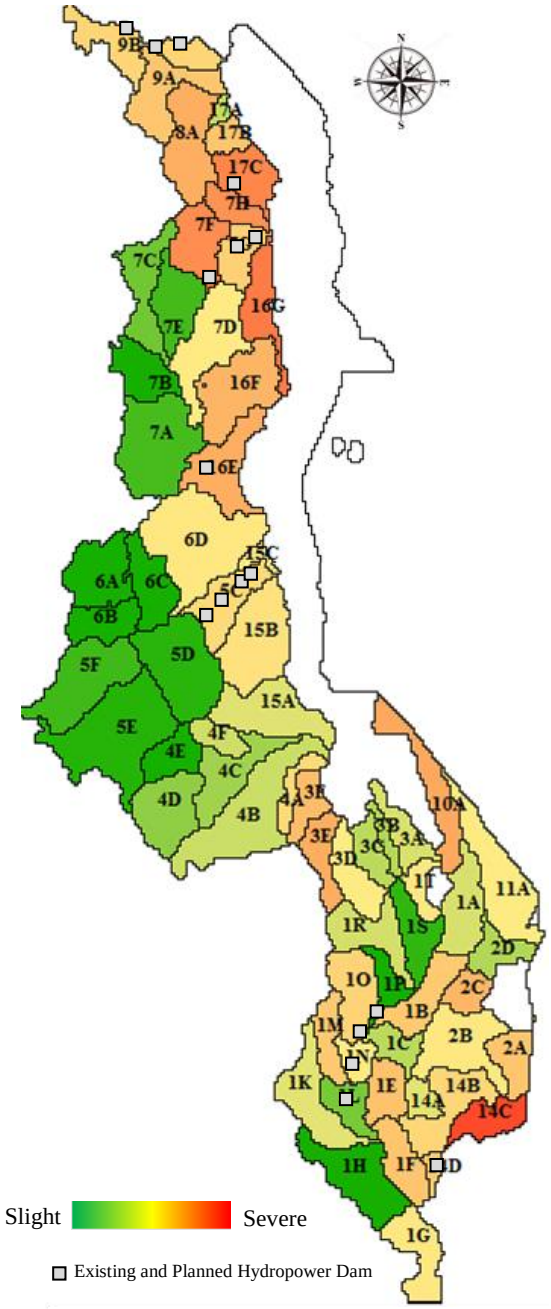


Figure 7.2.11 Estimated Sediment Yields in Malawi

7.2.8 Sediment and Weed Management at the Hydropower Dams on the Shire River

The three hydropower dams on the Shire River, the Nkula Dam, the Tedzani Dam, the Kapichira Dam, have siltation problems which cause the reduction of storage capacity. To resolve these problems, scouring is conducted at all three dams. However, scouring is not effective because it removes only sediment in main river channel. Among the hydropower dams at the Shire River, the Nkula Dam is most affected by sediment deposition. At the Nkula Dam, dredging and pumping are conducted as measures against sediment deposition. Pumping is done at 16 hours per day intermittently by pumping up sediment from the reservoir and storage at the land of lower stream. On the other hand, the removal of weeds is conducted by human labor. The flow of weeds and plants from the Shire River had decreased because plants at upper stream are removed at the Kamuzu Barrage. However, the problem is the flow of weeds from the tributaries. (See picture below.)

The Kapichira Dam has four low level gates for flushing operations conducted regularly on monthly basis to prevent sediment deposition from damage of turbines and reduction of power generation. At

the downstream of the Kapichira Dam, there are intake facilities for agricultural use. Sediment from the Kapichira Dam has caused problems with these facilities.

Dredging Machine at the Nkula Reservoir

Discharge Point for Sediment Suction

Dust Remover at the Intake Point

Weeds and Plants Removal

Removed weeds and Plants

7.3 Road Map for Short, Middle and Long Term Plans

7.3.1 Concept

Soil erosion and degradation of watershed are mainly caused by deforestation due to low electrification rate, expansion of cropland, population growth, poverty and low literacy which are the challenges to watershed conservation. The major key to solve the challenges is how to sustainably use energy sources under the population growth and poverty. One of methods is to use resources effectively such as using briquettes. The reliance on biomass that generates energy from firewood, charcoal, etc., was at 93% in 2000 and the National Energy Policy sets that it shall be decreased to 50% in 2020. At the same time, electricity has increased from 2.3% to 40%. Presently in Malawi, 94% of electricity is generated by hydropower and hydropower generation will still be the major energy source for electricity in the future. Hydropower plays quite an important role in electric power generation and the effective and stable utilization of hydropower is required for the country's development. Therefore, soil erosion and watershed conservation measures such as afforestation should be carried out to prevent sediment deposition in the hydropower reservoirs. For biomass such as charcoal, sustainable utilization and management is necessary in order not to adversely affect various sectors. Non-structural and structural measures, enhanced institutional and legal framework, capacity building and monitoring and evaluation shown in **Table 7.3.1** are the actions for soil erosion and watershed conservation measures proposed to tackle the challenges. These actions should be implemented in collaboration with stakeholders to get synergistic effects.

Table 7.3.1 Challenges and Actions for Soil Erosion and Watershed Conservation

Challenges	Impacts on Water Resources	Actions
Natural Condition -Deforestation due to low electrification rate, etc. -Expansion of cropland	-Sedimentation in dams and ponds -Reduction of hydropower generation -Reduction of crop yields -Reduction of water resources -Increase of flood peak and reduction of flow capacity of rivers -Increase of loads on water treatment plant -Effect on water quality -Impact on environment, flora and fauna -Outflow of weeds which affect reservoir management	Non -Structural Measures -Establishment of conservation and co-management plans -Utilization of effective fuel and electricity -Promotion of afforestation, village forest area and agroforestry -Contour farming for existing farm -Setting of restricted zoning on settlement and farms -Enforcement of the relevant existing regulations
		Structural Measures -Structural measures (sedimentation tank, riprap, infiltration basin , check dams etc.)
Social Condition -Population growth -Poverty -Low literacy		Institution and Legal Framework -Establishment of catchment management committees -Participation of community -Co-management agreements with surrounding communities -Cooperation between sectors and relevant agencies -Intensified forest patrols and penalties -Topping up of water tariff and introduction of licenses for logging
		Capacity Building -Capacity building
Monitoring and Evaluation Condition -Insufficient observation		Monitoring and Evaluation -Strengthening of monitoring -Field Examination to find the effect of afforestation -Field examination to find the effect of structural measures (sedimentation tank, riprap, infiltration basin, check dams etc.)

7.3.2 Road Map

Considering the assessment of sediment volume and the location of existing and planned dams, the priority WRUs are selected to take actions on soil erosion measures and watershed conservation. The actions for soil erosion and watershed conservation should be implemented from the priority WRUs (which were determined by considering the assessment of sediment volume and the location of existing and planned dams).

Upon implementation, considering the Plan-do-check-action (PDCA) cycle, non-structural and structural measures are carried out after planning though some of them could be implemented in parallel. Then proper maintenance and management are done, while monitoring and evaluation is conducted, and this is reflected to the planning again. This is repeatedly carried out to spiral up for better soil erosion measures and watershed conservation.

7.4 Concrete Activities for Short, Middle and Long-Term Plan

7.4.1 Non-Structural Measures

(1) Establishment of Conservation and Co-Management Plans

The soil and forest conservation and co-management plan for watershed should be established at the priority WRUs. The soil conservation plan needs a comprehensive viewpoint from the whole watershed. Some forest reserves such as Kaning'ina forest reserves in NkhataBay District already has conservation plans with the District Council and the Department of Forestry. Referring to proceeded plans, the plans of the priority WRUs are developed. The soil conservation plan is necessary to be developed in consultation with relevant institutions and communities. It ensures their ownership as well.

(2) Utilization of Effective Fuel and Electricity

Intensifying the rural electrification program and making electricity affordable is described in the Malawi Vision 2020. The utilization of more effective fuel such as briquette is considered instead

of firewood to get energy more effectively. This reduces the demand pressure on logging and also reduces deforestation. The electricity rate is increased by 40 percent up to 2020 as set in the National Energy Policy. This is promoted to increase electrification coverage and reduce pressure of deforestation.

(3) Promotion of Afforestation, Village Forest Area and Agroforestry

For sustainable utilization of forest resources, after cutting trees, it is better to plant more trees. There are notable forest reserves where plantations have deliberately been established such as Jembya forest reserve in Chitipa District. Referring to the proceeded planting actions, it is introduced at the priority WRUs at first and then spread to other WRUs. Community participation is important for the promotion of planting and it results in sustainable and effective impacts. It is recommended that village forest areas (VFAs) should be established, more especially on forest reserves where forest cover is more critical. VFAs are areas created by and for the communities to reduce pressure on the forest reserves. One good example is the VFAs that has been established around Karonga South Escarpment in Karonga District and Masenjere forest reserves in Nsanje District. There are currently 19 VFAs around Karonga South Escarpment forest reserves. It was reported that these forest reserves have significantly and sustainably eased pressure on the forest reserves by supporting the communities around the reserves.

Promotion of agroforestry which is a land use management with trees and crops for sustainable land use and prevention of degradation of watershed is also important. Commercial forest ownership and forestry industries are promoted as well.

(4) Contour Farming for Existing Farm

Contour farming is one of methods to prevent soil erosion from farms. It does not promote the expansion of farm to mountainous forest area, but it is applied to existing farm to reduce soil erosion from farm. This method is spread to farmers utilizing lead farmers system. Lead farmers are the responsible people who are selected in villages. They learn the knowledge of contour farming from extension officers and after that they become teachers for village people to spread the knowledge which they get from extension officers. It is an effective way for agricultural extension service to spread contour farming and knowledge to reduce soil erosion for watershed conservation. It is introduced at the priority WRUs at first and then spread to other WRUs.

(5) Setting of Restricted Zoning on Settlement and Farm

In consultation with relevant institutions, restricted zoning on settlement and farm should be set to prevent expansion of unregulated development and destruction of forest land and watershed. Likewise, river bank cultivation should be restricted to prevent soil loss and outflow of weeds from river bank.

7.4.2 Structural Measures (Sedimentation Tank, Riprap, etc.)

To prevent soil erosion from watersheds by structural measures, construction of sedimentation tank is promoted on community basis. In addition, construction of riprap and check dams is proposed to prevent sediment flow from rivers and stabilization of riverbanks and riverbeds where there are problems. Furthermore, construction of infiltration basins is proposed to reduce flash floods plus floodwaters and enhance groundwater recharge in the process reducing sediment transport to river beds.. Appropriate maintenance and management of structures are important for keeping their functions.

7.4.3 Institution and Legal Framework

The Catchment Management Committee (CMC) is established for water resources conservation, coordination of stakeholders, monitoring, enforcement of regulations etc., under the National Water Resources Authority (NWRA) to contribute to the realization of IWRM in Malawi pursuant to the new Water Resources Act of 2013. CMC shall consist of the representatives of government agencies related to water resources in the catchment area and representatives of various stakeholders within the catchment area concerned.

Participation of communities, co-management agreements with surrounding communities and cooperation between sectors and relevant agencies are promoted for watershed conservation to control deforestation and soil erosion from watershed. It ensures ownership of forest through co-management communities and sustainable use of forest resource. Cooperation between sectors and relevant agencies is important in case that the scouring of hydropower dam on the Shire River impact on agricultural uses downstream.

Intensified forest patrols and penalties are effective ways to conserve forest. Eighty percent of the district Forestry Offices indicated to have plans to intensify forest patrols in the next annual action plans

Topping up of water tariff and introduction of licenses for logging should be considered for the protection of water source forests such as the Dzalanyama forest reserve upstream of the Kamuzu Dam which supplies water to Lilongwe City.

7.4.4 Capacity Building

Low literacy level for forest management, population growth and poverty promote deforestation and degradation of the watershed. Therefore, capacity building for village people is important for watershed conservation and creation of public awareness. Likewise, capacity building of ministries and departments related to watershed management is necessary.

7.4.5 Monitoring and Evaluation

Monitoring and evaluation should be conducted from the viewpoint of the whole watershed. To estimate the amount of soil erosion, sediment runoff and sediment deposition in the reservoir should be observed. However, it needs a great deal of effort to observe them in the whole country.

Therefore, the observation should focus on areas where there is a problem and possibility for them to occur, including the existing and planned reservoirs. For understanding the condition of a watershed, it is also important to know the change of land use. A land use survey should be carried out regularly.

A database is needed to be developed for the storage and utilization of observation data. Capacity development on the observation and operation of the database should be conducted to ensure accuracy and proper management of observation data.

7.5 Action Plan

The Action Plan including priority WRA, time schedule and responsible organization is shown in **Table 7.5.1**. The priority WRAs are selected by considering sediment yield and existing and planned structures.

Table 7.5.1 Action Plan for Soil Erosion Measures and Watershed Conservation by 2035

Program / Project / Activities	WRA Time Frame Organ/Budget	Prior WRA	Time Frame			Responsible Organ	
			Short Term	Middle Term	Long Term	Main	Associate
			2012-2020	2021-2025	2026-2035		
			12 13 14 15 16 17 18 19 20	21 22 23 24 25	26 27 28 29 30 31 32 33 34 35		
Soil Erosion and Watershed Conservation							
Non-Structural Measures							
	Establishment of conservation and co-management plans	1, 7, 9, 14, 16, 17				MoNREE (Dep. Forestry)	MoAIWD, Ministry of Energy, EAD, Local Government, Ministry of Housing and Physical Planning, ESCOM, Water Boards etc
	Utilization of effective fuel and electricity	All				ditto	ditto
	Promotion of afforestation, village forest area and agroforestry	1, 7, 9, 14, 16, 17				ditto	ditto
	Contour farming for existing farm	1, 7, 9, 14, 16, 17				ditto	ditto
	Setting of restricted zoning on settlement and farm	All				ditto	ditto
Structural Measures							
	Structural measures (sedimentation tank, riprap, etc.)	All				MoAIWD, MoNREE (Dep. Forestry) and others	DoDMA, Ministry of Energy, EAD, Local Government, Ministry of Housing and Physical Planning, ESCOM, Water Boards etc
Institution and Legal Framework							
	Establishment of catchment management committees	All				NWRA	MoAIWD, Ministry of Energy, EAD, Local Government, Ministry of Housing and Physical Planning, ESCOM, Water Boards etc
	Participation of community	All				MoNREE (Dep. Forestry)	MoAIWD, Ministry of Energy, EAD, Local Government, Ministry of Housing and Physical Planning, ESCOM, Water Boards etc
	Co-management agreements with surrounding communities	All				ditto	ditto
	Cooperation between sectors and relevant agencies	All				ditto	ditto
	Intensified forest patrols and penalties	All				ditto	ditto
	Topping up of water tariff and introduction of licenses for logging	All				MoAIWD and MoNREE (Dep. Forestry)	-
Capacity Building							
	Capacity building	All				MoNREE (Dep. Forestry)	MoAIWD, Ministry of Energy, EAD, Local Government, Ministry of Housing and Physical Planning, ESCOM, Water Boards etc
Monitoring and Evaluation							
	Strengthening of monitoring	1, 7, 9, 14, 16, 17				MoNREE (Dep. Forestry)	MoAIWD, Ministry of Energy, EAD, Local Government, Ministry of Housing and Physical Planning, ESCOM, Water Boards etc
	Field Examination to find the effect of afforestation	All				ditto	ditto

CHAPTER 8. IMPROVEMENT OF MANAGEMENT PLAN FOR WATER DEVELOPMENT FACILITIES

8.1 Waterworks Facility for Domestic Water Supply

The management for the water supply facility influences the safety and stability of drinking water, hence it shall be carried out adequately, effectively and rationally. The items in the **Table 8.1.1** should be considered for the operation and maintenance of the water supply schemes. These are listed according to the administrative body.

Table 8.1.1 Points for Management of Domestic Water Supply

Classification	Facilities	Required O&M points
Urban and Towns	Intake (Weir, Pump), Borehole/Power Pump, Treatment Plant, Storage tank, Transmission/Distribution pipe and dam	- Preparation/Upgrading of Manual for Operation, Monitoring, Risk Management - Capacity Development of Operator - Effective Outsourcing - Rehabilitation/Expansion
Market Center	Intake (Weir, Pump), Borehole/Power Pump, Treatment Plant, Storage tank, Transmission/Distribution pipe and dam	- Preparation/Upgrading of Manual for Operation, Monitoring, Risk Management - Capacity Development of Operator - Effective Outsourcing - Rehabilitation/Expansion
Community (Gravity-fed Water Supply)	-Water Supply Facilities -Intake (Weir, Pump), Treatment Plant, Storage tank, Transmission/Distribution pipe	- Preparation/Upgrading of Manual for - Operation, Monitoring, Risk Management - Quantity & Quality Control - Capacity Development of Water Users Association - Rehabilitation & Expansion
Community (Borehole)	-Borehole and Hand-pump	- Capacity Development of Water Committee - Manpower Training for Area Mechanic - Sales points of Spare-parts of Hand-pump

The management for waterworks facility is generally classified into two: operation management and maintenance engineering. The roadmap concerning the operation and maintenance of waterworks facility is formulated from these aspects.

(1) Operation Management

1) Short Term

- Examination and preparation of recording system for operation and control management, recording of job and operating diary.
- Preparation of operation management manual for water boards. (In this manual, the normal and aberrant values of the operation data, the normal and abnormal operating procedures, the accident response, restoration and its structure, etc., shall be described.)
- Procurement of necessary equipment for operations as well as chemicals for water treatment.
- Investigation of aging facilities and stocks of spare parts.
- Capacity development for responsible organizations and personnel.
- Management of wastewater generated from the water treatment facilities/works

2) Middle and Long Terms

- Recording of operation and control management; Recording of job and operating diary.
- Database architecture (for the routine work, the information management, the water supply control and management, the facilities management, the equipment inspection and rehabilitation archival record, the asset management, etc.)
- Water quantity and pressure control (for the integrated management from intake facility to feeder pipe end, the appropriate control regulation, the promotion of efficiency of energy use, the effective leakage prevention, etc.)

- Water quality control (for the target water quality, the appropriate sampling and monitoring, the planning and recording of water quality inspection, etc.)
- Management of wastewater generated from water treatment works/facilities

(2) Maintenance Engineering

1) Short Term

- Preparation of maintenance manuals
- Encouragement of compliance to manual
- Procurement of necessary machineries to maintain waterworks facilities
- Investigation of aging facilities
- Establishment of short, middle and long term maintenance plan
- Capacity development for responsible organizations and personnel

2) Middle and Long Terms

- Maintenance operation (for the inspection, maintenance, repair) and Functional advancement (for the functional assessment of waterworks facility, the rebuilding or update or life-extension diagnostics)
- Preventive and corrective maintenance
- Reliability risk evaluation for facilities
- Database architecture to record maintenance and results and revise the maintenance plan

8.2 Irrigation Facilities

For the proper operation and management of the irrigation facilities, the establishment of an organization to maintain the facilities is necessary.

The details of irrigation control system vary depending on the scale of the project, the composition of the facilities and level of function of the operation and control facilities. The irrigation system, however, is usually controlled by hierarchical control which takes responsibility for control function according to the channel diversion from the water source to the end. Thus totality on the control of overall system and the flexibility in response to individual demand of water supply are achieved.

On the assumption of organizing the Water Users Association, the association has a responsibility of the irrigation system working together with government irrigation officers. Normally there are three levels to maintain and control the irrigation system in the project area: (1) Central control office, (2) Local or diversion block control office, and (3) On-farm control office.

(1) Central Control Office

It is the core organization of the entire irrigation scheme. It divides the course of the main line and branches which lead to diversion blocks.

- Adjusting water supply in relation to other water supply schemes, if any;
- Collecting, exchanging, and adjusting of information from local control offices;
- Decision making for proper distribution of water; and
- Controlling of the water intake and distribution facilities.

(2) Local or Diversion Block Control Office

It takes responsibility for distribution of water from diversion blocks to lower farm ponds. It plays a part of the central control office in middle-sized area.

- Collecting, exchanging, and adjusting of information from on-farm control offices;
- Adjusting of water consumption in the area or in diversion blocks; and
- Controlling the water distribution facilities.

(3) Principle of Operation and Management of On-Farm Facilities

It is necessary to clarify the characteristics and the operation policy of the facilities and explain it explicitly to the beneficiaries or the farmers in order to ensure smooth operation and management

of the irrigation facilities in accordance with the design and the purposes of establishment. Such positive attitude will foster the farmers' sense that the facilities are the common property of the community.

The principle of operation of the on-farm facilities is as follows:

- Major facilities including the water source facilities, water distribution channels, the water diversion facilities and operation and control facilities should be managed by a reasonable number of personnel or a designated number of operators for clarifying the area of responsibilities.
- The date and time of water supply should be based on the planned rotation schedule. Any change of schedule requires the consent of related farmers and approval of responsible personnel.
- Rotational irrigation is employed, in principle. In the rotation block, the capacity of the on-farm facilities is shared by a number of farmers. Unless the capacity of water supply is designed specifically large, arbitrary use of water is not allowed.
- For the effective use of the facilities, joint operation in the field maintenance and intensive cultivation of crops are desired. If block is small, of if a number of crops are grown in the same field, careful distribution of crops in the field is necessary in order to avoid crops from contaminating adjacent crops by chemicals.
- Operational cost is desirable to be divided among farmers according to the volume of water used. However, in practice, because of the reasons for providing measuring devices and complicated calculation of the share of water charge for each farmer, it is often divided depending on the size of benefitted area. Thus fair and orderly share of water supply among the farmers is essential in general, and the timely operation of insect control and its period of application should be equally distributed, in particular.

In the irrigation facilities, examination of the following items of control should be conducted in order to protect the system from defective operation and maintenance. The structure and arrangement of the water supply facilities and the function of operation and maintenance facilities are taken into consideration for proper operation in general.

(a) Monitoring water source and planning water supply

- Designed seasonal water use, effective rainfall, and necessary water supply
- Changes of water source conditions, and possible water supply

(b) Operating water intake and distribution

- The demand of water supply and its formalities for use (on-farm to center), irrigation time required, and communication network
- Operation of water intake and distribution (center to on-farm), and allocated time and its conditions

(c) Emergency handling

- Emergency operation (spots of operation and countermeasures)
- Communication with related persons and organizations (communication and instruction network)

(d) Inspection and maintenance facilities

- Inspection, operation and maintenance of water supply facilities
- Operation and maintenance of control facilities, equipment and devices
- Inspection and adjustment of electric facilities and power supply
- Repair, maintenance and property administration of various ancillary facilities

(e) Collecting, arranging and analyzing water control data

- Range of collected data, purpose and method of data arrangement, and analysis method and its applications
- Storage of records

(f) Public relations

- Communication with related organizations, and adjustment with other related projects

Road Map and Activities for Irrigation Management

As described above, irrigation management is strongly and closely related to the irrigation development schemes. In each irrigation development scheme, WUA (Water Users Association) shall be established. At the same time, Central Control Office shall be established there as well. The structure of the control office depends on the scale of irrigation development.

1) Short Term

<Road Map>

- Water Users Association (WUA) is established among the beneficial farmers in each irrigation area in parallel with the progress of the irrigation development project by 2020.
- Central Control Office (CCO) is established in each irrigation area, and necessary offices are also established depending on the project scale by 2020.

<Activities>

- Collecting of on-farm information, and forming the communication and information sharing passage among the project sites, the Irrigation Service Division (ISD), and the Central Government.
- Gaining the operation and maintenance experiences at the project sites through controlling the irrigation facilities.
- Implementation of capacity development for proper operation and maintenance of the irrigation facilities by the ISD.

2) Middle and Long Term

<Road Map>

- Continuously establishing the WUAs and CCOs in parallel with the progress of irrigation development project until 2035.
- Formulating a strong network of irrigation information and human resources from the project sites to the DOI until 2035.

<Activities>

- Continuously gaining operation and maintenance experiences at the project sites through controlling the irrigation facilities.
- Implementation of capacity development for proper operation and maintenance of the irrigation facilities by the ISD

CHAPTER 9. PROJECT IMPLEMENTATION PROGRAM

9.1 Cost Estimation

9.1.1 Condition of Cost Estimation

(1) Constitution of Cost Estimation

Project cost consists of construction costs for the contractors, land acquisition costs, physical contingencies, costs for engineering services for the preliminary and detailed design, construction supervision, and administration costs for owner's management. The main items which constitute the project costs are as follows:

Construction Cost

- Land Acquisition Cost
- Physical Contingency
- Engineering Service Cost
- Administration Cost

(2) Construction Cost

Construction costs for the facilities proposed in this Master Plan are calculated based on the approximate bill of quantities and unit costs applied to the related project work items.

Construction costs for the various components of the proposed measures are basically estimated as the product of unit cost and the corresponding work quantity, as follows:

Construction Cost $= \Sigma$ (Unit Cost $\times$ Work Quantity)

In case it is judged not appropriate to estimate construction costs with unit cost for a proposed measure, the construction cost is estimated by other methods, such as formula of approximated curve or full set of construction cost. The details about setting of unit cost and the like are described in a later part of this section.

(3) Land Acquisition Cost

Land acquisition costs are not considered for the proposed projects in this Master Plan except for the part of Water Supply for the four (4) cities. Especially, the facilities for rural water supply are generally constructed in public lands; if private lands are used, such usage require agreement among the WUA and the local community members.

(4) Physical Contingency

Physical contingencies are provided to cater for the costs involved due to unpredictable physical conditions during the implementation of urgent and important components of the projects. Physical contingencies are estimated at 12% of the total sum of construction costs and land acquisition costs.

(5) Engineering Service Cost

Engineering service cost for the consultant is composed of the costs for the preliminary design, detailed design and construction supervision services for the construction works in the project implementation. The service costs are estimated at 10% of the total sum of construction costs, land acquisition costs and physical contingencies.

(6) Administration Cost

Administration costs are reserved for the activities of the government personnel as the administration expenses, which are estimated at 4% of the total sum of construction costs, land acquisition costs, physical contingencies and engineering service costs.

(7) Conditions of Cost Estimation

The conditions of cost estimation are summarized as follows.

Table 9.1.1 Conditions of Cost Estimation

Breakdown	Conditions of Cost Estimate
(1) Construction Cost	Labor, material and equipment for construction
(2) Land Acquisition Cost	Not considered except for the part of Water Supply for 4 Cities
(3) Physical Contingency	12% of the total sum of construction costs and land acquisition costs
(4) Engineering Service	10% of the total sum of construction costs, land acquisition costs and physical contingencies
(5) Administration Cost	4% of the total sum of construction costs, land acquisition costs, physical contingencies and engineering service costs

(8) Other Preconditions

1) Time of Cost Estimation

The costs for the Master Plan (M/P) is estimated in US dollars (USD) based on the currency exchange rate as of December 2012; namely, USD 1.00 = MK 329 = EURO 0.77.

When the construction costs for recent similar projects described in existing reports are made as reference, it is necessary to convert them into the present value of 2012 as the base year. In the M/P, construction costs and unit costs are estimated by converting them into the present value of 2012 by means of the GDP deflator from the World Bank database.

Inflation as measured by the annual growth rate of the GDP implicit deflator shows the rate of price change in the economy as a whole. The GDP implicit deflator is the ratio of GDP in current local currency to GDP in constant local currency.

Construction costs and unit costs at the base year (2012) are estimated by using the following formula with correction coefficient.

$$\text{Construction Cost at Basic Year (2012)} = \frac{\text{Construction Cost at the time}}{\text{Correction Coefficient}}$$

Table 9.1.2 Inflation, GDP Deflator and Correction Coefficient

Years	Inflation, GDP deflator (annual %)	Correction Coefficient	
2001	25.6225	0.17234	
2002	62.1647	0.27947	
2003	9.5617	0.30619	
2004	15.4088	0.35337	
2005	10.9726	0.39215	
2006	27.3153	0.49926	
2007	9.9914	0.54915	
2008	8.6549	0.59668	
2009	8.3739	0.64664	
2010	26.4482	0.81767	
2011	3.9061	0.84960	
2012	17.7018	1.00000	→ Basic Year

Source: World Bank database

2) Breakdown of Foreign and Local Currency Cost

The investments are broken down into foreign and local currency costs on the basis of the assumptions presented in **Table 9.1.3**.

Table 9.1.3 Breakdown of Foreign and Local Currency Costs

Sector	Facilities	Foreign	Local
Integrated Project	Barrage	10%	90%
Water Supply for 4 Cities	Dams and Intake	10%	90%
	Pipelines	60%	40%
	Pumping Stations	60%	40%
	Water Treatment Plants	40%	60%
	Tanks	30%	70%
	Borehole with Motor Pump	40%	60%
	Electric Lines	70%	30%
	Land Compensation Costs	0%	100%
	Engineering Service	100%	0%
Towns & Rural Water Supply	Towns and Market Center	40%	60%
	Gravity-fed WS System	20%	80%
	Deep Well with Hand Pump	20%	80%
	Engineering Service	0%	100%
Agriculture & Irrigation	Dams	10%	90%
	Irrigation Development	10%	90%
	Engineering Service	0%	100%

Source: SOGREAH Report

3) Service Life of Project Components

The service life expectancies for elements comprising the scheme in this study are as follows:

Table 9.1.4 Service life Expectancies for each Element Comprising the Scheme in this Study

Element	Economic Life Expectancy
Dams	>50 years
Civil Structures	50 years
Pipelines	40 years
Towns & Rural Water Supply Structures	40 years
Irrigation Structures	40 years
Electrical - Mechanical Equipment	15 years in regular operation

Source: SOGREAH report

9.1.2 Basis for Setting Unit Cost and Construction Cost for the Project

(1) Integrated Project

1) Upgraded Kamuzu Barrage

The construction cost of the upgraded Kamuzu barrage at Liwonde was estimated at 27.96 MUSD according to the Final Feasibility Study Report on The Integrated Water Resources Development Plan for Lake Malawi and Shire River System "Lake Malawi Level Control" – Stage 2 (Norconsult, 2003), with conversion into the present value in 2012.

(2) Water Supply for Four Cities

1) New Water Source Development

As for the new water source development project for Lilongwe, Blantyre, Mzuzu City, the feasibility study has been implemented by Sogreah in 2009-2010 and the validity of the respective projects have been verified by the World Bank in 2012 and the projects for the three cities are currently ongoing. The construction costs were estimated on the basis of the costs estimated in the respective reports. As for the cost of heightening the Mulunguzi Dam at

Zomba City, the project cost is estimated at 10.20 mil USD with reference to the estimated project cost of heightening the Kamuzu Dam being planned in Lilongwe City.

(i) Other Improvement Projects

(a) Network Expansion

As for the construction costs of network expansion, it is estimated as the product of the served population for expansion water supply area and the unit price for distribution pipe of 176 USD/capita which is estimated by the unit price for distribution pipe works per meter and the pipe length per capita of Lilongwe City in 2008. The unit price for distribution pipe works per meter is estimated by multiplying the length of pipeline with each diameter and the unit cost of pipeline with each diameter listed in **Table 9.1.5**. The following unit costs include supply cost and laying cost. The supply costs include the pipes, the fittings and valves and transport to the site. Steel pipes are used for all pipeline cost estimates. Pipe laying costs include trench excavation, pipe installation, backfilling of both loose soil and rocky soil, and pipeline flushing and testing.

Table 9.1.5 Unit Costs of Pipeline

Diameter	Pressure class	Unit Cost
mm	bars	USD/m
50	21	32
75	21	48
100	21	65
150	21	97
200	21	129
250	21	152
300	21	170
350	21	187
400	21	210
500	21	302
800	21	564

Source: SOGREAH report

(ii) Others

As for the construction costs of the other improvement projects such as the development of new groundwater borehole, extension of WTP, network improvement and rehabilitation, etc., they are estimated as project costs with reference to the reports of the Future Investment Plan, etc., of each city.

(3) Water Supply for Towns and Rural Water Supply

1) Towns and Market Center

(i) Case of Groundwater for Water Source

Towns utilize groundwater and surface water as water source in the water supply scheme. Also, the Market Center generally utilizes groundwater sources which are abstracted by means of boreholes equipped with submersible motor pumps, also raw water for groundwater is safe for human consumption. Therefore, water supply facility consists of submersible pumps for groundwater, transmission pipelines, elevated tank (including chlorination), distribution systems and public taps, with groundwater for water source.

The construction costs of water supply facilities utilizing groundwater are estimated by using the formula of the approximated curve which made served population the variable of this formula based on the unit costs of the similar projects and existing reports.

The figure of the approximated curve which shows the relation between unit cost per person and served population is shown as follows. However, the unit costs are set at 140 USD/person as upper limit and 40 USD/person as lower limit.

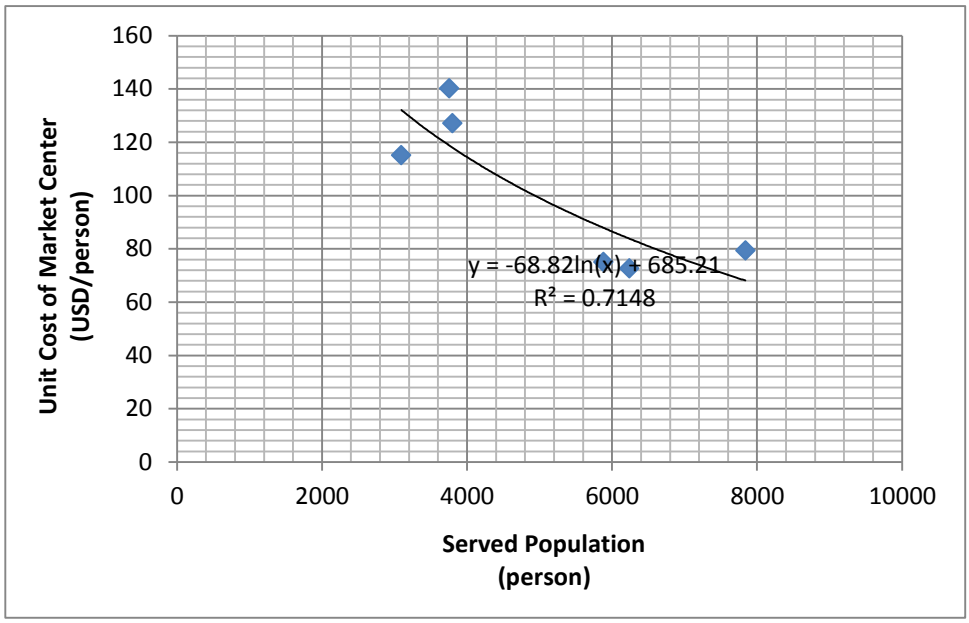


Figure 9.1.1 Approximated Curve between Unit Cost of MC and Served Population (Case of Groundwater for Water Source)

(ii) Case of Surface Water for Water Source

Concerning the investment costs for the water source of the towns and the market center, it becomes generally more expensive to adopt surface water than groundwater. However, when a good well cannot be hydrologically developed near the market center, there is no choice but to depend on surface water such as abstracting from river. When surface water as the water source is adopted, such as river, filtration treatment is generally necessary as the water-purifying process. In this Study, the water-purifying process in case surface water is the water source is set as the coagulation/sedimentation and rapid sand filtration process in consideration of safety.

Therefore, the water supply facility for the market center consists of intake weir, transmission pipelines, coagulation/sedimentation tank, rapid sand filters, service reservoir, distribution systems and public taps, with surface water as the water source.

The construction costs of water supply facilities for the market center utilizing surface water are estimated by using the formula of the approximated curve which made the served population the variable of this formula based on the unit costs of similar projects in the existing reports.

The figure of the approximated curve which shows the relation between unit cost per person and served population is shown as follows. However, the unit costs are set at 140 USD/person as the upper limit and 60 USD/person as the lower limit.

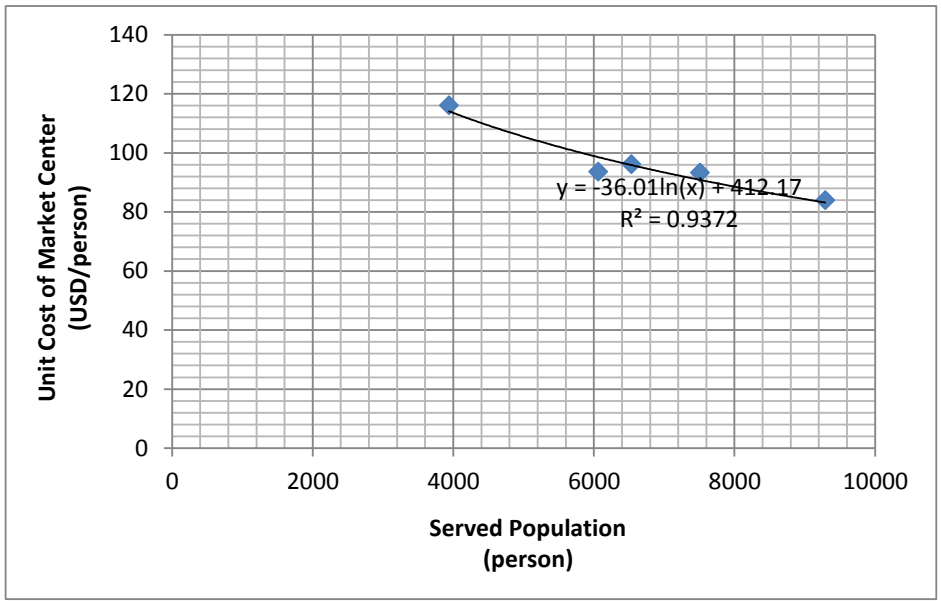


Figure 9.1.2 Approximated Curve between Unit Cost of MC and Served Population (Case of Surface Water as Water Source)

2) Community by Gravity-Fed Piped Water Supply

Gravity-fed WS generally utilizes surface water sources which are abstracted from river/mountain stream. It is recommended that roughening filters and slow sand filters are adopted as treatment process for the raw water, turbidity removal and bacteriological treatment. Water supply facilities for the Gravity-fed System shall be comprised of intake weir, transmission pipelines, roughening filters, slow sand filters, service reservoir, distribution systems and public taps.

The construction costs of water supply facilities for the gravity-fed system are estimated by using the formula of the approximated curve which made served population the variable of this formula based on the unit costs of similar projects and existing reports on the rehabilitation of existing water supply facilities.

The figure of the approximated curve which shows the relation between unit cost per person and served population is shown as follows. However, the unit costs are set at 40 USD/person as the upper limit and 10 USD/person as the lower limit.

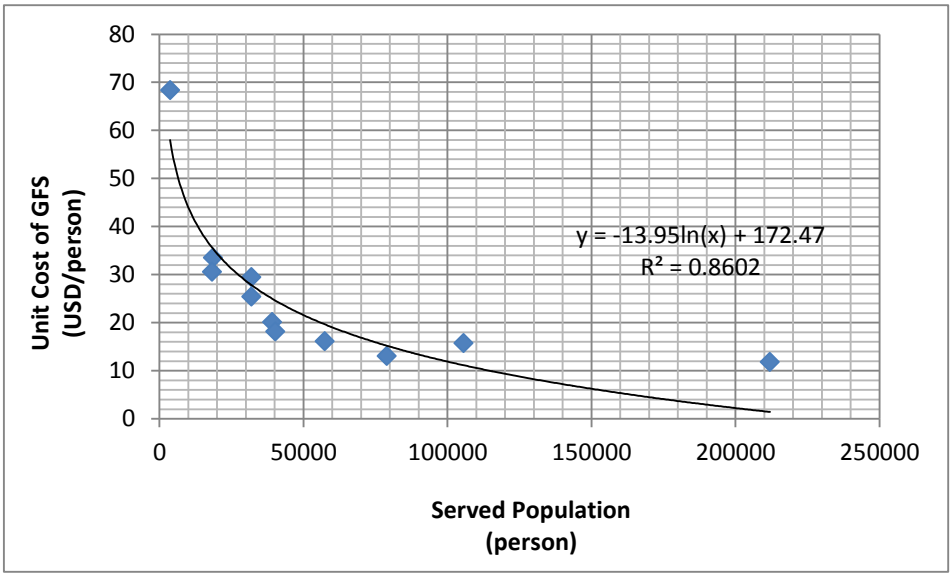


Figure 9.1.3 Approximated Curve between Unit Cost of Gravity-Fed Piped WS and the Served Population

3) Community by Borehole Water Supply (Deep Well with Hand Pump)

The costs of deep well with hand pump (Afridev pump) are estimated on the basis of similar projects under the condition that one deep well serves 250 people. The unit cost is estimated at 4,500 USD/deep well, which include site works, drilling, pump installation and ancillary works and water quality analysis.

(4) Agriculture & Irrigation

1) Criteria of Structural Measures Applied

From the viewpoints of topography, river features, advantageous location of intake facilities, and suppleness of structural component, the following four structural components as shown below are considered applicable for irrigation development.

Table 9.1.6 Applicability Criteria for Structural Measures in Irrigation Development

Structural Component			Applicability Criteria	Cost
1	a	Weir along tributaries	Normal prototype of structural component, without storage facilities	Low
	b	Canal/pipe works		
	c	Farm pond for water distribution		
2	a	Weir along tributaries	In addition to prototype, supplementarily supplying water from mainstream using pump facilities or Dambo, without storage facilities	Medium
	b	Canal/pipe works		
	c	Pump station along mainstream		
	d	Farm pond for water distribution		
3	a	Weir along tributaries	In addition to prototype, supplementarily supplying water from mainstream using pump facilities or Dambo, with irrigation pond to store the surplus water coping with water deficit	Medium
	b	Canal/pipe works		
	c	Pump station along mainstream		
	d	Irrigation pond for water storage		
4	a	Weir along tributaries	In addition to prototype, supplementarily supplying water from Lake Malawi using pump facilities coping with water deficit as well, without storage facilities	High
	b	Canal/pipe works		
	c	Pump station along Lake Malawi		
	d	Farm pond for water distribution		

Source: Existing project costs from DoI and GBI

Furthermore, the above structural components could be arranged from the external and surrounding conditions for easier comprehension.

Table 9.1.7 Applicability Criteria for Structural Measures in Irrigation Development

Water Balance and Location of Sub-basin	Water Sources		Major Facilities to be Applied
Normal	Tributaries	a	Weir
		b	Canal/pipe works
		c	Farm pond for water distribution
	Tributaries and mainstream/ Dambo	a	Weir along tributaries
		b	Canal/pipe works
		c	Farm pond for water distribution
		d	Pump facilities
Deficit in the mountainous sub-basin	Tributaries and mainstream/ Dambo	a	Weir along tributaries
		b	Canal/pipe works
		c	Irrigation pond for water storage
		d	Pump facilities
Deficit along the Lake Malawi sub-basin	Tributaries and Lake Malawi	a	Weir along tributaries
		b	Canal/pipe works
		c	Farm pond for water distribution
		d	Pump facilities

2) Unit Cost of Structural Measures for Irrigation Development

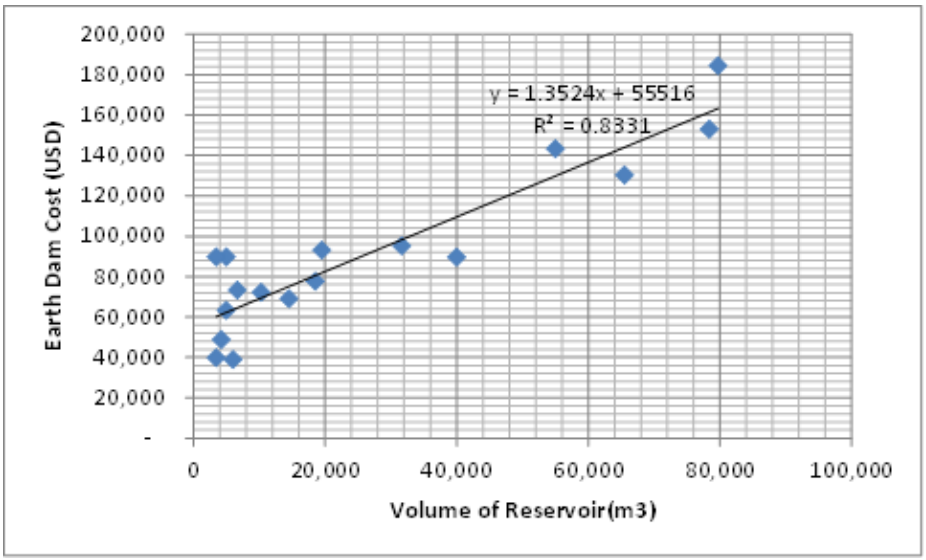
Irrigation development costs are worked out by multiplying the irrigation area with the unit cost (USD/ha) obtained from similar project costs and data from the relevant reports. Unit

costs are shown in the following table based on the above-mentioned applicability criteria.

Table 9.1.8 Unit Cost for Structural Measures

Irrigation Facilities		Unit Cost	Remarks
1	Weir + Canal/Pipe + Farm Pond	4,800 USD/ha	Prototype
2	Weir + Canal/Pipe + Pump Station + Farm Pond	10,100 USD/ha	Pump along the mainstream Additional 5,300 USD/ha on No.1
3	Weir + Canal/Pipe + Pump Station + Irrigation Pond	10,500 USD/ha	Pump along the mainstream
4	Weir + Canal/Pipe + Pump Station + Farm Pond	13,300 USD/ha	Pump along the Lake Malawi Additional 8,500 USD/ha on No.1

In order to meet the water deficit, a water storage facility is necessary. The costs of irrigation reservoir of earth dam are calculated by using the formula derived from the past and ongoing similar projects. The approximate curve which shows the relation between earth dam cost and necessary capacity is shown in the following figure.



Source: MoAIWD

Figure 9.1.4 Relation between Cost of Earth Dam and Reservoir Volume

9.1.3 Summary of Project Cost

(1) Summary of Project Cost

In this Master Plan, the proposed projects are classified into four sectors; namely, Integrated Project, Water Supply for Four Cities, Water Supply for Towns and Rural Water Supply; and Water Supply for Agriculture and Irrigation. The summary of project cost and breakdown for each term of the proposed projects are shown in **Table 9.1.9**.

Table 9.1.9 Summary of Project Cost in this Master Plan (1/3)

Unit: Million USD

Proposed Projects			Project Cost	Time Frame		
				Short Term (2012-2020)	Middle Term (2021-2025)	Long Term (2026-2035)
■Integrated Project						
	Upgraded Kamuzu Barrage		35.83	35.83	0.00	0.00
■Water Supply for 4 Cities						
	Lilongwe	New water source from Diamphwe dam	262.06	123.77	71.65	66.64
		Development new groundwater borehole (+10,000m3/d)	5.20	5.20	0.00	0.00
		Extension TWII (purification plant: +30,000m3/d)	5.00	5.00	0.00	0.00
		Raising Kamuzu dam I and associated rehabilitation works (+30,000m3/d)	5.10	5.10	0.00	0.00
		Extension TWII(2nd) (purification plant: +30,000m3/d) and Technical Assistance	9.70	9.70	0.00	0.00
		Network improvement	0.20	0.20	0.00	0.00
		Rehabilitation of TWII	4.00	2.66	1.34	0.00
		Network expansion	225.80	42.30	70.50	113.00
		Sub-total	517.06	193.93	143.49	179.64
	Blantyre	New water source from Shire river	162.64	91.97	2.58	68.09
		Network improvement	9.00	9.00	0.00	0.00
		Network expansion	129.80	24.33	40.55	64.92
		Poverty program (Kiosk and Toilet development)	14.00	3.50	10.50	0.00
		Sub-total	315.44	128.80	53.63	133.01
	Mzuzu	New water source from Lambilambi and Lichelemu dam	145.93	72.14	0.00	73.79
		Network improvement	1.80	0.70	1.10	0.00
		Network expansion	80.80	19.04	23.80	37.96
		Sub-total	228.53	91.88	24.90	111.75
	Zomba	Raising of Mulunguzi dam and associated rehabilitation works	10.20	0.00	0.23	9.97
		Expansion existing TW (18,200m3/d to 30,000m3/d)	8.14	8.14	0.00	0.00
		Network improvement	3.60	2.88	0.72	0.00
		Network expansion	7.30	0.98	2.45	3.87
		Sub-total	29.24	12.00	3.40	13.84
	Total		1,090.27	426.61	225.41	438.24

Table 9.1.9 Summary of Project Cost in this Master Plan (2/3)

Unit: Million USD

Proposed Projects				Project Cost	Time Frame		
					Short Term (2012-2020)	Middle Term (2021-2025)	Long Term (2026-2035)
■Water Supply for Towns & Rural Water Supply							
	Towns			143.28	65.06	61.55	16.67
	Market center			123.23	77.52	24.86	20.85
	Community by Gravity-fed WS			136.82	73.56	44.49	18.77
	Community by Borehole WS			287.42	71.88	71.88	143.66
	Total			690.75	288.02	202.78	199.95
■Agriculture & Irrigation							
2,500ha/year	WRA	WRU					
	1	A		3.67	3.67	0.00	0.00
		B		4.48	4.48	0.00	0.00
		C		4.78	4.78	0.00	0.00
		E		3.44	3.44	0.00	0.00
		F		1.78	1.78	0.00	0.00
		G		4.26	4.26	0.00	0.00
		K		5.14	5.14	0.00	0.00
		L		3.62	3.62	0.00	0.00
		M		3.87	3.87	0.00	0.00
		N		1.71	0.00	1.71	0.00
		O		5.10	0.00	5.10	0.00
		P		3.65	3.65	0.00	0.00
		R		7.04	7.04	0.00	0.00
		S		4.57	4.57	0.00	0.00
		T		0.60	0.60	0.00	0.00
	2	A		0.56	0.00	0.00	0.56
		B		0.41	0.41	0.00	0.00
		C		0.09	0.09	0.00	0.00
		D		0.14	0.00	0.00	0.14
	3	A		3.76	0.00	0.00	3.76
		B		3.42	0.00	0.00	3.42
		C		7.25	0.00	5.44	1.81
		D		3.99	0.00	0.00	3.99
		E		5.19	0.00	0.00	5.19
		F		1.50	0.00	0.00	1.50
	4	A		0.23	0.00	0.00	0.23
		B		2.09	2.09	0.00	0.00
		C		0.44	0.44	0.00	0.00
		D		1.22	1.22	0.00	0.00
		E		0.64	0.64	0.00	0.00
		F		0.12	0.12	0.00	0.00
	5	C		3.11	0.00	0.00	3.11
		D		2.61	0.00	0.00	2.61
		E		10.17	10.17	0.00	0.00
		F		7.94	7.94	0.00	0.00
	7	A		14.68	14.68	0.00	0.00
		B		6.14	0.00	6.14	0.00
		C		6.77	6.77	0.00	0.00
		D		18.23	18.23	0.00	0.00
		E		2.70	0.00	0.00	2.70
		F		5.78	0.00	5.78	0.00
		G		3.72	0.00	3.72	0.00
		H		1.94	1.94	0.00	0.00
	8	A		24.94	12.47	12.47	0.00
	9	A		1.37	0.00	0.00	1.37
		B		1.64	0.00	1.64	0.00
	14	B		0.63	0.00	0.00	0.63
		C		63.88	0.00	0.00	63.88
	15	A		22.01	0.00	0.00	22.01
		B		46.81	0.00	0.00	46.81
		C		7.40	0.00	0.00	7.40
	16	E		24.00	12.00	12.00	0.00
		F		26.93	0.00	20.20	6.73
		G		13.33	6.67	6.67	0.00
	17	A		0.25	0.00	0.00	0.25
		B		6.91	0.00	0.00	6.91
		C		13.06	0.00	9.80	3.27
	Total			425.71	146.78	90.66	188.28

Table 9.1.9 Summary of Project Cost in this Master Plan (3/3)

Unit: Million USD

Proposed Projects				Project Cost	Time Frame		
					Short Term (2012-2020)	Middle Term (2021-2025)	Long Term (2026-2035)
■Agriculture & Irrigation							
5,000ha/year	WRA	WRU					
	1	A		7.36	7.36	0.00	0.00
		B		8.94	8.94	0.00	0.00
		C		9.54	9.54	0.00	0.00
		E		6.91	6.91	0.00	0.00
		F		3.53	3.53	0.00	0.00
		G		8.54	8.54	0.00	0.00
		K		10.28	10.28	0.00	0.00
		L		7.20	7.20	0.00	0.00
		M		7.73	7.73	0.00	0.00
		N		3.41	0.00	3.41	0.00
		O		10.18	6.79	3.39	0.00
		P		7.32	7.32	0.00	0.00
		R		14.07	14.07	0.00	0.00
		S		9.12	9.12	0.00	0.00
		T		1.22	1.22	0.00	0.00
	2	A		0.73	0.00	0.00	0.73
		B		0.81	0.81	0.00	0.00
		C		0.20	0.20	0.00	0.00
		D		0.21	0.00	0.00	0.21
	3	A		7.55	0.00	0.00	7.55
		B		6.84	0.00	0.00	6.84
		C		14.51	0.00	10.88	3.63
		D		19.33	0.00	0.00	19.33
		E		10.39	0.00	0.00	10.39
		F		3.00	0.00	0.00	3.00
	4	A		0.43	0.00	0.00	0.43
		B		4.16	4.16	0.00	0.00
		C		0.88	0.88	0.00	0.00
		D		2.42	2.42	0.00	0.00
		E		1.28	1.28	0.00	0.00
		F		0.24	0.24	0.00	0.00
	5	C		6.20	0.00	0.00	6.20
		D		5.25	0.00	0.00	5.25
		E		20.31	20.31	0.00	0.00
		F		15.92	15.92	0.00	0.00
	7	A		29.37	29.37	0.00	0.00
		B		12.25	8.17	4.08	0.00
		C		13.58	13.58	0.00	0.00
		D		36.48	36.48	0.00	0.00
		E		5.42	0.00	0.00	5.42
		F		11.54	7.69	3.85	0.00
		G		7.45	4.97	2.48	0.00
		H		3.89	3.89	0.00	0.00
	8	A		56.60	0.00	42.45	14.15
	9	A		2.75	0.00	0.00	2.75
		B		3.30	0.00	3.30	0.00
	14	B		1.48	0.00	0.00	1.48
		C		153.80	0.00	0.00	153.80
	15	A		45.38	0.00	0.00	45.38
		B		103.05	0.00	0.00	103.05
		C		15.87	0.00	0.00	15.87
	16	E		48.01	24.01	24.01	0.00
		F		53.85	0.00	53.85	0.00
		G		26.66	13.33	13.33	0.00
	17	A		0.46	0.00	0.00	0.46
		B		16.52	0.00	0.00	16.52
		C		31.21	0.00	23.41	7.80
	Total			914.93	296.25	188.44	430.24

(2) Water Supply for Four Cities

1) Breakdown of Project Cost

Breakdown of project cost of Water Supply for the four Cities is shown below.

Table 9.1.10 Summary of Project Cost for New Water Resource Development of Water Supply for the Four Cities

Unit: Million USD

City	Description	Total	Time Frame		
			Short Term	Middle Term	Long Term
			2012 - 2020	2021 - 2025	2026 - 2035
Lilongwe	Construction cost				
	Dam	41.00	41.00	0.00	0.00
	New Water treatment plant	43.00	15.00	15.00	0.00
	Pipelines	90.00	18.00	36.00	0.00
	Balancing tanks	2.00	0.50	0.50	0.00
	Pumping stations	10.00	4.00	4.00	0.00
	Electric lines	0.40	0.20	0.20	0.00
	Resettlement / Compensation Irrigation	14.00	14.00	0.00	0.00
	Fisheries	0.11	0.08	0.03	0.00
	Development Irrigation	4.00	2.00	2.00	0.00
	Sub-total	204.51	94.78	57.73	0.00
	Land acquisition cost	0.02	0.01	0.00	0.00
	Physical contingency	24.54	11.37	6.93	0.00
	Engineering service	22.91	12.84	4.24	0.00
	Administration cost	10.08	4.77	2.75	0.00
	Total	**262.06**	**123.77**	**71.65**	**0.00**
Blantyre	Construction cost				
	River intake	2.22	2.22	0.00	0.00
	Water treatment plant	25.30	12.65	0.00	0.00
	Pipelines	62.85	35.24	0.00	0.00
	Reservoirs	17.52	11.12	0.00	0.00
	Pumping stations	18.72	10.23	0.00	0.00
	Electric lines	0.32	0.32	0.00	0.00
	Sub-total	126.93	71.78	0.00	0.00
	Land acquisition cost	0.00	0.00	0.00	0.00
	Physical contingency	15.23	8.61	0.00	0.00
	Engineering service	14.22	8.04	2.48	0.00
	Administration cost	6.26	3.54	0.10	0.00
	Total	**162.64**	**91.97**	**2.58**	**0.00**
Mzuzu	Construction cost				
	Dam	36.61	18.00	0.00	0.00
	Transmission system to WTP	30.77	15.07	0.00	0.00
	Water treatment plant	21.59	12.95	0.00	0.00
	Treated water tank	3.04	1.52	0.00	0.00
	Transmission system from WTP to service reservoirs	3.03	3.03	0.00	0.00
	Electric lines	0.65	0.03	0.00	0.00
	Sub-total	95.69	50.60	0.00	0.00
	Land acquisition cost	18.20	5.70	0.00	0.00
	Physical contingency	13.67	6.76	0.00	0.00
	Engineering service	12.76	6.31	0.00	0.00
	Administration cost	5.61	2.77	0.00	0.00
	Total	**145.93**	**72.14**	**0.00**	**0.00**
Zomba	Construction cost				
	Raising of Mulunguzi dam	7.96	0.00	0.00	0.00
	Sub-total	7.96	0.00	0.00	0.00
	Land acquisition cost	0.00	0.00	0.00	0.00
	Physical contingency	0.96	0.00	0.00	0.00
	Engineering service	0.89	0.00	0.22	0.00
	Administration cost	0.39	0.00	0.01	0.00
	Total	**10.20**	**0.00**	**0.23**	**0.00**

Table 9.1.11 Summary of Project Cost for Other Improvement Projects of Water Supply for the Four Cities (1/2)

City	Description	Total	Time Frame		
			Short Term	Middle Term	Long Term
			2012 - 2020	2021 - 2025	2026 - 2035
Lilongwe	Construction cost				
	Development new groundwater borehole (+10,000m3/d)	4.06	4.06	0.00	0.00
	Sub-total	4.06	4.06	0.00	0.00
	Land acquisition cost	0.00	0.00	0.00	0.00
	Physical contingency	0.49	0.49	0.00	0.00
	Engineering service	0.45	0.45	0.00	0.00
	Administration cost	0.20	0.20	0.00	0.00
	Total	**5.20**	**5.20**	**0.00**	**0.00**
	Construction cost				
	Extension Existing TWII (purification plant: +30,000m3/d)	3.90	3.90	0.00	0.00
	Sub-total	3.90	3.90	0.00	0.00
	Land acquisition cost	0.00	0.00	0.00	0.00
	Physical contingency	0.47	0.47	0.00	0.00
	Engineering service	0.44	0.44	0.00	0.00
	Administration cost	0.19	0.19	0.00	0.00
	Total	**5.00**	**5.00**	**0.00**	**0.00**
	Construction cost				
	Raising Kamuzu dam I and associated rehabilitation works (+30,000m3/d)	3.97	3.97	0.00	0.00
	Sub-total	3.97	3.97	0.00	0.00
	Land acquisition cost	0.00	0.00	0.00	0.00
	Physical contingency	0.48	0.48	0.00	0.00
	Engineering service	0.45	0.45	0.00	0.00
	Administration cost	0.20	0.20	0.00	0.00
	Total	**5.10**	**5.10**	**0.00**	**0.00**
	Construction cost				
	Extension Existing TWII(2nd) (purification plant: +30,000m3/d) and Technical Assistance	7.57	7.57	0.00	0.00
	Sub-total	7.57	7.57	0.00	0.00
	Land acquisition cost	0.00	0.00	0.00	0.00
	Physical contingency	0.91	0.91	0.00	0.00
	Engineering service	0.85	0.85	0.00	0.00
	Administration cost	0.37	0.37	0.00	0.00
	Total	**9.70**	**9.70**	**0.00**	**0.00**
	Construction cost				
	Network improvement	0.15	0.15	0.00	0.00
	Sub-total	0.15	0.15	0.00	0.00
	Land acquisition cost	0.00	0.00	0.00	0.00
	Physical contingency	0.02	0.02	0.00	0.00
	Engineering service	0.02	0.02	0.00	0.00
	Administration cost	0.01	0.01	0.00	0.00
	Total	**0.20**	**0.20**	**0.00**	**0.00**
	Construction cost				
	Rehabilitation of Existing TWII	3.12	2.08	1.04	0.00
	Sub-total	3.12	2.08	1.04	0.00
	Land acquisition cost	0.00	0.00	0.00	0.00
	Physical contingency	0.37	0.24	0.13	0.00
	Engineering service	0.35	0.24	0.11	0.00
	Administration cost	0.15	0.10	0.05	0.00
	Total	**4.00**	**2.66**	**1.34**	**0.00**
	Construction cost				
	Network expansion	176.23	33.03	55.05	88.15
	Sub-total	176.23	33.03	55.05	88.15
	Land acquisition cost	0.00	0.00	0.00	0.00
	Physical contingency	21.15	3.96	6.60	10.59
	Engineering service	19.74	3.69	6.15	9.90
	Administration cost	8.68	1.62	2.70	4.36
	Total	**225.80**	**42.30**	**70.50**	**113.00**

Table 9.1.11Summary of Project Cost for Other Improvement Projects of Water Supply for the Four Cities (2/2)

Unit: Million USD

City	Description	Total	Time Frame		
			Short Term	Middle Term	Long Term
			2012 - 2020	2021 - 2025	2026 - 2035
Blantyre	Construction cost				
	Network improvement	7.02	7.02	0.00	0.00
	Sub-total	7.02	7.02	0.00	0.00
	Land acquisition cost	0.00	0.00	0.00	0.00
	Physical contingency	0.84	0.84	0.00	0.00
	Engineering service	0.79	0.79	0.00	0.00
	Administration cost	0.35	0.35	0.00	0.00
	Total	**9.00**	**9.00**	**0.00**	**0.00**
	Construction cost				
	Network expansion	101.30	18.99	31.65	50.66
	Sub-total	101.30	18.99	31.65	50.66
	Land acquisition cost	0.00	0.00	0.00	0.00
	Physical contingency	12.16	2.28	3.80	6.08
	Engineering service	11.35	2.13	3.55	5.67
	Administration cost	4.99	0.93	1.55	2.51
	Total	**129.80**	**24.33**	**40.55**	**64.92**
	Construction cost				
	Poverty program (Kiosk and Toilet development)	10.93	2.73	8.20	0.00
	Sub-total	10.93	2.73	8.20	0.00
	Land acquisition cost	0.00	0.00	0.00	0.00
	Physical contingency	1.31	0.33	0.98	0.00
	Engineering service	1.22	0.31	0.91	0.00
	Administration cost	0.54	0.13	0.41	0.00
	Total	**14.00**	**3.50**	**10.50**	**0.00**
Mzuzu	Construction cost				
	Network improvement	1.40	0.56	0.84	0.00
	Sub-total	1.40	0.56	0.84	0.00
	Land acquisition cost	0.00	0.00	0.00	0.00
	Physical contingency	0.17	0.06	0.11	0.00
	Engineering service	0.16	0.06	0.10	0.00
	Administration cost	0.07	0.02	0.05	0.00
	Total	**1.80**	**0.70**	**1.10**	**0.00**
	Construction cost				
	Network expansion	63.06	14.84	18.55	29.67
	Sub-total	63.06	14.84	18.55	29.67
	Land acquisition cost	0.00	0.00	0.00	0.00
	Physical contingency	7.57	1.80	2.25	3.52
	Engineering service	7.06	1.68	2.10	3.28
	Administration cost	3.11	0.72	0.90	1.49
	Total	**80.80**	**19.04**	**23.80**	**37.96**
Zomba	Construction cost				
	Expansion existing TW (18,200m3/d to 30,000m3/d)	6.36	6.36	0.00	0.00
	Sub-total	6.36	6.36	0.00	0.00
	Land acquisition cost	0.00	0.00	0.00	0.00
	Physical contingency	0.76	0.76	0.00	0.00
	Engineering service	0.71	0.71	0.00	0.00
	Administration cost	0.31	0.31	0.00	0.00
	Total	**8.14**	**8.14**	**0.00**	**0.00**
	Construction cost				
	Network improvement	2.81	2.24	0.57	0.00
	Sub-total	2.81	2.24	0.57	0.00
	Land acquisition cost	0.00	0.00	0.00	0.00
	Physical contingency	0.34	0.28	0.06	0.00
	Engineering service	0.31	0.24	0.07	0.00
	Administration cost	0.14	0.12	0.02	0.00
	Total	**3.60**	**2.88**	**0.72**	**0.00**
	Construction cost				
	Network expansion	5.70	0.76	1.90	3.04
	Sub-total	5.70	0.76	1.90	3.04
	Land acquisition cost	0.00	0.00	0.00	0.00
	Physical contingency	0.68	0.10	0.25	0.33
	Engineering service	0.64	0.08	0.20	0.36
	Administration cost	0.28	0.04	0.10	0.14
	Total	**7.30**	**0.98**	**2.45**	**3.87**

(3) Water Supply for Towns and Rural Water Supply

1) Breakdown of Project Cost

Breakdown of project cost of Water Supply for Towns and Rural Water Supply is shown below.

Table 9.1.12 Summary of Project Cost of Water Supply for Towns and Rural Water Supply

Unit: Million US$

Classification	Description	Total	Time Frame		
			Short Term	Middle Term	Long Term
			2012 - 2020	2021 - 2025	2026 - 2035
Towns	Construction cost				
	Northern region	22.95	11.26	8.47	3.22
	Central region	37.85	19.21	9.48	9.16
	Southern region	51.03	20.31	30.09	0.63
	Sub-total	111.83	50.78	48.04	13.01
	Land acquisition cost	0.00	0.00	0.00	0.00
	Physical contingency	13.41	6.09	5.76	1.56
	Engineering service	12.53	5.69	5.38	1.46
	Administration cost	5.51	2.50	2.37	0.64
	Total	**143.28**	**65.06**	**61.55**	**16.67**
Market Center	Construction cost				
	Northern region	22.10	14.07	5.96	2.07
	Central region	37.83	25.88	7.51	4.44
	Southern region	36.25	20.55	5.93	9.77
	Sub-total	96.18	60.50	19.40	16.28
	Land acquisition cost	0.00	0.00	0.00	0.00
	Physical contingency	11.54	7.26	2.33	1.95
	Engineering service	10.77	6.78	2.17	1.82
	Administration cost	4.74	2.98	0.96	0.80
	Total	**123.23**	**77.52**	**24.86**	**20.85**
Community by Gravity-fed WS	Construction cost				
	Northern region	23.90	6.77	13.07	4.06
	Central region	24.75	12.43	10.62	1.70
	Southern region	58.13	38.21	11.03	8.89
	Sub-total	106.78	57.41	34.72	14.65
	Land acquisition cost	0.00	0.00	0.00	0.00
	Physical contingency	12.82	6.89	4.17	1.76
	Engineering service	11.96	6.43	3.89	1.64
	Administration cost	5.26	2.83	1.71	0.72
	Total	**136.82**	**73.56**	**44.49**	**18.77**
Community by Borehole WS	Construction cost				
	Northern region	21.02	5.26	5.26	10.50
	Central region	124.19	31.05	31.05	62.09
	Southern region	79.13	19.80	19.80	39.53
	Sub-total	224.34	56.11	56.11	112.12
	Land acquisition cost	0.00	0.00	0.00	0.00
	Physical contingency	26.91	6.73	6.73	13.45
	Engineering service	25.12	6.28	6.28	12.56
	Administration cost	11.05	2.76	2.76	5.53
	Total	**287.42**	**71.88**	**71.88**	**143.66**

2) Estimation of Construction Cost

The basis of construction cost estimation is as follows.

Table 9.1.13 Construction Cost of Water Supply for Towns

Region	District	Water Scheme	Population in 2012	Type of Water Source	Population in 2035	Water Demand (m3/day)		Priority	Unit Cost (USD/cpt)	Construction Cost (mil USD)	Short Term 2012-2020 (mil USD)	Middle Term 2021-2025 (mil USD)	Long Term 2026-2035 (mil USD)
						2,012	2,035						
Northern	Chitipa	CHITIPA Boma	23,313	Borehole	75,918	1,237	10,431	A	40	3.04	3.04		
	Karonga	KARONGA Boma	45,368	Lake	97,696	3,628	14,143	B	60	5.86		5.86	
		CHILUMBA	21,732	Lake	43,455	1,552	6,598	B	60	2.61		2.61	
	Nkhata Bay	NKHATABAY	24,334	Lake	36,632	1,802	5,794	C	60	2.20			2.20
		CHINTHECHE	7,933	Lake	15,863	876	2,552	C	64	1.02			1.02
	Rumphi	RUMPHI	44,122	River	73,354	2,361	10,522	A	60	4.40	4.40		
	Mzimba	MZIMBA	27,824	River	63,672	2,566	9,359	A	60	3.82	3.82		
	Total				**406,588**	**14,024**	**59,400**			**22.95**	**11.26**	**8.47**	**3.22**
Central	Kasungu	KASUNGU	66,117	Dam	143,321	3,034	20,390	A	60	8.60	8.60		
	Nkhotakota	NKHOTAKOTA	32,729	Borehole	55,923	1,735	8,352	A	40	2.24	2.24		
		DWANGWA	12,662	Borehole	26,009	459	3,599	B	40	1.04		1.04	
	Ntchisi	NTCHISI	18,404	Borehole	38,483	828	5,379	B	40	1.54		1.54	
	Dowa	DOWA	16,298	Borehole & River	39,293	636	5,540	C	40	1.57			1.57
		MPONELA	20,745	Borehole	50,013	719	6,963	A	40	2.00	2.00		
		MADISI	10,507	Borehole	25,331	357	3,561	B	40	1.01		1.01	
	Salima	SALIMA	42,838	Borehole	89,575	2,274	13,041	B	40	3.58		3.58	
		SENGA-BAY	2,929	Borehole	5,718	240	807	C	90	0.51			0.51
		CHIPOKA	3,371	Lake	6,582	303	1,136	C	96	0.63			0.63
		PARACHUTTE BATTALLION	1,346	Borehole	1,346	623	777	B	140	0.19		0.19	
		MAFCO	5,457	Lake	5,457	2,910	3,547	C	102	0.56			0.56
	Lilongwe Rural	LIKUNI	52,160	Borehole	92,620	2,802	14,042	A	40	3.70	3.70		
		BUNDA	27,109	Dam	48,137	502	6,881	C	60	2.89			2.89
	Mchinji	MCHINJI	17,288	Borehole & River	39,737	1,586	5,933	B	40	1.59		1.59	
		KOCHILIRA	4,515	Borehole	10,043	410	1,932	C	51	0.51			0.51
	Dedza	DEDZA	36,747	Borehole	66,850	1,573	9,080	A	40	2.67	2.67		
		BEMBEKE	1,937	River	3,308	89	509	C	120	0.40			0.40
		DEDZA SECONDARY SCHOOL	2,982	River	5,093	381	1,222	B	105	0.53		0.53	
	Ntcheu	NTCHEU	14,953	Borehole & River	34,915	879	4,835	C	60	2.09			2.09
	Total				**787,754**	**22,338**	**117,526**			**37.85**	**19.21**	**9.48**	**9.16**
Southern	Mangochi	MANGOCHI	34,944	River	80,322	2,895	11,618	B	60	4.82		4.82	
		MONKEYBAY	14,300	Lake	32,467	1,824	5,806	B	60	1.95		1.95	
		NAMWERA	7,626	Borehole	17,314	398	2,458	A	40	0.69	0.69		
	Machinga	MACHINGA	3,909	River	8,184	914	2,132	B	88	0.72		0.72	
		LIWONDE	26,977	River	61,593	2,028	8,337	A	60	3.70	3.70		
	Balaka	BALAKA	31,340	Dam	78,360	1,907	10,646	A	60	4.70	4.70		
	Zomba rural	DOMASI	144,186	River	284,564	569	1,675	B	60	17.07		17.07	
		CHAWE	8,065	River	12,243	566	1,040	A	73	0.89	0.89		
	Chiradzulu	CHIRADZULU	2,426	River	3,683	234	695	B	116	0.43		0.43	
		NAMADZI Trading Center	3,182	River	4,287	217	541	C	111	0.48			0.48
	Mwanza	MWANZA	2,835	River	3,819	1,100	10,218	B	115	0.44		0.44	
	Thyolo	THYOLO	29,305	River	74,947	1,094	3,396	A	60	4.50	4.50		
	Thyolo	LUCHENZA	9,501	Borehole & River	20,595	924	3,771	A	40	0.82	0.82		
		MIKOLONGWE	15,356	Borehole & River	24,827	62	177	A	40	0.99	0.99		
	Mulanje	MULANJE	684	River	1,047	2,097	5,144	C	140	0.15			0.15
		MULOZA Trading Center	20,685	Borehole	28,233	408	1,504	B	40	1.13		1.13	
	Phalombe	PHALOMBE	7,826	River	10,682	453	3,662	B	78	0.83		0.83	
	Chikwawa	CHIKWAWA	7,865	Borehole	25,737	1,407	5,562	A	40	1.03	1.03		
		NGABU Trading Center	18,674	Borehole	36,879	783	4,339	B	40	1.48		1.48	
		NCHALO Trading Center	15,453	Borehole	30,518	613	4,857	B	40	1.22		1.22	
	Nsanje	NSANJE	17,821	Borehole	35,194	883	5,841	A	40	1.41	1.41		
		BANGULA	21,928	Borehole	39,433	442	2,502	A	40	1.58	1.58		
	Total				**914,926**	**21,817**	**95,921**			**51.03**	**20.31**	**30.09**	**0.63**
Grand Total					**2,109,269**	**58,179**	**272,847**			**111.83**	**50.78**	**48.04**	**13.01**

Table 9.1.14 Construction Cost for Market Center in Northern Region

Region	District	Water Scheme	Population in 2012	Population in 2025	Population in 2035	Proposed water source	Priority	Unit Cost (USD/cpt)	Construction Cost (mil USD)	Short Term 2012-2020 (mil USD)	Middle Term 2021-2025 (mil USD)	Long Term 2026-2035 (mil USD)
Northern	Chitipa	Nthalire	5,400	8,133	11,021	Groundwater	A	45	0.50	0.50		
		Misuku	6,000	9,037	12,245	River	A	73	0.89	0.89		
		Kameme	4,598	6,925	9,384	Groundwater	B	56	0.53		0.53	
	Karonga	Songwe	4,000	6,144	8,367	Groundwater	A	64	0.54	0.54		
		Chilumba	7,039	10,813	14,724	Lake	A	67	0.99	0.99		
		Nyungwe	2,573	3,952	5,382	Groundwater	B	94	0.51		0.51	
		Chitimba	3,957	6,078	8,277	Groundwater	B	64	0.53		0.53	
		Kaporo	4,218	6,479	8,823	Groundwater	B	60	0.53		0.53	
		Mulare	3,716	5,674	7,726	Groundwater	B	69	0.53		0.53	
	Nkhata-Bay	Mzenga	8,705	12,160	15,256	Groundwater	A	40	0.61	0.61		
		Usisya	6,341	8,857	11,113	River	A	77	0.86	0.86		
		Kande	1,078	1,506	1,889	Groundwater	C	140	0.26			0.26
		Mpamba	9,220	12,880	16,160	Groundwater	A	40	0.65	0.65		
		Chintheche	4,205	5,874	7,370	Lake	B	91	0.67		0.67	
		Chikwina	4,535	6,334	7,948	River	A	89	0.71	0.71		
	Likoma	Likoma	7,683	10,755	14,140	Lake	A	68	0.96	0.96		
	Rumphi	Katowo	3,718	5,554	7,434	River	A	91	0.68	0.68		
		Nchenachena	6,691	9,995	13,379	River	A	70	0.94	0.94		
		Livingstonia	9,321	13,925	18,638	River	A	60	1.12	1.12		
		Mphompha	4,887	7,301	9,773	Groundwater	B	53	0.52		0.52	
		Bolero	8,046	12,020	16,088	River	A	63	1.01	1.01		
		Chiweta	5,314	7,939	10,626	Groundwater	A	47	0.50	0.50		
	Mzimba	Euthini	5,699	8,579	11,396	Groundwater	A	42	0.48	0.48		
		Emfeni	1,925	2,898	3,849	Groundwater	C	117	0.45			0.45
		Ekwendeni	13,695	20,616	27,386	River	A	60	1.64	1.64		
		Mbalachanda	3,750	5,645	7,499	Groundwater	B	71	0.53		0.53	
		Bulala	2,984	4,492	5,967	Groundwater	B	87	0.52		0.52	
		Edingeni	5,503	8,284	11,004	Groundwater	A	45	0.50	0.50		
		Chikangawa	2,751	4,141	5,501	River	B	102	0.56		0.56	
		Embangweni	5,489	8,263	10,976	Groundwater	A	45	0.49	0.49		
		Champhira	1,875	2,823	3,749	River	C	116	0.43			0.43
		Kafukule	2,500	3,763	4,999	Groundwater	C	99	0.49			0.49
		Manyamula	1,832	2,758	3,663	Groundwater	C	120	0.44			0.44
		Jenda	3,089	4,650	6,177	Groundwater	B	85	0.53		0.53	
	Total	**34**	**172,337**	**255,247**	**337,932**				**22.10**	**14.07**	**5.96**	**2.07**

Table 9.1.15 Construction Cost for Market Center in Central Region

Region	District	Water Scheme	Population in 2012	Population in 2025	Population in 2035	Proposed water source	Priority	Unit Cost (USD/cpt)	Construction Cost (mil USD)	Short Term 2012-2020 (mil USD)	Middle Term 2021-2025 (mil USD)	Long Term 2026-2035 (mil USD)
Central	Kasungu	Nkhamenya	6,990	15,569	25,057	River	A	60	1.50	1.50		
		Chisemphere	3,540	7,885	12,691	River	A	72	0.91	0.91		
		Chamama	7,400	16,484	26,528	River	A	60	1.59	1.59		
		Santhe	6,286	14,002	22,535	River	A	60	1.35	1.35		
	Nkhotakota	Msenjere	3,730	5,833	8,085	Groundwater	A	66	0.53	0.53		
		Dwambazi	8,000	12,510	17,342	River	A	61	1.06	1.06		
		Dwangwa	12,662	19,801	27,448	Groundwater	A	40	1.10	1.10		
		Mwasambo	6,400	10,008	13,873	Groundwater	A	40	0.55	0.55		
		Benga	4,130	6,458	8,953	Groundwater	B	59	0.53		0.53	
		Bua	2,190	3,425	4,747	Groundwater	C	103	0.49			0.49
		Liwalazi	1,980	3,096	4,292	Groundwater	C	110	0.47			0.47
		Kasitu	2,100	3,284	4,552	Groundwater	C	106	0.48			0.48
		Ngala	2,430	3,800	5,267	Groundwater	B	95	0.50		0.50	
	Ntchisi	Malomo	4,200	5,185	5,741	Groundwater	A	90	0.52	0.52		
		Khuwi	1,908	2,355	2,608	Groundwater	C	140	0.37			0.37
	Dowa	Madisi	10,500	15,831	21,568	Groundwater	A	40	0.86	0.86		
		Nambuma	4,870	7,342	10,003	Groundwater	A	51	0.51	0.51		
		Bowe	3,400	5,126	6,984	Groundwater	B	76	0.53		0.53	
		Mvera	3,968	5,982	8,151	Groundwater	B	65	0.53		0.53	
		Mponela	4,300	6,483	8,833	Groundwater	A	60	0.53	0.53		
		Lumbazi	4,500	6,785	9,243	Groundwater	A	57	0.53	0.53		
	Salima	Thavite	1,460	2,247	3,125	Groundwater	C	131	0.41			0.41
		Chagunda	1,800	2,770	3,852	Groundwater	C	117	0.45			0.45
		Khombedza	2,800	4,309	5,993	Groundwater	B	87	0.52		0.52	
		Chipoka	7,640	11,756	16,351	River	A	63	1.03	1.03		
		Kaphatenga	2,400	3,693	5,137	Groundwater	A	97	0.50	0.50		
	Lilongwe	Kasiya	3,915	6,630	9,439	Groundwater	A	55	0.52	0.52		
		Nkhoma	5,320	9,009	12,826	Groundwater	A	40	0.51	0.51		
		Nsaru	2,620	4,436	6,316	Groundwater	A	83	0.52	0.52		
		Namitete	6,891	11,669	16,613	Groundwater	A	40	0.66	0.66		
		Sinyala	2,400	4,064	5,786	Groundwater	B	89	0.51		0.51	
		Mitundu	6,872	11,637	16,568	Groundwater	A	40	0.66	0.66		
		Nathenje	5,645	9,559	13,609	River	A	69	0.94	0.94		
		Chimutu	2,800	4,741	6,750	Groundwater	B	78	0.53		0.53	
		Lumbadzi	7,400	12,531	17,840	Groundwater	A	40	0.71	0.71		
		Kabudula	2,130	3,607	5,135	Groundwater	B	97	0.50		0.50	
		Mpingu	1,980	3,353	4,774	Groundwater	C	102	0.49			0.49
	Mchinji	Mkanda	8,750	12,023	15,537	Groundwater	A	40	0.62	0.62		
		Kapiri	5,645	7,757	10,024	Groundwater	A	51	0.51	0.51		
		Kamwendo	10,110	13,893	17,953	Groundwater	A	40	0.72	0.72		
		Kochirira	1,780	2,446	3,161	Groundwater	C	131	0.41			0.41
		Nthema	1,850	2,542	3,285	Groundwater	C	128	0.42			0.42
	Dedza	Mtakataka	6,369	12,826	19,732	Groundwater	A	40	0.79	0.79		
		Mayani	5,039	10,147	15,611	Groundwater	A	40	0.62	0.62		
		Linthipe	3,886	7,825	12,038	Groundwater	A	40	0.48	0.48		
		Lobi	9,905	19,947	30,687	Groundwater	A	40	1.23	1.23		
		Golomoti	6,400	12,888	19,828	Groundwater	A	40	0.79	0.79		
		Chimbiya	1,750	3,524	5,422	Groundwater	B	93	0.50		0.50	
		Bembeke	2,500	5,034	7,745	River	A	90	0.70	0.70		
	Ntcheu	Lizulu	4,696	7,412	10,444	River	A	79	0.83	0.83		
		Senzani	5,333	8,419	11,863	Groundwater	A	40	0.47	0.47		
		Bwanje	4,137	6,531	9,202	Groundwater	B	57	0.52		0.52	
		Bilila	3,665	5,786	8,153	Groundwater	B	65	0.53		0.53	
		Tsangano	2,659	4,198	5,915	River	B	99	0.59		0.59	
		Manjawira	3,000	4,736	6,673	River	B	95	0.63		0.63	
		Chingeni	2,700	4,262	6,005	River	B	99	0.59		0.59	
		Mlangeni	3,000	4,736	6,673	Groundwater	A	79	0.53	0.53		
		Kampepuza	1,800	2,841	4,004	River	C	113	0.45			0.45
	Total	**58**	**264,532**	**443,027**	**634,567**				**37.83**	**25.88**	**7.51**	**4.44**

Table 9.1.16 Construction Cost for Market Center in Southern Region

Region	District	Water Scheme	Population in 2012	Population in 2025	Population in 2035	Proposed water source	Priority	Unit Cost (USD/cpt)	Construction Cost (mil USD)	Short Term 2012-2020 (mil USD)	Middle Term 2021-2025 (mil USD)	Long Term 2026-2035 (mil USD)
Southern	Mangochi	Makanjira	5,800	8,174	10,551	Groundwater	A	48	0.51	0.51		
		Malindi	6,800	9,583	12,371	Groundwater	A	40	0.49	0.49		
		Namwera	6,500	9,160	11,825	Groundwater	A	40	0.47	0.47		
		Nankumba	1,200	1,691	2,183	Groundwater	C	140	0.31			0.31
		Chilipa	2,108	2,971	3,835	Groundwater	C	117	0.45			0.45
		Maldeco	5,400	7,781	10,271	Lake	A	80	0.82	0.82		
		Namiyasi	3,450	4,971	6,562	Lake	A	96	0.63	0.63		
		Monkey Bay	6,300	9,078	11,983	Lake	A	74	0.89	0.89		
		Cape Maclear	3,200	4,611	6,086	Lake	A	98	0.60	0.60		
	Balaka	Phalula	7,293	10,740	14,402	River	A	67	0.96	0.96		
		Ulongwe	5,311	7,821	10,488	Groundwater	A	48	0.50	0.50		
		Mangochi Turn off	3,100	4,565	6,122	Groundwater	A	85	0.52	0.52		
		Kachenga	2,170	3,196	4,285	Groundwater	C	110	0.47			0.47
	Machinga	Nayuchi	3,200	4,611	6,086	Groundwater	A	86	0.52	0.52		
		Ngokwe	1,800	2,594	3,424	Groundwater	C	125	0.43			0.43
		Chikweo	1,740	2,507	3,309	Groundwater	C	127	0.42			0.42
		Nsanama	2,175	3,134	4,137	River	C	112	0.46			0.46
		Ntaja	2,181	3,143	4,149	River	C	112	0.46			0.46
	Zomba	Namwera T/Off	1,800	2,865	4,087	River	C	113	0.46			0.46
		Turn Off (Malosa)	1,202	1,913	2,729	River	C	127	0.35			0.35
		Chinseu	2,700	4,297	6,130	River	A	98	0.60	0.60		
		Jali	3,240	5,156	7,356	River	B	92	0.68		0.68	
		Kachulu	1,348	2,145	3,061	Groundwater	C	133	0.41			0.41
		Mayaka	3,400	5,411	7,719	Groundwater	B	69	0.53		0.53	
		Chingale	3,600	5,729	8,173	River	B	88	0.72		0.72	
		Malosa	2,145	3,414	4,870	River	C	106	0.52			0.52
		Thondwe	4,115	6,549	9,343	Groundwater	A	56	0.52	0.52		
	Chiradzulu	Namadzi	2,944	4,454	6,163	River	B	98	0.60		0.60	
		Namitambo	1,500	2,270	3,140	Groundwater	C	131	0.41			0.41
		Mbulumbuzi	3,100	4,690	6,490	Groundwater	B	81	0.53		0.53	
		Mbulumbuzi	3,120	4,721	6,532	Groundwater	A	81	0.53	0.53		
		Nguludi	2,150	3,253	4,501	Groundwater	C	106	0.48			0.48
		Milepa	2,130	3,223	4,459	Groundwater	C	107	0.48			0.48
	Blantyre	Lirange Nkula	7,620	15,876	24,935	Groundwater	A	40	1.00	1.00		
		Linjidzi	3,194	6,654	10,451	Groundwater	A	48	0.50	0.50		
		Chikuli	1,460	3,042	4,778	Groundwater	C	102	0.49			0.49
	Mwanza	Thambani	4,200	5,639	6,955	Groundwater	A	76	0.53	0.53		
		Kunenekude	3,800	5,102	6,293	Groundwater	B	83	0.52		0.52	
	Neno	Neno	2,281	3,177	4,181	Groundwater	C	111	0.46			0.46
		Lisungwi	2,350	3,274	4,308	Groundwater	C	109	0.47			0.47
	Thyolo	Thekerani	4,087	6,714	9,394	Groundwater	B	56	0.53		0.53	
		Goliati	6,804	11,178	15,640	Groundwater	A	40	0.63	0.63		
		Bvumbwe	8,800	14,457	20,228	Groundwater	A	40	0.81	0.81		
		Luchenza	16,901	27,766	38,848	River	A	60	2.33	2.33		
		Masamanjati	2,800	4,600	6,436	Groundwater	B	82	0.53		0.53	
	Mulanje	Muloza	5,248	6,325	7,039	Groundwater	A	76	0.53	0.53		
		Chinyama	1,347	1,623	1,807	River	C	140	0.25			0.25
		Nkando	1,375	1,657	1,844	River	C	140	0.26			0.26
		Mkando	5,285	6,369	7,089	Groundwater	A	75	0.53	0.53		
		Kamwendo	4,855	5,851	6,512	River	A	96	0.63	0.63		
	Phalombe	Migowi	2,456	3,115	3,759	River	C	116	0.44			0.44
		Chitekesa	1,895	2,404	2,901	River	C	125	0.36			0.36
		Sombani	6,120	7,763	9,368	River	B	83	0.78		0.78	
		Mulomba	2,125	2,695	3,253	Groundwater	C	129	0.42			0.42
		Chiringa	3,120	3,957	4,776	River	C	107	0.51			0.51
		Phaloni	4,180	5,302	6,398	River	A	97	0.62	0.62		
	Chikwawa	Chapananga	6,027	7,192	8,227	River	A	88	0.72	0.72		
		Ngabu	15,889	18,959	21,687	Groundwater	A	40	0.87	0.87		
		Nchalo	18,323	21,865	25,010	Groundwater	A	40	1.00	1.00		
	Nsanje	Bangula	10,147	14,401	19,020	Groundwater	A	40	0.76	0.76		
		Miseu Folo	4,250	6,032	7,967	Groundwater	A	67	0.53	0.53		
		Marka	3,032	4,303	5,683	Groundwater	B	90	0.51		0.51	
	Total		**62**	**268,191**	**387,714**	**511,605**				**36.25**	**20.55**	**5.93**	**9.77**
All Malawi			**154**	**705,059**	**1,085,987**	**1,484,104**				**96.18**	**60.50**	**19.40**	**16.28**

Table 9.1.17 Construction Cost for Communities with Gravity-Fed WS in Northern and Central Regions

No.	Region	District	Gravity scheme	Original Schemes			Planned Population			Priority	Unit Cost (USD/cpt)	Construction Cost (mil USD)	Short Term 2012-2020 (mil USD)	Middle Term 2021-2025 (mil USD)	Long Term 2026-2035 (mil USD)
				Designed Population	Design flow (m^3/day)	Year completed	2,015	2,025	2,035						
1	Northern	MZIMBA	Champhira South	32,000	1334.88	1987	78,553	107,467	142,759	B	10	1.43		1.43	
2		MZIMBA	Champhira North	24,000	1367.28	1984	65,131	89,105	118,366	B	10	1.18		1.18	
3		MZIMBA	Luwazi	8,000	466.56	1981	24,001	32,835	43,618	C	23	1.00			1.00
4		MZIMBA	Luzi	8,000	330.48	1975	29,332	40,129	53,308	B	21	1.12		1.12	
5		MZIMBA	Msaka	3,000	311.04	1986	7,615	10,418	13,839	C	39	0.54			0.54
6		MZIMBA	Khosolo	10,356	900.72	1983	29,059	39,756	52,812	B	21	1.11		1.11	
7		RUMPHI	Nkhamanga	12,000	1088.64	1978	34,960	47,549	63,643	A	18	1.15	1.15		
8		RUMPHI	Hewe	8,000	388.8	1977	24,006	32,651	43,701	A	23	1.01	1.01		
9		RUMPHI	Ng'onga	2,000	311.04	1972	6,957	9,463	12,665	A	40	0.51	0.51		
10		RUMPHI	Livingstonia	3,000	136.08	1984	7,320	9,955	13,325	A	40	0.53	0.53		
11		RUMPHI	Muhuju	1,000	395.28	1973	3,377	4,594	6,148	A	40	0.25	0.25		
12		RUMPHI	Ntchenachena	3,200	790.56	2002	4,586	6,238	8,349	A	40	0.33	0.33		
13		RUMPHI	Chitimba	950	414.72	1997	1,578	2,147	2,873	A	40	0.11	0.11		
14		RUMPHI	Bale	4,800	233.28	1994	8,714	11,852	15,864	B	38	0.60		0.60	
15		NKATA BAY	Lifutazi	11,000	414.72	1987	23,139	29,812	37,405	B	26	0.97		0.97	
16		NKATA BAY	Msese	7,560	207.36	1991	14,240	18,346	23,019	B	32	0.74		0.74	
17		NKATA BAY	Luwawa	8,880	479.52	1999	13,411	17,278	21,678	B	33	0.72		0.72	
18		NKATA BAY	Usisya	14880	803.52	1997	23,748	30,596	38,389	A	25	0.96	0.96		
19		NKATA BAY	Ruarwe	1008	77.76	1995	1,700	2,190	2,748	C	40	0.11			0.11
20		KARONGA	Lufira/Karonga	30,000	1620	1983	84,576	117,516	160,028	B	10	1.60		1.60	
21		KARONGA	Chilumba	4,000	239.76	1975	14,735	20,474	27,880	C	30	0.84			0.84
22		KARONGA	Ighembe	4,000	233.28	1983	11,277	15,669	21,337	C	33	0.70			0.70
23		KARONGA	Iponga	5,600	239.76	1983	15,787	21,936	29,872	C	29	0.87			0.87
24		CHITIPA	Chisenga/Chitipa	2,800	1321.92	1986	7,270	9,966	13,505	B	40	0.54		0.54	
25		CHITIPA	Misuku	8760	473.04	1984	24,366	33,401	45,260	A	23	1.04	1.04		
26		CHITIPA	Nthalire	6120	330.48	1983	17,619	24,151	32,727	A	27	0.88	0.88		
27		CHITIPA	Sekwa	10200	550.8	1997	18,141	24,867	33,697	B	27	0.91		0.91	
28		CHITIPA	Chinunkha	4200	226.8	1975	15,922	21,825	29,575	B	29	0.86		0.86	
29		CHITIPA	Ifumbo	3600	194.4	1982	10,727	14,704	19,925	B	34	0.68		0.68	
30		CHITIPA	Chintekwa	5160	278.64	1998	8,867	12,154	16,470	B	37	0.61		0.61	
Total				**248,074**			**630,714**	**859,046**	**1,144,786**			**23.90**	**6.77**	**13.07**	**4.06**
31	Central	NTCHEU	Mpira Balaka	222000		1992	394,629	560,229	789,378	A	10	7.89	7.89		
32		NTCHEU	Dombole	22,000	946.08	1984	47,649	67,644	95,312	B	13	1.24		1.24	
33		NTCHEU	Ntonda	25,000	706.32	1980	59,767	84,847	119,552	A	10	1.20	1.20		
34		NTCHEU	Sanjike	12,000	259.2	1980	28,688	40,727	57,385	B	20	1.15		1.15	
35		NTCHEU	Kasinje	14,000	615.6	1983	31,080	44,122	62,169	B	18	1.12		1.12	
36		NTCHEU	Nanyangu	20,000	764.64	1983	44,400	63,031	88,813	B	14	1.24		1.24	
37		NTCHEU	Kalitsiro	1,000	84.24	1977	2,575	3,655	5,150	A	40	0.21	0.21		
38		NTCHEU	Chilobwe	1,200	90.72	1975	3,246	4,608	6,493	A	40	0.26	0.26		
39		NTCHEU	Lizulu	6,000	220.32	1978	15,070	21,394	30,145	A	29	0.87	0.87		
40		MCHINJI	Mchinji	20,000	680.4	1976	71,549	91,614	118,389	B	10	1.18		1.18	
41		DEDZA	Ngwere	4200	226.8	1976	12,314	20,769	31,952	A	28	0.89	0.89		
42		DEDZA	Mongwera	1,400	64.8	1983	3,430	5,784	8,899	C	40	0.36			0.36
43		DEDZA	Mvula	8760	473.04	1983	21,459	36,194	55,683	A	20	1.11	1.11		
44		DEDZA	Ngodzi	19800	1069.2	2006	26,877	45,333	69,742	B	17	1.19		1.19	
45		NKHOTAKOTA	Mwansambo/ Kasakula	25,000	1542.24	1984	60,057	84,592	117,261	B	10	1.17		1.17	
46		NKHOTAKOTA	Mwansambo/ Mwadzama	18,000	648	1983	44,495	62,673	86,876	B	14	1.22		1.22	
47		NKHOTAKOTA	Dwambazi	20000	1620	2004	27,124	38,204	52,958	B	21	1.11		1.11	
48		SALIMA	Chipoka	10080	544.32	1991	20,931	29,122	40,506	C	24	0.97			0.97
49		NTCHISI	Mpamira	1680	90.72	1983	4,316	6,326	9,162	C	40	0.37			0.37
Total				**452,120**			**919,655**	**1,310,868**	**1,845,824**			**24.75**	**12.43**	**10.62**	**1.70**

Table 9.1.18 Construction Cost for Communities with Gravity-Fed WS in Southern Region

No.	Region	District	Gravity scheme	Original Schemes			Planned Population			Priority	Unit Cost (USD/cpt)	Construction Cost (mil USD)	Short Term 2012-2020 (mil USD)	Middle Term 2021-2025 (mil USD)	Long Term 2026-2035 (mil USD)
				Designed Population	Design flow (m^3/day)	Year completed	2,015	2,025	2,035						
50		MANGOCHI	Lingamasa	12,000	1360.8	1981	28,934	37,608	48,548	C	22	1.07			1.07
51		BALAKA	Mpira-Balaka	222000	11988	1983	457,977	618,008	828,726	A	10	8.29	8.29		
52		MACHINGA	Kawinga	70,000	3240	1983	169,183	224,581	296,443	A	10	2.96	2.96		
53		MACHINGA	Liwonde	23,000	1522.8	1983	55,589	73,791	97,403	A	12	1.17	1.17		
54		MACHINGA	Naungu	1800	97.2	2001	2,600	3,452	4,557	A	40	0.18	0.18		
55		MACHINGA	Nkala	1080	58.32	2002	1,516	2,013	2,657	A	40	0.11	0.11		
56		MACHINGA	Chagwa	7,000	1490.4	1976	20,666	27,434	36,212	A	26	0.94	0.94		
57		MACHINGA	Chinkwenzule	2,000	58.32	1983	4,834	6,417	8,470	A	40	0.34	0.34		
58		MACHINGA	Lifani	20,000	978.48	1977	57,383	76,172	100,546	A	12	1.21	1.21		
59		MACHINGA	Zumulu	23,500	272.16	2001	33,951	45,068	59,489	A	19	1.13	1.13		
60		MACHINGA	Chanyungu	7800	421.2	2000	11,596	15,392	20,318	A	34	0.69	0.69		
61		MACHINGA	Chanyungu 2	1320	71.28	1983	3,190	4,235	5,590	A	40	0.22	0.22		
62		MACHINGA	Machinga	1200	64.8	1983	2,900	3,850	5,082	A	40	0.20	0.20		
63		MACHINGA	Doza	1320	71.28	2003	1,801	2,391	3,156	A	40	0.13	0.13		
64		MACHINGA	Mirala	13,000	946.08	1985	29,674	39,390	51,994	A	21	1.09	1.09		
65		MACHINGA	Mangale	1320	71.28	1983	3,190	4,235	5,590	A	40	0.22	0.22		
66		ZOMBA	Zomba East-Domasi	100,000	5520.96	1981	132,820	190,435	271,671	A	10	2.72	2.72		
67		ZOMBA	Zomba west	60,000	2371.68	1986	77,344	110,894	158,199	A	10	1.58	1.58		
68		ZOMBA	Makwawa south	8040	434.16	1986	10,364	14,860	21,199	A	34	0.72	0.72		
69		ZOMBA	Makwawa North	16,000	382.32	1986	20,625	29,572	42,186	A	24	1.01	1.01		
70		ZOMBA	Chingale	5,000	388.8	1968	7,178	10,292	14,682	A	39	0.57	0.57		
71		MULANJE	Namitambo	60,000	2799.36	1979	118,439	136,274	151,662	A	10	1.52	1.52		
72		MULANJE	Mulanje West	90,000	2579.04	1975	192,303	221,261	246,246	A	10	2.46	2.46		
73		MULANJE	Mulanje SW	24,000	1172.88	1989	38,864	44,717	49,766	A	22	1.09	1.09		
74		MULANJE	Lichenya	46,000	3726	1982	85,566	98,451	109,568	A	11	1.21	1.21		
75		MULANJE	Muloza East	32,000	576.72	1983	58,357	67,145	74,726	A	16	1.20	1.20		
76	Southern	MULANJE	Nalipiri	9,000	356.4	1983	16,413	18,884	21,017	A	34	0.71	0.71		
77		MULANJE	Chambe	28,000	2980.8	1979	55,271	63,594	70,776	B	17	1.20		1.20	
78		MULANJE	Muloza crater	15,000	648	1983	27,355	31,474	35,028	C	26	0.91			0.91
79		MULANJE	Nalipili	25920	1399.68	1983	47,269	54,387	60,528	B	19	1.15		1.15	
80		MULANJE	Phwera	32000	298.08	1983	58,357	67,145	74,726	A	16	1.20	1.20		
81		MULANJE	Nansato school	3000	45.36	1983	5,471	6,295	7,006	C	40	0.28			0.28
82		MULANJE	Mbewa VH	7272	116.64	1983	13,262	15,259	16,982	C	37	0.63			0.63
83		PHALOMBE	Phalombe Major	145,000	5877.36	2005	183,006	220,887	266,573	B	10	2.67		2.67	
84		PHALOMBE	Sombani	54,400	1944	1979	151,852	183,285	221,193	B	10	2.21		2.21	
85		PHALOMBE	Phalombe Minor	46000	648	2005	58,057	70,075	84,568	B	14	1.18		1.18	
86		PHALOMBE	Sakanena(Action aid)	4920	265.68	2007	5,842	7,051	8,509	C	40	0.34			0.34
87		PHALOMBE	Migowi	9,420	583.2	1971	33,569	40,518	48,898	C	22	1.08			1.08
88		PHALOMBE	Chiringa	3,200	265.68	1972	11,061	13,350	16,111	C	37	0.60			0.60
89		THYOLO	Didi	12,000	239.76	2005	15,714	22,863	31,988	B	28	0.90		0.90	
90		THYOLO	Sankhulani	15,000	1172.88	2005	19,643	28,579	39,985	A	25	1.00	1.00		
91		THYOLO	Limphagwi	8000	550.8	1983	18,036	26,240	36,713	B	26	0.95		0.95	
92		THYOLO	Mvumoni	9,000	550.8	2005	11,786	17,147	23,991	B	32	0.77		0.77	
93		THYOLO	Mdala	1920	103.68	2005	2,514	3,658	5,118	C	40	0.20			0.20
94		THYOLO	Kalintulo	1440	77.76	1983	3,246	4,723	6,608	C	40	0.26			0.26
95		CHIKWAWA	Mwanza/ chapananga	60000	3240	1983	108,556	124,650	142,580	A	10	1.43	1.43		
96		CHIKWAWA	East Bank	18720	1010.88	1997	25,669	29,474	33,714	A	27	0.91	0.91		
97		MWANZA	Thabwani	4900	181.44	1983	16,147	20,265	24,996	C	31	0.77			0.77
98		MWANZA	Kukhoma	3500	97.2	1983	11,533	14,475	17,854	C	36	0.64			0.64
99		MWANZA	Nsupe	4080	220.32	1999	7,069	8,872	10,943	C	40	0.44			0.44
100		MWANZA	Mpeni	9189	304.56	1983	30,280	38,004	46,875	C	22	1.03			1.03
101		NSANJE	Mapelela	1200	64.8	2001	1,592	2,097	2,769	C	40	0.11			0.11
102		NSANJE	Chididi	3120	168.48	1972	7,563	9,959	13,154	C	40	0.53			0.53
Total				**1,384,581**	**35,472**		**2,572,975**	**3,251,148**	**4,083,885**			**58.13**	**38.21**	**11.03**	**8.89**
Grand Total				**2,084,775**	**35,472**		**4,123,343**	**5,421,062**	**7,074,496**			**106.78**	**57.41**	**34.72**	**14.65**

Table 9.1.19 Construction Cost of Communities by Borehole WS

Region/District	Population served by Borehole = Community total - Gravity-fed Project List						Number of Borehole in 2035	Construction Cost (mil USD)	Short Term 2012-2020 (mil USD)	Middle Term 2021-2025 (mil USD)	Long Term 2026-2035 (mil USD)
	2012	2015	2020	2025	2030	2035					
All Malawi	**6,943,720**	**7,671,946**	**8,136,271**	**9,359,849**	**10,799,382**	**12,460,386**	**49,852**	**224.34**	**56.11**	**56.11**	**112.12**
Northern Region	**704,457**	**757,422**	**763,589**	**879,149**	**1,011,729**	**1,167,486**	**4,672**	**21.02**	**5.26**	**5.26**	**10.50**
CHITIPA	54,510	56,260	47,703	44,629	38,303	29,160	**117**	**0.53**	**0.13**	**0.13**	**0.27**
KARONGA	79,731	85,547	80,682	91,579	104,259	118,745	**475**	**2.14**	**0.54**	**0.54**	**1.06**
NKHATABAY	93,131	99,079	105,678	131,879	161,403	196,007	**785**	**3.53**	**0.88**	**0.88**	**1.77**
RUMPHI	33,386	14,972	5,858	3,805	0	224	**1**	**0.00**	**0.00**	**0.00**	**0.00**
MZIMBA	443,699	501,565	523,668	607,258	707,764	823,350	**3,294**	**14.82**	**3.71**	**3.71**	**7.40**
LIKOMA											
MZUZU city											
Central Region	**3,593,786**	**4,033,581**	**4,365,902**	**5,082,553**	**5,918,437**	**6,897,779**	**27,595**	**124.19**	**31.05**	**31.05**	**62.09**
KASUNGU	560,900	639,899	712,061	860,328	1,037,961	1,251,415	**5,006**	**22.53**	**5.63**	**5.63**	**11.27**
NKHOTAKOTA	108,702	119,997	116,311	134,870	157,524	184,773	**740**	**3.33**	**0.83**	**0.83**	**1.67**
NTCHISI	207,108	228,920	252,034	297,226	350,060	413,097	**1,653**	**7.44**	**1.86**	**1.86**	**3.72**
DOWA	503,908	588,885	669,683	824,563	1,000,275	1,203,770	**4,816**	**21.67**	**5.42**	**5.42**	**10.83**
SALIMA	262,192	288,743	312,748	361,951	417,967	480,963	**1,924**	**8.66**	**2.17**	**2.17**	**4.32**
LILONGWE Rural	1,115,143	1,222,375	1,303,335	1,466,145	1,657,155	1,878,710	**7,515**	**33.82**	**8.46**	**8.46**	**16.90**
LILONGWE CITY	0	0	0	0	0	0					
MCHINJI	331,894	406,673	450,152	543,213	653,385	784,597	**3,139**	**14.13**	**3.53**	**3.53**	**7.07**
DEDZA	503,938	538,089	549,578	594,257	644,110	700,455	**2,802**	**12.61**	**3.15**	**3.15**	**6.31**
NTCHEU	0	0	0	0	0	0	**0**	**0.00**	**0.00**	**0.00**	**0.00**
Southern Region	**2,645,478**	**2,880,943**	**3,006,780**	**3,398,146**	**3,869,215**	**4,395,121**	**17,585**	**79.13**	**19.80**	**19.80**	**39.53**
MANGOCHI	688,267	793,109	877,599	1,052,787	1,267,862	1,521,792	**6,088**	**27.40**	**6.85**	**6.85**	**13.70**
MACHINGA	87,144	113,836	101,696	126,415	163,458	208,956	**836**	**3.76**	**0.94**	**0.94**	**1.88**
ZOMBA Rural	327,363	340,617	321,682	319,647	313,399	295,208	**1,181**	**5.31**	**1.33**	**1.33**	**2.65**
ZOMBA CITY	0	0	0	0	0	0					
CHIRADZULO	268,739	286,998	298,144	318,618	340,552	362,281	**1,450**	**6.53**	**1.63**	**1.63**	**3.27**
BLANTYRE rural	231,563	241,626	234,472	243,990	253,045	258,717	**1,035**	**4.66**	**1.17**	**1.17**	**2.32**
BLANTYRE CITY	0	0	0	0	0	0					
MWANZA	9,605	0	0	0	0	0	**0**	**0.00**	**0.00**	**0.00**	**0.00**
THYOLO	460,784	469,061	473,024	501,872	536,858	572,131	**2,289**	**10.30**	**2.58**	**2.58**	**5.14**
MULANJE	0	0	0	0	0	0	**0**	**0.00**	**0.00**	**0.00**	**0.00**
PHALOMBE	0	0	0	0	0	0	**0**	**0.00**	**0.00**	**0.00**	**0.00**
CHIKWAWA	273,929	296,595	326,750	392,506	471,094	561,533	**2,247**	**10.11**	**2.53**	**2.53**	**5.05**
NSANJE	195,398	213,466	228,221	259,014	295,933	338,913	**1,356**	**6.10**	**1.53**	**1.53**	**3.04**
BALAKA	0	0	0	0	0	0	**0**	**0.00**	**0.00**	**0.00**	**0.00**
NENO	102,686	125,635	145,192	183,298	227,015	275,590	**1,103**	**4.96**	**1.24**	**1.24**	**2.48**

(4) Agriculture and Irrigation

1) Breakdown of Project Cost

The breakdown of project cost for Agriculture and Irrigation is shown as follows in 2,500ha/year and 5,000ha/year respectively.

Table 9.1.20 Project Cost of Irrigation Development (2,500ha/year)

WRA	WRU	Irrigation Area (ha)	Construction Cost (mil USD)	Physical contingency (mil USD)	Engineering service (mil USD)	Administration cost (mil USD)	Total cost (mil USD)
		2500ha/year	2500ha/year	2500ha/year	2500ha/year	2500ha/year	2500ha/year
1	A	587	2.81	0.34	0.32	0.14	3.61
	B	712	3.41	0.41	0.38	0.17	4.37
	C	769	3.67	0.44	0.41	0.18	4.70
	E	517	2.47	0.30	0.28	0.12	3.17
	F	264	1.29	0.15	0.14	0.06	1.64
	G	679	3.25	0.39	0.36	0.16	4.16
	K	826	3.95	0.47	0.44	0.19	5.05
	L	580	2.77	0.33	0.31	0.14	3.55
	M	628	3.00	0.36	0.34	0.15	3.85
	N	274	1.31	0.16	0.15	0.06	1.68
	O	764	3.65	0.44	0.41	0.18	4.68
	P	589	2.82	0.34	0.32	0.14	3.62
	R	1,056	5.05	0.61	0.57	0.25	6.48
	S	734	3.51	0.42	0.39	0.17	4.49
	T	90	0.43	0.05	0.05	0.02	0.55
2	A	21	0.49	0.06	0.06	0.02	0.63
	B	60	0.29	0.03	0.03	0.01	0.36
	C	14	0.07	0.01	0.01	0.00	0.09
	D	7	0.20	0.02	0.02	0.01	0.25
3	A	533	2.55	0.31	0.29	0.13	3.28
	B	483	2.31	0.28	0.26	0.11	2.96
	C	1,024	4.90	0.59	0.55	0.24	6.28
	D	564	2.70	0.32	0.30	0.13	3.45
	E	733	3.50	0.42	0.39	0.17	4.48
	F	211	1.01	0.12	0.11	0.05	1.29
4	A	15	0.08	0.01	0.01	0.00	0.10
	B	300	1.44	0.17	0.16	0.07	1.84
	C	68	0.33	0.04	0.04	0.02	0.43
	D	188	0.90	0.11	0.10	0.04	1.15
	E	100	0.48	0.06	0.05	0.02	0.61
	F	19	0.10	0.01	0.01	0.00	0.12
5	C	466	1.78	0.21	0.20	0.09	2.28
	D	400	1.95	0.23	0.22	0.10	2.50
	E	1,549	7.56	0.91	0.85	0.37	9.69
	F	1,213	5.92	0.71	0.66	0.29	7.58
7	A	2,238	10.70	1.28	1.20	0.53	13.71
	B	934	4.47	0.54	0.50	0.22	5.73
	C	1,034	4.94	0.59	0.55	0.24	6.32
	D	2,737	13.09	1.57	1.47	0.65	16.78
	E	406	1.94	0.23	0.22	0.10	2.49
	F	867	4.14	0.50	0.46	0.20	5.30
	G	559	2.67	0.32	0.30	0.13	3.42
	H	293	1.40	0.17	0.16	0.07	1.80
8	A	3,742	17.89	2.15	2.00	0.88	22.92
9	A	209	1.00	0.12	0.11	0.05	1.28
	B	257	1.23	0.15	0.14	0.06	1.58
14	B	95	2.52	0.30	0.28	0.12	3.22
	C	8,973	49.59	5.95	5.55	2.44	63.53
15	A	3,106	14.85	1.78	1.66	0.73	19.02
	B	5,003	27.61	3.31	3.09	1.36	35.37
	C	611	3.37	0.40	0.38	0.17	4.32
16	E	3,387	16.20	1.94	1.81	0.80	20.75
	F	3,800	18.17	2.18	2.04	0.90	23.29
	G	1,881	8.99	1.08	1.01	0.44	11.52
17	A	16	0.08	0.01	0.01	0.00	0.10
	B	974	4.66	0.56	0.52	0.23	5.97
	C	1,843	8.81	1.06	0.99	0.43	11.29
Total		**60,000**	**300.27**	**36.02**	**33.64**	**14.75**	**384.68**

Table 9.1.21 Project Cost of Irrigation Development (5,000ha/year)

WRA	WRU	Irrigation Area (ha)	Construction Cost (mil USD)	Physical contingency (mil USD)	Engineering service (mil USD)	Administration cost (mil USD)	Total cost (mil USD)
		5000ha/year	5000ha/year	5000ha/year	5000ha/year	5000ha/year	5000ha/year
1	A	1,173	5.62	0.67	0.63	0.28	**7.20**
	B	1,425	6.83	0.82	0.77	0.34	**8.76**
	C	1,537	7.36	0.88	0.82	0.36	**9.42**
	E	1,034	4.95	0.59	0.55	0.24	**6.33**
	F	528	2.58	0.31	0.29	0.13	**3.31**
	G	1,358	6.51	0.78	0.73	0.32	**8.34**
	K	1,652	7.92	0.95	0.89	0.39	**10.15**
	L	1,160	5.56	0.67	0.62	0.27	**7.12**
	M	1,256	6.02	0.72	0.67	0.30	**7.71**
	N	548	2.62	0.31	0.29	0.13	**3.35**
	O	1,528	7.32	0.88	0.82	0.36	**9.38**
	P	1,178	5.64	0.68	0.63	0.28	**7.23**
	R	2,111	10.11	1.21	1.13	0.50	**12.95**
	S	1,467	7.03	0.84	0.79	0.35	**9.01**
	T	180	0.86	0.10	0.10	0.04	**1.10**
2	A	42	0.63	0.08	0.07	0.03	**0.81**
	B	120	0.58	0.07	0.07	0.03	**0.75**
	C	29	0.14	0.02	0.02	0.01	**0.19**
	D	13	0.25	0.03	0.03	0.01	**0.32**
3	A	1,065	5.10	0.61	0.57	0.25	**6.53**
	B	966	4.63	0.56	0.52	0.23	**5.94**
	C	2,048	9.81	1.18	1.10	0.48	**12.57**
	D	1,127	6.23	0.75	0.70	0.31	**7.99**
	E	1,465	7.02	0.84	0.79	0.35	**9.00**
	F	423	2.03	0.24	0.23	0.10	**2.60**
4	A	30	0.16	0.02	0.02	0.01	**0.21**
	B	601	2.88	0.35	0.32	0.14	**3.69**
	C	135	0.66	0.08	0.07	0.03	**0.84**
	D	376	1.80	0.22	0.20	0.09	**2.31**
	E	200	0.95	0.11	0.11	0.05	**1.22**
	F	39	0.18	0.02	0.02	0.01	**0.23**
5	C	932	5.21	0.63	0.58	0.26	**6.68**
	D	800	3.92	0.47	0.44	0.19	**5.02**
	E	3,097	15.15	1.82	1.70	0.75	**19.42**
	F	2,427	11.88	1.43	1.33	0.59	**15.23**
7	A	4,476	21.44	2.57	2.40	1.06	**27.47**
	B	1,868	8.95	1.07	1.00	0.44	**11.46**
	C	2,068	9.91	1.19	1.11	0.49	**12.70**
	D	5,475	26.23	3.15	2.94	1.29	**33.61**
	E	813	3.89	0.47	0.44	0.19	**4.99**
	F	1,734	8.47	1.02	0.95	0.42	**10.86**
	G	1,118	5.46	0.66	0.61	0.27	**7.00**
	H	586	2.81	0.34	0.32	0.14	**3.61**
8	A	7,485	44.40	5.33	4.97	2.19	**56.89**
9	A	419	2.06	0.25	0.23	0.10	**2.64**
	B	514	2.54	0.30	0.28	0.12	**3.24**
14	B	190	3.16	0.38	0.35	0.16	**4.05**
	C	17,946	120.04	14.40	13.44	5.92	**153.80**
15	A	6,212	34.35	4.12	3.85	1.69	**44.01**
	B	10,005	55.33	6.64	6.20	2.73	**70.90**
	C	1,221	6.75	0.81	0.76	0.33	**8.65**
16	E	6,774	32.45	3.89	3.63	1.60	**41.57**
	F	7,601	36.41	4.37	4.08	1.79	**46.65**
	G	3,761	18.02	2.16	2.02	0.89	**23.09**
17	A	32	0.20	0.02	0.02	0.01	**0.25**
	B	1,947	9.33	1.12	1.05	0.46	**11.96**
	C	3,686	19.13	2.30	2.14	0.94	**24.51**
Total		**120,000**	**637.47**	**76.50**	**71.41**	**31.44**	**816.82**

2) Estimation of Construction Cost

The basis of construction cost estimation is presented in **Annex 6: Table 2.5.3.**

9.1.4 Disbursement Schedule

The disbursement schedules for the overall project to the target year 2035 are set by classifying them into the following four sectors:

- Integrated Project
- Water Supply for the Four (4) Cities
- Water Supply for Towns & Rural Areas
- Agriculture and Irrigation

The disbursement schedules are estimated by classifying them into three (3) terms (short, middle, long term), in accordance with the priority of the studied action plans for each sector.

Regarding the implementation year of scheme of each sector, the Integrated Project is expected to be four (4) years from 2015. Water Supply for the four (4) Cities are as shown the implementation schedule of the action plan. Water supply for Towns and Rural Areas are set as short, middle and long term for each priority ABC respectively. Agriculture and Irrigation are set based on the ranking criteria and scores that have been studied in the action plan as shown in **Table 9.1.30**, the implementation period of scheme of each WRU can be classified into three types according to their irrigation development area as shown in the following table.

Table 9.1.22 Classification of Implementation Period by Irrigation Development Areas

Implementation Period	Case of 2,500ha/year	Case of 5,000ha/year
2 year	under 500ha	under 1,000ha
3 year	500 - 1000ha	1,000 - 2,000ha
4 year	beyond 1,000ha	beyond 2,000ha

The disbursement schedules for the target year of each sector have been estimated as shown in **Table 9.1.23** to **Table 9.1.32**.

(1) Integrated Project

Table 9.1.23 Disbursement Schedule for Upgraded Kamuzu Barrage

Unit: Million USD

Project	Description	Total	Time Frame																							
			Short Term									Middle Term					Long Term									
			2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Upgraded Kamuzu Barrage	Construction cost																									
	Civil works	13.68					6.84	6.84																		
	Mechanical/hydraulic steelworks	12.84						6.42	6.42																	
	Eelectircal works	1.44						0.72	0.72																	
	Sub-total	27.96	0.00	0.00	0.00	0.00	6.84	13.98	7.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Land acquisition cost	0.00																								
	Physical contingency	3.36					0.82	1.68	0.86																	
	Engineering service	3.13				0.78	0.78	0.78	0.79																	
	Administration cost	1.38				0.03	0.34	0.66	0.35																	
	Total	**35.83**	**0.00**	**0.00**	**0.00**	**0.81**	**8.78**	**17.10**	**9.14**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

1) Water Supply for Four Cities

Table 9.1.24 Summary of Disbursement Schedule for Water Supply for 4 Cities

Unit: Million USD

City	Description	Total	Time Frame																							
			Short Term									Middle Term					Long Term									
			2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Lilongwe	Construction cost	403.51	0.00	0.00	3.98	9.14	5.15	15.05	24.68	32.71	58.83	51.78	29.01	11.01	11.01	11.01	11.01	37.01	37.01	11.01	11.01	11.01	11.01	11.08	0.00	0.00
	Land acquisition cost	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Physical contingency	48.43	0.00	0.00	0.47	1.11	0.63	1.80	2.96	3.92	7.05	6.22	3.48	1.32	1.32	1.32	1.32	4.44	4.44	1.32	1.32	1.32	1.32	1.35	0.00	0.00
	Engineering service	45.21	0.00	0.00	0.56	3.13	2.68	2.26	3.37	3.49	3.49	3.48	3.33	1.23	1.23	1.23	3.17	3.17	3.18	1.23	1.23	1.23	1.23	1.29	0.00	0.00
	Administration cost	19.88	0.00	0.00	0.20	0.53	0.33	0.79	1.24	1.60	2.77	2.46	1.42	0.54	0.54	0.54	0.62	1.78	1.78	0.54	0.54	0.54	0.54	0.58	0.00	0.00
	Total	**517.06**	**0.00**	**0.00**	**5.21**	**13.91**	**8.79**	**19.90**	**32.25**	**41.73**	**72.14**	**63.95**	**37.24**	**14.10**	**14.10**	**14.10**	**16.13**	**46.40**	**46.41**	**14.10**	**14.10**	**14.10**	**14.10**	**14.30**	**0.00**	**0.00**
Blantyre	Construction cost	246.18	0.00	0.00	0.00	1.40	1.40	1.40	19.48	38.89	37.95	9.06	9.06	9.07	6.33	6.33	15.53	29.31	29.30	6.33	6.33	6.33	6.33	6.35	0.00	0.00
	Land acquisition cost	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Physical contingency	29.54	0.00	0.00	0.00	0.17	0.17	0.17	2.34	4.66	4.55	1.09	1.09	1.08	0.76	0.76	1.86	3.52	3.52	0.76	0.76	0.76	0.76	0.76	0.00	0.00
	Engineering service	27.58	0.00	0.00	0.00	0.16	1.77	1.77	2.48	2.47	2.62	1.02	1.02	1.00	1.95	1.95	1.95	1.95	1.93	0.71	0.71	0.71	0.71	0.70	0.00	0.00
	Administration cost	12.14	0.00	0.00	0.00	0.07	0.13	0.13	0.97	1.84	1.81	0.44	0.44	0.46	0.36	0.36	0.77	1.39	1.39	0.31	0.31	0.31	0.31	0.34	0.00	0.00
	Total	**315.44**	**0.00**	**0.00**	**0.00**	**1.80**	**3.47**	**3.47**	**25.27**	**47.86**	**46.93**	**11.61**	**11.61**	**11.61**	**9.40**	**9.40**	**20.11**	**36.17**	**36.14**	**8.11**	**8.11**	**8.11**	**8.11**	**8.15**	**0.00**	**0.00**
Mzuzu	Construction cost	160.15	0.00	0.00	0.00	0.00	6.00	26.03	25.99	3.99	3.99	3.99	3.99	3.99	3.71	3.71	3.71	14.99	14.99	18.08	11.87	3.71	3.71	3.70	0.00	0.00
	Land acquisition cost	18.20	0.00	0.00	0.00	0.00	2.85	2.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.25	6.25	0.00	0.00	0.00	0.00	0.00	0.00
	Physical contingency	21.41	0.00	0.00	0.00	0.00	1.06	3.47	3.13	0.48	0.48	0.48	0.48	0.50	0.45	0.45	0.45	1.80	2.55	2.92	1.44	0.45	0.45	0.37	0.00	0.00
	Engineering service	19.98	0.00	0.00	0.00	1.58	1.58	2.00	1.99	0.45	0.45	0.45	0.45	0.46	0.42	0.42	1.71	1.71	1.71	1.71	1.71	0.42	0.42	0.34	0.00	0.00
	Administration cost	8.79	0.00	0.00	0.00	0.06	0.46	1.37	1.24	0.19	0.19	0.19	0.19	0.21	0.18	0.18	0.23	0.74	1.02	1.16	0.59	0.18	0.18	0.23	0.00	0.00
	Total	**228.53**	**0.00**	**0.00**	**0.00**	**1.64**	**11.95**	**35.72**	**32.35**	**5.11**	**5.11**	**5.11**	**5.11**	**5.16**	**4.76**	**4.76**	**6.10**	**19.24**	**26.52**	**30.12**	**15.61**	**4.76**	**4.76**	**4.64**	**0.00**	**0.00**
Zomba	Construction cost	22.83	0.00	0.00	3.18	3.18	0.00	0.56	0.56	0.94	0.94	0.95	0.38	0.38	0.38	0.38	3.03	3.03	3.04	0.38	0.38	0.38	0.38	0.38	0.00	0.00
	Land acquisition cost	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Physical contingency	2.74	0.00	0.00	0.38	0.38	0.00	0.07	0.07	0.12	0.12	0.11	0.05	0.05	0.05	0.05	0.37	0.37	0.37	0.05	0.05	0.03	0.03	0.02	0.00	0.00
	Engineering service	2.55	0.00	0.00	0.36	0.35	0.00	0.06	0.06	0.10	0.10	0.11	0.04	0.04	0.04	0.26	0.26	0.26	0.27	0.04	0.04	0.05	0.05	0.06	0.00	0.00
	Administration cost	1.12	0.00	0.00	0.16	0.15	0.00	0.03	0.03	0.05	0.05	0.04	0.02	0.02	0.02	0.03	0.15	0.15	0.14	0.02	0.02	0.01	0.01	0.02	0.00	0.00
	Total	**29.24**	**0.00**	**0.00**	**4.08**	**4.06**	**0.00**	**0.72**	**0.72**	**1.21**	**1.21**	**1.21**	**0.49**	**0.49**	**0.49**	**0.72**	**3.81**	**3.81**	**3.82**	**0.49**	**0.49**	**0.47**	**0.47**	**0.48**	**0.00**	**0.00**

Table 9.1.25 Disbursement Schedule for New Water Resource Development of Water Supply for 4 Cities

Unit: Million USD

City	Description	Total	Phase1	Phase2	Time Frame																					
					Short Term									Middle Term					Long Term								
					2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Lilongwe	Construction cost																									
	Dam	41.00	41.00	0.00						13.67	13.67	13.66														
	New Water treatment plant	43.00	30.00	13.00									15.00	15.00						6.50	6.50						
	Pipelines	90.00	54.00	36.00									18.00	18.00	18.00					18.00	18.00						
	Balancing tanks	2.00	1.00	1.00									0.50	0.50						0.50	0.50						
	Pumping stations	10.00	8.00	2.00									4.00	4.00						1.00	1.00						
	Electric lines	0.40	0.40	0.00									0.20	0.20													
	Resettlement / Compensation Irrigation	14.00	14.00	0.00								7.00	7.00														
	Fisheries	0.11	0.11	0.00									0.08	0.03													
	Development Irrigation	4.00	4.00	0.00									2.00	2.00													
	Sub-total	204.51	152.51	52.00	0.00	0.00	0.00	0.00	0.00	13.67	13.67	20.66	46.78	39.73	18.00	0.00	0.00	0.00	0.00	26.00	26.00	0.00	0.00	0.00	0.00	0.00	0.00
	Land acquisition cost	0.02	0.01	0.01								0.01							0.01								
	Physical contingency	24.54	18.30	6.24						1.64	1.64	2.48	5.61	4.77	2.16				0.00	3.12	3.12						
	Engineering service	22.91	17.08	5.83				2.14	2.14	2.14	2.14	2.14	2.14	2.14	2.10				1.94	1.94	1.95						
	Administration cost	10.08	7.52	2.56				0.09	0.09	0.70	0.70	1.01	2.18	1.87	0.88				0.08	1.24	1.24						
	Total	**262.06**	**195.42**	**66.64**	**0.00**	**0.00**	**0.00**	**2.23**	**2.23**	**18.15**	**18.15**	**26.30**	**56.71**	**48.51**	**23.14**	**0.00**	**0.00**	**0.00**	**2.03**	**32.30**	**32.31**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Blantyre	Construction cost																									
	River intake	2.22	2.22	0.00								2.22															
	Water treatment plant	25.30	12.65	12.65								6.33	6.32							6.33	6.32						
	Pipelines	62.85	35.24	27.61							11.75	11.75	11.74						9.20	9.20	9.21						
	Reservoirs	17.52	11.12	6.40								5.56	5.56							3.2	3.2						
	Pumping stations	18.72	10.23	8.49								5.12	5.11							4.25	4.24						
	Electric lines	0.32	0.32	0.00								0.16	0.16														
	Sub-total	126.93	71.78	55.15	0.00	0.00	0.00	0.00	0.00	0.00	11.75	31.14	28.89	0.00	0.00	0.00	0.00	0.00	9.20	22.98	22.97	0.00	0.00	0.00	0.00	0.00	0.00
	Land acquisition cost	0.00	0.00	0.00																							
	Physical contingency	15.23	8.61	6.62							1.41	3.74	3.46						1.10	2.76	2.76						
	Engineering service	14.22	8.04	6.18					1.61	1.61	1.61	1.61	1.60				1.24	1.24	1.24	1.24	1.22						
	Administration cost	6.26	3.54	2.72					0.06	0.06	0.59	1.46	1.37				0.05	0.05	0.46	1.08	1.08						
	Total	**162.64**	**91.97**	**70.67**	**0.00**	**0.00**	**0.00**	**0.00**	**1.67**	**1.67**	**15.36**	**37.95**	**35.32**	**0.00**	**0.00**	**0.00**	**1.29**	**1.29**	**12.00**	**28.06**	**28.03**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Mzuzu	Construction cost																									
	Dam	36.61	18.00	18.61					6.00	6.00	6.00									6.20	6.20	6.21					
	Transmission system to WTP	30.77	15.07	15.70						7.54	7.53											7.85	7.85				
	Water treatment plant	21.59	12.95	8.64						6.48	6.47									4.32	4.32						
	Treated water tank	3.04	1.52	1.52						0.76	0.76									0.76	0.76						
	Transmission system from WTP to service reservoirs	3.03	3.03	0.00						1.52	1.51																
	Electric lines	0.65	0.03	0.62						0.02	0.01											0.31	0.31				
	Sub-total	95.69	50.60	45.09	0.00	0.00	0.00	0.00	6.00	22.32	22.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.28	11.28	14.37	8.16	0.00	0.00	0.00	0.00
	Land acquisition cost	18.20	5.70	12.50					2.85	2.85											6.25	6.25					
	Physical contingency	13.67	6.76	6.91					1.06	3.02	2.68									1.35	2.10	2.47	0.99				
	Engineering service	12.76	6.31	6.45				1.58	1.58	1.58	1.57								1.29	1.29	1.29	1.29	1.29				
	Administration cost	5.61	2.77	2.84				0.06	0.46	1.19	1.06								0.05	0.56	0.84	0.98	0.41				
	Total	**145.93**	**72.14**	**73.79**	**0.00**	**0.00**	**0.00**	**1.64**	**11.95**	**30.96**	**27.59**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**1.34**	**14.48**	**21.76**	**25.36**	**10.85**	**0.00**	**0.00**	**0.00**	**0.00**
Zomba	Construction cost																									
	Raising of Mulunguzi dam	7.96	7.96	0.00															2.65	2.65	2.66						
	Sub-total	7.96	7.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.65	2.65	2.66	0.00	0.00	0.00	0.00	0.00	0.00
	Land acquisition cost	0.00	0.00	0.00																							
	Physical contingency	0.96	0.96	0.00															0.32	0.32	0.32						
	Engineering service	0.89	0.89	0.00														0.22	0.22	0.22	0.23						
	Administration cost	0.39	0.39	0.00														0.01	0.13	0.13	0.12						
	Total	**10.20**	**10.20**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.23**	**3.32**	**3.32**	**3.33**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Table 9.1.26 Disbursement Schedule for Other Improvement Project of Water Supply for 4 Cities (1/2)

Unit: Million USD

City	Description	Total	Time Frame																								
			Short Term										Middle Term					Long Term										
			2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Lilongwe	Construction cost																										
	Development new groundwater borehole (+10,000m3/d)	4.06			2.03	2.03																					
	Sub-total	4.06	0.00	0.00	2.03	2.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Land acquisition cost	0.00																									
	Physical contingency	0.49			0.24	0.25																					
	Engineering service	0.45			0.23	0.22																					
	Administration cost	0.20			0.10	0.10																					
	Total	**5.20**	**0.00**	**0.00**	**2.60**	**2.60**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	Construction cost																										
	Extension of Existing TWII (purification plant: +30,000m3/d)	3.90			1.95	1.95																					
	Sub-total	3.90	0.00	0.00	1.95	1.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Land acquisition cost	0.00																									
	Physical contingency	0.47			0.23	0.24																					
	Engineering service	0.44			0.22	0.22																					
	Administration cost	0.19			0.10	0.09																					
	Total	**5.00**	**0.00**	**0.00**	**2.50**	**2.50**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	Construction cost																										
	Raising Kamuzu dam I and associated rehabilitation works (+30,000m3/d)	3.97				1.32	1.32	1.33																			
	Sub-total	3.97	0.00	0.00	0.00	1.32	1.32	1.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Land acquisition cost	0.00																									
	Physical contingency	0.48				0.16	0.16	0.16																			
	Engineering service	0.45			0.11	0.11	0.11	0.12																			
	Administration cost	0.20			0.00	0.06	0.06	0.08																			
	Total	**5.10**	**0.00**	**0.00**	**0.11**	**1.65**	**1.65**	**1.69**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	Construction cost																										
	Extension of Existing TWII(2nd) (purification plant: +30,000m3/d) and Technical Assistance	7.57				3.79	3.78																				
	Sub-total	7.57	0.00	0.00	0.00	3.79	3.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Land acquisition cost	0.00																									
	Physical contingency	0.91				0.45	0.46																				
	Engineering service	0.85				0.43	0.42																				
	Administration cost	0.37				0.19	0.18																				
	Total	**9.70**	**0.00**	**0.00**	**0.00**	**4.86**	**4.84**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	Construction cost																										
	Network improvement	0.15				0.05	0.05	0.05																			
	Sub-total	0.15	0.00	0.00	0.00	0.05	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Land acquisition cost	0.00																									
	Physical contingency	0.02				0.01	0.01	0.00																			
	Engineering service	0.02				0.01	0.01	0.00																			
	Administration cost	0.01				0.00	0.00	0.01																			
	Total	**0.20**	**0.00**	**0.00**	**0.00**	**0.07**	**0.07**	**0.06**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	Construction cost																										
	Rehabilitation of Existing TWII	3.12								1.04	1.04	1.04															
	Sub-total	3.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.04	1.04	1.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Land acquisition cost	0.00																									
	Physical contingency	0.37								0.12	0.12	0.13															
	Engineering service	0.35								0.12	0.12	0.11															
	Administration cost	0.15								0.05	0.05	0.05															
	Total	**4.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**1.33**	**1.33**	**1.34**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	Construction cost																										
	Network expansion	176.23							11.01	11.01	11.01	11.01	11.01	11.01	11.01	11.01	11.01	11.01	11.01	11.01	11.01	11.01	11.01	11.08		
	Sub-total	176.23	0.00	0.00	0.00	0.00	0.00	0.00	11.01	11.01	11.01	11.01	11.01	11.01	11.01	11.01	11.01	11.01	11.01	11.01	11.01	11.01	11.01	11.08	0.00	0.00
	Land acquisition cost	0.00																									
	Physical contingency	21.15							1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.35		
	Engineering service	19.74							1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.29		
	Administration cost	8.68							0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.58		
	Total	**225.80**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**14.10**	**14.10**	**14.10**	**14.10**	**14.10**	**14.10**	**14.10**	**14.10**	**14.10**	**14.10**	**14.10**	**14.10**	**14.10**	**14.10**	**14.30**	**0.00**	**0.00**
Blantyre	Construction cost																										
	Network improvement	7.02				1.40	1.40	1.40	1.40	1.42																	
	Sub-total	7.02	0.00	0.00	0.00	1.40	1.40	1.40	1.40	1.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Land acquisition cost	0.00																									
	Physical contingency	0.84				0.17	0.17	0.17	0.17	0.16																	
	Engineering service	0.79				0.16	0.16	0.16	0.16	0.15																	
	Administration cost	0.35				0.07	0.07	0.07	0.07	0.07																	
	Total	**9.00**	**0.00**	**0.00**	**0.00**	**1.80**	**1.80**	**1.80**	**1.80**	**1.80**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Table 9.1.26 Disbursement Schedule for Other Improvement Project of Water Supply for 4 Cities (2/2)

Unit: Million USD

City	Description	Total	Time Frame																						
			Short Term									Middle Term					Long Term								
			2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Blantyre	Construction cost																								
	Network expansion	101.30							6.33	6.33	6.33	6.33	6.33	6.33	6.33	6.33	6.33	6.33	6.33	6.33	6.33	6.33	6.33	6.35		
	Sub-total	101.30	0.00	0.00	0.00	0.00	0.00	0.00	6.33	6.33	6.33	6.33	6.33	6.33	6.33	6.33	6.33	6.33	6.33	6.33	6.33	6.33	6.33	6.35	0.00	0.00
	Land acquisition cost	0.00																								
	Physical contingency	12.16							0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76		
	Engineering service	11.35							0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.7		
	Administration cost	4.99							0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.34		
	Total	**129.80**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**8.11**	**8.11**	**8.11**	**8.11**	**8.11**	**8.11**	**8.11**	**8.11**	**8.11**	**8.11**	**8.11**	**8.11**	**8.11**	**8.11**	**8.15**	**0.00**	**0.00**
	Construction cost																								
	Poverty program (Kiosk and Toilet development)	10.93									2.73	2.73	2.73	2.74												
	Sub-total	10.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.73	2.73	2.73	2.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Land acquisition cost	0.00																								
	Physical contingency	1.31									0.33	0.33	0.33	0.32												
	Engineering service	1.22									0.31	0.31	0.31	0.29												
	Administration cost	0.54									0.13	0.13	0.13	0.15												
	Total	**14.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**3.50**	**3.50**	**3.50**	**3.50**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Mzuzu	Construction cost																								
	Network improvement	1.40								0.28	0.28	0.28	0.28	0.28												
	Sub-total	1.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.28	0.28	0.28	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Land acquisition cost	0.00																								
	Physical contingency	0.17								0.03	0.03	0.03	0.03	0.05												
	Engineering service	0.16								0.03	0.03	0.03	0.03	0.04												
	Administration cost	0.07								0.01	0.01	0.01	0.01	0.03												
	Total	**1.80**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.35**	**0.35**	**0.35**	**0.35**	**0.40**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	Construction cost																								
	Network expansion	63.06						3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.70		
	Sub-total	63.06	0.00	0.00	0.00	0.00	0.00	3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.71	3.70	0.00	0.00
	Land acquisition cost	0.00																								
	Physical contingency	7.57						0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.37		
	Engineering service	7.06						0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.34		
	Administration cost	3.11						0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.23		
	Total	**80.80**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**4.76**	**4.76**	**4.76**	**4.76**	**4.76**	**4.76**	**4.76**	**4.76**	**4.76**	**4.76**	**4.76**	**4.76**	**4.76**	**4.76**	**4.76**	**4.76**	**4.64**	**0.00**	**0.00**
Zomba	Construction cost																								
	Expansion existing TW (18,200m3/d to 30,000m3/d)	6.36			3.18	3.18																				
	Sub-total	6.36	0.00	0.00	3.18	3.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Land acquisition cost	0.00																								
	Physical contingency	0.76			0.38	0.38																				
	Engineering service	0.71			0.36	0.35																				
	Administration cost	0.31			0.16	0.15																				
	Total	**8.14**	**0.00**	**0.00**	**4.08**	**4.06**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	Construction cost																								
	Network improvement	2.81						0.56	0.56	0.56	0.56	0.57														
	Sub-total	2.81	0.00	0.00	0.00	0.00	0.00	0.56	0.56	0.56	0.56	0.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Land acquisition cost	0.00																								
	Physical contingency	0.34						0.07	0.07	0.07	0.07	0.06														
	Engineering service	0.31						0.06	0.06	0.06	0.06	0.07														
	Administration cost	0.14						0.03	0.03	0.03	0.03	0.02														
	Total	**3.60**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.72**	**0.72**	**0.72**	**0.72**	**0.72**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	Construction cost																								
	Network expansion	5.70								0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38		
	Sub-total	5.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.00	0.00
	Land acquisition cost	0.00																								
	Physical contingency	0.68								0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.03	0.03	0.02		
	Engineering service	0.64								0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.06		
	Administration cost	0.28						0.00	0.00	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.02		

Table 9.1.27 Disbursement Schedule for Water Supply for Towns and Rural Areas

Unit: Million USD

Classification	Description	Total	Time Frame																							
			Short Term									Middle Term					Long Term									
			2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Towns	Construction cost																									
	Northern region	22.95					2.25	2.25	2.25	2.25	2.26	1.69	1.69	1.69	1.69	1.71	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.34
	Central region	37.85					3.84	3.84	3.84	3.84	3.85	1.90	1.90	1.90	1.90	1.88	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.88
	Southern region	51.03					4.06	4.06	4.06	4.06	4.07	6.02	6.02	6.02	6.02	6.01	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.09
	Sub-total	111.83	0.00	0.00	0.00	0.00	10.15	10.15	10.15	10.15	10.18	9.61	9.61	9.61	9.61	9.60	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.31
	Land acquisition cost	0.00					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Physical contingency	13.41					1.22	1.22	1.22	1.22	1.21	1.15	1.15	1.15	1.15	1.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.12
	Engineering service	12.53					1.14	1.14	1.14	1.14	1.13	1.08	1.08	1.08	1.08	1.06	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.11
	Administration cost	5.51					0.50	0.50	0.50	0.50	0.50	0.47	0.47	0.47	0.47	0.49	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.10
	Total	**143.28**	**0.00**	**0.00**	**0.00**	**0.00**	**13.01**	**13.01**	**13.01**	**13.01**	**13.02**	**12.31**	**12.31**	**12.31**	**12.31**	**12.31**	**1.67**	**1.67**	**1.67**	**1.67**	**1.67**	**1.67**	**1.67**	**1.67**	**1.67**	**1.64**
Market Center	Construction cost																									
	Northern region	22.10					2.81	2.81	2.81	2.81	2.83	1.19	1.19	1.19	1.19	1.20	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.18
	Central region	37.83					5.18	5.18	5.18	5.18	5.16	1.50	1.50	1.50	1.50	1.51	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.48
	Southern region	36.25					4.11	4.11	4.11	4.11	4.11	1.19	1.19	1.19	1.19	1.17	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.95
	Sub-total	96.18	0.00	0.00	0.00	0.00	12.10	12.10	12.10	12.10	12.10	3.88	3.88	3.88	3.88	3.88	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.61
	Land acquisition cost	0.00					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Physical contingency	11.54					1.45	1.45	1.45	1.45	1.46	0.47	0.47	0.47	0.47	0.45	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.15
	Engineering service	10.77					1.36	1.36	1.36	1.36	1.34	0.43	0.43	0.43	0.43	0.45	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.20
	Administration cost	4.74					0.60	0.60	0.60	0.60	0.58	0.19	0.19	0.19	0.19	0.20	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
	Total	**123.23**	**0.00**	**0.00**	**0.00**	**0.00**	**15.51**	**15.51**	**15.51**	**15.51**	**15.48**	**4.97**	**4.97**	**4.97**	**4.97**	**4.98**	**2.09**	**2.09**	**2.09**	**2.09**	**2.09**	**2.09**	**2.09**	**2.09**	**2.09**	**2.04**
Community by Gravity-fed WS	Construction cost																									
	Northern region	23.90					1.35	1.35	1.35	1.35	1.37	2.61	2.61	2.61	2.61	2.63	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.37
	Central region	24.75					2.49	2.49	2.49	2.49	2.47	2.12	2.12	2.12	2.12	2.14	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
	Southern region	58.13					7.64	7.64	7.64	7.64	7.65	2.21	2.21	2.21	2.21	2.19	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.88
	Sub-total	106.78	0.00	0.00	0.00	0.00	11.48	11.48	11.48	11.48	11.49	6.94	6.94	6.94	6.94	6.96	1.47	1.47	1.47	1.47	1.47	1.47	1.47	1.47	1.47	1.42
	Land acquisition cost	0.00					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Physical contingency	12.82					1.38	1.38	1.38	1.38	1.37	0.83	0.83	0.83	0.83	0.85	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.14
	Engineering service	11.96					1.29	1.29	1.29	1.29	1.27	0.78	0.78	0.78	0.78	0.77	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.20
	Administration cost	5.26					0.57	0.57	0.57	0.57	0.55	0.34	0.34	0.34	0.34	0.35	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.09
	Total	**136.82**	**0.00**	**0.00**	**0.00**	**0.00**	**14.72**	**14.72**	**14.72**	**14.72**	**14.68**	**8.89**	**8.89**	**8.89**	**8.89**	**8.93**	**1.88**	**1.88**	**1.88**	**1.88**	**1.88**	**1.88**	**1.88**	**1.88**	**1.88**	**1.85**
Community by Borehole WS	Construction cost																									
	Northern region	21.02					1.05	1.05	1.05	1.05	1.06	1.05	1.05	1.05	1.05	1.06	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05
	Central region	124.19					6.21	6.21	6.21	6.21	6.21	6.21	6.21	6.21	6.21	6.21	6.21	6.21	6.21	6.21	6.21	6.21	6.21	6.21	6.21	6.20
	Southern region	79.13					3.96	3.96	3.96	3.96	3.96	3.96	3.96	3.96	3.96	3.96	3.95	3.95	3.95	3.95	3.95	3.95	3.95	3.95	3.95	3.98
	Sub-total	224.34	0.00	0.00	0.00	0.00	11.22	11.22	11.22	11.22	11.23	11.22	11.22	11.22	11.22	11.23	11.21	11.21	11.21	11.21	11.21	11.21	11.21	11.21	11.21	11.23
	Land acquisition cost	0.00					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Physical contingency	26.91					1.35	1.35	1.35	1.35	1.33	1.35	1.35	1.35	1.35	1.33	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.30
	Engineering service	25.12					1.26	1.26	1.26	1.26	1.24	1.26	1.26	1.26	1.26	1.24	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.22
	Administration cost	11.05					0.55	0.55	0.55	0.55	0.56	0.55	0.55	0.55	0.55	0.56	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.58
	Total	**287.42**	**0.00**	**0.00**	**0.00**	**0.00**	**14.38**	**14.38**	**14.38**	**14.38**	**14.36**	**14.38**	**14.38**	**14.38**	**14.38**	**14.36**	**14.37**	**14.37**	**14.37**	**14.37**	**14.37**	**14.37**	**14.37**	**14.37**	**14.37**	**14.33**

Table 9.1.28 Summary of Disbursement Schedule for Irrigation Development (2,500ha/year)

Unit: Million USD

WRA	WRU	Irrigation Area (ha)	Project Cost (mil USD)	Unit Cost (USD/ha)	Implementation Period (year)	Ranking	Time Frame																							
							Short Term									Middle Term					Long Term									
							2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
1	A	584	3.61	6,182	3	7					1.20	1.20	1.20																	
	B	710	4.37	6,155	3	7					1.46	1.46	1.46																	
	C	766	4.70	6,136	3	7					1.57	1.57	1.57																	
	E	515	3.33	6,466	3	1	1.11	1.11	1.11																					
	F	263	1.64	6,236	2	13							0.82	0.82																
	G	677	4.25	6,278	3	1	1.42	1.42	1.42																					
	K	823	5.05	6,136	3	7					1.68	1.68	1.68																	
	L	578	3.55	6,142	3	7				1.18	1.18	1.18																		
	M	626	3.85	6,150	3	32													1.28	1.28	1.28									
	N	273	1.68	6,154	2	44																0.84	0.84							
	O	761	4.68	6,150	3	32														1.56	1.56	1.56								
	P	587	3.62	6,167	3	32																1.21	1.21	1.21						
	R	1,051	6.48	6,166	4	1	1.62	1.62	1.62	1.62																				
	S	731	4.5	6,142	3	7					1.50	1.50	1.50																	
	T	90	0.55	6,111	2	13							0.28	0.28																
2	A	21	0.6	30,000	2	44																0.32	0.32							
	B	60	0.4	5,982	2	13								0.18	0.18															
	C	14	0.09	6,278	2	13							0.05	0.05																
	D	7	0.25	37,774	2	44																0.13	0.13							
3	A	530	3.28	6,189	3	32															1.09	1.09	1.09							
	B	481	2.96	6,154	2	44																1.48	1.48							
	C	1,020	6.28	6,157	4	13							1.57	1.57	1.57	1.57														
	D	562	3.45	6,139	3	32												1.15	1.15	1.15										
	E	730	4.48	6,137	3	32																1.49	1.49	1.49						
	F	211	1.29	6,114	2	32																0.65	0.65							
4	A	15	0.10	6,761	2	32																0.05	0.05							
	B	299	1.84	6,154	2	13								0.92	0.92															
	C	67	0.43	6,418	2	13						0.22	0.22																	
	D	187	1.15	6,150	2	13							0.58	0.58																
	E	100	0.61	6,102	2	13							0.31	0.31																
	F	19	0.12	6,192	2	13							0.06	0.06																
5	C	464	2.28	4,914	2	44															1.14	1.14								
	D	399	2.50	6,266	2	44																1.25	1.25							
	E	1,543	9.69	6,280	4	13									2.42	2.42	2.42	2.42												
	F	1,209	7.58	6,270	4	13								1.90	1.90	1.90	1.90													
7	A	2,229	13.71	6,151	4	13					3.43	3.43	3.43	3.43																
	B	930	5.73	6,161	3	32													1.91	1.91	1.91									
	C	1,030	6.32	6,136	4	13								1.58	1.58	1.58	1.58													
	D	2,727	16.78	6,153	4	13									4.20	4.20	4.20	4.20												
	E	405	2.49	6,148	2	44																			1.25	1.25				
	F	864	5.30	6,134	3	32																1.77	1.77	1.77						
	G	557	3.42	6,140	3	32																1.14	1.14	1.14						
	H	292	1.80	6,164	2	13						0.90	0.90																	
8	A	3,728	22.92	6,148	4	13												5.73	5.73	5.73	5.73									
9	A	209	1.28	6,124	2	44																			0.64	0.64				
	B	256	1.58	6,172	2	44																			0.79	0.79				
14	B	95	3.22	33,853	2	57																			1.61	1.61				
	C	8,974	63.53	7,079	4	44																					15.88	15.88	15.88	15.88
15	A	3,094	19.02	6,147	4	13								4.76	4.76	4.76	4.76													
	B	4,983	35.37	7,098	4	44																	8.84	8.84	8.84	8.84				
	C	608	4.32	7,105	3	56																		1.44	1.44	1.44				
16	E	3,374	20.75	6,150	4	1	5.19	5.19	5.19	5.19																				
	F	3,785	23.29	6,153	4	1	5.82	5.82	5.82	5.82																				
	G	1,873	11.52	6,151	4	1			2.88	2.88	2.88	2.88																		
17	A	16	0.10	6,314	2	44																		0.05	0.05					
	B	970	5.97	6,155	3	32													1.99	1.99	1.99									

Table 9.1.29 Summary of Disbursement Schedule for Irrigation Development (5,000ha/year)

Unit: Million USD

WRA	WRU	Irrigation Area (ha)	Project Cost (mil USD)	Unit Cost (USD/ha)	Implementation Period (year)	Ranking	Time Frame																								
							Short Term									Middle Term					Long Term										
							2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
1	A	1,171	7.20	6,149	3	5					2.40	2.40	2.40																		
	B	1,422	8.93	6,280	3	5					2.98	2.98	2.98																		
	C	1,534	9.63	6,278	3	5					3.21	3.21	3.21																		
	E	1,032	6.82	6,609	3	5				2.27	2.27	2.27																			
	F	527	3.31	6,281	2	12							1.66	1.66																	
	G	1,356	8.77	6,468	3	1	2.92	2.92	2.92																						
	K	1,649	10.36	6,283	3	5					3.45	3.45	3.45																		
	L	1,158	7.27	6,278	3	5				2.42	2.42	2.42																			
	M	1,254	7.87	6,276	3	28									2.62	2.62	2.62														
	N	547	3.43	6,271	2	41												1.72	1.72												
	O	1,525	9.61	6,302	3	28												3.20	3.20	3.20											
	P	1,176	7.39	6,284	3	28												2.46	2.46	2.46											
	R	2,107	15.81	7,504	4	28	3.95	3.95	3.95	3.95																					
	S	1,464	9.2	6,270	3	5					3.06	3.06	3.06																		
	T	180	1.10	6,111	2	12							0.55	0.55																	
2	A	41	0.8	19,756	2	41													0.41	0.41											
	B	120	0.8	6,231	2	12								0.38	0.38																
	C	29	0.19	6,627	2	28									0.10	0.10															
	D	13	0.32	24,175	2	41													0.16	0.16											
3	A	1,063	6.53	6,143	3	28												2.18	2.18	2.18											
	B	964	5.94	6,162	2	41												2.97	2.97												
	C	2,044	12.57	6,150	4	12					3.14	3.14	3.14	3.14																	
	D	1,125	7.99	7,102	3	53															2.66	2.66	2.66								
	E	1,462	9.00	6,156	3	28									3.00	3.00	3.00														
	F	422	2.60	6,161	2	28									1.30	1.30															
4	A	30	0.21	7,099	2	41													0.11	0.11											
	B	600	3.69	6,150	2	12					1.85	1.85																			
	C	135	0.84	6,215	2	12								0.42	0.42																
	D	376	2.31	6,144	2	12					1.16	1.16																			
	E	200	1.22	6,102	2	12							0.61	0.61																	
	F	39	0.23	5,934	2	12							0.12	0.12																	
5	C	930	6.68	7,183	2	55															3.34	3.34									
	D	799	5.02	6,283	2	41												2.51	2.51												
	E	3,091	19.42	6,283	4	12							4.86	4.86	4.86	4.86															
	F	2,422	15.23	6,288	4	12								3.81	3.81	3.81	3.81														
7	A	4,467	27.47	6,150	4	12					6.87	6.87	6.87	6.87																	
	B	1,864	11.46	6,148	3	28												3.82	3.82	3.82											
	C	2,064	12.70	6,153	4	12								3.18	3.18	3.18	3.18														
	D	5,464	33.61	6,151	4	12								8.40	8.40	8.40	8.40														
	E	811	4.99	6,153	2	41													2.50	2.50											
	F	1,730	10.86	6,277	3	28											3.62	3.62	3.62												
	G	1,115	7.00	6,278	3	28												2.33	2.33	2.33											
	H	584	3.61	6,182	2	12						1.81	1.81																		
8	A	7,470	56.89	7,616	4	41														14.22	14.22	14.22	14.22								
9	A	418	2.64	6,316	2	41														1.32	1.32										
	B	515	3.24	6,291	2	41													1.62	1.62											
14	B	190	4.05	21,289	2	55															2.03	2.03									
	C	17,911	153.80	8,587	4	41																					38.45	38.45	38.45	38.45	
15	A	8,200	44.01	5,367	4	12															11.00	11.00	11.00	11.00							
	B	9,986	70.90	7,100	4	41																	17.73	17.73	17.73	17.73					
	C	1,219	8.65	7,096	3	53																		2.88	2.88	2.88					
16	E	6,761	41.57	6,148	4	1	10.39	10.39	10.39	10.39																					
	F	7,586	46.65	6,149	4	1	11.66	11.66	11.66	11.66																					
	G	3,754	23.09	6,151	4	1	5.77	5.77	5.77	5.77																					
17	A	32	0.25	7,892	2	55																		0.13	0.13						
	B	1,943	11.96	6,155	3	28											3.99	3.99	3.99												
	C	3,679	24.51	6,662	4	28									6.13	6.13	6.13	6.13													
Total		121,770	822.14				34.70	34.70	34.70	36.48	32.81	34.61	34.70	33.98	34.18	33.39	34.74	34.93	33.58	34.32	34.57	33.25	45.61	31.74	20.73	20.61	38.45	38.45	38.45	38.45
Accumulated Investment Cost							34.70	69.41	104.11	140.59	173.39	208.01	242.71	276.68	310.86	344.25	378.99	413.92	447.50	481.82	516.40	549.65	595.26	627.00	647.73	668.34	706.79	745.24	783.69	822.14

Table 9.1.30 Ranking Criteria and Scores for Irrigation Development

WRA	WRU	Irrigation Area (ha)		Total cost (mil USD)		Unit Cost (USD/ha)		Water Supply Potential (m3/ha)	Ranking Criteria									
									2500ha/year					5000ha/year				
		2500ha/year	5000ha/year	2500ha/year	5000ha/year	2500ha/year	5000ha/year		Cost Efficiency	Development Effect	Water Supply Potential	Final Score	Ranking	Cost Efficiency	Development Effect	Water Supply Potential	Final Score	Ranking
1	A	587	1,173	3.61	7.20	6,154	6,136	34	3	2	2	**12**	**7**	3	2	2	**12**	**7**
	B	712	1,425	4.37	8.76	6,134	6,148	28	3	2	2	**12**	**7**	3	2	2	**12**	**7**
	C	769	1,537	4.70	9.42	6,115	6,128	20	3	2	2	**12**	**7**	3	2	2	**12**	**7**
	E	517	1,034	3.17	6.33	6,132	6,123	42	3	2	3	**18**	**1**	3	2	3	**18**	**1**
	F	264	528	1.64	3.31	6,218	6,275	52	3	1	3	**9**	**13**	3	1	3	**9**	**13**
	G	679	1,358	4.16	8.34	6,126	6,140	44	3	2	3	**18**	**1**	3	2	3	**18**	**1**
	K	826	1,652	5.05	10.15	6,112	6,143	27	3	2	2	**12**	**7**	3	2	2	**12**	**7**
	L	580	1,160	3.55	7.12	6,120	6,137	29	3	2	2	**12**	**7**	3	2	2	**12**	**7**
	M	628	1,256	3.85	7.71	6,129	6,137	17	3	2	1	**6**	**32**	3	2	1	**6**	**28**
	N	274	548	1.68	3.35	6,135	6,117	18	3	1	1	**3**	**44**	3	1	1	**3**	**40**
	O	764	1,528	4.68	9.38	6,124	6,137	18	3	2	1	**6**	**32**	3	2	1	**6**	**28**
	P	589	1,178	3.62	7.23	6,146	6,137	18	3	2	1	**6**	**32**	3	2	1	**6**	**28**
	R	1,056	2,111	6.48	12.95	6,139	6,134	20	3	3	2	**18**	**1**	3	3	2	**18**	**1**
	S	734	1,467	4.49	9.01	6,121	6,141	22	3	2	2	**12**	**7**	3	2	2	**12**	**7**
	T	90	180	0.55	1.10	6,116	6,116	45	3	1	3	**9**	**13**	3	1	3	**9**	**13**
2	A	21	42	0.63	0.81	30,348	19,509	85	1	1	3	**3**	**44**	1	1	3	**3**	**40**
	B	60	120	0.36	0.75	5,982	6,231	89	3	1	3	**9**	**13**	3	1	3	**9**	**13**
	C	14	29	0.09	0.19	6,278	6,627	97	3	1	3	**9**	**13**	2	1	3	**6**	**28**
	D	7	13	0.25	0.32	37,774	24,175	113	1	1	3	**3**	**44**	1	1	3	**3**	**40**
3	A	533	1,065	3.28	6.53	6,159	6,131	16	3	2	1	**6**	**32**	3	2	1	**6**	**28**
	B	483	966	2.96	5.94	6,129	6,150	16	3	1	1	**3**	**44**	3	1	1	**3**	**40**
	C	1,024	2,048	6.28	12.57	6,133	6,138	17	3	3	1	**9**	**13**	3	3	1	**9**	**13**
	D	564	1,127	3.45	7.99	6,121	7,087	17	3	2	1	**6**	**32**	1	2	1	**2**	**53**
	E	733	1,465	4.48	9.00	6,116	6,143	20	3	2	1	**6**	**32**	3	2	1	**6**	**28**
	F	211	423	1.29	2.60	6,103	6,151	21	3	1	2	**6**	**32**	3	1	2	**6**	**28**
4	A	15	30	0.10	0.21	6,761	7,099	66	2	1	3	**6**	**32**	1	1	3	**3**	**40**
	B	300	601	1.84	3.69	6,125	6,141	66	3	1	3	**9**	**13**	3	1	3	**9**	**13**
	C	68	135	0.43	0.84	6,363	6,215	52	3	1	3	**9**	**13**	3	1	3	**9**	**13**
	D	188	376	1.15	2.31	6,113	6,139	52	3	1	3	**9**	**13**	3	1	3	**9**	**13**
	E	100	200	0.61	1.22	6,102	6,102	52	3	1	3	**9**	**13**	3	1	3	**9**	**13**
	F	19	39	0.12	0.23	6,192	5,934	52	3	1	3	**9**	**13**	3	1	3	**9**	**13**
5	C	466	932	2.28	6.68	4,894	7,169	17	3	1	1	**3**	**44**	1	1	1	**1**	**55**
	D	400	800	2.50	5.02	6,247	6,272	17	3	1	1	**3**	**44**	3	1	1	**3**	**40**
	E	1,549	3,097	9.69	19.42	6,258	6,270	17	3	3	1	**9**	**13**	3	3	1	**9**	**13**
	F	1,213	2,427	7.58	15.23	6,247	6,276	17	3	3	1	**9**	**13**	3	3	1	**9**	**13**
7	A	2,238	4,476	13.71	27.47	6,127	6,138	11	3	3	1	**9**	**13**	3	3	1	**9**	**13**
	B	934	1,868	5.73	11.46	6,135	6,135	10	3	2	1	**6**	**32**	3	2	1	**6**	**28**
	C	1,034	2,068	6.32	12.70	6,111	6,140	11	3	3	1	**9**	**13**	3	3	1	**9**	**13**
	D	2,737	5,475	16.78	33.61	6,130	6,139	11	3	3	1	**9**	**13**	3	3	1	**9**	**13**
	E	406	813	2.49	4.99	6,128	6,141	10	3	1	1	**3**	**44**	3	1	1	**3**	**40**
	F	867	1,734	5.30	10.86	6,114	6,264	12	3	2	1	**6**	**32**	3	2	1	**6**	**28**
	G	559	1,118	3.42	7.00	6,121	6,264	11	3	2	1	**6**	**32**	3	2	1	**6**	**28**
	H	293	586	1.80	3.61	6,148	6,165	110	3	1	3	**9**	**13**	3	1	3	**9**	**13**
8	A	3,742	7,485	22.92	56.89	6,125	7,601	10	3	3	1	**9**	**13**	1	3	1	**3**	**40**
9	A	209	419	1.28	2.64	6,110	6,301	15	3	1	1	**3**	**44**	3	1	1	**3**	**40**
	B	257	514	1.58	3.24	6,147	6,303	15	3	1	1	**3**	**44**	3	1	1	**3**	**40**
14	B	95	190	3.22	4.05	33,853	21,289	8	1	1	1	**1**	**57**	1	1	1	**1**	**55**
	C	8,973	17,946	63.53	153.80	7,080	8,570	8	1	3	1	**3**	**44**	1	3	1	**3**	**40**
15	A	3,106	6,212	19.02	44.01	6,124	7,085	7	3	3	1	**9**	**13**	1	3	1	**3**	**40**
	B	5,003	10,005	35.37	70.90	7,070	7,086	5	1	3	1	**3**	**44**	1	3	1	**3**	**40**
	C	611	1,221	4.32	8.65	7,076	7,084	5	1	2	1	**2**	**56**	1	2	1	**2**	**53**
16	E	3,387	6,774	20.75	41.57	6,126	6,136	39	3	3	2	**18**	**1**	3	3	2	**18**	**1**
	F	3,800	7,601	23.29	46.65	6,128	6,138	35	3	3	2	**18**	**1**	3	3	2	**18**	**1**
	G	1,881	3,761	11.52	23.09	6,126	6,139	39	3	3	2	**18**	**1**	3	3	2	**18**	**1**
17	A	16	32	0.10	0.25	6,314	7,892	17	3	1	1	**3**	**44**	1	1	1	**1**	**55**
	B	974	1,947	5.97	11.96	6,132	6,142	17	3	2	1	**6**	**32**	3	2	1	**6**	**28**
	C	1,843	3,686	11.29	24.51	6,126	6,649	16	3	3	1	**9**	**13**	2	3	1	**6**	**28**
Total		**60,000**	**120,000**	**384.68**	**816.82**													

Table 9.1.31 Disbursement Schedule for Irrigation Development (2,500ha/year) (1/6)

Unit: Million USD

WRA	WRU	Descriptiion	Total	Time Frame																						
				Short Term									Middle Term					Long Term									
				2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
1	A	Construction cost	2.81	0.94	0.94	0.94																				
		Physical contingency	0.34	0.11	0.11	0.11																				
		Engineering service	0.32	0.11	0.11	0.11																				
		Administration cost	0.14	0.05	0.05	0.05																				
		Total	3.61	1.20	1.20	1.20																				
	B	Construction cost	3.41	1.14	1.14	1.14																				
		Physical contingency	0.41	0.14	0.14	0.14																				
		Engineering service	0.38	0.13	0.13	0.13																				
		Administration cost	0.17	0.06	0.06	0.06																				
		Total	4.37	1.46	1.46	1.46																				
	C	Construction cost	3.67	1.22	1.22	1.22																				
		Physical contingency	0.44	0.15	0.15	0.15																				
		Engineering service	0.41	0.14	0.14	0.14																				
		Administration cost	0.18	0.06	0.06	0.06																				
		Total	4.70	1.57	1.57	1.57																				
	E	Construction cost	2.60	0.87	0.87	0.87																				
		Physical contingency	0.31	0.10	0.10	0.10																				
		Engineering service	0.29	0.10	0.10	0.10																				
		Administration cost	0.13	0.04	0.04	0.04																				
		Total	3.33	1.11	1.11	1.11																				
	F	Construction cost	1.29						0.65	0.65																
		Physical contingency	0.15						0.08	0.08																
		Engineering service	0.14						0.07	0.07																
		Administration cost	0.06						0.03	0.03																
		Total	1.64						0.82	0.82																
	G	Construction cost	3.32	1.11	1.11	1.11																				
		Physical contingency	0.40	0.13	0.13	0.13																				
		Engineering service	0.37	0.12	0.12	0.12																				
		Administration cost	0.16	0.05	0.05	0.05																				
		Total	4.25	1.42	1.42	1.42																				
	K	Construction cost	3.95	1.32	1.32	1.32																				
		Physical contingency	0.47	0.16	0.16	0.16																				
		Engineering service	0.44	0.15	0.15	0.15																				
		Administration cost	0.19	0.06	0.06	0.06																				
		Total	5.05	1.68	1.68	1.68																				
	L	Construction cost	2.77	0.92	0.92	0.92																				
		Physical contingency	0.33	0.11	0.11	0.11																				
		Engineering service	0.31	0.10	0.10	0.10																				
		Administration cost	0.14	0.05	0.05	0.05																				
		Total	3.55	1.18	1.18	1.18																				
	M	Construction cost	3.00			1.00	1.00	1.00																		
		Physical contingency	0.36			0.12	0.12	0.12																		
		Engineering service	0.34			0.11	0.11	0.11																		
		Administration cost	0.15			0.05	0.05	0.05																		
		Total	3.85			1.28	1.28	1.28																		
	N	Construction cost	1.31												0.66	0.66										
		Physical contingency	0.16												0.08	0.08										
		Engineering service	0.15												0.08	0.08										
		Administration cost	0.06												0.03	0.03										
		Total	1.68												0.84	0.84										

Table 9.1.31 Disbursement Schedule for Irrigation Development (2,500ha/year) (2/6)

Unit: Million USD

WRA	WRU	Description	Total	Time Frame																						
				Short Term									Middle Term					Long Term									
				2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
1	O	Construction cost	3.65												1.22	1.22	1.22										
		Physical contingency	0.44												0.15	0.15	0.15										
		Engineering service	0.41												0.14	0.14	0.14										
		Administration cost	0.18												0.06	0.06	0.06										
		Total	4.68												1.56	1.56	1.56										
	P	Construction cost	2.82			0.94	0.94	0.94																			
		Physical contingency	0.34			0.11	0.11	0.11																			
		Engineering service	0.32			0.11	0.11	0.11																			
		Administration cost	0.14			0.05	0.05	0.05																			
		Total	3.62			1.21	1.21	1.21																			
	R	Construction cost	5.05	1.26	1.26	1.26	1.26																				
		Physical contingency	0.61	0.15	0.15	0.15	0.15																				
		Engineering service	0.57	0.14	0.14	0.14	0.14																				
		Administration cost	0.25	0.06	0.06	0.06	0.06																				
		Total	6.48	1.62	1.62	1.62	1.62																				
	S	Construction cost	3.51	1.17	1.17	1.17																					
		Physical contingency	0.42	0.14	0.14	0.14																					
		Engineering service	0.39	0.13	0.13	0.13																					
		Administration cost	0.17	0.06	0.06	0.06																					
		Total	4.49	1.50	1.50	1.50																					
	T	Construction cost	0.43						0.22	0.22																	
		Physical contingency	0.05						0.03	0.03																	
		Engineering service	0.05						0.03	0.03																	
		Administration cost	0.02						0.01	0.01																	
		Total	0.55						0.28	0.28																	
2	A	Construction cost	0.49																			0.25	0.25				
		Physical contingency	0.06																			0.03	0.03				
		Engineering service	0.06																			0.03	0.03				
		Administration cost	0.02																			0.01	0.01				
		Total	0.63																			0.32	0.32				
	B	Construction cost	0.29								0.15	0.15															
		Physical contingency	0.03								0.02	0.02															
		Engineering service	0.03								0.02	0.02															
		Administration cost	0.01								0.01	0.01															
		Total	0.36								0.18	0.18															
	C	Construction cost	0.07	0.04	0.04																						
		Physical contingency	0.01	0.01	0.01																						
		Engineering service	0.01	0.01	0.01																						
		Administration cost	0.00	0.00	0.00																						
		Total	0.09	0.05	0.05																						
	D	Construction cost	0.20																			0.10	0.10				
		Physical contingency	0.02																			0.01	0.01				
		Engineering service	0.01																			0.01	0.01				
		Administration cost	0.01																			0.01	0.01				
		Total	0.25																			0.13	0.13				

Table 9.1.31 Disbursement Schedule for Irrigation Development (2,500ha/year) (3/6)

Unit: Million USD

WRA	WRU	Description	Total	Time Frame																						
				Short Term									Middle Term					Long Term										
				2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
3	A	Construction cost	2.55																			0.85	0.85	0.85			
		Physical contingency	0.31																			0.10	0.10	0.10			
		Engineering service	0.29																			0.10	0.10	0.10			
		Administration cost	0.13																			0.04	0.04	0.04			
		Total	3.28																			1.09	1.09	1.09			
	B	Construction cost	2.31																							1.16	1.16
		Physical contingency	0.28																							0.14	0.14
		Engineering service	0.26																							0.13	0.13
		Administration cost	0.11																							0.06	0.06
		Total	2.96																							1.48	1.48
	C	Construction cost	4.90												1.23	1.23	1.23	1.23									
		Physical contingency	0.59												0.15	0.15	0.15	0.15									
		Engineering service	0.55												0.14	0.14	0.14	0.14									
		Administration cost	0.24												0.06	0.06	0.06	0.06									
		Total	6.28												1.57	1.57	1.57	1.57									
	D	Construction cost	2.70																					0.90	0.90	0.90	
		Physical contingency	0.32																					0.11	0.11	0.11	
		Engineering service	0.30																					0.10	0.10	0.10	
		Administration cost	0.13																					0.04	0.04	0.04	
		Total	3.45																					1.15	1.15	1.15	
	E	Construction cost	3.50																						1.17	1.17	1.17
		Physical contingency	0.42																						0.14	0.14	0.14
		Engineering service	0.39																						0.13	0.13	0.13
		Administration cost	0.17																						0.06	0.06	0.06
		Total	4.48																						1.49	1.49	1.49
	F	Construction cost	1.01																						0.51	0.51	
		Physical contingency	0.12																						0.06	0.06	
		Engineering service	0.11																						0.06	0.06	
		Administration cost	0.05																						0.03	0.03	
		Total	1.29																						0.65	0.65	
4	A	Construction cost	0.08																			0.04	0.04				
		Physical contingency	0.01																			0.01	0.01				
		Engineering service	0.01																			0.01	0.01				
		Administration cost	0.00																			0.00	0.00				
		Total	0.10																			0.05	0.05				
	B	Construction cost	1.44								0.72	0.72															
		Physical contingency	0.17								0.09	0.09															
		Engineering service	0.16								0.08	0.08															
		Administration cost	0.07								0.04	0.04															
		Total	1.84								0.92	0.92															
	C	Construction cost	0.33			0.17	0.17																				
		Physical contingency	0.04			0.02	0.02																				
		Engineering service	0.04			0.02	0.02																				
		Administration cost	0.02			0.01	0.01																				
		Total	0.43			0.22	0.22																				

Table 9.1.31 Disbursement Schedule for Irrigation Development (2,500ha/year) (4/6)

Unit: Million USD

WRA	WRU	Description	Total	Time Frame																						
				Short Term									Middle Term					Long Term									
				2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
4	D	Construction cost	0.90	0.45	0.45																					
		Physical contingency	0.11	0.06	0.06																					
		Engineering service	0.10	0.05	0.05																					
		Administration cost	0.04	0.02	0.02																					
		Total	1.15	0.58	0.58																					
	E	Construction cost	0.48	0.24	0.24																					
		Physical contingency	0.06	0.03	0.03																					
		Engineering service	0.05	0.03	0.03																					
		Administration cost	0.02	0.01	0.01																					
		Total	0.61	0.31	0.31																					
	F	Construction cost	0.10	0.05	0.05																					
		Physical contingency	0.01	0.01	0.01																					
		Engineering service	0.01	0.01	0.01																					
		Administration cost	0.00	0.00	0.00																					
		Total	0.12	0.06	0.06																					
5	C	Construction cost	1.78																				0.89	0.89		
		Physical contingency	0.21																				0.11	0.11		
		Engineering service	0.20																				0.10	0.10		
		Administration cost	0.09																				0.05	0.05		
		Total	2.28																				1.14	1.14		
	D	Construction cost	1.95																			0.98	0.98			
		Physical contingency	0.23																			0.12	0.12			
		Engineering service	0.22																			0.11	0.11			
		Administration cost	0.10																			0.05	0.05			
		Total	2.50																			1.25	1.25			
	E	Construction cost	7.56				1.89	1.89	1.89	1.89																
		Physical contingency	0.91				0.23	0.23	0.23	0.23																
		Engineering service	0.85				0.21	0.21	0.21	0.21																
		Administration cost	0.37				0.09	0.09	0.09	0.09																
		Total	9.69				2.42	2.42	2.42	2.42																
	F	Construction cost	5.92				1.48	1.48	1.48	1.48																
		Physical contingency	0.71				0.18	0.18	0.18	0.18																
		Engineering service	0.66				0.17	0.17	0.17	0.17																
		Administration cost	0.29				0.07	0.07	0.07	0.07																
		Total	7.58				1.90	1.90	1.90	1.90																
7	A	Construction cost	10.70				2.68	2.68	2.68	2.68																
		Physical contingency	1.28				0.32	0.32	0.32	0.32																
		Engineering service	1.20				0.30	0.30	0.30	0.30																
		Administration cost	0.53				0.13	0.13	0.13	0.13																
		Total	13.71				3.43	3.43	3.43	3.43																
	B	Construction cost	4.47												1.49	1.49	1.49									
		Physical contingency	0.54												0.18	0.18	0.18									
		Engineering service	0.50												0.17	0.17	0.17									
		Administration cost	0.22												0.07	0.07	0.07									
		Total	5.73												1.91	1.91	1.91									
	C	Construction cost	4.94				1.24	1.24	1.24	1.24																
		Physical contingency	0.59				0.15	0.15	0.15	0.15																
		Engineering service	0.55				0.14	0.14	0.14	0.14																
		Administration cost	0.24				0.06	0.06	0.06	0.06																
		Total	6.32				1.58	1.58	1.58	1.58																

Table 9.1.31 Disbursement Schedule for Irrigation Development (2,500ha/year) (5/6)

Unit: Million USD

WRA	WRU	Description	Total	Time Frame																						
				Short Term									Middle Term					Long Term									
				2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
7	D	Construction cost	13.09				3.27	3.27	3.27	3.27																	
		Physical contingency	1.57				0.39	0.39	0.39	0.39																	
		Engineering service	1.47				0.37	0.37	0.37	0.37																	
		Administration cost	0.65				0.16	0.16	0.16	0.16																	
		Total	16.78				4.20	4.20	4.20	4.20																	
	E	Construction cost	1.94																			0.97	0.97			
		Physical contingency	0.23																			0.12	0.12			
		Engineering service	0.22																			0.11	0.11			
		Administration cost	0.10																			0.05	0.05			
		Total	2.49																			1.25	1.25			
	F	Construction cost	4.14												1.38	1.38	1.38									
		Physical contingency	0.50												0.17	0.17	0.17									
		Engineering service	0.46												0.15	0.15	0.15									
		Administration cost	0.20												0.07	0.07	0.07									
		Total	5.30												1.77	1.77	1.77									
	G	Construction cost	2.67												0.89	0.89	0.89									
		Physical contingency	0.32												0.11	0.11	0.11									
		Engineering service	0.30												0.10	0.10	0.10									
		Administration cost	0.13												0.04	0.04	0.04									
		Total	3.42												1.14	1.14	1.14									
	H	Construction cost	1.40						0.70	0.70																
		Physical contingency	0.17						0.09	0.09																
		Engineering service	0.16						0.08	0.08																
		Administration cost	0.07						0.04	0.04																
		Total	1.80						0.90	0.90																
8	A	Construction cost	17.89								4.47	4.47	4.47	4.47												
		Physical contingency	2.15								0.54	0.54	0.54	0.54												
		Engineering service	2.00								0.50	0.50	0.50	0.50												
		Administration cost	0.88								0.22	0.22	0.22	0.22												
		Total	22.92								5.73	5.73	5.73	5.73												
9	A	Construction cost	1.00																			0.50	0.50			
		Physical contingency	0.12																			0.06	0.06			
		Engineering service	0.11																			0.06	0.06			
		Administration cost	0.05																			0.03	0.03			
		Total	1.28																			0.64	0.64			
	B	Construction cost	1.23												0.62	0.62										
		Physical contingency	0.15												0.08	0.08										
		Engineering service	0.14												0.07	0.07										
		Administration cost	0.06												0.03	0.03										
		Total	1.58												0.79	0.79										
14	B	Construction cost	2.52																			1.26	1.26			
		Physical contingency	0.30																			0.15	0.15			
		Engineering service	0.28																			0.14	0.14			
		Administration cost	0.12																			0.06	0.06			
		Total	3.22																			1.61	1.61			
	C	Construction cost	49.59																12.40	12.40	12.40	12.40					
		Physical contingency	5.95																1.49	1.49	1.49	1.49					
		Engineering service	5.55																1.39	1.39	1.39	1.39					
		Administration cost	2.44																0.61	0.61	0.61	0.61					
		Total	63.53																15.88	15.88	15.88	15.88					

Table 9.1.31 Disbursement Schedule for Irrigation Development (2,500ha/year) (6/6)

Unit: Million USD

WRA	WRU	Descriptiion	Total	Time Frame																						
				Short Term									Middle Term					Long Term									
				2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
15		Construction cost	14.85															3.71	3.71	3.71	3.71						
		Physical contingency	1.78															0.45	0.45	0.45	0.45						
	A	Engineering service	1.66															0.42	0.42	0.42	0.42						
		Administration cost	0.73															0.18	0.18	0.18	0.18						
		Total	19.02															4.76	4.76	4.76	4.76						
		Construction cost	27.61																				6.90	6.90	6.90	6.90	
		Physical contingency	3.31																				0.83	0.83	0.83	0.83	
	B	Engineering service	3.09																				0.77	0.77	0.77	0.77	
		Administration cost	1.36																				0.34	0.34	0.34	0.34	
		Total	35.37																				8.84	8.84	8.84	8.84	
		Construction cost	3.37																						1.12	1.12	1.12
		Physical contingency	0.40																						0.13	0.13	0.13
	C	Engineering service	0.38																						0.13	0.13	0.13
		Administration cost	0.17																						0.06	0.06	0.06
		Total	4.32																						1.44	1.44	1.44
		Construction cost	16.20								4.05	4.05	4.05	4.05													
		Physical contingency	1.94								0.49	0.49	0.49	0.49													
	E	Engineering service	1.81								0.45	0.45	0.45	0.45													
		Administration cost	0.80								0.20	0.20	0.20	0.20													
		Total	20.75								5.19	5.19	5.19	5.19													
		Construction cost	18.17												4.54	4.54	4.54	4.54									
		Physical contingency	2.18												0.55	0.55	0.55	0.55									
16	F	Engineering service	2.04												0.51	0.51	0.51	0.51									
		Administration cost	0.90												0.23	0.23	0.23	0.23									
		Total	23.29												5.82	5.82	5.82	5.82									
		Construction cost	8.99								2.25	2.25	2.25	2.25													
		Physical contingency	1.08								0.27	0.27	0.27	0.27													
	G	Engineering service	1.01								0.25	0.25	0.25	0.25													
		Administration cost	0.44								0.11	0.11	0.11	0.11													
		Total	11.52								2.88	2.88	2.88	2.88													
		Construction cost	0.08																							0.04	0.04
		Physical contingency	0.01																							0.01	0.01
	A	Engineering service	0.01																							0.01	0.01
		Administration cost	0.00																							0.00	0.00
		Total	0.10																							0.05	0.05
		Construction cost	4.66																						1.55	1.55	1.55
		Physical contingency	0.56																						0.19	0.19	0.19
17	B	Engineering service	0.52																						0.17	0.17	0.17
		Administration cost	0.23																						0.08	0.08	0.08
		Total	5.97																						1.99	1.99	1.99
		Construction cost	8.81												2.20	2.20	2.20	2.20									
		Physical contingency	1.06												0.27	0.27	0.27	0.27									
	C	Engineering service	0.99												0.25	0.25	0.25	0.25									
		Administration cost	0.43												0.11	0.11	0.11	0.11									
		Total	11.29												2.82	2.82	2.82	2.82									
		Construction cost	300.47	10.72	10.72	12.05	13.92	12.49	12.11	12.11	11.64	11.64	10.77	10.77	14.22	14.22	12.95	11.68	16.11	16.11	16.11	14.61	12.73	12.27	12.15	13.35	5.04
		Physical contingency	36.04	1.29	1.29	1.45	1.67	1.50	1.45	1.45	1.39	1.39	1.29	1.29	1.71	1.71	1.56	1.40	1.93	1.93	1.93	1.75	1.52	1.47	1.45	1.60	0.61
Total		Engineering service	33.65	1.20	1.20	1.35	1.57	1.40	1.36	1.36	1.30	1.30	1.21	1.21	1.60	1.60	1.45	1.31	1.80	1.80	1.80	1.63	1.42	1.37	1.36	1.49	0.57
		Administration cost	14.76	0.52	0.52	0.60	0.69	0.62	0.60	0.60	0.57	0.57	0.53	0.53	0.70	0.70	0.64	0.58	0.79	0.79	0.79	0.72	0.63	0.61	0.60	0.65	0.25
		Total	384.92	13.72	13.72	15.44	17.85	16.01	15.52	15.52	14.90	14.90	13.80	13.80	18.22	18.22	16.59	14.97	20.64	20.64	20.64	18.71	16.31	15.72	15.56	17.09	6.45
Accumulated Investment Cost				13.72	27.44	42.89	60.73	76.74	92.26	107.77	122.67	137.57	151.36	165.16	183.38	201.60	218.20	233.17	253.80	274.44	295.08	313.79	330.09	345.82	361.38	378.47	384.92

Table 9.1.32 Disbursement Schedule for Irrigation Development (5,000ha/year) (1/6)

Unit: Million USD

WRA	WRU	Descriptiion	Total	Time Frame																						
				Short Term									Middle Term					Long Term									
				2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
1	A	Construction cost	5.62	1.87	1.87	1.87																				
		Physical contingency	0.67	0.22	0.22	0.22																				
		Engineering service	0.63	0.21	0.21	0.21																				
		Administration cost	0.28	0.09	0.09	0.09																				
		Total	7.20	2.40	2.40	2.40																				
	B	Construction cost	6.97	2.32	2.32	2.32																				
		Physical contingency	0.84	0.28	0.28	0.28																				
		Engineering service	0.78	0.26	0.26	0.26																				
		Administration cost	0.34	0.11	0.11	0.11																				
		Total	8.93	2.98	2.98	2.98																				
	C	Construction cost	7.52	2.51	2.51	2.51																				
		Physical contingency	0.90	0.30	0.30	0.30																				
		Engineering service	0.84	0.28	0.28	0.28																				
		Administration cost	0.37	0.12	0.12	0.12																				
		Total	9.63	3.21	3.21	3.21																				
	E	Construction cost	5.32	1.77	1.77	1.77																				
		Physical contingency	0.64	0.21	0.21	0.21																				
		Engineering service	0.60	0.20	0.20	0.20																				
		Administration cost	0.26	0.09	0.09	0.09																				
		Total	6.82	2.27	2.27	2.27																				
	F	Construction cost	2.58						1.29	1.29																
		Physical contingency	0.31						0.16	0.16																
		Engineering service	0.29						0.15	0.15																
		Administration cost	0.13						0.07	0.07																
		Total	3.31						1.66	1.66																
	G	Construction cost	6.84	2.28	2.28	2.28																				
		Physical contingency	0.82	0.27	0.27	0.27																				
		Engineering service	0.77	0.26	0.26	0.26																				
		Administration cost	0.34	0.11	0.11	0.11																				
		Total	8.77	2.92	2.92	2.92																				
	K	Construction cost	8.08	2.69	2.69	2.69																				
		Physical contingency	0.97	0.32	0.32	0.32																				
		Engineering service	0.91	0.30	0.30	0.30																				
		Administration cost	0.40	0.13	0.13	0.13																				
		Total	10.36	3.45	3.45	3.45																				
	L	Construction cost	5.67	1.89	1.89	1.89																				
		Physical contingency	0.68	0.23	0.23	0.23																				
		Engineering service	0.64	0.21	0.21	0.21																				
		Administration cost	0.28	0.09	0.09	0.09																				
		Total	7.27	2.42	2.42	2.42																				
	M	Construction cost	6.14			2.05	2.05	2.05																		
		Physical contingency	0.74			0.25	0.25	0.25																		
		Engineering service	0.69			0.23	0.23	0.23																		
		Administration cost	0.30			0.10	0.10	0.10																		
		Total	7.87			2.62	2.62	2.62																		
	N	Construction cost	2.68												1.34	1.34										
		Physical contingency	0.32												0.16	0.16										
		Engineering service	0.30												0.15	0.15										
		Administration cost	0.13												0.07	0.07										
		Total	3.43												1.72	1.72										

Table 9.1.32 Disbursement Schedule for Irrigation Development (5,000ha/year) (2/6)

Unit: Million USD

WRA	WRU	Description	Total	Time Frame																							
				Short Term									Middle Term					Long Term										
				2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
1	O	Construction cost	7.50								2.50	2.50	2.50														
		Physical contingency	0.90								0.30	0.30	0.30														
		Engineering service	0.84								0.28	0.28	0.28														
		Administration cost	0.37								0.12	0.12	0.12														
		Total	9.61								3.20	3.20	3.20														
	P	Construction cost	5.77			1.92	1.92	1.92																			
		Physical contingency	0.69			0.23	0.23	0.23																			
		Engineering service	0.65			0.22	0.22	0.22																			
		Administration cost	0.28			0.09	0.09	0.09																			
		Total	7.39			2.46	2.46	2.46																			
	R	Construction cost	12.34	3.09	3.09	3.09	3.09																				
		Physical contingency	1.48	0.37	0.37	0.37	0.37																				
		Engineering service	1.38	0.35	0.35	0.35	0.35																				
		Administration cost	0.61	0.15	0.15	0.15	0.15																				
		Total	15.81	3.95	3.95	3.95	3.95																				
	S	Construction cost	7.17	2.39	2.39	2.39																					
		Physical contingency	0.86	0.29	0.29	0.29																					
		Engineering service	0.80	0.27	0.27	0.27																					
		Administration cost	0.35	0.12	0.12	0.12																					
		Total	9.18	3.06	3.06	3.06																					
	T	Construction cost	0.86						0.43	0.43																	
		Physical contingency	0.10						0.05	0.05																	
		Engineering service	0.10						0.05	0.05																	
		Administration cost	0.04						0.02	0.02																	
		Total	1.10						0.55	0.55																	
2	A	Construction cost	0.63																			0.32	0.32				
		Physical contingency	0.08																			0.04	0.04				
		Engineering service	0.07																			0.04	0.04				
		Administration cost	0.03																			0.02	0.02				
		Total	0.81																			0.41	0.41				
	B	Construction cost	0.58								0.29	0.29															
		Physical contingency	0.07								0.04	0.04															
		Engineering service	0.07								0.04	0.04															
		Administration cost	0.03								0.02	0.02															
		Total	0.75								0.38	0.38															
	C	Construction cost	0.14						0.07	0.07																	
		Physical contingency	0.02						0.01	0.01																	
		Engineering service	0.02						0.01	0.01																	
		Administration cost	0.01						0.01	0.01																	
		Total	0.19						0.10	0.10																	
	D	Construction cost	0.25																			0.13	0.13				
		Physical contingency	0.03																			0.02	0.02				
		Engineering service	0.03																			0.02	0.02				
		Administration cost	0.01																			0.01	0.01				
		Total	0.32																			0.16	0.16				

Table 9.1.32 Disbursement Schedule for Irrigation Development (5,000ha/year) (3/6)

Unit: Million USD

WRA	WRU	Description	Total	Time Frame																						
				Short Term									Middle Term					Long Term									
				2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
3	A	Construction cost	5.10																			1.70	1.70	1.70			
		Physical contingency	0.61																			0.20	0.20	0.20			
		Engineering service	0.57																			0.19	0.19	0.19			
		Administration cost	0.25																			0.08	0.08	0.08			
		Total	6.53																			2.18	2.18	2.18			
	B	Construction cost	4.63																							2.32	2.32
		Physical contingency	0.56																							0.28	0.28
		Engineering service	0.52																							0.26	0.26
		Administration cost	0.23																							0.12	0.12
		Total	5.94																							2.97	2.97
	C	Construction cost	9.81												2.45	2.45	2.45	2.45									
		Physical contingency	1.18												0.30	0.30	0.30	0.30									
		Engineering service	1.10												0.28	0.28	0.28	0.28									
		Administration cost	0.48												0.12	0.12	0.12	0.12									
		Total	12.57												3.14	3.14	3.14	3.14									
	D	Construction cost	6.23																					2.08	2.08	2.08	
		Physical contingency	0.75																					0.25	0.25	0.25	
		Engineering service	0.70																					0.23	0.23	0.23	
		Administration cost	0.31																					0.10	0.10	0.10	
		Total	7.99																					2.66	2.66	2.66	
	E	Construction cost	7.02																						2.34	2.34	2.34
		Physical contingency	0.84																						0.28	0.28	0.28
		Engineering service	0.79																						0.26	0.26	0.26
		Administration cost	0.35																						0.12	0.12	0.12
		Total	9.00																						3.00	3.00	3.00
	F	Construction cost	2.03																						1.02	1.02	
		Physical contingency	0.24																						0.12	0.12	
		Engineering service	0.23																						0.12	0.12	
		Administration cost	0.10																						0.05	0.05	
		Total	2.60																						1.30	1.30	
4	A	Construction cost	0.16																			0.08	0.08				
		Physical contingency	0.02																			0.01	0.01				
		Engineering service	0.02																			0.01	0.01				
		Administration cost	0.01																			0.01	0.01				
		Total	0.21																			0.11	0.11				
	B	Construction cost	2.88								1.44	1.44															
		Physical contingency	0.35								0.18	0.18															
		Engineering service	0.32								0.16	0.16															
		Administration cost	0.14								0.07	0.07															
		Total	3.69								1.85	1.85															
	C	Construction cost	0.66			0.33	0.33																				
		Physical contingency	0.08			0.04	0.04																				
		Engineering service	0.07			0.04	0.04																				
		Administration cost	0.03			0.02	0.02																				
		Total	0.84			0.42	0.42																				

Table 9.1.32 Disbursement Schedule for Irrigation Development (5,000ha/year) (4/6)

Unit: Million USD

WRA	WRU	Descriptiion	Total	Time Frame																						
				Short Term									Middle Term					Long Term									
				2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
4	D	Construction cost	1.80	0.90	0.90																						
		Physical contingency	0.22	0.11	0.11																						
		Engineering service	0.20	0.10	0.10																						
		Administration cost	0.09	0.05	0.05																						
		Total	2.31	1.16	1.16																						
	E	Construction cost	0.95	0.48	0.48																						
		Physical contingency	0.11	0.06	0.06																						
		Engineering service	0.11	0.06	0.06																						
		Administration cost	0.05	0.03	0.03																						
		Total	1.22	0.61	0.61																						
	F	Construction cost	0.18	0.09	0.09																						
		Physical contingency	0.02	0.01	0.01																						
		Engineering service	0.02	0.01	0.01																						
		Administration cost	0.01	0.01	0.01																						
		Total	0.23	0.12	0.12																						
5	C	Construction cost	5.21																				2.61	2.61			
		Physical contingency	0.63																				0.32	0.32			
		Engineering service	0.58																				0.29	0.29			
		Administration cost	0.26																				0.13	0.13			
		Total	6.68																				3.34	3.34			
	D	Construction cost	3.92																			1.96	1.96				
		Physical contingency	0.47																			0.24	0.24				
		Engineering service	0.44																			0.22	0.22				
		Administration cost	0.19																			0.10	0.10				
		Total	5.02																			2.51	2.51				
	E	Construction cost	15.15				3.79	3.79	3.79	3.79																	
		Physical contingency	1.82				0.46	0.46	0.46	0.46																	
		Engineering service	1.70				0.43	0.43	0.43	0.43																	
		Administration cost	0.75				0.19	0.19	0.19	0.19																	
		Total	19.42				4.86	4.86	4.86	4.86																	
	F	Construction cost	11.88				2.97	2.97	2.97	2.97																	
		Physical contingency	1.43				0.36	0.36	0.36	0.36																	
		Engineering service	1.33				0.33	0.33	0.33	0.33																	
		Administration cost	0.59				0.15	0.15	0.15	0.15																	
		Total	15.23				3.81	3.81	3.81	3.81																	
7	A	Construction cost	21.44				5.36	5.36	5.36	5.36																	
		Physical contingency	2.57				0.64	0.64	0.64	0.64																	
		Engineering service	2.40				0.60	0.60	0.60	0.60																	
		Administration cost	1.06				0.27	0.27	0.27	0.27																	
		Total	27.47				6.87	6.87	6.87	6.87																	
	B	Construction cost	8.95								2.98	2.98	2.98														
		Physical contingency	1.07								0.36	0.36	0.36														
		Engineering service	1.00								0.33	0.33	0.33														
		Administration cost	0.44								0.15	0.15	0.15														
		Total	11.46								3.82	3.82	3.82														
	C	Construction cost	9.91				2.48	2.48	2.48	2.48																	
		Physical contingency	1.19				0.30	0.30	0.30	0.30																	
		Engineering service	1.11				0.28	0.28	0.28	0.28																	
		Administration cost	0.49				0.12	0.12	0.12	0.12																	
		Total	12.70				3.18	3.18	3.18	3.18																	

Table 9.1.32 Disbursement Schedule for Irrigation Development (5,000ha/year) (5/6)

Unit: Million USD

WRA	WRU	Description	Total	Time Frame																							
				Short Term									Middle Term					Long Term										
				2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
7	D	Construction cost	26.23				6.56	6.56	6.56	6.56																	
		Physical contingency	3.15				0.79	0.79	0.79	0.79																	
		Engineering service	2.94				0.74	0.74	0.74	0.74																	
		Administration cost	1.29				0.32	0.32	0.32	0.32																	
		Total	33.61				8.40	8.40	8.40	8.40																	
	E	Construction cost	3.89																			1.95	1.95			
		Physical contingency	0.47																			0.24	0.24			
		Engineering service	0.44																			0.22	0.22			
		Administration cost	0.19																			0.10	0.10			
		Total	4.99																			2.50	2.50			
	F	Construction cost	8.47								2.82	2.82	2.82														
		Physical contingency	1.02								0.34	0.34	0.34														
		Engineering service	0.95								0.32	0.32	0.32														
		Administration cost	0.42								0.14	0.14	0.14														
		Total	10.86								3.62	3.62	3.62														
	G	Construction cost	5.46								1.82	1.82	1.82														
		Physical contingency	0.66								0.22	0.22	0.22														
		Engineering service	0.61								0.20	0.20	0.20														
		Administration cost	0.27								0.09	0.09	0.09														
		Total	7.00								2.33	2.33	2.33														
	H	Construction cost	2.81						1.41	1.41																	
		Physical contingency	0.34						0.17	0.17																	
		Engineering service	0.32						0.16	0.16																	
		Administration cost	0.14						0.07	0.07																	
		Total	3.61						1.81	1.81																	
8	A	Construction cost	44.40												11.10	11.10	11.10	11.10									
		Physical contingency	5.33												1.33	1.33	1.33	1.33									
		Engineering service	4.97												1.24	1.24	1.24	1.24									
		Administration cost	2.19												0.55	0.55	0.55	0.55									
		Total	56.89												14.22	14.22	14.22	14.22									
9	A	Construction cost	2.06																				1.03	1.03			
		Physical contingency	0.25																				0.13	0.13			
		Engineering service	0.23																				0.12	0.12			
		Administration cost	0.10																				0.05	0.05			
		Total	2.64																				1.32	1.32			
	B	Construction cost	2.54												1.27	1.27											
		Physical contingency	0.30												0.15	0.15											
		Engineering service	0.28												0.14	0.14											
		Administration cost	0.12												0.06	0.06											
		Total	3.24												1.62	1.62											
14	B	Construction cost	3.16																							1.58	1.58
		Physical contingency	0.38																							0.19	0.19
		Engineering service	0.35																							0.18	0.18
		Administration cost	0.16																							0.08	0.08
		Total	4.05																							2.03	2.03
	C	Construction cost	120.04																30.01	30.01	30.01	30.01					
		Physical contingency	14.40																3.60	3.60	3.60	3.60					
		Engineering service	13.44																3.36	3.36	3.36	3.36					
		Administration cost	5.92																1.48	1.48	1.48	1.48					
		Total	153.80																38.45	38.45	38.45	38.45					

Table 9.1.32 Disbursement Schedule for Irrigation Development (5,000ha/year) (6/6)

Unit: Million USD

WRA	WRU	Descriptiion	Total	Time Frame																						
				Short Term									Middle Term					Long Term									
				2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
15	A	Construction cost	34.35															8.59	8.59	8.59	8.59						
		Physical contingency	4.12															1.03	1.03	1.03	1.03						
		Engineering service	3.85															0.96	0.96	0.96	0.96						
		Administration cost	1.69															0.42	0.42	0.42	0.42						
		Total	44.01															11.00	11.00	11.00	11.00						
	B	Construction cost	55.33																				13.83	13.83	13.83	13.83	
		Physical contingency	6.64																				1.66	1.66	1.66	1.66	
		Engineering service	6.20																				1.55	1.55	1.55	1.55	
		Administration cost	2.73																				0.68	0.68	0.68	0.68	
		Total	70.90																				17.73	17.73	17.73	17.73	
	C	Construction cost	6.75																						2.25	2.25	2.25
		Physical contingency	0.81																						0.27	0.27	0.27
		Engineering service	0.76																						0.25	0.25	0.25
		Administration cost	0.33																						0.11	0.11	0.11
		Total	8.65																						2.88	2.88	2.88
16	E	Construction cost	32.45								8.11	8.11	8.11	8.11													
		Physical contingency	3.89								0.97	0.97	0.97	0.97													
		Engineering service	3.63								0.91	0.91	0.91	0.91													
		Administration cost	1.60								0.40	0.40	0.40	0.40													
		Total	41.57								10.39	10.39	10.39	10.39													
	F	Construction cost	36.41											9.10	9.10	9.10	9.10										
		Physical contingency	4.37											1.09	1.09	1.09	1.09										
		Engineering service	4.08											1.02	1.02	1.02	1.02										
		Administration cost	1.79											0.45	0.45	0.45	0.45										
		Total	46.65											11.66	11.66	11.66	11.66										
	G	Construction cost	18.02								4.51	4.51	4.51	4.51													
		Physical contingency	2.16								0.54	0.54	0.54	0.54													
		Engineering service	2.02								0.51	0.51	0.51	0.51													
		Administration cost	0.89								0.22	0.22	0.22	0.22													
		Total	23.09								5.77	5.77	5.77	5.77													
17	A	Construction cost	0.20																							0.10	0.10
		Physical contingency	0.02																							0.01	0.01
		Engineering service	0.02																							0.01	0.01
		Administration cost	0.01																							0.01	0.01
		Total	0.25																							0.13	0.13
	B	Construction cost	9.33																						3.11	3.11	3.11
		Physical contingency	1.12																						0.37	0.37	0.37
		Engineering service	1.05																						0.35	0.35	0.35
		Administration cost	0.46																						0.15	0.15	0.15
		Total	11.96																						3.99	3.99	3.99
	C	Construction cost	19.13												4.78	4.78	4.78	4.78									
		Physical contingency	2.30												0.58	0.58	0.58	0.58									
		Engineering service	2.14												0.54	0.54	0.54	0.54									
		Administration cost	0.94												0.24	0.24	0.24	0.24									
		Total	24.51												6.13	6.13	6.13	6.13									
Total		Construction cost	641.60	22.28	22.28	25.12	28.54	25.12	24.35	24.35	24.47	24.47	22.74	21.72	30.05	30.05	27.44	26.92	38.60	38.60	38.60	34.19	23.59	23.19	24.62	28.62	11.70
		Physical contingency	77.01	2.67	2.67	3.01	3.43	3.02	2.93	2.93	2.94	2.94	2.73	2.61	3.61	3.61	3.30	3.23	4.63	4.63	4.63	4.10	2.84	2.79	2.95	3.43	1.40
		Engineering service	71.90	2.50	2.50	2.82	3.20	2.82	2.74	2.74	2.74	2.74	2.55	2.43	3.36	3.36	3.07	3.02	4.32	4.32	4.32	3.83	2.65	2.60	2.77	3.21	1.31
		Administration cost	31.63	1.10	1.10	1.23	1.41	1.24	1.21	1.21	1.21	1.21	1.12	1.07	1.48	1.48	1.35	1.33	1.90	1.90	1.90	1.68	1.16	1.14	1.22	1.42	0.58
		Total	822.14	28.55	28.55	32.18	36.57	32.19	31.21	31.21	31.36	31.36	29.14	27.83	38.49	38.49	35.16	34.50	49.45	49.45	49.45	43.81	30.24	29.72	31.56	36.68	14.99
Accumulated Investment Cost				28.55	57.11	89.28	125.85	158.05	189.26	220.47	251.83	283.19	312.34	340.16	378.65	417.14	452.30	486.79	536.25	585.70	635.15	678.96	709.19	738.91	770.47	807.15	822.14

9.2 Economic Evaluation of Projects

9.2.1 Methodology

(1) General

The main objective of the economic evaluation here is to examine the investment efficiency of the project components of the Master Plan from the viewpoint of national economy using cost-benefit analysis in cases where it can be applied. Market prices have been converted to economic ones where the influence of market distortion is removed (the so-called shadow prices). Opportunity costs are used for the costs of goods and services whose markets do not exist. Willingness-to-pay is used for benefits whose markets do not exist. Internal Rate of Return (IRR) is used here as the indicator of the efficiency of a project investment. IRR is defined as the discount rate which makes the present value of the flow of costs incurred in the project the same as that of benefit, or which makes the Net Present Value (NPV) 0 (zero), showing what percentage of profit the investment will be paid back. IRR used in economic evaluation is called Economic Internal Rate of Return (EIRR).

(2) Precondition

The following preconditions are assumed in the economic evaluation. Additional preconditions will be clarified as necessary.

1) With-Project and Without-Project

"Without-project" is the case where the water resources are managed by the currently existing systems. "With-project" is the case where the project is implemented into the currently existing systems. By comparing the with-project and the without-project situations, costs and benefits are estimated to calculate EIRR.

2) Evaluation Period

The evaluation period is 2012 to 2060.

3) Standard Conversion Factor (SCF)

SCF is the ratio of the economic price value of all goods in an economy at their border price equivalent values to their domestic market price value. Prices of goods and services procured domestically are converted to economic ones by the SCF. This project employs an SCF of 1.0 (one point zero), which is the value employed in Ministry of Water Development (2003), "The Integrated Water Resources Development Plan for Lake Malawi and Shire River System."

4) Other Preconditions

Price Level	:	Year 2012
Social Discount Rate	:	10% (in accordance with the above-mentioned document of the Ministry of Water Development)

(3) Costs

Additional costs of projects are included in the evaluation by comparing the with-project and the without-project situations. The additional costs are calculated in the form of cash flow of each year during the evaluation period. The following cost items are calculated:

1) Investment Cost

Investment cost includes costs of construction of the facility, equipment, and consulting services. Economic evaluation excludes price escalation but includes physical contingencies.

2) Operation and Maintenance (O&M) Cost

O&M costs for each year are included. Price escalation is not included.

3) Depreciation

Since the money allocated and subject to depreciation is not actually spent at that time, it is not included in the cost items.

(4) Benefits

Additional benefits are included in the evaluation by comparing with-project and without-project. The benefits are calculated in the form of cash flow in each year during the evaluation period. Since each component has different effects, their benefits should be identified for each component. Contents, expected effects and the benefits of components are summarized in the following table.

Table 9.2.1 Expected Effects, and Benefit of Components

Component	Expected Effect	Benefit
• Domestic and Industrial Water Supply	To increase water supply in urban and Rural Water Supply	Living condition of the people improves.
• Irrigation	To increase agricultural productions	Income of farmers increases.
• Navigation	To improve the water transportation	Transportation cost decreases.
• Hydropower Generation	To increase the electric power generation	GDP increases. Living condition of the people improves.
• Water Quality Conservation	To conserve the water quality	Living environment of the residents improves.

9.2.2 Cost-Benefit Analysis of Projects

Cost-Benefit Analysis (CBA) is conducted for the projects of Domestic and Industrial Water Supply component excluding rural community water supply, and Irrigation component. CBA is necessary for the calculation of EIRR and it is not suitable for projects of rural community water supply because it is calculated for checking the efficiency of investment or GDP increase as mentioned above but projects of rural water supply are not conducted for GDP increase but for meeting the basic human needs of rural communities as well as correcting the disparities between urban and Rural Water Supply from the viewpoint of political integration.

(1) Project Cost

The following items are included in the cost calculation:

- Construction
- Engineering services
- Physical contingencies
- Administration cost
- O&M
- Replacement (if any)

These cost items are converted to economic ones as mentioned above, but they are the same figures since 1.0 is employed for SCF. Details on the project costs are mentioned in **Section 9.1, Cost Estimation**.

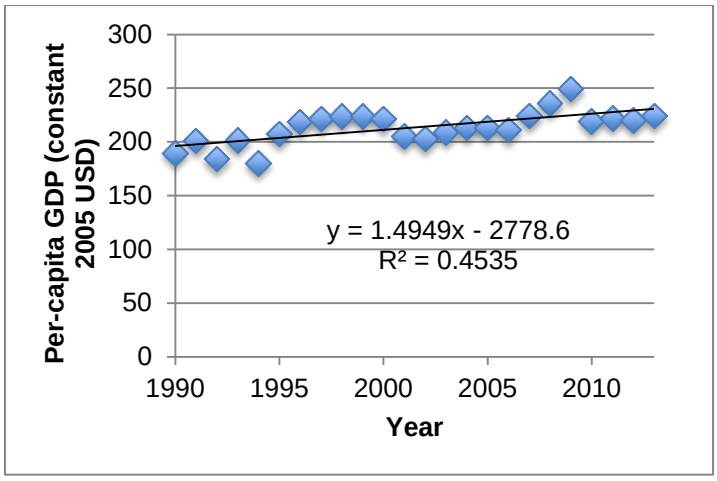
(2) Project Benefit

1) Domestic and Industrial Water Supply

The benefit of the project of this component is calculated by the willingness-to-pay (WTP) for the supplied water.

Per-capita GDP Growth Rate

WTP is assumed to increase in accordance with the per-capita GDP Growth rate. Per-capita GDP in the future is projected with utilizing a result of the regression analysis of the World Bank data. The result of the regression analysis of past per-capita GDP data of the World Bank is presented below.



Source: World Bank data

Figure 9.2.1 Regression Analysis of Per-capita GDP

$y = 1.4949x - 2778.6$

$R^2 = 0.45348$

Where;

x: year

y: per-capita GDP (constant 2005 USD) in year x

R^2: determination coefficient

By using this result, future per-capita GDP and its real growth rates are projected as follows:

Table 9.2.2 Future Projections of Per-capita GDP and Real Growth Rate

	2012	2015	2020	2025	2030	2035
Per-capita GDP (constant 2005 USD)	229.14	233.62	240.10	248.57	256.05	263.52
Growth Rate	0.66%	0.64%	0.62%	0.61%	0.59%	0.57%

Source: World Bank data

Willingness-to-Pay (WTP)

According to JICA (2002), "Study on Economic Evaluation Methodology for Development Study, Part 9. Water Supply " (Japanese), various research results of WTP for supplied water by using the Contingent Valuation Method (CVM) fall in the range of 3-5% of disposable income. Thus, the Project employs 5% of disposable income.

The Project uses consumption data of The National Statistics Office (NSO), "Integrated Household Survey 2010 - 2011" instead of disposal income due to availability of data.

Table 9.2.3 Average Per-capita Consumption in 2011

	MK	USD	Applied To
Lilongwe City	106,735	681.9	Four Cities
Blantyre City	152,907	976.9	
Mzuzu City	98,302	628.1	
Zomba City	115,604	738.6	
Nortern Region	46,160	294.9	Towns
Central Region	57,455	367.1	
Southern Region	54,269	346.7	
Rural North	39,366	251.5	Market Centers
Rural Center	48,320	308.7	
Rural South	39,101	249.8	

Source: NSO, "Integrated Household Survey 2010-2011" and Project Team

The calculation result of WTP for the urban water supply is shown below:

Table 9.2.4 Calculation Result of WTP for Urban Water Supply (Four Cities)

Region	Calculation Item	2012	2015	2020	2025	2030	2035
Lilongwe	Increase in Water Supply by Project (m^3/day)	0	28,211	60,000	105,951	144,960	191,206
	Servded Population (pers.)	0	104,997	318,084	562,571	778,058	1,027,696
	Per-capita Consumption (l/c/day)	93	106	127	135	135	135
	WTP for Water Supply (USD/c/year)	40.4	41.2	42.5	43.8	45.1	46.5
	WTP for Water Supply (USD/m^3/day)	1.18	1.07	0.92	0.89	0.92	0.94
	Total WTP (USD/year)	0	10,969,501	20,129,884	34,393,179	48,470,707	65,800,750
Blantiyre	Increase in Water Supply by Project (m^3/day)	0	0	16,638	40,223	68,376	103,338
	Servded Population (pers.)	0	0	161,947	404,271	636,881	827,879
	Per-capita Consumption (l/c/day)	67	69	73	78	84	90
	WTP for Water Supply (USD/c/year)	57.9	59.0	60.9	62.8	64.7	66.6
	WTP for Water Supply (USD/m^3/day)	2.37	2.34	2.29	2.21	2.11	2.03
	Total WTP (USD/year)	0	0	13,878,211	32,374,598	52,639,185	76,418,985
Mzuzu	Increase in Water Supply by Project (m^3/day)	0	8,773	20,548	34,178	45,867	59,161
	Servded Population (pers.)	0	0	51,928	119,750	170,990	226,914
	Per-capita Consumption (l/c/day)	65	77	93	102	106	110
	WTP for Water Supply (USD/c/year)	37.2	37.9	39.1	40.4	41.6	42.8
	WTP for Water Supply (USD/m^3/day)	1.57	1.35	1.15	1.08	1.07	1.06
	Total WTP (USD/year)	0	0	8,644,588	13,516,189	17,955,695	22,967,472
Zomba	Increase in Water Supply by Project (m^3/day)	0	524	5,864	9,918	13,636	17,870
	Servded Population (pers.)	0	7,008	23,407	42,325	64,150	89,329
	Per-capita Consumption (l/c/day)	100	101	101	101	101	101
	WTP for Water Supply (USD/c/year)	43.8	44.6	46.0	47.5	48.9	50.3

Region	Calculation Item	2012	2015	2020	2025	2030	2035
	WTP for Water Supply (USD/m^3/day)	1.19	1.21	1.25	1.29	1.32	1.36
	Total WTP (USD/year)	0	231,185	2,669,657	4,655,301	6,593,129	8,892,286

Note: USD is converted to 2012 level.
Source: World Bank data

Table 9.2.5 Calculation Result of WTP for Urban Water Supply (Towns)

Region	Calculation Item	2012	2015	2020	2025	2030	2035
Northern	Increase in Water Supply by Project (m^3/day)	0	0	9,330	18,613	33,207	48,799
	Served Population (pers.)	0	0	85,028	138,171	212,658	302,228
	Per-capita Consumption (l/c/day)	93	93	93	130	130	130
	WTP for Water Supply (USD/c/year)	17.5	17.8	18.4	19.0	19.5	20.1
	WTP for Water Supply (USD/m^3/day)	0.51	0.52	0.54	0.40	0.41	0.42
	Total WTP (USD/year)	0	0	1,844,251	2,713,516	4,986,622	7,542,050
Central	Increase in Water Supply by Project (m^3/day)	0	0	17,170	33,145	63,720	99,885
	Served Population (pers.)	0	0	142,726	231,929	406,815	626,719
	Per-capita Consumption (l/c/day)	93	93	93	130	130	130
	WTP for Water Supply (USD/c/year)	21.7	22.2	22.9	23.6	24.3	25.0
	WTP for Water Supply (USD/m^3/day)	0.64	0.65	0.67	0.50	0.51	0.53
	Total WTP (USD/year)	0	0	4,224,182	6,014,457	11,910,293	19,214,947
Southern	Increase in Water Supply by Project (m^3/day)	0	0	15,450	29,142	53,353	80,617
	Served Population (pers.)	0	0	125,314	203,635	334,522	495,982
	Per-capita Consumption (l/c/day)	93	93	93	130	130	130
	WTP for Water Supply (USD/c/year)	20.5	20.9	21.6	22.3	23.0	23.6
	WTP for Water Supply (USD/m^3/day)	0.61	0.62	0.64	0.47	0.48	0.50
	Total WTP (USD/year)	0	0	3,590,215	4,994,893	9,419,405	14,648,516

Note: USD is converted to 2012 level.
Source: World Bank data

The calculation result of WTP for the rural water supply is shown below:

Table 9.2.6 Calculation Result of WTP for Rural Water Supply (Market Centers)

Region	Calculation Item	2012	2015	2020	2025	2030	2035
Northern	Increase in Water Supply by Project (m^3/day)	0	0	5,262	11,133	13,743	15,858
	Served Population (pers.)	0	0	49,232	112,196	150,926	193,228
	Per-capita Consumption (l/c/day)	41.0	41.0	41.0	46.0	46.0	46.0
	WTP for Water Supply (USD/c/year)	14.9	15.2	15.7	16.2	16.6	17.1
	WTP for Water Supply (USD/m^3/day)	1.00	1.02	1.05	0.96	0.99	1.02
	Total WTP (USD/year)	0	0	954,704	1,898,827	2,320,377	2,655,238
Central	Increase in Water Supply by Project (m^3/day)	0	0	6,436	15,820	21,691	26,595
	Served Population (pers.)	0	0	93,014	215,467	305,102	403,177
	Per-capita Consumption (l/c/day)	41.0	41.0	41.0	46.0	46.0	46.0
	WTP for Water Supply (USD/c/year)	18.3	18.6	19.2	19.8	20.4	21.0
	WTP for Water Supply (USD/m^3/day)	1.22	1.25	1.29	1.18	1.22	1.25
	Total WTP (USD/year)	0	0	3,020,652	6,822,907	9,636,417	12,159,809
Southern	Increase in Water Supply by Project (m^3/day)	0	0	5,744	12,652	18,612	21,823
	Served Population (pers.)	0	0	72,758	167,116	224,306	288,529
	Per-capita Consumption (l/c/day)	41.0	41.0	41.0	46.0	46.0	46.0
	WTP for Water Supply (USD/c/year)	14.8	15.1	15.6	16.1	16.5	17.0
	WTP for Water Supply (USD/m^3/day)	0.99	1.01	1.04	0.96	0.98	1.01
	Total WTP (USD/year)	0	0	2,181,493	4,415,592	6,690,698	8,074,086

Note: USD is converted to 2012 level.
Source: World Bank data

The calculation result of WTP for the urban water supply is shown below:

Table 9.2.7 Calculation Result of WTP for Urban Water Supply (Four Cities)

Region	Calculation Item	2012	2015	2020	2025	2030	2035
Lilongwe	Increase in Water Supply by Project (m^3/day)	0	28,211	60,000	105,951	144,960	191,206
	Per-capita Consumption (l/c/day)	93	106	127	135	135	135
	WTP for Water Supply (USD/c/year)	40.4	41.2	42.5	43.8	45.1	46.5
	WTP for Water Supply (USD/m^3/day)	1.18	1.07	0.92	0.89	0.92	0.94
	Total WTP (USD/year)	0	10,969,501	20,129,884	34,393,179	48,470,707	65,800,750
Blantiyre	Increase in Water Supply by Project (m^3/day)	0	0	16,638	40,223	68,376	103,338
	Per-capita Consumption (l/c/day)	67	69	73	78	84	90
	WTP for Water Supply (USD/c/year)	57.9	59.0	60.9	62.8	64.7	66.6
	WTP for Water Supply (USD/m^3/day)	2.37	2.34	2.29	2.21	2.11	2.03
	Total WTP (USD/year)	0	0	13,878,211	32,374,598	52,639,185	76,418,985
Mzuzu	Increase in Water Supply by Project (m^3/day)	0	8,773	20,548	34,178	45,867	59,161
	Per-capita Consumption (l/c/day)	65	77	93	102	106	110
	WTP for Water Supply (USD/c/year)	37.2	37.9	39.1	40.4	41.6	42.8
	WTP for Water Supply (USD/m^3/day)	1.57	1.35	1.15	1.08	1.07	1.06
	Total WTP (USD/year)	0	0	8,644,588	13,516,189	17,955,695	22,967,472
Zomba	Increase in Water Supply by Project (m^3/day)	0	524	5,864	9,918	13,636	17,870
	Per-capita Consumption (l/c/day)	100	101	101	101	101	101
	WTP for Water Supply (USD/c/year)	43.8	44.6	46.0	47.5	48.9	50.3
	WTP for Water Supply (USD/m^3/day)	1.19	1.21	1.25	1.29	1.32	1.36
	Total WTP (US/year)	0	231,185	2,669,657	4,655,301	6,593,129	8,892,286

Note: USD is converted to 2012 level.
Source: World Bank data

Table 9.2.8 Calculation Result of WTP for Urban Water Supply (Towns)

Region	Calculation Item	2012	2015	2020	2025	2030	2035
Northern	Increase in Water Supply by Project (m^3/day)	0	0	9,330	18,613	33,207	48,799
	Per-capita Consumption (l/c/day)	93	93	93	130	130	130
	WTP for Water Supply (USD/c/year)	17.5	17.8	18.4	19.0	19.5	20.1
	WTP for Water Supply (USD/m^3/day)	0.51	0.52	0.54	0.40	0.41	0.42
	Total WTP (USD/year)	0	0	1,844,251	2,713,516	4,986,622	7,542,050
Central	Increase in Water Supply by Project (m^3/day)	0	0	17,170	33,145	63,720	99,885
	Per-capita Consumption (l/c/day)	93	93	93	130	130	130
	WTP for Water Supply (USD/c/year)	21.7	22.2	22.9	23.6	24.3	25.0
	WTP for Water Supply (USD/m^3/day)	0.64	0.65	0.67	0.50	0.51	0.53
	Total WTP (USD/year)	0	0	4,224,182	6,014,457	11,910,293	19,214,947
Southern	Increase in Water Supply by Project (m^3/day)	0	0	15,450	29,142	53,353	80,617
	Per-capita Consumption (l/c/day)	93	93	93	130	130	130
	WTP for Water Supply (USD/c/year)	20.5	20.9	21.6	22.3	23.0	23.6
	WTP for Water Supply (USD/m^3/day)	0.61	0.62	0.64	0.47	0.48	0.50
	Total WTP (USD/year)	0	0	3,590,215	4,994,893	9,419,405	14,648,516

Note: USD is converted to 2012 level.
Source: World Bank data

The calculation result of WTP for the rural water supply is shown below:

Table 9.2.9 Calculation Result of WTP for Rural Water Supply (Market Centers)

Region	Calculation Item	2012	2015	2020	2025	2030	2035
Northern	Increase in Water Supply by Project (m^3/day)	0	0	5,262	11,133	13,743	15,858
	Per-capita Consumption (l/c/day)	41.0	41.0	41.0	46.0	46.0	46.0
	WTP for Water Supply (USD/c/year)	14.9	15.2	15.7	16.2	16.6	17.1
	WTP for Water Supply (USD/m^3/day)	1.00	1.02	1.05	0.96	0.99	1.02
	Total WTP (USD/year)	0	0	954,704	1,898,827	2,320,377	2,655,238
Central	Increase in Water Supply by Project (m^3/day)	0	0	6,436	15,820	21,691	26,595
	Per-capita Consumption (l/c/day)	41.0	41.0	41.0	46.0	46.0	46.0
	WTP for Water Supply (USD/c/year)	18.3	18.6	19.2	19.8	20.4	21.0
	WTP for Water Supply (USD/m^3/day)	1.22	1.25	1.29	1.18	1.22	1.25
	Total WTP (USD/year)	0	0	3,020,652	6,822,907	9,636,417	12,159,809
Southern	Increase in Water Supply by Project (m^3/day)	0	0	5,744	12,652	18,612	21,823
	Per-capita Consumption (l/c/day)	41.0	41.0	41.0	46.0	46.0	46.0
	WTP for Water Supply (USD/c/year)	14.8	15.1	15.6	16.1	16.5	17.0
	WTP for Water Supply (USD/m^3/day)	0.99	1.01	1.04	0.96	0.98	1.01
	Total WTP (USD/year)	0	0	2,181,493	4,415,592	6,690,698	8,074,086

Note: USD is converted to 2012 level.
Source: World Bank data

2) Irrigation

The benefit of the project of this component is the increase in income of farmers due to increase in agricultural production. Combination of irrigation development and change of variety to those grow faster contributes the increase in harvest in a year. It is assumed that maize and rice are cropped in the newly irrigated area, where they are cropped twice in a year from once in a year thanks to the irrigation development. In other words, productions of maize and rice will be doubled in the newly irrigated area by the project.

Economic prices of maize and rice are calculated based on the international price data of the Food and Agriculture Organization (FAO).

Table 9.2.10 International Prices of Crops

	Maize		Rice		Exchange Rate
	(USD/Ton)	(MK/Ton)	(USD/Ton)	(MK/Ton)	(MK/USD)
2009	169.42	583.48	23,917	82,368	141.17
2010	195.26	520.00	29,384	78,253	150.49
2011	289.25	566.24	45,272	88,625	156.52
2012	270.42	590.39	88,968	194,238	329.00
2013	243.81	532.67	88,846	194,109	364.41

Note: Current price

Source: FAO and the World Bank

Table 9.2.11 Economic Prices of Crops

Unit: MK/kg

	Maize	Rice
2009/10	26.65	80.31
2010/11	37.33	83.44
2011/12	67.12	141.43
2012/13	88.91	194.17

Note 1: Arithmetic mean of the 2 years
Note 2: Current price
Source: FAO data

Increase in income is calculated by the gross margin (USD/ha) times increase in irrigation area (ha). Gross margin of maize and rice are shown as follows:

Table 9.2.12 Gross Margin of Maize Production

Unit: MK/ha

	2009/10	2010/11	2011/12	2012/13
Revenue	61,296	75,253	201,360	284,503
Production Cost				
Inputs				
Seed	7,500	8,750	9,750	15500
Fertilizer (basal dressing)	11,400	11,000	15,000	28000
Fertilizer (top dressing)	17,850	16,500	22,500	42000
Pesticides	2,280	2,400	2,400	6400
Inputs Total	39,030	38,650	49,650	91,900
Labor				
Land clearing	3,900	3,000	4,000	4,000
Ridging	4,500	4,500	5,000	10,000
Planting	1,500	1,500	2,000	5,000
Fertilizer application	1,500	1,500	2,000	3,000
Thinning	450	450	600	1,200
Banking	2,400	2,400	3,200	10,000
Stooking	1,500	1,500	2,000	4,000
Harvesting	1,500	1,500	2,000	12,000
Shelling	1,500	750	1,000	5,000
Winnowing	450	450	600	800
Bagging	150	150	200	200
Post harvest treating	750	750	1,000	1,000
Loading	600	600	800	1,600
Labor Total	20,700	19,050	24,400	57,800
Post Harvest Costs				
Transport	3,000	3,000	6,000	12800
Bagging material	4,600	9,200	6,000	12000
Post Harvest Costs Total	7,600	12,200	12,000	24,800
Production Cost Total	67,330	69,900	86,050	174,500
Gross Margin	-6,034	5,353	115,310	110,003

Note: Current price
Source: MoAFS data

Table 9.2.13 Gross Margin of Rice Production

Unit: MK/ha

	2009/10	2010/11	2011/12	2012/13
Revenue	185,517	192,745	353,580	485,434
Production Cost				
Inputs				
Seed	5,625	5,625	5,625	15,000
Fertilizer - 23:21:0+4S	11,400	11,000	11,000	28,000
Fertilizer - Urea	17,850	16,500	16,500	40,500
Inputs Transport	0	0	0	600
Inputs Total	34,875	33,125	33,125	84,100
Labor				
Clearing	4,500	4,500	6,000	5,000
Puddling	2,250	2,250	3,000	6,000
Nursery preparation & management	750	750	1,000	2,000
Transplanting	6,900	6,900	9,200	9,200
First weeding	9,000	9,000	12,000	16,000
Second weeding	5,250	5,250	7,000	8,000
Harvesting	4,500	4,500	6,000	12,000
Threshing	3,750	3,750	5,000	6,000
Drying	600	600	800	1,200
Winnowing/Grading	300	300	400	800
Packaging	450	450	600	1,200
Loading	300	300	400	800
Labor Total	38,550	38,550	51,400	68,200
Post Harvest Costs				
Transport	3,000	3,000	5,000	5,000
Packaging materials	4,700	4,700	5,000	5,000
Post Harvest Costs Total	7,700	7,700	10,000	10,000
Production Cost Total	81,125	79,375	94,525	162,300
Gross Margin	104,392	113,370	259,055	323,134

Note: Current price
Source: MoAFS data

According to the above data, the average values of the gross margins of maize and rice are calculated with consideration of adjustment to 2012 price level as follows:

Table 9.2.14 Adjusted Gross Margin of Maize and Rice

	2009/10	2010/11	2011/12	2012/13	Average
Correction Coefficient*	0.65893	0.75529	0.83527	1.0000	–
Adjusted Gross Margin					
Maize (MK/ha)	-9,158	7,088	138,051	110,003	45,327
Rice (MK/ha)	158,427	150,100	310,144	323,134	206,224
Maize (USD/ha)	-27.84	21.54	419.61	334.36	186.92
Rice (USD/ha)	481.54	456.23	942.69	982.17	715.66

Note: 2012 price
*: Geometric mean of the two years' correction coefficients
Source: World Bank and MoAFS data

Increase in irrigation area by the project is shown below. Ratio of cropping areas between maize and rice is set in accordance with that in 2011.

Table 9.2.15 Increase in Irrigation Area by Crop (2,500ha case)

Unit: ha

WRA	Crop	2012	2015	2020	2025	2030	2035
1	Total	0	2,243	6,788	6,788	9,035	9,035
	Maize	0	2,170	6,567	6,567	8,741	8,741
	Rice	0	73	221	221	294	294
2	Total	0	0	75	75	102	102
	Maize	0	0	69	69	95	95
	Rice	0	0	5	5	7	7
3	Total	0	0	0	1,582	3,534	3,534
	Maize	0	0	0	1,542	3,446	3,446
	Rice	0	0	0	40	88	88
4	Total	0	0	672	672	687	687
	Maize	0	0	663	663	677	677
	Rice	0	0	10	10	10	10
5	Total	0	0	0	2,752	3,615	3,615
	Maize	0	0	0	2,665	3,500	3,500
	Rice	0	0	0	87	115	115
6	Total	0	0	0	0	0	0
	Maize	0	0	0	0	0	0
	Rice	0	0	0	0	0	0
7	Total	0	0	2,521	6,278	8,629	9,034
	Maize	0	0	2,518	6,271	8,620	9,024
	Rice	0	0	3	7	9	10
8	Total	0	0	0	0	3,728	3,728
	Maize	0	0	0	0	3,352	3,352
	Rice	0	0	0	0	376	376
9	Total	0	0	0	0	0	465
	Maize	0	0	0	0	0	402
	Rice	0	0	0	0	0	63
14	Total	0	0	0	0	0	9,069
	Maize	0	0	0	0	0	8,716
	Rice	0	0	0	0	0	353
15	Total	0	0	0	3,094	3,094	8,685
	Maize	0	0	0	2,921	2,921	8,199
	Rice	0	0	0	173	173	486
16	Total	0	7,159	9,032	9,032	9,032	9,032
	Maize	0	6,201	7,823	7,823	7,823	7,823
	Rice	0	958	1,209	1,209	1,209	1,209
17	Total	0	0	0	0	2,822	2,822
	Maize	0	0	0	0	2,040	2,040
	Rice	0	0	0	0	781	781

Source: World Bank and MoAFS data

Table 9.2.16 Increase in Irrigation Area by Crop (5,000ha case)

Unit: ha

WRA	Crop	2012	2015	2020	2025	2030	2035
1	Total	0	1,356	11,493	15,995	18,102	18,102
	Maize	0	1,312	11,119	15,474	17,512	17,512
	Rice	0	44	374	521	590	590
2	Total	0	0	120	203	203	203
	Maize	0	0	112	189	189	189
	Rice	0	0	9	14	14	14
3	Total	0	0	2,044	5,955	7,080	7,080
	Maize	0	0	1,993	5,806	6,903	6,903
	Rice	0	0	51	149	177	177
4	Total	0	0	1,350	1,379	1,379	1,379
	Maize	0	0	1,331	1,360	1,360	1,360
	Rice	0	0	19	20	20	20
5	Total	0	0	0	6,312	7,242	7,242
	Maize	0	0	0	6,112	7,012	7,012
	Rice	0	0	0	200	230	230
6	Total	0	0	0	0	0	0
	Maize	0	0	0	0	0	0
	Rice	0	0	0	0	0	0
7	Total	0	0	5,051	18,099	18,099	18,099
	Maize	0	0	5,046	18,079	18,079	18,079
	Rice	0	0	5	20	20	20
8	Total	0	0	0	0	7,470	7,470
	Maize	0	0	0	0	6,716	6,716
	Rice	0	0	0	0	754	754
9	Total	0	0	0	515	933	933
	Maize	0	0	0	445	807	807
	Rice	0	0	0	70	126	126
14	Total	0	0	0	0	190	18,101
	Maize	0	0	0	0	183	17,397
	Rice	0	0	0	0	7	704
15	Total	0	0	0	0	8,200	19,405
	Maize	0	0	0	0	7,741	18,318
	Rice	0	0	0	0	459	1,087
16	Total	0	18,101	18,101	18,101	18,101	18,101
	Maize	0	15,678	15,678	15,678	15,678	15,678
	Rice	0	2,423	2,423	2,423	2,423	2,423
17	Total	0	0	0	5,622	5,654	5,654
	Maize	0	0	0	4,065	4,088	4,088
	Rice	0	0	0	1,557	1,566	1,566

Source: World Bank and MoAFS data

Multiplier Effect

Factor applied to the total direct benefits above, to represent the indirect economic benefits of irrigation, such as job creation in input and downstream (e.g. transport and agro-processing) sectors. 1.5 (one point five) is employed as the factor value according to the Ministry of Irrigation and Water Development (2011), "Water Resource Investment Strategy." It assumes that indirect benefits are 50% of direct benefits.

(3) Calculation Results

1) Domestic and Industrial Water Supply

The calculation results are shown in the following table.

Table 9.2.17 Calculation Results of Domestic and Industrial Water Supply

	EIRR (%)	NPV (Million USD)	B/C
Urban			
Lilongwe City	13.21	40.49	1.20
Blantyre City	19.39	97.97	1.85
Mzuzu City	10.06	0.38	1.00
Zomba City	20.67	16.20	2.26
Towns	17.30	50.10	1.81
Rural			
Market Center	15.14	30.49	1.54

EIRR of all projects are more than social discount rate (10%), they are efficient ones from the viewpoint of the national economy.

2) Irrigation

The calculation results are shown below.

Table 9.2.18 Calculation Results of Irrigation

	EIRR (%)	NPV (Million USD)	B/C
2,500ha Case	2.19	-86.24	0.41
5,000ha Case	3.16	-159.72	0.48

Although EIRRs are less than social discount rate (10%); they are all positive. It just means that such projects are inappropriate from the viewpoint of investment efficiency. It can be said that they are still meaningful in terms of food security of the people on the basis of the national economy.

3) Cash Flow Tables

(i) Domestic and Industrial Water Supply

Table 9.2.19 Cash Flow Table of Urban Water Supply (Lilongwe City)

Unit: Million USD

Year	Benefit	Cost								Net Benefit
		Construction	Land Acquisition	Physical Contingency	Engineering Service	Admin.	O&M	Replacement	Cost Total	
2012	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2013	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2014	0.00	3.98	0.00	0.47	0.56	0.20	0.00	0.00	5.21	-5.21
2015	10.97	9.14	0.00	1.11	3.13	0.53	0.13	0.00	14.04	-3.07
2016	11.30	5.15	0.00	0.63	2.68	0.33	0.18	0.00	8.97	2.32
2017	15.93	15.05	0.00	1.80	2.26	0.79	0.33	0.00	20.23	-4.30
2018	18.27	24.68	0.00	2.96	3.37	1.24	0.58	0.00	32.83	-14.56
2019	20.61	32.71	0.01	3.92	3.49	1.60	0.91	0.00	42.64	-22.03
2020	20.13	58.83	0.00	7.05	3.49	2.77	1.50	0.00	73.64	-53.51
2021	25.44	51.78	0.00	6.22	3.48	2.46	2.01	0.00	65.96	-40.51
2022	27.95	29.01	0.00	3.48	3.33	1.42	2.30	0.00	39.54	-11.59
2023	30.06	11.01	0.00	1.32	1.23	0.54	2.41	0.00	16.51	13.55
2024	32.21	11.01	0.00	1.32	1.23	0.54	2.52	0.00	16.62	15.58
2025	34.39	11.01	0.00	1.32	1.23	0.54	2.63	0.00	16.73	17.66
2026	37.15	11.01	0.01	1.32	3.17	0.62	2.74	0.00	18.87	18.28
2027	39.88	37.01	0.00	4.44	3.17	1.78	3.11	0.00	49.51	-9.64
2028	42.67	37.01	0.00	4.44	3.18	1.78	3.48	0.00	49.89	-7.22
2029	45.54	11.01	0.00	1.32	1.23	0.54	3.59	0.00	17.69	27.84
2030	48.47	11.01	0.00	1.32	1.23	0.54	3.70	0.00	17.80	30.67
2031	51.77	11.01	0.00	1.32	1.23	0.54	3.81	0.00	17.91	33.86
2032	55.15	11.01	0.00	1.32	1.23	0.54	3.92	0.00	18.02	37.13
2033	58.62	11.08	0.00	1.35	1.29	0.58	4.04	0.00	18.34	40.28
2034	62.17	0.00	0.00	0.00	0.00	0.00	4.04	0.00	4.04	58.13
2035	65.80	0.00	0.00	0.00	0.00	0.00	4.04	0.00	4.04	61.77
2036	65.80						4.04	0.00	4.04	61.77
2037	65.80						4.04	0.00	4.04	61.77
2038	65.80						4.04	0.00	4.04	61.77
2039	65.80						4.04	0.00	4.04	61.77
2040	65.80						4.04	0.00	4.04	61.77
2041	65.80						4.04	0.00	4.04	61.77
2042	65.80						4.04	0.00	4.04	61.77
2043	65.80						4.04	0.00	4.04	61.77
2044	65.80						4.04	0.00	4.04	61.77
2045	65.80						4.04	36.57	40.60	25.20
2046	65.80						4.04	0.00	4.04	61.77
2047	65.80						4.04	0.00	4.04	61.77
2048	65.80						4.04	0.00	4.04	61.77
2049	65.80						4.04	0.00	4.04	61.77
2050	65.80						4.04	0.00	4.04	61.77
2051	65.80						4.04	0.00	4.04	61.77
2052	65.80						4.04	0.00	4.04	61.77
2053	65.80						4.04	0.00	4.04	61.77
2054	65.80						4.04	0.00	4.04	61.77
2055	65.80						4.04	0.00	4.04	61.77
2056	65.80						4.04	0.00	4.04	61.77
2057	65.80						4.04	0.00	4.04	61.77
2058	65.80						4.04	0.00	4.04	61.77
2059	65.80						4.04	0.00	4.04	61.77
2060	65.80						4.04	0.00	4.04	61.77
	Total	403.51	0.02	48.43	45.21	19.88				
									EIRR	13.21%

Table 9.2.20 Cash Flow Table of Urban Water Supply (Blantyre City)

Unit: Million USD

Year	Benefit	Cost								Net Benefit
		Construction	Land Acquisition	Physical Contingency	Engineering Service	Admin.	O&M	Replacement	Cost Total	
2012	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2013	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2014	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2015	0.00	1.40	0.00	0.17	0.16	0.07	0.00	0.00	1.80	-1.80
2016	1.79	1.40	0.00	0.17	1.77	0.13	0.03	0.00	3.50	-1.71
2017	4.36	1.40	0.00	0.17	1.77	0.13	0.04	0.00	3.51	0.85
2018	7.25	19.48	0.00	2.34	2.48	0.97	0.24	0.00	25.51	-18.26
2019	10.23	38.89	0.00	4.66	2.47	1.84	0.63	0.00	48.49	-38.25
2020	13.88	37.95	0.00	4.55	2.62	1.81	1.01	0.00	47.94	-34.06
2021	17.58	9.06	0.00	1.09	1.02	0.44	1.10	0.00	12.71	4.87
2022	21.32	9.06	0.00	1.09	1.02	0.44	1.19	0.00	12.80	8.53
2023	25.08	9.07	0.00	1.08	1.00	0.46	1.28	0.00	12.89	12.19
2024	28.82	6.33	0.00	0.76	1.95	0.36	1.34	0.00	10.74	18.08
2025	32.37	6.33	0.00	0.76	1.95	0.36	1.40	0.00	10.80	21.57
2026	36.15	15.53	0.00	1.86	1.95	0.77	1.56	0.00	21.67	14.48
2027	40.01	29.31	0.00	3.52	1.95	1.39	1.85	0.00	38.02	1.99
2028	43.96	29.30	0.00	3.52	1.93	1.39	2.15	0.00	38.29	5.68
2029	48.01	6.33	0.00	0.76	0.71	0.31	2.21	0.00	10.32	37.70
2030	52.64	6.33	0.00	0.76	0.71	0.31	2.27	0.00	10.38	42.26
2031	57.23	6.33	0.00	0.76	0.71	0.31	2.34	0.00	10.45	46.78
2032	61.87	6.33	0.00	0.76	0.71	0.31	2.40	0.00	10.51	51.36
2033	66.57	6.35	0.00	0.76	0.70	0.34	2.46	0.00	10.61	55.96
2034	71.32	0.00	0.00	0.00	0.00	0.00	2.46	0.00	2.46	68.86
2035	76.42	0.00	0.00	0.00	0.00	0.00	2.46	0.00	2.46	73.96
2036	76.42						2.46	0.00	2.46	73.96
2037	76.42						2.46	0.00	2.46	73.96
2038	76.42						2.46	0.00	2.46	73.96
2039	76.42						2.46	0.00	2.46	73.96
2040	76.42						2.46	0.00	2.46	73.96
2041	76.42						2.46	0.00	2.46	73.96
2042	76.42						2.46	0.00	2.46	73.96
2043	76.42						2.46	0.00	2.46	73.96
2044	76.42						2.46	0.00	2.46	73.96
2045	76.42						2.46	27.15	29.61	46.81
2046	76.42						2.46	0.00	2.46	73.96
2047	76.42						2.46	0.00	2.46	73.96
2048	76.42						2.46	0.00	2.46	73.96
2049	76.42						2.46	0.00	2.46	73.96
2050	76.42						2.46	0.00	2.46	73.96
2051	76.42						2.46	0.00	2.46	73.96
2052	76.42						2.46	0.00	2.46	73.96
2053	76.42						2.46	0.00	2.46	73.96
2054	76.42						2.46	0.00	2.46	73.96
2055	76.42						2.46	0.00	2.46	73.96
2056	76.42						2.46	0.00	2.46	73.96
2057	76.42						2.46	0.00	2.46	73.96
2058	76.42						2.46	0.00	2.46	73.96
2059	76.42						2.46	0.00	2.46	73.96
2060	76.42						2.46	0.00	2.46	73.96
	Total	246.18	0.00	29.54	27.58	12.14				

EIRR	19.39%

Table 9.2.21 Cash Flow Table of Urban Water Supply (Mzuzu City)

Unit: Million USD

Year	Benefit	Cost								Net Benefit
		Construction	Land Acquisition	Physical Contingency	Engineering Service	Admin.	O&M	Replacement	Cost Total	
2012	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2013	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2014	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2015	0.00	0.00	0.00	0.00	1.58	0.06	0.00	0.00	1.64	-1.64
2016	5.18	6.00	2.85	1.06	1.58	0.46	0.06	0.00	12.01	-6.83
2017	6.03	26.03	2.85	3.47	2.00	1.37	0.32	0.00	36.04	-30.01
2018	6.90	25.99	0.00	3.13	1.99	1.24	0.58	0.00	32.93	-26.03
2019	7.77	3.99	0.00	0.48	0.45	0.19	0.62	0.00	5.73	2.04
2020	8.64	3.99	0.00	0.48	0.45	0.19	0.66	0.00	5.77	2.87
2021	9.55	3.99	0.00	0.48	0.45	0.19	0.70	0.00	5.81	3.74
2022	10.49	3.99	0.00	0.48	0.45	0.19	0.74	0.00	5.85	4.64
2023	11.46	3.99	0.00	0.50	0.46	0.21	0.78	0.00	5.94	5.52
2024	12.47	3.71	0.00	0.45	0.42	0.18	0.82	0.00	5.58	6.90
2025	13.52	3.71	0.00	0.45	0.42	0.18	0.85	0.00	5.61	7.90
2026	14.34	3.71	0.00	0.45	1.71	0.23	0.89	0.00	6.99	7.35
2027	15.19	14.99	0.00	1.80	1.71	0.74	1.04	0.00	20.28	-5.09
2028	16.08	14.99	6.25	2.55	1.71	1.02	1.19	0.00	27.71	-11.63
2029	17.00	18.08	6.25	2.92	1.71	1.16	1.37	0.00	31.49	-14.49
2030	17.96	11.87	0.00	1.44	1.71	0.59	1.49	0.00	17.10	0.86
2031	18.89	3.71	0.00	0.45	0.42	0.18	1.53	0.00	6.29	12.60
2032	19.85	3.71	0.00	0.45	0.42	0.18	1.56	0.00	6.32	13.53
2033	20.86	3.70	0.00	0.37	0.34	0.23	1.60	0.00	6.24	14.61
2034	21.89	0.00	0.00	0.00	0.00	0.00	1.60	0.00	1.60	20.29
2035	22.97	0.00	0.00	0.00	0.00	0.00	1.60	0.00	1.60	21.37
2036	22.97						1.60	0.00	1.60	21.37
2037	22.97						1.60	0.00	1.60	21.37
2038	22.97						1.60	0.00	1.60	21.37
2039	22.97						1.60	0.00	1.60	21.37
2040	22.97						1.60	0.00	1.60	21.37
2041	22.97						1.60	0.00	1.60	21.37
2042	22.97						1.60	0.00	1.60	21.37
2043	22.97						1.60	0.00	1.60	21.37
2044	22.97						1.60	0.00	1.60	21.37
2045	22.97						1.60	13.86	15.46	7.51
2046	22.97						1.60	0.00	1.60	21.37
2047	22.97						1.60	0.00	1.60	21.37
2048	22.97						1.60	0.00	1.60	21.37
2049	22.97						1.60	0.00	1.60	21.37
2050	22.97						1.60	0.00	1.60	21.37
2051	22.97						1.60	0.00	1.60	21.37
2052	22.97						1.60	0.00	1.60	21.37
2053	22.97						1.60	0.00	1.60	21.37
2054	22.97						1.60	0.00	1.60	21.37
2055	22.97						1.60	0.00	1.60	21.37
2056	22.97						1.60	0.00	1.60	21.37
2057	22.97						1.60	0.00	1.60	21.37
2058	22.97						1.60	0.00	1.60	21.37
2059	22.97						1.60	0.00	1.60	21.37
2060	22.97						1.60	0.00	1.60	21.37
	Total	160.15	18.20	21.41	19.98	8.79				

EIRR	10.06%

Table 9.2.22 Cash Flow Table of Urban Water Supply (Zomba City)

Unit: Million USD

Year	Benefit	Cost								Net Benefit
		Construction	Land Acquisition	Physical Contingency	Engineering Service	Admin.	O&M	Replacement	Cost Total	
2012	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2013	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2014	0.00	3.18	0.00	0.38	0.36	0.16	0.00	0.00	4.08	-4.08
2015	0.23	3.18	0.00	0.38	0.35	0.15	0.06	0.00	4.12	-3.89
2016	0.67	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.06	0.60
2017	1.13	0.56	0.00	0.07	0.06	0.03	0.07	0.00	0.79	0.34
2018	1.62	0.56	0.00	0.07	0.06	0.03	0.07	0.00	0.79	0.82
2019	2.13	0.94	0.00	0.12	0.10	0.05	0.08	0.00	1.29	0.83
2020	2.67	0.94	0.00	0.12	0.10	0.05	0.09	0.00	1.30	1.37
2021	3.03	0.95	0.00	0.11	0.11	0.04	0.10	0.00	1.31	1.72
2022	3.41	0.38	0.00	0.05	0.04	0.02	0.11	0.00	0.60	2.82
2023	3.81	0.38	0.00	0.05	0.04	0.02	0.11	0.00	0.60	3.21
2024	4.22	0.38	0.00	0.05	0.04	0.02	0.11	0.00	0.60	3.62
2025	4.66	0.38	0.00	0.05	0.26	0.03	0.12	0.00	0.84	3.82
2026	5.02	3.03	0.00	0.37	0.26	0.15	0.15	0.00	3.96	1.06
2027	5.39	3.03	0.00	0.37	0.26	0.15	0.18	0.00	3.99	1.40
2028	5.78	3.04	0.00	0.37	0.27	0.14	0.21	0.00	4.03	1.75
2029	6.18	0.38	0.00	0.05	0.04	0.02	0.21	0.00	0.70	5.48
2030	6.59	0.38	0.00	0.05	0.04	0.02	0.22	0.00	0.71	5.89
2031	7.02	0.38	0.00	0.03	0.05	0.01	0.22	0.00	0.69	6.33
2032	7.47	0.38	0.00	0.03	0.05	0.01	0.22	0.00	0.69	6.77
2033	7.93	0.38	0.00	0.02	0.06	0.02	0.23	0.00	0.71	7.22
2034	8.40	0.00	0.00	0.00	0.00	0.00	0.23	0.00	0.23	8.17
2035	8.89	0.00	0.00	0.00	0.00	0.00	0.23	0.00	0.23	8.66
2036	8.89						0.23	0.00	0.23	8.66
2037	8.89						0.23	0.00	0.23	8.66
2038	8.89						0.23	0.00	0.23	8.66
2039	8.89						0.23	0.00	0.23	8.66
2040	8.89						0.23	0.00	0.23	8.66
2041	8.89						0.23	0.00	0.23	8.66
2042	8.89						0.23	0.00	0.23	8.66
2043	8.89						0.23	0.00	0.23	8.66
2044	8.89						0.23	0.00	0.23	8.66
2045	8.89						0.23	3.34	3.57	5.32
2046	8.89						0.23	0.00	0.23	8.66
2047	8.89						0.23	0.00	0.23	8.66
2048	8.89						0.23	0.00	0.23	8.66
2049	8.89						0.23	0.00	0.23	8.66
2050	8.89						0.23	0.00	0.23	8.66
2051	8.89						0.23	0.00	0.23	8.66
2052	8.89						0.23	0.00	0.23	8.66
2053	8.89						0.23	0.00	0.23	8.66
2054	8.89						0.23	0.00	0.23	8.66
2055	8.89						0.23	0.00	0.23	8.66
2056	8.89						0.23	0.00	0.23	8.66
2057	8.89						0.23	0.00	0.23	8.66
2058	8.89						0.23	0.00	0.23	8.66
2059	8.89						0.23	0.00	0.23	8.66
2060	8.89						0.23	0.00	0.23	8.66
	Total	22.83	0.00	2.74	2.55	1.12				

EIRR	20.67%

Table 9.2.23 Cash Flow Table of Urban Water Supply (Towns)

Unit: Million USD

Year	Benefit	Cost								Net Benefit
		Construction	Land Acquisition	Physical Contingency	Engineering Service	Admin.	O&M	Replacement	Cost Total	
2012	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2013	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2014	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2015	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2016	1.88	10.15	0.00	1.22	1.14	0.50	0.10	0.00	13.11	-11.23
2017	3.79	10.15	0.00	1.22	1.14	0.50	0.20	0.00	13.21	-9.42
2018	5.72	10.15	0.00	1.22	1.14	0.50	0.30	0.00	13.31	-7.59
2019	7.68	10.15	0.00	1.22	1.14	0.50	0.41	0.00	13.42	-5.74
2020	9.66	10.18	0.00	1.21	1.13	0.50	0.51	0.00	13.53	-3.87
2021	8.24	9.61	0.00	1.15	1.08	0.47	0.60	0.00	12.91	-4.67
2022	9.36	9.61	0.00	1.15	1.08	0.47	0.70	0.00	13.01	-3.65
2023	10.40	9.61	0.00	1.15	1.08	0.47	0.80	0.00	13.11	-2.71
2024	11.39	9.61	0.00	1.15	1.08	0.47	0.89	0.00	13.20	-1.81
2025	13.72	9.60	0.00	1.16	1.06	0.49	0.99	0.00	13.30	0.42
2026	16.18	1.30	0.00	0.16	0.15	0.06	1.00	0.00	2.67	13.51
2027	18.67	1.30	0.00	0.16	0.15	0.06	1.01	0.00	2.68	15.99
2028	21.19	1.30	0.00	0.16	0.15	0.06	1.03	0.00	2.70	18.50
2029	23.74	1.30	0.00	0.16	0.15	0.06	1.04	0.00	2.71	21.03
2030	26.32	1.30	0.00	0.16	0.15	0.06	1.05	0.00	2.72	23.59
2031	29.27	1.30	0.00	0.16	0.15	0.06	1.07	0.00	2.74	26.53
2032	32.25	1.30	0.00	0.16	0.15	0.06	1.08	0.00	2.75	29.51
2033	35.27	1.30	0.00	0.16	0.15	0.06	1.09	0.00	2.76	32.51
2034	38.32	1.30	0.00	0.16	0.15	0.06	1.11	0.00	2.78	35.55
2035	41.41	1.31	0.00	0.12	0.11	0.10	1.12	0.00	2.76	38.65
2036	41.41						1.12	0.00	1.12	40.29
2037	41.41						1.12	0.00	1.12	40.29
2038	41.41						1.12	0.00	1.12	40.29
2039	41.41						1.12	0.00	1.12	40.29
2040	41.41						1.12	0.00	1.12	40.29
2041	41.41						1.12	0.00	1.12	40.29
2042	41.41						1.12	0.00	1.12	40.29
2043	41.41						1.12	0.00	1.12	40.29
2044	41.41						1.12	0.00	1.12	40.29
2045	41.41						1.12	0.00	1.12	40.29
2046	41.41						1.12	0.00	1.12	40.29
2047	41.41						1.12	0.00	1.12	40.29
2048	41.41						1.12	0.00	1.12	40.29
2049	41.41						1.12	0.00	1.12	40.29
2050	41.41						1.12	0.00	1.12	40.29
2051	41.41						1.12	0.00	1.12	40.29
2052	41.41						1.12	0.00	1.12	40.29
2053	41.41						1.12	0.00	1.12	40.29
2054	41.41						1.12	0.00	1.12	40.29
2055	41.41						1.12	0.00	1.12	40.29
2056	41.41						1.12	0.00	1.12	40.29
2057	41.41						1.12	0.00	1.12	40.29
2058	41.41						1.12	0.00	1.12	40.29
2059	41.41						1.12	0.00	1.12	40.29
2060	41.41						1.12	0.00	1.12	40.29
	Total	111.83	0.00	13.41	12.53	5.51				

EIRR	17.30%

Table 9.2.24 Cash Flow Table of Rural Water Supply (Market Center)

Unit: Million USD

Year	Benefit	Cost								Net Benefit
		Construction	Land Acquisition	Physical Contingency	Engineering Service	Admin.	O&M	Replacement	Cost Total	
2012	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2013	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2014	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2015	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2016	1.41	12.10	0.00	1.45	1.36	0.60	0.12	0.00	15.63	-14.22
2017	2.83	12.10	0.00	1.45	1.36	0.60	0.24	0.00	15.75	-12.92
2018	4.27	12.10	0.00	1.45	1.36	0.60	0.36	0.00	15.87	-11.60
2019	5.74	12.10	0.00	1.45	1.36	0.60	0.48	0.00	15.99	-10.26
2020	7.21	12.10	0.00	1.46	1.34	0.58	0.61	0.00	16.09	-8.87
2021	8.13	3.88	0.00	0.47	0.43	0.19	0.64	0.00	5.61	2.52
2022	9.86	3.88	0.00	0.47	0.43	0.19	0.68	0.00	5.65	4.20
2023	11.60	3.88	0.00	0.47	0.43	0.19	0.72	0.00	5.69	5.91
2024	13.37	3.88	0.00	0.47	0.43	0.19	0.76	0.00	5.73	7.63
2025	15.15	3.88	0.00	0.45	0.45	0.20	0.80	0.00	5.78	9.37
2026	16.35	1.63	0.00	0.20	0.18	0.08	0.82	0.00	2.91	13.45
2027	17.57	1.63	0.00	0.20	0.18	0.08	0.83	0.00	2.92	14.65
2028	18.80	1.63	0.00	0.20	0.18	0.08	0.85	0.00	2.94	15.86
2029	20.04	1.63	0.00	0.20	0.18	0.08	0.86	0.00	2.95	17.09
2030	21.30	1.63	0.00	0.20	0.18	0.08	0.88	0.00	2.97	18.33
2031	22.25	1.63	0.00	0.20	0.18	0.08	0.90	0.00	2.99	19.26
2032	23.44	1.63	0.00	0.20	0.18	0.08	0.91	0.00	3.00	20.44
2033	24.88	1.63	0.00	0.20	0.18	0.08	0.93	0.00	3.02	21.86
2034	26.57	1.63	0.00	0.20	0.18	0.08	0.95	0.00	3.04	23.54
2035	26.14	1.61	0.00	0.15	0.20	0.08	0.96	0.00	3.00	23.14
2036	26.14						0.96	0.00	0.96	25.18
2037	26.14						0.96	0.00	0.96	25.18
2038	26.14						0.96	0.00	0.96	25.18
2039	26.14						0.96	0.00	0.96	25.18
2040	26.14						0.96	0.00	0.96	25.18
2041	26.14						0.96	0.00	0.96	25.18
2042	26.14						0.96	0.00	0.96	25.18
2043	26.14						0.96	0.00	0.96	25.18
2044	26.14						0.96	0.00	0.96	25.18
2045	26.14						0.96	0.00	0.96	25.18
2046	26.14						0.96	0.00	0.96	25.18
2047	26.14						0.96	0.00	0.96	25.18
2048	26.14						0.96	0.00	0.96	25.18
2049	26.14						0.96	0.00	0.96	25.18
2050	26.14						0.96	0.00	0.96	25.18
2051	26.14						0.96	0.00	0.96	25.18
2052	26.14						0.96	0.00	0.96	25.18
2053	26.14						0.96	0.00	0.96	25.18
2054	26.14						0.96	0.00	0.96	25.18
2055	26.14						0.96	0.00	0.96	25.18
2056	26.14						0.96	0.00	0.96	25.18
2057	26.14						0.96	0.00	0.96	25.18
2058	26.14						0.96	0.00	0.96	25.18
2059	26.14						0.96	0.00	0.96	25.18
2060	26.14						0.96	0.00	0.96	25.18
	Total	96.18	0.00	11.54	10.77	4.74				

EIRR	15.14%

(ii) Irrigation

Table 9.2.25 Cash Flow Table of Irrigation (2,500ha Case)

Unit: Million USD

Year	Benefit	Cost								Net Benefit
		Construction	Land Acquisition	Physical Contingency	Engineering Service	Admin.	O&M	Replacement	Cost Total	
2012	0.00	10.72	0.00	1.29	1.20	0.52	0.00	0.00	13.72	-13.72
2013	0.00	10.72	0.00	1.29	1.20	0.52	0.00	0.00	13.72	-13.72
2014	0.33	12.05	0.00	1.45	1.35	0.60	0.17	0.00	15.61	-15.27
2015	2.64	13.92	0.00	1.67	1.57	0.69	0.24	0.00	18.08	-15.45
2016	2.64	12.49	0.00	1.50	1.40	0.62	0.30	0.00	16.31	-13.67
2017	3.32	12.11	0.00	1.45	1.36	0.60	0.36	0.00	15.88	-12.55
2018	4.44	12.11	0.00	1.45	1.36	0.60	0.42	0.00	15.94	-11.50
2019	5.25	11.64	0.00	1.39	1.30	0.57	0.48	0.00	15.38	-10.13
2020	5.35	11.64	0.00	1.39	1.30	0.57	0.54	0.00	15.43	-10.08
2021	5.64	10.77	0.00	1.29	1.21	0.53	0.59	0.00	14.39	-8.75
2022	7.13	10.77	0.00	1.29	1.21	0.53	0.64	0.00	14.44	-7.31
2023	8.33	14.22	0.00	1.71	1.60	0.70	0.72	0.00	18.94	-10.61
2024	8.33	14.22	0.00	1.71	1.60	0.70	0.79	0.00	19.01	-10.68
2025	8.49	12.95	0.00	1.56	1.45	0.64	0.85	0.00	17.44	-8.96
2026	10.76	11.68	0.00	1.40	1.31	0.58	0.91	0.00	15.88	-5.12
2027	11.10	16.11	0.00	1.93	1.80	0.79	0.99	0.00	21.63	-10.53
2028	11.64	16.11	0.00	1.93	1.80	0.79	1.07	0.00	21.71	-10.07
2029	12.41	16.11	0.00	1.93	1.80	0.79	1.15	0.00	21.79	-9.38
2030	12.41	14.61	0.00	1.75	1.63	0.72	1.22	0.00	19.94	-7.52
2031	14.25	12.73	0.00	1.52	1.42	0.63	1.29	0.00	17.59	-3.34
2032	14.25	12.27	0.00	1.47	1.37	0.61	1.35	0.00	17.07	-2.82
2033	14.25	12.15	0.00	1.45	1.36	0.60	1.41	0.00	16.97	-2.72
2034	14.25	13.35	0.00	1.60	1.49	0.65	1.48	0.00	18.57	-4.32
2035	16.77	5.04	0.00	0.61	0.57	0.25	1.50	0.00	7.96	8.81
2036	16.77						1.50	0.00	1.50	15.27
2037	16.77						1.50	0.00	1.50	15.27
2038	16.77						1.50	0.00	1.50	15.27
2039	16.77						1.50	0.00	1.50	15.27
2040	16.77						1.50	0.00	1.50	15.27
2041	16.77						1.50	0.00	1.50	15.27
2042	16.77						1.50	0.00	1.50	15.27
2043	16.77						1.50	0.00	1.50	15.27
2044	16.77						1.50	0.00	1.50	15.27
2045	16.77						1.50	0.00	1.50	15.27
2046	16.77						1.50	0.00	1.50	15.27
2047	16.77						1.50	0.00	1.50	15.27
2048	16.77						1.50	0.00	1.50	15.27
2049	16.77						1.50	0.00	1.50	15.27
2050	16.77						1.50	0.00	1.50	15.27
2051	16.77						1.50	0.00	1.50	15.27
2052	16.77						1.50	0.00	1.50	15.27
2053	16.77						1.50	0.00	1.50	15.27
2054	16.77						1.50	0.00	1.50	15.27
2055	16.77						1.50	0.00	1.50	15.27
2056	16.77						1.50	0.00	1.50	15.27
2057	16.77						1.50	0.00	1.50	15.27
2058	16.77						1.50	0.00	1.50	15.27
2059	16.77						1.50	0.00	1.50	15.27
2060	16.77						1.50	0.00	1.50	15.27
	Total	300.47	0.00	36.04	33.65	14.76				

EIRR	2.19%

Table 9.2.26 Cash Flow Table of Irrigation (5,000ha Case)

Unit: Million USD

Year	Benefit	Cost								Net Benefit
		Construction	Land Acquisition	Physical Contingency	Engineering Service	Admin.	O&M	Replacement	Cost Total	
2012	0.00	22.28	0.00	2.67	2.50	1.10	0.00	0.00	28.55	-28.55
2013	0.00	22.28	0.00	2.67	2.50	1.10	0.00	0.00	28.55	-28.55
2014	0.42	25.12	0.00	3.01	2.82	1.23	0.35	0.00	32.53	-32.11
2015	7.41	28.54	0.00	3.43	3.20	1.41	0.49	0.00	37.06	-29.65
2016	7.41	25.12	0.00	3.02	2.82	1.24	0.62	0.00	32.81	-25.40
2017	8.37	24.35	0.00	2.93	2.74	1.21	0.74	0.00	31.95	-23.58
2018	10.75	24.35	0.00	2.93	2.74	1.21	0.86	0.00	32.07	-21.32
2019	12.90	24.47	0.00	2.94	2.74	1.21	0.98	0.00	32.34	-19.44
2020	12.98	24.47	0.00	2.94	2.74	1.21	1.10	0.00	32.47	-19.48
2021	14.07	22.74	0.00	2.73	2.55	1.12	1.22	0.00	30.36	-16.29
2022	17.75	21.72	0.00	2.61	2.43	1.07	1.33	0.00	29.15	-11.41
2023	19.59	30.05	0.00	3.61	3.36	1.48	1.48	0.00	39.97	-20.38
2024	21.74	30.05	0.00	3.61	3.36	1.48	1.63	0.00	40.12	-18.37
2025	24.18	27.44	0.00	3.30	3.07	1.35	1.76	0.00	36.92	-12.74
2026	24.99	26.92	0.00	3.23	3.02	1.33	1.90	0.00	36.39	-11.40
2027	25.33	38.60	0.00	4.63	4.32	1.90	2.09	0.00	51.54	-26.21
2028	28.36	38.60	0.00	4.63	4.32	1.90	2.29	0.00	51.74	-23.37
2029	31.03	38.60	0.00	4.63	4.32	1.90	2.48	0.00	51.93	-20.90
2030	31.04	34.19	0.00	4.10	3.83	1.68	2.65	0.00	46.46	-15.41
2031	34.68	23.59	0.00	2.84	2.65	1.16	2.77	0.00	33.00	1.68
2032	34.68	23.19	0.00	2.79	2.60	1.14	2.88	0.00	32.60	2.08
2033	34.68	24.62	0.00	2.95	2.77	1.22	3.01	0.00	34.56	0.12
2034	34.68	28.62	0.00	3.43	3.21	1.42	3.15	0.00	39.83	-5.15
2035	40.26	11.70	0.00	1.40	1.31	0.58	3.21	0.00	18.20	22.06
2036	40.26						3.21	0.00	3.21	37.05
2037	40.26						3.21	0.00	3.21	37.05
2038	40.26						3.21	0.00	3.21	37.05
2039	40.26						3.21	0.00	3.21	37.05
2040	40.26						3.21	0.00	3.21	37.05
2041	40.26						3.21	0.00	3.21	37.05
2042	40.26						3.21	0.00	3.21	37.05
2043	40.26						3.21	0.00	3.21	37.05
2044	40.26						3.21	0.00	3.21	37.05
2045	40.26						3.21	0.00	3.21	37.05
2046	40.26						3.21	0.00	3.21	37.05
2047	40.26						3.21	0.00	3.21	37.05
2048	40.26						3.21	0.00	3.21	37.05
2049	40.26						3.21	0.00	3.21	37.05
2050	40.26						3.21	0.00	3.21	37.05
2051	40.26						3.21	0.00	3.21	37.05
2052	40.26						3.21	0.00	3.21	37.05
2053	40.26						3.21	0.00	3.21	37.05
2054	40.26						3.21	0.00	3.21	37.05
2055	40.26						3.21	0.00	3.21	37.05
2056	40.26						3.21	0.00	3.21	37.05
2057	40.26						3.21	0.00	3.21	37.05
2058	40.26						3.21	0.00	3.21	37.05
2059	40.26						3.21	0.00	3.21	37.05
2060	40.26						3.21	0.00	3.21	37.05
	Total	641.60	0.00	77.01	71.90	31.63				
									EIRR	3.16%

9.3 Evaluation from Social and Environmental Aspects

9.3.1 Objectives of Evaluation from Social and Environmental Aspects

The principal objective of this evaluation is to examine the current condition of the natural and social environment and how the proposed projects in the M/P may have influence on them. If negative impacts are forecasted by the project's implementation, then, necessary mitigation measures will be examined.

9.3.2 Methodology on Evaluation of Environmental and Social Aspects

The projects proposed in the M/P shall be evaluated through the execution of the Initial Environmental Examination (IEE). The terms of reference for IEE is presented in **Appendix 1**.

9.3.3 Evaluation through IEE

(1) Natural and Social-Environmental Condition of the Study Area

Since the present M/P study is at country level, an initial assessment of the current state of the environment in the country considering relevant environmental components to this M/P study was made and presented in the following table.

Table 9.3.1 Initial Assessment of Natural and Social-Environmental Condition in Malawi

Component	Assessment
Surface water quality	Many river basins in the country are under severe pressures due to deforestation, unsustainable agriculture, settlements, mining, industry, commerce, tourism and climate change. These activities have influenced changes in water quality especially due to sediment loads, domestic and industrial wastes, chemicals from agricultural lands. The proliferation of aquatic vegetation also is a concern in some dams
Groundwater quality	Generally good except for the presence of sulphur, fluoride, iron and other such minerals in some localities and pollution introduced by human activities.
Water Pollution	In Malawi, the treatment of wastewater is poorly managed and most of them reach watercourses without any treatment causing water pollution. Sources of pollution are domestic, industrial, solid waste and agricultural lands.
Fauna and Flora	Malawi is rich in fauna and flora. Faunal resources include about 192 species of mammals (8 endangered), 648 species of birds, more than 1,000 species of fish, etc. Floral resources include about 6,000 species of plants (261 threatened). New research must be conducted to update the above figures.
Vegetation	Malawi has varied topography and rainfall regimes and as a result is reach in vegetation types. Major vegetation types include the miombo woodland, deciduous forests and thickets, evergreen and semi-evergreen forests, and Afromontane grassland.
Fisheries	Main species that can be found in major water bodies of Malawi are as follows: Lake Malawi (28 species): among them we can cite Chambo, Chisawasawa, Samwamowa, Utaka, Kambuzi, Binga, Saguga, Mzomba, Dimba, Mbaba, etc. Lake Malombe (5 species): Chambo, Utaka, Mlamba, Kampango, Ntchira Lake Chilwa (3 species): Makumba, Mlamba, Matemba Lake Chiuta (2 species): Kampango, Ntchira Lower Shire (12 species): Ntcheni, Nchenka, Nghenka, Matemba, Njole, Tsimbu; Mlamba, Chikanu, Nkhonokono, Dande, Mphende, Mkokafodya.
Protected Areas	In Malawi exists five (5) national parks, four (4) wildlife reserves, three (3) nature sanctuaries and eighty-eight (88) Gazetted Forest Reserves that are considered as protected areas. Illegal cutting of trees and poaching are the major threat of protected areas.

Socio-economy	Population and Settlement: Malawi has a population of 13,077,160 (2008 census). The density is 139 persons/km^2 and the average number of persons per household is 4.6. The population growth is estimated at 2.9% and the migration from rural to urban areas is growing. Low income areas such as Ntopwa in Blantyre, Chinsapo, Mgona, and Mtandire in Lilongwe and Mchengautuwa in Mzuzu are growing at unprecedented rates. The 2008 Crude Birth Rate (CBR) was about 39.5 births per thousand population. The peoples belong to many ethnic groups like Chewa, Tumbuka, Nyanja, Yao, Lomwe, Sena and communication is made using different languages namely, Chichewa, Chinyanja, Chiyao, Chilomwe, and many more. Population in poverty account for 65% of the total population and population in absolute poverty account for 29% of the total population (census 2008). Employment: Agriculture alone accounts for 90% of export earnings as well as employing nearly half of those in employment. In Malawi a large proportion of the population (86%) is rural and largely dependent on subsistence agriculture with nearly 60% cultivating less than 1 hectare of arable land. People living in the rural parts of Malawi are also engaged in making various types of hard wood carvings.
Water related diseases	Among the four water related diseases reported by Ministry of Health for 2011 year, at Country and District levels the malaria occupies the highest level followed by diarrhea, schistosomiasis and cholera. At district level, the highest cases of malaria and diarrhea were reported in Lilongwe, as for schistosomiasis, Mangochi ranked the highest place, while for cholera few districts suffered from this disease and Dedza reported the highest number of cases. The diarrheal diseases may be attributable to poor or inadequate sanitary facilities and hygienic practices. In Malawi, the sewerage sector is not well developed yet in important cities, permitting the contamination of water sources with untreated sewage. On the other hand, the high rate of Malawian people suffering from malaria negatively impacts on the social and economic development of communities.

(2) Project Description

Projects were classified into same type of projects by Sector, i.e., Sector Dams, Sector Water Supply and so on. In addition projects were classified according to its current status of implementation (e.g. ongoing projects and planning projects). Ongoing projects are those that are under construction or under detailed design study, however, planning projects are those that are under master plan or feasibility studies.

The list of projects is composed of four sectors including 31 ongoing and 75 planning projects as listed below. The complete list of the projects with a brief description of the main activities is given in **Appendix 4** for Dams Sector; **Appendix 5** for Water Supply Sector; **Appendix 6** for Irrigation Sector; and **Appendix 7** for Water Resources Management.

Table 9.3.2 Number of Projects under Water Resources Master Plan

Sector	Ongoing Projects	Planning Projects*	Total
1. Dams	2	19	21
2. Water Supply	29	36	65
3. Irrigation	-	17	17
4. Water Resources Management	-	3	3
Total	31	75	106

It is opportune to mention here that for IEE purposes the Sector Water Supply included projects using surface water and groundwater through the construction of boreholes.

(3) Categorization of Projects

This categorization (screening) was made on on-going and planning projects following Malawian EIA guidelines. The procedure for categorization is presented below:

- Screening by list of prescribed projects for which EIA is required (Category I)
- Screening by list of prescribed projects for which a EIA may be required (Category II)

- Screening by list of not prescribed projects for which EIA is not required, specifically those which only involve preparation of studies, environmental awareness programs, institutional development, etc. (Category III)

The screening of projects was made based on the Categories List stipulated in the Malawian Guidelines for Environmental Impact Assessment, 1997. Categories List is shown in **Appendix 2** and **Appendix 3**.

The result of the screening is shown in **Appendix 4** to **Appendix 7** and summarized in the following Table.

Table 9.3.3 Categorization of Projects in M/P subjected to IEE/EIA Study

Prescribed Project	EIA Category	Description	Documents Required For Application to EIA Division	Projects affected	
				Sector	Number
Prescribed Project (List A)	1	EIA is required	Submission of Project Brief	Dams	21
				Water Supply	33
				Irrigation	17
				WRM	0
				Total Category 1	71
Prescribed Project (List B)	2	EIA may be required	Submission of Project Brief	Dams	0
				Water Supply	20
				Irrigation	0
				WRM	0
				Total Category 2	20
No Prescribed Project	3	Not require EIA	Application letter for EIS	Dams	0
				Water Supply	12
				Irrigation	0
				WRM	3
				Total Category 3	15
	Total Projects in the Master Plan				106

Projects in Category 3 such as capacity development, awareness creation, development of studies, etc., do not require EIA; therefore, these projects are not scoped for IEE.

From the above table, 71 projects in Category I and 20 projects in Category II are subject to scoping at IEE study level (total=91) in four (4) Sectors (Dams, Water Supply, Irrigation and WRM). This is in compliance with the Guidelines for EIA and the JICA guidelines for environmental and social considerations.

(4) Identification of Impacts and its Significance

For projects that have been scoped for IEE study as shown in the **Appendix 4** to **Appendix 7**, the identification of impacts and its significance were made based on the scoping matrix. To realize this, each Sector of projects was divided into several groups that might have similar scoping outcome. The criteria applied for this grouping is as follows:

Table 9.3.4 Grouping of Projects subject to IEE Study

Sector	Criteria	Group	Nº Projects
Dams	Group 1: Hydropower dams with TH more than 20 m or firm flow=100 m3/sec; or Multipurpose dam (area >100 ha; high=4.5 m or higher; TH>20 or firm flow=100 m3/sec); or Construction or expansion of dams with high=4.5 m or higher for WS	1	11
	Group 2: Hydropower or multipurpose dams located in protected area or vicinity	2	10
Water Supply Scheme	Water supply scheme for > 10,000 people	1	15
	Water supply scheme for < 10,000 people	2	3
	Groundwater utilization > 15 liters/second or well>=60m	3	5
	Groundwater utilization < 15 liters/second or well < 60m	4	9
	Rehabilitation, improvement or maintenance of water system (big scale activities)	R1	13
	Rehabilitation, improvement or maintenance of water system (small scale activities)	R2	8
Irrigation Scheme	Irrigation Scheme with area more than 10 has	1	17
	Irrigation Scheme with area less than 10 has	2	0
	Irrigation Scheme with area located in Protected Area	3	0

The summary results of identification of impacts and its significance are presented in the following tables.

Table 9.3.5 Summary of Matrix for Scoping (Sector Dams and Water Supply)

Environmental Component	Nº	Likely Impact Items	Overall Rating							
			Sector Dams		Sector Water Supply					
			Dams - Group 1	Dams - Group 2	WS with Capacity to serve >10,000 people- Group 1	WS with Capacity to serve <10,000 people- Group 2	Groundwater utilization > than 15 l/sec or serving > 10,000 persons- Group 3	Groundwater utilization < 15 l/sec or serving < 10,000 persons- Group 4	Rehabilitation of Facilities with big scale of activities- Group R1	Rehabilitation of Facilities with smale scale of activities- Group R2
Social Environment	1	Involuntary resettlement	A-	-	-	-	-	-	-	-
	2	Local Economy such as Employment & Livelihood, etc.	A+	A+	A+	B+	B+	-	A+	B+
	3	Land use and utilization of local resources	A-	A-	B-	B-	-	-	-	-
	4	Social institutions such as social infrastructure and local decision-making institutions	C-	C-	-	-	C-	-	-	-
	5	Existing social infrastructure & Services such as Traffic/Public Facilities	A-	A-	A-	B-	-	-	A-	B-
	6	The poor, indigenous and ethnic people	C-	-	-	-	-	-	-	-
	7	Inequality between beneficiaries and project-affected peoples	-	-	-	-	-	-	-	-
	8	Cultural heritage	C-	C-	-	-	-	-	-	-
	9	Local conflict of interests	C-	A-	C-	-	-	-	-	-
	10	Water use right and common land use right	C-	C-	-	-	-	-	-	-
	11	Water supply and/or Irrigation with Potential Power generation	A+	A+	A+	A+	A+	A+	-	-
	12	Vector of diseases	A-	A-	-	-	-	-	-	-
	13	Disaster (natural risk) and infectious diseases such as HIV/AIDS	A-	A-	B-	B-	B-	B-	B-	B-
Natural Environment	14	Topography and geographical features	B-	B-	-	-	-	-	-	-
	15	Accumulation of sediment into Dams	B-	B-	-	-	-	-	-	-
	16	Protected Area	-	A-	C-/C+	C-/C+	C-/C+	-	-	-
	17	Ground water	C-/C+	C-/C+	-	-	-	-	-	-
	18	Soil erosion	B-	B-	B-	B-	-	-	-	-
	19	Hydrological situation (flow regime)	B-	B-	B-	B-	C-	-	-	-
	20	Coastal zone	-	-	C-	C-	-	-	-	-
	21	Flora, Fauna and Biodiversity	A-	A-	B-	B-	-	-	-	-
	22	Meteorology	-	-	-	-	-	-	-	-
	23	Landscape	-	-	-	-	-	-	-	-
	24	Global warming	-	-	-	-	-	-	-	-
Pollution	25	Air pollution	B-	B-	B-	B-	B-	B-	B-	B-
	26	Water pollution	B-	B-	B-	B-	B-	B-	B-	B-
	27	Soil pollution	-	-	-	-	-	-	-	
	28	Waste	B-	B-	B-	B-	B-	B-	B-	B-
	29	Noise and vibration	B-	B-	B-	B-	B-	B-	B-	B-
	30	Ground subsidence	-	-	-	-	-	-	-	-
	31	Offensive odor	-	-	-	-	-	-	-	-
	32	Bottom sediment	C-	C-	B-	B-	-	-	-	-
	33	Accident	C-	C-	C-	C-	C-	C-	C-	C-

Rating Criteria

A+/-: Significant positive/negative impact is expected.

B+/-: Some positive/negative impact is expected.

C+/-: Extent of positive/negative impact is unknown. (A further examination is required in the further project formulation)

・-: No impact is expected.

Table 9.3.6 Summary of Matrix for Scoping (Sector Irrigation)

Environmental Component	Nº	Likely Impact Items	Overall Rating	
			Sector Irrigation	
			Irrigation Schemes with Area > 10 ha - Group 1	Irrigation Schemes with Area < 10 ha - Group 2
Social Environment	1	Involuntary resettlement	A-	B-
	2	Local Economy such as Employment & Livelihood, etc.	A+	B+
	3	Land use and utilization of local resources	A-	B-
	4	Social institutions such as social infrastructure and local decision-making institutions	-	-
	5	Existing social infrastructure & Services such as Traffic/Public Facilities	A-	B-
	6	The poor, indigenous and ethnic people	C-	C-
	7	Inequality between beneficiaries and project-affected peoples	-	-
	8	Cultural heritage	-	-
	9	Local conflict of interests	C-	C-
	10	Water use right and common land use right	B-	B-
	11	Water supply and/or Irrigation with Potential Power generation	-	-
	12	Vector of diseases	A-	B-
	13	Disaster (natural risk) and infectious diseases such as HIV/AIDS	B-	B-
Natural Environment	14	Topography and geographical features	-	-
	15	Accumulation of sediment into Dams	-	-
	16	Protected Area	-	-
	17	Ground water	-	-
	18	Soil erosion	B-	B-
	19	Hydrological situation (flow regime)	B-	B-
	20	Coastal zone	-	-
	21	Flora, Fauna and Biodiversity	A-	B-
	22	Meteorology	-	-
	23	Landscape	-	-
	24	Global warming	-	-
Pollution	25	Air pollution	B-	B-
	26	Water pollution	A-	B-
	27	Soil pollution	B-	B-
	28	Waste	B-	B-
	29	Noise and vibration	B-	B-
	30	Ground subsidence	-	-
	31	Offensive odor	-	-
	32	Bottom sediment	B-	B-
	33	Accident	C-	C-
		Rating Criteria		
		A+/-: Significant positive/negative impact is expected.		
		B+/-: Some positive/negative impact is expected.		
		C+/-: Extent of positive/negative impact is unknown. (A further examination is required in the further p		
		・-: No negative impact is expected.		

(5) Description of Mitigation Measures against Adverse Impacts

Based on the scoping activities shown above, the following mitigation measures are recommended for adverse impacts in each Sector.

1) Sector Dams

The table below summarizes the mitigation measures for adverse impacts expected in the sector of dams.

Table 9.3.7 Potential Negative Impacts and Mitigation Measures (Sector Dam)

Potential Impacts	Impact Stage	Mitigation Measure
Involuntary settlement	PL	• Conduct public consultation with Project affected person (PAPs) and local residents to explain the benefits of the project. For PAPs prepare detail analysis for compensation
Utilization of local resources	C	• Prepare utilization and post utilization plan for those areas from where materials will be extracted for construction of the dam
Traffic	C	• Control on the number of vehicles/equipment to avoid traffic congestion
Vector of diseases	O	• Implement medical check-up program
Infectious diseases such as HIV/AIDS	C	• Implement medical check-up program
Sediment	O	• The entrance of sediments into the dams will reduce its storage capacity as it already happen in many dams of Malawi. The well management of the water basin including forest management is recommended to minimize this impact.
Soil erosion	C	• Provision of drains with sediment traps
Protected Area, Flora &Fauna	PL, C	• 10 Dams in total are expected to be located in forest or proposed forest reserves. However, the list of forest reserves is old and some of them may not be in place presently. Therefore it is recommended to check these candidates' sites in the EIA stage to confirm the forest reserves. Anyway, many conflicts may arise if the project is to be located into a protected area. Some mitigation shall include the plantation of forest to be home of the biodiversity and to compensate deforestation due to the construction of the dams.
	O	• Minimum environmental flow shall be maintained downstream to support aquatic life.
Flow regime	O	• Minimum environmental flow shall be maintained downstream. Operation of Dam Manual must be prepared including this subject.
Air pollution (Dust, exhaust fumes from vehicles and equipment)	C, O	• Control on the number or speed of vehicles/ equipment • Watering of access road and operational places. Soil materials should be covered with sheet • Proper maintenance of vehicle and equipment
Water Pollution	C	• Provision of drains with sediment traps • Proper management of the construction • Proper management of waste oil from vehicle maintenance
	O	• Removal of vegetal before filling the dam
Waste	C	• Proper management of construction waste
Noise	C, O	• Trucks shall use exhaust mufflers to maintain the current noise levels • Control of number or speed of vehicles/ equipment • Adequate maintenance of equipment • Work schedule should be informed to the public and operation of heavy equipment should be limited to the day time only

Legend: PL: Planning Phase; C: Construction Phase, O: Operation Phase

2) Sector Water Supply

The activities to be implemented in the projects of this Sector depend on the type of water sources they use (surface or groundwater). Thus, mitigation measures are proposed for (a) projects using surface water as water source (Construction of Water Treatment Plant); and (b) projects using groundwater as water source (Construction of Boreholes). The following tables show the impacts and the mitigation measures for the two cases**.**

Table 9.3.8 Potential Negative Impacts and Mitigation Measures for Projects using Surface Water as Water Source (Sector Water Supply)

Potential Impacts	Impact Stage	Mitigation Measure
Utilization of local resources	C	• Prepare utilization and post utilization plan for those areas from where materials will be extracted for land reclamation of the facility site (water treatment Plant and intake)
Traffic	C	• Control on the number of vehicles/equipment to avoid traffic congestion

Infectious diseases such as HIV/AIDS	C	• Implement medical check-up program
Soil erosion	C	• Provision of drains with sediment traps
Flow regime	O	• Minimum environmental flow shall be maintained down stream
Flora & Fauna	O	• Minimum environmental flow shall be maintained downstream to support aquatic life.
Air pollution (Dust, exhaust fumes from vehicles and equipment)	C, O	• Control on the number or speed of vehicles/ equipment • Watering of access road and operational places. Soil materials should be covered with sheet • Proper maintenance of vehicle and equipment
Water Pollution	C	• Provision of drains with sediment traps • Proper management of waste oil from vehicle maintenance • Proper management of the construction
	O	• Proper management of chemicals and waste oil from equipment maintenance • Provision of treatment facility for wastewater and sludge originated from the water treatment plant
Waste	C,O	• Proper management of construction waste • Proper management of chemical waste
Noise	C, O	• Trucks shall use exhaust mufflers to maintain the current noise levels • Control of number or speed of vehicles/ equipment • Adequate maintenance of equipment • Work schedule should be informed to the public and operation of heavy equipment should be limited to the day time only
Bottom sediment	O	• Provision of treatment facility for wastewater and sludge originated from the water treatment plant

Legend: C: Construction Phase, O: Operation Phase

Table 9.3.9 Potential Negative Impacts and Mitigation Measures for Projects using Groundwater as Water Source (Sector Water Supply)

Potential Impacts	Impact Stage	Mitigation Measure
Infectious diseases such as HIV/AIDS	C	• Implement medical check-up program
Air pollution (Dust, exhaust fumes from truck of drill rig and power generator)	C, O	• Proper maintenance of vehicle and equipment
Water Pollution	C	• Provision of drains with sediment traps • Proper management of the borehole construction
Waste	C	• Proper management of construction waste
Noise	C, O	• Truck of drill rig shall use exhaust mufflers to maintain the current noise levels • Adequate maintenance of equipment • Operation of equipment should be limited to the day time only

Legend: C: Construction Phase, O: Operation Phase

3) Sector Irrigation

The following table shows the impacts that can be expected in the sector of irrigation and summarize the mitigation measures.

Table 9.3.10 Potential Negative Impacts and Mitigation Measures (Sector Irrigation)

Potential Impacts	Impact Stage	Mitigation Measure
Utilization of local resources	C	• Prepare utilization and post utilization plan for those areas from where materials will be extracted for land reclamation of the irrigation site
Traffic	C	• Control on the number of vehicles/equipment to avoid traffic congestion
Vector of diseases	O	• Implement medical check-up program
Infectious diseases such as HIV/AIDS	C	• Implement medical check-up program
Soil erosion	C	• Introduction of right agriculture practices • Provision of drains with sediment traps
Flow regime	O	• Minimum environmental flow shall be maintained downstream. Operation of Intake for Irrigation Manual must be prepared including this subject.

Air pollution (Dust, exhaust fumes from vehicles and equipment)	C, O	• Control on the number or speed of vehicles/ equipment • Watering of access road and operational places. Soil materials should be covered with sheet • Proper maintenance of vehicle and equipment
Water Pollution	C	• Provision of drains with sediment traps • Proper management of waste oil from vehicle maintenance • Proper management of the construction
	O	• Proper management of chemicals and waste oil from equipment maintenance • Implement training and education of farmers on the kind of chemicals they can use rationally • Check that only authorized chemicals are used at the site • Implement water quality monitoring for existing drinking wells. If affected, construct boreholes for affected people
		• Proper management of waste oil from equipment maintenance
Soil pollution	C, O	• Proper management of chemicals
Waste	C,O	• Proper management of construction waste • Proper management of chemical waste
Noise	C, O	• Trucks shall use exhaust mufflers to maintain the current noise levels • Control of number or speed of vehicles/ equipment • Adequate maintenance of equipment • Work schedule should be informed to the public and operation of heavy equipment should be limited to the day time only
Bottom sediment	O	• Proper management of chemicals and waste oil from equipment maintenance

Legend: C: Construction Phase, O: Operation Phase

(6) Conclusion and Recommendations

In general, the projects proposed in the M/P will benefit three main sectors; namely, power generation, water supply and irrigation. As for power generation, high positive impact is expected on the current economic development of the country. As for water supply, high positive impacts are expected through the project implementation on the current health level of the beneficiary population by consuming potable water which in turn will allow the exercise of better hygiene practices in the households. As for irrigation, the socio-economic status of the population will be highly upgraded through the increase of agricultural production and employment opportunities. In addition food security for the population will be improved.

Some adverse impacts on the environment are also expected from the project implementation, which shall be diminished through the proposed mitigation measures. In this sense, especial attention must be given to the dam sector since it involves huge physical intervention and may need the resettlement of people living around the candidate site.

APPENDIX

Appendix 1 Terms of Reference for Initial Environmental Examination - Technical Specifications

TERMS OF REFERENCE FOR INITIAL ENVIRONMENTAL EXAMINATION

TECHNICAL SPECIFICATIONS

1. General

The Initial Environmental Examination (IEE) is the first field recognizance of the environment where a project is planned to be executed. The IEE is conducted during the Master Plan (M/P) study using for the analysis existing information. As for the Environmental Impact Assessment (EIA), it is conducted during the Feasibility Study (F/S) stage. The Terms of Reference (TOR) for EIA must be prepared in the F/S stage taking into consideration the results of the IEE and in consultation with Environmental Affairs Department (Ministry of Environment and Climate Change Management).

2. Targeted Projects and Programs for IEE

The M/P in this JICA Survey involves the study for the execution of projects nationwide on water resources development and management such as (1) Construction of Dams; (2) Construction of Irrigation System; (3) Construction of Water Supply System; and (4) Water Resources Management. In this sense, the IEE in this stage will be realized on all planning and on-going projects that relates to water resources development and management.

3. Items to be study into the IEE

The following points shall be checked utilizing existing information in Malawi

3.1 Legal and Institutional Aspects on Environment and Social Considerations

3.2 Natural Environmental Condition

The state of the environment in the country shall be checked from the point of view of the followings components.

(1) Water

The actual condition of surface and groundwater shall be checked.

(2) Fauna and Flora

Existing species of flora and fauna shall be checked.

(3) Protected Areas

The protected areas shall be identified including forest reserves.

3.3 Social Environment

The social environmental condition shall be checked from the point of view of the followings components.

(1) Socio-economy

The socioeconomic condition of the population shall be checked. This includes population and economic activities.

Appendix 1 Terms of Reference for Initial Environmental Examination - Technical Specifications

(2) Health condition

The number of people affected by waterborne or other communicable disease shall be checked

3.4 List of Projects and Brief Description

Projects will be listed by location with a brief description of the major activities

3.5 Categorization of Projects (Screening)

Projects will be categorized through the following steps:

- Screening by list of projects for which EIA is required (Category I)
- Screening by list of projects for which EIA may be required (Category II)
- Screening by list of projects for which EIA is not required (Category III), specifically those which only involve preparation of studies, environmental awareness programs, institutional development, etc.
- Classification and grouping into same type of projects. After such grouping, projects that do not require IEE will be determined.
- Checking the status of projects (e.g. ongoing project)

The screening of projects will be made based on the Categories List (see Annexes 8.2 and 8.3) stipulated in the Environmental Management Act of 1996 and the Guidelines for Environmental Impact Assessment of 1997.

3.6 Identification of Impacts and Mitigation Measures

For all projects that need IEE/EIA, the identification of impacts and its significance shall be made based on scoping matrix.

3.7 Identification of Impacts and Mitigation Measures

Mitigation measures shall be proposed based on the identified impacts in the scoping process.

3.8 Conclusion and Recommendations

4. Methodology

4.1 Data Collection and Analysis Methods

The IEE will start with the collection of existing data and information on natural and social environment in Malawi. These data, so called primary data, may be available in relevant institutions or agencies and will be used for further analysis work on environmental components of the Study.
For analysis of the IEE shall be used the following documents:

(1) Malawian Environmental Guidelines and Standards and International standards

(2) JICA Guidelines for Environmental and Social Considerations

4.2 Methods for Identification of Impacts and Determination of Significant Impacts

The impacts, its significance and its sources shall be identified in preliminary form during the IEE.

Appendix 1 Terms of Reference for Initial Environmental Examination - Technical Specifications

(1) Identification of Impacts and Impact Sources

Environmental impacts and impact sources shall be predicted for each phase of project implementation, i.e., planning, construction, and operation.

(2) Significant impacts

The relevant environmental impacts will be ranked depending on its environmental and social significance in accordance with rating criteria listed below.

Rating Criteria

A+/-: Significant positive/negative impact is expected.

B+/-: Some positive/negative impact is expected.

C+/-: Extent of positive/negative impact is unknown. (A further examination is required in the further project formulation)

・ -: No impact is expected.

Significant impact shall be determined on the basis of non-negligible environmental changes induced by project implementation.

(3/3)

Appendix 2 Mandatory List of Projects that require EIA Study (List A) (1/3)

1	**Agriculture /Aquaculture Projects**
1.1	Agricultural drainage projects of more than 1 ha.
1.2	Irrigation schemes designed to serve more than 10 ha.
1.3	Land development for the purposes of agriculture on greater than a 20ha landholding
1.4	Agricultural projects necessitating resettlement of 20 or more families. Any change from one agricultural land use to another on greater than a 20ha land holding.
1.5	Use of more than 1 ton of fertiliser per hectare per annum on greater than a 20 ha landholding except for lime applications.
1.6	Use of the following concentrations of pesticides on greater than a 5 ha holding: more than 5 l/ha of ultra low volume pesticides per application; or more than 1 l/ha of aerial application of pesticides; or more than 20kg/ha for each application of granular pesticides.
1.7	Construction of fish-farming or ornamental pond(s) where the capacity is greater than 100 cubic metres or where there is any direct discharge from a fishpond to a receiving water body.
1.8	Any proposal to introduce fish species in an area where they do not presently exist.
2	**Projects in the Food and Beverage Production Industry**
2.1	Construction of new abattoir or slaughterhouse with a capacity greater than 100 animals/day and expansions to existing abattoirs or slaughterhouse to a capacity greater than 100 animals/day.
2.2	Construction of new canning and bottling operation with work space greater than 5000 square metres or expansion to an existing canning or bottling operation to a work space greater than 5000 square metres.
2.3	Construction of new breweries and distilleries with a production capacity greater than 25,000 liters per day, or expansions to existing breweries or distilleries to a production capacity f greater than 25,000 liters per day
2.4	Construction of new sugar production operations or expansions to existing sugar production operations by greater than 10%.
2.5	Construction, or expansions to, tea or coffee processing industries
3	**Water Resources Development**
3.1	Construction, or expansion of, groundwater utilization projects where the utilization will be greater than 15 l/s or where the well is 60 m or deeper.
3.2	Construction of new water pipelines or canals longer than 1 km, or expansion to existing water pipelines or canals by longer than 1 km, where the cross-sectional area is greater than 20 square meters and the volume of water carried will be greater than 50 cubic metres per second.
3.3	Water pumping stations adjacent to lakes, rivers, and reservoirs that withdraw more than 2 cubic meters per second.
3.4	Drinking water supply schemes to serve a population of greater than 10,000 people, or expansions of existing schemes to serve such a population, or water reticulation networks with more than 10 kilometres of pipeline.
3.5	Area of greater than 100 ha, or expansions of existing reservoirs by greater than 500,000 l or greater than 100 ha.
3.6	Construction or expansion of dams with a height of 4.5 m or higher.
4	**Infrastructure Projects**
4.1	Construction of new sanitary sewerage works or expansion of existing sanitary sewerage works, to serve a population of more than 5,000 people.
4.2	Construction of new storm sewerage works or expansion of existing storm sewerage works, to drain an area of greater than 10 ha.
4.3	Any new sewerage outfall to a receiving water body or location of sewerage systems or septic tanks within 1 km of a water body.
4.4	Construction or expansion of septic tanks servicing more than 100 people or 20 homes or which receive more than 100 cubic meters per day of wastewater.
4.5	Construction of new highways and feeder roads or expansion of existing highways and feeder roads
4.6	Construction of new airport and airstrips or expansion of existing and airstrips and their ancillary facilities
4.7	Construction of hospitals with a bed capacity of greater than 200 beds, or expansions of existing hospitals to a capacity of greater than 200 beds
4.8	Construction of new, or expansions to existing, railway lines.
4.9	Construction of new, or expansions to existing port or harbour facilities
4.10	Establishment or expansion of industrial estates
5	**Waste Management Projects**
5.1	Establishment, or expansion, of any of the following hazardous waste management facilities: incineration plant, off-site recovery plant, off-site waste disposal facility, off-site storage facility, landfill site
5.2	Establishment, or expansion, of any of the following municipal solid waste management facilities serving a population of greater than 1,000 people: landfill site, incineration facility, composting facility, recovery/recycling facility, waste depots/transfer stations.
5.3	Establishment, or expansion of, on-site waste treatment facilities

Source: EIA Guidelines, 1997

Appendix 2 Mandatory List of Projects that require EIA Study (List A)

(2/3)

6	**Energy generation, transmission and storage projects**
6.1	Construction or expansion of electrical generating facilities designed to operate at greater than 4 MW or, in the case of hydro-electric generating facilities, where the total head is greater than 20 m or where there is a firm flow of 100 cubic metres per second
6.2	Construction of electrical transmission facilities operating at a voltage of 132 kV or greater
6.3	Construction or expansion of oil and gas pipelines longer than 1 km
6.4	Construction or expansion of storage facilities (excluding services station) for oil, gas, petrol or diesel located within 3 kilometres of commercial, industrial or residential areas and with a storage capacity of 500,000 litres or more
6.5	All activities associated with nuclear power development
7	**Industrial Projects**
7.1	Construction of, and expansions to, industries involving the use, manufacturing, handling storage; transport or disposal of hazardous or toxic chemicals as regulated under the hazardous chemicals regulation under the Environment Management Act
7.2	Construction of, or expansion to, any of the following industrial operations: tanneries, pulp and paper mills, lime plants, cement plants, all types of smelters, soap and detergent plants, fertiliser manufacturing operations
7.3	Construction of textile manufacturing operations (including carpet-making) which consume greater than 5,000 square metres of surface area, or expansions to existing textile manufacturing operations to a capacity of more than 5000 square metres
8	**Mining and Quarrying Projects**
8.1	All mining of minerals, expansions to mines, mining exploration activity, minerals prospecting activity, quarries, gravel pits and removal of sand or gravel from shore lines, except for those activities which have received a project specific exemption under subsection 26 (3) of the Environment Management Act signed by the Director for Environmental Affairs and co-signed by the Director of Mines
8.2	Explosives manufacturing
8.3	Extraction of top soil or the expansion of such an operation, when the operation or the expansion is greater than 0.5 ha or when the depth of a pit to burn bricks from the top soil is deeper than 3 m.
9	**Forestry Projects**
9.1	Establishment or expansion of logging operations covering an area of greater than 50ha.
9.2	Establishment of, or expansions to existing, logging operations on hill sides with a slope of greater than 10% covering an area of greater than 10 ha or any conversion of forested land with a slope of greater than 10% to another land use on greater than 10 ha
9.3	Establishment of logging or conversion of forested land to another land use within the catchment area of reservoirs
9.4	Establishment of forest plantations of greater than 50 ha
10	**Land Development, Housing and Human Settlement Projects**
10.1	Establishment of, or expansion to an existing; housing development of a size greater than 5 ha or where more than 500 people are intended to be housed
10.2	Resettlement programmes for 500 or more people or the creation of refugee camps intended to shelter 500 or more people.
10.3	Filling in water bodies for the purposes of land development where the surface area of gross fill deposit is greater than 50 ha
10.4	Land reclamation projects greater than 100 ha
11	**Remedial Flood and Erosion Control Projects**
11.1	Construction of breakwaters, seawalls, jetties, dikes and groynes of greater than 2 metres in height or 1 km in length to remedy shoreline erosion or flooding
11.2	Construction of dams or weirs with a height of greater than 2 metres, or which divert more than 20 cubic metres per second, or any bypass channels or channel realignments to remedy riverine erosion or flooding.
11.3	Shoreline stabilisation projects where the shoreline involved is greater than 50m
12	**Tourism Development Projects**
12.1	Construction of resort facilities and hotels with a capacity of more than 50 people, or expansions to existing facilities by a factor of greater than 50 people.
12.2	Construction of safari lodges and operations with a capacity of more than 50 people, or expansions to existing facilities by factor of greater than 50 people
12.3	Construction of marine facilities with more than 10 boat slips, or expansion of existing marine facilities by more than 10 boat slips
12.4	Development of tourism master plans which have several projects associated with them.

Source: EIA Guidelines, 1997

Appendix 2 Mandatory List of Projects that require EIA Study (List A) (3/3)

13	**Projects in proximity to or which have the potential to affect:**
13.1	Areas of unique historical, cultural, scientific or geographical significance or which have received some kind of world heritage designation
13.2	National parks, game reserves and protected areas
13.3	Wetlands.
13.4	Water bodies
13.5	Flood zones
13.6	Major sources of drinking water, including communal wells
13.7	Cemeteries or ancestral shrines
13.8	Residential, school and hospital areas, as designed in local planning documents.
14	**Major Policy Reforms**
	For example:
14.1	Degazettement of Forestry Reserves
14.2	Changes to Zoning Plans
14.3	Proposed introduction of exotic species

Source: EIA Guidelines, 1997

Appendix 3 List of Projects that may require EIA Study (List B)

1	Agriculture and aquaculture schemes
2	Drainage and irrigation projects
3	Forestry and logging schemes
4	Industrial projects
5	Infrastructure projects
6	Land development projects
7	Mining projects
8	Energy generation, transmission and use projects
9	Tourism projects
10	Waste treatment and disposal projects
11	Water supply projects
12	Health and population projects
13	Projects in areas protected under legislation
14	Projects in areas containing rare or endangered flora and fauna
15	Projects in areas containing unique or outstanding scenery
16	Projects in tribal habitats

Source: EIA Guidelines, 1997

Appendix 4 List of Dams Projects in the Water Resources Master Plan

SN	Sector	Status G/P	Code	Devel. Type N/E	Name of Project [River Name]	Implementing Agency	WRA	District	Outline/Scope of the Project	Group1	Group 2	Protected Area	Category for EIA	Scoping for IEE
1	D	P	DP1	E	Nkula upgrade [Shire]	DoE	1	Neno, Brantyre	Purpose = E, Expansion Capacity = 6MW		1	Proposed Forest Reserve	1	1
2	D	P	DP2	E	Tedzani IV [Shire]	DoE	1	Neno, Brantyre	Purpose = E, Total Head = 40m, Installed Capacity = 18MW, Firm Flow = N/A, Max. Flow = 70m3/s		1	Proposed Forest Reserve	1	1
3	D	P	DP3	E	Kapichira III [Shire]	DoE	1	Chikwawa	Purpose = E, Total Head = 60m, Installed Capacity = 35MW, Firm Flow = N/A, Max. Flow = 82m3/s		1	Majete Game Reserve	1	1
4	D	P	DP4	N	Kholombidzo [Shire]	DoE	1	Neno, Brantyre	Purpose = E, Dam Height = 24m, Total Head = 75m, Installed Capacity = 170MW, Firm Flow = 183m3/s, Max. Flow = 285m3/s		1	Proposed Forest Reserve	1	1
5	D	P	DP5	N	Mpatamanga [Shire]	DoE	1	Neno, Brantyre	Purpose = E, Dam height = 64m, Total Head = 62m, Installed Capacity = 228MW, Firm Flow = 136~170, Max. Flow = 418m3/s		1	Proposed Forest Reserve	1	1
6	D	P	DP6	N	Mbongozi [Bua]	DoE	5	Kasungu, Ntchisi	Purpose = E, Dam Height = 76m, Total Head = 143m, Installed Capacity = 55MW, Firm Flow = 16.3m3/s, Max. Flow = 50m3/s	1			1	1
7	D	P	DP7	N	Malenga [Bua]	DoE	5	Kasungu, Nkhotakota	Purpose = E, Dam Height = 115m, Total Head = 170m, Installed Capacity = 62MW, Firm Flow = 16.6m3/s, Max. Flow = 50m3/s		1	Nkhotakota Game Reserve	1	1
8	D	P	DP8	N	Chasombo [Bua]	DoE	5	Nkhotakota	Purpose = E, Dam Height = 110m, Total Head = 122m, Installed Capacity = 55MW, Firm Flow = 17m3/s, Max. Flow = 60m3/s		1	Nkhotakota Game Reserve	1	1
9	D	P	DP9	N	Chizuma [Bua]	DoE	5	Nkhotakota	Purpose = E, Dam Height = 37m, Total Head = 130m, Installed Capacity = 50MW, Firm Flow = 18.5m3/s, Max. Flow = 60m3/s		1	Nkhotakota Game Reserve	1	1
10	D	P	DP10	N	Rumphi [South Rukuru]	DoE	7	Rumphi, Mzimba	Purpose = E, Dam Height = 39m, Total Head = 56m, Installed Capacity = 10MW, Firm Flow = N/A, Max. Flow = 30m3/s	1			1	1
11	D	P	DP11	N	Hengu Valley [South Rukuru]	DoE	7	Rumphi	Purpose = E, Dam Height = 48m, Total Head = 106m, Installed Capacity = 28MW, Firm Flow = N/A, Max. Flow = 40m3/s	1			1	1
12	D	P	DP12	N	Lower Fufu [South Rukuru, North Rumphi]	DoE	7	Rumphi	Purpose = E, Dam Height = 24m, Total Head = 346m, Installed Capacity = 100MW, Firm Flow = N/A, Max. Flow = 40m3/s		1	Chombe Proposed Forest Reserve (Intake in North Rumphi River)	1	1
			DP12 Alt-1		Ditto (Alternetive-1) High Fufu [South Rukuru]	DoE	7	Rumphi	Purpose = E, Dam Height = 101m, Total Head = 441m, Installed Capacity = 174MW, Firm Flow = N/A, Max. Flow = 50m3/s					
			DP12 Alt-2		Ditto (Alternetive-2) Low Fufu [South Rukuru]	DoE	7	Rumphi	Purpose = E, Dam Height = 44m, Total Head = 364m, Installed Capacity = 144MW, Firm Flow = N/A, Max. Flow = 50m3/s					
13	D	P	DP13	N	Zoa Falls [Ruo]	DoE	14	Thyolo	Purpose = E, Dam Height = 21m, Total Head = 76m, Installed Capacity = 37MW, Firm Flow = N/A, Max. Flow = 70m3/s	1			1	1
14	D	P	DP14	N	Chimgonda [Dwambazi]	DoE	16	Nkhata Bay, Nkhotakota	Purpose = E, Dam Height = 97m, Total Head = 385m, Installed Capacity = 50MW, Firm Flow = N/A, Max. Flow = 20m3/s		1	Dwambazi Forest Reserve, South Viphya Forest Reserve	1	1
15	D	P	DP15	N	Upper Songwe (Bupiga) [Songwe]	DoE	9	Chitipa	Multi-Purpose = E & I & FC, Dam Height = 70m, Total Head = 75m, Installed Capacity = 32MW, Firm Flow = N/A, Max. Flow = 50m3/s	1			1	1
16	D	P	DP16	N	Middle Songwe (Sofwe) [Songwe]	DoE	9	Chitipa	Multi-Purpose = E & I & FC, Dam Height = 112m, Total Head = 315m, Installed Capacity = 159MW, Firm Flow = N/A, Max. Flow = 60m3/s	1			1	1
17	D	P	DP17	N	Lower Songwe (Manolo) [Songwe]	DoE	9	Karonga	Multi-Purpose = E & I & FC, Dam Height = 140m, Total Head = 253m, Installed Capacity = 148MW, Firm Flow = N/A, Max. Flow = 70m3/s	1			1	1
18	D	G	DG1	E	Raising of Kamuzu1 [Lilongwe]	LWB	4	Lilongwe	Purpose =WS, Dam Height from 20m to 25m, Targeted Yield from 4.5million to 18million m3/year, Equivalent Population to additional quantity of water intake = 200,099.	1			1	1
19	D	G	DG2	N	Diamphwe Lower [Diamphwe]	LWB	4	Lilongwe	Multi-Purpose = WS+I (compensation)+FR, Dam Height = 32m, Effective Storage Capacity = 294 M m3, Targeted Yield = 218,300 (WS: 149200 + I: 68800 + FR: 300) m3/d, Equivalent Population to quantity of water intake for WS= 1,000,495, Irrigation Area = 1000ha (Compensation: 177 + Development: 823), Fish farm = 40000m3.	1			1	1
20	D	P	DP18	N	Lambilambi [Lambilambi]	NRWB	16	Nkhata Bay	Purpose = WS, Dam Height = 25m, Effective Storage Capacity = 21 M m3, Targeted Yield = 45,000 m3/d, Equivalent Population to quantity of water intake = 215,811.	1			1	1
21	D	P	DP19	N	Lichelemu [Lichelemu]	NRWB	16	Nkhata Bay	Multi-Purpose = WS + I(compensation), Dam Height = 24m, Effective Storage Capacity = 15 M m3, Targeted Yield = 29,600 m3/d, Equivalent Population to quantity of water intake = 141,955, Irrigation Area = 800ha + Future expansion plan	1			1	1
										11	10			21

G: on-going project (include detail design or construction); P: planning phase (include F/S)
Development Type: N: New, E: Expansion
Purpose : E: Energy generation, I: Irrigation, FC: Flood Control, WS: Water Supply, FR: Fisheries
Group of projects for For IEE Study:
Group 1: Hydropower dams withTH more than 20 m or firm flow=100 m3/sec; or Multipurpose dam (area >100 ha; high=4.5 m or higher; TH>20 or firm flow=100 m3/sec) or Construction or expansion of dams with high=4.5 m or higher for WS
Group 2: Hydropower or multipurpose dams located in protected area

Summary			
Categorization			Projects for EIA/IEE
Category 1	21		21
Category 2	0		0
Category 3	0		
Total	21		21

Summary			
Dams	G	P	Total
Hydropower dams	0	14	14
Multipurpose dams (E+I+FC)	0	3	3
Multipurpose dams (WS+I)	1	1	2
Dam for WS only	1	1	2
Total	2	19	21

Appendix 5 Water Supply Projects in the Water Resources Master Plan

S/N	Sector	Status G/P	Devel. Type N/R	Code	Name of Project	Implementing Agency	District	Water Source (S/G)	Develop't Water Supply (m3/day)	Served Population	Outline / Scope of the Project(s)	Group 1	Group 2	Group 3	Group 4	Rehabilitation Type R1	Rehabilitation Type R2	Category for EIA	Scoping for IEE
Urban Water Supply for four Cities (Lilongwe, Blantyre, Mzuzu and Zomba)																			
1	WS	G	N	WSU1	Develop new groundwater borehole (+10,000 m3/d)	LWB	Lilongwe	G	10,000	66,700	Develop new groundwater borehole (+10,000 m3/d)				1			1	1
2	WS	G	N	WSU2	Extension TWII (purification plant: +30,000 m3/d)	LWB	Lilongwe	S	30,000	200,099	Extension TWII (purification plant: +30,000 m3/d)	1						1	1
3	WS	G	R	WSU3	Raising of Kamzu dam 1 and associated rehabilitation works (+30,000 m3/d)	LWB	Lilongwe	S	30,000	200,099	Raising of Kamzu dam 1 and associated rehabilitation works (+30,000 m3/d)					1		1	1
4	WS	P	N	WSU4	Extension TWII(2nd) (purification plant: +30,000 m3/d) and Technical Assistance	LWB	Lilongwe	S	30,000	200,099	Extension TWII(2nd) (purification plant: +30,000 m3/d) and Technical Assistance	1						1	1
5	WS	P	R	WSU5	Network improvement	LWB	Lilongwe		-	913,785	Network improvement					1		1	1
6	WS	P	N	WSU6	Full implementation GIS/Hydraulic Model	LWB	Lilongwe		-	-	Full implementation GIS/Hydraulic Model							3	0
7	WS	P	N	WSU7	Phase 1, New water source Diamphwe dam including transports system (+75,000 m3/d, TW+66000 m3/d)	LWB	Lilongwe	S	75,000	500,247	Phase 1, New water source Diamphwe dam including transports system (+75,000 m3/d, TW+66000 m3/d)	1						1	1
8	WS	P	N	WSU8	Implementation telemetry system	LWB	Lilongwe		-	-	Implementation telemetry system						1	2	1
9	WS	P	R	WSU9	Rehabilitation of TWII	LWB	Lilongwe		-	-	Rehabilitation of TWII						1	2	1
10	WS	P	N	WSU10	Network expansion	LWB	Lilongwe		-	1,000,495	Network expansion	1						1	1
11	WS	P	N	WSU11	Review of water demand study	LWB	Lilongwe		-	-	Review of water demand study							3	0
12	WS	P	N	WSU12	Phase 2, New water source Diamphwe dam including transports system (Dam+75,000 m3/d, TW+66000 m3/d)	LWB	Lilongwe	S	75,000	500,247	Phase 2, New water source Diamphwe dam including transports system (Dam+75,000 m3/d, TW+66000 m3/d)	1						1	1
13	WS	P		WSU13	Network improvement	BWB	Blantyre		-	796,112	Network improvement					1		1	1
14	WS	P		WSU14	additional NRW reduction programme	BWB	Blantyre		-	-	additional NRW reduction programme							3	0
15	WS	P		WSU15	Metering and Water leakage control	BWB	Blantyre		-	-	Metering and Water leakage control							3	0
16	WS	P		WSU16	Phase 1, New water source from Shire River including transports system (+39,000 m3/d)	BWB	Blantyre	S	39,000	287,485	Phase 1, New water source from Shire River including transports system (+39,000 m3/d)	1						1	1
17	WS	P		WSU17	Network expansion	BWB	Blantyre		-	574,970	Network expansion	1						1	1
18	WS	P		WSU18	Poverty program (Kiosk and Toilet development)	BWB	Blantyre	G	-	-	Poverty program (Kiosk and Toilet development)				1			2	1
19	WS	P		WSU19	Phase 2, New water source from Shire River including transports system (+39,000 m3/d)	BWB	Blantyre	S	39,000	287,485	Phase 2, New water source from Shire River including transports system (+39,000 m3/d)	1						1	1
20	WS	P		WSU20	Review of water demand study	BWB	Blantyre		-	-	Review of water demand study							3	0
21	WS	P		WSU21	Phase 1, New water source Lambilambi dam including transports system (+45,000 m3/d)	NRWB	Mzuzu	S	45,000	215,811	Phase 1, New water source Lambilambi dam including transports system (+45,000 m3/d)	1						1	1
22	WS	P		WSU22	Network improvement	NRWB	Mzuzu		-	77,212	Network improvement						1	2	1
23	WS	P		WSU23	Re-examination of water demand and raw water source study	NRWB	Mzuzu		-	-	Re-examination of water demand and raw water source study							3	0
24	WS	P		WSU24	Phase2, New water source Lichelemu dam inclusing transports system (+29,600 m3/d)	NRWB	Mzuzu		29,600	141,955	Phase2, New water source Lichelemu dam inclusing transports system (+29,600 m3/d)	1						1	1
25	WS	P		WSU25	Network expansion	NRWB	Mzuzu		-	357,766	Network expansion	1						1	1
26	WS	P		WSU26	NRW reduction programme	NRWB	Mzuzu		-	-	NRW reduction programme							3	0
27	WS	G		WSU27	Expansion existing TW (18,200 to 30,000 m3/d)	SRWB	Zomba	S	11,800	61,792	Expansion existing TW (18,200 to 30,000 m3/d)	1						1	1
28	WS	P		WSU28	Network improvement	SRWB	Zomba		-	157,098	Network improvement					1		1	1
29	WS	P		WSU29	Feasibility study of water demand and new raw water source	SRWB	Zomba		-	-	Feasibility study of water demand and new raw water source	1						1	1
30	WS	P		WSU30	Raising of Mulunguzi dam and associated rehabilitation works (+6,100 m3/d)	SRWB	Zomba	S	6,100	31,943	Raising of Mulunguzi dam and associated rehabilitation works (+6,100 m3/d)					1		1	1
31	WS	P		WSU31	Network expansion	SRWB	Zomba		-	31,943	Network expansion	1						1	1
32	WS	P		WSU32	Capacity Building for Water demand management	LWB, BWB, NRWB, SRWB	4 cities		-	-	Capacity Building for Water demand management							3	0
33	WS	P		WSU33	Programme for Water Saving (improvement of awareness, usage of water saving device, regulation change, etc.)	LWB, BWB, NRWB, SRWB	4 cities		-	-	Programme for Water Saving (improvement of awareness, usage of water saving device, regulation change, etc.)							3	0
34	WS	P		WSU34	Improvement Programme of Water, Sanitation and Hygiene awareness	LWB, BWB, NRWB, SRWB	4 cities		-	-	Improvement Programme of Water, Sanitation and Hygiene awareness							3	0
35	WS	P		WSU35	Maintenance Programme of Waterworks Facility	LWB, BWB, NRWB, SRWB	4 cities		-	-	Maintenance Programme of Waterworks Facility						1	2	1
Water Supply for Towns																			
36	WS	G		WST1	Supply of Water meter & pipes	NRWB	Mzuzu, etc. 9 districts				Supply of Water meter & pipes for 9 distircts							3	0
37	WS	G		WST2	Upgrading & Expansion for Mzimba Water Supply Scheme(WSS)	NRWB	Mzimba		40000		New water intake & pipelinme 10km					1		1	1
38	WS	G		WST3	Supply & Diesel Generator for Chitipa	NRWB	Chitipa	G			Supply & Diesel Generator for Borehole							3	0
39	WS	G		WST4	Construction/Expansion of Nkhotakota WSS	NRWB	Nkhotakata						1					2	1
40	WS	G		WST5	Expansion of Salima WSS	CRWB	Salima	S	50000		New Intake, Treatment Plant, Transmission Pipe					1		1	1
41	WS	G	R	WST6	Rehabilitation and Expansion of Kasungu WSS	CRWB	Kasungu		12700		Distibution Pipe, Water Tank and Water Point					1		1	1
42	WS	G		WST7	Upgrading of Mangochi WSS	SRWB	Mangochi		17634								1	2	1
43	WS	G		WST8	Construction of Balala WSS	SRWB	Balaka		22110			1						1	1
44	WS	G		WST9	Construction of Nsanje WSS	SRWB	Nsanje	G	22000		Drilling & Transmission pipe, water Point			1				1	1
45	WS	P	R	WST10	Project for the Rehabilitation and Expansion of Water Supply schemes in Local City Centers of Malawi	3 RWBs	All	S/G			Rehabilitation/Expantion of Water Supply Facilities (Schemes on short term target)						1	2	1
46	WS	P	R	WST11	Feasibility Study for Water Supply Improvement in Local City Centers	3 RWBs	All	S/G			F/S on Water Demand Projection, Analysis of Water Source(Surface & Groundwater), Planning of Facilities		1					2	1
Water Supply for Market Center																			
47	WS	G		WSM1	Songwe WSS	NRWB		G	4000		Borehole & Storage Tank			1				1	1
48	WS	G		WSM2	Rehabilitation and Expansion of Mponela WSS	CRWB		G	40000		Rehabilitation, Expansion of Pipeline & Water Tank						1	2	1
49	WS	G		WSM3	Kochilira-Kamwendo WSS	CRWB		G	?						1			2	1
50	WS	G		WSM4	Mitundo & Linthipe	CRWB		G	?		Borehole & Storage Tank				1			2	1
51	WS	G		WSM5	Construction of Lirangwe MC WSS	SRWB		G	7620					1				1	1
52	WS	G		WSM6	Construction of WSS for MCs (Chididi, Ntwe, Tengani, Jali, Mayaka, Chimba, Maldeco,)	SRWB		G	60000						1			2	1
53	WS	G		WSM7	Construction of Neno WSS	SRWB	Neno	S	2000		Intake		1					2	1
54	WS	G		WSM8	Rehabilitation/Expantion Project for Misue folo	SRWB		G	8000		Borehole & Storage Tank			1				1	1
55	WS	P		WSM9	Project for the improvement of Water Supply schemes in the Market Centers of Malawi	3 RWBs	All	G			Basic Design & Implementation of Water Supply Facilities (Schemes of short term target)				1			2	1
56	WS	P		WSM10	Feasibility Study for Water Supply Improvement in the Market Centers	3 RWBs	All	G			F/S on Water Demand Projection, Analysis of Water Source(Surface & Groundwater), Planning of Facilities (schemes of middle & long term plan)				1			2	1
Water Supply to Community by Gravity Fed Scheme																			
57	WS	G	R	WSGF1	Rehabilitation/Expantion Project for Chikuwaka East Bank	MoAIWD		S	11040		Rehabilitation & Expansion of GFS, Intake, Transmission Pipe, Water Point					1		1	1
58	WS	G	R	WSGF2	Rehabilitation/Expantion Project for Ushisya	MoAIWD		S	18360		Rehabilitation & Expansion of GFS, Intake, Transmission Pipe, Water Point					1		1	1
59	WS	G	R	WSGF3	Rehabilitation/Expantion Project for Nkhamanga-Katizi	MoAIWD		S	34200		Rehabilitation & Expansion of GFS, Intake, Transmission Pipe, Water Point					1		1	1
60	WS	G	R	WSGF4	Rehabilitation/Expantion Project for Ntonda	MoAIWD		S	7680		Rehabilitation & Expansion of GFS, Intake, Transmission Pipe, Water Point					1		1	1
61	WS	G	R	WSGF5	Rehabilitation/Expantion Project for Chapanga	MoAIWD		S	49320		Rehabilitation & Expansion of GFS, Intake, Transmission Pipe, Water Point					1		1	1
62	WS	P	R	WSGF6	Rehabilitation/Expantion Project for the Gravity-fed Piped Water Supply in Rural Area	MoAIWD		S			Rehabilitation & Expansion of GFS, Intake, Transmission Pipe, Water Point Capacity Development of WUA						1	2	1
Water Supply to Community by Borehole																			
63	WS	G		WSB1	WASH	District Government	All	G	940,000		Water and Sanitation				1			2	1
64	WS	G	N/R	WSB2	Groundwater Development & management Program	District Government	Chitapa, karonga etc. (27 Districts)	G	100000		New Borehole and Rehabilitation				1			2	1
65	WS	G	N/R	WSB3	Groundwater Development & management Program	District Government	All	G			Rehabilitation and New Construction				1			2	1
												15	3	5	9	13	8		53

G: on-going project (include detail design or construction); P: planning phase (include F/S); N: new project; R: rehabilitation project

Group of projects for For IEE Study: Group 1: Water treament plant with capacity to serve more than 10,000 people; Group 2: Water treatment plant with capacity to serve less than 10,000 people; Group 3: groundwater utilization > than 15 l/sec (1296m3/d)
Group 4: groundwater utilization < than 15 l/sec (1296m3/d)
Group R1: Rehabilitation, improvement or maintenance of water system (big scale activities including important civil works); Group R2: Rehabilitation, improvement or maintenance of water system (small scale activities including minor civil works)

Summary			
Categorization		Projects for EIA/IEE	
Category 1	33		33
Category 2	20		20
Cagegory 3	12		-
Total MP	65	Total	53

Appendix 6 List of Irrigation Projects in the Water Resources Master Plan

SN	Sector	Status G/P	Code	Name of Project	Implementing Agency	WRA	District	Outline/Scope of the Project	Group 1	Group 2	Group 3	Protected Area Name	Category for EIA	Scoping for IEE
1	I	P	I1	Nothla/Ilora-Ngosi Irrig. Site	OPC	17	Karonga	1,200 ha, Water source: Lake Malawi	1				1	1
2	I	P	I2	Chikwawa	OPC		Salima	530 ha, Water source: Lake Malawi	1				1	1
3	I	P	I3	Malombe	OPC		Mangochi	500 ha, Water source: Lake Malombe	1				1	1
4	I	P	I4	Chilengo	OPC		Chikhwawa	240 ha, Water source: Livunzu River, tributary of Shire River	1				1	1
5	I	P	I5	Mphenga Corled	DOI	17	Karonga	480 ha, Water source: Wovwe River	1				1	1
6	I	P	I6	Timoti Irrig. Scheme	DOI	17	Karonga	75 ha, Water source:Tinofi River	1				1	1
7	I	P	I7	Ukanga Irrig. Site	DOI	17	Karonga	30 ha, Water source: Nyungwe River	1				1	1
8	I	P	I8	Limphasa (Gravity)	DOI	16	Mzuzu	403 ha, Water source: Limphasa River, Major Crop: rice	1				1	1
9	I	G	I9	Malawi Irrigation Development Support Programme	DOI	-	-	900 ha, to be implemented up to 2015	1				1	1
10	I	G	I10	Small Farms Irrigation Project	DOI	-	-	800 ha, to be implemented up to 2015, Major Crop: rice & others	1				1	1
11	I	G	I11	Agriculture Infrastructure Support Project	DOI	-	-	1600 ha, to be implemented up to 2015, Major Crop: Horticulture & maize	1				1	1
12	I	G	I12	Small holder Irrigation & Value Addition Project	DOI	-	-	2050 ha, to be implemented up to 2018	1				1	1
13	I	G	I13	Shire Valley Irrigation Project	DOI	-	-	11,000 ha, to be implemented up to 2020, Major Crop: Sugarcane, Rice, Cotton	1				1	1
14	I	G	I14	Shire River Basin Management Project	DOI	-	-	1,000 ha, to be implemented up to 2017, Major Crop: Sugarcane, Rice, Cotton	1				1	1
15	I	P	I15	Songwe River Basin Development Programme	DOI	-	-	1,000 ha, to be implemented up to 2020 & 1,750 ha, to be implemented up to 2035, Major Crop: Sugarcane, Rice, Cotton	1				1	1
16	I	P	I16	Development of Medium Scale Irrig. Project	DOI	-	-	200 ha, to be implemented up to 2014	1				1	1
17	I	P	I17	Lweya (pumping)	DOI	-	Mzuzu	800 ha	1				1	1
									17	0	0			17

G: on-going project (include detail design or construction); P: planning phase (include F/S); WRA: water resource area

Group of projects for For IEE Study: Group 1: Irrigation shemes with area more than 10 has; Group 2: Irrigation shemes with area less than 10 has;
Group 3: Irrigation shemes located in Protected Area or vicinity

Summary		
Categorization		Projects for EIA/IEE
Category 1	17	17
Category 2	0	0
Category 3	0	0
Total	17	17

Appendix 7 List of Water Resources Management in the Water Resources Master Plan

SN	Sector	Status G/P	Type	Code	Name of Project	Implementing Agency	WRA	Outline/Scope of the Project	Category for EIA	Scoping for IEE
1	WRM	P	WM	WM1	Catchment area conservation and rehabilitation	LWB	4	Catchment area conservation and rehabilitation (currently at study stage where components will be determined)	3	0
2	WRM	P	WQ	WQ1	Strengthening of Water Laboratory	MoAIWD	-	The functions of three (3) existing water laboratories including the Central, North and South labs will be strengthened in upgrading facilities, staffing and capacity building of lab staff in this project	3	0
3	WRM	P	GM	GM1	Construction of Groundwater Monitoring Wells	MoAIWD	All	Approx. sixty (60) monitoring wells for monitoring groundwater fluctuation are newly constructed in all WRAs (for Research)	3	0

G: on-going project (include detail design or construction); P: planning phase (include F/S); WRA: water resource area; HM: hydrological monitoring; WQ: Water Quality 0

GM: Groundwater Monitoring; WM: Watershed Management

Summary		
Categorization		Projects for EIA/IEE
Category 1	0	0
Category 2	0	0
Cagegory 3	3	
Total	3	0

Reference List

1. Feasibility Study and Preliminary Design for Lilongwe's new water source, April 2010 (SOGREAH Consultants)..... 1-6
2. Feasibility Study and Preliminary Design for Blantyre's New Raw Water Source and Other Purposes, August 2010 (SOGREAH Consultants)..... 1-6
3. Feasibility Study and Preliminary Design of Multi-Purpose Water Source Development for Mzuzu & Mzimba and Surrounds, September 2010 (SOGREAH Consultants)..... 1-6
4. Preliminary and Detailed Design and Construction Supervision for Zomba and Mangochi Water Supplies, June 2010 (SSI Engineers Environmental Consultants)..... 1-6
5. Draft Report "Water Resources Investigations For Selected Market Centres In Lilongwe, Machinga, Zomba And Mulanje Districts", Centre For Development Research And Information In Southern Africa, May 2011 1-6
6. Ministry of Irrigation and Water Development 2000, Technical Manual for Gravity fed Rural Piped water schemes. 1-6
7. Malawi Water Sector Investment Plan, Vol. I, World Bank, April 2012..... 1-6