Ministry of Irrigation and Water Development (MoIWD)

Republic of Malawi

PREPARATORY SURVEY REPORT
ON
THE PROJECT FOR THE GROUNDWATER DEVELOPMENT IN MWANZA AND NENO
IN
REPUBLIC OF MALAWI

January 2011

JAPAN INTERNATIONAL COOPERATION AGENCY

CTI ENGINEERING INTERNATIONAL CO., LTD.

GED
JR
11-012

Ministry of Irrigation and Water Development (MoIWD)

Republic of Malawi

PREPARATORY SURVEY REPORT
ON
THE PROJECT FOR THE GROUNDWATER DEVELOPMENT IN MWANZA AND NENO
IN
REPUBLIC OF MALAWI

January 2011

JAPAN INTERNATIONAL COOPERATION AGENCY

CTI ENGINEERING INTERNATIONAL CO., LTD.

Summary

1. Outline of the Republic of Malawi

Republic of Malawi(hereinafter refers to Malawi) is located in the southern part of Africa continental with a population of approximately 13.07 million in 2008, and its total area is around 118 thousands square km, landlocked country.

Malawi has a tropical savanna climate, with a dry season from April to November and a rainy season from December to March. Annual rainfall is of about 1,000mm.

Topography is characterized by the Africa rift valley which runs north to south in the east part of the country, and the Lake Malawi (20% of the total area) formed along the Rift Valley. The country is divided into four regions such as "Rift Valley Plain", "Rift Valley Escarpment", "Plateau Area", and "Highland Area" according to the topographic property. The Highland Area located in the west part of the Lift Valley is 900-1,200m in elevation, especially Nyika high land is famous with an elevation of about 2,000m and Mulanje mountain with an elevation of 3,000m is highest mountain in central Africa.

The most part of the geology of Malawi belongs to the Mozambique belt of the Pre-Cambrian to Lower Paleozoic, and consists of metamorphic rocks such as gneiss and schist formed due to regional metamorphism and plutonic rocks such as granite and gabbro that intruded into the basement rocks.

The Mozambique belt has experienced structural transformation due to the repeated orogenic movements. The northwest-southeast direction of the structures is dominant and a north-south and east-west directions follow those. In addition, the Rift Valley, which runs north to south through Malawi, had been formed with the fault movement that began in the Cenozoic Era. Accordingly, a number of fractures had been formed with this activity around the Rift Valley.

Economy of Malawi in terms of GDP is approximately US$ 500 millions, the economic growth rate is around 5% in these years, and the GNI per person is US$ 280. The first sector (agriculture) occupies around 35% of GDP, the secondary sector occupies around 20%, and the tertiary sector around 45%. The first sector (agriculture) accounts for around 90% of the labor population, second and tertiary is only 10%.The first sector covers 90% of the export product.

However, the principal export products like tobacco, tea and sugar are influenced by international price, therefore Malawi’s economic basement is not so strong. Economic growth rates have been more than 6% in 2005-2008, however decreased by drop of agricultural product price occurred by international financial crisis in 2008.

2. Background and Outline of the Project

The Project would be guided by the Malawi Growth and Development Strategy (2006-11) and the National Water Policy (2006). Their aims are to extend rural water supply and sanitation services and to promote Community Based Management (CBM) of water and sanitation programme. The targets are to increase the proportion of the population with access to safe potable water within 500m of their households up to 80% by 2011, 85% by 2015 and attain full coverage by 2025. This project is planned in accordance with the overall objectives as part of a project to improve access rate to water supply in rural areas.

The current access rate to safe water was estimated to be 75% (MDG report, 2007). However, 'Joint Sector Review 2008' reports that 30% of water supply facilities in rural areas is dysfunctional and under this scenario the realistic estimation of access rates are 65% in urban and 46% in rural areas respectively whereby rural water supply remains an important challenge.

Ministry of Irrigation and Water Development of Malawi (hereinafter refers to as "MoIWD") has been implementing construction of rural water supply facilities. Primarily the budget of the Government of Malawi is still spent for ordinary expenses and therefore cannot secure the necessary additional budget to invest on new projects of water supply.

In response to this constrains, through the last 5 projects the Government of Japan has constructed some 1,200 boreholes in rural areas under the grant aid scheme.

The target areas of the project have existing boreholes in the communities. However, due to a large increase of population and far distances between communities and boreholes, other traditional water sources such as small streams, spring water and dug wells are used as their primary water sources (55% in Mwanza and 67% in Neno). These traditional waters are used without any treatment, therefore, water quality is problematic for people's health. For example, typhoid fever struck an area near the Mozambique border claiming many victims in 2009. Additionally, water supply condition is unstable, especially in dry season. An urgent solution is awaited.

The Government of Malawi made a plan composed of borehole construction and handpump installation to solve this problem, and requested the implementation of the Project to Government of Japan.

3. Outline of the survey and the Project

Japan International Cooperation Agency (hereinafter refers to JICA) dispatched a preparatory survey team from between March, 2010 and January, 2011.

In this survey, a series of discussions were held with the officials concerned of the Government of Republic of Malawi, and conducted field investigations on environmental conditions (topography, geology, potentiality of groundwater) and social conditions(community's population, economical conditions, etc.), facility's operation and maintenance system, and surveys concerned to the implementation of the project.

With the results of further studies in Japan, the draft report was prepared, and a mission for the draft report explanation was dispatched from September 25 to October 5 in 2010. The Contents and Obligation of Malawi side were discussed and agreed.

Outline of the Project is as follows:

(a) Construction of Facilities

Table－1 Borehole with handpump & related facilities

District	No. of communities
Mwanza	59
Neno	61
total	120

Table－2 Outline of Facilities

Items	outline
Borehole	119 sites（※）、diameter of borehole（4”）、depth:50～55m、material of borehole: PVC casing & screen, pumping test, etc.
Related facility	120sites, apron, drainage channel, filter pit
handpump	120sites, Afridev type procurement and installation

※ one test drilling site will be used for installation of handpump and related facilities.

(b) Procurement of Equipment

To achieve the above objectives, the Project constructs water supply facilities and boreholes in 120 communities with high priority in the requested areas that face problems with security and stability of water sources. Further, the Project procures vehicles for operation and maintenance management to be used with implementation of CBM programme to realize effective and sustainable use of the facilities, as well as GPS equipment for accurate positioning of boreholes.

Table－3 Procurement of the Equipment

Item	Contens
Vehicles for operation and maintenance	Double cabin pick-up 1 vehicle in each district: total 2
GPS	Portable type in each district: total 2

(c) Soft Component

Soft Component will be conducted to support establishment of a operation and maintenance system under the CBM Program in order to obtain the condition in which the water supply facilities of the Project is managed by the water users effectively and sustainably . Activities will be (i) Training of the extension workers in the district, (ii) Constitution of VHWC in all communities, and newly establishment of WPC, (iii) Capacity building of the committee members of VHWC/WPC, (iv) Hygiene and sanitary education for the village people.

Soft Component activities will be planned and conducted by a Japanese consultant and a local consultant in collaboration with a CBM coordinator of MoIWD. The activities and the implementation period as mentioned above are summarized in the following table.

Table－4 Activities (Input Plan, including activities of the Executing Agency)

Items	Activities	Period
(1) Establishment of VHWCs and WPCs	- Explanation of the Project - Confirmation on the collaboration with the project construction works - Explanation on establishment of a VHWC, WPC - Selection of committee members	D/D Stage construction stage
(2) Training of District Extension Workers	- Organizational management - Organizational management - Health Education - O&M and repair technology	D/D Stage construction stage
(3) Training of Committee Members of VHWCs and WPCs	- Organizational management - Financial management - O&M and repair technology - Health education	Post-construction stage, before operation of the facility
(4) Health and Sanitary Training for Village People	-Introduction to health and sanitation - Causes and prevention of water related diseases - Sanitary consideration for the facility	construction stage, after activities 1-3

Main output of the Soft Component activities is confirmed by the Completion Report, Training manuals for the District Extension Workers and the committee members of VHWCs and WPCs, and Activity Report of operation, maintenance and sanitary condition by District's water officer.

4. Implementation Schedule and Project Cost Estimation

The Project is implemented as a single-year project, totally around 24 months for the detailed design and construction after Exchange of Notes (E/N).

Estimated Project Cost to be shouldered by the Malawi side is approximately 25 million yen and it will be used for the preparation of the borehole sites, required access, etc.

5. Project Evaluation

Project Validities

The Target of the Project is the village people living in Mwanza and Neno Districts located in the southern part of Malawi, The direct beneficiary people will be of approximately 28,700.

Principally traditional water source like river water, spring water and dug well is utilized for drinking water without any treatment in the Area, therefore many people is affected by water born diseases. Around 20 people were dead by typhoid fever in the boundary between Mozambique in 2009 due to the problem of water; therefore, the water service condition is required to be improved as a urgent work.

New borehole with hand-pump and related facilities to be constructed by the Project will be maintained by the water source committee to be established at each Borehole site. Maintenance cost is estimated around MK35 per household per month, and the results of WTP survey shows that the village people can pay around MK50-60 per household per month, i.e., the maintenance of the facility is expected to be conducted by the community itself.

The Project's superior program in Malawi are the MDGS (2006-11) and the National Water Policy (2006). Their aims are to extend rural water supply and sanitation services and to promote Community Based Management (CBM) of water and sanitation programme. The targets are to increase the proportion of population with access to safe potable water within 500m of their households up to 80% by 2011, 85% by 2015 and to attain full coverage by 2025. This project will contribute to the overall objectives.

The category of Environmental and Social consideration of JICA's guideline is C, i.e. , there is little influence to the environmental condition.

Project Effects

The quantitative effect by the Project is the increase of the population with access to safety and stable water of approximately 28,700 in the target year 2015 in Mwanza and Neno districts. The proportion of the population covered with safety water will be from 41.6% in 2010 to 47.3% in 2015, i.e., 5.7% of increase.

The Qualitative Effects by the Project are as follows:

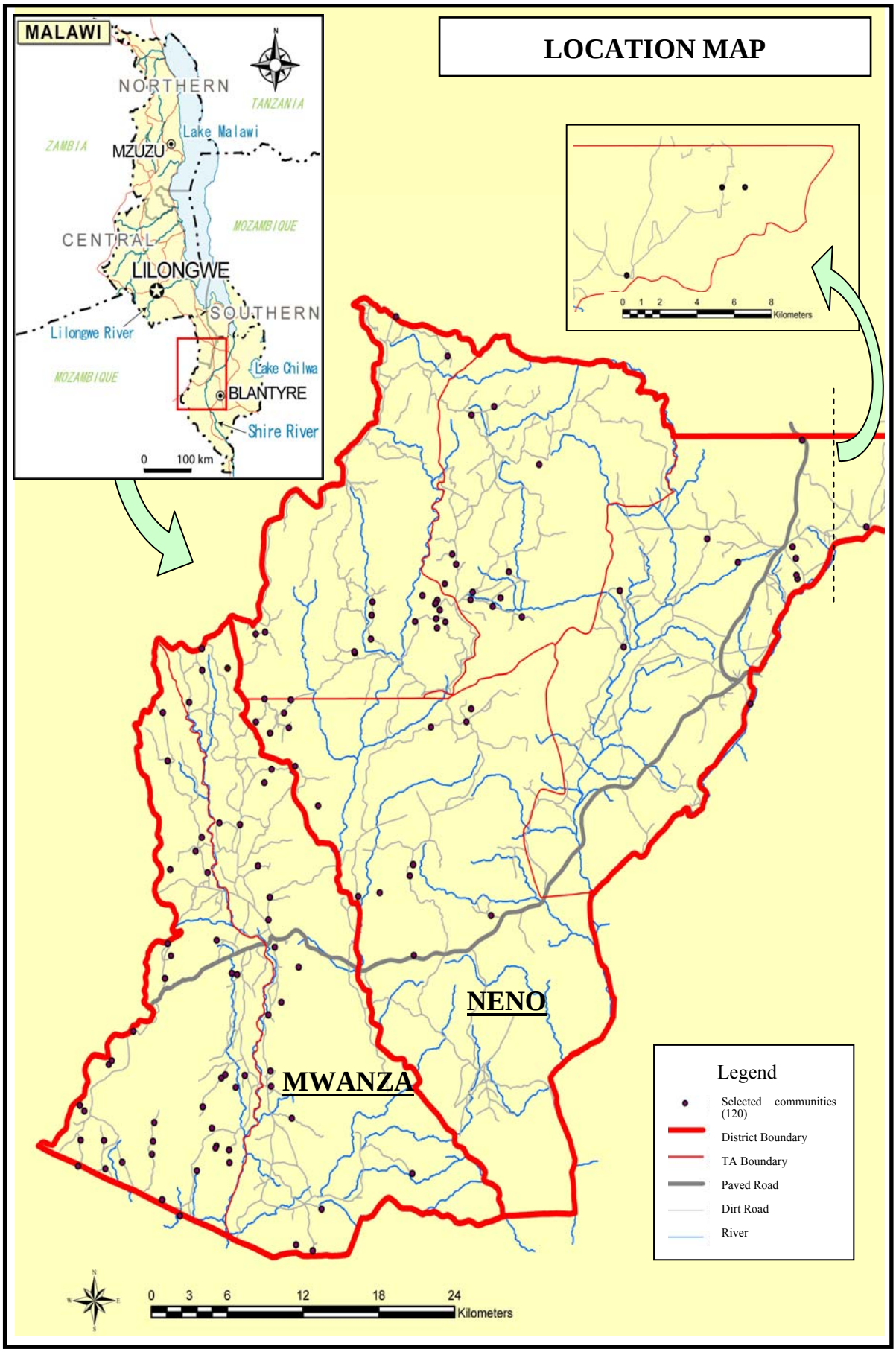
i) It is expected to reduce water born diseases like diarrhea, dysentery.

ii) It is expected to reduce the labour of transportation of the water. Approximately 14,950 women and 13,500 children under 14 years old exists in the above mentioned benefitted population of 108,787, it is estimated that around 2 hours of transportation time will be reduced.

iii) 120 water point committees will be established for the facility maintenance, and their capability to maintenance will be improved by the soft-component support.

In consideration with the mentioned above, validity of the Project is evaluated high, and the effect of the Project is expected.

Table of Contents


LOCATION MAP
MALAWI
NORTHERN
TANZANIA
ZAMBIA
MZUZU
Lake Malawi
MOZAMBIQUE
CENTRAL
LILONGWE
SOUTHERN
Lilongwe River
Lake Chilwa
MOZAMBIQUE
BLANTYRE
Shire River
0 100 km
0 1 2 4 6 8
Kilometers
NENO
MWANZA
Legend
Selected communities (120)
District Boundary
TA Boundary
Paved Road
Dirt Road
River
0 3 6 12 18 24
Kilometers

Perspective of the Project

List of Figures

List of Tables

Abbreviation

ADC:	Area Development Committee
AEC:	Area Executive Committee
AfDB:	African Development Bank
CBM:	Community Based Management
CIDA:	Canadian International Development Agency
DCT:	District Coordination Team
DEC:	District Executive Committee
DPD:	Director of Planning and Development
EU:	European Union
GPS:	Global Positioning System
HSA:	Health Surveillance Assistant
IDA:	International Development Association
JICA:	Japan International Cooperation Agency
MASAF:	Malawi Social Action Fund
MoIWD:	Ministry of Irrigation and Water Development
NGO:	Non Governmental Organization
NWDP:	National Water Development Project
OJT:	On the Job Training
TA:	Traditional Authority
UNDP:	United Nations Development Program
UNICEF:	UN International Children's Emergency Fund
VDC:	Village Development Committee
VHWC:	Village Health Water Committee
WHO:	World Health Organization
WPC:	Water Point Committee

CHAPTER 1 BACKGROUND OF THE PROJECT

1-1 Overview and Background of the Project

The Ministry of Irrigation and Water Development of Malawi has been implementing the construction of rural water supply facilities. Primarily the budget of the Government of Malawi is still spent for ordinary expenses and therefore cannot secure the necessary additional budget to invest on new projects of water supply.

In response to this constrains, through the last 5 projects, the Government of Japan has constructed some 1,200 boreholes in rural areas under the grant aid scheme.

The current access rate to safe water is estimated to be 75% (MDG report, 2007). However, 'Joint Sector Review 2008' reports that 30% of water supply facilities in rural areas is dysfunctional and under this scenario the realistic estimation of access rates are 65% in urban and 46% in rural areas respectively whereby rural water supply remains an important challenge.

In order to face to these challenges, the Government of Malawi prepared a 'Groundwater Development Plan' and requested to the Government of Japan the drilling of boreholes and the installation of hand pumps in Mwanza and Neno districts.

1-2 Environmental condition in the Project Area

1-2-1 Climate

Malawi has a tropical savanna climate, with a dry season from April to October and a rainy season from November to March. All land, except the steep ground areas, can be cultivated since the annual rainfall is of about 1,000mm. The study area's rainfall and meteorological data at the Chileka meteorological station, located in the south of Mwanza city, are as shown in Figure 1-1.

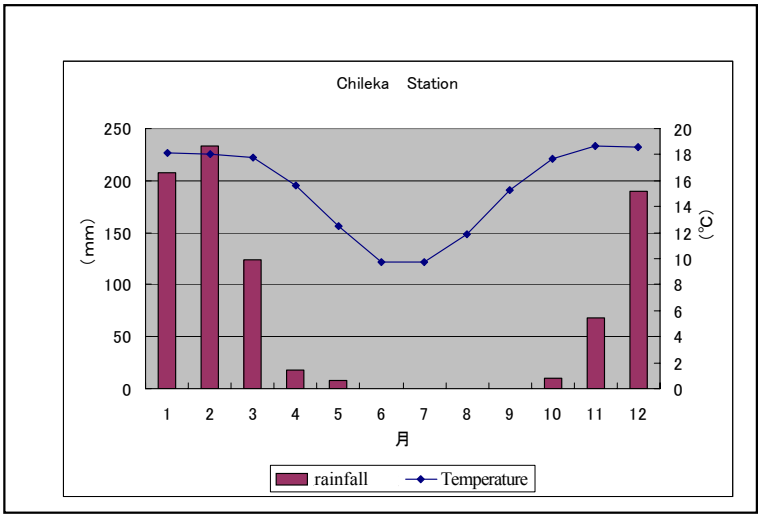
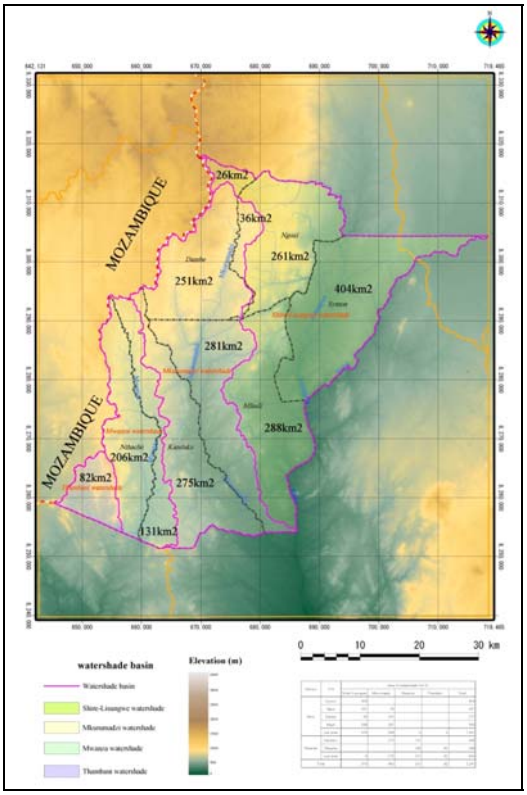


Figure 1-1 Rainfall and Temperature

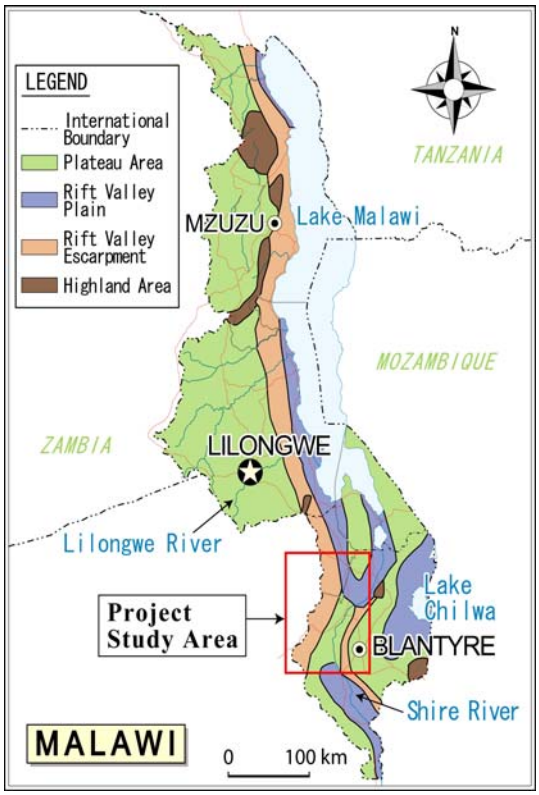
In the project site a lot of small rivers exists. These small rivers are flowing into the main four rivers such as Mwanza River, Mkurumadi River, Lisungwe River and Shire River, and the first three rivers join the Shire River. The main rivers flows north to south, and the mountains which conform the watersheds runs north to south

between the main rivers (refer to Figure 1-2). Discharge of main river has been observed by the MoIWD and the data of flow measured from 1980 to 2003 were obtained from this Institution. The basin of each river is shown in Figure 1-2. Shire River is the outlet of Lake Malawi.



Source: Study Team

Figure 1-2 Topographic Condition and Catchment Basin



Source: Malawi Geological Survey

Figure 1-3 Topographic Classification

1-2-2 Topography

Malawi is located in the southeast of African continent and it is a long inland country running from south to north as shown in Figure 1-3. The Africa rift valley runs north to south in the east part of the country, and the Lake Malawi is formed along the Rift Valley. The area of the country is 118,000km^2, and the Lake Malawi (23,000km^2) is occupying about 20% of the area. The country is divided into four regions such as "Rift Valley Plain", "Rift Valley Escarpment", "Plateau Area", and "Highland Area" according to the topographic property. Prolonged weathering under the tropical conditions has produced a characteristic topography of peneplain and inselberg hills.

The Project site belongs to "Rift Valley Escarpment" in the west and to the "Plateau Area" in the east. The west part has mountainous topographical features where ups and downs are intense, while the east part has hilly and flat features. The highest and lowest sites have altitudes of about 1,500m in the northwest part and 400m in the southeast part. Thus, the difference of the elevations is quite large with 1,000 m or more.

Northwest part(altitude: 1,200 -1,500m): The ridge is narrow, and the valleys on the both sides are deep and steep. The villages are usually located on the ridge. The cropland and meadow spread out in the surrounding mountains, and the trees and bush grow thick in the valleys.

Central part (altitude: 600 -1,000m): Ups and downs are comparatively gentle. The village is distributed on a gradual ridge part, and the cropland and the forest extend in the surroundings.

Southwest part(altitude: 500 -600m):. Ups and downs are very intense. The surrounding mountains are covered with the forest.

Southeast part (altitude: 500 -600m). The topographic features are gently undulating, and the valleys are also shallow. Villages are seen in the plain and crop fields are extended in the surroundings. The trees and bush are sparse.

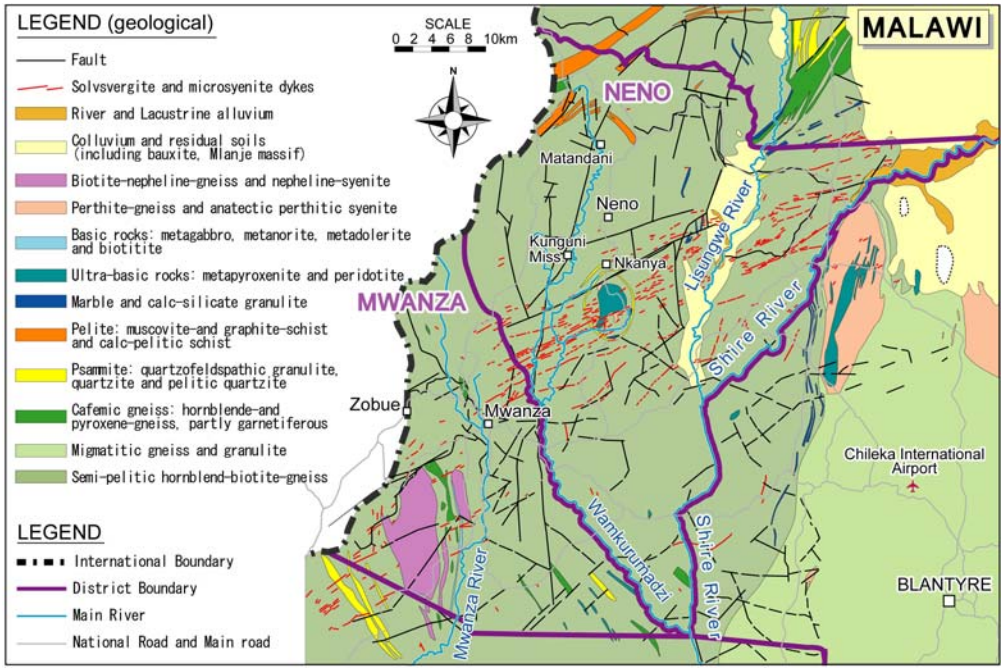
East part(400-450m) : Almost flat with the altitude of 400m to 450m.

1-2-3 Geology

The most part of the geology of Malawi belongs to the Mozambique belt of the Pre-Cambrian to Lower Paleozoic, and consists of metamorphic rocks, such as gneiss and schist formed due to regional metamorphism, and plutonic rocks such as granite and gabbro that intruded into the basement rocks.

The Mozambique belt has experienced structural transformations due to the repeated orogenic movements. The northwest-southeast direction of the structures is dominant and a north-south and east-west directions follows this. In addition, the Rift Valley, which runs north to south through Malawi, had been formed with the fault movement that began in Cenozoic Era. Accordingly, a number of fractures had been formed with this activity around the Rift Valley.

The area along the River Lisungwe, which flows from north to south in the project site, is covered with colluviums and residual soils, while the area along the River Shire is covered with the river and lacustrine alluvium.

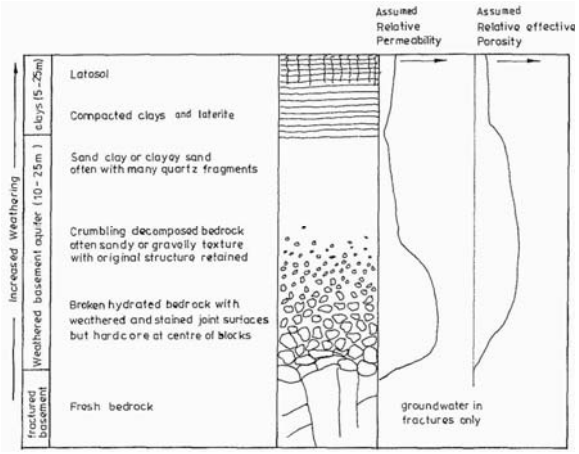


Source: Malawi Geological Survey Department

Figure 1-4 Geological Condition

1-2-4 Hydrogeology

The plateau surface is characterized by a layer of unconsolidated material produced by the prolonged in situ weathering of the bedrock. Weathering condition changes strong to weak with depth, and fresh rocks exist in deeper place. In detail, the characteristic of the weathered zone carries with the parent rock type and texture, but a generalized profile can be given in Figure 1-5. Laterite soils had been produced on the surface layer due to the intense weathering of basement rock. However, the deeper layers show sandy to gravelly textures as weathering become weaker and finally reach to the fresh rock. The layers of sandy to gravelly textures are considered to be excellent aquifers.



Source: P.J. CHILTON & A.K. SMITH-CARINGTON, Characteristic of the weathered basement aquifer in Malawi

Figure 1-5 Generalized Profile of weathered zone

The weathering profile is generally 15-30m thick, and may be thicker where faults or fracture zones have permitted the weathering processes to penetrate more freely. The weathered zone also thins towards the bedrock outcrops in inselberg hills. In the project area, the weathering products of the basement rocks provide a thin, but extensive and more or less continuous aquifer, of great importance as source of rural domestic water.

It is also expected the presence of a lot of faults generated by the fault movement in the project site, and those faults accompanies the fracture zones. Because the fracture zones usually have high porosity and high permeability, groundwater flow in from surroundings and the fracture zones work as water channels. Fracture zones are less resistant to erosion than the surrounding rocks. Accordingly, the fracture zones are eroded and topographically located at lower places.

The lineament analysis using the satellite image is effective as the means to trace the fracture zones which are promising for groundwater development.

In addition to the weathered layers mentioned above, it is thought that the colluviums and residual soils layers along the River Lisngwe and the lacustrine alluvium layers along the River Shire forms excellent aquifers. Therefore, the layers of weathered rocks, colluviums, alluvium and fracture zones are the targets for groundwater development in the project site.

1-2-5 Distribution of existing well

The distribution of the existing wells in the project site are shown in the Table 1-1 based on the results of mapping investigation of water supply facilities conducted by Malawi Water Supply and Sanitation Conference (WSSC) in 2006.

Table 1-1 Distribution of existing wells in the Project Site

District	T/A	Number of Wells	Number of wells in operation
Mwanza District	Kanduku	197	166
	Nthache	308	240
Neno District	Dambe	47	35
	Mlauli	168	126
	Chekucheku	103	62
	Nthache	280	204

Figure 1-6 shows the distribution of the wells surveyed by WSSC in 2006. (25% of these plots are shallow wells and abandon/ no operated boreholes). The analysis of this survey made it clear that eight hundred deep wells have been developed along the main road or around the villages. Around 25% of these boreholes have been passed more than 20 years, and they are probably abandoned if no rehabilitation has been conducted.

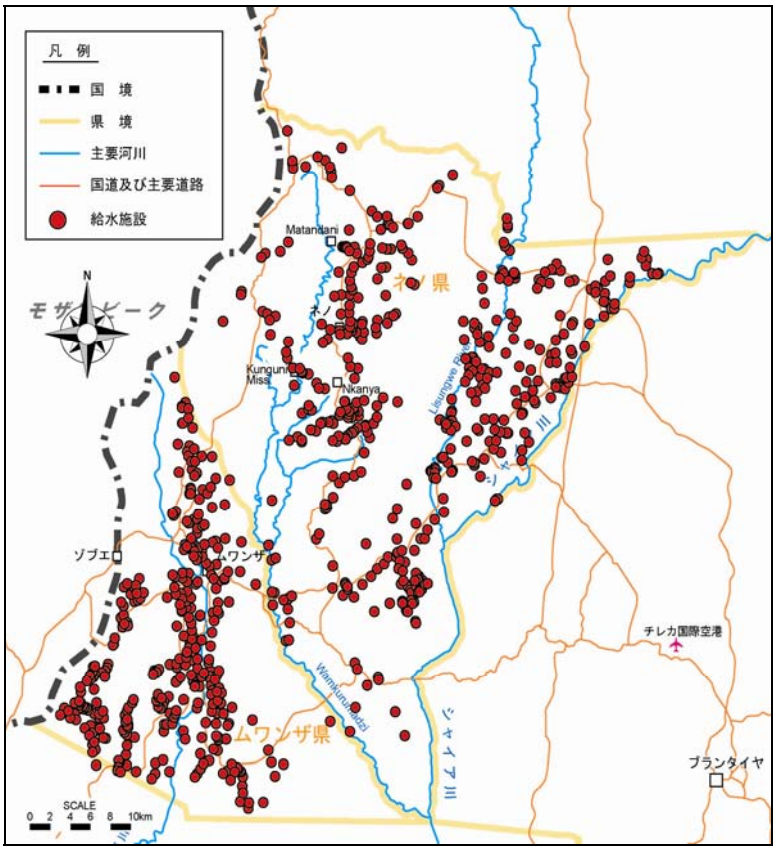


Figure 1-6 Distribution of the existing wells (Survey results by WSSC)

1-2-6 Lineament Interpretation Results

Lineament is a line or a curve which reflect the fault in underground from the lines distinguished on the satellite image, and distribution of the faults in the Project Area can be estimated by the lineament analysis. The interpretation of the lineament that reflected the faults was executed ahead of the site investigation. The satellite images used for the interpretation were ASTER and AVNIR-2, and the resolution of each was 15m by 10m. The basement rock in the study area is mainly composed of exposed gneiss, and the soft-sediment by weathering is distributed thinly according to a local geologic map (1/250,000 geologic maps ZOMBA). Figure 1-7 shows the interpretation results.

The faults of the NNE-SSW systemand the ENE-WSW system are notably seen in the study area. The most remarkable fault among of the NNE-SSW system is along the Mkurumadzi River, and the most remarkable fault among of the ENE-WSW system is along the Mwamjidza River. Also, a small-scale fault and fracture related to these faults is seen. Moreover, a lot of feature dykes develop in the vicinity of the center due to strikes, the same being restricted to the fault in the ENE-WSW direction. These dykes are thought to be the result of fault movement and inferred to exist from the distribution, although we cannot confirm a causal relationship between the fault and dyke. But, from its distribution, we think that the dyke is closely tied with fault movement.

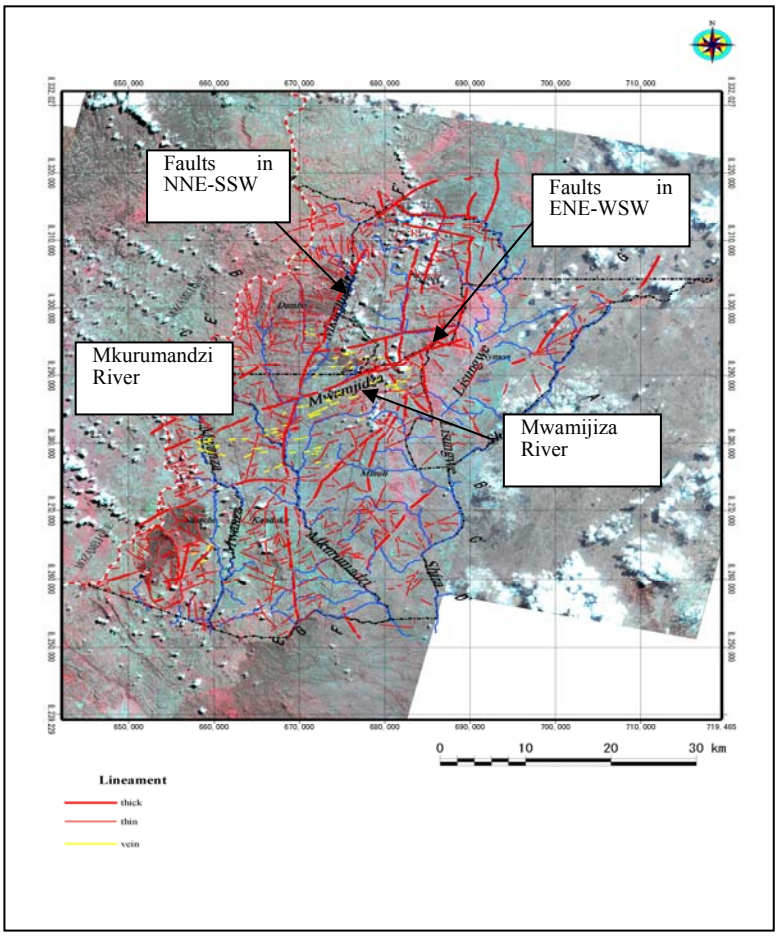


Figure 1-7 Lineament interpretation results

Geographical features and geological information were added to the lineament created, and the geophysical exploration target point was selected chiefly in consideration of the following points for the fissure type.

i) Presence of fault and fracture zones.

ii) Location of the faults and fractures (in the valley or the hollow).

iii) Other notable faults and fractures that are seen nearby.

iv) Intersection of NNE-SSW and ENE-WSW systems strikes.

1-2-7 Geophysical Survey

（1） Outline of Survey

The geophysical survey was specifically selected and executed in locations with undetermined hydrogeological features to evaluate the potential for groundwater in the study area.

The high-density electrical resistivity method (hereafter abbreviated as resistivity method) shown in fig. 1-8 was employed for the expectation of fissure water in the fracture zone, rather than the vertical electric profiling method. Fig. 1-9 shows locations of the resistivity survey line.

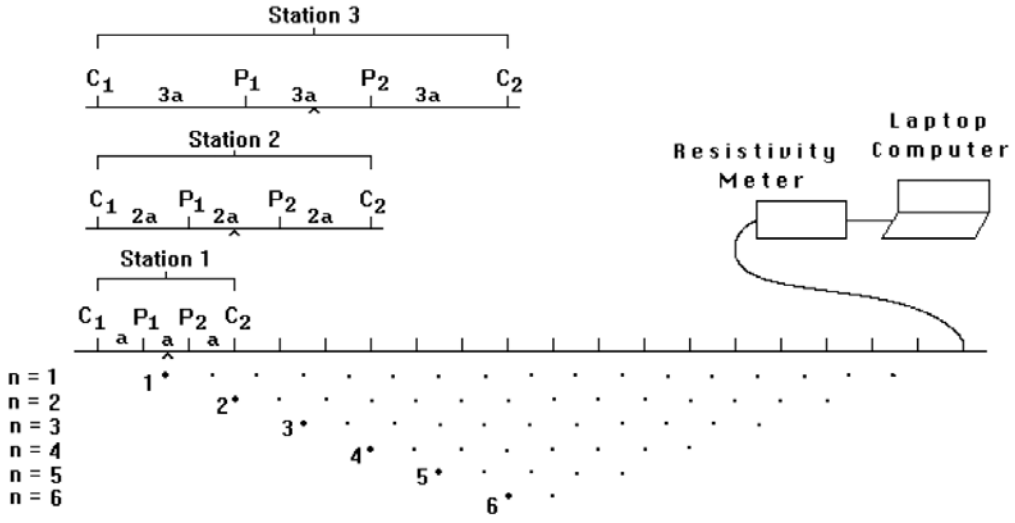


Figure 1-8 Electrode configuration for the high-density electrical resistivity method

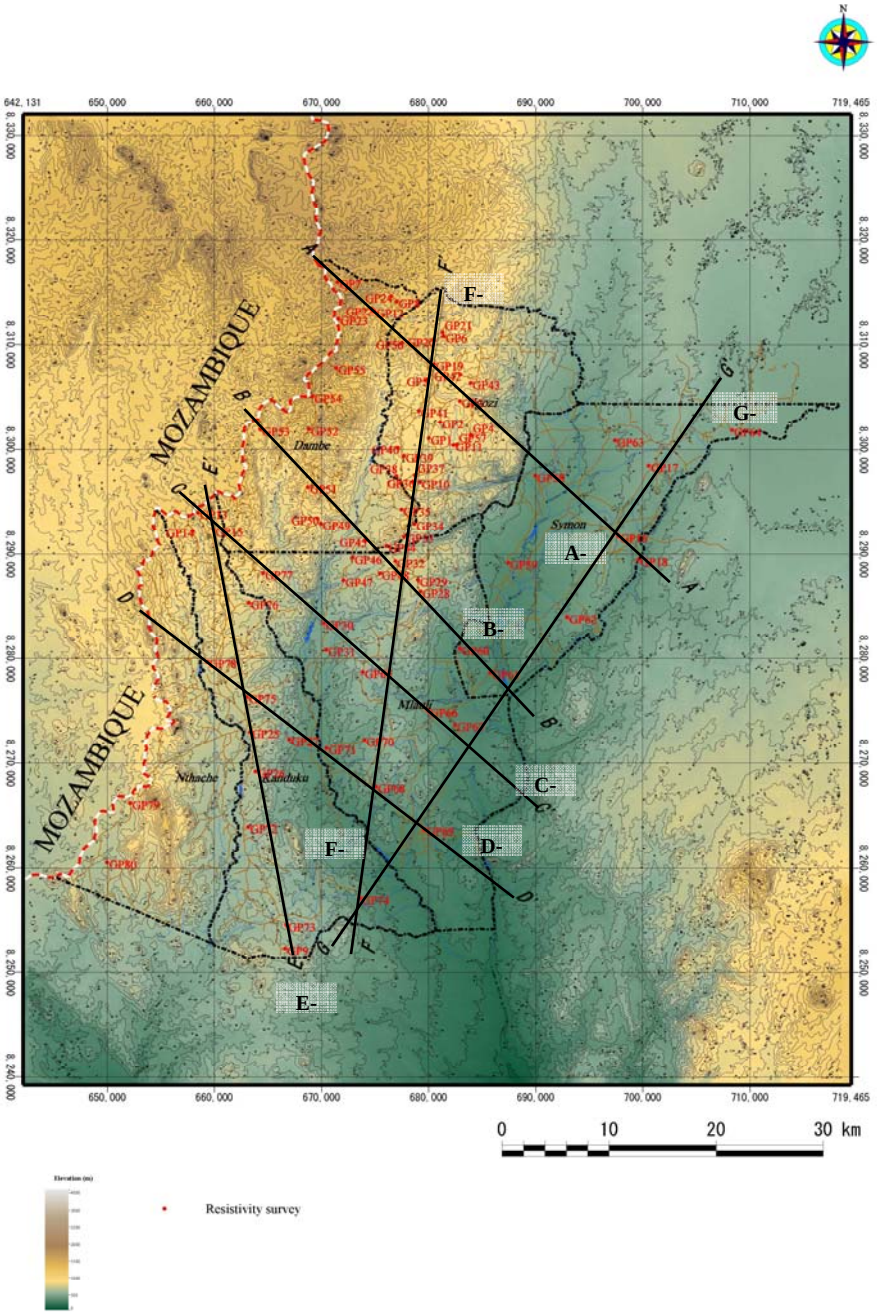


Figure 1-9 Location of resistivity survey line

（２） Results of the resistivity survey

Figure 1-9 shows the survey points. All points were selected according to the distribution of existing wells with lineament that could include fissure water and the distribution of villages.

After adding the topographical features data to the measurement data, the analysis was subjected to two-dimensional analyses by RES2DINV. The analytical results of all the survey lines is shown in Appendix 7-4, including the survey line coordinates, a index map, a detailed location map, and site

photographs.

Figure 1-11 is a distribution chart showing the resistivity sections where all the survey lines were arranged around the survey line position. According to the degree of the resistivity in the resistivity section, the red system shows a high resistivity of almost 1,000Ω·m or more, and the blue system shows a low resistivity of almost 100Ω·m or less. Here, as a matter of convenience by the degree of the specific resistance value, 1,000Ω·m or more is called 'high resistivity', 100 to 1,000Ω·m is called 'middle resistivity', and 100Ω·m or less is called 'low resistivity'. The resistivity structure in each section is classified into five patterns according to the degree of the resistivity as follows ( ).

i) A two-layer model consisting of high – high; It is distributed on the mountains ridges above sea level 1,000m or more along the border of the survey area west and Mozambique. We can expect that this covers the fresh part of the basement rock with the weathering layer (laterite) where the permeability is bad.

ii) A three-layer model consisting of high – middle (or low) – high; It is distributed around the edge of the survey area northwest. We can expect here the presence of a weak weathering layer where the permeability is good for the interlayer, though covers the fresh part of the basement rock with the weathering layer.

iii) A two-layer model consisting of middle (or low) – high; Most of the resistivity section follows this model, and we can expect that the fresh part of the basement rock is covered with a weathering layer where the permeability is good, and resistivity will be lower depending on the amount of groundwater.

iv) A two-layer model consisting of middle (or low) – middle (or low); It is distributed along the Lisungwe river, which flows south to north in the east part of the study area. We can expect that the basement rock is thickly covered with a weathering layer where the permeability is good.

v) Some of the resistivity sections, including above four resistivity structure models, retain a vertically low (or middle) resistivity anomaly, which is indicated in the fracture zone or concealed fractures from lineament.

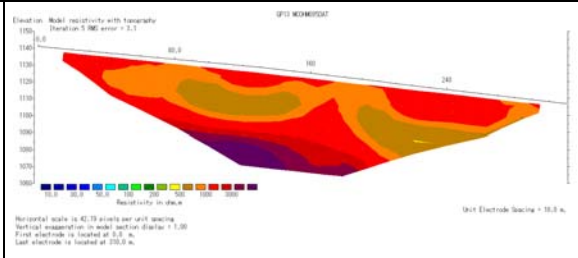
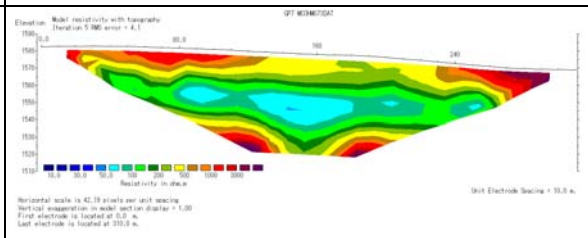
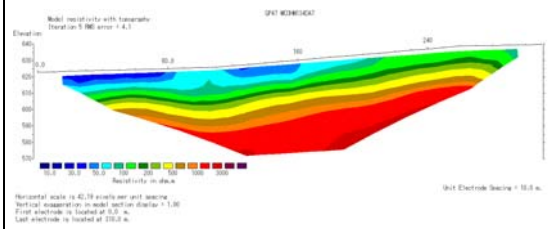
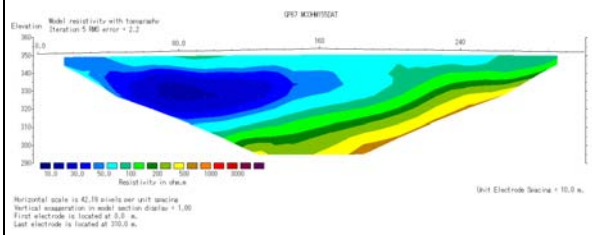
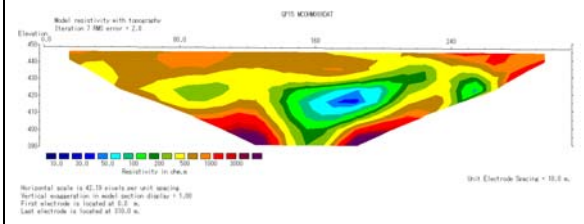
Model	Example	Feature and distribution
high – high		It is distributed on the mountains ridges above sea level 1,000m or more along the border of the survey area west and Mozambique. We can expect that this covers the fresh part of the basement rock with the weathering layer (laterite) where the permeability is bad.
high – middle (or low)		It is distributed around the edge of the survey area northwest. We can expect that the weak weathering layer where the permeability is good for the interlayer is placed, though covers the fresh part of the basement rock with the weathering layer.
middle (or low) – high		Most of the resistivity section follows this model, and we can expect that the fresh part of the basement rock is covered with a weathering layer where the permeability is good, and resistivity will be lower depending on the amount of groundwater.
middle (or low) – middle (or low)		It is distributed along the Lisungwe river, which flows south to north in the east part of the study area. We can expect that the basement rock is thickly covered with a weathering layer where the permeability is good.
High-middle (low)		Some of the resistivity sections, including above four resistivity structure models, retain a vertically low (or middle) resistivity anomaly, which is indicated in the fracture zone or concealed fractures from lineament.

Figure 1-10 Patterns of the resistivity structure

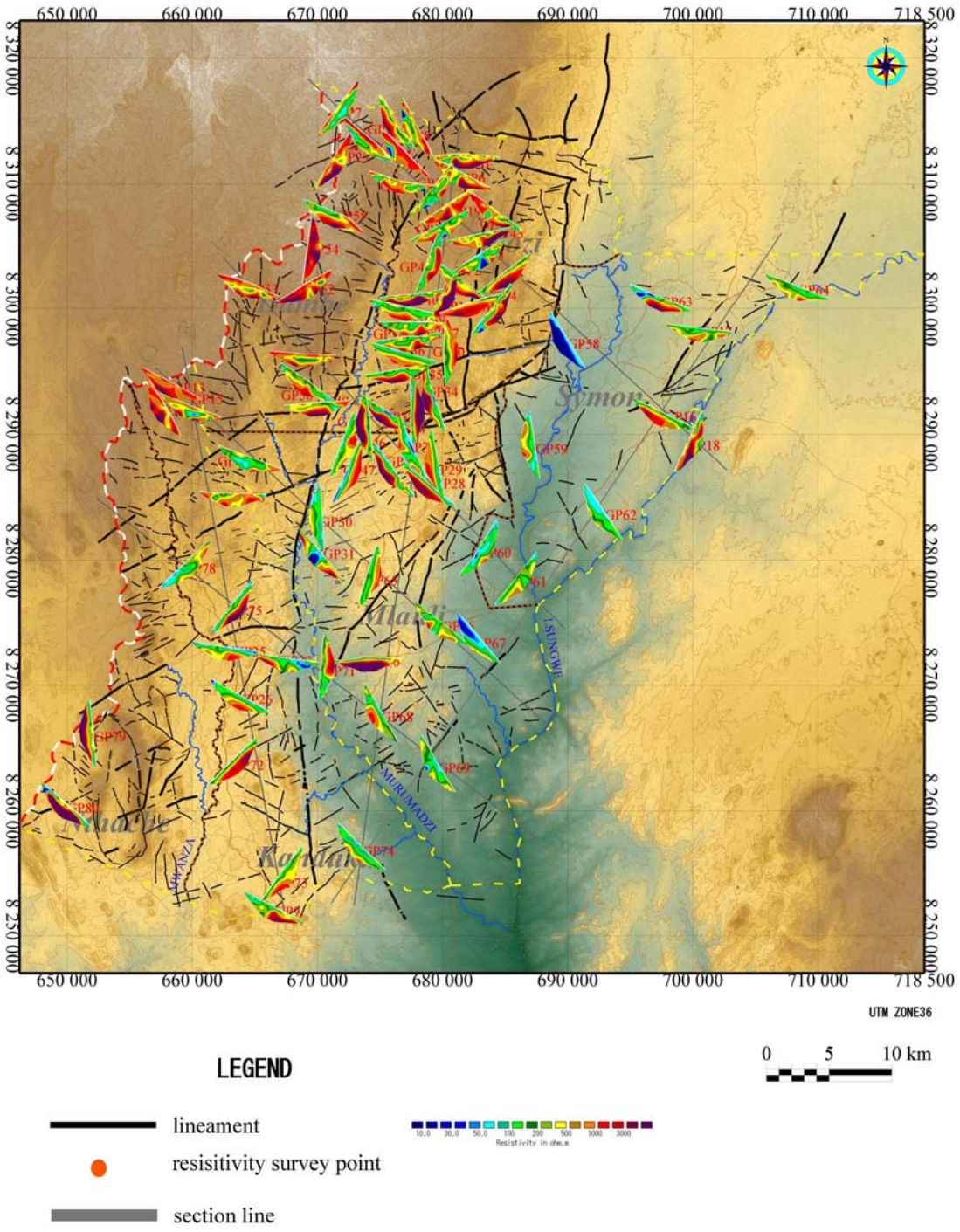


Figure 1-11 Resistivity structure sections

（３） Inferential underground structure

The inferential underground structure, based on the resistivity structure, of four sections (A-A', B-B', C-C', D-D') that run NW-SE and three sections (E-E', F-F', G-G') that run NS are shows in Figure 1-12 (1) and Figure 1-12 (2).

In these figures, a resistivity structural section that passes over the surrounding section line is shown. In this section, the high resistivity layer of the depth was assumed and the fresh part of the basement rock and the upper layer were assumed to be weathered. And, this weathering part is divided with layer having 1,000Ω･m or more in the vicinity of the surface and a low (or middle) resistivity layer in the lower layers. From the weathering, we believe that this layer is like gravel and forms an aquifer. The aspect ratio in the figures is 5:1. The features of the section are described as follows.

The section A-A' is in the northern part of the study area, crossing Dambe, Ngozi, and Symon. The elevation varies widely, from 1,600m to 400m above sea level. Areas above 1,200m are covered with a high resistivity layer that indicates laterite. In the lower elevations, the fresh rock is covered with a thick weathering layer. Notably, this weathering layer has a resistivity of less than 50Ω･m and a thickness of 50m or more in Symon, which means that this weathering layer forms a good aquifer.

The B-B' section crosses Dambe, Mlauli, and Symon, which are in the center of the study area. A high resistivity layer that indicates laterite is seen at elevations above 1,000m. A weathering layer of about 75Ω･m in Mlauli and Symon might indicate the existence of an aquifer.

The C-C' section crosses Kanduku and Mlauli. A high resistivity layer which indicates laterite is seen at elevations above 1,000m, the same as in the B-B' section. A weathering layer of 100Ω･m distributes around the lower level in Mlauli, and is assumed to contain an aquifer.

The D-D' section crosses Nthache and Kanduku, in the southern part of the study area. The profile is as the same as for the C-C' section.

The E-E' section traverses Kanduku, and the weathering layer's thickness is from 10s to 50m and its resistivity increases with elevation.

The F-F' section crosses Kanduku, Mlauli, and Ngozi. The weathering layer trends to thicken in the lower level land.

The G-G' section traverses at lower level lands in Kanduku, Mlauli, and Symon. A weathering layer more than 50m thick is seen there, just as in the A-A' section.

The results of the resistivity survey in the study area can be summarized as follows:

i) The surfaces above 1,000m are less than 100 meters thick, and show laterite, which indicates an aquiclude. (Check this term)

ii) The weathering layer that becomes an aquifer is at least 50m thick, and is thicker at lower level lands in the eastern part of the study area.

iii) The resistivity of the weathering layer decreases as altitude decreases. We think this is caused by low resistivity groundwater, including many potential targets, or by the decreased permeability of aquifers.

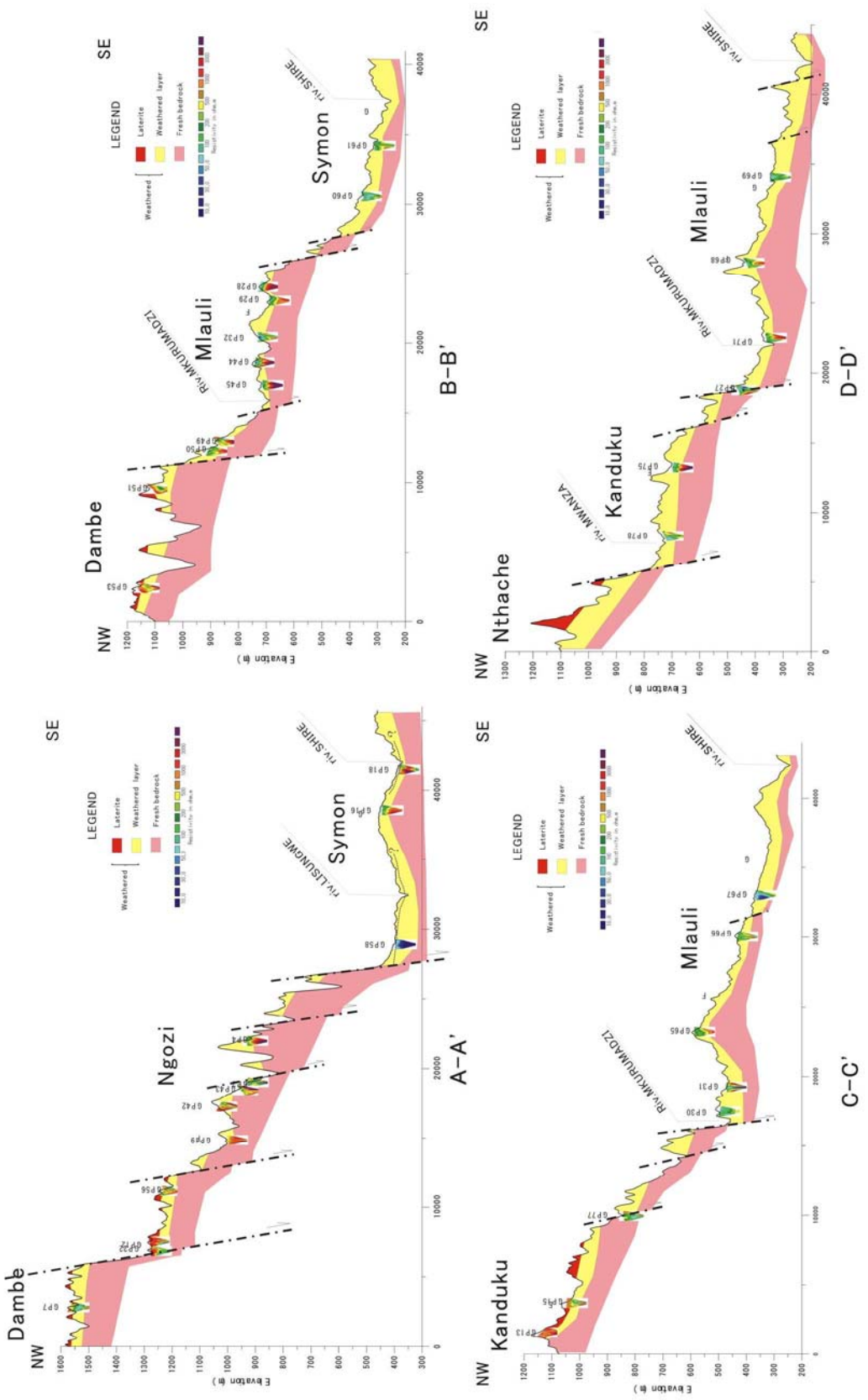


Figure 1-12 (1) **Inferential underground structure (A~D)**

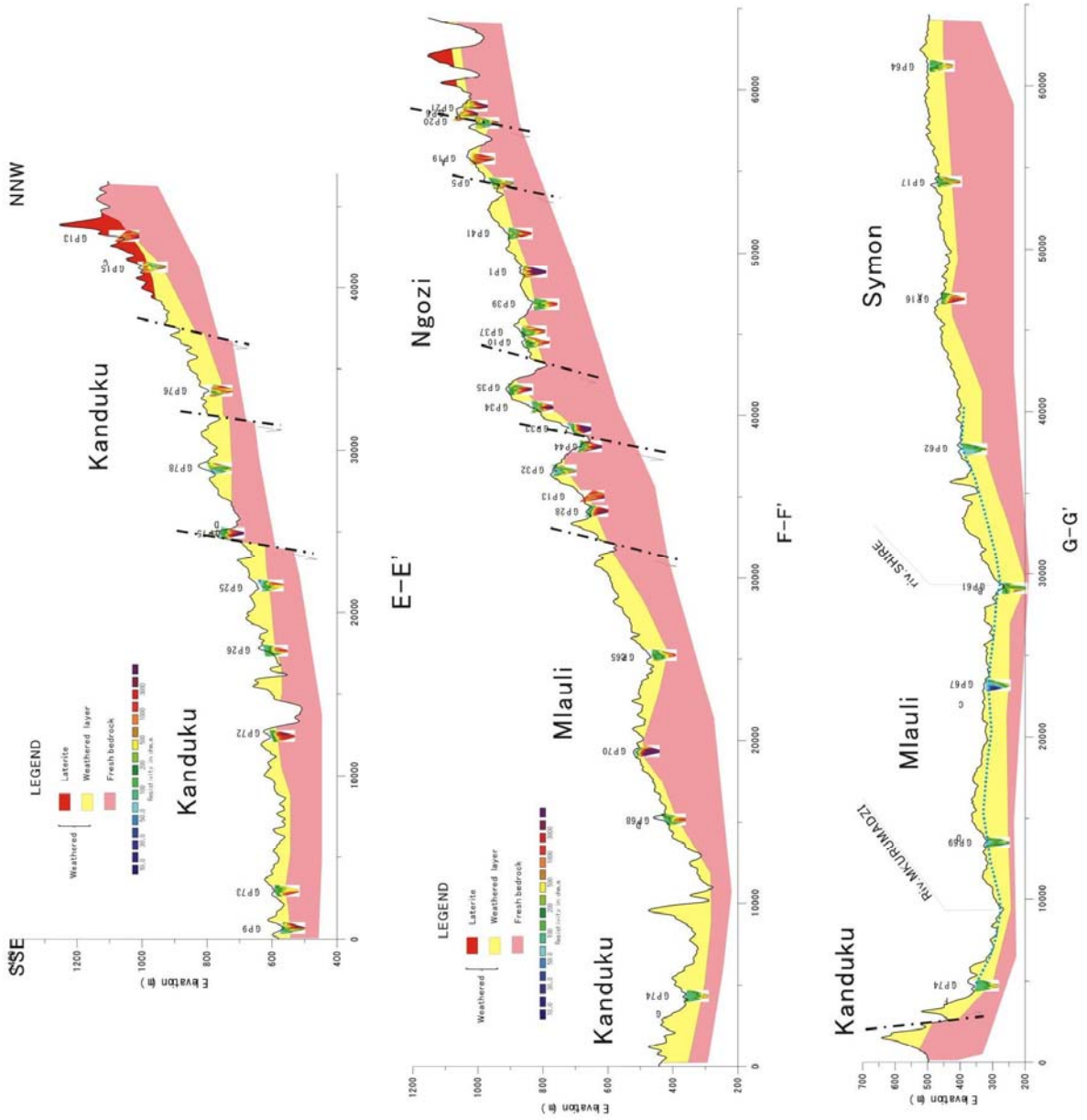


Figure 1-12 (2) **Inferential underground structure (E~G)**

1-2-8 Test Drilling of Boreholes

（１） Selection of Locations for Test Drilling

Test Drilling of boreholes had been conducted up to the depth of 50m to 80m in the target villages where the hydrogeological informations are not available. Thus, the useful information for water supply plan and outline of design shall be obtained by understanding the geological information and water quality. Therewith, the information shall be used as basic data for securing water sources, evaluating the wells (yield and water quality) in the selected target villages. Because test drilling of boreholes had to be done within the limited period, lineaments were specified using the geological maps and satellite images beforehand and some places were proposed for test drilling in Japan. In the project area, geophysical investigations were carried out at the proposed sites. The places where the low resistivity layer had been confirmed in the survey results were selected as the drilling positions considering the possibilities of the occurrence of fracture zones or weathered layers around the ridge near the villages.

（２） Test Drilling

Total number of the selected test drilling sites is five, of which two are in Mwanza District and three are in Neno District. The results of Test Drilling are shown in Table 1-2.

Table 1-2 Results of Test Drilling

No	Date	Village	Result	Remarks
1	May 4	Mwanza、Lopati	Dry	Drilled up to -50m. Hard rock is found below -34m. No water entirely.
2	May 5 and 6	Mwanza、Amosi	Production well	Drilled up to -68m. Hard rock is found below -63m. Static water level is -19m.
3	May 13 and 14	Neno Chimbalanga 1B	Wet but non-productive	Drilled up to -78m. Hard rock is found below -60m. Static water level is -28m. The permeability of the material is very low and the well is non-productive.
4	May 15	Neno、Hiwa	Dry	Drilled up to -72m. Hard rock is found below -50m. No water entirely.
5	May 21	Neno 、Lumbe	Wet but non-productive	Drilled up to -80m. Hard rock is found below -40m. Static water level is -33.8m. The permeability of the material is very low and the well is non-productive.

Step drawdown pumping test had been conducted at the productive well in Amosi village. The relation between pumping rate and draw down after 120 minutes is shown in Table 1-3.

Table 1-3 Results of step drawdown test at Amosi village

	Step 1	Step 2	Step 3	Step4
Pumping Rate Q(ℓ /sec)	0.23	0.31	0.42	0.5
Drawdown(m)	5.00	9.75	12.30	26.00

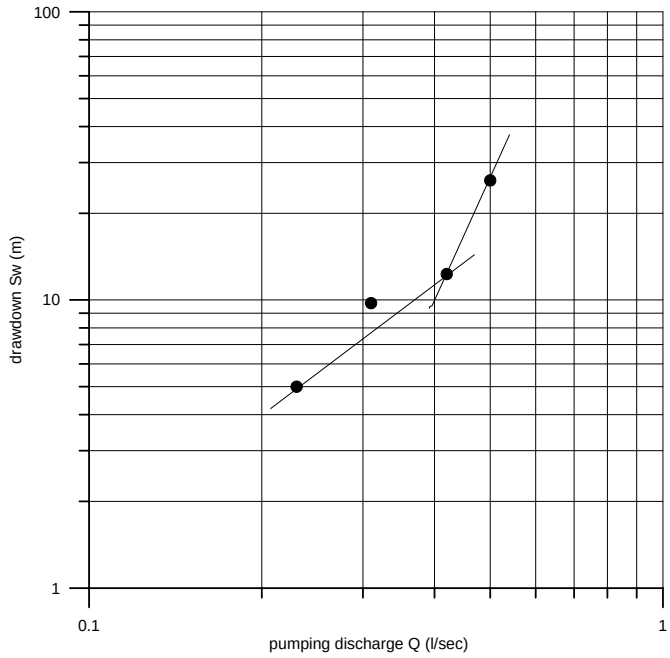


Figure 1-13 Pumping rate and drawdown

The critical yield of this well was judged to be 0.42L/sec from the Figure 1-13. The continuous pumping test was carried out for 24 hours at the rate of 0.34 L/sec which is 80% of the critical yield. As a result, 0.34 L/sec was judged the amount of the safety pumping because the drawdown is almost regular and steady.

In case groundwater had to be developed on the ridge like in the northwest part of the project site where the surface sags or low places are not found, fracture zones are targets structures for groundwater development because the weathered layers are very thin. Test drilling had been carried out at the places which were considered to be faulted fracture zones with low resistivity judging from the results of high density electric survey. However, one productive well, one dry well and wells with little water had been obtained. It cannot be said that the fracture zone forms a good aquifer with high permeability. Groundwater development in the ridge turned out to be very difficult. A test borehole was drilled on the slope where was supposed to contain groundwater in the weathering layers based on the results of electric resistivity survey, but it was a dry well. As pointed out in the Chapter of Electric Resistivity Survey, the electric resistivity of groundwater accompanies a regional change and it has been turned out to be necessary that the standard of the electric resistivity reflecting the target groundwater should be considered in each region.

P.J. Chilton et al pointed out that the weathering profile is generally 15-30m thick, and may be thicker where faults or fracture zones have permitted the weathering processes to penetrate more freely. It has been confirmed by these test drillings that weathering has advanced to the depth of 34m in the flat area, while weathering thickness is 40m to 60m in the place where is presumed to be fracture zone.

Thickness of weathering layer must be considered when the groundwater potential is evaluated. Therefore, thickness of weathering layer was obtained from the cross section of the 2D electric resistivity survey results. Table 1-4 summarized the results and Figure 1-14 shows the distribution of the weathering thickness. Note that the thickness of the weathering layer in this case is the thickness of layer which can become aquifer except the surface layer of laterite.

The thickness of the weathering layer is almost 50m or more and constant in Symon in the east part and in the low places in Mlauli. It can be said that promising aquifers are formed in those area. On the other hand, layer thickness is not constant but changes from 10 m to 50m in Ngozi, Dambe, and Kanduku extending in the area of mountainous topography in the west part. The weathering layer is discontinuous because the thickness of the weathering layer is restricted due to the development of the erosion of the ground surface and many faults. Therefore, analysis of hydrogeological structure is important theme in developing groundwater. The weathering layer is almost constant with the thickness of 20m to 30m in Nthache in the southwest though the measurement point distribution might be rough.

Table 1-4 Summary of Electric Resistivity Survey

District	TA	Topography	Thickness of weathering layer (m)
Mwanza	STA Govati	Hilly area	20-45
	Kanduku	Ridge(steep)	45
		Hilly area	18-54
Neno	Chekucheku	Ridge(steep)	35-37
		Hilly area	19-51
		Flat area	28
	Dambe	Ridge(steep)	11-54
		Hilly area	11-56
	Mlauli	Hilly area	17-56
		Flat area	57m 以上
	Symaon	Flat area	57m 以上

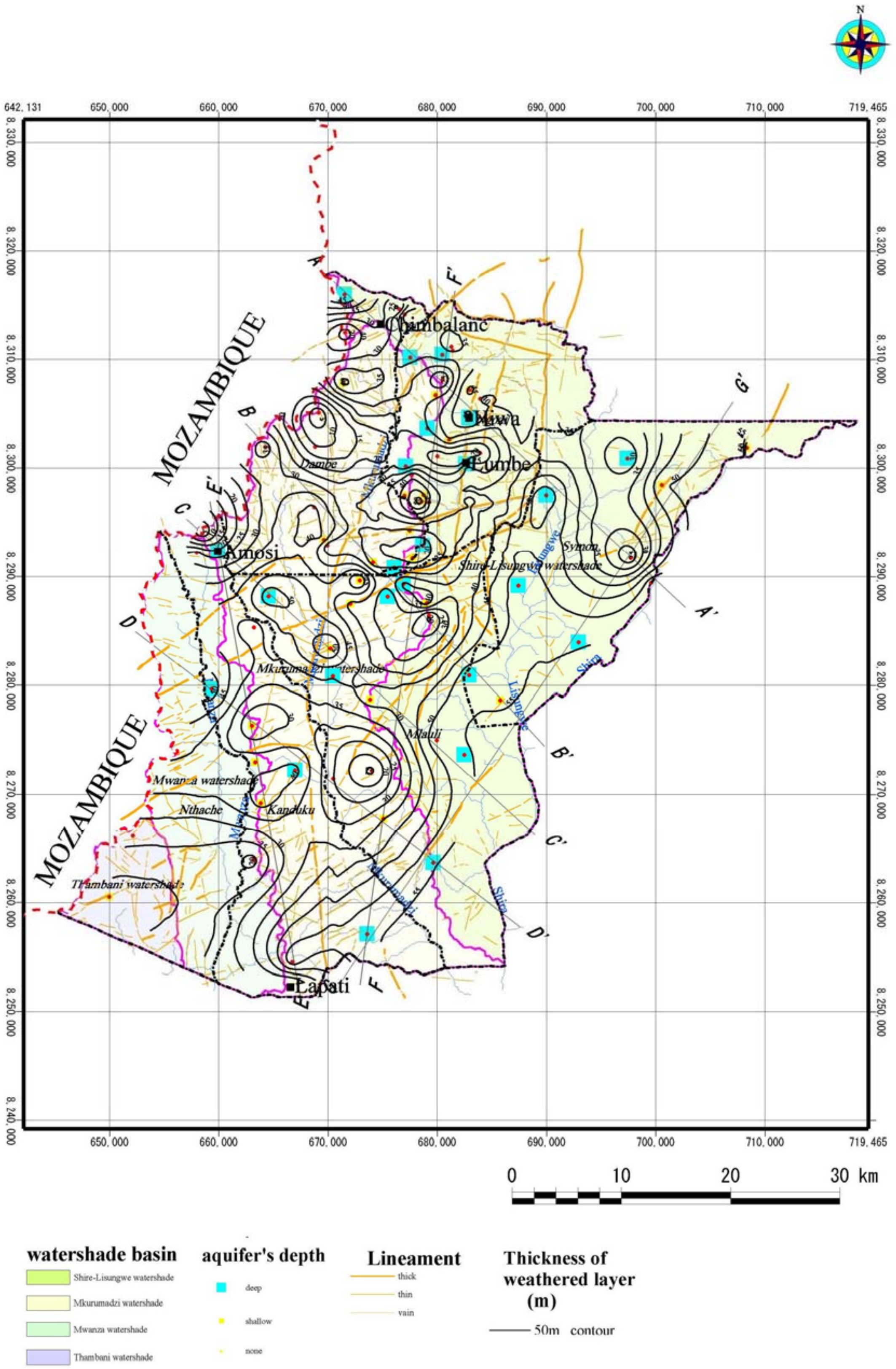


Figure 1-14 distribution of the weathering thickness

1-2-9 Water quality test

（１） Water quality standards in Malawi

Water quality guidelines by WHO/ MoIWD (tentative) are shown in Table 1-5. Basically, MoIWD standard was selected for water quality test.

However, acceptable values of MoIWD standards in some elements (iron and fluoride) are higher than that of WHO guidelines. For the elements which affected to human health, the Guideline value of WHO is preferred for evaluation (To choose the use of WHO guideline, discussion with Malawi government will be done).

Table 1-5 Water quality guidelines (WHO/MoIWD)

Elements	Unit	WHO（1993）	WHO（2004）	MoIWD (tentative)	Remark
Arsenic as As	Mg/l	0.01	0.01	0.50	Guideline value will be selected
Cadmium as Cd	Mg/l	0.003	0.003	0.01	
Cyanide as CN	Mg/l	0.07	0.07	0.05	
Fluoride as F	mg/l	1.5	1.5	3.0	To decide water quality guideline of Fluoride, It is necessary to consider not only intake from drinking water but also exposure.
Lead as Ld	mg/l	0.01	0.01	0.05	
Nitrate as NO3	mg/l	50	50	100	Short duration of exposure
Selenium as Se	mg/l	0.01	0.01	0.01	
Faecal coliform Treated Water Untreated Water	 Number/ 100ml	 0 0	 0 0	 0 50	
Faecal streptococci Treated Water Untreated Water	 Number/ 100ml	 0 0	 0 0	 0 50	
Calcium as Ca	mg/l	-	-	250	Water quality guideline of Ca is not described by WHO
Magnesium as Mg	mg/l	-	-	200	Water quality guideline of Ca is not described by WHO.
Chloride as Cl	mg/l	250	250	750	
Aluminium as Al	mg/l	0.20	-	0.50	Guideline of Al cannot be decided from the view points of human health
Copper as Cu	mg/l	2	2	2.0	
Hardness as CaCO3	mg/l	500		800	There are some facilities which tolerates more than 500mg/L
Colour	TCU	Not mentioned	15	50	
Sodium as Na	mg/l	200	200	500	Na not much affects to human health.
Potassium as K	mg/l	-		-	
Iron as Fe	mg/l	Not mentioned	2	3.0	Fe will not affect to human health
Manganese as Mn	mg/l	0.50		1.5	
Conductivity at 25 0C	ms/m	-		-	
Total Dissolved Solids	mg/l	No guidelines		2000	TDS will not much affect to human health.
Sulphate as SO42-	mg/l	500	500	800	Guideline value is not mentioned.
Zinc as Zn	mg/l	3 mg/l		15 mg/l	In Drinking water with normal condition, it will not be affected to human health
pH Minimum	pH units	No guideline	6.5	6.0	There is no guideline for pH, which is based on the health.
pH Maximum	pH units	No guideline	9.5	9.5	
Turbidity	NTU	5		25	

Result of water quality test in the project area are shown in Table 1-6.

Table 1-6 Result of water quality test

Elements	MoIWD Standards	MIN	MAX
pH Value	6.5-8.5	6.01	8.6
CONDUCTIVITY (µs/cm at 250C)	-	86	4249
TOTAL DISSOLVED SOLIDS, mg/l	2,000	57	2,098
CARBONATE (as CO32-), mg/l	-	0	251
BICARBONATE (as HCO3-), mg/l	-	12	1044
CHLORIDE (as Cl-), mg/l	750	5.8	342
SULPHATE (as SO42-), mg/l	800	2.1	300
NITRATE (as NO3-), mg/l	100	0.003	14.3
FLUORIDE (as F-), mg/l	3.0	0.3	1.88
SODIUM (as Na+), mg/l	500	4.5	376
POTASSIUM (as K+), mg/l	-	0.1	19
CALCIUM (as Ca++), mg/l	250	5	374
MAGNESIUM (as Mg++), mg/l	200	2	109
TOTAL IRON (Fe++), mg/l	3.0	0.003	4.01
MANGANESE (Mn++), mg/l	1.5	0.001	21.7
TOTAL HARDNESS (as CaCO3), mg/l	800	22	1278
TOTAL ALKALINITY (as CaCO3), mg/l	-	11	1236
TURBIDITY, NTU	25	0.01	23.9
SUSPENDED SOLIDS, mg/l	-	0.4	38
COLOUR, TCU	50	15	15
ODOUR	Not unpleasant	0	0
TASTE	Not unpleasant	0	0
COPPER (Cu), mg/l	2.0	0.004	0.218
LEAD (Pb ++), mg/l	0.05	0	0
ARSENIC (As), mg/l	0.50	0	0
BACTERIA TYPE ENUMERATED （FC/100 ml）	50	0	800
BACTERIA TYPE LEVELS （FC/100 ml）	50	0	288

Result/ Review of water quality test are shown below:

i) streptococci

Despite samples are taken from borehole, streptococci was detected in 7 samples in total 100 samples. Maximum value of streptococci was detected in Siledi village in Kanduku, Mwanza and it because of mix of surface water occurred by problem of sealing.

ii) physical, chemical

pH/ EC

pH values ranges from 6.0 to8.0 and lower values were observed in some boreholes. Basically, pH value is affected by geological condition. It could be drinking water even if value is high/ low. If those lower values are due to the geological condition, it could be drinking water.

Standard of EC is not mentioned in the tentative standard of MoIWD, but EC value is available to show the saltiness. In the eastern part of Mlauli and Symon, EC value shows more than 2000（μS/cm^2）and in these areas also exceeds the standards of Ca and TDS. If the EC value is more than 3000（μS/cm^2） in the study area, the water will be recognized as a salty water.

Iron (Fe)

Fe were detected in Symon and Chekucheku and those values were 3.1(mg/L) and 4.0 (mg/L). On the whole, Fe value is lower in the project area.

Fluoride (F)

2 samples (total 100 samples) exceed WHO guideline and those values are 1.88 (mg/L) and 1.72 (mg/L). Average value also shows higher value (1.1 (mg/L)) and it is necessary to pay attention to F value.

Cu, Pb and As

Result of Cu, Pb and As are lower than Standards of Malawi

（2） Notes of groundwater development

There are no problems about water quality in hilly area. However, Saltiness is higher in Mlauli, Neno and Symon (Neno), which are located in south-eastern part of the project sites, and Fluoride shows higher value in the East-south part. It is necessary to pay much attention to the saltiness and Fluoride value during underground water development.

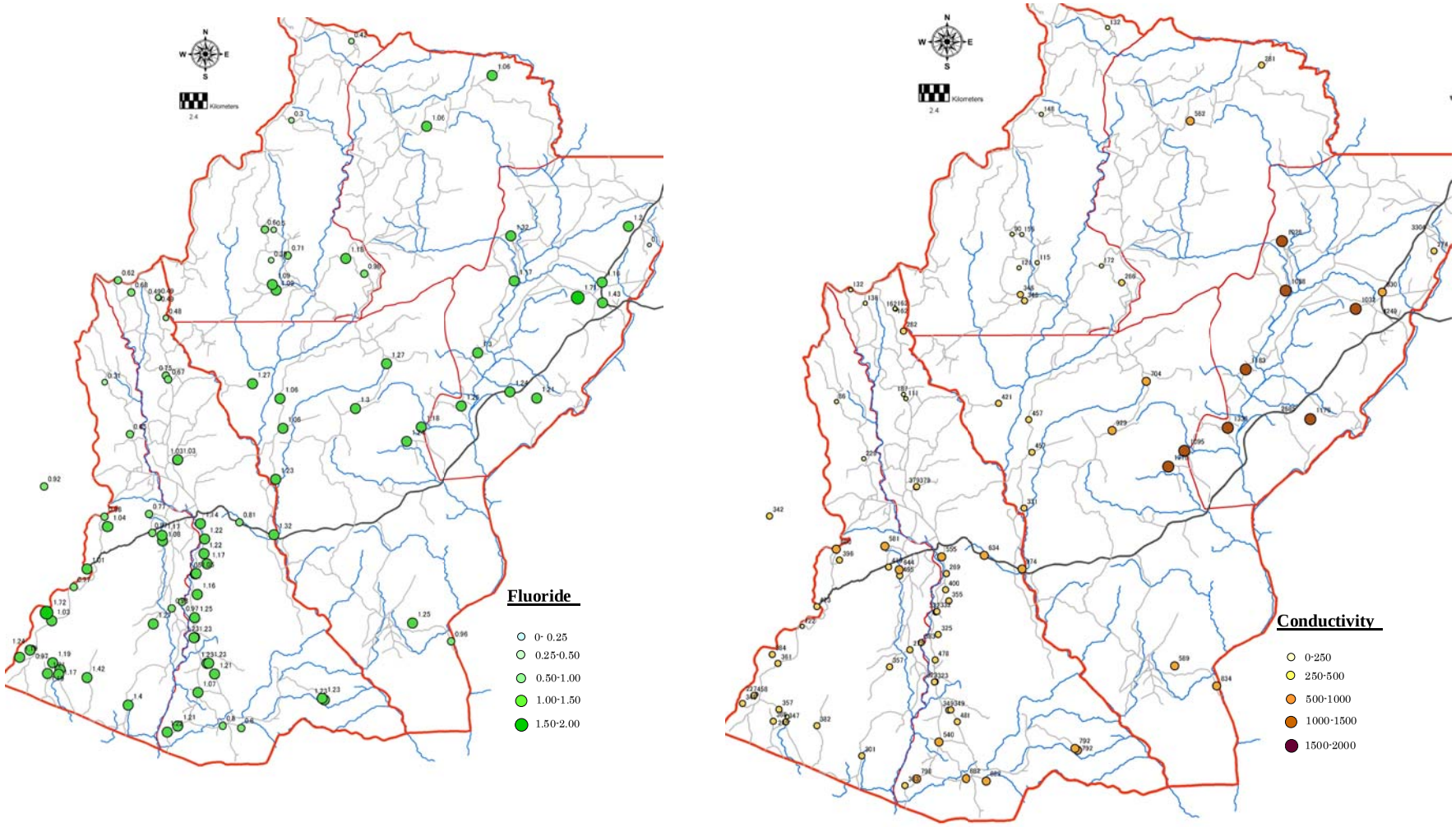


Figure 1-15 Water quality test

1-2-10 Possibility of Groundwater Development

The basement in the project site consists of metamorphic rocks such as gneiss and schist with low permeability. The surface of the earth is covered with the laterite of the hard clay and under it the weathering layer of sand and gravel is formed. In the Rift Valley Plain in the east part of the project area, “the colluviums and residual soils” and “the river and lacustrine alluvium” of Quaternary Era were deposited along the rivers. A lot of faults have developed inside and outside of the project site with the fault movement in Cenozoic Era and it can be considered that the fracture zones had been generated with the fault development in the basement rocks.

From the above mentioned matter, the weathered layer of sand and gravel, fracture zones, “the colluviums and residual soils” and the river and lacustrine alluvium” are hydrogeologically the targets for groundwater development.

Based on the results of analysis of the existing information, lineament analysis, geophysical survey and test drilling of borehole, the hydrogeological structure models in the project site are constructed and they are shown in the following drawings. The topography of the project site is steep like feature which is inclined lower from west to east because it was horizontally pulled at the time of the rift valley belt formation. The surface of the earth is covered with the weathering layers. The surface water flows from the high place to the lower place, and part of it infiltrate the ground around the fault zone and flows down to the lower place as groundwater. It is expected that the amount of groundwater is larger in the thicker weathering layer.

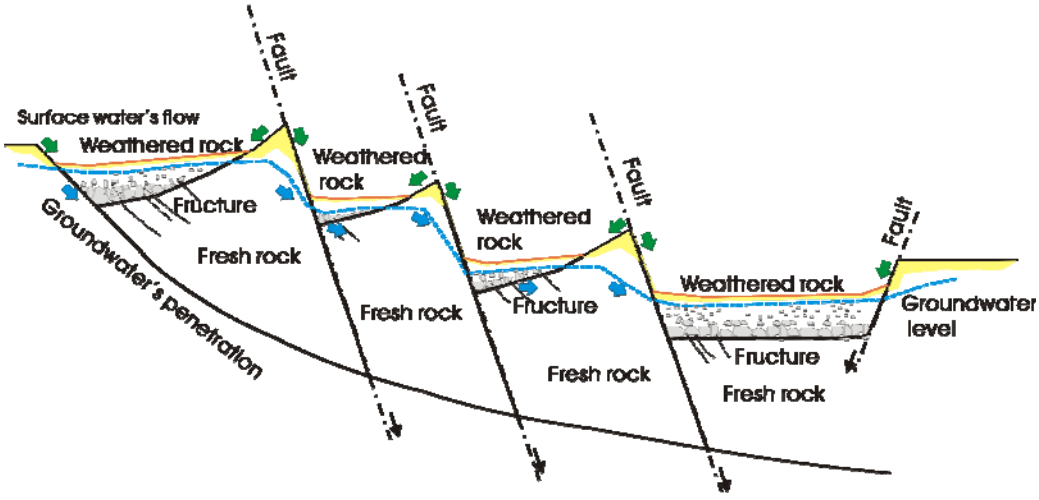


Figure 1-16 Hydrogeologic Structure Model in the Project Site

Judging from the survey results, it is necessary to conduct groundwater development carefully, taking into account the geophysical survey results in addition to the conditions of topography and geology due to the difficulty of selection of the well position. Therefore, the matters to be considered on selecting the drilling site are as follows;

1. The groundwater development is more promising in the flat area with surface sag than in the site on the ridge.

2. The thickness of the aquifer might change greatly by place on the mountainous area. Therefore, it is necessary to analyze the hydrogeological features by the geophysical exploration beforehand.

3. A high density electric resistivity survey, which analyze the subsurface structure two-dimensionally, is one of the effective techniques as the geophysical exploration.

4. There are some cases in which no fracture zones are found in the zones which are specified as faults by the lineament analysis, but there are other cases in which fracture zones exist in the zones which are not considered as lineaments. Therefore, the judgments for selecting the drilling spot should be done comprehensively.

5. It is also effective to change the direction of the electric resistivity survey line when the assumed fracture zone is not caught.

6. Because the resistivity of the aquifer changes by region, the standard value of each region is set.

From the above mentioned matters, the notes of the groundwater development in each site are shown in Table 10.

Table 1-7 Notes of the Groundwater Development

Region	Topography ・Geology	The results of Electric Resistivity Survey	Possibility for Groundwater Development
The west and edge of the northwest	Rift Valley Escarpment: Western part of the project site. Mountainous area with altitude of 1000m or more along the border with Mozambique. The valley on both sides is deep and steep in this region.	A two-layer model consisting of high – high. The fresh part of the basement rock is covered with laterite with low permeability. A three-layer model consisting of high – middle (100～1000Ω・m) – high. The fresh part of the basement rock is covered with the weathered layers which includes high permeable layer between them.	It is necessary to select the following places; The places which are presumed to be locating on the lineament or its extension. The places where the valleys approaches from both sides and fracture zones are presumed to exist or the layers of weathered rock which are thick.
Center part and southern part	Rift Valley Escarpment: Most part of this area is undulating. Altitude is 500m to 1000m. The villages are existing between the mountains where ups and downs are gentle. However, there are places where valleys are deep and steep and undulating area is small.	A two-layer model consisting of middle (100～1000Ω・m) ／low (under 100Ω・m) – high. The fresh part of the basement rock is covered with the high permeable weathered layers. Electric resistivity will be lowered depending on the amount of groundwater. The thickness of weathered layers change from 10 m to 50m.	Surface sags are seen around the villages. Possibility is quite high that a small fracture zone exists in such surface sag and groundwater concentrate to such fracture zone and flow through it. Therefore such surface sags are favorable for groundwater development. However, it is necessary to be careful of fluorine concentration in water quality in some places.
East part	Rift Valley Plain / Plateau Area: Most of this area is almost flat with altitude 400m to 450m. This area consists of high permeable layers because the colluviums and residual soils had deposited on the weathered rock of basement rock, or the river and lacustrine alluvium layers had been formed.	The thickness of the weathering layer is almost 50m or more in Rift Valley Plain of Symon and Mlauli.	The flat area of this region consists of promising aquifers and the possibility of groundwater is high. However it is necessary to be careful of hardness and calcium concentration in water quality.

CHAPTER 2 CONTENTS OF THE PROJECT

2-1 Basic Concept of the Project

The Project would be guided by the Malawi Growth and Development Strategy (2006-11) and the National Water Policy (2006). Their aims are to extend rural water supply and sanitation services and to promote Community Based Management (CBM) of water and sanitation programme. The targets are to increase the proportion of the population with access to safe potable water within 500m of their households up to 80% by 2011, 85% by 2015 and attain full coverage by 2025. This project is planned in accordance with the overall objectives as part of a project to improve access rate to water supply in rural areas.

The target areas of the project have existing boreholes in communities. However, due to a large increase of population and far distances between communities and boreholes, other traditional water sources such as small streams, spring water and dug wells are used as their primary water sources (55% in Mwanza and 67% in Neno). These traditional waters are used without any treatment, therefore, water quality is problematic for people's health. For example, typhoid fever struck an area near the Mozambique border claiming many victims in 2009. Additionally, water supply condition is unstable, especially in dry season. An urgent solution is awaited.

The Project targets 120 communities in Mwanza and Neno districts(approximately 28,700 in population). Totally 120 boreholes with hand pump facilities will be constructed in order to increase the water supply coverage and to supply sustainable safe and stable water to the population in the target areas.

2-2 Outline design of the Japanese Assistance

To achieve the above objectives, the Project constructs water supply facilities and boreholes in 120 communities with high priority in the requested areas that face problems with security and stability of water sources. Further, the Project procures vehicles for operation and maintenance management to be used with implementation of CBM programme to realize effective and sustainable use of the facilities, as well as GPS equipment for accurate positioning of boreholes. A soft-component will provide training to extension workers in the areas. Through the Project it is expected that water supply facilities are constructed and the local residents and both districts will build management capacity to operate and maintain the water supply facilities. A summary of the cooperation is outlined in Table 2-1.

Table 2-1 Scope of the Project

Items	Contents	Outline
Facility Construction	Borehole and hand pumps installation	Mwanza District：59 communities(incl. one test drilling site, with water quantity & quality confirmation) Neno District：61 communities
Procurement of equipment	Vehicles for operation and maintenance	Double cabin pick-up 1 vehicle in each district: total 2
	GPS	Portable type in each district: total 2
Soft-component	Organisational capacity building, training	1） Training of District extension workers 2） Support for water committee formation 3) CBM training to water committee 4） Sanitation education for users

Table 2-2 Project・Design・Matrix（PDM）

Project Title： Preparatory Study on Groundwater Development in Malawi

Target Area： Mwanza and Neno Districts

Narrative Summary	Indicators	Means of Verification	Important Assumptions
Overall Goal Living environment of the target areas is improved.	Decrease of waterborne diseases among local residents	Statistics on health	
Project Purpose In the project area population served increases, and safe water is sustainably supplied	・improvement of water supply rate ・increase of water supply population	・Register of Water Point Committees, Records of maintenance	Policies in Malawi remain without drastic changes
Outputs 1.Water supply facilities are installed in the project areas 2. Communities operate and maintain the facilities sustainably through CBM programme implementation 3. Services of implementation agency for operation and maintenance are improved 4 . Awareness on sanitation among the communities is improved	1-1.Number of water supply facilities in the target area 1-2.Decrease of labour hours to fetch water 2-1.Activness of water committee 2-2.Fees collection rate 3-1.Times of monitoring by the implementing agency 3-2.Satisfaction of communities towards the implementing agency 4-1.Facility use during rainy seasons 4-2.Decrease of medical costs related to waterborne diseases	1-1.Social study report, records of facility construction 1-2.Interview from water committees 2-1.Activity records of water committees 2-2.Fees collection records 3-1. Activity records of the implementing agency 3-2. Interview from water committees 4-1.Operation records, Fees collection records 4-2.Interview from water committee	Population does not increase rapidly
Activities 1-1.Planning of water supply facilities 1-2.Construction of water supply facilities and procurement of equipment for operation and maintenance 1-3.Drilling of boreholes and installation of water supply facilities 2-1.Establishment of Community Based Management system 2-2.Training on operation and maintenance to the communities 3.Training on operation and maintenance to the implementation agency 4.Hygine and sanitation education programme to the communities	Inputs (Japanese Side) ・Construction of borehole ・Equipment for operation and maintenance ・Soft Component ・Consulting Services (Malawi Side) ・Land secure for borehole construction ・Construction of access route for borehole construction ・Human resources for operation and maintenance Implementation Agency : Malawi Ministry of Irrigation and Water Resources Development		There won't be an unexpected groundwater level decrease Pre-conditions The communities wish to implement the project

2-2-1 Design Policy

2-2-1-1 Basic Policy

（１） Scope of Cooperation

Based on the review of the request, the Project constructs water supply facilities with boreholes equipped with hand pumps in communities with high priority. The Project will be conducted as a single fiscal year project implemented within 24 months after the Exchange of Notes (E/N).

Procurement of equipment related to drilling rigs will not be included, which were listed in the initial request. Because borehole drilling rigs are planned to be procured in 2011 by environment and climate change grant aid scheme. Additionally, the Ministry of Irrigation and Water Resources Development owns 5 working drilling rigs that were procured from Japan in the past, and private drilling companies in Malawi also own sufficient number of rigs with sufficient capacity. However, necessary equipment for the operation and maintenance of the facilities will be procured to strengthen technical capacity of the district water development offices in Mwanza and Neno in order to support community's water committees.

Soft component programme will be planned for sustainable operation and maintenance through implementation of Community Based Management programme, to build capacity of the district water development offices.

（２） Selection of Target Communities

Target communities will be selected on the priority basis considering conditions of the existing water supply facilities, access to a borehole site, groundwater development potential and other criteria from the Study Team results on the natural and social condition surveys and community visits.

（３） Target Communities and Water Supply Facility Level

The Project aims to upgrade the overall water supply of the target area within the scope of a single fiscal year project, therefore plans to construct one borehole in each community. Further, a facility type of borehole with hand pump is chosen for its easiness of operation and maintenance.

2-2-1-2 Policy on Natural Conditions

（１） Climate Conditions

The target area receives concentrated rainfalls during the rainy season between December and March. Having no paved route except for national route from east to west connecting the Mozambique border and Blantyre, access conditions get worse during the rainy seasons to the many communities situated on hilly areas. Therefore, This condition will be considered in the implementation plan , and

vehicles for operation and maintenance will be selected in accordance with the capability for travelling and endurance.

（２） Geographical･Geological Conditions

The target areas are rift valley slopes in the Midwestern areas with fiery mountains and hills, the Eastern areas are rift valley plains and plateau regions in a flat terrain. Geologically a rift was formed to divide the country with which surrounding areas of rift were fractured to produce numerous fault fractures.

From the results of the geological exploration, electrical exploration and prospecting, carried out in the environmental survey, groundwater development can be expected at fissure water in a steep ridge of lineament, weathered layer and products in hilly areas and weathered layers and sedimentary layers in flat area.

Principally, the target communities will be selected from hilly area and flat area, because the well site selection at fissured points in the deep ridge area has difficulty and the risk of success borehole construction is higher. Further, the detailed design study will conduct electrical explorations and select drilling sites to improve success rates.

2-2-1-3 Policy on Social Conditions

Sufficient considerations will be paid to select target communities such as the population size, population structure, existing water sources, and existing water supply facilities, living water requirements, water transportation distance, transportation time, access conditions, awareness of the communities on water supply water conditions, willingness to establish rural sanitation water Committee and water supply points Committee, willingness to participate in maintenance activities and maintenance cost.

A baseline of served population is taken from the survey population in 2010 and a population growth rate (approximately 4%) will be considered. The planned year is set for 2017 after five years of completion of the Project. A work schedule is planned with due consideration of the CBM programme implementation by the communities.

2-2-1-4 Construction / Procurement Conditions

Numerous construction companies including borehole drilling companies operate in Malawi, therefore, the Project deploys such local capacities. And, construction equipment and materials are almost available in Malawi, but those of them which are not available will be procured from a third country or Japan.

2-2-1-5 Capacity of Implementation Agency for Operations and Maintenance

After introduction of decentralization policy in 1998, social capital construction including borehole construction was shifted to the district level which would be responsible for planning, implementation and administration. Nevertheless, the project support capacity at the district level is not sufficient in terms of technical skills and personal numbers. A support from the head office of the Ministry and Regional Water Resources Development Office will be essentially required.

Therefore, the Project will be conducted with Water Resources Department of MoIWD as the counter- part. As to the operations and maintenance of the completed facilities, Water Supply Department of MoIWD will supervise operations and maintenance training activities conducted by CBM extension workers and Water Monitoring Assistants of the Regional Water Resources Development Office as well as the District Water Development Office.

For an effective operational maintenance of water supply facilities, training on establishment and management of water committees will be conducted at 3 stages of before, during and completion of construction. Further, training on operations, maintenance and reparation of the facilities will be conducted by the implementation agency and community based operations and maintenance organisations at the stage of construction.

2-2-1-6 Facilities and Equipment Grade Setting

Water supply facilities are designed as simple to reduce costs. As a community facility, they will be designed for easy operations and maintenance with high durability to enable a sustainable use. The target area lags behind in infrastructure development, and even main trunk roads are unpaved. A 4 x4 pick-up truck will be procured because the road conditions are very poor especially during the rainy seasons.

2-2-1-7 Construction Method / Procurement and Construction Period

The Project will adopt a construction method that the local companies can work with, taking it into account to deploy local construction companies. The specifications of construction materials will be selected to lower costs, which can be procured on site or from the neighbouring countries.

Concrete apron and waste water drainage will be installed primarily when the boreholes are drilled, but installation of hand pumps clustered by neighbouring areas will be considered for efficient work. The order of construction will take priorities by the communities' urgency due into account, yet efficiency with the work plan will have its priority.

2-2-2 Basic Plan

2-2-2-1 Contents of the Request

（１） Basic Design

a) Target Year of the Project

Target year of the Project is set at 2015, three years after the construction completion. The target population adds a population growth rate (3.8% in Mwanza, 4.1 % in Neno) to the population survey in 2010 as a baseline. The served population will be estimated from the survey results of this Study within the scope of the social condition survey and interviews by the Study Team.

b) Construction standards for Borehole Facilities Construction

The standard for borehole water supply facilities in Malawi aims at 1 borehole per 250 persons. Transporting distance of water is to be 500m by MGDS. The Project targets communities with a minimum population of 125 persons (25 households) in 2015, because monthly operation and maintenance fee per household is estimated around 35 Kwacha in case the community has 50 households, and according to the Social condition survey, willingness to pay was around 60 kwacha per household

c) Basic Water Supply Unit

The basic water supply unit will be set at 27 litter/person/day based on the Malawi standard.

（２） Selection of the Planned Target Communities

Basic Design narrowed down and prioritized the planned target communities for the Project from a viewpoint of necessity and construction possibility in the requested list of 414 areas. The requested list includes 25 rehabilitation boreholes in Neno district. The Project will include construction of new boreholes in case an existing borehole is dysfunctional, but such rehabilitation as borehole cleaning and renewal of hand pumps will not be included.

The following 5 criteria are used to narrow down the sites.

a) Access to the site

The drilling rigs can access to the borehole construction site at the communities.

b) Needs of the potable water

The communities have been using traditional water like spring water, hand dig shallow wells and stream water which do not secure safe and stable potable water.

c) Potentiality of groundwater development

The target area is either hilly or flat ground. In comparison with the steep ridges in the northern and north-western areas, successful rate of the borehole construction is considered high and is to secure a necessary volume of water. Moreover, the water quality will be sufficiently safe for drinking use.

d) Operations and maintenance capacity

The communities have sufficient capacity to operate and maintain the facilities to be constructed.

e) Population of the communities

The requested communities include the communities that will not reach the target coverage rate of 250 per facility at the target year of 2015. From the viewpoint of operations and maintenance, a population of 125 persons is taken as a minimum at 2015.

The 220 target communities are selected from the requested 414 communities as a result. Further, the priority communities are selected based on the condition of existing water supply facilityas follows:

a) the communities do not have an existing borehole

b) the communities need 2 boreholes or more for the planned population and the number of existing boreholes

Finally, 120 are selected as priority communities, include one test drilling site. The Project constructs one borehole at each community. (See Table 2-3 and Figure 2-2）.

An increase of served population by district in the Project site is as shown in Table 2-4. A population of approximately 28,700 will newly have access to safe and stable potable water.

Table 2-3 The Number of Target Communities in the Project site

Rank	Items	Mwanza	Neno	Total
		Number of the village	Number of the village	Number of the village
A	Target villages（higher priority）	59	61	119
B	Target villages	45	56	101
C	Excluded villages (existing water supply and low possibility of Groundwater development)	61	86	148
D	No access	8	38	46
	Total	173	241	414

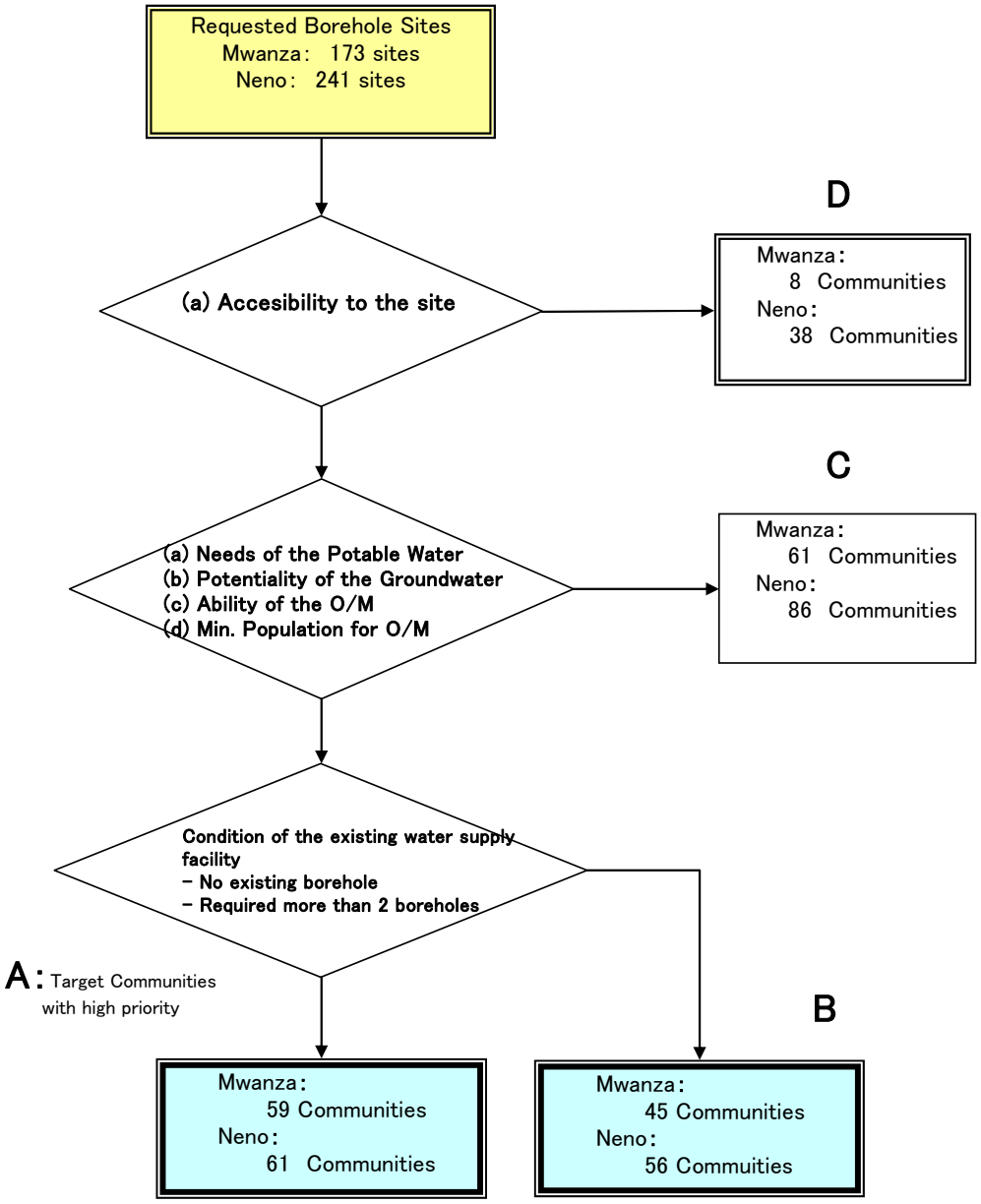


Figure 2-1 Selection Flow

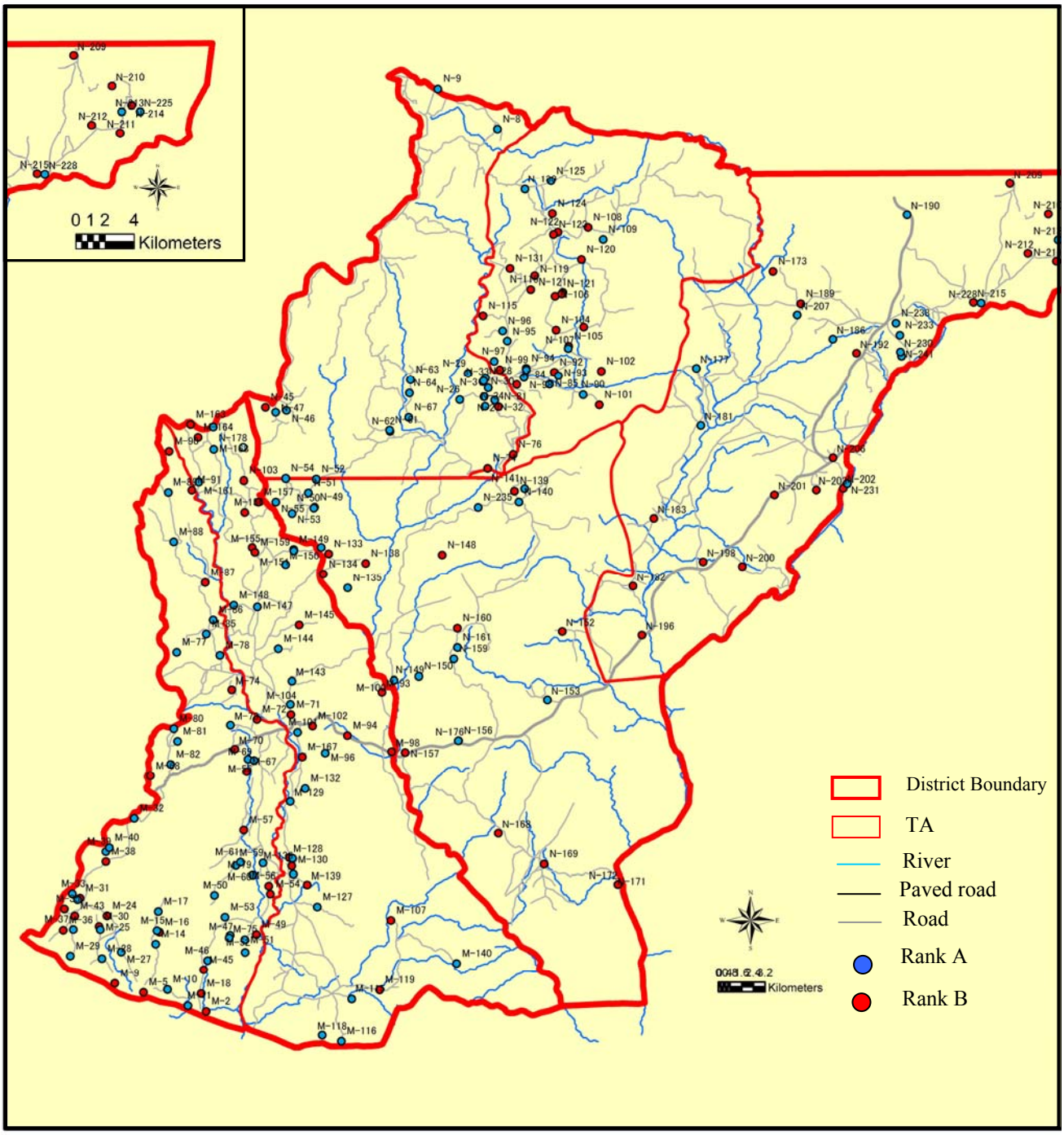


Figure 2-2 Location of Target committees

Served population with access to safety and stable water will be increased approximately 28,700 in the target year 2015 in Mwanza and Neno districts, and the proportion of the population covered by safety water will be from 41.6% in 2010 to 47.2% in 2015.

Table 2-4 Increase of water served population

District	Mwanza	Neno	total	Proportion of the population with access to potable water supply
Population in 2010	94,891	97,544	192,435	—
Population with water supply 2010	42,445	37,642	80,087	41.6%
Population in 2015	112,630	117,540	230,170	—
Benefited Population by the Project	14,386	14,408	28,794	—
Population in 2015	56,541	52,050	108,591	47.2%

Additionally, Male & female rate and Age group rate in the Target Area are shown in Figure 2-3. The female population benefited by the Project is expected to be around 14,950, and the population under 14 year old is also expected to be around 13,500, consequently their working hours for carrying water will be reduced.

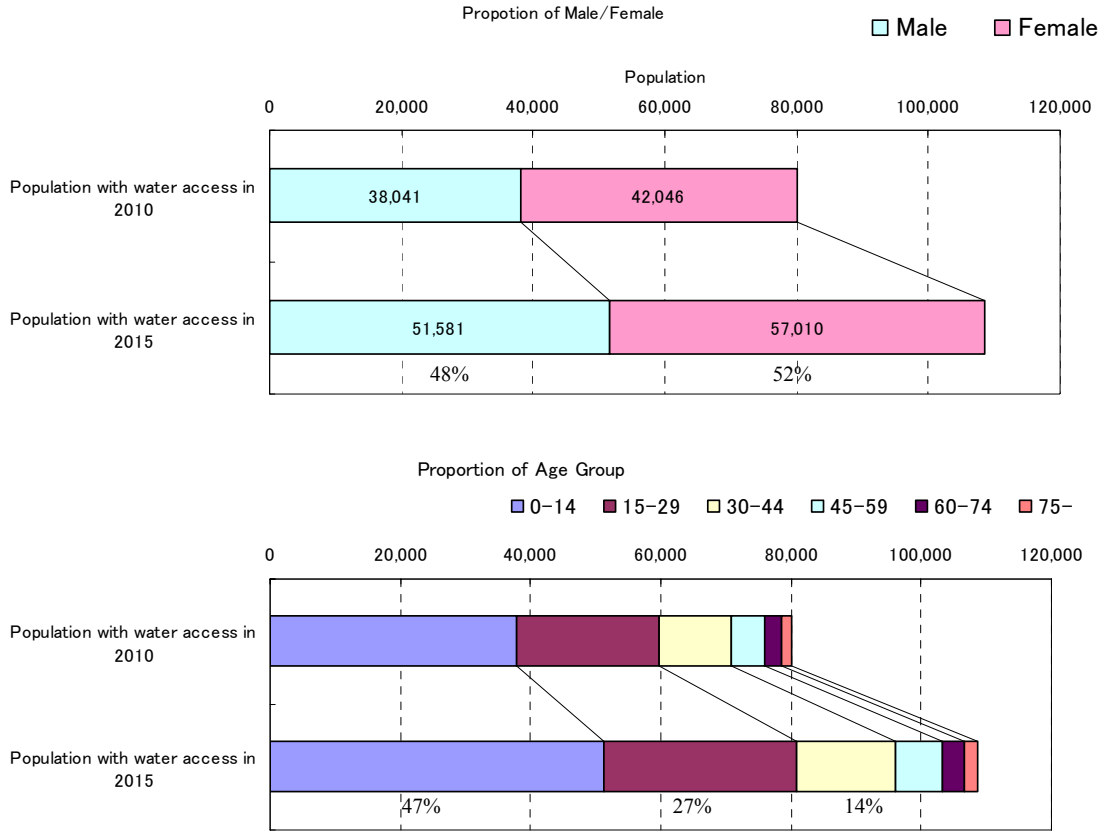


Figure 2-3 Detail of served population

（３） Procurement of Equipment and Materials

The initial request included new drilling rigs, supporting vehicles and materials for wells. However, borehole drilling rigs are planned to be procured in 2011 by environment and climate change grant aid scheme. The Ministry of Irrigation and Water Resources Development owns old but working 5 drilling rigs that were procured from Japan in the past. Further, private drilling companies in Malawi also own sufficient number of rigs with sufficient capacity. Therefore, procurement of equipment will not include equipments related to drilling rigs.

On the other hand, Department of water resources in both districts own 1 vehicle respectively for the CBM program, but in Neno district a 13 year old pick-up is still mobilized but its breakdowns are frequent. In Mwanza district, a pick-up procured by UNICEF in WASH project is used but WASH project will continue till 2015 and it cannot be available for the Project. For the implementation of CBM program there is a need for transport of more than 3 personals and materials such as pump lodes at renewal of pumps.

Also, the department does not own GPS to position the new and existing boreholes that mapping is difficult. Therefore, vehicles for operations and maintenance to implement CBM program and GPS are included in the procurement by the Project in order to maintain the constructed facilities sustainably. Responsible organization of vehicles and GPS equipment is water development offices in Mwanza and Neno.

（４） Soft Component

The initial request includes 1) training to water point extension workers at districts and 2) training on community based management (CBM) to water committees at communities as a support for operations and maintenance of the water supply facilities.

The Government of Malawi revised its National Water Policy in 2005, a basic policy promotes community participations in the water supply projects, cost sharing of operations and maintenance by the service recipients and sensitization activities for safe water and sanitation. But at the target area, a sense of ownership is still low and the concept of cost sharing of operations and maintenance not well understood.

The goal of the Project is that ‘water served population increases in the project area, and safe water will be supplied sustainably’. The overall goal is that ‘sanitary environment of the target communities will be improved’. To attain this, it is necessary to rise the awareness of the local residents on sanitation together with an improvement of water supply rate so that clean and safe water is used with appropriate operations and maintenance of the facilities. A soft component with contents outlined below will render supporting activities in order the Malawi administration to conduct sanitation

education and operations and maintenance activities after the completion of the Project.

- Education and training of extension workers
- Sensitization of the community participation
- Foundation of operations and maintenance system
- Sensitization on health and sanitation

（５） Contents of the Requests and Modifications

The following table summarizes the components of the request and modifications.

Table 2-5 Comparison between requested components and Basic Plan

Requested components			Basic Plan		Rationale
1	Drilling well(includes drainage/Apron)				
(1)	Well(includes drainage/Apron)	414 sites	same as on the left	119 sites	Communities in urgent need of safety water supply are selected, in consideration with access problem/ difficulty of borehole construction.120 sites include one test drilling site confirmed water quality and quantity.
(2)	Pumping facility (Handpump)	414 sites	same as on the left	120 sites	
2	Procurement Plan for Equipment and materials				
(1)	drilling rigs (carried by truck)(4x4)	1 set	Delete		Drilling machines will be procured by Environment and climate change grant aid scheme to MoIWD..
(2)	Facilities for pumping test and borehole development.	1 set	Delete		
(3)	Pick-up single cabin (4x4)	2 sets	Delete		
(4)	Pick-up double cabin(4x4)	2 sets	same as on the left	2 sets	Pickup truck will be used for CBM program.
(5)	GPS	3 sets	same as on the left	2sets	GPS will be necessary for Borehole mapping (includes existing well), and process of monitoring.
(6)	Equipment for Geographical survey	1 set	Delete		Same as (1), (2), (3)
(7)	Casing and Screen	1 set	Delete		Casing/ Screen will be included in construction material.
(8)	Spare parts	1 set		Same as (1), (2), (3)	
(9)	Spare parts for the drilling well	1 set	Delete		
3	Soft components				Soft component program will includes support for promoting CBM and training to extension worker for the new water supplies.
(1)	Support for managing CBM program	1set	same as on the left	1set	
(2)	Training to extension worker	1set	same as on the left	1set	

2-2-2-2 Water Supply Facility Plan

（１） Water Service Population

Malawi conducted a census in 2008, but population by community is not clear. Therefore, the results of social survey and visits by the Study Team is taken as a baseline, the planned target year is set at 2015 to estimate the following water service population with the population growth rates of the census.

- Mwanza district： 3.8％
- Neno district： 4.1％

（２） Basic Water Supply Unit

The Malawi standard of basic water supply unit is 27 litter/person/day for the borehole water supply facilities. The results of social survey shows various water consumption volume per person depending on their water sources (stream water, hand dig shallow well etc.) as well as distances to their water sources.

When the distance to a water source is far (2km and beyond one way), water use volume is only 10 litter per capita per day, however if a water source like a shallow well or a small stream is in the vicinity of their community, water use volume is more than 30 liter. The Project adopts 27 litter/person/day as adequate.

（３） Planned Water Supply Volume

The Project employs hand pump as a water intake facility. A basic unit calculates a planned water supply volume per facility and a planned pumping-up volume as the followings.

Service volume per capita: 27 litter/person/day

Operation hours per day：12 hours

Rate of operation per pump：0.8

Planned Water Supply Volume = 6,750 litre per day

Planned pumping-up volume of a borehole=27 lpcd x 250 persons/12 hrs/ 0.8 = 0.19 ℓ/sec

Pumping yield 0.20 ℓ/sec is adopted as a success criterion for the pumping-up volume.

（４） Water Supply Facility

a) Hand pump

Afridev hand pump will be adopted in the project, which is a standard model of MoIWD. A supply

chain of spare parts for this pump exists already in the Project Area, and Area Mechanics are able to repair and renew. In the future, the reparation of the pump is expected to be done by the community. Hand pumps will be supplied with some spare parts such as 0- ring, seals as well as repairing tools to the communities. Further, an antitheft lock will be attached with hand pumps because some pumps were stolen in other project area .

b) Water apron and waste water drainage

Intake facility of a borehole is designed using the standard of MoIWD which includes apron and footing, drainage channel, washing basin and bucket stand to put a bucket on the head. This standard specification is adopted by UNICEF and other aid agencies, and the projects funded by Japanese grant aids in the past. Additionally, a filtration pit will be placed at the end of drainage to keep clean around the facilities, because unhygienic conditions are observed at the end of drainage channel in the field survey.

（５） Basic Structure of a borehole

① Well diameter and drilling diameter

The well diameter is set at 4 inches in order to install hand pump. The drilling diameter is set at 6.5 inches by DTH method to secure a clearance space to fill gravels and filling materials. In case the mud drilling method is used, the drilling diameter will be 8 inches for temporary casing needs to be inserted to prevent collapse of the drilling.

② Casing and screen

PVC pipes are used for casing and screen materials.

③ Borehole depth

The results of electrical exploration show that an average of weathered layers at the hilly areas is 47m, while weathered layers and river sediments are 50m at flat lands in the east. Adding 2 to 3m for surface soil and 5m of sand traps on these layers, drilling depths of 55m at the hilly areas and 50m at the eastern flat lands are set together with consideration of drilling depths of existing boreholes.

④ Success borehole criteria

As stated by the planned water supply volume, a success criterion is a yield of 0.20 (l/sec). The water quality needs to be in line with the temporary water quality standards in MoIWD and for fluorine a standard of WHO will be considered.

⑤ Success rate

Success rates of a borehole construction are set at 70% at hilly areas and 80% at flat lands (Table 2-6) based on the results of the past grant aid projects and interviews from the local contractors. The total success rate is estimated as 72% for the selected communities (95 at hilly areas and 24 at flat lands in both districts).

Table 2-6 Success rate and depth of Borehole Construction

Region	Topography・Geology	The results of Electric Resistivity Survey	Water quality	Borehole depth (m)	Success rate
West and edge of the northwest	Ridge with deep valley Mountainous area along the border with Mozambique, etc.. The fresh part of the basement rock is covered with the weathered layers which includes high permeable layer between them.	A two-layer model consisting of high – high. The fresh part of the basement rock is covered with laterite with low permeability. A three-layer model consisting of high – middle (100～1000Ω・m) – high.	No problem	60m	It will be difficult to find fissured water point for borehole in the steep ridge. By conducting interview to the constructer, and reviewing experience, success rate is estimated as 50% or less
Center and South	Hilly area with gentle slope. The fresh part of the basement rock is covered with the high permeable weathered layers.	A two-layer model consisting of middle (100～1000Ω・m)／low (under 100Ω・m) – high. Electric resistivity will be lowered depending on the amount of groundwater. The thickness of weathered layers change from 10 m to 50m.	Concentration of fluorine will be higher in some project sites.	55m	Success rate was around 80% in Dedza, and 70%. in Mzimba Area with hilly condition. Additionally with risk of water fluorine, 70% is estimated as Success rate.
East	Rift Valley Plain / Plateau Area: This area is almost flat with altitude 400m to 450m. This area consists of high permeable layers because the colluviums and residual soils had deposited on the weathered layer of basement rock, or the river and lacustrine alluvium layers had been formed.	The thickness of the weathering layer is almost 50m or more in Rift Valley Plain in Symon and Mlauli.	Concentration of fluorine will be higher in some project sites.	50m	In the previous project in Lilongwe west for flat area, success rate was 80-90%.. In addition, there is a risk of fluorine and salinity, success rate is estimated as 80%

⑥ Unsuccessful borehole

The followings are the countermeasures in case the yields or water quality do not meet the success standards with planned drilling depths.

(a) Hydrogeological conditions are examined within the same community to find an alternative drilling point for a second try.

(b) A second try is up to one more try. In other words, a maximum of 2 drillings will be undertaken within a same community.

(c) An alternative community will be selected in place of an unsuccessful borehole from other target communities (B rank). (Priority of B rank communities is shown in the Community List in Annex)

2-2-3 Outline Design Drawings

1. Structure of borehole
2. Structure of Intake facility

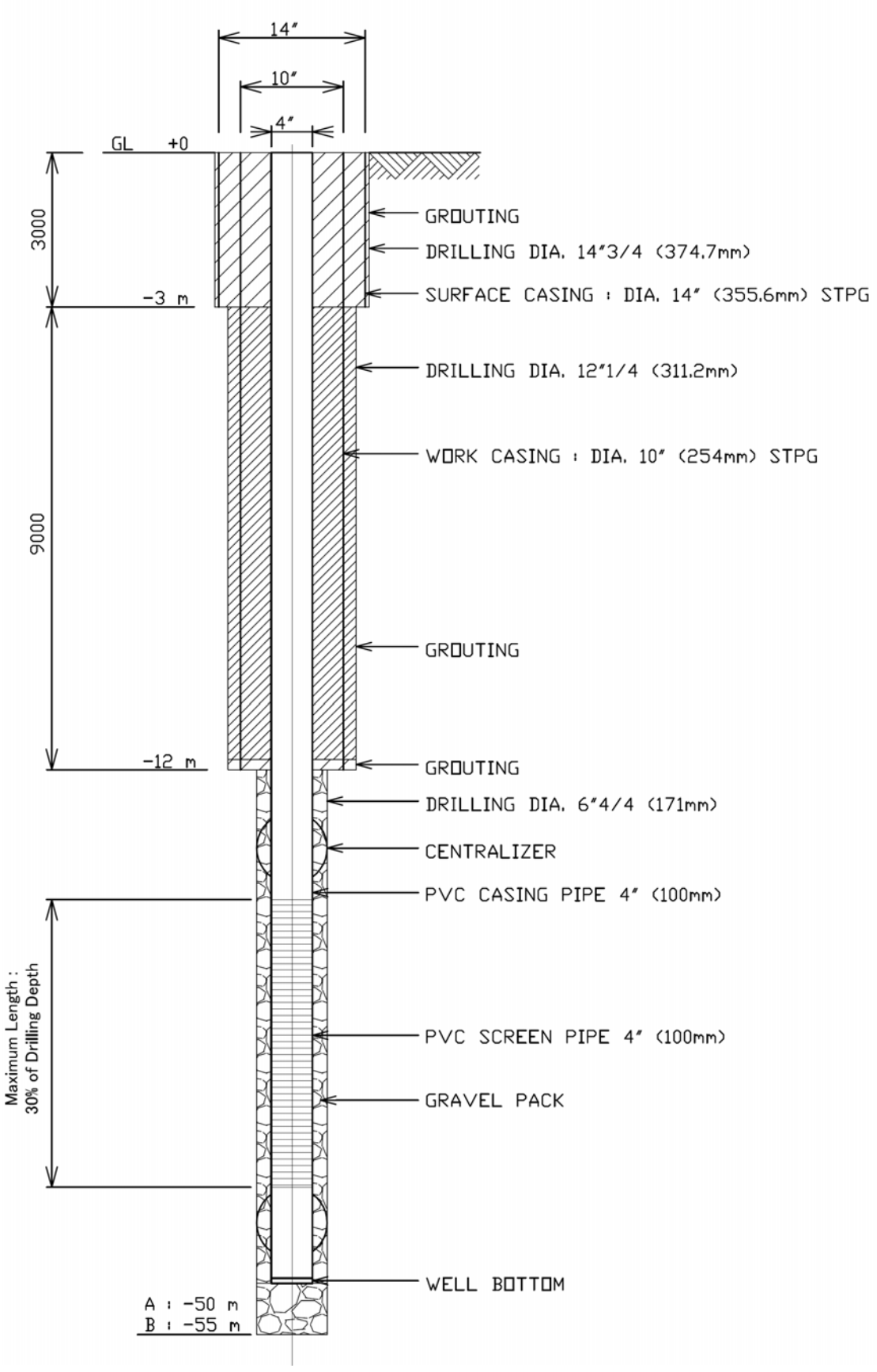


Figure 2-4 Structure of Borehole

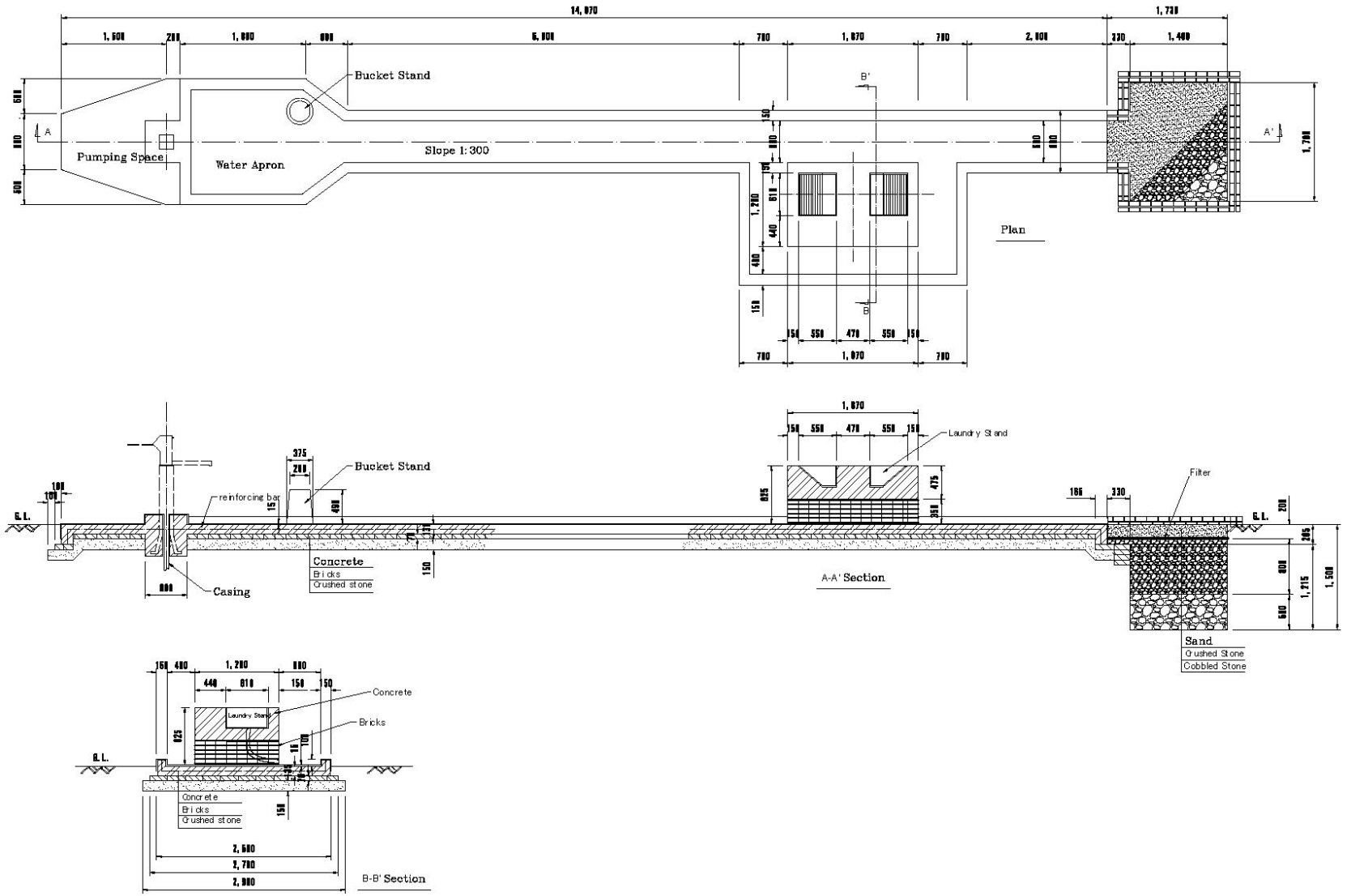


Figure 2-5 Intake facility

2-2-4 Implementation/Procurement Plan

2-2-4-1 Implementation/Procurement Policy

（１） Fundamental Matters

After conclusions of Exchange of Notes (E/N) and Grant Agreement (GA) between the Governments of Malawi and Japan, the Government of Malawi will conclude a contract with a Japanese consultant for facility design, equipment procurement and implementation supervision with which a detailed design process will set out facility constructions and equipment procurement. Thereafter, a tendering will be conducted in the presence of a representative of Malawi to select a Japanese contractor to proceed with the procurement of equipment and construction.

For the construction and good procurement, the following construction policy will guide the works.

1. In accordance with the Japanese grant aid scheme, the Project will be implemented by the Department of Water Resources of MoIWD as the implementing agency.
2. The Project will be undertaken as a single fiscal year project (24 months from E/N).
3. The planned target area requires 4 teams for constructions to keep a sufficient quality control considering the climate and geographical conditions. The machinery for drilling will be utilized with adequate combinations in terms of efficiency and economy among the MoIWD owned machineries procured by the Japanese grant aid in the past and the ones that are owned by private contractors.
4. Prior to the commencement of works the Malawi side will secure and prepare the construction sites and storage spaces for materials.

（２） Construction System and Work Schedule

1) Overall Schedule

For the overall construction period, the following conditions are taken into consideration.

- The planned number of borehole (depth 50m x 24, 55m x 95, total 119)
  - ✧ Borehole success rate: 72%,
  - ✧ Total drilling Number of Borehole = 119/0.72 = 165
  - ✧ Unsuccessful number of Borehole = 165 – 119 = 46
- Preparation (base camp set-up, selection of local subcontractor, 2 months)
- Cycle time of construction ()
- Access conditions during rainy seasons (December to March)
- Coordination with CBM activities

Construction period will be as follows with a 4 team set up.

Table 2-7 Construction period

Item		Period	Remarks
Preparation		2 month	
Drilling Well	Successful borehole	23.8 month	4day / Well x 119Well = 476day = 23.8 month
	Unsuccessful borehole	8.0 month	3.5day / well x 46 well = 161 day = 8.0 month
	Total	7.9 month / 1 team	Total = 31.8 month、31.8 month / 4 teams
Borehole Development		0.5 month	
Total		10.4 month	

The rainy season in the target area is between December and March during which access to the target communities deteriorates, so that a practical working period would be 8 months per year. Preparation works will commence at the end of the rainy season in March. In certain communities which have comparably easier access, installations of pumps and test operations will be planned at the beginning of rainy season to make it possible to finalize within 10 months as a Government Bond A scheme.

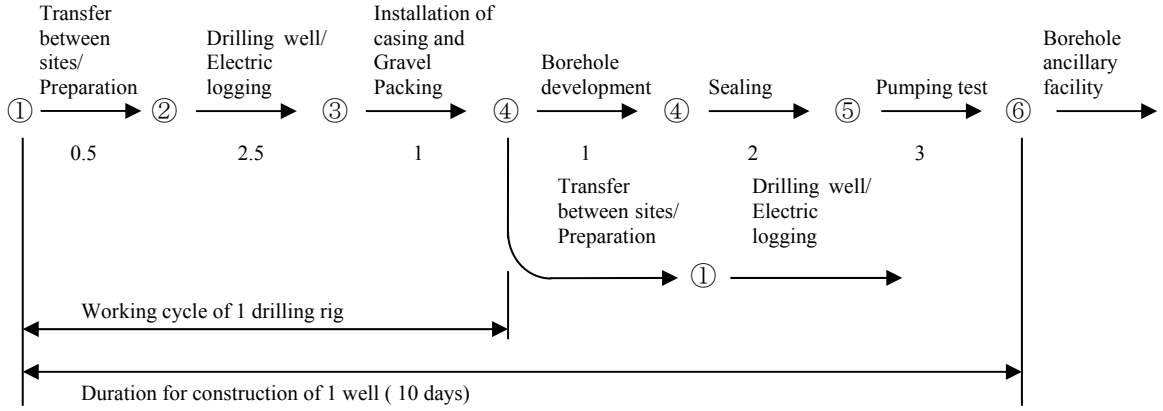


Figure 2-6 Cycle Time of Borehole Construction

2) Implementation Organisation

Figure 2-7 shows the implementation organisation. Under an office representative, administrator/accountant, civil engineer, drilling engineer and hydrogeological engineer will supervise the works together with the local engineers.

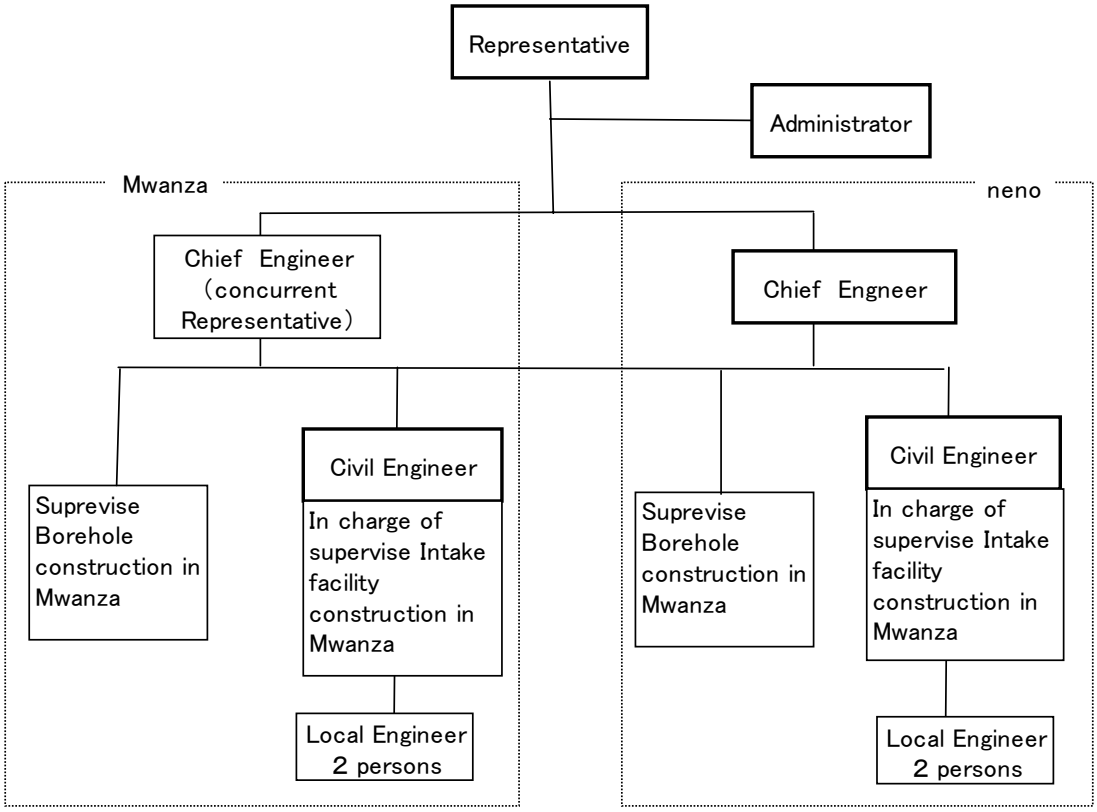


Figure 2-7 Implementation organization

2-2-4-2 Implementation Condition

（１） Accessibility to sites

Access to the target communities has no problem during the dry season, but during a rainy season the road conditions get worse, therefore it is anticipated a difficult access at the sites in rainy period. Accessibility needs to be well thought over to plan a construction schedule.

（２） Temporary Construction Yard

The target area spreads over 40km x 60km. Each district needs to prepare temporary construction yards such as a stock yard for equipment and materials since the access conditions are not good among the mountainous and hilly areas.

（３） Quality Control

The target area has no place to conduct concrete tests. The temporary construction yard needs a concrete testing laboratory (concrete slump test, curing tank).

Water quality tests will be simply and conducted at the time of drilling. The samples will be tested at the laboratory of MoIWD in Lilongwe or the water quality testing laboratory in Blantyre for its appropriateness as drinking water.

（４） Power Supply

Electric power is only supplied in the district capitals and alongside the main trunk roads. In addition, a constant lack of power supply causes frequent power cuts. Thus, it is not sufficient for its using in construction works.

（５） Water Supply

Tap water is available at the district capitals. In other areas, the water for the construction purpose is not available. Therefore, some measures need to be taken to secure water for construction works.

（６） Means of Communication

Telephone lines are connected only in the district capitals. Mobile phones are available, yet the network is feeble in some communities. To establish a necessary communication flow for the project implementation, radio contacts are indispensable. A satellite phone needs to be ready for use in case of emergency.

（７） Accommodation for Japanese Engineers

In Mwanza district, the capital has 1 hotel and some guesthouses. In Neno district, there is 1 guesthouse. These establishments are not appropriate for a long term stay for Japanese engineers. Therefore, it is necessary either to build an accommodation facility in the temporary construction yard or to rent a private house.

2-2-4-3 Scope of Works

The Project implemented under the Japanese grant aid scheme will have the following divisions of works and procurement between Malawian and Japanese sides as follows:

The implementing agency is MoIWD of Malawi as the chief executive officer of the Project to be implemented. The Project will be implemented in accordance with the budgeting system of Japan. Therefore, in the course of project implementation, necessary procedures need to be processed without delay at each stage. The range of responsibilities is listed below.

1. To conclude Grant Agreement(GA) based on the Exchange of Notes (E/N)
2. To conclude a contract with a Japanese consultant based on the E/N and GA
3. To conclude a contract with a Japanese contractor based on the E/N
4. To open Authorization to pay(A/P) at a Japanese bank in order to pay the contracting fees to a contractor upon conclusion of a contract

5. To pay service charges to a Japanese bank in accordance with a banking arrangement（Upon opening A/P）
6. To open an office for supervision of works (Mwanza, Neno district department of development) and deploy staff
7. To accord Japanese national consultants and contractors such facilities as may be necessary for their entry into Malawi and register therein and issue a long term stay permit for the performance of their work and pay for its fees. (as necessary)
8. To accord Japanese national consultants and contractors such facilities as may be necessary for their business and engineer registry and pay for its fees. (as necessary)
9. To expropriate land for facility construction（immediately after the contract conclusion）
10. To prepare for access to construction sites
11. To exempt taxes with regard to facility constructions and procurement of equipment
12. To arrange payments of custom duties for equipment and materials to be procured from Japan or a third country
13. To attend inspections of facilities and equipment (upon consultant's request)
14. To issue a certificate of payment to the consultant and contractor
15. To assist community based operations and maintenance and sanitation and hygiene education after handing over the facilities

2-2-4-4 Consultant Supervision

Construction supervision is divided into 2 stages of detailed design and construction supervision.

The works at the detailed design stage are listed as follows as to facility construction and procurement of equipment as stipulated in the basic design.

1. Preparation of detailed design drawings
2. Preparation of specifications of construction works and procurement of equipment
3. Preparation of tender documents
4. Calculation of bidding target price
5. Execution of tendering process

The contents of the local survey at the detailed design are shown as follows.

1. Water quality testing at the drilling points
2. Electric exploration at the drilling points
3. Confirmation of procurement plan
4. Confirmation of construction and procurement plan
5. Market research for integration
6. Research matters that are not clarified at the basic design stage

The works at the construction supervision stage are as listed below.

1. Approval of the construction plan, design as well as inspections of materials
2. Confirmation of works of the Malawi side
3. Supervision of progress of works
4. Supervision of facility construction
5. Report to both countries authorities as to the progress of works
6. Supervision of delivery progress of procured equipment and materials
7. Supervision of procurement, inspection before delivery
8. Completion inspection
9. Cooperation with payments and other administrative processes

Followings are necessary engineers at each stage to conduct stipulated tasks.

A. Detailed design stage

Chief Engineer	1 person	Manager
Hydrogeologist	1 person	Borehole site selection, Borehole structure design
Geophysical expert	2 persons	Positioning drilling points
Civil Engineer	1 person	Design, procurement plan, cost estimation (Design and Cost Estimation)
Tender document	1 person	Preparation of tender document

B. Construction supervision stage

Chief Engineer	1 person	Commencement and completion of the works

Civil engineer	1 person	Commencement of the facility construction and completion of the works
Hydrogeologist	1 person	Commencement of borehole construction
Resident supervisor	1 person	During the construction works (handing over of equipment)

C. Soft component stage

Operations and maintenance	1 person	Operations and maintenance/ sanitation and hygiene education Specialist

2-2-4-5 Quality Control Plan

The consultant will conduct analysis and testing on the following items for quality control of borehole drilling in relation to the subcontractor.

Borehole Construction

- ♦ Pumping test (step-drawdown test, continuous test)：Every borehole
- ♦ Water quality test (MoIWD temporary water quality standards)：Every borehole
- ♦ Gravel packing (Particle size analysis)：Every delivery

Borehole intake facilities

- ♦ Concrete trial mixture test (aggregate particle size analysis, compressive strength test): for trial
- ♦ Concrete quality control test (Slump test, compressive strength)：Once at each 5 water point
- ♦ Reinforcing bar：Inspection Certificate：Every delivery

Hand Pump

- ♦ Visual Inspection：Every delivery
- ♦ Test Operation：Every installation

2-2-4-6 Procurement Plan

Cement, bricks, aggregates, reinforcing bar and other construction materials will be purchased on site to lower the costs. Mud materials are a consumption material needed for drilling. Imported products are on the local market, thus will be procured on site.

Petrol and diesel are also imported but a shortage was experienced in 2009 for some time. In Neno district there is no Gas Station, therefore storage tank of fuel is needed.

PVC pipes are planned for borehole casing, screen and yielding pumps. They will be purchased from Malawian companies.

For hand pumps there is a sales agent in Malawi. Considering the future needs for spare parts, they will be locally procured.

There are sales agents in Malawi for pick-up trucks for operations and maintenance. Considering the future maintenance needs, they will be locally procured.

GPS will be procured from Japan including products made in a third country. Local purchase is difficult.

Table 2-8 Countries planned to procure equipment and materials

No.	Items	Malawi	Third country	Japan
1	Casing	○		
2	Screen	○		
3	Reinforcing bar/ Cement	○		
4	Hand Pump	○		
5	Pickup truck	○		
6	GPS			○

2-3 Obligation of the Recipient Country

The followings are responsibilities of the Government of Malawi to implement the Project.

（1） Preparation for borehole drilling sites

The final borehole drilling sites are determined by both the results of electrical exploration and consultations with the communities and officers of MoIWD.

（2） Preparation of Access Route for works, Fence, Drainage

Other than the sites alongside a well maintained road, the communities away from a good access road need to prepare for access routes for works. Fences are needed around the borehole facilities to avoid animals. These are also to be prepared by the communities.

（3） Land Preparation for Field Office, Warehouses and Stock Yard

A base camp site needs to be secured for temporary warehouses of necessary construction materials, cement, aggregate, fuel tanks and construction vehicle storage.

（4） Lending of Machinery owned by MoIWD

An agreement was made so that the drilling rigs owned by MoIWD can be lent for free of charge to a subcontractor during the Project if they wish to use them. In such a case, the newest machinery is the ones that were procured by the Lilongwe West Project.

Table 2-9 Lending of Machinery

Procurement Year	Year 2005
Project	Lilongwe West Groundwater Development
Contents for equipment	Drilling rigs, Compressor on the truck, Truck with a crane and other related equipment

（5） Securing Project Personnel and Budget

MoIWD will selects an officer to be in charge of the entire project. The Department of water supply will select a CBM coordinator to implement the CBM project. These officers need to be available at the detailed design stage.

The personnel expenses in relation to CBM activities will be discussed with the implementing agency, the districts. These personnel expenses (allowance, transport) need to be budgeted as much as possible prior to the commencement of the Project.

（6） Coordination with Other Donors, NGO and other related Organisations

MoIWD has to arrange not to overlap the plans with other donors and NGOs projects in the both districts. UNICEF is implementing WASH project in Mwanza. A favorable cooperation will be arranged to implement the CBM activities in the Project Operation and Maintenance Plan.

2-3-1 Current Operation and Maintenance System

2-3-1-1 Supporting System of the Executing Agencies

Since introduction of the decentralization policy in 1998, all the social capital projects including construction of boreholes with hand pump facilities have been planned, implemented and maintained by the local government. Based on the policy, the MoIWD is extending its technical support for the management of the rural water supply facilities in each district through CBM coordinators in the Department of Water Supply and its regional offices.

District Water Development Office (WDO) plays a leading role in coordinating all the activities related to water supply projects in the district. Concerning the operation and maintenance of water supply facilities, extension workers such as a water monitoring assistant (WMA) and a borehole maintenance technician of WDO are extending technical guidance to train area mechanics (AMs) and also to train hand pump caretakers of each village organizations such as Village Health Water Committees (VHWCs) and Water Point Committees (WPCs).

The roles of these executing agencies concerning operation and maintenance activities, are summarized as follows.

（１） **MoIWD**

- Overall monitoring of the water supply projects in the country
- Technical guidance for regional and district staff on the operation and maintenance management
- Technical guidance for the staff of Regional Water Development Office and District Water Development Office

（２） **Regional Water Development Office**

- Monitoring of water supply projects in the region
- Technical guidance for the district staff on the operation and maintenance management

（３） **District Water Development Office**

- Monitoring of water supply projects in the district
- Technical guidance for the VHWC and WPC committee members on the operation and maintenance management
- Coordination with the related agencies in the district
- Repair of major breakdowns of the water supply facilities

2-3-1-2 Roles of the Area Mechanic

Due to lack of extension workers of the WDO, technical guidance and assistance for the community organizations (VHWCs and WPCs) have not been conducted sufficiently. In order to improve the situation, WDOs in Mwanza and Neno districts are conducting a training programme to train additional area mechanics (AMs). There are 11 AMs in Mwanza and 12 in Neno district. These AMs are extending maintenance services to the community organizations based on the agreement made between AM and the community. In Mwanza district, about 62 % of the community organizations have concluded service contract with AMs.

2-3-1-3 Operation and Maintenance System at Village Level

Under the guidance of the WDO, most of the villages have already established Village Health and Water Development Committees (VHWCs). In addition, in the villages where there are more than two water points, a water point committee (WPC) has been established at each water point to operate and maintain the facilities.

The VHWC committee members usually consist of 10 committee members, i.e. 5 male and 5 female members in usual case. Out of these members, executive members such as a chairman, vice-chairman, accountant, secretary and hand pump caretakers are selected. The WPC committee members also have the same composition and the main roles of the WPC are collection of water service charge and maintenance of the facilities.

The roles of these executing agencies concerning operation and maintenance activities, are summarized as follows.

1) VHWC

- Maintenance of the water supply facility (periodical inspection, simple repair)
- Collection of the water charge
- Maintenance of the water supply facilities in the village(water source is more than 1)
- Communication with WDO(Request of repair of break down, spare parts, etc.)
- Request of Sanitary Education

2) WPC

- Maintenance of the water supply facility (periodical inspection, simple repair)
- Collection of the water charge
- Request of repair of break down, spare parts, etc. to VHWC

Current Operation and Maintenance System is shown in Figure 2-8

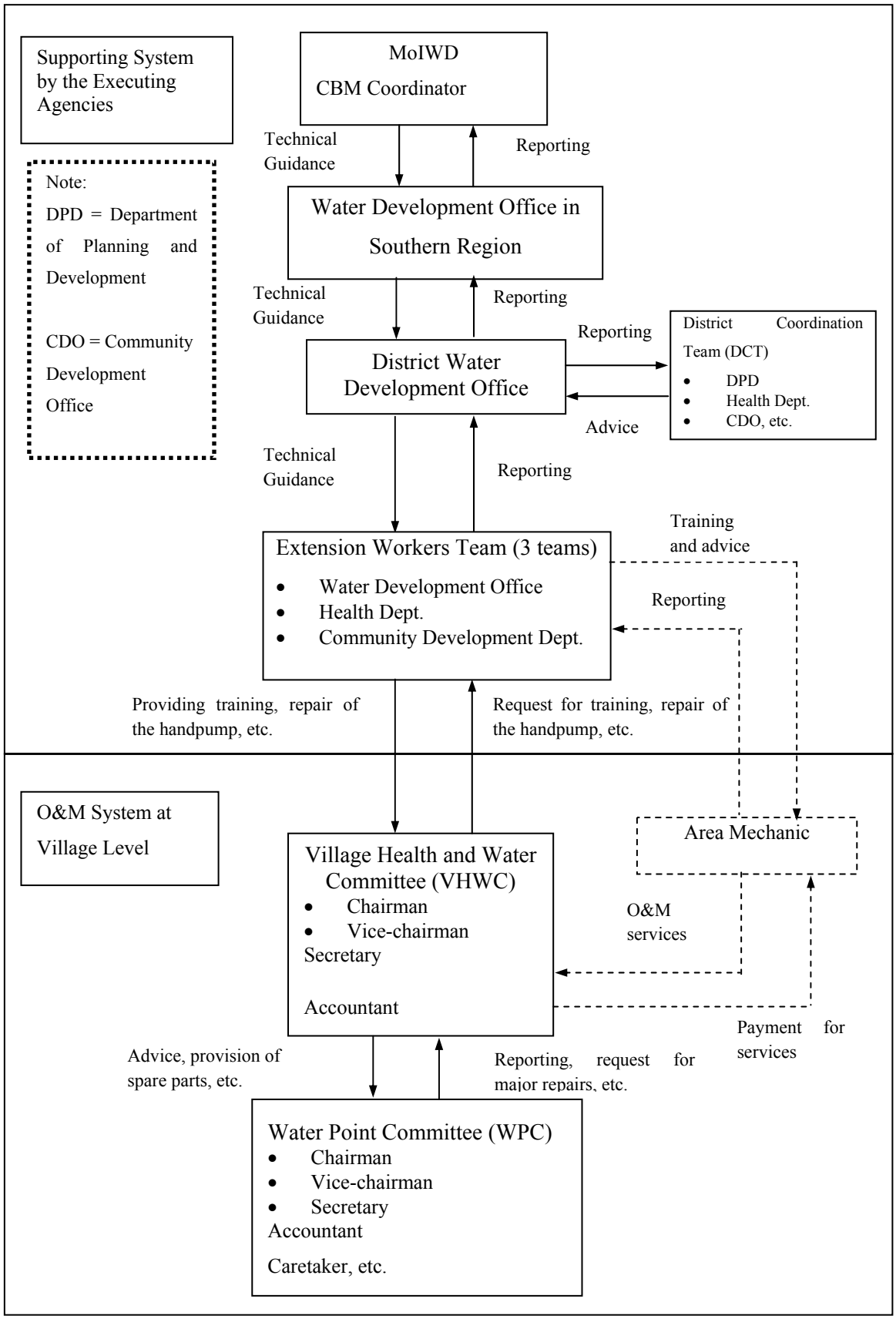


Figure 2-8 Operation and Maintenance System

2-3-2 Strengthening of Current Operation and Maintenance System

2-3-2-1 Problems in Current Operation and Maintenance System

In most villages having boreholes with handpumps (HP), the Village and Water Development Committees (VHWC) have been established around 90%) and the committee members (10 persons) have also been selected for the committee activities. In the villages where there are more than 2 water points, the Water Point Committees (WPCs) have also been established to conduct the operation and maintenance (O&M) activities for the facilities. The record of Water Development Office in Mwanza indicated that about 62% of the WPCs concluded agreement with AMs (area mechanics) for O&M services and the average funds available in each WPC for O&M activities amounted to 2,350 Kwacha in 2010.

However, about 10% of the villages with existing HP facilities, have no VHWC and some of the VHWC and WPCs still request minor repair works and installation of spare parts to AM or WDO although such minor repairs should be done by the committees by themselves.

It was also noted that some of the committees have not collected enough funds for the repair works such as to repair the major breakdowns of the facilities.

In the target villages, most villagers are using traditional water sources such as small rivers, springs, dug wells, etc. After construction of the new HP facilities, if some problems occur in the facilities, they might abandon the HP facilities without trying to repair them as they have not enough knowledge on the importance of using safe water. In this regard, health education for the village people is an important component for the effective use of the water facility.

2-3-2-2 Strengthening of Operation and Maintenance System

Although Water Development Offices in Mwanza and Neno districts are trying to improve the current situation, the problems as mentioned above occur as a result of the following factors: (i) lack of training for the extension workers in the district; (ii) lack of training for the committee members (VHWCs and WPCs); and (iii) lack of training for the village people on health education and committee activities. Among these factors, training for extension workers is particularly necessary in the case of Neno district where opportunities for trainings are very limited.

After construction of the new facilities, the number of AMs and WPCs should be increased. As a countermeasure to this situation, WDO in Mwanza is conducting training program for the new AMs under UNICEF project, 11 AMs will be increased to 18 AMs, likewise, WDO in Neno also have a plan to train the AMs, 12 AMs will increased to 14-15 AMs. Therefore, the training of the AMs will be conducted by WDOs in Mwanza and Neno districts.

In summary, the activities to improve the current O&M system as mentioned above will be conducted as a Soft Component in the proposed project which includes training of the extension workers in the districts, training of the committee members and training of the village people in general. More concretely, the Soft Component will consist of the following items.

- Establishment of VHWC in the villages where VHWCs are not established yet
- Establishment of WPCs in the villages where new HP facilities are constructed
- Strengthening of the committee activities through training of committee members on the management and collection of water service fee; technical training on O&M particularly for HP take care ; etc.

2-3-2-3 Operation and maintenance of the Equipment

Vehicles for the operation and maintenance and GPS devices will belong to WDO of Mwanza and Neno districts, and WDO will have the responsibility to maintain them. Budget for the activities on the potable water supply sector in the Districts is expected to receive basically subsidy from the Central Government, MoIWD, therefore required budget for the project should be prepared by the MoIWD and the District Government.

2-4 Soft Component Program

2-4-1 Soft Component Policy

The CBM Program will be conducted in order to establish a smooth and sustainably operation and maintenance system of the water supply facilities of the Project under the Operation and Maintenance System mentioned in Section 2-3.

The CBM program will be managed to sensitize the water users of the constructed water facility to operate and maintain such facility by themselves and for the improvements in hygiene and sanitation at the community level, therefore, water users should take part of the Project from the beginning stage. In order to obtain this condition, enough discussion with District and TA will be done to implement the capacity building of District's water extension workers and committee members and for conducting the hygiene and sanitary education for the water user .

According to the field survey, following issues are recognized as important ones on the water use, maintenance and CBM program in the target area.

(i) Establishment of extension teams by increasing the water development office's staff and support from the other offices in the District

(ii) Training of the extension workers in the district

(iii) Constitution of VHWC in all communities and establishment of new WPC

(iv) Training of the committee members of VHWC/WPC

(iv) Hygiene and sanitary education for the village people

Basically, the establishment of the operation and maintenance system is the responsibility of the Malawi side, however it is considered that Japan's Soft Component is required, in order to start operation and maintenance smoothly and confirm its sustainability, due to the following aspects:

(i) There is a possibility that implementation of CBM Program will be delayed if only Malawi side conduct it because budget and staff is not enough in fact,

(ii) This is the first case for Mwanza and Neno Districts to construct many boreholes in a short period, therefore their experiences are not enough.

2-4-2 Contents of the Programme

2-4-2-1 Objective

The objective of the Soft Component is set "to establish an autonomous and sustainable operation and maintenance system, based on the CBM program, for the water supply facilities constructed by the Project with smooth start of operation and maintenance and confirming sustainable results ".

2-4-2-2 Activities

（1） Training of Extension Workers

There are limited number of extension workers for operation and maintenance training in Mwanza and Neno districts. There are only two extension workers in WDO of Mwanza district, and three extension workers in WDO of Neno district. Basically, three extension teams will be required in each district, therefore, Mwanza district will require more extension workers. And, additional extension workers will be required from other departments, such as Health Department and Community Development Office. Extension workers from the Health Department will be mainly in charge of extending health education training, likewise, the workers from the Community Development Office will be mainly in charge of training for community awareness raising for the establishment of VHWCs and WPCs.

The training program for the extension workers will be planned and conducted by a local consultant and by a CBM coordinator from MoIWD and/or from regional office in the southern region. MoIWD has experiences in conducting such training programs and have training materials.

（２） Establishment of VHWCs and WPCs

After the completion of the training for the extension workers, the meetings will be held at each TA headquarters to explain the contents and schedule of the workshops and training program for the target villages. The meetings will be arranged by a local consultant and will be chaired by extension workers from WDO, assisted by extension workers from Health and Community Development Offices. Main participants will be: a TA chief, group village headpersons, village headpersons, executive members of Village Development Committees, and representatives of the village people.

After the meeting at TA headquarters, Extension Workers Team will proceed to the target villages to conduct village workshops for the formation of a VHWC and/or WPC at each village. The objective of establishing VHWC or WPC will be explained as well as the roles of such a committees. Finally, the selection of the committee members will be done. The committee member will be composed of the following:

Chairman and sub-chairman each : 1 person

Account: 1 person

Caretaker: 2 persons

Secretary: 1 person

Others: 4 persons

（３） Capacity Building for the Committee Members

In order to improve the management capacity of the committee members, training program will be conducted for the committee members. Extension Workers Team will conduct training according to their respective expertise, for example, technical training items for O&M to be done by a water monitoring assistant (WMA). Main items for the training will be as follows.

(a) Initial training for the committee members of the newly established committees (leadership training for the executive members, financial management training for the accountant, technical training for the caretakers, etc.)

(b) Financial management training for the existing WPCs (calculation of water service fee, collection and management of water service fee, and bookkeeping)

(c) Technical training on operation and maintenance management for handpump caretakers

（４） Health Education

The goal of the project is to achieve improved environmental living conditions in the target villages through provision of safe water. The constructed water supply facility can contribute to improve the

environmental living conditions through proper use of the facility and proper treatment of the collected water. Careful attention should be paid to such matters as: (i) a platform environs should be kept clean; (ii) water containers should be kept clean; (iii) proper stock of water at home; and (iv) knowledge on the adverse effect of using contaminated water.

Health education program is presently conducted by Health Department staff under UNICEF project in Mwanza district and the training materials can be utilized in the proposed project. It is recommendable that the health education program be commenced during the construction of the water supply facility.

2-4-2-3 Outcomes of Soft Component

The activities and its outcomes of the Soft Component are as follows.

Table 2-10 Outcomes of soft component

	Outcomes	Issues
Outcome 1	Operation and maintenance system is established by the water users at each water point, where the water supply facility is operated and maintained by them on a sustainable base	(1), (3), (4)
Outcome 2	Technical assistance services on O&M activities made by the executing agency will be improved	(2)
Outcome 3	Consciousness on the public health and sanitation of the village people will be improved	(5)

2-4-2-4 Confirmation of Outcomes

In conducting the Soft Component Program, the contents of the Program will be explained to the counterpart personnel (extension workers, etc.) so that they will have a full understanding on the objectives of the Program. Progress of the program and confirmation of understanding of the participants will be monitored by extension workers using check sheets and will finally be evaluated.

The contents of the Check Sheet will be explained to the counterpart personnel before the commencement of the activities so that they will have a full understanding of the Program implementation.

A sample of a Check Sheet is presented in Table 2-11.

Table 2-11 A Sample of a Check Sheet

Training Items (Draft)	Testing Items (Draft)
1. Organizational management	Interview to the participants on the trained items. • Degree of understanding on each training item: (1) full understanding; (2) good understanding; (3) poor understanding • The reasons for (3) poor understanding will be clarified.
1-1 Procedure for community organization	
1-2 Leadership	
1-3 Conflict management	
2. O&M and Repair Technology	
2-1 Background of the Village Level Operation and Maintenance System	
2-2 Structure and Function of Afridev Pump	
2-3 Daily Operation and Maintenance and Repair of Afridev Pump	
3. Health Education	
3-1 Introduction to Health Issues	
3-2 Causes and Prevention of Water-borne and Water-related Diseases	
3-3 Sanitary Protection for the Water Supply Facility	

2-4-2-5 Activities of the Soft Component (Input Plan)

The Soft Component activities will be conducted at: (i) detailed design (D/D) stage; (ii) the construction stage; and (iii) post-construction stage.

As shown in Table 4, after the completion of the training for the District Extension Workers, extension services for the establishment of VHWCs (4 villages) and WPCs (10 water points) will be made. These activities will be conducted by the Japanese and local consultants in collaboration with the District Extension Workers in the form of "on the job" training. Additional activities to establish another VHWCs (6 villages) and WPCs (110 water points) will be conducted by the District Extension Workers continuously.

Under the Soft Component activities, training for the committee members of VHWCs and WPCs will be conducted at 6 locations with participants from 18 villages (3 villages per location). Training on the health and sanitation will be conducted at 10 villages. These activities will also be conducted by the Japanese and local consultants in collaboration with the District Extension Workers in the form of "on the job" training. Additional activities in the remaining villages will be conducted by the District Extension Workers later on.

Monitoring survey under the Soft Component will be conducted at 20 water points to be selected from the facilities that have been constructed and operated at the first half stage of the project implementation. Monitoring items will include the results of training made by the District Extension Workers, activities of VHWCs and WPCs, and so on. The results of the monitoring will be utilized for the base of the evaluation of the project, and recommendations for the future activities will also be made. The activities and the implementation period as mentioned above are summarized in the following table.

Table 2-12 Activities (Input Plan, including activities of the Executing Agency)

Items	Main Actors/Target	Days	Activities	Period	Output
1-1 Meeting with CBM Coordinators & and Preparation of Training Manuals	Japanese and local consultants CBM coordinators in the ministry and regional office	5	- Explanation of the Soft Component Plan - Preparation of training manuals	D/D Stage	- Soft Component Plan (Draft) - Manuals (Draft) - Form of monitoring (Draft)
1-2 Explanation to Local Government (Mwanza and Neno Districts)	- Japanese and local consultants - CBM coordinators from the ministry and regional office DCT members from Mwanza and Neno	2	- Explanation of the Project - Confirmation on the collaboration with the project - Confirmation on the establishment of VHWVs and WPCs	D/D Stage After the activities 1-1	Presentation Report
1-3 Explanation to TA Leaders	- Japanese and local consultants - CBM coordinator from regional office - TA - Group Village Heads - Village Heads - Representative of the target villages	7 (7 TAs x 1 day)	- Explanation of the Project - Confirmation on the collaboration with the project (e.g. construction of access roads) - Confirmation on the establishment of VHWCs and WPCs	During D/D Stage After the activities 1-2	Report and Presentation documents
1-4-1 Establishment of VHWCs	- Japanese and local consultants - CBM coordinators - Village Heads - Representative of the target villages	8 (4 villages x 2 days)	- Explanation of the Project - Confirmation on the collaboration with the project construction works - Explanation on establishment of a VHWC - Selection of committee members	D/D Stage After the activities 1-3	List of VHWCs Records of establishment of VHWCs
1-4-2 Establishment of WPCs	- Japanese and local consultants - CBM coordinators - Village Heads - Representative of the target villages	10 (10 villages x 1 day)	- Explanation of the Project - Confirmation on the collaboration with the project construction works - Explanation on establishment of a WC - Selection of committee members	construction stage	List of WPCs Records of establishment of WPCs
1-5 Monitoring and Evaluation	- Japanese and local consultants - CBM coordinators - Village Heads - Representative of the target villages	20 (2 districts x 10 villages x 1 day)	-Monitoring - Evaluation	Post-construction stage (3 months before operation)	Results of monitoring and evaluation
2-1 Training of District Extension Workers (1)	- Japanese and local consultants - CBM coordinators District extension workers	2	- Organizational management	D/D Stage After the activities 1-1	Records of training Manuals Tools
2-2 Training of District Extension Workers (2)	- Japanese and local consultants - CBM coordinators District extension workers	4	- Organizational management - Health Education - O&M and repair technology	construction stage	Records of training Manuals Tools
2-3 Training of Committee Members of	- Japanese and local consultants - District extension workers	12 (6 locations x 2 days)	- Organizational management - Financial management - O&M and repair	Post-construction stage, before operation of	Records of training Manuals Tools

VHWCs and WPCs	Committee members of VHWCs and WPCs	*3 villages per location	technology - Health education	the facility	
3-1 Health and Sanitary Training for Village People	- Japanese and local consultants - District extension workers Village people	10 (2 districts x 5 villages x 1 day)	-Introduction to health and sanitation - Causes and prevention of water related diseases - Sanitary consideration for the facility	construction stage, after activities 1-3	-Manuals for water and sanitation - Education tools

2-4-2-6 Measures to secure necessary Resources for Implementation

Soft Component activities will be planned and conducted by a Japanese consultant and a local consultant in collaboration with a CBM coordinator of MoIWD. A local consultant will be employed by a Japanese consultant based on the results of interviews and examination of his/her career as a consultant in the field of rural water supply project and community development project.

The consultant team will be assisted by a CBM coordinator and extension workers in the district as they have experiences in conducting CBM program for rural water supply projects. In addition to extension workers from WDO in Mwanza and Neno districts, those from Health Departement and Community Development Office will also join in the activities. Based on the candidate list of extension workers, several teams of extension workers will be formulated to conduct the activities.

2-4-2-7 Implementation Schedule of the Soft Component Activities

Figure 2-9 shows a implementation schedule of the Soft Component.

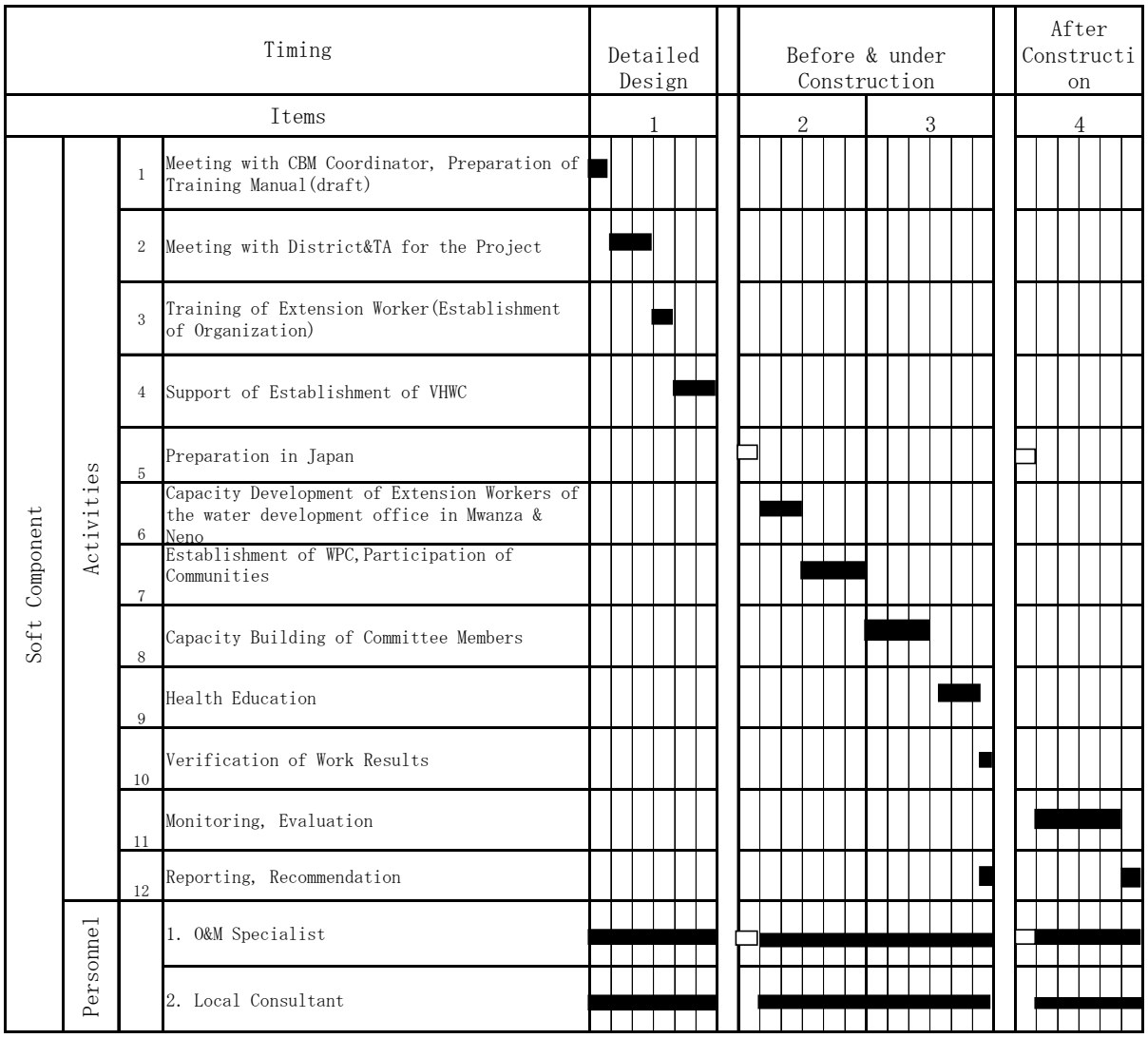


Figure 2-9 Implementation Schedule of the Soft Component Activities

2-4-2-8 Output of the Soft Component

Main output of the Soft Component activities is as follows.

Completion Report

Training manuals for the District Extension Workers (organizational management, operation and maintenance technology, and health education)

Training manuals for the committee members of VHWCs and WPCs(organizational management, operation and maintenance technology, and health education)

List of the VHWCs and WPCs

2-4-2-9 Estimated Cost

The cost for the Soft Component activities to be borne by Japanese side is estimated at 13,852 thousand Japanese yen.

2-4-2-10 Obligations of the Executing Agency

The overall cost for the Soft Component activities to be borne by both Japanese and Malawi side is presented in the following table.

Activities	Japanese Side	Malawi Side
1-1 Meeting with CBM Coordinators and Preparation of Training Manuals	- Remuneration of Japanese and local consultant - Preparation of manuals	- Allowance for CBM coordinators
1-2 Explanation to Local Government (Mwanza and Neno Districts)	- Remuneration of Japanese and local consultant - Vehicle expenses	- Allowance for district officers and extension workers
1-3 Explanation to TA Leaders	- Remuneration of Japanese and local consultant - Vehicle expenses	- Allowance for CBM coordinators and district extension workers - Vehicle expenses
1-4-1 Establishment of VHWCs and WPCs	- Remuneration of Japanese and local consultant - Vehicle expenses	- Allowance for district extension workers - Vehicle expenses
1-5 Monitoring and Evaluation	- Remuneration of Japanese and local consultant - Vehicle expenses	- Allowance for district extension workers - Vehicle expenses
2-1 Training of District Extension Workers (1)	- Remuneration of Japanese and local consultant - Vehicle expenses - Copying expenses - Stationery	- Allowance for CBM coordinators and district extension workers - Vehicle expenses
2-2 Training of District Extension Workers (2)	- Remuneration of Japanese and local consultant - Vehicle expenses - Copying expenses - Stationery	- Allowance for CBM coordinators and district extension workers - Vehicle expenses
2-3 Training of Committee Members of VHWCs and WPCs	- Remuneration of Japanese and local consultant - Vehicle expenses	- Allowance for district extension workers - Vehicle expenses
3-1 Health and Sanitary Training for Village People	- Remuneration of Japanese and local consultant - Vehicle expenses - Copying expenses	- Allowance for district extension workers - Vehicle expenses

2-5 Obligation of Recipient Country

The followings are responsibilities of the Government of Malawi to implement the Project.

Preparation for borehole drilling sites

The positions of borehole drilling are determined by both the results of electrical exploration and consultations with the communities and officers of MoIWD.

Preparation of Access Route for works, Fence, Drainage

Other than the sites alongside a well maintained road, the communities away from a good access road need to prepare for access routes for works. Fences are needed around the borehole facilities to avoid animals. These are also to be prepared by the communities.

Land Preparation for Field Office, Warehouses and Yard

A base camp site needs to be secured for temporary warehouses of necessary construction materials, cement, aggregate, fuel tanks and construction vehicle storage.

Lending of Machinery owned by MoIWD

An agreement was made that the drilling rigs owned by MoIWD can be lent for free of charge to a subcontractor during the Project if they wish to use them. In such a case, the newest machinery is the ones that were procured by the Lilongwe West Project.

Table 2-13 Lending of Machinery

Procurement Year	Year 2005
Project	Lilongwe West Groundwater Development
Contents for equipment	Drilling rigs, Compressor on the truck, Truck with a crane and other related equipment

Securing Project Personnel and Budget

MoIWD will select an officer in charge of the entire project. The department of water supply will select a CBM coordinator to implement the CBM project. These officers need to be available at the detailed design stage.

The personnel expenses in relation to CBM activities will be discussed with the implementing agency, the districts. These personnel expenses (allowance, transport) need be budgeted as much as possible prior to the commencement of the Project.

Coordination with Other Donors, NGO and other related Organisations

MoIWD has to arrange not to overlap the plans with other donors and NGOs projects in the both districts. UNICEF is implementing WASH project in Mwanza. A favorable cooperation will be arranged to implement the CBM activities in the Project.

2-6 Project Cost Estimation

2-6-1 Initial Cost Estimation

The break down of respective cost charged in Malawi Side is shown in Table 2-14.

（1） Estimated Project Cost charged in Malawi side:

Table 2-14 Estimated Project Cost

Million yen

Responsibilities of Malawi	Cost
Land preparation for a base camp	0.5
Land preparation of the borehole site	13.6
Access to the borehole site	3.8
Fencing work for the intake facility	0.1
Total	18.0

（2） Condition of Cost Estimation

1) Month of Cost estimation: June, 2010

2) Exchange Rate: 1 US$=¥91.51

1 MK= ¥1.66

3) Project period: Single phase scheme

4) Others: This Project will be conducted in accordance with the Grant Aid Scheme by Japanese Government

2-6-2 Operation and Maintenance Cost

Operation and maintenance costs that MoIWD bears in relation to the Project are personnel and activities expenses to support WPCs that administrate the facilities.

Table 2-15 Salary and Operation & Maintenance Cost (WDO Mwanza & Neno)

Unit: Malawi Kwacha

No.	Items	Unit	Unit Price	Volume	Cost per Year	Remarks
1	District water development office extension workers salary	monthly	20,000	12	240,000	1 person Mwanza office
2	Daily Allowance	daily	1,500	40	60,000	40 days per year
3	Vehicle fuel	Km	30	2,000	60,000	50km x 40 days
4	Vehicle Maintenance	set	1	-	450,000	US$30,000x 5% x MK150/US$ x2
	total				810,000	

Note: 40 days are estimated to visit 119 communities.

Table 2-16 Cost for CBM Program

Unit: Malawi Kwacha

No.	Items	No. of persons	No. of sites	Unit Price	Days	Cost	Remarks
1.	Regional CBM Coordinator	1	5	5,000	1	25,000	
	District WDO Extension Worker	2	119	1,500	1	357,000	
2.	District WDO Extension Worker	2	40	1,500	2	240,000	119 sites/3=40 groups
	District WDO Extension Worker	2	40	1,500	2	240,000	119 sites/3=40 groups
3.	District WDO Extension Worker	2	40	1,500	1	120,000	119 sites/3=40 groups
	Vehicle Maintenance					494,500	
	total					1476,540	

Below is presented the communities expenses required in relation to operation and maintenance of the borehole water supply facilities.

Table 2-17 Community Operation and Maintenance Cost

No.	Items	Cost Estimation Basis per Year	Cost per Year (kwacha)	Per household per month (50 households)
1.	WPC members and other personnel costs	The committee members will take turns among the villagers.	0	0
2.	Spare parts Purchase	5% of the purchasing price of hand pump 5%、USD761 x 0.05	5,708	9.51
3.	Area Mechanic contract	Annual contract	400	0.66
4.	Pump reparation	5% of the purchasing price of hand pump 5%、USD761 x 0.05	5,708	9.51
5.	Renewal reserve	Renewal duration is set as 15 years. 20% of the purchase price will be added to a pump for transportation and installation.	9,132	15.22
	total		20,948	34.90

CHAPTER 3 Project Evaluation

3-1 Prerequisite of the Project

3-1-1 Prerequisite of the Project by Japan's Grant Aid Scheme

Many village people in the targeted communities have utilized only traditional water source like river water, spring water, dug well etc., therefore they have problems of drinking water on the aspects of safety and instability of seasonal volume.

This project will construct new boreholes with hand pump and related facilities (apron, drain, etc.), and will supply vehicles for operation and maintenance. Additionally, "soft component" will be implemented for training of extension workers, capacity building of the communities organization, and sanitary education of village people.

Prerequisite of the Project is assumed as follows:

1) Preparation for borehole drilling sites

2) Preparation of Access Route for works, Fence, Drainage

3) Land Preparation for Field Office, Warehouses and Yard

4) Securing Project Personnel and Budget

MoIWD Groundwater: Personnel in charge of the Project Implementation
MoIWD Water Supply: CBM Coordinator
Mwanza and Neno Districts: each 3 Extension Teams composed by 3 extension workers

3-1-2 Prerequisite and external condition of the Project

Prerequisite and external condition in order to achieve the Project's aim is as follows:

Prerequisite

Logistic budget for the personal cost, transportation and others is secured to implement activities of the water development offices in Mwanza and Neno District. And, their sustainable support will be proceeded to Village Health Water Committees and Water Point committees.

External condition

1) Steep rise in commodity price is not occurred, and materials and equipment are procured in stable condition.

2) Related Policies in Malawi remain without drastic change

3) Access condition is not worsen by increased rainy condition

4) Population does not increase rapidly

5) There is no occurrence of an unexpected groundwater level decrease

3-2 Evaluation of the Project

3-2-1 Project Validity

The Target of the Project is the village people living in Mwanza and Neno District located in the southern part of Malawi. The Direct beneficiary people will be of approximately 28,700.

Principally traditional water source like river water, spring water and dug well is utilized for drinking water without any treatment in the Area, therefore many people is affected by water born diseases. Around 20 people were dead by typhoid fever in the boundary between Mozambique in 2009 due to problem of water, therefore, the water service condition is required to be improved as a urgent work.

New borehole with hand-pump and related facilities to be constructed by the Project will be maintained by the water source committee to be established at each Borehole site. Maintenance cost is estimated around MK35 per household per month, and the results of WTP survey shows that the village people can pay around MK50-60 per household per month, i.e., the maintenance of the facility is expected to be conducted by the community itself.

The Project's superior program in Malawi are the MDGS (2006-11) and the National Water Policy (2006). Their aims are to extend rural water supply and sanitation services and to promote Community Based Management (CBM) of water and sanitation programme. The targets are to increase the proportion of population with access to safe potable water within 500m of their households up to 80% by 2011, 85% by 2015 and to attain full coverage by 2025. This project will contribute to the overall objectives.

The category of Environmental and Social Consideration is C, i.e. , there is little influence to the environmental condition.

3-2-2 Project Effect

（1） Quantitative Effect

Indicator	Base year (2010)	Target year (2015)
Population with access to safety and stable water	80,087	108,787
Proportion of the population with access to safety and stable water	41.6%	47.3

Above mentioned objectives are to be monitored by the indicators, which could be taken from the monitoring information collected by the water source committees at all borehole sites.

（２） Qualitative Effect

1) It is expected to reduce water born diseases like diarrhea, dysentery.

2) It is expected to reduce the labour of transportation of the water. Approximately 14,950 women and 13,500 children under 14 years old exists in the above mentioned benefitted population of 108,787; it is estimated that around 2 hours of transportation time will be reduced.

3) 120 water point committees will be established for the facility maintenance, and their capability to maintenance will be improved by the soft-component support.

In consideration with the mentioned above, validity of the Project is evaluated high, and the effect of the Project is expected.