

**Ministry of Water
The United Republic of Tanzania**

**BASIC DESIGN STUDY REPORT
ON
RURAL WATER SUPPLY PROJECT
IN
THE UNITED REPUBLIC OF TANZANIA**

March 2007

**JAPAN INTERNATIONAL COOPERATION AGENCY
EARTH SYSTEM SCIENCE CO. LTD
JAPAN TECHNO CO. LTD**

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PREFACE

In response to the request from the United Republic of Tanzania, the Government of Japan decided to conduct a basic design study on Rural Water Supply Project in Coast Region and Dar es Salaam Peri-Urban and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Tanzania a study team from 10 June to 12 September 2006.

The team held discussions with the officials concerned of the Government of Tanzania, and conducted a field survey at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Tanzania in order to discuss a draft basic design, and as this result, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the United Republic of Tanzania for their close cooperation extended to the teams.

March 2007

Masafumi Kuroki
Vice-President
Japan International Cooperation Agency

March 2007

Letter of Transmittal

We are pleased to submit to you the basic design study report on Rural Water Supply Project in the United Republic of Tanzania.

This study was conducted by the Consortium of Earth System Science Co., Ltd. and Japan Techno Co., Ltd, under a contract to JICA, during the period from 10 June to 12 September 2006. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Tanzania and formulated the most appropriate basic design for the project under Japan's Grant Aid Scheme.

Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,

Yasumasa Yamasaki

Project Manager,

Basic design study team on
Rural Water Supply Project in Coast Region
and Dar es Salaam Peri-Urban

The consortium of Earth System Science Co., Ltd.
and Japan Techno Co., Ltd.

SUMMARY

SUMMARY

1. General Description of Tanzania

The United Republic Tanzania (hereinafter referred as “Tanzania”) is located in the eastern part of Africa covering 945 thousand km². The population reaches 34.57 million in 2002. The coastal area where Coast Region and Dar es Salaam Peri-Urban lie, has two rainy seasons in a year, from March to May and from November to December. Annual precipitation ranges from 800 to 2,000 mm. The highest Temperature 32.5 °C was observed in February and the lowest 18.3 °C in August.

Tanzania is classified as one of the Least Developed Countries due to its low per capita Gross National Product of 287 US\$/capita in 2003. Breakdown of GDP by industry is 53% for the first industry, 8% for the second industry and 39% for the third industry. Increasing rate of GDP is 5.1% in 2004, while it is 3.5% during past four decades.

Economy in Tanzania largely depends on agriculture which occupies 37% of GDP. Production of mining industry is remarkable. It increased from 3.34 million US\$ in 1998 to 120.53 million US\$ in 2000.

Socioeconomic system in Tanzania was socialistic economy system since independent, however, it became stuck. In 1986, Tanzania accepted social adjustment programme by World Bank and International Monetary Fund (IMF) in order to outgrow from the economic crises. However, redress of trade deficit and international account, and solution of problems of accumulated debt was not attained. Since Tanzania became one of the heavily indebted poor countries, Tanzania was approved debt reduction for heavily indebted poor countries pursuing IMF and World Bank by developing a Poverty Reduction Strategy Paper (PRSP). Recently, although Tanzanian economy has been stable increase, GDP has still remained in a low level. Therefore, reduction of poverty is the largest national issue.

2. Background of the Project

The Government of Tanzania started Rural Water Supply Project in 1971 under the assistance by International Organizations, Donors and NGOs. National Water Policy was developed in 1991 and aimed to provide safe water to entire nation within 400 m by 2002. However, this target was not achieved and the covering rate of national level water supply was 53%. National Strategy for Growth and Poverty Reduction (NSGRP) stemmed from Vision 2025, targets universal access to safe water within 400 m by 2025 through involvement of the private sector, and empowering local government and communities. According to a survey in 2002, water supply coverage is 85% in the urban area and 42% in the rural area. Among them, 23% of population in the target villages of the project receives safe water. It is much lower than the average of national level.

In order to improve water supply situation in the study area, the Government of Tanzania requested the Government of Japan to carry out the formulation of the water supply plan and the feasibility study of

the priority projects to be formulated through the study. In response to this request, a master plan study was commenced in August 2004 to prepare water supply master plan for Coast Region and Dar es Salaam Peri-Urban, to select priority project, to strengthen capacity of staff of MoW and relevant organizations. As the results, a water supply master plan for 217 villages in Coast Region and 61 villages in Dar es Salaam Peri-Urban was formulated. It composed of construction of 22 piped water supply schemes (Level-2), 607 deep wells with handpump and rehabilitation of existing water supply schemes. Among them, construction of 22 piped water supply schemes (Level-2) was selected as the priority project.

On the basis of this results, the government of Tanzania requested government of Japan to implement the priority project as a Japan's Grant Aid Project. The request consists of construction of 22 piped water supply schemes (Level-2) in Coast Region and Dar es Salaam Peri-Urban, and capacity development of relevant organizations and community-owned water supply organizations.

The project is considered as the priority project in the study area, as well as the National Rural Water Supply Programme (NRWSSP) to provide water supply and sanitary facilities supported by World Bank, to improve the water supply environment in the study area.

Contents of the request were construction of 22 piped water supply schemes (Level-2) in Coast Region and Dar es Salaam Peri-Urban, and capacity development of relevant organizations and community-owned water supply organizations. In responding the request, the Government of Japan dispatched through Japan International Cooperation Agency (JICA) a basic design study team to Tanzania from 10 June 2006 to 12 September 2006. During this period the study team had meetings with relevant members of MoW and other organization, and carried out field survey. After returning to Japan, the team prepared a Draft Basic Design Study Report based on the results of analyses in the home office. The team was dispatched to Tanzania to submit and discuss the Draft Basic Design Study Report with the Tanzanian side from 7 January to 16 January 2007. Through the discussion with the Tanzanian side during this period, the contents of the report were accepted by the Tanzanian side.

3. Study Results and contents of the Project

In the study, it is evaluated that operation and maintenance cost for piped water supply scheme (Level-2) exceeds the affordability to pay in four villages in the study area. The type of water supply scheme was changed from Level-2 to deep well with handpump (Level-1) to optimize operation and maintenance cost. However, one village was excluded from the target villages because no alternative groundwater source is expected in the village. As the results, the basic design is composed of 18 piped water supply schemes (Level-2) in 18 villages and 14 deep wells with handpump (Level-1) in three villages as well as the assistance by software component for empowerment of relevant organizations and community-owned water supply organizations.

The target year of the project is 2015 and service population increases about 59.2 thousand populations in 2015. Unit water demand is 25 L/capita/day and the daily maximum water supply is about 2.0 thousand m³. Service population and design water supply are shown in Table S-1.

Table S-1 Population and Summary of Water Supply Plan in the Target Villages

District/Municipality Village/Street	Name of Village	Serial No. of Scheme	Original Population		Design Population (2015)	Water Demand (m ³ /day)	Type of Facility	Expected Yield (L/min/well)	Number of Well	Operation of Pump (hour)	Water Production (L/min/day)	2015	
			Population	Year Surveyed								Service Population (person)	Service Coverage (%)
BAGAMOYO													
KIBINDU	KIBINDU	BGM-1	4,078	2002	5,276	175	Level-2	110	2	12	158	4,776	90.5
KWAMDUMA	KWAMDUMA	BGM-2	1,800	2002	2,329	77	Level-1	12	4	12	26	1,000	42.9
	TOTAL				7,605	252					184	5,776	75.9
KIBAHA													
RUVU	MINAZI MIKINDA (1/2)	KBH-1A	1,368	2001	2,185	76	Level-1	12	4	12	35	1,000	45.8
RUVU	MINAZI MIKINDA (2/2)	KBH-1B	1,256	2001	2,006	92	Level-2	112	1	12	81	2,334	87.7
RUVU	KITOMONDO		541	2006	657								
	TOTAL				4,848	168					115	3334	133.4
KISARAWE													
CHOLE	CHOLE	KSW-1	2,654	2002	3,180	110	Level-2	79	2	10	95	2,741	86.2
MSIMBU	MSIMBU	KSW-2	2,199	2002	2,636	79	Level-1	12	6	12	52	1,500	56.9
	TOTAL				5,816						147	4,241	72.9
MKURANGA													
LUKANGA	NJOPEKA	MKR-1	2,700	2002	4,222	138	Level-2	177	1	12	127	3,899	92.3
VIKINDU	MWANDEGE	MKR-2	1,300	2002	2,033	92	Level-2	117	1	12	84	2,578	91.6
	KIPALA		500	2002	782								
VIKINDU	KISEMVULE	MKR-3	1,504	2002	2,352	77	Level-2	50	2	12	72	2,199	93.5
VIKINDU	MAROGORO	MKR-4	1,240	2002	1,939	86	Level-2	110	1	12	79	2,427	92.1
	MFURU MWAMBAAO		445	2002	696								
VIKINDU	VIANZI	MKR-5	2,625	2002	2,926	96	Level-2	123	1	12	89	2,699	92.3
	TOTAL				14,950	489					451	13,802	92.3
	TOTAL (COAST)				33,219	909					898	27,152	81.7
ILALA													
KITUNDA	KITUNDA-Kivule (1/2)	ILL-1A	2,614	2002	4,690	151	Level-2	98	2	12	141	4,384	93.5
KITUNDA	KITUNDA-Kivule (2/2)	ILL-2B	1,744	2002	3,129	101	Level-2	131	1	12	94	2,922	93.4
KITUNDA	KITUNDA-Mzinga	ILL-3C	4,114	2002	7,382	238	Level-2	154	2	12	222	6,878	93.2
MSONGOLA	MSONGOLA	ILL-4	1,713	2004	2,530	76	Level-2	106	1	12	76	2,530	100.0
PUGU	PUGU STATION	ILL-5	2,772	2002	2,882	93	Level-2	120	1	12	86	2,677	92.9
	TOTAL				20,614	659					620	19,392	94.1
KINONDONI													
GOBA	MATOSA	KND-1	2,229	2002	2,747	88	Level-2	115	1	12	83	2,585	94.1
	TOTAL				2,747	88	Level-2				83	2,585	94.1
TEMEKE													
MJIMWEMA	KIBUGUMO	TMK-1	1,883	2002	3,379	110	Level-2	141	1	12	102	3,119	92.3
MJIMWEMA	MJIMWEMA-Salanga	TMK-2	1,750	2006	2,623	85	Level-2	110	1	12	79	2,444	93.2
PEMBA MNAJ	YALEYALE PUNA	TMK-3	1,529	2006	2,292	75	Level-2	96	1	12	69	2,112	92.2
PEMBA MNAJ	TUNDWI SONGANI	TMK-4	1,702	2006	2,551	83	Level-2	54	2	12	78	2,390	93.7
	TOTAL				10,845	353					328	10,065	92.8
	TOTAL (DSM)				34,205	1,100					1,030	32,041	93.7
	TOTAL (COAST & DSM)				67,424	2,009					1,928	59,193	87.8

(Note) No. of well (Level-2) : 24
 No. of well (Level-1) : 14
 Total 38

Basic concept of project is as follows.

- Design Manual (MoW, 1997) is applied in the designing of water supply facilities. Unit water demand is 25 L/capita/day. Items not described in the manual are designed applying Japanese Design Standard for Waterworks Facilities.
- Applicable standards for materials and equipment are those widely applied in Tanzania such as ISO, BS, SABS and DIN.

Summary

- Water quality shall satisfy WHO Guideline (2004) for “Chemicals that are of health significance” and Tanzanian Drinking Water Quality Standard (1974) for other items.
- In order to minimize the operation and maintenance cost, water sources should be groundwater. However, source is spring water in Njopeka Village in Mkuranga district, where groundwater potential is evaluated as not enough for water source.
- Type of water supply facilities are basically piped water supply facilities (Level-2), however, deep wells with handpump are constructed in Kwamduma, Minazi Mikinda (1/2) and Msimbu to reduce the operation and maintenance cost to a proper level of affordability to pay of community people.
- Source water is transmitted by pressure of the submersible pump from deep well to distribution tank through pipeline and is distributed from a distribution tank without chlorination. Only spring water is distributed from a tank after chlorination.
- Water supply service area is limited to areas to where water reaches by gravity. One distribution tank is constructed in one water supply scheme. No auxiliary tank and booster pump are included. Water is distributed by gravity to the service area from a distribution tank.
- Assistance by software component is carried out to empower the ability of for empowerment of relevant organizations and community-owned water supply organizations.

4. Project Period and Approximate Initial Cost

- Project Period

The project is implemented dividing into two phases. Project period of the Japanese side is estimated as 32.5 months in total since around 8.5 months are required for Detailed Design Study and Tendering after Exchanging of Notes between both countries in phase 1 as well as phase 2.

Software component is carried out by despatching one Japanese expert during the period.

- Approximate Initial Cost

Approximate initial cost for implementation of the project is estimated as 14.84 million US\$ (the Japanese side: 14.80 million US\$ and the Tanzanian side: 0.04 million US\$).

5. Justification of the Project

Following effects are expected by implementation of the project.

- Direct Effects

By constructing of water supply facilities, accesses to safe water are provided for the community people within approximately 400 m and water quality of water supply facilities constructed by the project satisfy the water quality standard. Then, community people become capable to use the

safe water 25 L/capita/day. As the results, water supply coverage is improved from 23% (water supply population, 16.7 thousand) in 2002 to 65% (water supply population, 75.9 thousand).

Water tariff is reduced from 50-300 Tsh/20L to 20 to 24 Tsh/20L in the villages where community people depend on the water vendors.

Empowerment of ability of operation and maintenance is expected through the assistance by software component. Community-Owned-Water-Supply-Organization (COWSO) is organized and registered to MoW or District/Municipality following the national policy. DWST and MWST are organized in the target Districts and Municipalities. Capability to assist communities on community participation type of operation and maintenance is developed.

- Indirect Effects

Fetching water is basically task of women and children. Time for fetching water is much reduced, and then times for participating in the social activities and chance to works of women, and chance to getting education of children are increased. Reduction of infant mortality (68/1000 in 2004) is expected by improved drinking water quality. Medical cost is much reduced by improved drinking water quality.

Ownership of community people is improved by organizing of community participation type of operation and maintenance system.

Aforesaid effects are expected by the implementation of the project. From these aspects, the Project is justified for implementation under the Japan's Grant Aid Scheme

In addition, the following issues should be fully taken into consideration for smooth implementation and effective performance of the Project.

- ① Periodical monitoring on groundwater level and water quality should be carried out to avoid recession of groundwater level and deterioration of water quality due to aging.
- ② DWST and MWST are requested to instruct community people to use water supply facilities constructed under the project and to monitor its situation.
- ③ Collaboration with technical assistance project planned to be implemented should be taken into consideration to empower the ability of DWST and MWST for assistance to communities, and community-owned water supply organization in operation and maintenance of the water supply schemes. In addition, AMREF aims to improve the ability of community people to operate and maintenance of the water supply schemes through Mkuranga Water, Hygiene and Sanitation Project in Mkuranga District. Collaboration with this project should be also taken into consideration.

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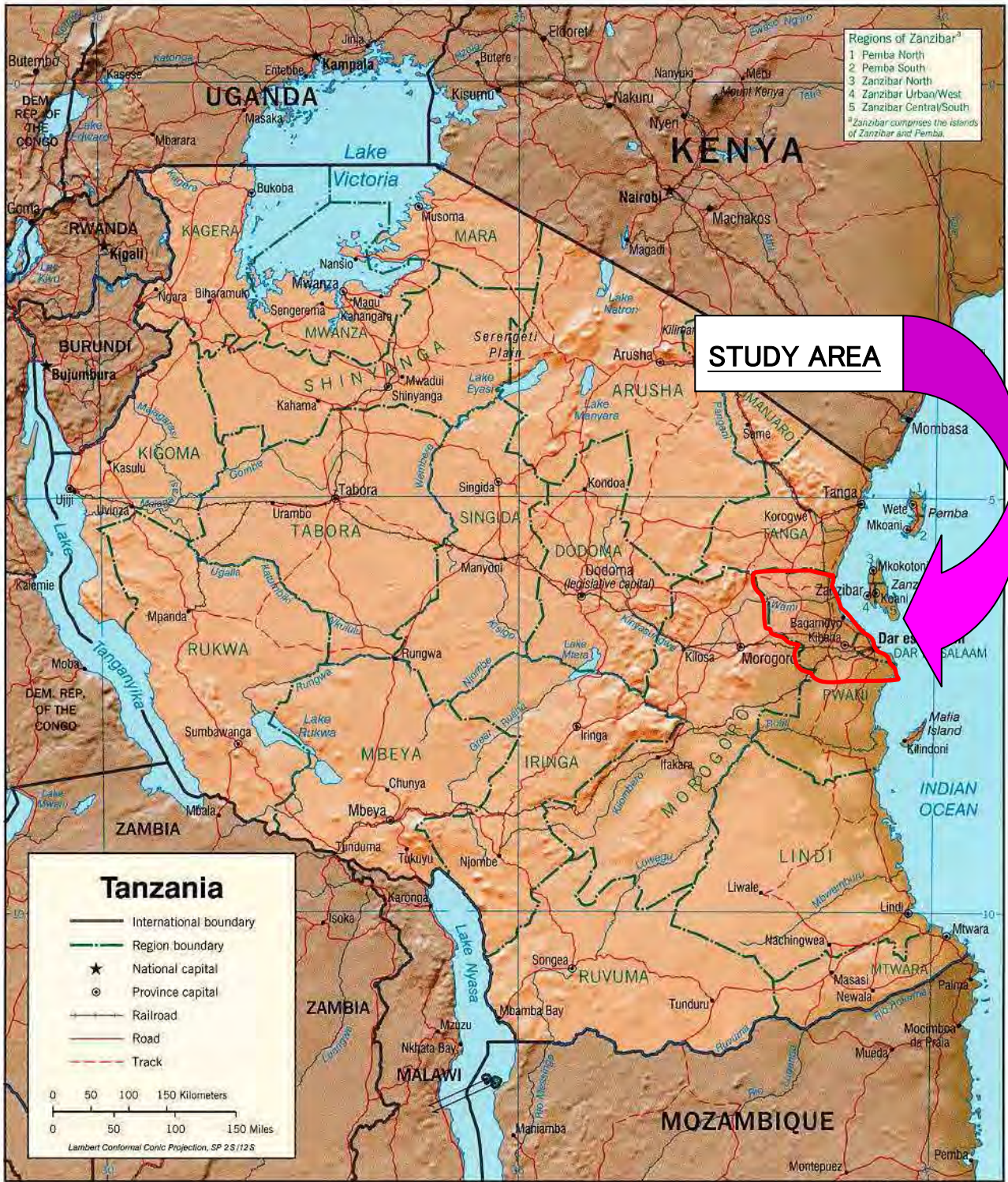
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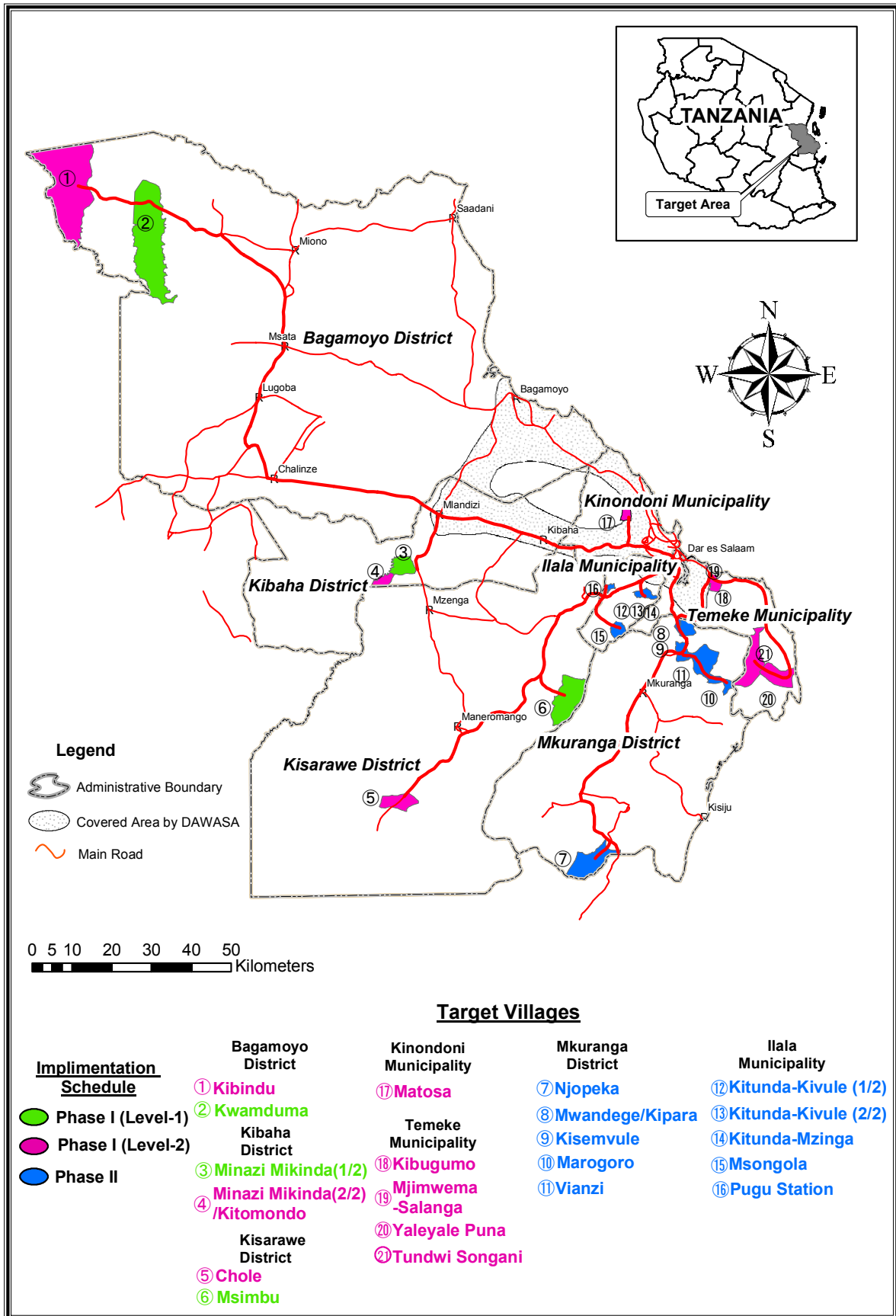
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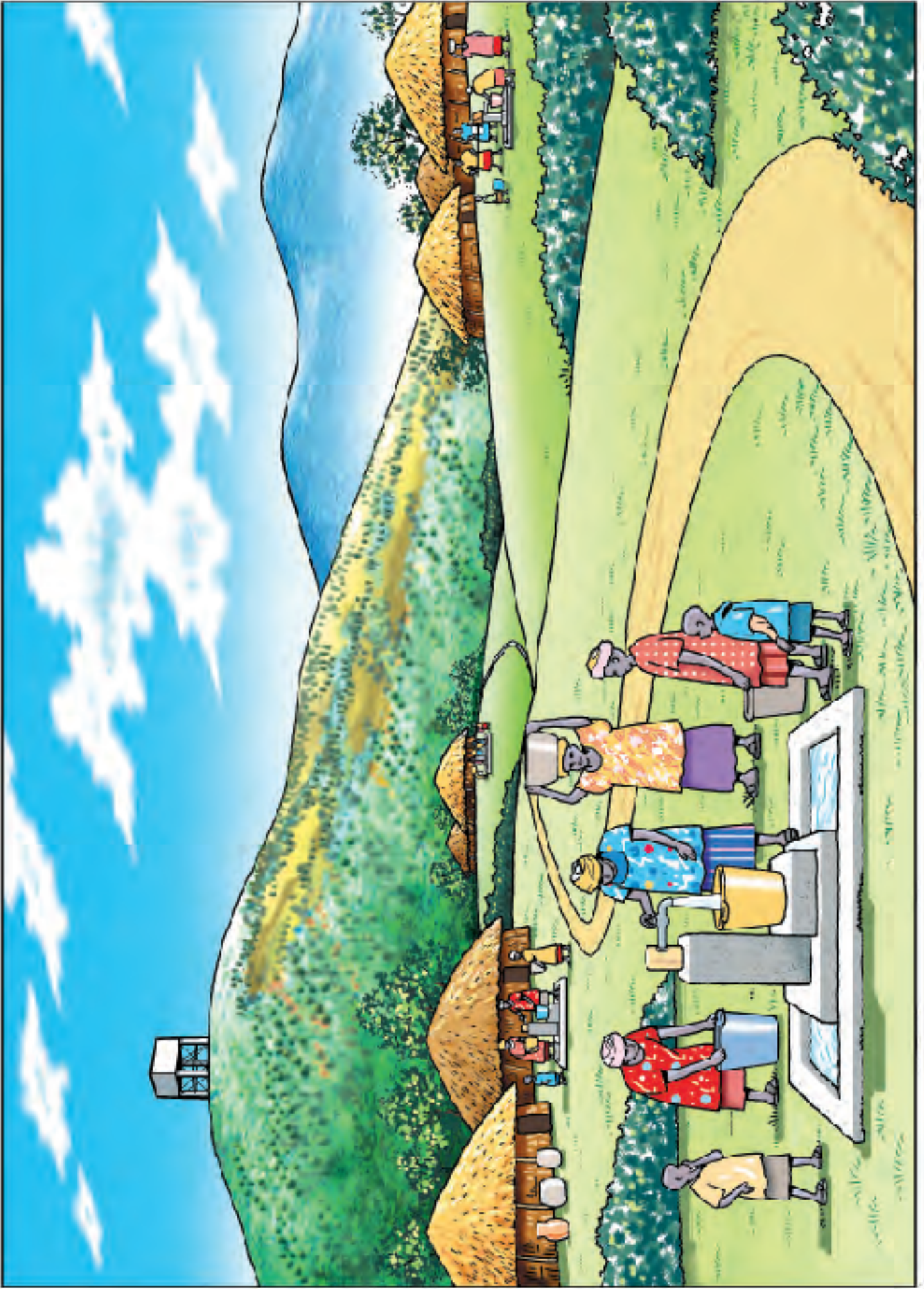


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LOCATION MAP OF STUDY AREA



LOCATION MAP OF TARGET VILLAGES



Rendering

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ABBREVIATIONS

ATP	Affordability-to-Pay
CBOs	Community-Based Organizations
COWSOs	Community-Owned Water Supply Organizations
CRB	Contractor Registration Board
DD	Draw Down
DDCA	Drilling & Dam Construction Agency
DRWS	Division of Rural Water Supply
DSM	Dar es Salaam
DTH	Dawn-the-hole Hammer
DUWS	Division of Urban Water Supply
DWE	District Water Engineer
DWL	Dynamic Water Level
DWSP	DAWASA Water Supply Project
DWST	District Water and Sanitation Team
EC	Electric Conductivity
EIA	Environmental Impact Assessment
ESAs	External Support Agencies
EU	Europe Union
FRP	Fiber Reinforced Plastic
GDP	Gross Domestic Product
GNP	Gross National Product
GPS	Global Positioning System
GSP	Galvanized Steel Pipe
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit
HDPE	High Density Poly-Ethylene
IEE	Initial Environmental Examination
JICA	Japan International Cooperation Agency
LGRP	Local Government Reform Policy
M/M	Minutes of Meetings
MoH	Ministry of Health
MoL	Ministry of Land
MoNRT	Ministry of Natural Resource and Tourism
MoW	Ministry of Water
MoWLD	Ministry of Water and Livestock Development
MWE	Municipal Water Engineer
NCC	National Construction Council
NEMC	National Environmental Management Council

NTU	Number of Transfer Units
NWP	National Water Policy
NRWSSP	National Rural Water and Sanitation Programme
NWSDS	National Water Sector Development Strategy
O&M	Operation and Maintenance
PEDP	Primary Education Development Programme
PER	Preliminary Environmental Report
PHAST	Participatory Health and Sanitation Transformation
PRSP	Poverty Reduction Strategy Paper
PVC	Polyvinyl chloride
PWP	Public Water Point
RF	Registration Form
RWSD	Rural Water Supply Division
RWSSP	Rural Water Supply and Sanitation Program
SC	Specific Capacity
SGP	Steel Galvanized Pipe
SR	Scoping Report
SW	Scope of Work
SWAP	Sector Wide Approach
SWL	Static Water Level
TANESCO	The Tanzania Electric Supply Company
TDS	Total Dissolved Solid
TOR	Terms of Reference
TRC	Technical Review Committee
UFW	Unaccounted-for water
UNICEF	United Nations International Children's Fund
VES	Vertical Electrical Sounding
VWCs	Village Water Committees
WC	Water Cooperative
WDC	Ward Development Committee
WHO	World Health Organization
WRI	Water Resources Institute
WSS	Water Supply System
WSSAs	Water Supply and Sanitation Authorities
WSSMC	Water Supply System Management Center
WT	Water Trust
WTP:	Willingness-to-Pay
WUAs	Water User Associations
WUGs	Water User Groups

KVA	Kilovolt Ampere
L	litre
L/min	litter/minute
masl	meter above sea level
mbgl	meter below ground level
min	minute
EUR	Euro)
Tsh	Tanzanian Shilling
USD	US Dollar

CHAPTER 1
BACKGROUND OF THE STUDY

CHAPTER 1 BACKGROUND OF THE STUDY

1.1 BACKGROUND OF THE STUDY

A water supply master plan for Coast Region and Dar es Salaam Peri-Urban was formulated in 1979. However, construction of those proposed water supply scheme were not been accomplished due to financial constraints. Only Chalinze Water Supply Scheme was constructed in Bagamoyo District. There are two major piped water supply schemes of which water source is surface water, DAWASA Water Supply Scheme and Chalinze Water Supply Scheme. The former covers the urban area of Dar es Salaam and supplies water to approximately half of population. The latter covers 17 villages in Bagamoyo district. Regarding the small scale water supply scheme, there are 20 in Coast Region in Dar es Salaam Region and 77. However, these schemes are functioning 35% in Coast Region and 77% in Dar es Salaam Region, due to malfunction of intake facilities, stolen of machineries, drought of water sources, etc. In addition, rapid increasing in population, and improper operation and maintenance cause deterioration of water sources and insufficient water supply. Accordingly, 65% of inhabitants in the two regions still do not have access to safe and clean water.

In order to improve water supply situation in the study area, the Government of Tanzania requested the Government of Japan to carry out the formulation of the water supply plan and the feasibility study of the priority projects to be formulated through the study. In response to this request, a master plan study was commenced in August 2004 to prepare water supply master plan for Coast Region and Dar es Salaam Peri-Urban, to select priority project, to strengthen capacity of staff of MoW and relevant organizations, and technical transfer of geophysical prospecting technique to Water Resources Institute (WRI). As the results, a water supply master plan for 217 villages in Coast Region and 61 villages in Dar es Salaam Peri-Urban was formulated. It composed of construction of 22 piped water supply schemes (Level-2), 607 deep wells with handpump and rehabilitation of existing water supply schemes. Among them, construction of 22 piped water supply schemes (Level-2) was selected as the priority project.

On the basis of this results, the government of Tanzania requested government of Japan to implement the priority project as a Japan's Grant Aid Project. The request consists of construction of 22 piped water supply schemes (Level-2) in Coast Region and Dar es Salaam Peri-Urban, and capacity development of relevant organizations and community-owned water supply organizations.

In responding the request, the basic design study was carried out. In the study, it is evaluated that operation and maintenance cost exceeds the affordability to pay in four villages in the study area. The type of water supply scheme was changed from Level-2 to Level-1 to optimize operation and maintenance cost. However, one village was excluded from the target villages because no alternative groundwater source is expected in the village. As the results, the basic design is composed of 18 piped water supply schemes (Level-2) in 18 villages and 14 deep wells with handpump in three villages.

The project is considered as the priority project in the study area, as well as the National Rural Water Supply Programme (NRWSSP) to provide water supply and sanitary facilities supported by World Bank, to improve the water supply environment in the study area.

1.2 NATURAL CONDITIONS

1.2.1 METEOROLOGY AND HYDROLOGY

1) Meteorology

In the mainland of Tanzania, generally two rainy seasons occur in a year; one is from March to May and the other is from November to December. Annual average precipitation reaches 1,000mm. There are 79 rainfall gauging stations in the Study area, 57 in Coast region and 22 in Dar es Salaam region.

(1) Annual Rainfall

Figure 2.1 shows the location of meteorological stations and distribution of annual rainfall. Annual total rainfall varies greatly by the station. It ranges from 849.7 mm in Utete Bomani to 1529.9 in Kisarawe even within the Study area.

(2) Monthly Rainfall

In the study area, rainfall patterns are similar in all stations though annual total rainfall varies by the station. Maximum rainfall occurs in the month of April in all stations, and minimum in the month of September in nine stations, July in three stations and August in one station.

(3) Monthly Temperature

Average monthly minimum and maximum temperatures are observed in the months of August (18.3°C) and February (32.5°C) at Dar es Salaam International Airport, and also in the same months of August (18.9°C) and February (32.3°C) at Kibaha Agromet. Annual average temperature at both of these locations are the same value of 26.0°C with small monthly variation.

(4) Sunshine

Annual average sunshine at Dar es Salaam International Airport and Kibaha Agromet is 7.7 and 7.3 hours, respectively. Radiation is measured only at Dar es Salaam International Airport Station. Annual average radiation averaged over the period 1983-1993 is calculated at 551.3 Mega joule/m².

2) River System

(1) River System in Tanzania

Tanzania is divided into nine major river basins, namely Lake Victoria Basin, Lake Tanganyika Basin, Internal Drainage Basin, Pangani Basin, Wami and Ruvu Basin, Lake Rukwa Basin, Rufiji Basin, Lake Nyasa Basin, and Ruvuma River and the Southern coast basin. Almost the entire Study area is included in Wami and Ruvu Basin.

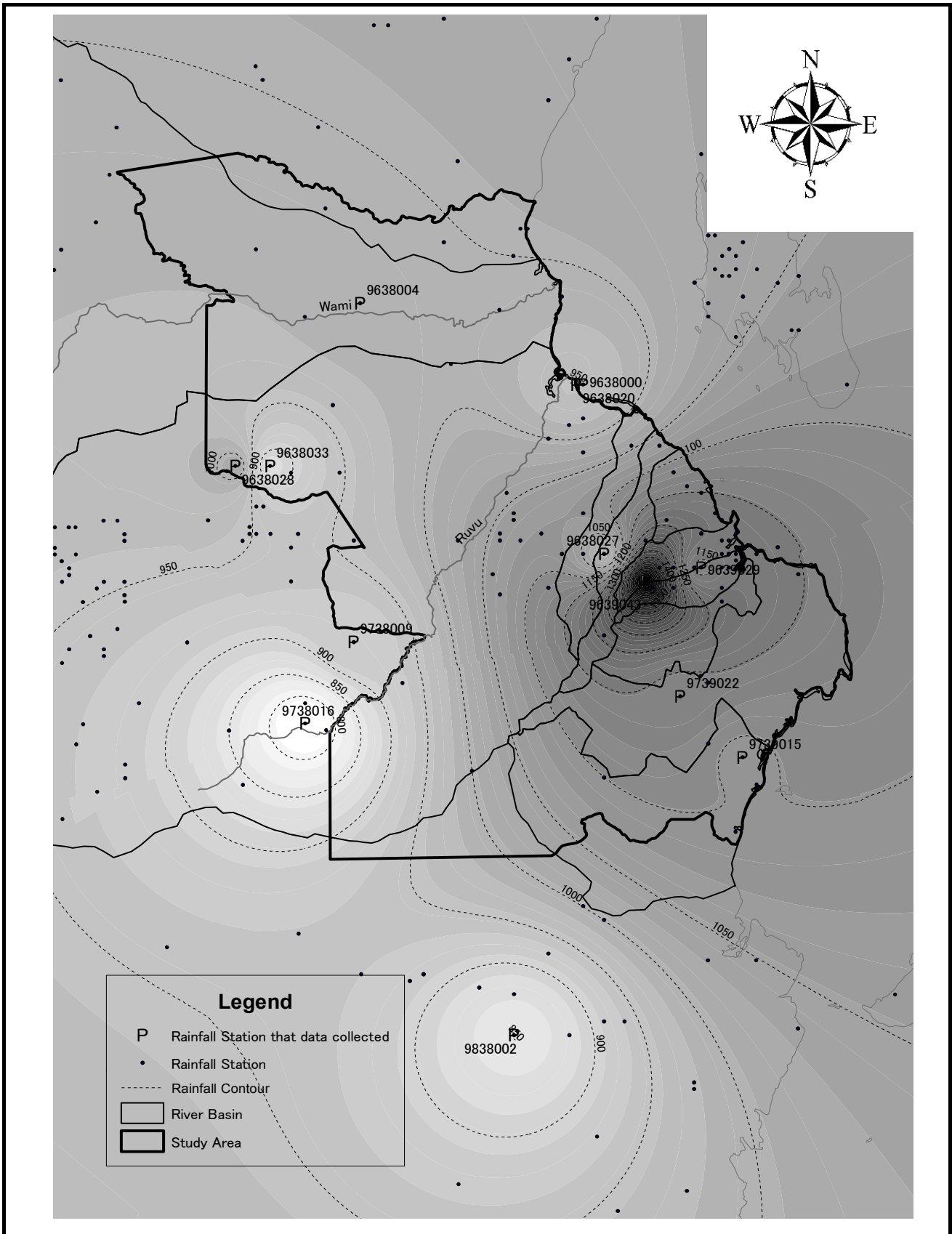


Figure 1.1 Meteorological Stations and Annual Rainfall Distribution

Rural Water Supply Project in Coast & Dar Es Salaam Peri-Urban

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(2) River System in the Study Area

Study area contains three major river basins, Pangani, Wami and Ruvu, and Rufiji basin. Wami and Ruvu basin is divided into two river basins, namely Wami, and Ruvu basin. In addition, Ruvu basin includes basin that Ruvu River itself flows, and other small river basins located east of Ruvu basin and along the ocean.

3) Hydrological Characteristics

Table 1.1 shows the characteristic of the river basins in the study area. As the result of interview survey to related persons and investigation of the past discharge data, three rivers, namely the mainstream of Wami and Ruvu, and Kizinga are confirmed as perennial rivers in the study area.

Table 1.1 Characteristics of the River Basins

Basin Name	River Name	Area (km ²)	Average Elevation (m)
Pangani	Tributary of Pangani	957	246.5
Wami	Wami	3,749	285.1
Ruvu	Ruvu	8,202	143.7
Coast R1	Mkuza, Kerege	518	140.7
Coast R2	Mpiji	489	168.6
Coast R3	Mbezi	312	77.7
Coast R4	Msimbo	319	115.4
Coast R5	Kizinga	249	88.9
Coast R6	Mzinga	615	109.5
Coast R7	Mbezi, Mbele, Ukooni	2,128	80.5
Coast R8	Luhute, Luhule	1553	104.1
Rufiji	Tributary of Rufiji	723	150.0

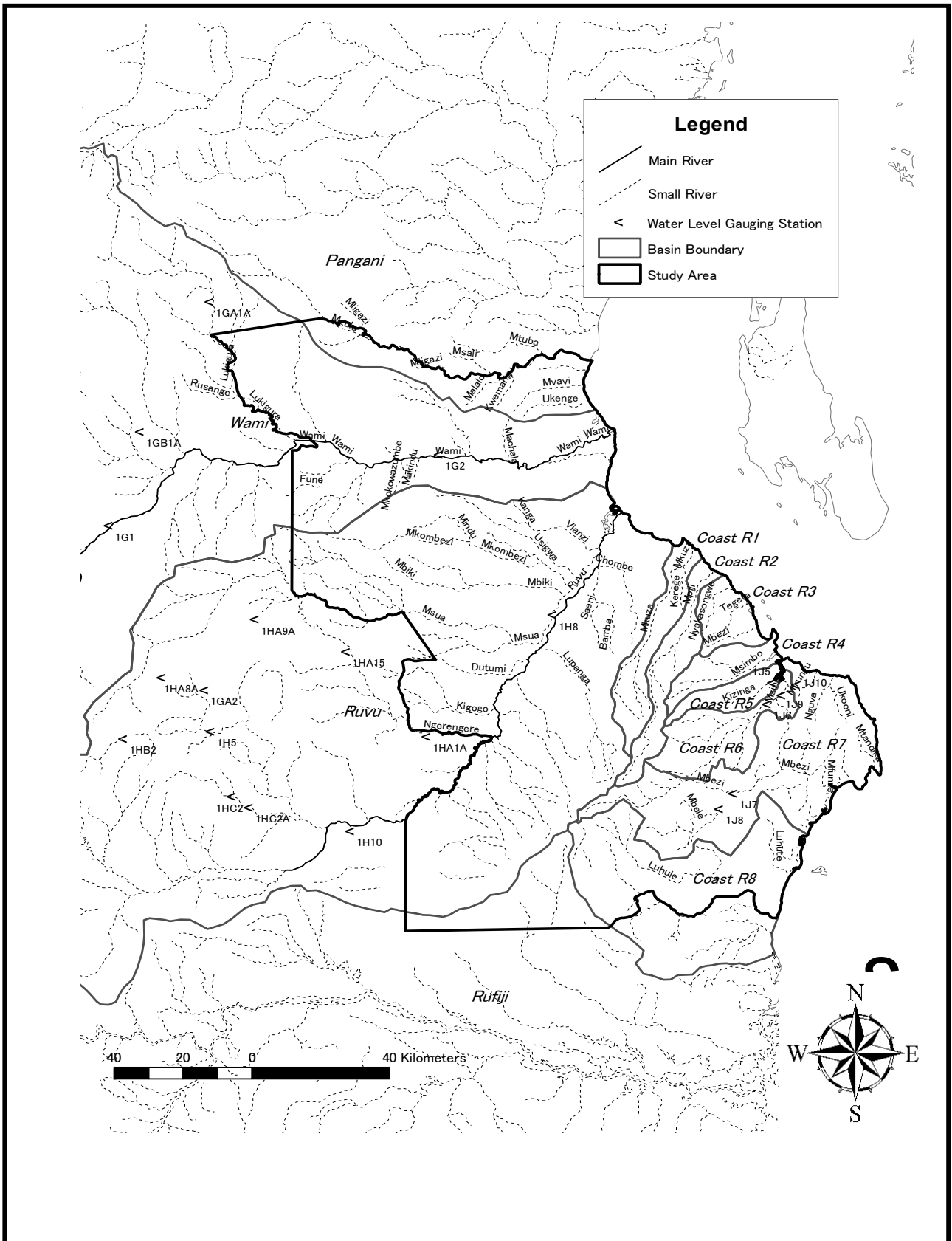


Figure 1.2 River System, Basin and Hydrological Stations

Rural Water Supply Project in Coast & Dar Es Salaam Peri-Urban

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1.2.2 TOPOGRAPHY AND GEOLOGY

1) General Geology of Tanzania

The geology of Tanzania comprises mainly the Precambrian (Archaean, Proterozoic) and Phanerozoic (Upper Palaeozoic, Mesozoic and Cenozoic) Formations. The Archaean rocks are characterized by a granite-greenstone terrain. The Tanzanian Craton covers the central part of the territory up to south and east part of Lake Victoria.

2) Topography and Geomorphology of the Study Area

Altitudes of the Study area range from 0 m (sea level) in the coastal area along the Indian Ocean to approximately 600 m in the north-western hilly area in Bagamoyo District. The topography in general reflects the geological structure in the Study area. The north-western area, mainly in Bagamoyo District is characterized by the plateau with 200 to 600 m high. The eastern fringe of the plateau is surrounded by generally flat hills of which height is approximately 100 to 300 m. The hilly topography is widespread in the eastern half of the Study area. A pair of hills is recognized elongating in NE-SW direction. River terraces and coastal terraces are recognized along the Wami River, the Ruvu River and the Indian Ocean.

3) Geology of the Study Area

In the Study area, a total of five major geological formations of 1) Precambrian, 2) Jurassic, 3) Cretaceous, 4) Neogene and 5) Quaternary are identified.

(1) Precambrian

The Precambrian is distributed mainly in Bagamoyo Plateau. It consists mainly of gneiss and granulite in the lower part and crystalline limestone intercalated with schists and gneiss. Many faults and lineaments are recognized in the area. Due to weathering of formation, surface of Bagamoyo Plateau is generally dense covered with soils.

(2) Jurassic

The eastern edge of Bagamoyo Plateau is occupied by the Jurassic which unconformably overlies the Precambrian and overlain by the Cretaceous. The Jurassic is unmetamorphosed and comprised mainly of sandstone intercalated sometimes with shale, siltstone and conglomerate.

(3) Cretaceous

The Cretaceous crops out in narrow areas occupying the edge of Bagamoyo Plateau. It is underlain by the Jurassic and overlain by the Neogene. Another distribution area is in the southwestern foot of the Msanga-Pugu Hills. In this area, the Cretaceous Formation is distributed in the hillside and foot of hills underlying the Neogene Formation.

(4) Neogene

The Neogene strata occur widely in the eastern half of the Study area, covering most areas in Ruvu Hill, Msanga-Pugu Hills and Mkuranga Hills.

The Neogene consists of less sorted intercalation of sandy clay and clayey sand accompanied with lenses of sand and clay.

(5) Quaternary

The Quaternary is distributed in a limited area, along the Ruvu River, near the river mouth of the Wami River and along the coast. These deposits consist of sand, gravel, silt and clay.

A fluvial deposit is distributed filling the Ruvu Graben along the Ruvu River.

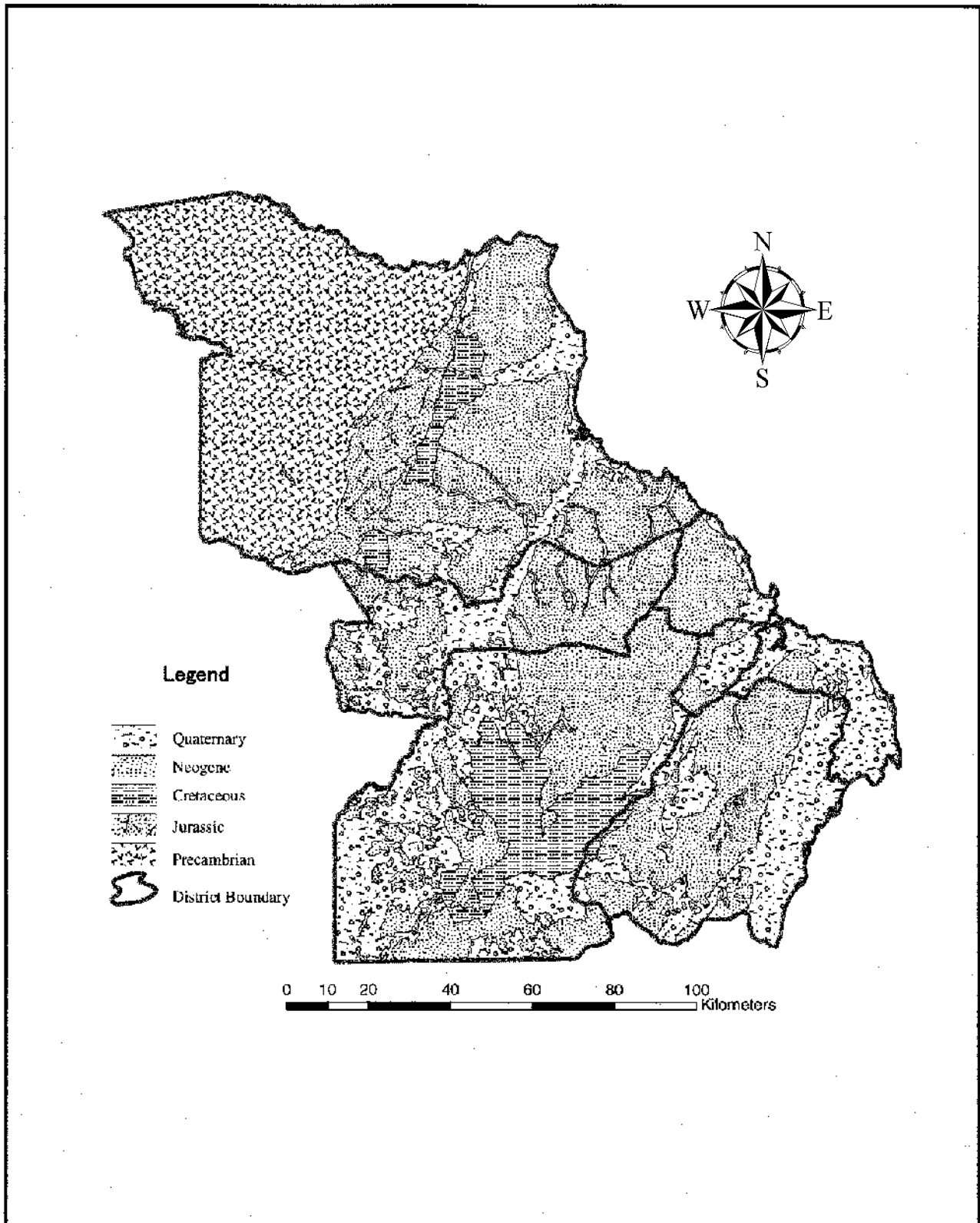


Figure 1.3 Geological Map of the Study Area

Rural Water Supply Project in Coast & Dar Es Salaam Peri-Urban

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1.2.3 HYDROGEOLOGY

1) Yield and Water Quality

The well yields and water qualities by the geological formation is graphically shown in Figure 1.4.

Quaternary aquifer shows very high yield of more than 100 L/min in median value. Next to Quaternary aquifer, Neogene aquifer shows relatively higher yield. In Neogene aquifer, median yield is only 24.5 L/min.

For the geological formations of Precambrian, Cretaceous and Jurassic, the yields are generally low of about 10 L/min in average, which is almost 0 L/min as median yield.

For the water quality, electric conductivity (EC) shows relatively low value in Neogene and Quaternary aquifers. It is 1,150 micro-S/cm in Neogene aquifer, and 1088 μ S/cm in Quaternary aquifer.

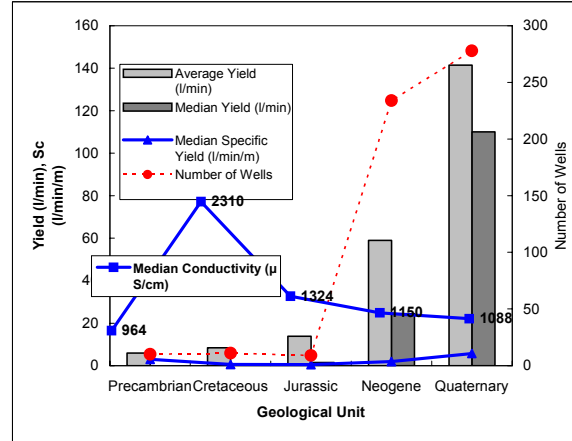


Figure 1.4 Yield and Water Quality by Geological Formation

2) Aquifer Evaluation

Table 1.2 shows the overall ranges of hydraulic conductivity for soils and rocks. The foremost range of the obtained values by the pumping test for each aquifer was also shown in the table.

The results suggested that for the two major aquifers of Quaternary and Neogene in the study area, hydraulic conductivity varies widely from “Very Low” to “High”. The Quaternary still has slightly higher range of Hydraulic Conductivity than that of Neogene aquifer. For the Cretaceous, Jurassic and Precambrian aquifers, since the number of sample is very low, scattered result is observed.

Table 1.2 Evaluation of Hydraulic Conductivity of Aquifers

	10^4	10^3	10^2	10^1	1	10^{-1}	10^{-2}	10^{-3}	10^{-4}	10^{-5}	10^{-6}
Quaternary		4.07×10^2					2.05×10^{-1}				
Neogene			2.30×10^1				3.00×10^{-2}				
Cretaceous				1.27			7.00×10^{-2}				
Jurassic											6.21×10^{-6}
Precambrian						2.20×10^{-1}			5.48×10^{-4}		

Relative permeability				
Very high	High	Moderate	Low	Very low
Clean gravel	Clean sand and sand and gravel	Fine sand	Silt, clay and mixture of sand, silt and clay	Massive clay
Vesicular and scorioceous basalt and covernous limestone and dolomite	Clean sandstone and fractured igneous and metamorphic rocks	Laminated sandstone shale, and mudstone	Massive igneous and meramorphic rocks	

Remarks : ● Median Value
: ▲ Only one samples

After Kashef, A.I GROUNDWATER ENGINEERING, 1987
U.S. Bureau of Reclamation, Groundwater Manual, U.S. Department of Interior, Washington, 1977.

3) Groundwater Potential Evaluation

A hydrogeological map was prepared as shown in Figure 1.5. The map contains the information on groundwater yield, quality (EC), depth to groundwater, existing well location, geological structure and physiographic information such as surface water and contour lines. Groundwater potential was evaluated by using these information. Naturally, groundwater yield, or productivity, is one of the most important factors for groundwater exploitation. The quality of groundwater is another essential factor. Pumping and maintenance costs depend on the depth to water.

The rank of groundwater potential evaluation is described as follows.

Weighting: 12 and 8 Good

Promising water source for the Piped Scheme of more than 2,500 population with single well. EC is good or fair for drinking, and besides the yield expected is 100 L/min and more.

Weighting: 6 and 4 Fair

Promising water source for the Piped Scheme of more than 2,500 populations with multi-well system. EC is good or fair for drinking, and the yield expected is from 10 to 100 L/min. This volume is exploitable using small submersible pumps.

Weighting: 3 and 2 Poor

The yield is fair to exploit for hand pump water supply scheme. EC is good for drinking or fair for drinking.

Weighting: 0 Not Applicable

EC is poor for drinking. It may be possible to use as a source for small scale industrial water or livestock water, otherwise elaborate water treatment facility is necessary for drinking water use.

4) Geophysical Prospecting and Test Well Drilling

Geophysical prospecting was carried out using Two Dimensional Electric Imaging Method (2D Imaging) to decide test well locations in 20 villages where groundwater was supposed to be water source. Results of the prospecting and data are cited as Reference 8 (1).

Five test wells were drilled in five villages, in Kibaha and Kisarawe Districts and Kinondoni Municipality, where groundwater development is evaluated as difficult in the master plan study. Table 1.3 shows the locations of test well sites. The results are shown as Reference 8 (2).

Table 1.3 Test Well Drilling Site and Target Aquifer

No.	Village	Drilling Depth	Target Aquifer
1	Minazi Mikinda, Kibaha	50m	Neogene
2	Kitomondo, Kibaha	50m	Neogene
3	Msimbu, Kisarawe	120m	Neogene
4	Chole, Kisarawe	80m	Cretaceous
5	Matosa, Kinondoni	120m	Neogene

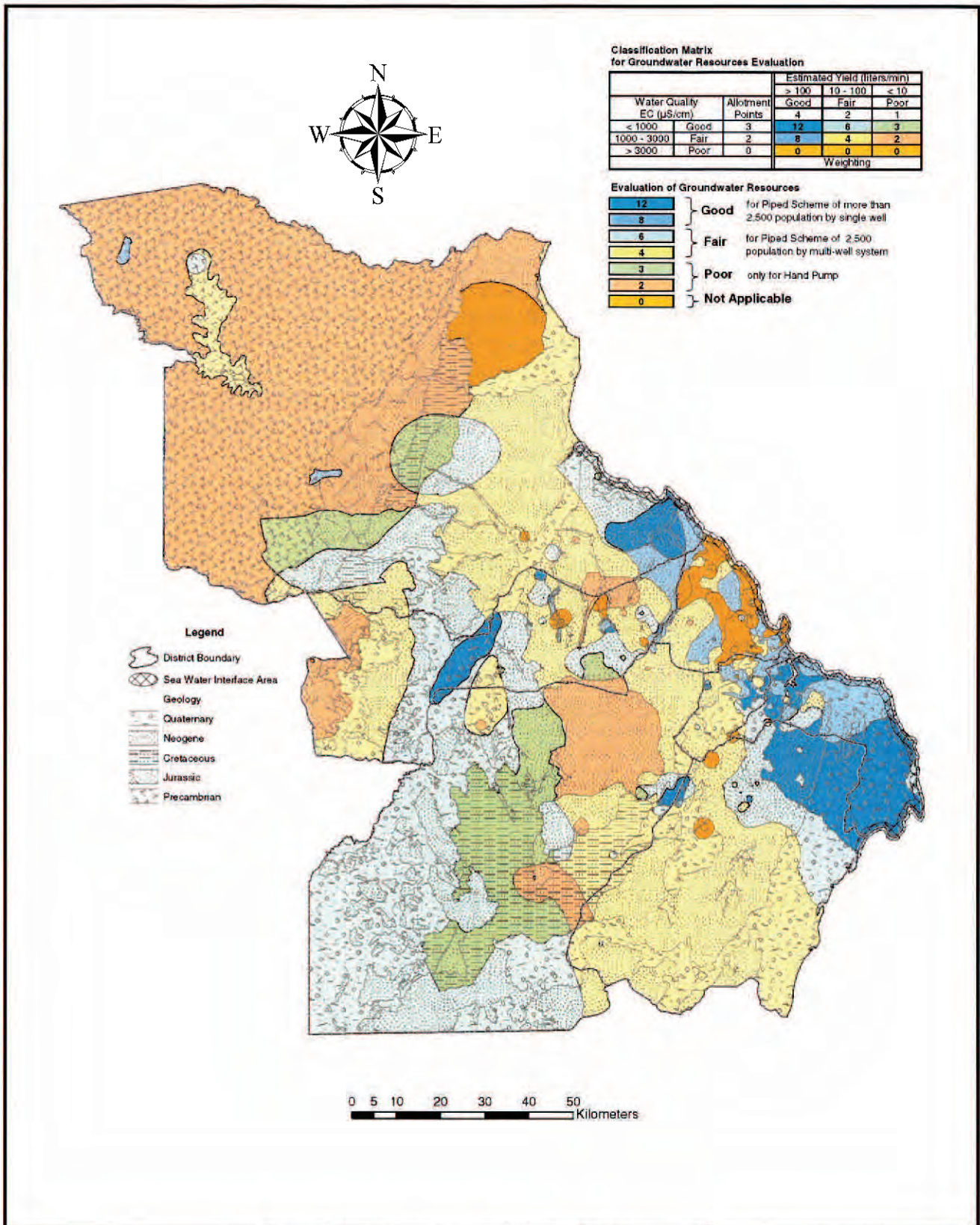


Figure 1.5 Groundwater Resources Evaluation Map

Rural Water Supply Project in Coast & Dar Es Salaam Peri-Urban

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CHAPTER 2

CONTENTS OF THE PROJECT

CHAPTER 2 CONTENTS OF THE PROJECT

2.1 BASIC CONCEPT OF THE PROJECT

The Government of Tanzania made a request (hereinafter, called “the Request”) for grant aid for Rural Water Supply Project (hereinafter, called “the Project”) in Coast Region and Dar es Salaam Peri-Urban to the Government of Japan. Contents of the Request are as follows;

- (1) To construct 22 piped water supply facilities (Level-2) (20 groundwater sources, 2 surface water sources, elevated water distribution tanks, transmission pipelines, distribution pipe lines and public water points)
- (2) To strengthen capability of relevant organizations and water supply associations in operation and maintenance.

As mentioned in Chapter 1, as the results of the basic design study, it is evaluated that operation and maintenance cost exceeds the affordability to pay in four villages in the study area. The type of water supply scheme was changed from Level-2 to Level-1 to optimize operation and maintenance cost. However, one village was excluded from the target villages because no alternative groundwater source is expected in the village. As the results, the basic design is composed of 18 piped water supply schemes (Level-2) in 18 villages and 14 deep wells with handpump in three villages.

Target villages and their population of the project are shown in Table 2.1.

The Project will contribute to improve the water supply situation by increasing the service population from 23% in 2002 to 70% in the target year 2015.

Initial Environmental Evaluation (IEE) revealed that all the categories related to social and environmental consideration fell into category C which meant no Environmental Impact Assessment (EIA) is necessary. Letter of Exemption for EIA was issued by NEMC (Appendix 6).

Direct and indirect effect by implementation of the Project is expected as summarized in Table 2.2.

Table 2.1 Target village and Design Population

District/Municipality Village/Street	Name of Village	Serial No. of Scheme	Original Population		Design Population (2015)	Data Source
			Population	Year Surveyed		
BAGAMOYO						
KIBINDU	KIBINDU	BGM-1	4,078	2002	5,276	Census
KWAMDUMA	KWAMDUMA	BGM-2	1,800	2002	2,329	Census
MKANGE	MATIPWILI	BGM-3	1,999	2002	2,584	Census
	TOTAL				10,189	
KIBAHA						
RUVU	MINAZI MIKINDA (1/2)	KBH-1A	1,368	2001	2,185	Registration in 2001
	MINAZI MIKINDA (2/2)	KBH-1B	1,256	2001	2,006	Registration in 2001
RUVU	KITOMONDO		541	2006	657	2006 data for food supply by Prime Minister Office
	TOTAL				4,848	
KISARAWA						
CHOLE	CHOLE	KSW-1	2,654	2002	3,180	Census
MSIMBU	MSIMBU	KSW-2	2,199	2002	2,636	Census
	TOTAL				5,816	
MKURANGA						
LUKANGA	NJOPEKA	MKR-1	2,700	2002	4,222	Census
VIKINDU	MWANDEGE	MKR-2	1,300	2002	2,033	M/P data
	KIPALA		500	2002	782	M/P data
VIKINDU	KISEMVULE	MKR-3	1,504	2002	2,352	Census
VIKINDU	MAROGORO	MKR-4	1,240	2002	1,939	M/P data
	MFURU MWAMBAO		445	2002	696	M/P data
VIKINDU	VIANZI	MKR-5	2,625	2002	2,926	M/P data
	TOTAL				14,950	
	TOTAL (COAST)				35,803	
ILALA						
KITUNDA	KITUNDA-Kivule (1/2)	ILL-1A	2,614	2002	4,690	M/P data
KITUNDA	KITUNDA-Kivule (2/2)	ILL-2B	1,744	2002	3,129	M/P data
KITUNDA	KITUNDA-Mzinga	ILL-3C	4,114	2002	7,382	M/P data
MSONGOLA	MSONGOLA	ILL-4	1,713	2004	2,530	Registration in 2004
PUGU	PUGU STATION	ILL-5	2,772	2002	2,882	M/P data
	TOTAL				20,614	
KINONDONI						
GOBA	MATOSA	KND-1	2,229	2002	2,747	Census
	TOTAL				2,747	
TEMEKE						
MJIMWEMA	KIBUGUMO	TMK-1	1,883	2002	3,379	M/P data
MJIMWEMA	MJIMWEMA-Salanga	TMK-2	1,750	2006	2,623	Assumption by the Street in 2006
PEMBA MNAJI	YALEYALE PUNA	TMK-3	1,529	2006	2,292	Counted by the Street in June 2006 (M. of Health)
PEMBA MNAJI	TUNDWI SONGANI	TMK-4	1,702	2006	2,551	Counted by CSPD in June 2006 (M. of Health)
	TOTAL				10,845	
	TOTAL (DSM)				34,205	
	TOTAL (COAST & DSM)				70,008	

Table 2.2 Project Design Matrix (PDM)

Title of Project : Rural Water Supply Project in Coast Region
and Dar es Salaam Peri-Urban

Target Area : 21 Villages in 4 Districts
and 3 Municipalities

Ver. 1.0

Recipient : Residents in Target Villages (59,193 persons)

Project Period: August 2006 – March 2010

Date: November 2006

Narrative Summary	Indicators	Means of Verification	Important Assumption
<p><u>Overall Goal</u> Water supply situation in Coast Region and Dar es Salaam Peri-Urban is improved.</p>	<p>(1) Water supply service rate is improved from 35% to 40.8 % in the target year 2015 in Coast Region and Dar es Salaam Peri-Urban.</p>	<ul style="list-style-type: none"> • Report in Master Plan Study • Completion Report of the Project • Completion Certificates of the Project 	<ul style="list-style-type: none"> • National policy in the water supply sector is not changed. • Water supply service by other schemes is continued.
<p><u>Project Purpose</u> Covering rate of water supply services is improved by sustainable supply of safe water to residents in the target villages and consuming of the water in the villages.</p>	<p>(1) Water supply service rate in the target villages is improved up to 65 % in the target year 2015</p> <p>(2) All the water supply facilities constructed in the project are functioning.</p> <p>(3) Water quality of every water source of the facilities satisfy the WHO Guideline and Tanzanian Standard.</p> <p>(4) Unit water supply is increased to 25 L/capita/day.</p>	<p>(1) Report in Master Plan Study, Completion Report of the Project, Project Completion Certificates</p> <p>(2) Post Evaluation Report</p> <p>(3) Water Quality Analyses Report, Tanzanian Water Quality Standard, Basic Design Study Report</p> <p>(4) Project Completion Report, Basic Design Study Report</p>	<ul style="list-style-type: none"> • Improved management, operation and maintenance system is sustained by implementation agencies and the villages.
<p><u>Outputs</u> 1. Water supply schemes are developed in the target villages 2. Management, Operation and Maintenance system by COWSO is established.</p>	<p>(1) Water supply facilities are constructed in the target villages.</p> <p>(2) COWSO is organized in the target villages.</p> <p>(3) DWST is organized in the target Districts/Municipalities.</p> <p>(4) A organization for operation and maintenance is organized and registration is taken place.</p>	<p>(1) Project Completion Report, Project Completion Certificate</p> <p>(2) Software Component Activity Report</p> <p>(3) Software Component Activity Report</p> <p>(4) Registration Certificate of COWSO, Software Component Activity Report</p> <p>(5) Software Component Activity Report, Accounting Report of Village Water Committee, Water Fund, Post Evaluation Report</p>	<ul style="list-style-type: none"> • Replacement and repairing of the water supply facilities are carried out. • Rapid change in population due to worsening of the situation is not caused. • Rapid worsening of socio-economic situation is not happened in the target villages.
<p><u>Activities</u> 1. Construction of water supply schemes in 21 target villages 2. Technical assistance on operation and maintenance of water supply schemes</p>	<p><u>Input</u> <i>Japanese side</i> <Construction of facility> Construction of water supply schemes in 21 target villages <Human Resources> • Consultant • Technical Supervisor <Implementation Cost> • Construction cost for water supply facilities • Cost for software component assistance</p>	<p><i>Tanzanian Side</i> <Machineries and Materials> Construction equipment Construction materials <Human Resources> • Engineers • Technicians • Technical workers <Implementation Cost> • Construction cost • Operation and management cost for water supply schemes</p>	<ul style="list-style-type: none"> • Staff trained in the project stay in their organization. <p><u>Preconditions</u></p> <ul style="list-style-type: none"> • Rapid price boosting is not caused.

1): Community-Based Operation and Maintenance

2): District Water and Sanitation Team

2.2 BASIC DESIGN OF THE REQUESTED JAPANESE ASSISTANCE

2.2.1 DESIGN POLICY

1) Target Villages and Selection of the Type of Water Supply Scheme

The contents of the Request were to construct piped water supply schemes (Level-2) in 22 villages in Coast Region and Dar es Salam Peri-Urban.

It is considered that the groundwater development is not easy in these target villages. Therefore, test wells were sunken in five (5) villages where groundwater development is more difficult. It is agreed between the Study team and MoW that Level-1 water supply scheme will be planned if suitable water source cannot be obtained by test well drilling (Refer, Minutes of Discussions signed on 16 June 2006).

Appropriateness to construct Level-2 schemes in the target villages were evaluated from view points of availability of water sources (yield and water quality) and socio-economical condition for operation and maintenance of the schemes. As the results, one (1) village was excluded from the target villages and type of scheme was changed from Level-2 to Level-1 in three (3) villages.

(1) Principle of the Test Well Drilling (Yield and Water Quality)

i) Target village of test well drilling

Test well drilling was carried out at five (5) villages in Kibaha and Kisarawe Districts and Kinondoni Municipality where it was evaluated as difficult during the Master Plan Study (JICA, 2004-2005) to develop groundwater. Each village was allocated one test well. In addition, two (2) preparatory wells were provided to sink as the second test well in case that successful well was not obtained by the first test well in the village. Therefore, seven (7) wells were provided in total.

Table 2.3 Test Well Drilling Plan

Target Village			Number of Water Source	Number of Test Well	Drilling Depth (m)	Target Aquifer
1	Kinondoni	Matosa	1	1	120	Neogene
2	Kibaha	Minazi Mikinda (1/2)	1	1	50	
		Minazi Mikinda (2/2) /Kitomondo	1	1	50	
3	Kisarawe	Msimbu	2	1	120	Cretaceous
		Chole	2	1	80	

ii) Criteria for successful water source

Following two (2) criteria are applied for evaluation of successful water source.

<Yield>

Capable of yielding of water to satisfy the water demand of each target village planned in the Development Study by pumping within 12 hours.

<Water Quality>

To satisfy the WHO Guideline (2004) for items related to health significance and the Tanzanian Drinking Water Standard (1974) for other items. Water quality standard and items to be analyzed are shown in Table 2.4.

Table 2.4 Water Quality Standard and Items to be Analyzed

Aspects and Items		Unit	Tanzanian Standard (1974) *1	WHO Guideline (2004) *2	
Microbial aspects	1 Total coliform bacteria	count/100ml	0	-	
	2 Escherichia Coli	count/100ml	0	0	
Chemicals that are of health significance	3 Cadmium (Cd)	mg/l	0.05	0.003	
	4 Cyanide (CN)	mg/l	0.20	0.07	
	5 Lead (Pb)	mg/l	0.10	0.01	
	6 Arsenic (As)	mg/l	0.05	0.01	
	7 Mercury (Hg)	mg/l	-	0.001	
	8 Selenium (Se)	mg/l	0.05	0.01	
	9 Barium (Ba)	mg/l	1.00	0.7	
	10 Fluoride (F)	mg/l	8.0	1.5	
	11 Hexavalent-chromium (Cr ⁶⁺)	mg/l	0.05	-	
	12 Total chromium (T-Cr)	mg/l	-	0.05	
	13 Nitrate (NO ₃ -N)	mg NO ₃ /l	100	50	
	14 Nitrite (NO ₂ -N)	mg NO ₂ /l	-	3 / 0.2 *3	
	15 Boron (B)	mg/l	-	0.5	
	16 Nickel (Ni)	mg/l	-	0.02	
	17 Antimony (Sb)	mg/l	-	0.020	
	18 Molybdenum (Mo)	mg/l	-	0.07	
	19 Manganese (Mn)	mg/l	0.5	0.4	
	20 Organic Carbon (as carbon in Chloroform)	mg/l	0.5	-	
	Acceptability aspects	21 Hardness	mg/l	600	-
		22 Calcium (Ca)	mg/l	-	-
23 Magnesium (Mg)		mg/l	-	-	
24 Iron (Fe)		mg/l	1.0	-	
25 Zinc (Zn)		mg/l	15.0	-	
26 Copper (Cu)		mg/l	3.0	2.0	
27 Chloride (Cl)		mg/l	800	-	
28 Residue*4		mg/l	-	-	
29 Total filterable residue*5		mg/l	2,000	-	
30 Anionic surface active agents (as ABS)		mg ABS/l	2.0	-	
31 Phenols		mg/l	0.002	-	
32 Hydrogen sulfide (H ₂ S)		mg/l	-	-	
33 Ammonium (NH ₃ +NH ₄)		mg/l	-	1.5	
34 Total nitrogen (Excluding NO ₃)		mg/l	1.0	-	
35 BOD		mg/l	6.0	-	
36 Potassium permanganate consumption		mg/l	20	-	
37 pH		-	6.5 - 9.2	-	
38 Taste		dilution	not objectionable	-	
39 Odour		dilution	not objectionable	-	
40 Colour		mg Pt/l	50	15	
41 Turbidity (Tr)	NTU	30	5		
42 Temperature	°C	-	-		
43 Conductivity (EC)	mS/m	-	-		
44 Residual chlorine (Cl)	mg/l	-	-		
45 Sulfate (Mg+Na Salts)	mg/l	-	-		
Water quality items related to the characteristics of groundwater	46 Sodium (Na)	mg/l	-	-	
	47 Potassium (K)	mg/l	-	-	
	48 Bicarbonate (HCO ₃ ⁻)	mg/l	-	-	
	49 Total alkalinity	mg/l	-	-	
	50 Sulfate (SO ₄ ²⁻)	mg/l	600	-	

*1: "Maji Review" Ministry of Water Development and Power vol. 1, No. 1, MoWDP, Dar es Salaam, 1974

*2: "WHO Guideline for Drinking Water Quality Third Edition", World Health Organization, Geneva, 2004

*3: Short term / long term

*4: Residue is equal to [Total solids - Total dissolved solids]

*5: Total filterable residue is equal to Total dissolved solids (TDS).

Items adopted for water quality evaluation.

iii) Evaluation of surface water source of the Wami River

Turbidity of the surface water of the Wami River is more than the Tanzanian Drinking Water Standard in dry season. Therefore, it is necessary to reduce the turbidity lower than the Standard in order to use the source of the water supply scheme in Matipwili Village. It is theoretically possible to reduce the turbidity by 24 hour’s sedimentation. However, such effect shall be confirmed by sedimentation test using the water samples taken from the river. If the turbidity cannot be reduced to satisfy the level of the Standard, alternative solution will be proposed including the addition of sedimentation tank or construction of water treatment system.

iv) Alternative solution in case no suitable water source is available by test well

Results of test well drilling are evaluated applying the criteria described in (1) above. If quantity of yield of well is not enough for Level-2 scheme, Level-1 scheme is provided instead of Level-2. When water quality is not suitable for drinking, the village is excluded from the target village. No alternative village is included in the target villages even a village is excluded, because no other village meets the criteria for Level-2 water supply scheme. Flow chart for selection of type of water supply scheme is shown in Figure 2.1.

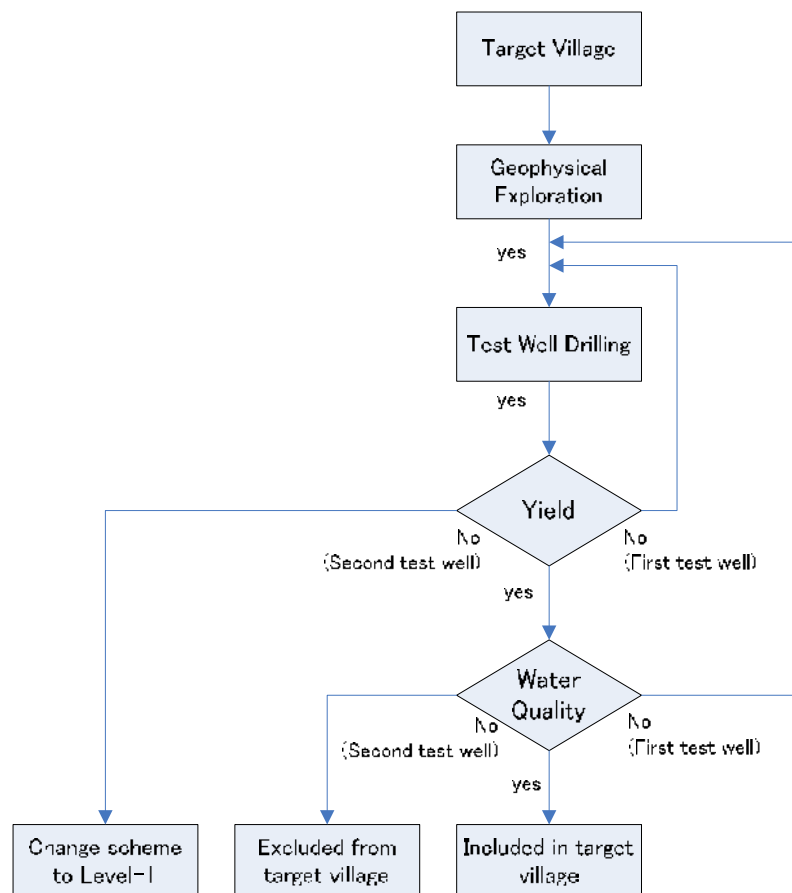


Figure 2.1 Flow Chart for Selection of Water Supply Scheme

Following items were evaluated to decide the water supply schemes as mentioned from 1) to 5).

(2) Evaluation of test well drilling results (Yield and Water Quality)

Criteria for successful well are to satisfy the estimated water demand of each village within the 12 hours pumping and to satisfy the water quality standard, WHO Guideline (2004) for “Chemicals that are of health significance” and Tanzanian Drinking Water Quality Standard (1974) for other items.

Results of test well drilling are summarized in Table 2.5.

Table 2.5 Results of Test Well Drilling

No.	Village	Depth (m)	Evaluation		Remarks
			Yield (L/min)	Water Quality	
1	Matosa	120	Cannot be measured	Cannot be analyzed	First well: not successful The second well will be drilled in D/D study.
2	Minazi Mikinda (1/2) (First well)	50	20 L/min (Insufficient)	Not suitable due to high salinity	Not successful
	Minazi Mikinda (1/2) (Second well)	50	264 L/min (Sufficient)	Suitable	Successful
3	Minazi Mikinda (2/2) /Kitomondo (First well)	50	12 L/min (Insufficient)	Not suitable	Not successful
	Minazi Mikinda (2/2) /Kitomondo (Second well)	50	108 L/min (Sufficient)	Suitable	Successful
4	Chole	80	9.2 L/min (Insufficient)	Not suitable	First well: not successful The second well will be drilled in D/D study.
5	Msimbu	120	264 L/min (Sufficient)	Suitable	Successful

Results of the first test wells were not successful in Matosa, Minazi Mikinda (1/2), Minazi Mikinda (2/2)/Kitomondo and Chole. Among them, the second wells were drilled in two (2) villages, Minazi Mikinda (1/2) and Minazi Mikinda (2/2) /Kitomondo. As the results, these wells were successful.

In order to decide the type of water supply facility in Matosa and Chole, the second test wells should be drilled in the Detailed Design Study.

(3) Evaluation of water quality

Evaluation criteria for water quality are the WHO Guideline (2004) for “Chemicals that are of health significance” and the Tanzanian Drinking Water Standard (1994) for other items. Proposed water sources are groundwater, spring water and surface water. The results of water quality analyses of these sources are shown in Table 2.6.

As the results, all the items (No. 3-10) related to “Chemicals that are of health significance” satisfy the WHO Guideline. Except for Coliforms and Escherichia coli., chloride value is more than the Tanzanian Standard in Minazi Mikinda (1/2), and Colour and Turbidity are more than the Tanzanian Standard in Chole.

Turbidity and Colour analyses results are described in 3) and 4) later.

Table 2.6 Results of Water Quality Analyses

Water Quality Analysis Items	Tanzania Standard for Rural Water Supplies (1974)	WHO Guideline (2004)*1	River	Spring	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
			Bagamoyo	Mkuranga	Kibaha	Kibaha	Kibaha	Kibaha	Kisarawe	Kisarawe	Mkuranga
			Matipwili	Njopeka	Minazi Mkinda (1st well)	Minazi Mkinda (2nd well)	Kotomondo (1st well)	Kotomondo (2nd well)	Chole	Msimbu	Vianzi (Existing Well)
1 Coliforms (count/100ml)	0	–	400	800	0	0	0	0	0	0	0
2 Escherichia Coli. (count/100ml)	0	0	50	250	0	0	0	0	0	0	0
3 Cadmium: Cd (mg/l)	0.05	0.003	ND	ND	0.3	ND	ND	ND	ND	ND	ND
4 Lead: Pb (mg/l)	0.1	0.01	ND	ND	0.2	ND	0.1	ND	ND	ND	0.1
5 Arsenic: As (mg/l)	0.05	0.01	–	–	–	–	–	–	–	–	–
6 Fluoride: F (mg/l)	8.00	1.50	0.44	1.42	0.89	1.00	ND	0.20	ND	1.0	0.17
7 Nitrate: NO ₃ (mg/l)	100	50	1.4	3.5	3.5	5.3	3.1	1.3	ND	5.3	4.4
8 Nitrite: NO ₂ (mg/l)	–	3	0.010	0.220	0.033	0.430	0.026	0.016	ND	0.023	0.230
9 Nickel	–	0.02	–	–	–	–	–	–	–	–	–
10 Manganese: Mn (mg/l)	0.5	0.1	0.1	ND	0.08	ND	ND	ND	0.05	ND	ND
11 Total Hardness (as CaCO ₃ mg/l)	600	–	100	295	14,000	280	690	130	34	355	33
12 Calcium: Ca (mg/l)	–	–	30.0	48	1,880	36.0	108	20	2.8	54	3.2
13 Magnesium: Mg (mg/l)	–	–	601	42.6	2,261.2	46.2	102.0	19.5	6.6	53.5	6.1
14 Iron: Fe (mg/l)	1.0	0.3	0.22	ND	0.11	0.01	ND	0.01	0.17	0.01	0.02
15 Zinc: Zn (mg/l)	15	3.0	0.1	0.1	0.6	ND	0.1	0.1	0.4	0.2	3.0
16 Copper: Cu (mg/l)	3.0	1.0	ND	ND	0.1	ND	ND	ND	ND	ND	ND
17 Chlorides (Cl mg/l)	800	250	49.6	467	13,400	220	1,181	9.0	60.3	519.8	52
18 Total dissolved solids : TDS (mg/l)	2,000	1,000	125	855	22,800	740	2,435	130	150	786	290
19 Ammonium : NH ₃ +NH ₄ -N (mg/l)	–	1.5	0.15	–	9.35	0.10	0.08	0.20	0.10	0.03	0.01
20 BOD (mg/l)	6	–	3.5	–	–	–	–	–	–	–	–
21 pH	6.5 – 9.2	–	7.1	7.0	6.3	7.5	6.9	7.4	5.1	6.5	6.1
22 Taste	not objectionable	–	UN	UN	UN	UN	UN	UN	UN	UN	UN
23 Odor	not objectionable	–	UN	UN	UN	UN	UN	UN	UN	UN	UN
24 Colour (TCU mg Pt/l)	50	15	104	41	24	ND	49	18	219	ND	10
25 Turbidity: Tr (NTU)	30	5	21.7	2.17	2.6	1.2	16.9	4.5	76.2	0.8	2.17
26 Temperature (°C)	–	–	28.3	23.0	31.0	29.2	29.1	28.6	30.2	28.9	28.0
27 Electrical Conductivity (microS/cm)	–	–	250	1710	45,410	1,490	4,870	280	300	1673	290
28 Sodium: Na (mg/l)	–	200	10	200	4,000	150	800	2	50	200	50.6
29 Potassium: K (mg/l)	–	–	2.50	10.00	15.00	0.20	3.75	0.50	7.50	12.50	1.25
30 Bicarbonate: HCO ₃ ⁻ (as CaCO ₃ mg/l)	–	–	52.0	56.0	430.0	320.0	204.0	122.0	8.0	40.0	22.0
31 Sulphate (as SO ₄ ²⁻ mg/l)	600	250	5.0	68	1,725	70	370	ND	54	45	50
Evaluation					Not suitable		Not suitable	Suitable	Not suitable		Suitable

*1: Guideline Value in "WHO Guideline for Drinking Water Quality Second Edition, World Health Organization, Geneva 2004
UN : unobjectionable
OB: Objectionable

(4) Evaluation of the experiment results on reducing Turbidity and Colour

As Turbidity and Colour are more than the Tanzanian Drinking Water Standard (1974) in mostly rainy season, these should be reduced to within the Standard for drinking water use. Although it is considered as theoretically possible to reduce them by sedimentation in 24 hours, it is necessary to confirm the effect by actual testing. Therefore, tests by sedimentation were carried out in the study using the river water of the Wami collected at Matipwili Village. Samples were collected in June (rainy season), and August and November (dry season) in 2006. The results are summarized in Table 2.7.

Samples collected in June and August showed the Turbidity value less than the Standard and 30% of Turbidity was reduced after 24 hours of sedimentation. Values of Colour were reduced from 50 mg pt/ L (more than Standard) to 44 mg pt/ L (within the Standard) after 24 hours of sedimentation.

A sample collected in November showed both Turbidity and Colour values more than the Tanzanian Standard. Turbidity was reduced to less than the standard after 42 hours sedimentation, however, Colour was still more than the standard after 48 hours of sedimentation.

When the sample was collected in Matipwili, it was raining. It might increase the outflow of soil.

The results of experiment shows that water quality of the Wami River generally meets the Tanzanian Standard, however, it is sometimes more than the standard. Therefore, treatment system for Colour is necessary to keep the water quality of the Wami River within the standard throughout the year.

Table 2.7 Test Results of Turbidity and Colour by 24 hours of Sedimentation

Month/Year Time	June 2006		August 2006		November 2006	
	Turbidity (NTU)	Colour (mg pt/ L)	Turbidity (NTU)	Colour (mg pt/ L)	Turbidity (NTU)	Colour (mg pt/ L)
Tanzanian Standard	30	50	30	50	30	50
Start	26	115	16	83	216	748
After 12 hours	14	59	14	67	78	374
After 16 hours	12	59	11	59	71	350
After 20 hours	11	51	11	44	64	328
After 24 hours	9	44	9	44	62	305
After 30 hours	9	44	9	44	43	195
After 36 hours	9	44	9	44	36	176
After 42 hours	9	44	8	44	29	141
After 48 hours	9	36	8	44	26	115

(5) Evaluation of Colour of spring water in Njopeka

Spring water in Njopeka spring showed brown in colour when the Study team visited the spring in June. Such phenomenon was not observed during the Master Plan Study. Therefore, attention was paid to analysis of Colour. The spring water showed 41 mg pt/ L of value against the Standard value of 50 mg pt/ L. Therefore, the spring water is suitable for the water source of Level-2 in Njopeka. However, chlorination is necessary for sterilization.

(6) Socio-Economic Consideration for the Target Villages

Socio-economic survey was carried out in all target communities, in order to assess Willingness-to-Pay (WTP) and Affordability-to-Pay (ATP) of the communities in operation and maintenance of the water supply scheme to be constructed under the Project. Based on the findings and results of the survey, analysis of operation and maintenance cost was conducted.

i) Survey methods and items

Socio-economic survey was conducted by sub-contracting with local consultant company under supervision of Japanese consultant (questionnaire/interview survey and data entry was sub-contracted, while compiling and analysis was carried out by Japanese consultant), of which objectives are as followed:

- (i) To comprehend socio-economic features of the target communities, current situations in water use and development needs, willingness and capability for operation and maintenance of the scheme, socio-gender issues to be considered in the formulation of water supply plan.
- (ii) To optimize water supply plan from socio-economic aspects.
- (iii) To develop operation and maintenance plans most suitable with the socio-economic conditions of the target communities.

In the socio-economic survey, total of 550 households (25 sample households in each target village) were interviewed using structured-questionnaire and the same number of samples are collected. A random selection method is adopted for the selection of sample households in a target village, dividing the area into clusters and select same number of samples from each cluster.

ii) Findings and results of the survey

Findings and results of the socio-economic survey, of which issues are deliberately examined and considered in the formulation of water supply plan and operation and maintenance plan, are described as followed:

(i) General economic characteristics of the village

Among various economic activities observed in the target communities, most of sample households (63.3%) responded farming as their prime means of living, followed by casual work (10.6%), and retail (8.6%). Observing the survey results in the secondary means of living, however, farming becomes less shared at 25.7% among communities, closely followed by casual work at 25.2 and retail at 12.6%, due to their location near to the urban centres. Thus, the target communities can be characterized as a complex of rural village and peri-urban setting, rather than typical type of rural village setting.

In the result of the survey, mean household expenditure per capita per month in the target communities' amounts to Tsh 12,500, while the figure in the region defers at Tsh 15,000 and Tsh 10,000 in Dar es Salaam Region and Coast Region, respectively. The mean figures on the same item obtained in the Household Budget Survey 2000/2001 conducted by National Bureau of Statistics are Tsh 16,349 and Tsh 8,172 in Dar es Salaam Region and Coast Region as a whole, respectively. Thus, the result in the socio-economic survey conducted in the Study can be relevant and realistic focusing on the target communities only, taking consideration on the differences in the survey period of the both survey and price index. Figure 2.2 illustrates the result of the survey in the mean household expenditure in each target village.

Observing the result of the socio-economic survey in mean household income per capita per month, the most dominant group of the sample households in the communities is distributed to the range of Tsh 30,001 – Tsh 60,000, followed by the range of Tsh 100,001 – Tsh 150,000. Although the distribution pattern by the Region is similar, in Dar es Salaam Region, relatively

better-off group in the range of Tsh 150,001 – Tsh 200,000 and the range of 200,001 – 300,000 are second and third largest dominant at 10.9% and 7.9%, while those ranges at 5.9% and 0.4% in Coast Region, respectively. In Household Budget Survey 2000/2001, mean household income in Dar es Salaam is Tsh 16,473 / capita / month, while the one in Coast Region is Tsh 8,102.

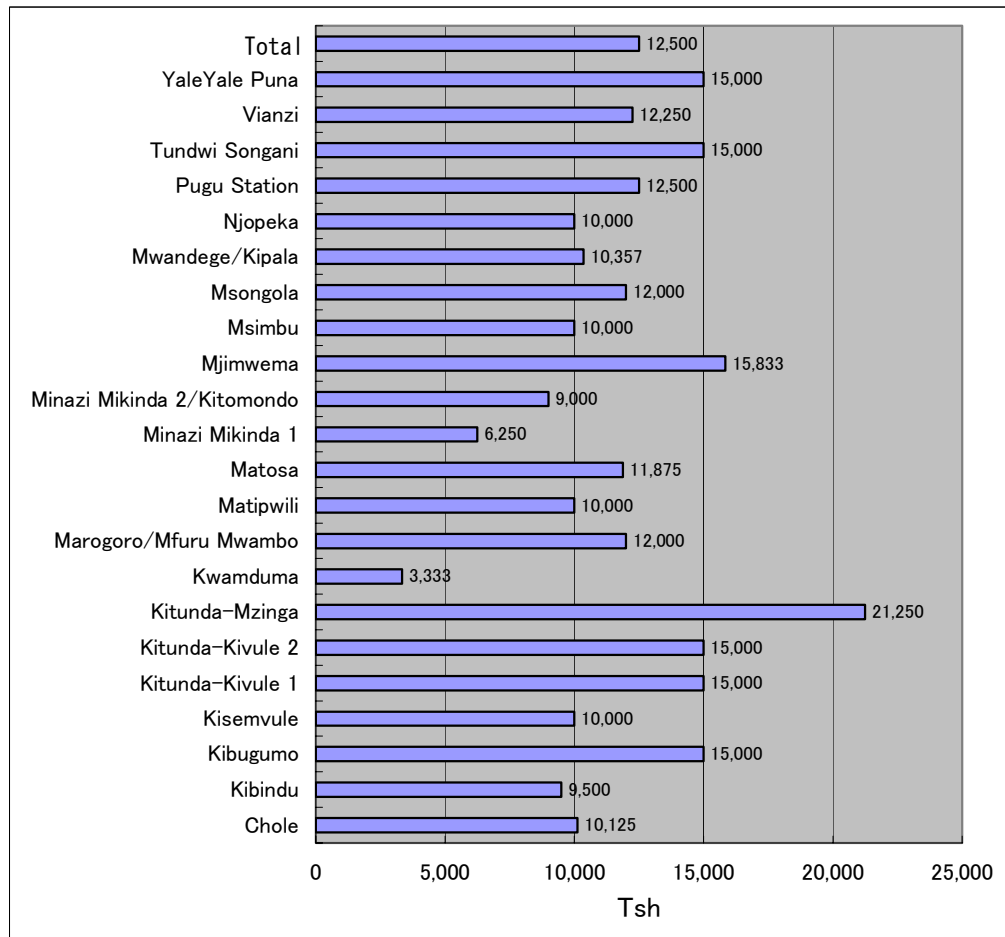


Figure 2.2 Mean Household Expenditure / Capita / Month (Tsh)

(ii) Current situation in water use and development needs in the target communities

The existing water source in the most frequent use for domestic purposes in the target communities is unprotected shallow well (45.4% and 42.1% of households in the communities rely on the said source in rain season and dry season, respectively), followed by protected shallow well (18.1% in rain season, 18,7% in dry season) and river/stream (16.3% in rain season, 16.4% in dry season). Awareness and satisfaction of the communities in the use of those existing water sources are measured by the sample households, by ranking the current condition at 5 levels (very good, good, fair, bad, and very bad). The result shows that more than 60% of sample households ranked the current situation either ‘bad’ or ‘very bad’. On the other hand, mean time taken to fetch water (go, queue, and come back) is 30 minutes in rain season, while it is doubled in dry season at 70 minutes. Taking consideration of less satisfaction of the

communities on current water situation and burden in water fetching, considerable expectation and needs of the communities on development of improved water supply scheme is identified.

The survey also results that mean water consumption/capita/day in the target communities amounts to 26.7 litre and 20.0 litre in rain season and dry season, respectively. Awareness and satisfaction of the communities on the amount of water currently available and consumed is also ranked by five level same as above, more than 60% of the sample households ranked the current amount of 26.7 litre/capita/day in rain season into either ‘fair’, ‘satisfactory’ or ‘very satisfactory’. This result support the relevance on unit amount of 25 litre/capita/day set in the water supply plan under the Project.

Furthermore, village needs of development and their priority in the target communities are identified, among various development sectors of rural electrification, health service and clinic, school and education, sanitation/sewerage system, disposal of garbage (solid waste management), access and approach roads. 66.9% of the sample households identified improvement of water facilities and service as first priority in their community development, while another 16.9% identified as second priority, of which total amounts to more than 80% (refer to the Figure 2.3).

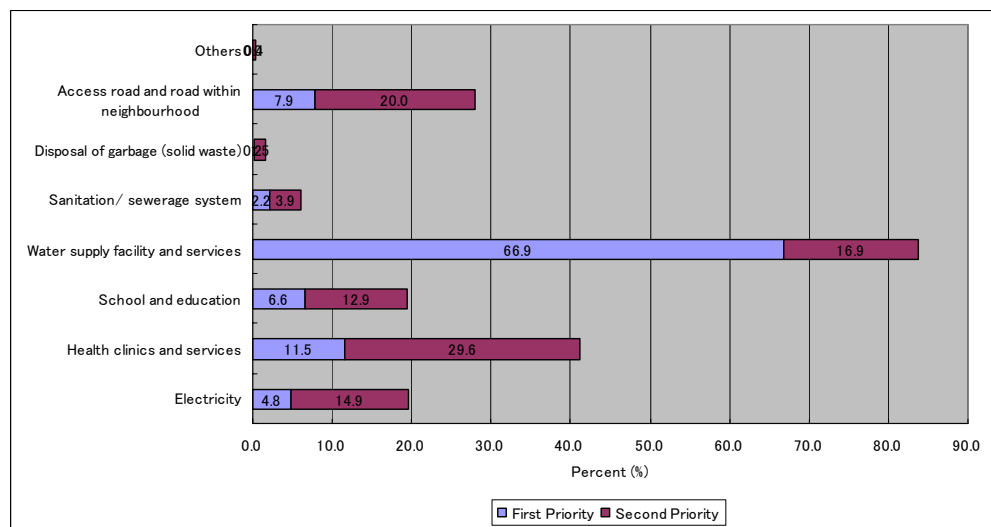


Figure 2.3 Development Needs of Target Communities and Priority

Although more than 70% - 80% of the sample households in the most of target communities regard improvement of water supply facilities and services as first or second priority, only 40% (32% as first priority, and 8.3% as second) put significance on water supply development in the target village of Matipwili in Bagamoyo District, while 73.7% in the same community put first and second priority on school and education (refer to Figure 2.4).

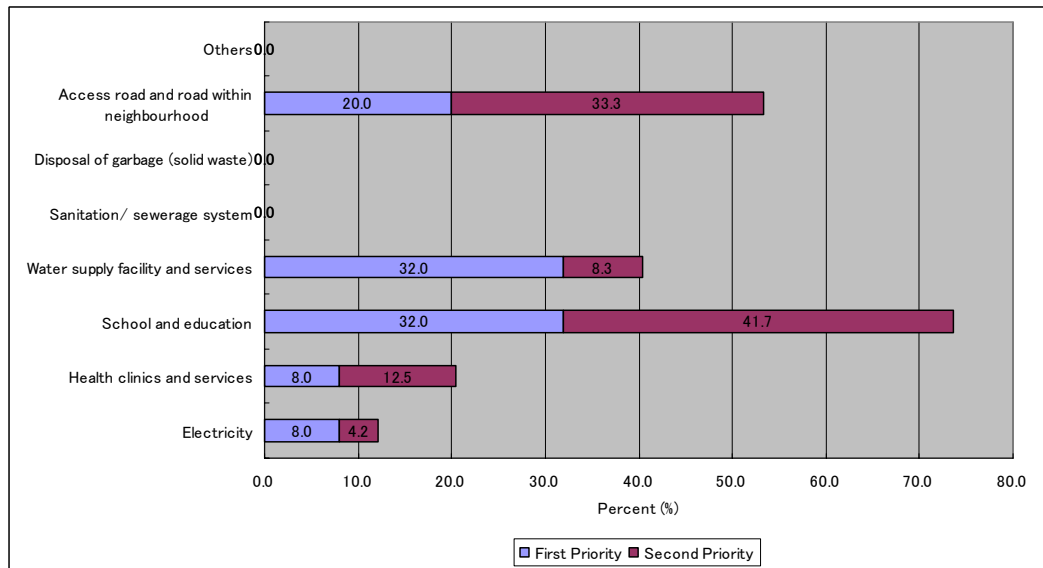


Figure 2.4 Development Needs and Priority in Matipwili, Bagamoyo District

In the same question to measure awareness and satisfaction of target communities on the current water situation by ranking five level (very satisfactory, satisfactory, fair, unsatisfactory, very unsatisfactory), 83.2% of total sample households responded either ‘unsatisfactory’ or ‘very unsatisfactory’, while in the contrary to the result of the entire target communities, 86.0% of sample households in Matipwili only perceive the current water supply condition as either ‘fair’, ‘satisfactory’ or ‘very satisfactory’. In the implementation of process for water supply development and establishment of operation and maintenance mechanism in Matipwili, activities to improve village awareness and ownership in the development process shall be intensively facilitated.

(iii) Village willingness and ability for operation and maintenance

Most of sample households (94.3%) of target communities responded that the responsibilities for operation and maintenance of the supply scheme shall be belong either to ‘beneficiary village’, in which response as ‘users themselves’, ‘community-based organization’, and ‘village council’ shares 20.3%, 50.4%, and 26.3%, respectively, while response as ‘local authority’, ‘water company’ and ‘donor/NGO’ amounts only 5.7% in total. Observing their awareness on the responsibility to bear the cost for operation and maintenance of the supply scheme, 90.7% of sample households regarded also that ‘beneficiary village’ is responsible, in which response as ‘users themselves’, ‘community-based organization’, and ‘village council’ shares 21.7%, 36.8%, 32.2%, respectively. However, it shall be noted that about 10% of sample communities maintain that responsibilities to bear the cost for operation and maintenance be belong to ‘external institutes’, such as ‘local authority’, ‘water company’, and ‘donor/NGO’. Thus, community understandings on ‘user-pay-principle’ in operation and maintenance of the supply scheme shall be further enhanced in the target communities.

In the analysis on the Willingness-to-Pay (WTP), the mean amount of user fee that the village is willing to pay is assessed in maximum at Tsh 20 per 20 litre container (Tsh 1 / litre). The following figure (Figure 2.5) shows the mean amount of user fee that the village is willing to pay in maximum.

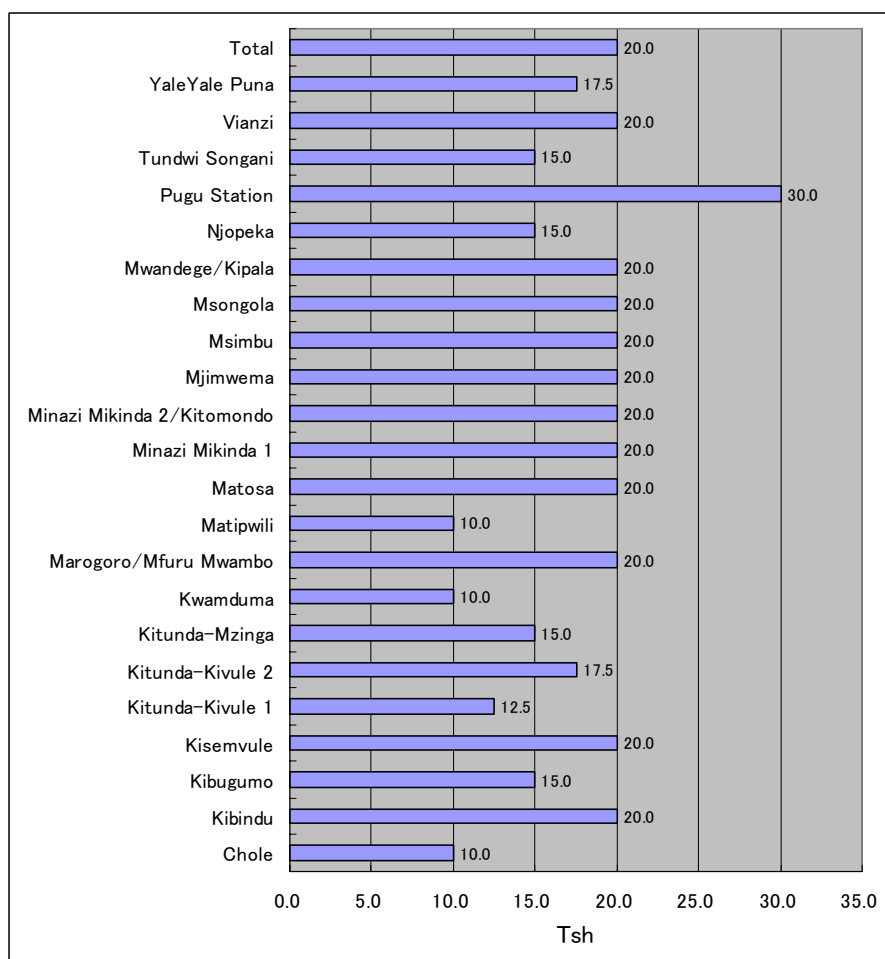


Figure 2.5 Village Willingness-to-Pay (Tsh/20 litre Container)

On the other hand, in the analysis of Affordability-to-Pay (ATP), the percentage of expense for water use in the total household expenditure per capita, which realizes full cost recovery for operation and maintenance over 10 years, is estimated, based on assumption that 25 litre / day / capita is consumed and 80% of users pay for the consumption. As a result, it is recommended necessary to reconsider the feasibility of full cost recovery in Kwamduma in Bagamoyo District and Minazi Mikinda 1/2 in Kibaha District, while the affirmative results are confirmed in other target communities.

(iv) Cost recovery for operation and maintenance

User-Pay-Principle is introduced in the Project in operation and maintenance of the supply schemes. The costs for operation and maintenance for the water supply scheme are estimated in general by calculating operational costs such as fuel and personnel costs. However, in the

estimation under the Study, management costs are also included for the basis of estimation, such as management costs for Community-Owned Water Supply Organization (COWSO) and costs for contracting-out of service provision for private service providers. Furthermore, considering maintenance costs (such as spare parts, regular maintenance of pumping unit, and office supplies) and replacement cost of the supply facilities, cost for operation and maintenance in the scheme management under the Project is estimated in more realistic manners.

In estimation of operation cost, annual consumption of fuel and chemical is determined in each supply scheme, and market price of these goods in the Study period is applied for. On the other hand, personnel costs included both in operation cost and management cost are determined in proportion to the requirement in duties, based on mean annual household income (Household Budget Survey 2000/2001). Estimation of replacement cost for the supply facilities are based on the initial capital cost (i.e. construction costs) of local standard and average not to be overestimate the cost, instead of construction costs in the Japanese Grant Aid Scheme, since the supply facilities would be replaced with ones with less asset values applying local standard of construction and employing local contractors. In those estimations, target planning period is set 10 years from 2010 when the construction is completed. The basis of estimation for operation and maintenance cost are shown below (see Table 2.8).

Table 2.8 Basis of Cost Estimation for Operation and Maintenance

Cost	Item	Approximation
Operation Cost	Fuel	Consumption in each scheme is estimated and market price of fuel (*1) is applied.
	Chemical	Consumption in each scheme is estimated and market price of chemical (*2) is applied.
	Wage and Allowance	
	Pump Operators	100% of Mean Annual Income/Person (*2)
	Kiosk Attendants	25% of Mean Annual Income/Person
	Security Guards	100% of Mean Annual Income/Person
Management Cost	Commission for COWSO	20% of Mean Annual Income/Person
	Management/Service Contract	
	Scheme Manager	200% of Mean Annual Income/Person
	Accountant	150% of Mean Annual Income/Person
	Overhaul of Pump	3% of Cost for Pump
Maintenance Cost	Supply, Tools	10% of Locally Estimated Construction Cost for First 5 Years
	Spare Parts	20% of Locally Estimated Construction Cost for Later 5 Years
	Regular Pump Maintenance	
Replacement		10% of Locally Estimated Construction Cost/Year
Risks and Inflation		5% of Replacement Cost

*1: Unit Price of Diesel Tsh.1,300/Liter

*2: Unit Price of Chemical Tsh.1,500/kg

*3: Mean Monthly Income Tsh.99,876/capita (Household Budget Survey 2000/2000, National Bureau of Statistics Tanzania, 2002)

Estimating the operation and maintenance cost for the supply scheme in each village applying the basis of estimation above, financial sustainability of each supply scheme under the Project are assessed with analysis on Willingness-to-Pay (WTP) and Affordability-to-Pay (ATP). The table below (Table 2.9) summarized the results.

Table 2.9 Operation and Maintenance Cost and WTP/ATP

Community	Population (2010)	① Total Capital Cost (USD)	② Capital Cost / Capita (USD)	③ Total OM Cost / Year (USD)	④ OM Cost/ Year/ Capita (USD)	⑦ % of Per Capita OM Cost in Median Income	⑤ % of Per Capita OM Cost in Median Expenditure	⑥ OM Cost Over 10 Years	⑦ Water Rate/ Litre (Tsh) for Full OM Cost Recovery
BAGAMOYO									
Kibindu	4,778	89,703	18.8	39,301	6.7	7.3%	6.2%	393,008	1.0
Kwanduma	2,109	66,128	31.4	24,391	9.5	10.2%	24.9%	243,915	1.4
Matipwili	2,342	68,187	29.1	25,254	8.8	9.6%	7.7%	252,537	1.3
KIBAHA									
Minazi Mikinda 1/2	1848	64,977	35.2	18,242	7.1	7.6%	9.9%	182,417	1.1
Minazi Mikinda 2/2, Kitomondo	2315	69,390	30.0	20,322	6.3	6.8%	6.1%	203,215	1.0
KISARAWE									
Chole	2966	72,938	24.6	26,669	7.8	8.4%	6.8%	266,689	1.0
Msimbu	2458	68,577	27.9	25,398	9.0	9.7%	7.9%	253,979	1.3
MKURANGA									
Njopeka	3555	81,281	22.9	28,555	5.7	6.1%	5.0%	285,546	0.9
Mwandege, Kipala	2370	70,021	29.5	24,767	7.4	8.0%	6.3%	247,673	1.0
Kisemvule	1980	66,318	33.5	22,163	7.9	8.6%	6.9%	221,635	1.2
Marogoro, Mfuru Mwambao	2219	68,582	30.9	19,326	6.2	6.7%	4.5%	193,257	1.0
Vianzi	3457	80,343	23.2	27,195	5.6	6.0%	4.0%	271,952	0.9
ILALA									
Kitunda-Kivule 1/2	3,746	85,024	22.7	28,139	4.8	2.6%	2.8%	281,393	0.8
Kitunda-Kivule 2/2	2,499	72,535	29.0	24,615	6.3	3.4%	3.7%	246,149	1.0
Kitunda-Mzinga	5,895	106,556	18.1	41,305	4.5	2.4%	1.8%	413,047	0.7
Msongola	2,244	69,975	31.2	20,227	5.7	3.1%	4.2%	202,269	0.9
Pugu Station	3,972	87,292	22.0	28,355	4.6	2.4%	3.2%	283,552	0.7
KIDONDONI									
Matosa	3,074	77,565	25.2	26,946	5.9	3.1%	4.3%	269,462	0.9
TEMEKE									
Kibugumo-Salanga	2,698	74,530	27.6	21,389	5.1	2.7%	2.9%	213,886	0.8
Mjimwema	2,095	68,485	32.7	19,032	5.8	3.1%	3.2%	190,321	0.9
YaleYale Puna	1,830	65,835	36.0	19,239	6.7	3.6%	3.9%	192,394	1.1
Tundwi Songani	2,037	67,910	33.3	22,281	7.0	3.7%	4.1%	222,814	1.1

- ① Construction cost (asset value) is estimated according to the scale of supply scheme which satisfy the needs of the population in 2015.
- ② Per capita construction cost (per capita asset value) in 2020 is estimated, when the construction of supply scheme is completed.
- ③ Annual operation and maintenance cost is calculated based on the estimation of ③ applying “the basis of estimation for operation and maintenance cost”.
- ④ Per capita annual operation and maintenance cost is estimated based on the assumption that 80% of population including the increase over 10 years utilize and pay for use of the supply scheme.
- ⑤ Percentage of expense for use of the scheme in household expenditure/capita, of which data is collected under the socio-economic survey under Basic Design Study, is estimated.
- ⑥ Total cost for operation and maintenance cost necessary over 10 years is estimated.
- ⑦ Water fee per liter is estimated which satisfy the required operation and maintenance cost over 10 years, based on the assumption that 80 percent of population consume 25 liter/capita/day and pay for the consumption.

In the aspect of “Willingness-to-Pay” (WTP), the Socio-Economic Survey conducted under the Study revealed that the maximum amount affordable to pay for water supplied through piped scheme is 1Tsh/L (i.e. 20 Tsh per 20 litre container). In the analysis of WTP, water tariff per litre set for realization of full recovery for operation and maintenance cost over 10 years (see ⑦ in the above table) is compared with maximum amount affordable to pay (i.e. 1 Tsh/L as an amount of WTP). Water tariff for realization of full operation and maintenance cost recovery is set based on the assumption that 80% of village consume 25 litre/day/capita and pay for the

consumption. As a result, there are four communities in that amount of WTP exceeds tariff set for full recovery of operation and maintenance cost over 10 years (Kwamduma and Matipwili in Bagamoyo District, Minazi Mikinda 1/2 in Kibaha District, Kisemvule in Mkuranga District, Yaleyale Puma and Tundwi Songani in Temeke Municipality).

In the analysis of “Affordability-to-Pay” (ATP), percentage of expense for water supplied by the newly constructed scheme in the total household expenditure/month/capita is estimated in order to realize full recovery of operation and maintenance cost including replacement cost over 10 years. The estimation of percentage is made, based on the assumption that 80% of population consume 25 litre/day/capita and pay for their consumption (see ⑤ in the above table). Figures in the total household expenditure/month/capita are varied according to the communities, applying the median figure among each village obtained by the Socio-Economic Survey conducted under the Basic Design Survey. International organizations such as WHO recommends the expense for water in total household expenditure shall be remained in the range of 4-5%. In the analysis of operation and maintenance cost for the supply scheme in the Study, the acceptable range is kept the 6% level, taking consideration on that operation and maintenance cost in the Study is estimated in relatively expansive manners including cost for service/management contracting-out and full replacement of the scheme. In spite of such an application, in Kwamduma in Bagamoyo District and Minazi Mikinda 1/2 in Kibaha District, percentage of expense for water in total household expenditure exceeds considerably at 24.9.7% and 9.9%, respectively.

In the both aspects of WTP and ATP, financial feasibility and sustainability for the scheme operation and maintenance is confirmed in the most of target communities. However, it is observed that the tariff set for full cost recovery exceeds the amount of WTP in six communities (Kwamduma and Matipwili in Bagamoyo District, Minazi Mikinda 1/2 in Kibaha District, Kisemvule in Mkuranga District, and Yaleyale Puna and Tundwi Songani in Temeke Municipality).

Some of international development organizations such as WHO recommend that the household expense for water use be remain within 4% - 5% of total household income. In the operation and maintenance plan of the Study, operation and maintenance cost of the supply schemes are estimated comparatively higher than in the conventional estimation, including cost for contracting-out of provision services to private service providers and full replacement cost. Thus, the range of maximum percentage of household expenditure for water in the total income is set 6% - 7%. With applying this parameter, among six communities of critical mentioned above, enough ‘Affordability-to-Pay’ (ATP) is confirmed in three communities (Kisemvule in Mkuranga District, Yaleyale Puna and Tundwi Songani in Temeke Municipality). However, in other three communities, namely Kwamduma and Matipwili in Bagamoyo, Minazi Mikinda in Kibaha District, and Msimbu in Kisarawe, it is assessed that realization of full cost recovery for operation and maintenance by user communities is not supported both by Willingness-to-Pay

and Affordability-to-Pay analysis, in which construction of Level-2 supply scheme is not applicable with less financial sustainability. Details in the issues in this section would be further elaborated in Chapter 4 of Operation and Maintenance Plan.

In case that the technology option is replaced by number of Level-1 supply facilities (borehole fitted with hand pump) necessary to serve same target population with user fee set at 1 Tsh/litre, the percentage of water expense in total household expenditure becomes below the parameter in those three communities as shown below. Therefore, construction of Level-1 scheme is considered appropriate in those communities.

Kwamduma in Bagamoyo District (4 Level-1 schemes):	6.0%
Minazi Mikinda 1/2 in Kibaha District (4 Level-1 schemes):	3.2%
Msimbu in Kisarawe District (6 Level-1 schemes):	2.0%

(7) Summary of Type of Water Supply Scheme in each Village

Evaluation results from 1) to 5) are summarized as shown in Table 2.10.

Table 2.10 Summary of Type of Water Supply Scheme

District/ Municipality	Village	Test Well		Socio -Economy	Evaluation (Type of Scheme)
		Yield	Water Quality		
Bagamoyo	Kibindu	/	/	suitable	Level-2
	Kwamduma			not suitable	Level-1 x 4
	Matipwili	sufficient	suitable	not suitable	No alternatives Excluded from the target village
Kibaha	Minazi Mikinda (1/2)	sufficient	suitable	not suitable	Level-1 x 4
	Minazi Mikinda (2/2) /Kitomondo	sufficient	suitable	suitable	Level-2
Kisarawe	Chole	not sufficient	not suitable	suitable	Level-2 (Second test well will be drilled in D/D study)
	Msimbu	sufficient	suitable	not suitable	Level-1 x 6
Mkuranga	Njopeka	/	/	suitable	Level-2
	Mwandege/Kipala			suitable	Level-2
	Kisemvule			suitable	Level-2
	Marogoro/ Mfuru Mwambao			suitable	Level-2
	Vianzi			suitable	Level-2
Ilala	Kitunda-Kivule (1/2)	/	/	suitable	Level-2
	Kitunda-Kivule (2/2)			suitable	Level-2
	Kitunda-Mzinga			suitable	Level-2
	Msongola			suitable	Level-2
	Pugu Station			suitable	Level-2
Kinondoni	Matosa	not sufficient	not analyzed	suitable	Level-2 (Second test well will be drilled in D/D study)
Temeke	Kibugumo	/	/	suitable	Level-2
	Mjimwema-Salanga			suitable	Level-2
	Yaleyale Puna			suitable	Level-2
	Tundwi Songani			suitable	Level-2

Level-2 water supply scheme: 18 schemes (Two schemes are waiting for the results of the second test well drilling in D/D study)

Level-1 water supply scheme: 14 schemes in 3 villages

Excluded from the target: 1 village (Matipwili in Bagamoyo District)

(8) Timing of Test Well Drilling

Test well drilling was carried out in five (5) villages in this Study. It was planned to decide the type of water supply scheme based on the result of the test well drilling. Two (2) preparatory wells were provided in case that the first test well was not successful well. As four (4) wells were not successful, therefore, two (2) well were further necessary to drill the second wells. Therefore, additional two (2) test wells are planned to drill in the Detailed Design Study of the Project.

A Level-2 water supply scheme is composed of intake facility (groundwater, surface water and spring water), transmission line, distribution tank, distribution lines and public water point. In case of Level-2, changing of design will be frequently required during the construction work of a scheme if water source is fixed before starting of construction work.

17 Level-2 schemes of that water source are groundwater require 23 deep wells. Among them, two (2) wells are the second test wells. In order to keep remaining 21 wells, a total of 30 wells will be required considering the successful rate as 70%. Therefore, 32 test wells will be necessary in total.

There are three (3) alternative plans for the timing of test well drilling;

- ① To drill the entire test wells at the first stage of the Detailed Design Study.
- ② To drill allocated number of test wells in each phase of the Detailed Design Study.
- ③ To drill the entire test well in the construction stage, except two (2) second test wells.

These alternative plans were evaluated as shown in Table 2.11.

Comparing three (3) alternatives, the alternative-2 is evaluated as the most effective for following reasons.

- ① Both period of the Detailed Design Study and the implementation cost are well balanced.
- ② Changing of design will be minimized during the construction stage.

Table 2.11 Alternatives of Test Well Drilling Schedule

Timing of drilling	Alternatives -1	Alternatives -2	Alternatives -3
The second test wells	D/D Study period in phase 1	D/D Study period in phase 1	D/D Study period in phase 1
Deep wells for water sources	The entire test wells (31 wells in Maximum) are drilled in the D/D study period in phase 1.	The allocated number of test wells will be drilled in the D/D study period in each phase.	The entire test well will be drilled in the construction stage, except two (2) second test wells.
Necessary period for drilling work	Approximately 6 months	Approximately 3 months	—
Evaluation	Period of the D/D study is too long since test well drilling work requires 6 months. It cause the construction period too short. As the water sources are fixed at the initial stage of the project, the D/D study period of phase 2 will be minimized. However, period of the Detailed Design Study and the implementation cost are not well balanced.	Drilling period requires 3 months. Changing of design will be minimized because water sources are fixed before the construction work. The implementation cost of each phase will be averaged.	The construction work will start without fixing of the water sources. It will cause frequent changing of design during the construction work period.

<Test well drilling plan in the Detailed Design stage>

Necessary number of test well for Level-2 scheme is 23 wells for 18 schemes (11 well in phase 1 and 12 wells in phase 2). One (1) well out of 23 was already obtained as a successful well in the basic Design Study, therefore, the total of 22 successful wells shall be obtained as the test wells. When the first test well is not successful, the second test well will be drilled following the agreement with the Tanzanian side. Thus, a maximum of 42 test well will be provided to get 22 successful wells as shown in Table 2.12.

Table 2.12 Summary of Test Well Drilling

District/Municipality	Village	Number of Well	Level-2				
			Basic Design Study		Detailed Design study		
			Successful Well	Non-successful Well	Test Well (1)	1st Test Well (2)	2nd Test Well (2)
Bagamoyo	Kibindu	2	0	0	0	2	2
Kibaha	Minazi Mikinda(2/2)Kitomondo	1	1	1	0	0	0
Kisarawe	Chole	2	0	1	1	1	1
Mkuranga	Mwandege /Kipala	1	0	0	0	1	1
	Kisenvule	2	0	0	0	2	2
	Marogoro /Mfuru Mwambao	1	0	0	0	1	1
	Vianzi	1	0	0	0	1	1
Ilala	Kitunda-Kivule (1/2)	2	0	0	0	2	2
	Kitunda-Kivule (2/2)	1	0	0	0	1	1
	Kitunda-Mzinga	2	0	0	0	2	2
	Msongala	1	0	0	0	1	1
	Pugu Station	1	0	0	0	1	1
Kinondoni	Matosa	1	0	1	1	0	0
Temeke	Kibugumo	1	0	0	0	1	1
	Mjimwema	1	0	0	0	1	1
	Yaleyale Puna	1	0	0	0	1	1
	Tundwi Songani	2	0	0	0	2	2
Total		23	1	3	2	20	20

Test Well (1): Supplement to the Basic Design Study (2 wells)

Test Well (2): Other test wells (Number of the 2nd well is same as that of the 1st well) (maximum 40 test well)

Maximum number of test well is 18 in phase 1 and 24 in phase 2 as shown in Table 2.13.

Table 2.13 Test Well Drilling Plan for Phase 1

Phase	Village	Number of Well	Basic Design	Detailed Design					
			Successful Well	Test Well (1)	1st Test Well (2)	2nd Test Well (2)	Total	Type of Well	
1	Matosa	1	0	1	0	0	1	3S	
	Minazi Mikinda(2/2)Kitomondo	1	1	0	0	0	0	1S	
	Kibugumo	1	0	0	1	1	2	1S	
	Mjimwema	1	0	0	1	1	2	1S	
	Kibindu	2	0	0	2	2	4	3H	
	Chole	2	0	1	1	1	3	2S	
	Yaleyale Puna	1	0	0	1	1	2	2S	
	Tundwi Songani	2	0	0	2	2	4	2S	
	Total	11	1	2	8	8	18		
	Number of the 1st Test Well in Phase 1				10		-	18	
	Number of the 2nd Test Well in Phase 1				-		8		

Table 2.14 Test Well Drilling Plan for Phase 2

Phase	Village	Number of Well	Basic Design	Detailed Design			Total	Type of Well
			Successful Well	Test Well (1)	1st Test Well (2)	2nd Test Well (2)		
2	Kitunda-Kivule (1/2)	2	0	0	2	2	4	2S
	Kitunda-Kivule (2/2)	1	0	0	1	1	2	2S
	Kitunda-Mzinga	2	0	0	2	2	4	2S
	Msongala	1	0	0	1	1	2	2S
	Pugu Station	1	0	0	1	1	2	2S
	Mwandege /Kipala	1	0	0	1	1	2	2S
	Kisemvule	2	0	0	2	2	4	2S
	Marogoro /Mfuru Mwambao	1	0	0	1	1	2	1S
	Vianzi	1	0	0	1	1	2	3S
	Total	12	0	0	12	12	24	
	Number of the 1st Test Well in Phase 1				12		-	24
Number of the 2nd Test Well in Phase 1				-		12		
Total		1st Test Well		22		-		
		2nd Test Well		-		20		

Test Well (1): Supplementary test well for Basic Design Study (2 wells)

Test Well (2): Other test wells (Number of 2nd test well is same as that of 1st test well, 40 wells in maximum)

Table 2.15 Number of Each Type of Test Well

Type	Aquifer	Depth (m)	Number of Test Well		
			Phase 1	Phase 2	Total
1S	Neogene formation	50	4	2	6
2S	Neogene formation	80	9	20	29
3S	Neogene formation	120	1	2	3
3H	Rock	120	4	0	4
Total			18	24	42

Drilling results will be evaluated whether successful or not considering the criteria on yield by pumping test and water quality. Criteria are same as that of agreement during the Basic Design Study.

If yield is not enough for the water demand of a target village, following evaluation will be considered. Capacity of a Level-2 scheme will be reduced to meet the yield, then the scheme will be evaluated whether the operation and maintenance cost is proper level or not considering the socio-economic condition of the village. If it is evaluated as feasible, appropriate capacity of Level-2 scheme will be planned. On the other hand, if it is not feasible, Level-1 schemes will be planned.

In the evaluation, total yield of wells will be considered when multiple number of well is planned.

<Warranty against defects on test wells drilled during the Detailed Design Study>

Warranty against defects on facilities is generally provided in the construction contract. It is not provided in case that the well are drilled as the test wells. However, the test wells are planned to

be used as the water source of the water supply facilities in this plan. Therefore, the study was carried out how to provide warranty against defects in order to make clear this issue. If the wells are drilled in the construction contract by a Contractor, the Contractor is responsible for warranty against defects. When the wells are drilled in the Study stage, such work is generally sub-contracted to a local drilling contractor without any warranty. In these case, responsibility for against defects is not clear. The study results are summarized as shown in Table 2.16.

Table 2.16 Summary of Responsibility for Warranty of Wells

Organization	Work Contents	Responsibility for Warranty
MoW	To employ a Consultant for implementation of Detailed Design Study including test well drilling and Supervision. To receive completed wells from the Consultant.	Responsible for management of wells.
Consultant	To carry out test well drilling as a part of the Detailed Design Study and to hand over the completed wells. Responsibility for warranty is generally expired when the wells are handed over to MoW.	Not responsible for management of wells. But, has moral obligation to manage the wells up to the start of construction work. If warranty is necessary, it is included in the contract with the sub-contractor.
Local Drilling Contractor	To drill the test wells as the sub-contracting work of the Consultant.	It could be possible to include responsibility for warranty against defects in the contract between the Consultant and the local contractor.
Japanese Construction Contractor	To be employed by MoW for the construction work of water supply facilities. Existing wells drilled during the Detailed Design Stage are used as water sources.	Responsible for warranty against defects of water supply facilities except wells.

As the results of the study above, it is considered as reasonable to provide responsibility for warranty against defects as shown in Table 2.17, when test wells are drilled in the Detailed Design Study atage.

Table 2.17 Responsibility for Warranty against Defects on Water Supply Facilities

	Wells	Water Supply Facilities other than Wells
MoW		
Consultant	Responsible for management	
Local Drilling Contractor	Responsible for warranty against defects	
Japanese Construction Contractor	No responsibility	Responsible for warranty against defects

2) General Concept of Design

- ① Design Manual (MoW, 1997) is applied in the designing of water supply facilities. Unit water demand is 25 L/capita/day. Items not described in the manual are designed applying Japanese Design Standard for Waterworks Facilities.
- ② Applicable standards for materials and equipment are those widely applied in Tanzania such as ISO, BS, SABS and DIN.

- ③ Water quality shall satisfy WHO Guideline (2004) for “Chemicals that are of health significance” and Tanzanian Drinking Water Quality Standard (1974) for other items.
- ④ In order to minimize the operation and maintenance cost, water sources should be groundwater. However, source is spring water in Njopeka Village in Mkuranga district, where groundwater potential is evaluated as not enough for water source.
- ⑤ Type of water supply facilities are basically piped water supply facilities (Level-2), however, deep wells with handpump are constructed in Kwamduma, Minazi Mikinda (1/2) and Msimbu to reduce the operation and maintenance cost to a proper level of affordability to pay of community people.
- ⑥ Source water is transmitted by pressure of the submersible pump from deep well to distribution tank through pipeline and is distributed from a distribution tank without chlorination. Only spring water is distributed from a tank after chlorination.
- ⑦ Water supply service area is limited to areas to where water reaches by gravity. One distribution tank is constructed in one water supply scheme. No auxiliary tank and booster pump are included. Water is distributed by gravity to the service area from a distribution tank.
- ⑧ Assistance by software component is carried out to empower the ability of for empowerment of relevant organizations and community-owned water supply organizations.

3) Concept against Natural Condition

The study area, Coast Region and Dar es Salaam Peri-Urban, is characterized by hot and humid tropical savanna climate. Rainy seasons are generally observed twice in a year, from March to May and From November to December. Annual precipitation reaches approximately 1,000 mm. Since roads in the Study area are not paved except for main highways, access roads to the target villages become muddy and slippery in places. Therefore, water supply schemes in such villages shall be constructed in dry season.

Aquifers distributed in the Study area are of fissure in Pre-Cambrian Rocks in Bagamoyo District and of stratified aquifer in Neogene formations in other area. Attention shall be paid to these characteristics of aquifers in developing groundwater in the Study area. In Neogene aquifers, rapid changes in water quality and potential are frequently observed due to sharp horizontal change in phases of formations. Especially it is characteristically observed that groundwater suddenly changes from fresh to saline from place to place. Drilling site for water wells shall be carefully decided considering these circumstances. As for drilling method of water wells, DTH method is applied for consolidated hard Pre-Cambrian Rocks and mud rotary method for Neogene formations.

4) Concept against the Socio-Economic Condition

User-Pay-Principle (UPP) is introduced in the operation and maintenance of the supply schemes to be developed in the Project. Water tariff for use of the scheme shall be set to realize full cost recovery for operation and maintenance, but also, not to exceed affordability of the target communities. The

tariff would be set in the careful consideration of Willingness-to-Pay (WTP) and Affordability-to-Pay (ATP) of the communities. Introduction of increasing block tariff structures and lifeline block is considered in the Study, of which implementation is further recommended in the collaboration with future technical cooperation in the Project area.

5) Condition for Construction Works and Procurement

(1) Access to the Target Villages

Roads in the Study area are not paved except for main roads. These are generally less than 3m in width, therefore, it is difficult for heavy vehicles to access to the sites. Road condition is generally good in dry season, however, it becomes worse in rainy season from March to May and from November to December. In the implementation plan, much attention shall be paid to accessibility to the sites.

(2) Procurement Plan

i) Materials for construction works

Cement is produced by three (3) major local makers. Reinforcement is locally produced from basic steel imported from South Africa. Materials such as sand, gravel, wooden forms, etc. are easily procured in the local market. Therefore, materials for construction works shall be purchased in the local market.

ii) Pipes for deep well and water works

PVC and HDPE pipes to be used in the project are processed by two (2) major manufacturers in Tanzania using raw chips imported from Middle Eastern countries. Qualities of these are good enough to be used in the project. They are widely used and are obtainable through local agents.

As for GPS pipes to be used for road crossing, ones locally processed and/or imported from South Arica are available.

Submersible pumps and engine generator should be imported from Japan or the third countries considering the supplying of spare parts and after services.

6) Concept on Local Contractors

Construction contractors in Tanzania are all registered with Contractor Registration Board (CRB), National Construction Council (NCC). Approximately 4,000 contractors are registered to the board. They are ranked from Class 1 to Class 7 in descending order according to the capital, experiences, machineries possessed and so on. In 2005, contractors ranked to Class 1 consist of 30 companies in the civil sector (including 20 foreign companies) and 51 in the architect sector (including 29 foreign companies). Local major contractors have enough experiences in the construction of water supply facilities like this project implemented by Donors and International Organizations. When Japanese contractors work in Tanzania, these local contractors ranked to level 1 are available as the sub-contractors.

7) Capability of Operation and Maintenance of Implementation Agencies

User-Pay-Principle (UPP) in operation and maintenance of the rural water supply schemes has been one of major strategy in the country, and also stipulated clearly in the National Water Policy of 2002. In addition, in Draft Final of National Water Sector Development Strategy 2005 - 2015, reorganization of sub-sector institutions and decentralization is facilitated, under which responsibilities and duties for operation and maintenance are transferred to the lowest appropriate level. Along with the implementation of those policies and strategies, functional roles and responsibilities of Ministry of Water, implementing agency of the Project, is defined to 'policy making, regulation and monitoring' in the sub-sector development.

In the institutional/organizational framework of decentralization promoted under the current sub-sector policies and strategies, the primary roles and responsibilities for operation and maintenance shall be taken by beneficiary communities. However, weaknesses and limits of conventional Village Water Committee (VWC) in operation and maintenance being pointed out, Community-Owned Water Supply Organization (COWSO) shall be introduced in the Project in order to establish firm community-based operation and maintenance structures on the ground. On the other hand, taking consideration on the fact that less developed capacity of governmental authorities in sub-sector development for provision of technical guidance to the communities resulted in non-functioning of community-based operation and maintenance mechanism, capacity development of such authorities, in particular District/Municipal Council and District/Municipal Water Engineer Office (DWE) shall be planned and facilitated under the Project.

Ministries responsible for the development of water and sanitation sectors in the countries are Ministry of Water (MoW) and Ministry of Health (MoH). While MoW is responsible for water sector development in planning and implementation, MoH takes in charge of health and sanitation sector development. At the local administrative level, local authorities such as Regional Secretariat and District Council, along with Regional/District Water Engineer Office (RWE/DWE) is responsible for the sector development.

MoW is responsible entirely for water supply development and resource management. For the water supply development, the Ministry operates through Division of Water Supply (DUWS) for urban development and Division of Rural Water Supply (DRWS) for rural development. Figure 2.6 illustrates organizational diagram of MoW. DRWS, responsible for rural water supply development, employs 91 engineers and 352 technicians under the Director.

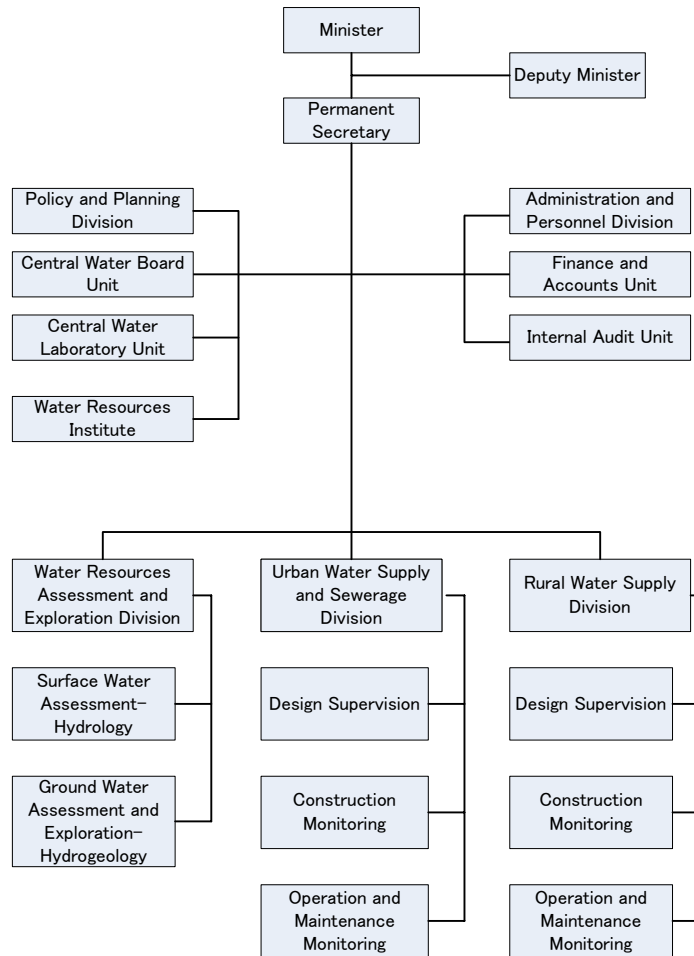


Figure 2.6 Organizational Chart of MoW

Organizational setup of District/Municipal Council and District/Municipal Water Engineer office (DWE/MWE) is delineated in Figure 2.7 and 2.8, respectively, citing example from Bagamoyo District, of which structure is typical and similar in other District/Municipal.

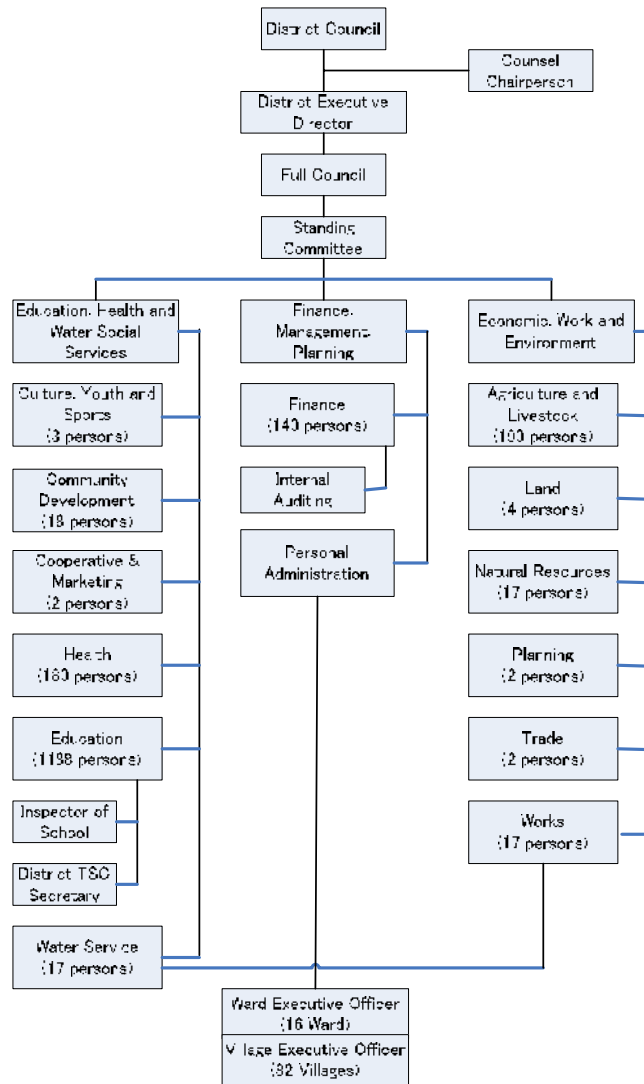


Figure 2.7 Organizational Setup of Bagamoyo District Council

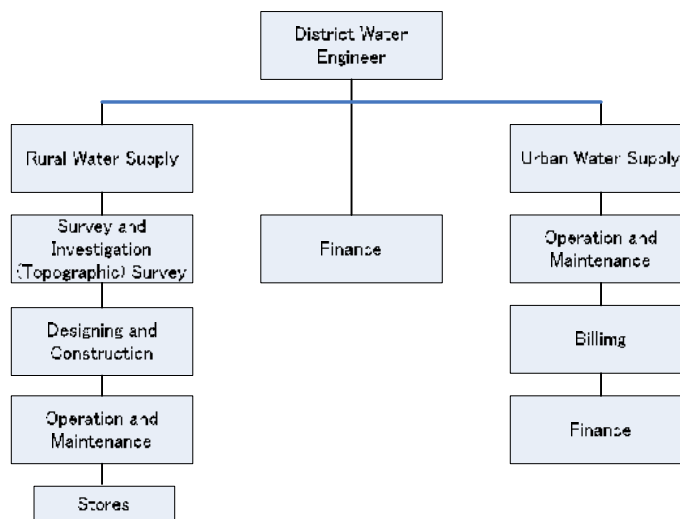


Figure 2.8 Organizational Setup of Bagamoyo District Water Engineer Office

Development budgets allocated for DRWS/MoW since 2002 are shown in the Table 2.18.

Table 2.18 Development Budget allocated for DRWS

Item	(Unit: Million Tsh)				
	Year	2003	2004	2005	2006
Rate of Increase (%)		-	117.7	10.7	31.1
Extension of Existing Scheme		5,062.0	7,226.1	5,236.5	8,102.1
Rehabilitation of Existing Scheme		2,604.6	4,153.9	8,410.0	823.4
Construction of Well and Reservoir		445.5	351.9	351.9	791.9
Rural Water and Sanitation Project		2,621.7	11,728.5	11,963.0	23,995.3
Strengthen of DDCA		193.5	328.5	363.6	795.3
Total		10,927.2	23,788.9	26,325.0	34,508.0

Amount of budget allocated to the rural water supply sector is steadily increasing. Especially, remarkable increases are observed in 2004 and 2006. The former correspond to the year of commencement of a Japanese Grant Aid Schemes (Rindi and Mtwara Rural Water Supply Project). and the latter to that of NRWSSP.

Operation and maintenance of the supply scheme constructed under the Project is undertaken by beneficiary communities. As mentioned earlier, conventional Village Water Committee (VWC) is assumed to take the roles and responsibilities in the scheme operation and maintenance. However, VWCs, in the most cases, has less awareness and capacity in management of the supply schemes, which resulted in malfunctioning of the supply facilities. Introduction of the process to form Community-Owned Water Supply Organization, which is widely and currently regarded as one of the best options in the community-based management and facilitates community awareness and capacity in the scheme management, shall be enhanced under the Project, providing training packages for their capacity development.

Although MoW is the implementing agency responsible for the Project, in the operation and maintenance stage, District/Municipal Water Engineer office (DWE/MWE) under District/Municipal Council is responsible in provision of technical guidance to the communities. Thus, capacity development of DWE/MWE in provision of technical guidance to the community is indispensable for the sustainability of the Project. Under the Project, capacity development of District/Municipal Council is facilitated, through formation of and provision of training packages to the District/Municipal Water and Sanitation Team (DWST/MWST).

In the implementation of the Project, Rural Water Supply Division under MoW is primarily responsible for the execution.

8) Grade on Water Supply Facilities

Type of water supply scheme is decided considering (1) water source development potential, (2) suitability of water quality and (3) affordability to pay for operation and maintenance cost.

16 villages out of 22 villages were evaluated to satisfy all the criteria (1), (2) and (3), therefore, Level-2 schemes are planned. In three (3) villages, criteria (1) and (2) were satisfied but criterion (3) was not satisfied, therefore, Level-1 schemes are planned. Since no criteria were satisfied in one village and no alternative water source was available, the village was excluded from the target village. Remaining two (2) villages will be evaluated based on the results of the second test well drilling in the Detailed Design Stage, although Level-2 schemes are planned in these villages at present.

9) Construction Method, Procurement Plan and Construction Period

(1) Construction Method and Procurement Plan

Construction work of water supply facilities consists of drilling of deep wells, earth works, laying out of water pipes, concrete works, machinery/electric works and other works. Special techniques are not required to these works. Local techniques and machineries used in Tanzania are applicable to the construction works. Materials for water supply facilities are procured in Tanzania. However, a few machineries such as submersible pump and engine generator will be procured from foreign countries such as EU, South Africa and Japan.

PVC and HDPE pipes to be used in the project are produced in Tanzania applying the ISO Standard. Diameters of the pipes are 63, 90, 110, 160 and 200 mm to adopt the gate valves of which diameters are 50, 75, 100, 150 and 200 mm. Three (3) types of pressure hearing intensity (Class 10: 10 kPa, 12: 12 kPa and 16: 16 kPa) are available, therefore, it is decided considering the result of hydraulic calculation.

GSP pipes are used for expose piping.

(2) Construction Period

Many Level-2 water supply schemes (18 schemes in total) are constructed in the project. Therefore, it is difficult to complete a series of work from Detailed Design to the construction work in one (1) phase. Therefore, construction period is divided into two (2) phases.

Assistance by soft component is also planned to accelerate the educational campaign for operation and maintenance of the water supply facilities.

10) Priority of the Target Villages

District/Municipality wise priority of all villages in the study area including the target villages of this basic design study was established in “The Study on Water Supply Improvement in Coast Region and Dar es Salaam Peri-Urban in the United Republic of Tanzania” (JICA, 2005). However, priority among the target villages was not established. Since the evaluation of priority was carried out using the same criteria in the entire study area, it was agreed between the Tanzanian side and the Study Team to apply the evaluation results to the priority of target villages.

Criteria applied in the evaluation of priority are two (2): urgency of water and availability of water source.

(1) Evaluation of Urgency

Factors for evaluation of urgency are (1) time requirement for fetching water from the existing water source even when the sources is unstable, (2) months in which period water source is available and (3) daily water consumption amount per household per day. Scoring of factors for urgency is shown in Table 2.19.

Table 2.19 Scoring of Evaluation Factors for Urgency

Scoring	1	2	3	4	Note
Average Time	<30 min	30-59 min	60-120 min	120 min <	Time for fetching water
Reliability	10-12 month	7-9 month	4-6 month	<3 month	Available months in a year
Consumption	200 liter <	100-199 liter	50-99 liter	<50 liter	Water consumption per household

Those factors were compared and evaluated using the “Pair-Wise Ranking” method as shown in Table 2.20.

Table 2.20 Weighting of Evaluation Factors for Urgency

	Average Time	Consumption	Reliability	Score	Multiplication Rate
Average Time	/	Average Time	Average Time	2 points	3
Consumption	/	/	Consumption	1 point	2
Reliability	/	/	/	0 point	1

Evaluation of each village is given by using the following formula quoting the scoring and weighting presented in Table 2.17 and 2.18, respectively.

$$\text{Evaluation value} = (\text{Average time}) \times 3 + (\text{Consumption}) \times 2 + (\text{Reliability})$$

The maximum and the minimum values are 24 points and 6 points, respectively.

(2) Evaluation of Water Source

Criteria for evaluation of water source are water development potential and water quality. In case of spring water, yield of spring was considered as that of deep well. The evaluation criteria and their weighting are shown in Table 2.21. As shown in the table, the maximum and the minimum values are 12 and 0 points, respectively.

Table 2.21 Criteria and Weighting for Groundwater Sources Evaluation

			Estimated Yield (liters/min)		
			100 <	10 - 100	< 10
Water Quality EC (µS/m)		Allotment Points	Good	Fair	Poor
< 1000	Good	3	4	2	1
1000 - 3000	Fair	2	8	4	2
3000 <	Poor	0	0	0	0
			Weighting		

(3) Evaluation of Priority for Target Villages

Evaluation point of each target village was obtained using the criteria mentioned above. In order to combine the weighting for urgency and water resource, weighting of both are considered as the same. The maximum point for water sources is 12: it is half of that of urgency. Therefore, point for water source was multiplied by two. The evaluation formula becomes;

$$\text{Evaluation point} = (\text{Point for urgency}) \times 1 + (\text{Point for water source}) \times 2$$

The maximum point and minimum point are 48 and 6, respectively. Result of evaluation is shown in Table 2.22. This ranking of priority was agreed in the Minutes of Discussions for the Inception Report in June 2006 between the Tanzanian side and the Study Team.

Table 2.22 Priority of Target Villages

Priority	District/Municipality	Ward	Name of Village	Scoring				Evaluation of Priority (Urgency+(Water Source)x2)
				Urgency			Water Source	
				Average Time	Reliability	Consumption		
1	MKURANGA	VIKINDU	MWANDEGE/KIPALA	3	2	2	12	39
2	KISARAWA	MSIMBU	MSIMBU	3	1	2	12	38
2	TEMEKE	PEMBA MNAZI	YALEYALE PUNA	3	3	1	12	38
4	MKURANGA	VIKINDU	KISEMVULE	2	3	2	12	37
4	MKURANGA	VIKINDU	MAROGORO/MFURU MWAMBAO	2	3	2	12	37
4	MKURANGA	VIKINDU	VIANZI	2	3	2	12	37
4	ILALA	KITUNDA	KITUNDA	2	3	2	12	37
8	TEMEKE	PEMBAMNAZI	TUNDWI SONGANI	2	3	1	12	35
9	KINONDONI	GOBA	MATOSA	4	2	2	8	34
10	KIBAHA	RUVU	MINAZI MIKINDA	2	1	1	12	33
11	KIBAHA	RUVU	KITOMONDO	1	1	1	12	30
11	BAGAMOYO	KIBINDU	KIBINDU	3	1	2	8	30
11	MKURANGA	LUKANGA	NJOPEKA	3	1	2	8	30
11	BAGAMOYO	KIBINDU	KWAMDUMA	4	2	2	6	30
15	ILALA	MSONGOLA	MSONGOLA	2	1	2	8	27
15	TEMEKE	MJIMWEMA	MJIMWEMA-SALANGA	2	3	1	8	27
17	ILALA	PUGU	PUGU STATION	2	2	1	8	26
18	TEMEKE	MJIMWEMA	KIBUGUMO	1	1	1	8	22
19	KISARAWA	CHOLE	CHOLE	2	1	1	3	15

Note: Kitunda in Ilala Municipality includes three (3) schemes.

Therefore, number of priority is 19 from 1 to 19 instead of 21.

2.2.2 BASIC PLAN

1) Basic Design

(1) Target Year

The year 2015 is set as the target year of the Project as agreed in the Master Plan Study (JICA, 2005).

(2) Water Demand

Unit water demand for drinking water is defined as 25 L/capita/day by Design Manual (MoWLD, 1997). Design water supply is estimated applying this unit water demand to populations shown in Table 2.1. Furthermore, institutional water demand such as school and dispensary are added to the water demand.

Unit water demand in Tanzania is shown in Table 2.23. Water demand in each village is shown in Table 2.24.

As for Level-1 scheme, population capable to be supplied by handpump is 250 persons/well.

Table 2.23 Unit Water Demand for Rural Water Supply in Tanzania

Category		Unit	Rural	Urban	Remarks
Domestic		lit/capita/day	25	25	served from public taps
Public Institution (School)* ¹	Day School	lit/pupil/day	10	10	without flush toilet (pit latrine, VIP* ² , pour flush toilet only)
	Boarding School	lit/pupil/day	70	70	
	Dispensary	lit/visitor/day	10	10	out patient only
Public Institution (Health)* ¹	Health Centre 1	lit/bed/day	50	50	without flush toilet (pit latrine, VIP, pour flush toilet only)
	Health Centre 2	lit/bed/day	100	100	with flush toilet
	Hospital	lit/bed/day		200	District hospital

Table 2.24 Water Demand and Water Source for Target Village

District/Municipality Village/Street	Name of Village	Serial No. of Scheme	Original Population		Design Population (2015)	Water Demand (m ³ /day)	Type of Facility	Expected Yield (L/min/well)	Number of Well	Operation of Pump (hour)	Water Production (L/min/day)	2015		
			Population	Year Surveyed								Service Population (person)	Service Coverage (%)	
BAGAMOYO														
KIBINDU	KIBINDU	BGM-1	4,078	2002	5,276	175	Level-2	110	2	12	158	4,776	90.5	
KWAMDUMA	KWAMDUMA	BGM-2	1,800	2002	2,329	77	Level-1	12	4	12	26	1,000	42.9	
	TOTAL				7,605	252					184	5,776	75.9	
KIBAHA														
RUVU	MINAZI MIKINDA (1/2)	KBH-1A	1,368	2001	2,185	76	Level-1	12	4	12	35	1,000	45.8	
RUVU	MINAZI MIKINDA (2/2)	KBH-1B	1,256	2001	2,006	92	Level-2	112	1	12	81	2,334	87.7	
RUVU	KITOMONDO		541	2006	657									
	TOTAL				4,848	168					115	3334	133.4	
KISARAWA														
CHOLE	CHOLE	KSW-1	2,654	2002	3,180	110	Level-2	79	2	10	95	2,741	86.2	
MSIMBU	MSIMBU	KSW-2	2,199	2002	2,636	79	Level-1	12	6	12	52	1,500	56.9	
	TOTAL				5,816						147	4,241	72.9	
MKURANGA														
LUKANGA	NJOPEKA	MKR-1	2,700	2002	4,222	138	Level-2	177	1	12	127	3,899	92.3	
VIKINDU	MWANDEGE	MKR-2	1,300	2002	2,033	92	Level-2	117	1	12	84	2,578	91.6	
	KIPALA		500	2002	782									
VIKINDU	KISEMVULE	MKR-3	1,504	2002	2,352	77	Level-2	50	2	12	72	2,199	93.5	
VIKINDU	MAROGORO	MKR-4	1,240	2002	1,939	86	Level-2	110	1	12	79	2,427	92.1	
	MFURU MWAMBAO		445	2002	696									
VIKINDU	VIANZI	MKR-5	2,625	2002	2,926	96	Level-2	123	1	12	89	2,699	92.3	
	TOTAL				14,950	489					451	13,802	92.3	
	TOTAL (COAST)				33,219	909					898	27,152	81.7	
ILALA														
KITUNDA	KITUNDA-Kivule (1/2)	ILL-1A	2,614	2002	4,690	151	Level-2	98	2	12	141	4,384	93.5	
KITUNDA	KITUNDA-Kivule (2/2)	ILL-2B	1,744	2002	3,129	101	Level-2	131	1	12	94	2,922	93.4	
KITUNDA	KITUNDA-Mzinga	ILL-3C	4,114	2002	7,382	238	Level-2	154	2	12	222	6,878	93.2	
MSONGOLA	MSONGOLA	ILL-4	1,713	2004	2,530	76	Level-2	106	1	12	76	2,530	100.0	
PUGU	PUGU STATION	ILL-5	2,772	2002	2,882	93	Level-2	120	1	12	86	2,677	92.9	
	TOTAL				20,614	659					620	19,392	94.1	
KINONDONI														
GOBA	MATOSA	KND-1	2,229	2002	2,747	88	Level-2	115	1	12	83	2,585	94.1	
	TOTAL				2,747	88	Level-2				83	2,585	94.1	
TEMEKE														
MJIMWEMA	KIBUGUMO	TMK-1	1,883	2002	3,379	110	Level-2	141	1	12	102	3,119	92.3	
MJIMWEMA	MJIMWEMA-Salanga	TMK-2	1,750	2006	2,623	85	Level-2	110	1	12	79	2,444	93.2	
PEMBA MNAJ	YALEYALE PUNA	TMK-3	1,529	2006	2,292	75	Level-2	96	1	12	69	2,112	92.2	
PEMBA MNAJ	TUNDWI SONGANI	TMK-4	1,702	2006	2,551	83	Level-2	54	2	12	78	2,390	93.7	
	TOTAL				10,845	353					328	10,065	92.8	
	TOTAL (DSM)				34,205	1,100					1,030	32,041	93.7	
	TOTAL (COAST & DSM)				67,424	2,009					1,928	59,193	87.8	

(3) Design Water Flow

Design water flow is calculated following to the Design Manual.

$$\text{Daily average flow (m}^3/\text{day)} = \text{Design daily water demand (m}^3/\text{day)} \times (1 + \text{Leakage (20\%)})$$

$$\text{Daily maximum flow (m}^3/\text{day)} = \text{Daily average flow} \times 110\%$$

Hourly maximum flow is calculated considering that peaks of water supply occur three hours in both morning and evening every day.

$$\text{Hourly maximum flow (m}^3/\text{day)} = \text{Daily maximum flow} / 6 \text{ (hours)}$$

(4) Hydraulic Calculation

Hazen-Williams's formula is applied for hydraulic calculation.

$$H=10.666 \times C - 1.85 \times D - 4.87 \times Q \times 1.85 \times L$$

H : Friction loss head (m)

C : coefficient of velocity (110): including loss of frock, from Design Standard
for Water Works in Japan

D : Inner diameter (m)

Q : Flow rate (m³/s)

L : Distance (m)

Diameter of pipes is economically decided by the hydraulic calculation assuming the velocity in pipes as less than 0.6 m/sec.

In designing of transmission pipes, special attention was paid into water hammer.

Water head at the public water points shall be 5 m or more and less than 25 m as specified in the Design Manual. However, if it is difficult due to topographical or economical reason, water head is 3 m in minimum. If water head is less than 3 m at a public water point, such water point is changed in its location or is not constructed.

2) Water Supply Facility Plan

(1) Component and Layout of Facility

i) Piped water supply scheme with public water points (Level-2)

Level-2 water supply facility consists of water source (deep well and spring), transmission line from water source to distribution tank, distribution tank (ground tank or elevated tank), distribution lines and public water points. Drilling of deep wells for water sources is not included because deep wells will be drilled as test wells in the Detailed Design Study. An intake facility is necessary for the spring water in Njopeka Village.

ii) Deep well with handpump (Level-1)

Level-1 water supply facility is composed of deep well, handpump and drainage.

Component of water supply facilities planned in the study is summarized in Table 2.25. Layout plan for every types of water supply schemes are shown in Table 2.25 - Table 2.27.

Table 2.25 Summary of Water Supply Facility (Level-1) (Phase 1)

Village	No. of Well	Drilling Depth (m)	No. of Handpump	No. of concrete Pad
Kwamduma	4	100	4	4
Minazi Mikinda (1/2)	3*	50	4	4
Msimbu	6	100	6	6

*: One out of four wells is obtained as a successful well in the test well drilling in the Basic Design Study.

Table 2.26 Summary of Water Supply Facility (Level-2) (Phase 1)

Village name	Water Supply Facilities (Level-2)														Note	
	Type of Water Supply System	Intake facilities				Transmission facilities			Distribution facilities					Water service facilities		
		No. of Well	Well Depth(m)	Submerged Pump (KW)	Generator (KVA)	No. of Control house	Pipe Dia (mm)	Total Length(m)	Tank Capacity (m ³)	Type of tank	Height (m) from ground to bottom slab of tank	Pipe Dia(mm)	Total Length(m)	Public Tap (Single Tap)		Public Tap (Double Taps)
KIBINDU	TYPE-1	2	100	4.0	16.0	2	PVC90(C10)	1,543	100	E	10	HDPE32(C10)~PVC160(C10)	6104	13	5	
MINAZI MIKINDA(2)/KITOMONDO	TYPE-1	1	50	4.0	16.0	1	PVC90(C10)	2,733	50	E	10	HDPE50(C10)~PVC160(C10)	6019	9	0	
CHOLE	TYPE-2	2	80	4.0	16.0	2	PVC90(C12)	4,836	60	G	—	HDPE32(C10)~PVC160(C10)	8591	18	0	
MATOSA	TYPE-1	1	120	5.5	20.0	1	PVC90(C10)	1,857	50	E	5	HDPE32(C10)~PVC110(C10)	4618	4	3	
KIBUGUMO	TYPE-1	1	50	2.2	10.5	1	PVC90(C10)	138	60	E	5	HDPE40(C10)~PVC160(C10)	2955	7	2	
MIMWEMA-SALANGA	TYPE-1	1	50	1.5	6.0	1	PVC90(C10)	16	50	E	10	HDPE40(C10)~PVC160(C10)	4158	6	3	
YALEYALE PUNA	TYPE-1	1	80	2.2	10.5	1	PVC90(C10)	52	50	E	5	HDPE32(C10)~PVC160(C10)	8478	6	6	
TUNDWI SONGANI	TYPE-1	2	80	1.5	6.0	2	PVC63(C10)	780	50	E	10	HDPE40(C10)~PVC110(C10)	7738	15	0	
合計		11				11		11,955				48,661	78	19		

Notes : Diameter of the well casing & screen : 6 inches

The wells are constructed at the time of the detail design.

Type 1 : Well (submerged pump)-Control house- Elevated reservoir tank - Public faucet

Type 2 : Well (submerged pump)-Control house- Ground reservoir tank-Public faucet

Type 3 : Intake from spring water(submerged pump)-Control house (chlorination)-Ground reservoir tank-Public faucet

PVC90(C10) : PVC(rigid polyvinyl chloride pipe) Outer dia 90mm Resisting pressure 10Bar

HDPE32 (C10) : HDPE (high-density polyethylene pipe) Outer dia 32mm Resisting pressure 10Bar

Type of tank : G : Ground tank E : Elevated tank

Table 2.27 Summary of Water Supply Facility (Level-2) (Phase 2)

Village name	Water Supply Facilities (Level-2)														Note	
	Type of Water Supply System	Intake facilities				Transmission facilities			Distribution facilities					Water service facilities		
		No. of Well	Well Depth(m)	Submerged Pump (KW)	Generator (KVA)	No. of Control house	Pipe Dia (mm)	Total Length(m)	Tank Capacity (m3)	Type of tank	Height (m) from ground to bottom slab of tank	Pipe Dia(mm)	Total Length(m)	Public Tap (Single Tap)		Public Tap (Double Taps)
NJOPEKA	TYPE-3	—	—	5.5	20.0	1	PVC110(C12)	2,223	80	G	—	HDPE32(C10)~PVC160(C10)	13069	12	3	Intake from Spring, Chlorination
MWANDEGE/KIPALA	TYPE-1	1	80	2.2	10.5	1	PVC90(C10)	32	50	E	10	HDPE32(C10)~PVC160(C10)	9417	22	0	
KISEMVULE	TYPE-2	2	80	1.5	6.0	2	PVC63(C10)	475	50	G	—	HDPE32(C10)~PVC160(C10)	9152	12	0	
MAROGORO	TYPE-1	1	50	2.2	10.5	1	PVC90(C10)	31	50	E	15	HDPE40(C10)~PVC110(C10)	9520	13	0	
VIANZI	TYPE-1	1	120	4.0	16.0	1	PVC90(C10)	837	60	E	5	HDPE32(C10)~PVC160(C10)	6503	13	0	
KITUNDA-KIVULE(1/2)	TYPE-1	2	80	2.2	10.5	2	PVC90(C10)	334	90	E	15	HDPE50(C10)~PVC160(C10)	8817	0	9	
KITUNDA-KIVULE(2/2)	TYPE-1	1	80	4.0	16.0	1	PVC90(C10)	100	60	E	10	PVC63(C10)~PVC160(C10)	6172	0	5	
KITUNDA-MZINGA	TYPE-1	2	80	4.0	16.0	2	PVC90(C10)	166	130	E	10	PVC63(C10)~PVC200(C10)	8299	0	12	
MSONGOLA	TYPE-1	1	80	2.2	10.5	1	PVC90(C10)	21	50	E	15	HDPE40(C10)~PVC110(C10)	5918	9	0	
PUGU STATION	TYPE-2	1	80	5.5	20.0	1	PVC90(C10)	1,706	60	G	—	PVC63(C10)~PVC160(C10)	2132	0	5	
合 計		12				13		5,925					78,999	81	34	

Notes : Diameter of the well casing & screen : 6 inches

The wells are constructed at the time of the detail design.

Type 1 : Well (submerged pump)-Control house-Elevated reservoir tank -Public faucet

Type 2 : Well (submerged pump)-Control house- Ground reservoir tank-Public faucet

Type 3 : Intake from spring water(submerged pump)-Control house (chlorination)-Ground reservoir tank-Public faucet

PVC90(C10) : PVC(rigid polyvinyl chloride pipe) Outer dia - 90mm Resisting pressure 10Bar

HDPE32 (C10) : HDPE (high-density polyethylene pipe) Outer dia 32mm Resisting pressure 10Bar

Type of tank : G : Ground tank E : Elevated tank

(i) Level-2: Type 1 (Deep well-Control house- Elevated tank-Public water points) 14sites

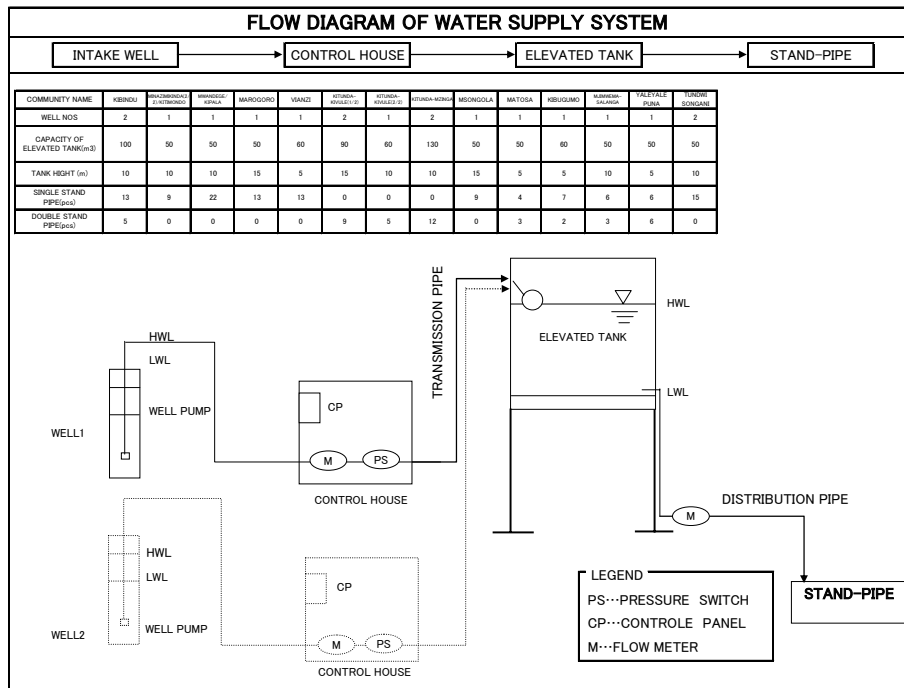


Figure 2.9 Layout Plan for Level-2 (Type 1)

(ii) Level-2: Type 2 (Deep well-Control house- Ground tank-Public water points) 3 sites

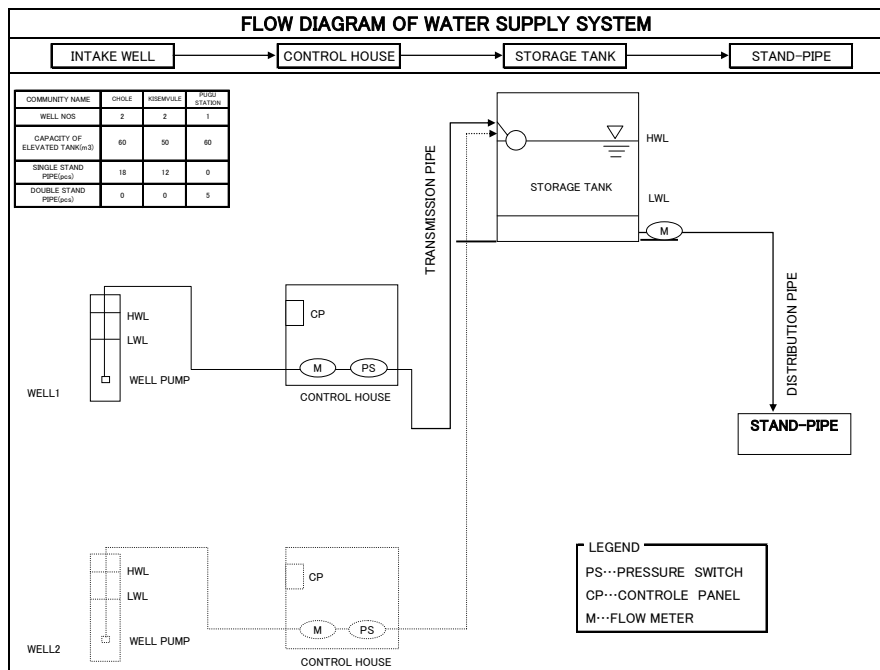


Figure 2.10 Layout Plan for Level-2 (Type 2)

(iii) Level-2: Type 2 (Spring-Control house- Ground tank-Public water points) 1 site

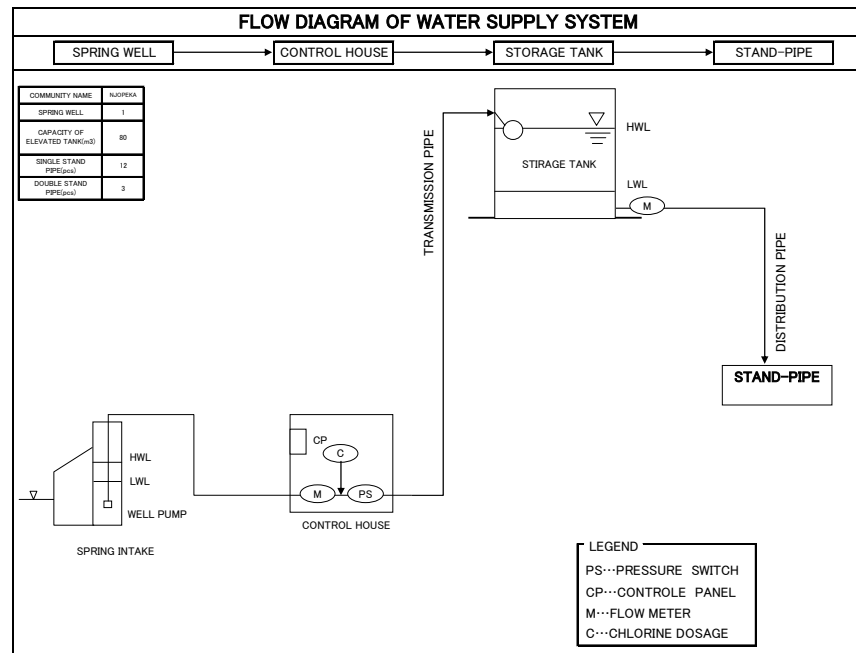


Figure 2.11 Layout Plan for Level-2 (Type 3)

(2) Level-2 Water Supply Scheme

i) Water Source

<Deep well>

Out of 23 wells necessary for water sources, one (1) well is already confirmed as a successful well in the Basic Design Study. Remaining 22 wells will be drilled as test wells in the Detailed Design Study. Casing and screen piped made of PVC are installed in the well to prevent corrosion by slightly acidic groundwater.

Opening ratio of screen pipe is approximately 10% in order to collect groundwater effectively. Annular space between wall of borehole and screen pipes is filled with gravels. Outside of casing pipes is filled with excavated materials during drilling of deep well. Top of annular space is protected by cement grouting to protect intrusion of pollutant from ground surface. Those specification is applied to the test wells to be drilled in the Detailed Design Study.

Criteria for successful well are as follows;

Yield

Yield shall be more than estimated water demand described in Table 2.22 within 12 hours. In case multiple numbers of wells are planned as water source, total yield of wells is evaluated.

Water Quality

As shown in Table 2.2, WHO Guideline (2004) is applied for “Chemicals that are of health significance” and the Tanzanian Drinking Water Standard (1974) for “Applicable aspects”.

<Control House>

Groundwater is extracted by submersible motor pump from the deep wells. Rising pipes are made of stainless steel to prevent corrosion. Engine generator is used as power source. A control house is constructed near the water source to install the engine generator and control panel.

Method of excavation and skeleton works is same as that of construction method for distribution tanks described below.

A ventilating duct is provided to evacuate smoke from the diesel engine.

Power supply by TANESCO reaches Kisemvule, Mwandege/Kipala and Vianzi Villages in Mkuranga District. However, electric failures are so frequently happened every day in Dar es Salaam due to insufficient power supply situation against growing electric demand in Tanzania. In addition, troubles to electric appliances are frequently happened due to changing in voltage of electricity. Several water supply schemes in Dar es Salaam are obliged to stop their service because of malfunction of motor pump.

Operation hour is planned 10 to 12 hours in the Project, necessary yield of groundwater cannot be extracted unless these power supply situation is improved. Therefore, the engine generator is installed in order to keep stable water supply.

Table 2.28 shows the comparison of characteristics between power supply and engine generator.

Table 2.28 Comparison between Power Supply and Engine Generator

	Diesel Engine Generator	Power Supply
Stability as power source of water supply facility	Voltage is stable and no electric failures are happened.	Frequent electric failure and changing in voltage are happened every day. Necessary amount of yield cannot be extracted. Malfunction of existing water supply facility is confirmed.
Construction of branch line	Generator is installed near the water source, therefore, no branch line is required.	Construction cost of branch line from power line to meter is borne by the Tanzanian side.
Construction cost	About 1, 670~2,670 Thousand Tsh for diesel engine,	About 1,700~2, 980 Thousand Tsh/100m for branch line.
Operation and maintenance	Technical training to operators of water supply facility and operation of engine generator is necessary,	Training on water supply facility is necessary for operators.
Operation cost	226,440 Tsh/month (11 KVA)	145,530 Tsh/month (11 KVA)

ii) Distribution Tank

Excavation work

The open-cut method is used for ground leveling work and excavation of foundation of structures. Either backhoe (0.6 m³) or backhoe (0.35 m³) is used considering the condition of the site and the access road. Backhoe is used for excavation work and loading work. Surplus soil is carried out by a dump truck.

Construction of framework of structures

Type of reinforcement is deformed reinforcement procured in Tanzania. Frame work is carried out using locally produced wooden or steel frame. Concrete is mixed by mixer at the site and placed by manpower or crane.

iii) Laying out of Pipelines

Pavement

Paved road is cut by a asphalt cutter. Road is re-paved with 10 cm thick of asphalt as it was before. Asphalt is procured from a local plant.

Excavation and Refilling Works

Clearing of bush is required along the roads at the places where transmission and distribution lines pass the narrow thoroughfare. Clearing is necessary to keep 3 m in width, considering the space for width of excavation and temporal piling of excavated soil. If access road will not allow the heavy vehicles to pass, excavation work will be done by manpower.

The open-cut method is used for excavation work. A backhoe (0.35 m³) is principally used. Excavated soil is temporally piled up along the road, then is used for filling back after laying of pipes. Surplus soil is loaded by a backhoe to a dump truck and carried out from the site by dump truck.

Pipe Laying Work

HDPE pipe is used for the small diameter pipe (outer diameter less than 50 mm) and PVC pipe for larger diameter pipes (outer diameter from 63 to 200 mm). Pipes are laid manually. Pipeline is laid along the road with 1 to 3 m distance from the side of the road. In case that it is difficult from view points of natural or artificial condition, the pipes may be laid under the road. Pipes are laid in the sand bed for protection in the depth less than 3 m under the ground. In crossing of road or laying under the road, pipes are laid in the depth more than 1.2 m.

Pipes are protected by concrete pipes in traversing a stream of which water flow is low. If water flow is high, GSP with elastic joint is installed in the sidelong of a bridge by fulcrums. In case of railway crossing, GSP are laid in the existing culvert under the railway. In crossing a main road, 300 mm diameter of concrete pipes is laid as sleeve pipes and GSPs are let through these concrete pipes. T-tube and bend pipes are protected by concrete.

Valves such as gate valves, air valves and blowoff valves are properly installed following the Design Manual (MoWLD, 1997), Japanese Design Standard for Waterworks Facilities. Concrete blocks for prevention of scouring are placed in the steep slope of more than 10 % gradient.

iv) Public Water Point

Location of public water points are decided considering the access from each household within around 400 m based on the field survey with members of village council. Single tap is applied to each 150 persons and double taps are provided in case of population more than 150 persons. Drain is constructed at each water points. Drained water infiltrates into ground.

(3) Level-1 Water Supply Scheme

Level-1 Water Supply Schemes to be constructed in the Project are 14 wells in three (3) villages as shown in Table 2.29. Among them, one (1) well is obtained as a successful well in Minazi Mikinda (1/2). Therefore, remaining 13 deep wells are required to be drilled.

Table 2.29 Level-1 Water Supply Scheme

Type	Aquifer	Depth (m)	Village	Number of Scheme	Successful well	Number of Wells to be drilled
A	Neogene	50	Minazi Mikinda (1/2)	4	1	3
B	Neogene	100	Msimbu	6	0	6
C	Pre-Cambrian	100	Kwanduma	4	0	4
Total				14	1	13

Following criteria are applied for successful rate of deep well for Level-1.

Yield

The minimum yield for handpump is approximately 10 L/min in case of India Extra Deep Well Handpump. Therefore, 10 L/min (≈ 0.17 L/sec x 60 sec) is applied as the criteria for yield of deep well.

Water Quality

Evaluation criteria for water quality analyses are same as those for Level-2 scheme: WHO Guideline (2004) for “Chemicals that are of Health significance” and the Tanzanian Standard for Drinking Water (1974) for other items (Refer to Table 2.2).

Successful rate for deep wells is set as shown in Table 2.30 considering the existing borehole data collected in the M/P Study.

Table 2.30 Successful Rate for Deep Well

	No. of Existing Well	Successful Well	Successful Rate (%)
Precambrian	10	1	10
Cretaceous	11	3	27
Neogene	234	159	68
Total	255	163	64
Average Successful Rate (%)			≈ 70

Target aquifer of test well is Neogene formations in most case. Although successful rate for Neogene formation is 68 %, that of Precambrian is extremely low. It depresses average successful rate to 64 %. Sites of test wells for Precambrian rocks are located near the locations where deep wells were drilled as the water source of Level-2 scheme. It is expected that such situation will raise successful rate of deep wells. Therefore successful rate is set as 70 %.

The total number of wells for Level-1 is 14. One (1) out of 14 was already obtained as a test well drilled in the Basic Design Study. Thus, the number of wells to be newly drilled is 13. Considering the successful rate, the number of wells to be drilled becomes 19 in total.

The well structure of wells for Level-1 is basically same as that of Level-2. Type of handpump is one commonly used in Tanzania. The maximum head of handpump is 90 m which is same as that of India Extra Deep Well type of handpump.

(4) Waste Disposal

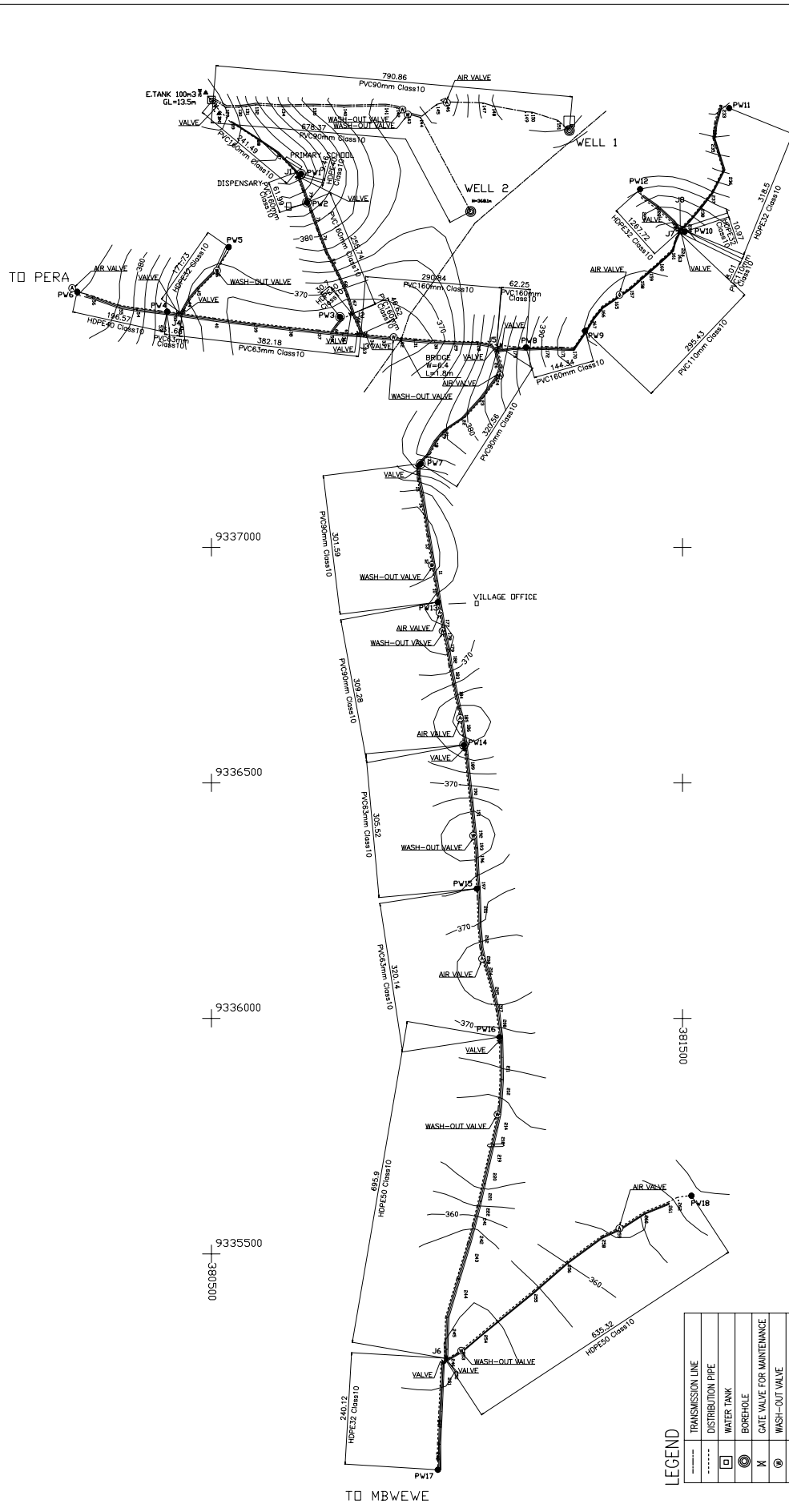
Wastes generated in the construction works such as asphalt concrete, residual clay, etc. are carried to waste disposals appointed by Districts and Municipalities. Average distance to the waste disposals is approximately 4 km.

2.2.3 BASIC DESIGN DRAWINGS

Following drawings compose the basic design drawings for the project.

- (1) Location Map for Target Villages (shown at the top of the report)
- (2) Layout Plan of Water Supply Facility in each Village (Figure2.12~Figure2.29)
- (3) Deep Well Structure for Level-2 (Figure2.30)
- (4) Structure of Water Intake (Njopeka, Mkuranga District) (Figure2.31)
- (5) Structure of Transmission and Distribution Pipelines (Figure2.32)
- (6) Structure of Distribution Tank (Figure2.33)
- (7) Structure of Public Water Points (Figure2.34)
- (8) Structure of Deep Well for Level-1 (Figure2.35)

KIBINDU



THE RURAL WATER SUPPLY PROJECT
 IN COAST REGION AND DAR ES SALAAM PERI-URBAN
 IN THE UNITED REPUBLIC OF TANZANIA

KIBINDU

LAYOUT OF PIPELINE

SCALE SEE DWG DWG No. KIBI-1

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LEGEND

---	TRANSMISSION LINE
----	DISTRIBUTION PIPE
□	WATER TANK
○	BOREHOLE
M	GATE VALVE FOR MAINTENANCE
⊕	WASH-OUT VALVE
⊙	AIR-VALVE
●	STAND-PIPE (SINGLE)
⊙	STAND-PIPE (DOUBLE)

Figure 2.12 Layout Plan of Water Supply Facility (Kibindu)

MINAZI MIKINDA(2/2)/KITOMONDO (1/2)

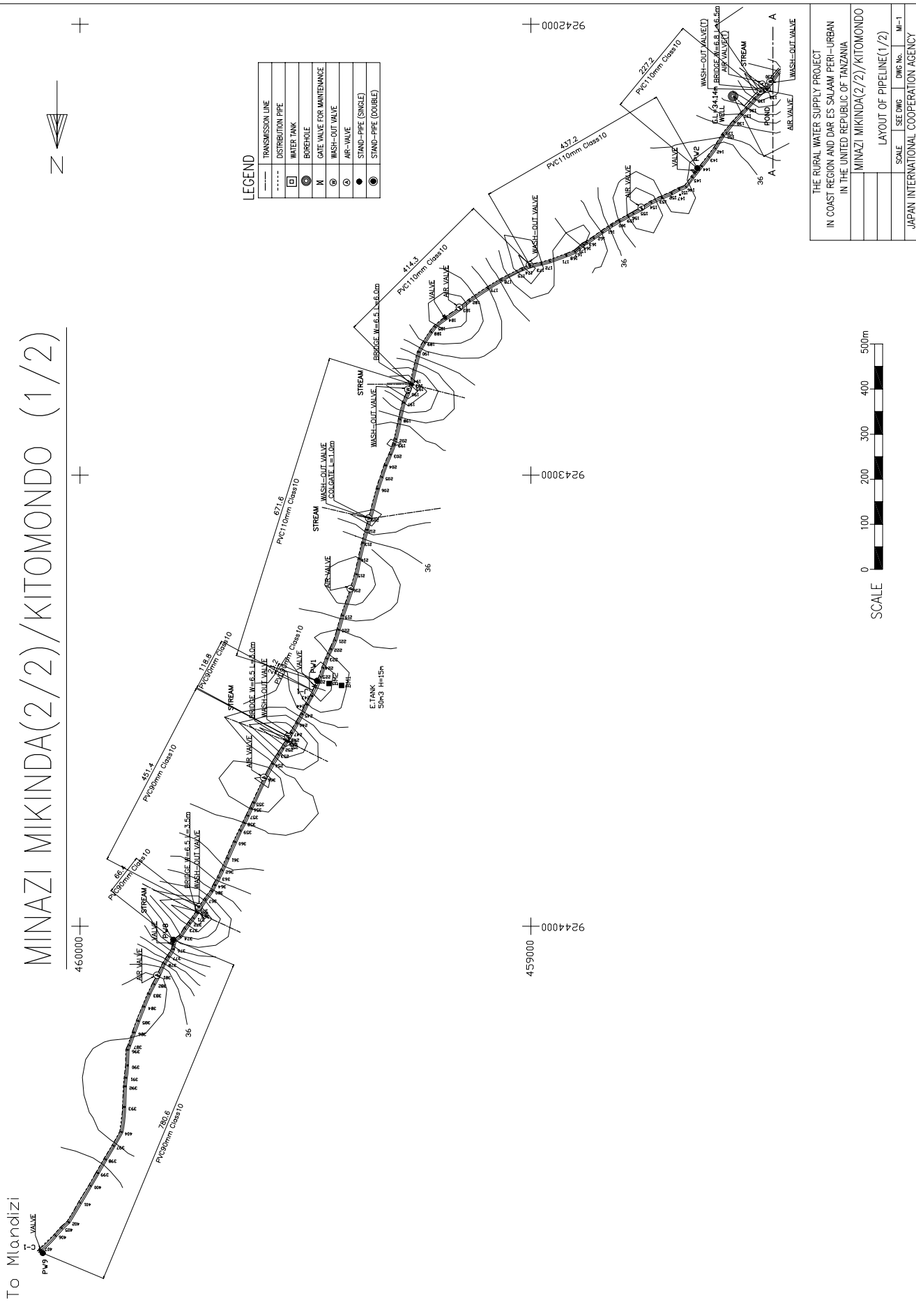


Figure 2.13 Layout Plan of Water Supply Facility (Minazi Mikinda (2/2)/Kitomondo)

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JICA

MINAZI MIKINDA(2/2)/KITOMONDO (2/2)



LEGEND

—	TRANSMISSION LINE
----	DISTRIBUTION PIPE
□	WATER TANK
○	BOREHOLE
⊞	GATE VALVE FOR MAINTENANCE
⊕	WASH-OUT VALVE
⊙	AIR-VALVE
●	STAND-PIPE (SINGLE)
⊙	STAND-PIPE (DOUBLE)

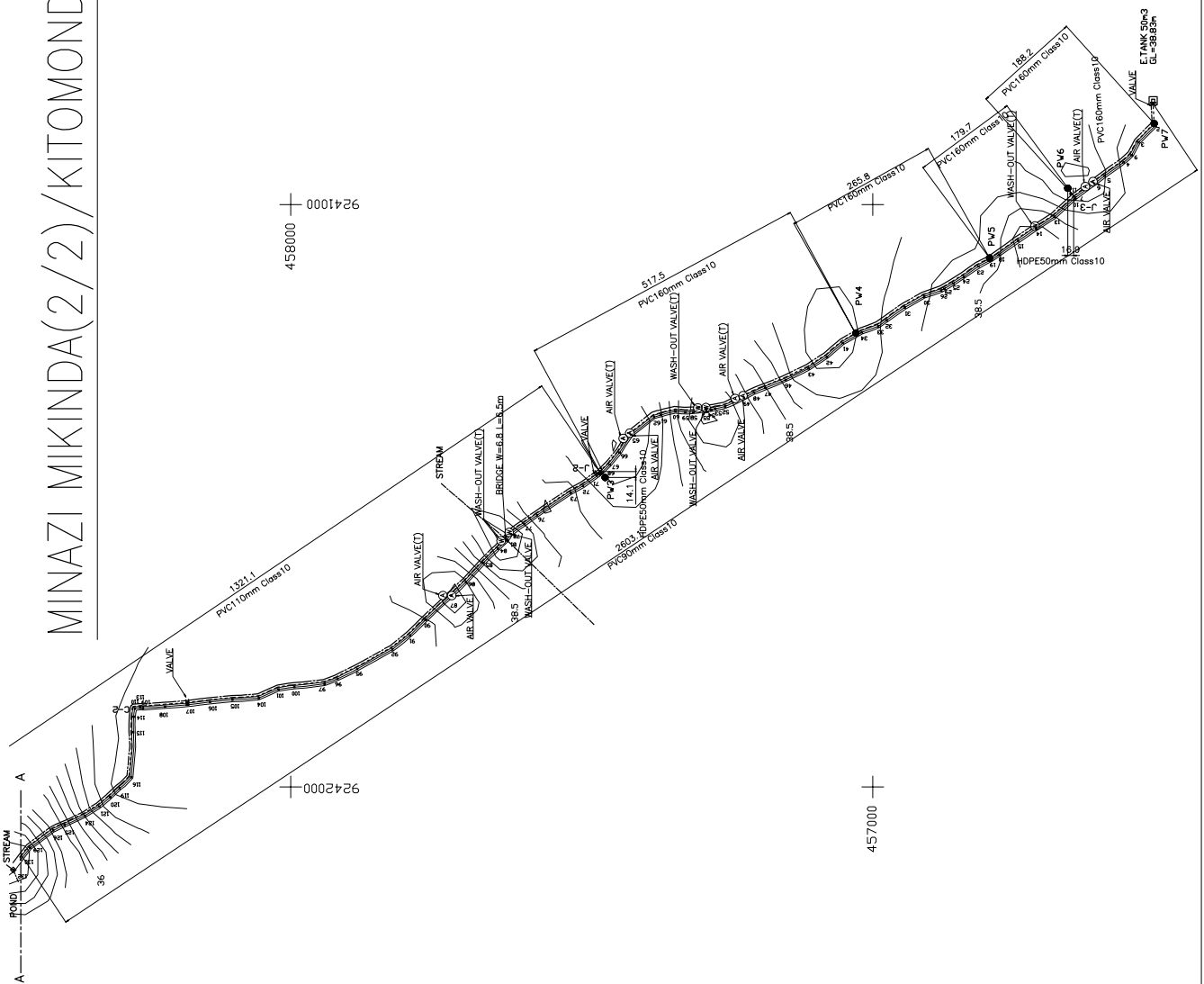
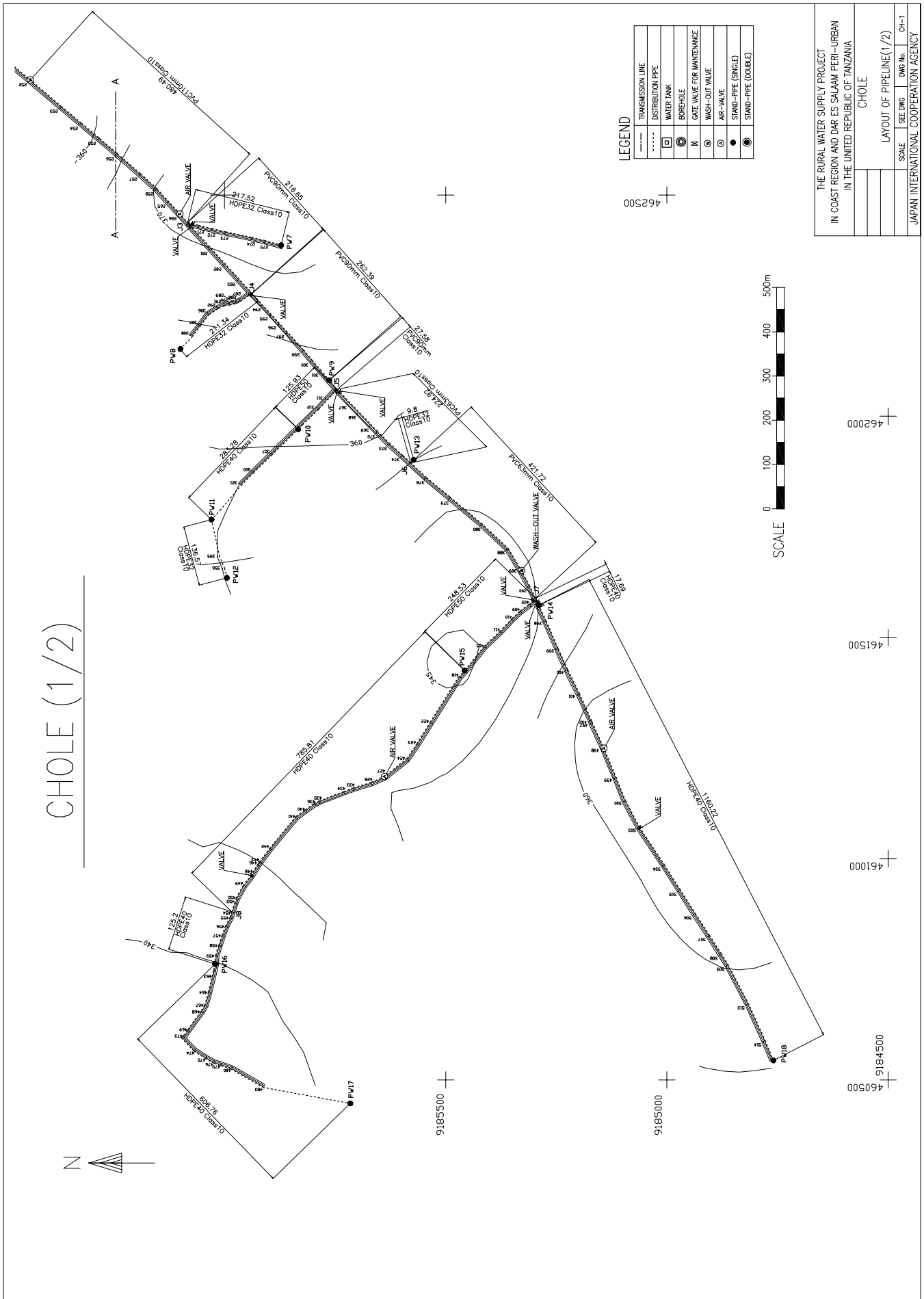


Figure 2.13 Layout Plan of Water Supply Facility (Minazi Mikinda (2/2)/Kitomondo)

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CHOLE (1/2)



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CHOLE

LAYOUT OF PIPELINE(1/2)

SCALE	SEE DWG	DWG No.	CH-1

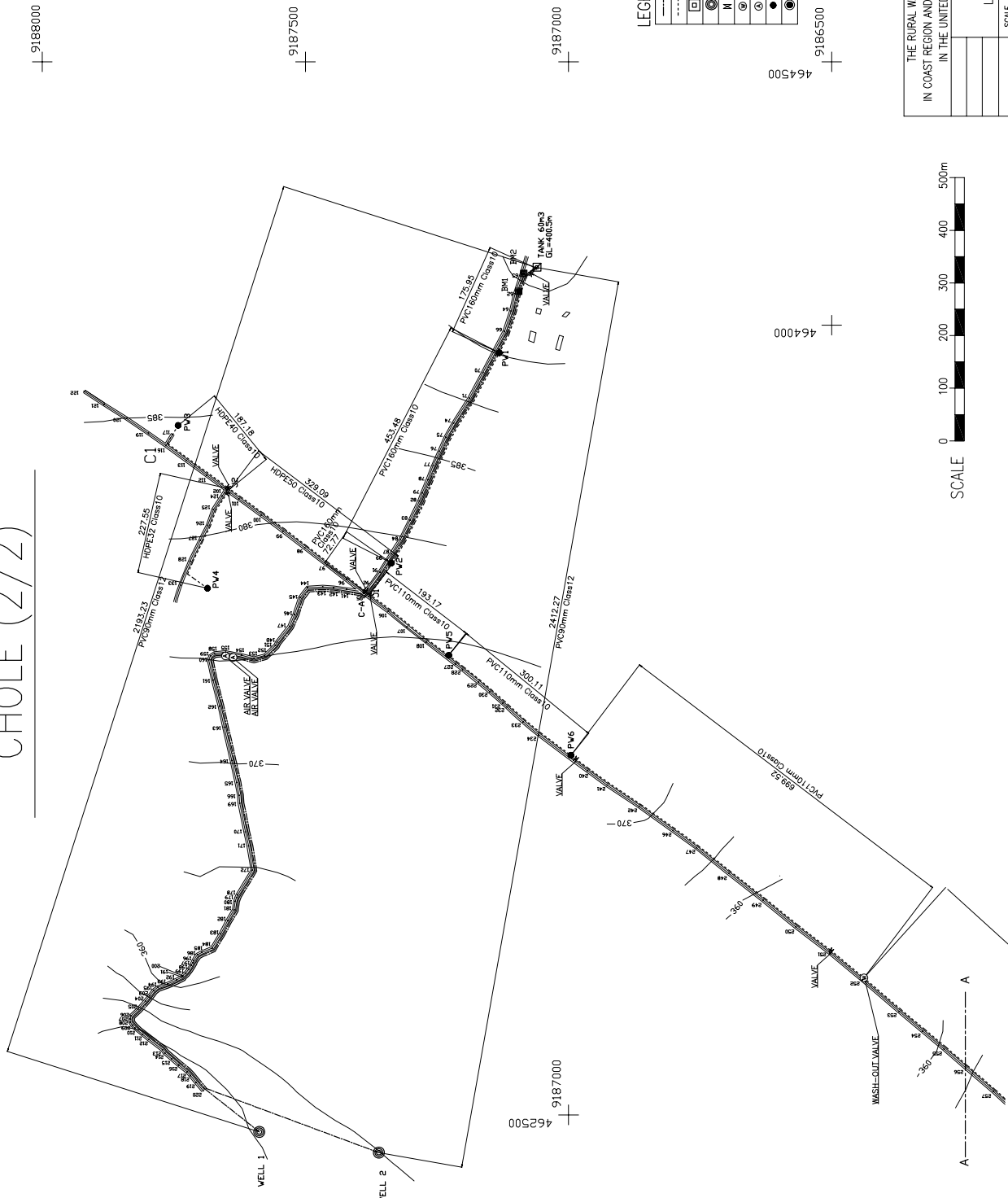
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Figure 2.14 Layout Plan of Water Supply Facility (Chole)

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JICA

CHOLE (2/2)



THE RURAL WATER SUPPLY PROJECT IN COAST REGION AND DAR ES SALAAM PERI-URBAN IN THE UNITED REPUBLIC OF TANZANIA		
CHOLE		
LAYOUT OF PIPELINE(2/2)		
SCALE	SEE DWG	DWG No.
		CH-2
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Figure 2.14 Layout Plan of Water Supply Facility (Chole)

NJOPEKA (1/3)

