Chapter 2 Contents of the Project

Chapter 2. Contents of the Project

2-1 Basic Concept of the Project

2-1-1 Overall Goal and Project Goal

The government of Tanzania had started the rural water supply project from 1971 targeting "Every Tanzanian citizen to be able to obtain safe water within 400m of their residence by the year 1991", however it produced limited results. Presently, according to the long-term development strategy in 2004, the government of Tanzania set the same goal (safe water for every citizen within 400m of their residence) in its "Tanzania development vision 2025". This project will contribute to the improvement of the rural water supply included as part of the above target.

This project targets increasing the served population for water supply from 9,401 people (2005) to 55,151 people (2020) by providing a safe and stable water source through water supply facilities in 26 villages in the Mwanza region and 18 villages in the Mara region.

2-1-2 Basic Concept of the Project

To achieve the overall goal of the project, water supply facility shall be constructed in this project. Procured facility is planed content based on capability of beneficiaries. However beneficiary's capability for operation and maintenance is partially seems insufficient, therefore soft component activity shall introduce to support for improvement of their capacity. It may introduce improvement of operation and maintenance management for beneficiary, region and district government by construction of the facility.

The table below gives a list of the requested items and followed by a summary of project descriptions in the Project Design Matrix (PDM).

Table 2-1: Contents of Request by Tanzanian side

Item	Request
Equipment procurement	Well drilling equipment, associate vehicles 1 lump sum
	Operation and maintenance vehicles for water supply facilities and investigation equipment 1 lump sum
Facility construction	Target village 45 villages
	Construction of 289 hand pump well facilities (in 35 villages)
	Construction of Public faucet facility 7 schemes (in 8 villages, groundwater 4 schemes, lake water 3 schemes)
	Rehabilitation of Public faucet facility 1 scheme (in 2 villages)

Table 2-2: Project Design Matrix

Name of project: Rural water supply in Mwanza and Mara region
Target area: 45 villages in Mwanza and Mara region

Period: January 2009~March 2012
Target group: Villagers

Date: October 5 2008

Summary of Project	Indicators	Measurement	External conditions
Overall goal To improve the living environment of target area villagers	Decreased rate of waterborne disease among villagers ..... A	・Statistical health data ・Questionnaire survey	
Project goal To supply safe water and improve water supply rate in the target area	Population of those receiving safe water supply .....B	・VWC users Inventory list	No major changes in government water supply policy
Outcomes 1. Water supply facilities will be constructed in target villages	1-1. Water supply rate in target area .....C 1-2. Decreased time spent on fetching water ..... D 1-3. Supply safe water .....E	1-1. VWC's Facility running records Questionnaire 1-2. Questionnaire 1-3. VWC's Facility running records VWC users Inventory list	No rapid increase or shift in population
2. Strengthens operation and maintenance management for the water supply facilities by beneficiary, district and regional council.	2-1. Activities of VWC.....F 2-2. Collection of O/M fees... G 2-3. number of visits by Agency ..... H 2-4. Satisfaction with service provided by Agency.....I	2-1. VWC activity records 2-2. O/M fee collection records 2-3. Agency's activity records 2-4. Questionnaire	
Activities **Japanese side** 1-1. Construct Hand Pump well 1-2. Construct spring protection facility 2-1. Established O/M system by beneficiary 2-2. Instruct beneficiary on O/M methods 2-3. Instruct Agency on O/M methods 2-4. Strengthen supply spare parts to Agencies **Tanzanian side** 1-1. Beneficiary maintains access road 1-2. Explain project contents to beneficiary 1-3. Secure tax benefits for material procurement 2-1. Assist in establishing VWC 2-2. Conduct hygiene education to VWC 2-3. Assist monitoring and VWC activities	**Input** (Japanese side) ・Construction of water supply facilities ・Soft component ・Consultancy service (Tanzanian side) ・Secured budget, human resources ・Secure construction area ・Maintain access road		No drought or decrease in the ground-water level beyond expectations **Prerequisite** The beneficiary desires to execute the project

2-2 Basic Design of the Requested Japanese Assistance

2-2-1 Design Policy

2-2-1-1 Basic Plan

(1) Procurement of equipment

All of the well facility will be constructed by Japan side and there is no adequate governmental agency for Tanzania side which to receive equipment for boring, therefore procurement of equipment shall eliminate from this project.

(2) Target villages

Target villages for the project shall be selected by criteria including hand pump wells (289 points) and public faucets (8 schemes) facilities in 45 target villages that the Tanzania side requested based on the result of development study.

(3) Target year of the project

A target year of 2020 has been set for the project. Initially, a target year of 2015 was proposed in the development study based on the project implementation period of 2007 to 2009, with a renewal period of 6 years from completion of the project. However, the actual implementation of the project will be from 2009 to 2012. If target year is set to 2015, the population served by this project will be reached only 3 years after completion of the project. The Tanzania side strongly requested to keep at least 5 years between the year completion of the project and target year based on development study. Another factor that needed consideration when setting the target year is that this project will contribute to the goal of the "Tanzania development vision 2025", that people to will be able to obtain safe water within 400m of their residence by 2025. However, if the target year is set to 2025, the scope of the project would then be 13 years after its' completion, resulting in an excessive project design. As a result of discussions with the Tanzania side, the target year of the project was set for 2020 as it is half way between 2015 and 2025.

(4) Served population for water supply

The design served population for water supply in the each target village shall be estimated at 2020 based on the "Population and Housing Census", published by the Government of Tanzania 2002. However, populations that served by the existing facilities will be excluded.

(5) Basic Water supply quantity

A basic water supply quantity of 25 liter/capita/day shall be applied based on "Design Manual for Water Supply Facility" issued by Ministry of Water and Irrigation on 1997.

(6) Alternative villages and hand pump scheme site

924 villages were requested on development study as target villages. According to selection in development study, 45 villages were selected as priority project. Therefore, alternation for eliminated schemes and well points by selection in this basic design study shall not be selected, because the villages not selected as priority project were evaluated that not suitable as grant aid project.

(7) Population basis per hand pump well facility

In principle, a basis of 250 capita per facility has been set for the population per hand pump well facility.

(8) Selection of the Public Faucet scheme

1) Planning of the other projects by the other donors in the target area

The facilities shall be eliminated from this project in the case that other donors are planning projects in the target village. The government of Tanzania has set a target to supply safe water to all of its citizens within 400m from their houses by 2025, however, this target will not be reached in this area through the successful execution of this Project alone. Therefore, the other projects planned in the same villages shall be acceptable, whereas if the other projects are planned in the same commune, then the facility shall be eliminated from this project.

2) Yield test

A trial borehole excavation will be carried out to perform a yield test at villages marked for a public faucet scheme that have not yet secured a water source. The yield test will be deemed successful if the water volume complies with that necessary in each scheme. In cases where trial boreholes do not comply with the required volume of water, the scheme shall be eliminated from the public faucet scheme and either designated as the hand pump wells or eliminated from the project.

Successful water yield define for each facility as below.

a) Successful water yield of the public faucet schemes has to comply with the water volume that is able to provide required water volume for each scheme (25 liter/capita/day×design served population of the scheme) within 12 hours

b) Successful water yield of the hand pump well scheme has to comply with 15 liter/min

3) Water quality analyses

Water quality analysis will be conducted on successful trial boreholes which obtained certain

amount of yield. Water quality standards shall follow that of the Tanzania Standard. However, for items which affect human health, World Health Organization (WHO) guidelines will be followed.

4) Operation and maintenance cost

Operating and maintenance costs for the public faucet facilities are higher than for the hand pump well facilities. Some facilities have stopped to use by beneficiaries in developing countries due to lack of the operation and maintenance costs which is covered by correcting the water fee. In order to utilize the facilities sustainably, a payable amount of the water fee will be determined by the socio-economic survey. In the event the amount is lower than operation and maintenance costs, the scheme shall be changed to a hand pump well facility. The water fee per household shall be set at 5% of household income.

5) Technical evaluation

Technical evaluation will carried out for the public faucet scheme. In the event, evaluation result shows that the scheme are unable to conduct sustainable operation and maintenance by the beneficiaries, the scheme will be eliminated from Public faucet scheme and it will exam for hand pump scheme.

6) Flow diagram for selection of schemes

Diagram showing the selection process for public faucet schemes is shown in Figure 2-1.

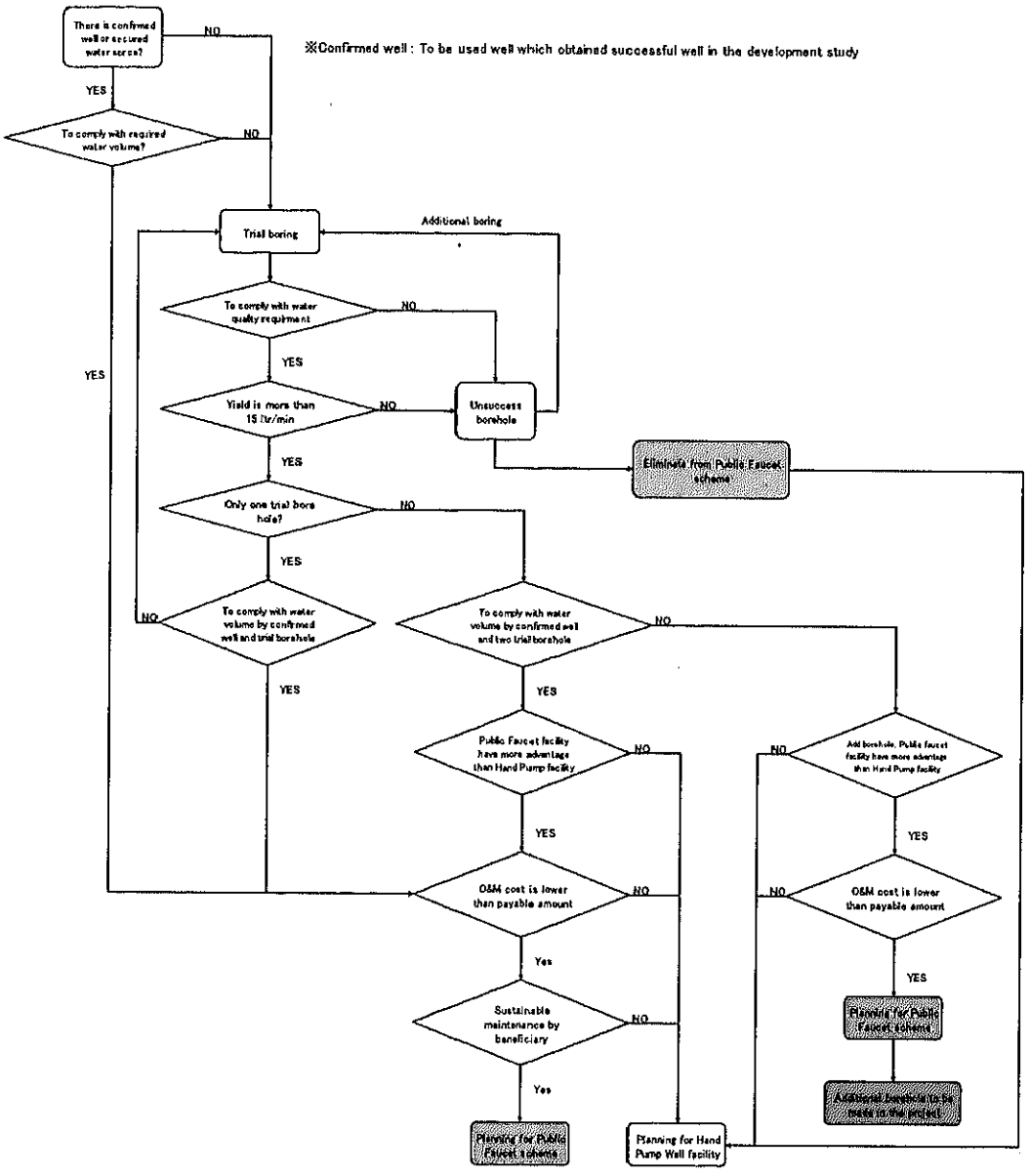


Figure 2-1: Flow diagram of selection process for public faucet schemes

(9) Selection of hand pump well points

1) Planning of the other projects by the other donor in the target area

The facilities shall be eliminated from this project in the case that other donors are planning a project in the target village. The government of Tanzania has set a target to supply safe water to all of its citizens within 400m from their houses by 2025; however, this target will not be reached in this area through the successful execution of this Project alone. Therefore, the other projects planned in the same villages shall be acceptable, whereas if the other projects are planned in the same commune, then the facility shall be eliminated from this project.

2) Field survey

The facilities that were requested are selected based on the priority project which was recommended by JICA development study conducted from 2004 to 2006. Therefore the basic surveys such as the utilization of existing facilities have already been carried out. The purpose of this field survey is to check if the location is accessible by construction equipment and whether it can be expected that villagers would continue to use the facility. If these conditions are not met, those facilities shall be eliminated from this project.

3) Hydro-geological survey

The expected successful drilling rate will be estimated based on the development study results and drilling results of the past projects by the other donors in the project site. If it is deemed that a location has a low possibility for ground water development, the location shall be eliminated from this project.

4) Geophysical survey

Vertical electrical prospecting will be carried out according to positions selected through the field survey and results of the hydro-geological survey. In principle, a location would not be eliminated from the plan unless results uncover a situation where 1) the aquifer is located within 20m depth from the ground level, or 2) the analysis result shows the second layer and third layer are thin (see figure below) and, additionally, encounter a high resistance value, which indicates there is little potential for an aquifer in those layers and any deeper would likely reach the foundation, so the above locations shall be eliminated from this project.

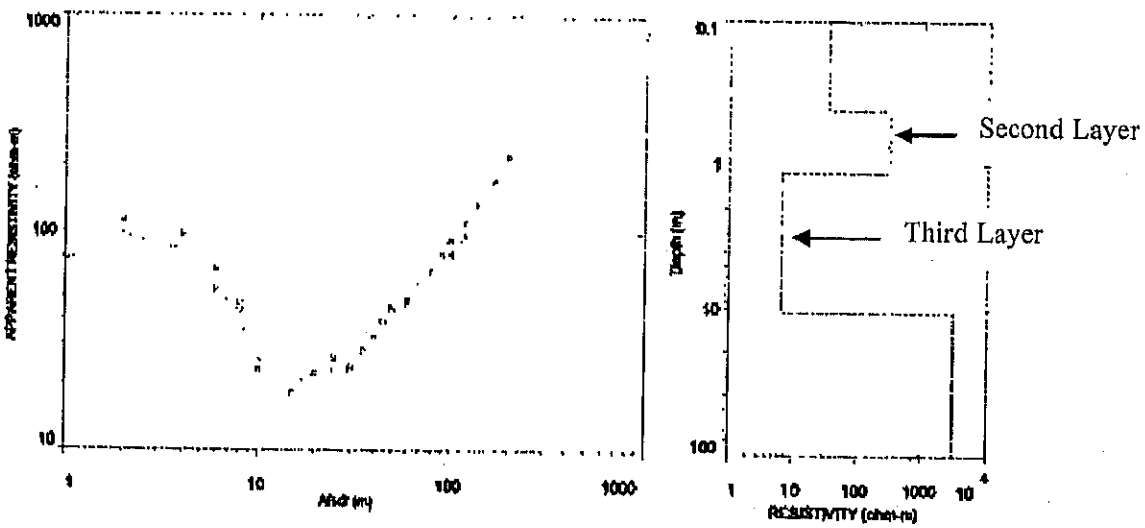


Figure 2-2: Non-Resistant column diagram based on analysis of electrical conductivity

5) Ranking

The selected drilling points which are seemed to be low successful rate and low cost performance rather than the other schemes shall be eliminated from this project.

6) Flow diagram for selection of schemes

Diagram showing the selection process for hand pump well facilities is shown in Figure 2-3.

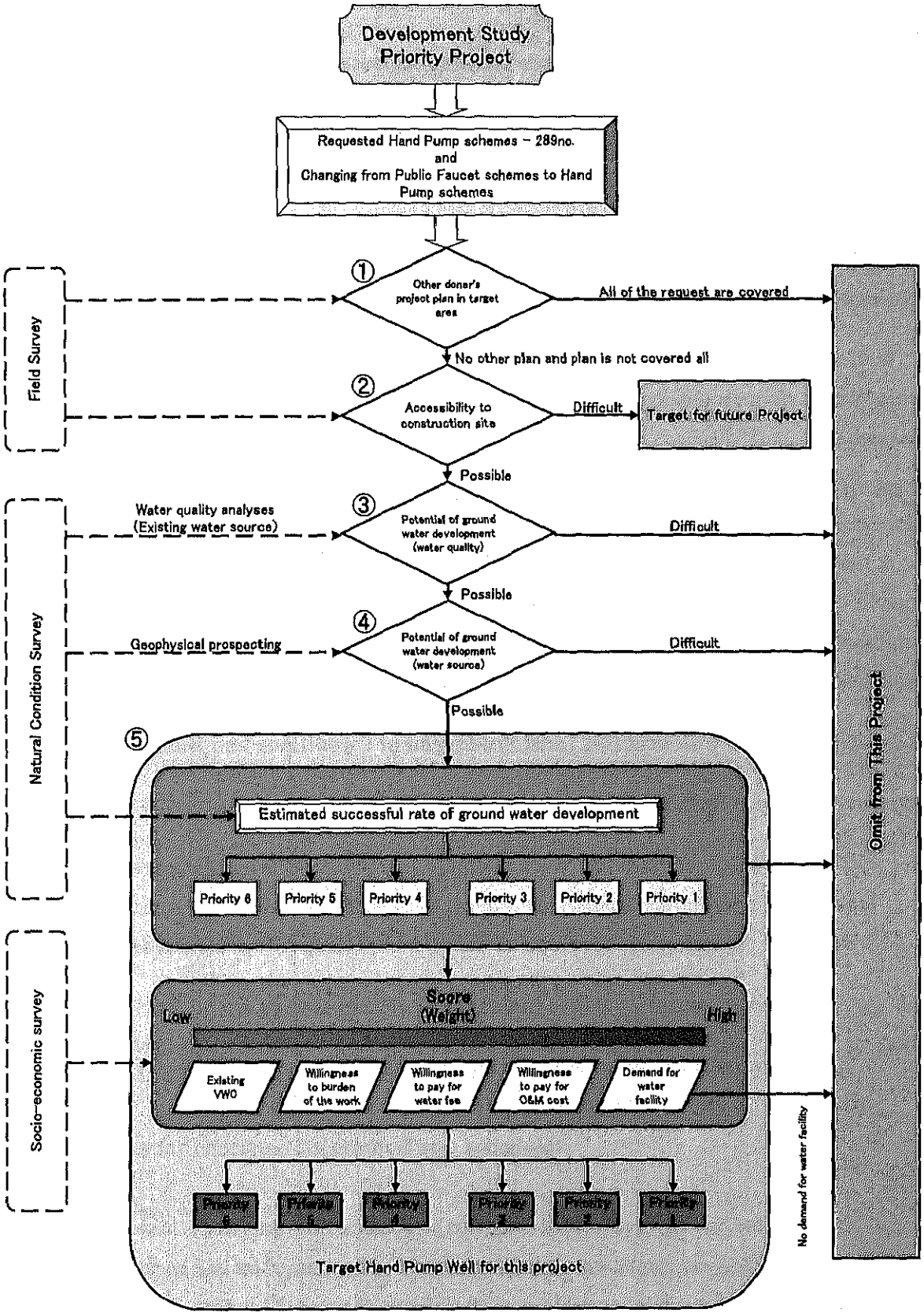


Figure 2-3: Flow diagram of selection process for hand pump well facilities

2-2-1-2 Policy for natural condition

The target area is located in the Mwanza and Mara regions which faces Lake Victoria. Both regions are located on the plateau which lowest altitude is 1,134m on the surface of Lake Victoria. The climate is relatively warm in comparison with the shoreline. In addition, the annual mean rainfall of both regions is 946mm and the annual mean air temperature is 24.5 degrees. Meanwhile, the annual mean rainfall at the observatories is between 356mm and 2,080mm, whereas the monthly mean rainfall is between 1.7mm and 234.35mm. The dry season is from July to September, and the rainy season begins from November to April of the following year.

In the target area, unpaved road will be muddy condition during the rainy season, therefore construction work should be planed to conduct during the dry season which the areas keep good road condition.

2-2-1-3 Policy for Social and Environment Conditions

A sense of ownership for water supply facilities should be cultivated and a concept of sanitation should be established among villagers in order to utilize the facility sustainably. Activities for the explanation and the education to the villagers will be carried out as part of the soft component (Technical Assistance) to achieve above policy.

2-2-1-4 Policy for Construction (and Procurement Conditions and Business Customs)

(1) Procurement of materials and equipments

There are small shops who sell some materials and equipments in the Mwanza and Mara regions, however the selection and quantity are limited. As a result, materials and equipments which will be prepared for the project shall be procured from Dar es Salaam, the commercial center of Tanzania.

(2) Approval and licenses

The Tanzanian side agreed to obtain the necessary approval and licenses from the relevant authority for facility construction so as not to interfere with the project.

(3) Work force

Based on the hearing from local construction companies, the work force is made up of Tanzanian workers and they will meet the needs of the project. Furthermore, there will be no need for workers from third countries unless special technical skills are required. Therefore, the work force will be planned by the local contractor in this project.

2-2-1-5 Policy of Utilization of Local Contractor

There are many drilling companies in Tanzania. They have adequate drilling technique and equipments, however they are unable to carry out construction management and quality control such as borehole logging test. Nonetheless, if Japanese contractors were to conduct the drilling work, the costs would be unmanageably high. Therefore, in order to maintain an appropriate cost, the local contractors shall be engaged in the drilling construction under the construction management and supervision by Japanese contractors.

2-2-1-6 Policy for Operation and maintenance

(1) Village level

Many of the target villages already have Village Water Committees (VWCs); however many of them are no longer functional because the facilities have broken down. On the implementation stage, the soft component activities will help VWC to strengthen restructuring the organization, and improving water fee collection and control methods.

(2) Authorities concerned

Currently, services to villagers and existing facilities are not provided sufficiently due to restructuring the organization budget and shortages of the Regional Water Engineer's office (RWE) and District Water Engineer's office (DWE). It is necessary to restructure organization, increase staff and improve technical capabilities of the authorities concerned, however this project does not have enough time to cover all of them. Therefore, suggestions concerning technical assistance to be supported by the other donors will be given in this project.

2-2-1-7 Policy for Facility Design

The facilities shall be design user-friendly as much as possible to operate and maintain by the villagers easily. Materials, equipments and spare parts which can be available in the local market shall be adopted.

2-2-1-8 Policies for construction method and schedule

(1) Method of deep well construction

The Mud Circulation Rotary method or the Down the Hole Hammer method (DTH) will be adopted as to the soil character at the drilling points. Both methods are commonly used in Tanzania. but Mud Circulation Rotary method will be used for surface and soft subsoil, whereas DTH will be adopted for foundation drilling.

(2) Construction schedule

The majority of facility construction of this project is the construction of hand pump well facilities. A term of project will be heavily influenced by the drilling period. Therefore, the contractor's ability and number of available equipments will be paid attention to set up an economical duration of the project.

2-2-2 Basic Plan

2-2-2-1 Selection of Public Faucet scheme

(1) Detail of the selection process

1) Other projects planned by the other donors in the target area

As a result of hearing to the Ministry of Water and Irrigation (MoWI) and Regional Water Engineer office in Mwanza and Mara regions, there is no other project in the target villages.

2) Yield test

The locations of yield tests conducted are shown as below.

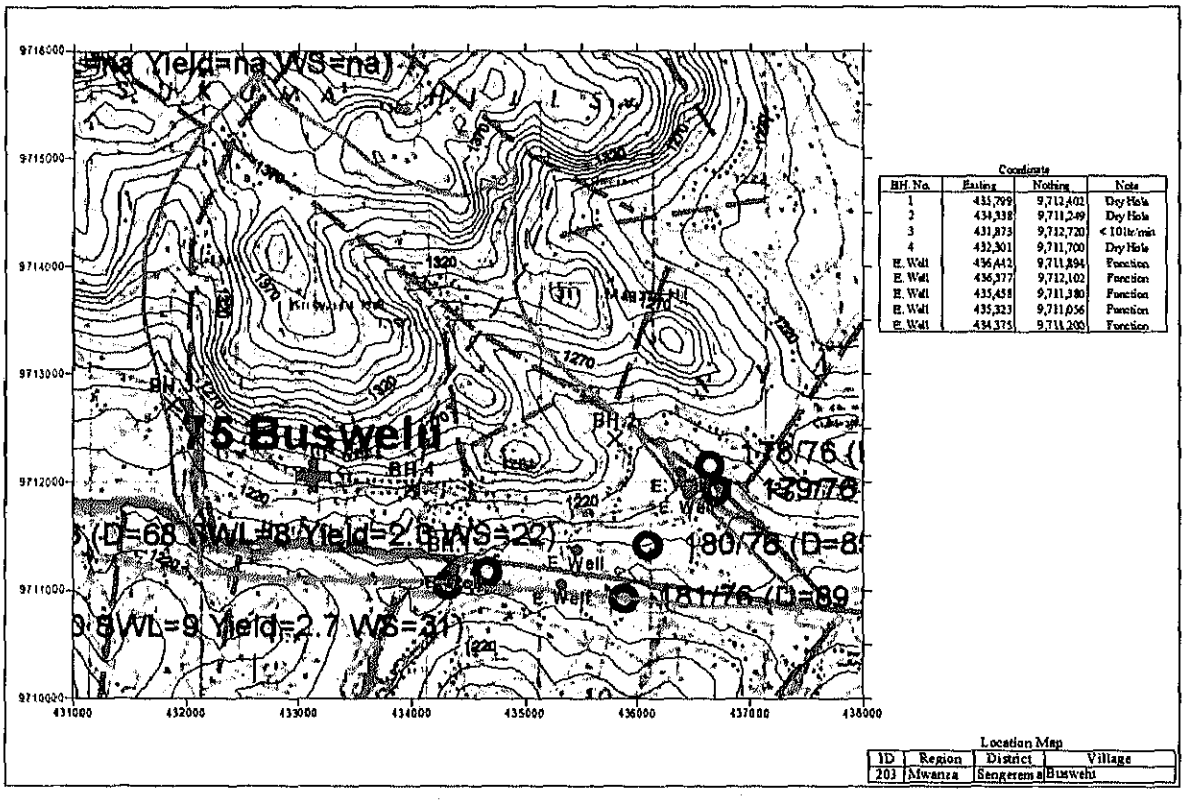


Figure 2-4: Location of yield tests in BUSWELU village

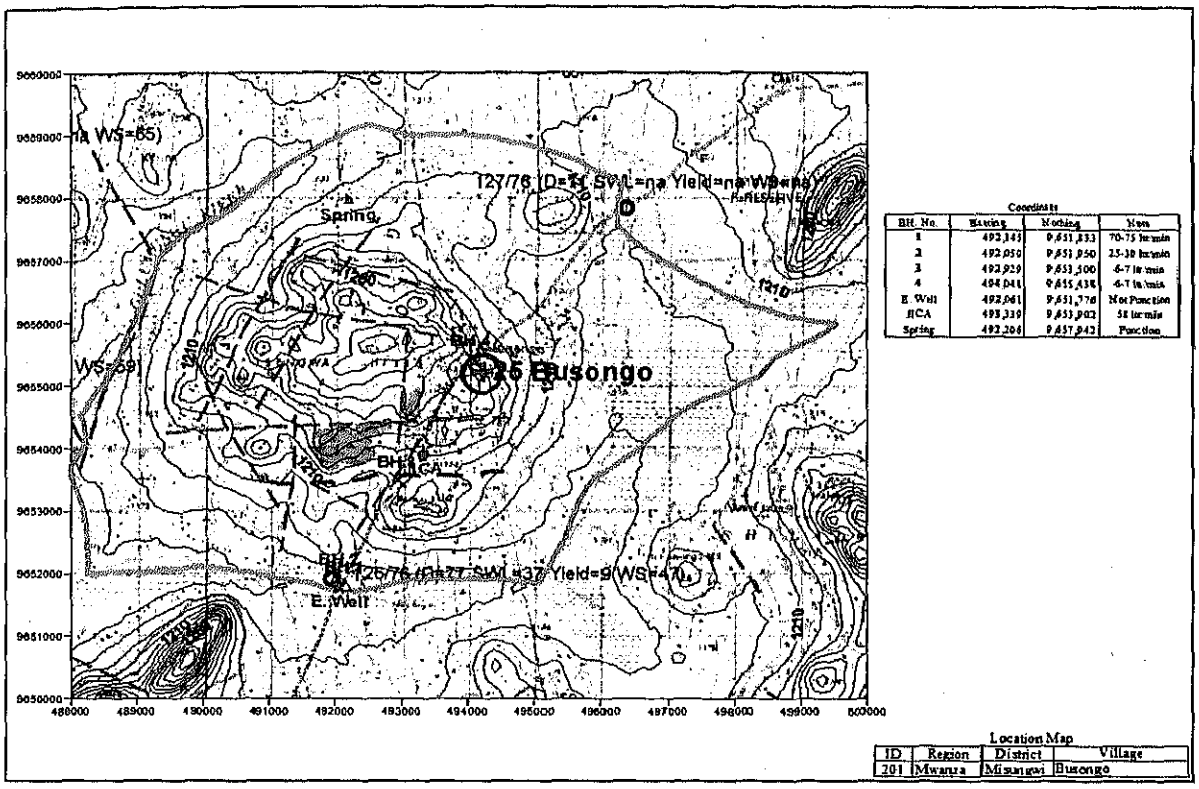


Figure 2-5: Location of yield tests in BUSONGO village

Yield tests were conducted at four points each at the BUSONGO and BUSWELU schemes, however none of them satisfied the required water volume. Therefore both schemes were eliminated from the Public Faucet schemes and had been changed to the candidate of the hand pump well scheme selection. Required water volume and the result of the yield tests for each scheme are shown as below.

Table 2-3: Required water yield for the each scheme

Region	District	ID	Scheme	Village	Water supply pop. in 2020 (Capita/village)	Water supply rate (ltr/capita/day)	Water demand (ltr/month/village)	Water demand per scheme (ltr/month/scheme)	Operation hours (hr/day)	Required water volume (ltr/min)
Mwanza	Misungwi	201	Busongo	Busongo	5,725	25	4,293,806	4,293,806	12	198.79
		202	Ngaya	Ngaya	4,170	25	3,127,541	3,127,541	12	144.79
	Sengerema	203	Buswelu	Buswelu	4,191	25	3,142,937	3,142,937	12	145.51
		204	Nyamiswi	Nayamiswi	3,902	25	2,926,230	8,043,563	12	372.39
		205		Nyakasasa	6,823	25	5,117,333			
		206	Nyakahako	Nyakahako	9,065	25	6,798,845	6,798,845	12	314.76
	Kwimba	207	Hungmalwa	Hungmalwa	6,299	25	4,724,191	4,724,191	12	218.71
	Ukerewe	208	Bukonyo	Bukonyo	2,577	25	1,932,779	6,324,668	12	292.81
		209		Namilemba	5,856	25	4,391,889			
Mara	Musoma	210	Saragana	Saragana	4,814	25	3,610,692	3,610,692	12	167.16
Total					53,422		40,066,242	40,066,242		1,854.92

Table 2-4: Yield test results

BUSONGO

BH. No.	Easting	Nothing	Depth (m)	Static water level (GL- m)	Dinamic water level (GL- m)	Yield (ltr/min)	Judgement
1	492,145	9,651,833	100	22.0	-	70-75	Not enough yield for Level 2
2	492,050	9,651,950	102	18.0	38.0	25-30	Not enough yield for Level 2
3	492,929	9,653,500	100	3.1	68.3	6-7	Not enough yield for Level 2 also Level 1
4	494,048	9,655,438	100	34.0	75.5	6-7	Not enough yield for Level 2 also Level 1

BUSWELU

BH. No.	Easting	Nothing	Depth (m)	Static water level (GL- m)	Dinamic water level (GL- m)	Yield (ltr/min)	Judgement
1	435,799	9,712,402	110	-	-	-	Dry hole
2	434,338	9,711,249	98	-	-	-	Dry hole
3	431,854	9,711,940	103			<10	Not enough yield for Level 2 also Level 1
4	432,301	9,711,700	100	-	-	-	Dry hole

The yield values given above were derived from a simple measurement after completion of drilling and are not official yield test results.

The yield at existing wells at HUNGMALWA and SARAGANA are 192 liter/min and 114.4 liter/min respectively. This did not comply with the required volume of 218.17 liter/min and 167.16 liter/min respectively. Therefore, those two schemes are changed to the hand pump well schemes.

3) Result of water quality analysis

■ Criteria of water quality analysis

The criteria of water quality analysis for this project are shown as below.

Table 2-5: Criteria of water quality for this project

No	Name of Constituent	Symbol	Units	Tanzania Standards		WHO Guideline		Project Standards
				Allowable	Upper Limit	Allowable	Acceptable	
	Bacteriological							
1	Coliform	CT	MPN/100ml	0	1-3	0		0
2	Escherichia Coil	E-Coil	MPN/100ml	0	0	0		0
	Toxic							
3	Lead	Pb	mg/l	0.05	0.10	0.01		0.01
4	Arsenic	As	mg/l	0.05	0.05	0.01		0.01
5	Selenium	Se	mg/l	0.01	0.05	0.01		0.01
6	Chromium	Cr	mg/l	0.05	0.05	0.05		0.05
7	Cyanide	Cn	mg/l	0.10	0.20	0.07		0.07
8	Cadmium	Cd	mg/l	0.01	0.05	0.003		0.003
9	Barium	Ba	mg/l	1.00	1.00	0.70		0.70
10	Mercury	Hg	mg/l	-	-	0.001		0.001
11	Silver	Ag	mg/l	-	-	-		-
	Affecting Human Health							
12	Fluoride	F	mg/l	1.50	8.00	1.50		1.50
13	Nitrate	NO_3	mg/l	30	100	50		50
	Being Orago-Septic							
14	Colour		mg/l	15	50	-	15	15
15	Turbidity		mg/l	15	30	-	5	15
16	Taste		-	Not Objectional	Not Objectional	-	-	Not Objectional
17	Odour		-	Not Objectional	Not Objectional	-	-	Not Objectional
	Salinity and Hardness							
18	pH			6.5-8.5	6.5-9.2	-	-	6.5-8.5
19	Total Filtrable		mg/l	1,500	2,000	-	-	1,500
20	Total Dissolved Solids	TDS	mg/l	-	-	-	1,000	-
21	Residue	$CaCO_3$	mg/l	500	600	-	-	500
	Total Hardness							
22	Calcium	Ca	mg/l	200	300	-	-	200
23	Magnesium	Mg	mg/l	150	100	-	-	150
24	Magnesium- Sodium Salphate	$Mg-Na_2SO_4$	mg/l	1,000	1,000	-	-	1,000
25	Sulphate	SO4	mg/l	400	600	-	250	400
26	Chloride	Cl	mg/l	250	800	-	250	250
	None Toxic Metals							
27	Iron	Fe	mg/l	0.30	1.00	-	0.30	0.30
28	Manganese	Mn	mg/l	0.10	1.50	0.40	0.10	0.10
29	Copper	Cu	mg/l	1.50	3.00	2.00	1.00	1.50
30	Zinc	Zn	mg/l	5.00	15.00	-	3.00	5.00
	Organic Pollution of Natural Origin							
31	BOD	BOD	mg/l	6.00	6.00	-	-	6.00
32	PV (Oxygen abs. KMnO4)		mg/l	10.00	20.00	-	-	10.00
33	Ammonium	NH_3	mg/l	0.50	2.00	-	1.50	0.50
34	Total Nitrogen Exclusive Nitrate		mg/l	0.10	1.00	-	-	0.10
	Organic Pollution Introduced Artificially							
35	Surfactants ABS (Alkyl Benxyl Sulphonates)		mg/l	1.00	1.00	-	-	1.00
36	Organic matter as carbon in chloroform extract		mg/l	0.50	0.50	-	-	0.50
37	Phenolic substance as phenol		mg/l	0.002	0.002	-	-	0.002

Adoption value

■ Results of water quality analysis

Water quality analysis was conducted at two trial boreholes in BUSONGO village, however, concentration of Chlorine and Fluorine were higher than the project standard. Therefore, the two trial wells had been eliminated from the public faucet schemes.

Table 2-6: Result of laboratory water quality analysis

Category	Northings	Eastings	Elevation (m)	Region	District	ID	Village	Description	Sampling Date	Laboratory Test											
										CN	Fe	Mn	F	pH	Ba	NH_4	NO_3	Color	Turbidity	TSS	TDS
										mg/l	mg/l	mg/l	mg/l		mg/l	mg/l	mg/l	mg/Pt.l	NTU	mg/l	mg/l
										0.07	0.30	0.10	1.50	6.5-8.5	0.7	0.50	50.00	15	15	1,500	-
Tap of Well and Victoria Lake	9,651,833	492,145	1,171	Mwanza	Misungwi	201	BUSONGO	BSO #1	12/01/2008	<0.001	0.04	<0.01	3.36	8.90	0	0.35	2.67	0	0	110	760.0
				Mwanza	Misungwi	201	BUSONGO	BSO #2	12/01/2008	<0.001	0.16	<0.01	3.97	9.00	0	0.46	9.50	0	0	230	765.0
	9,687,524	490,207	1,127	Mwanza	Misungwi	202	NGAYA	Victoria Lake	24/12/2007	<0.001	0.28	<0.01	1.09	8.47	0	0.35	0.70	14	23	280	67.6
	9,742,914	441,850	1,130	Mwanza	Sengerema	204	NYAMISWI	Victoria Lake	28/12/2007	<0.001	0.01	<0.01	0.81	8.49	0	0.44	0.81	0	2	240	52.3
	9,725,528	464,898	1,131	Mwanza	Sengerema	206	NYAKAHAKO	Victoria Lake	27/12/2007	<0.001	<0.01	<0.01	0.87	8.54	0	1.65	0.87	14	4	260	53.4
	9,784,198	493,418	1,129	Mwanza	Ukerewe	208	BUKONYO	Victoria Lake	23/12/2007	<0.001	0.04	<0.01	0.58	8.19	0	0.37	0.50	0	0	260	47.2

Category	Northings	Eastings	Elevation (m)	Region	District	ID	Village	Description	Sampling Date	Laboratory Test												Judgement
										Coliform	T-Hardness	Ca	Mg	SO_4	Cl	BOD	COD	HCO_3	Na	As	Organic Phosphorus	
										cons/100ml	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l	mg/l	
										0	500	200.0	150.00	400.00	250	6	10	-	-	1.00	0.50	
Tap of Well and Victoria Lake	9,651,833	492,145	1,171	Mwanza	Misungwi	201	BUSONGO	BSO #1	12/01/2008	0	247	113.0	32.56	91.60	460	0	0	539.0	119.1	<1.00	-	NG
				Mwanza	Misungwi	201	BUSONGO	BSO #2	12/01/2008	0	145	85.0	14.58	123.00	440	0	0	579.0	116.5	<1.00	-	NG
	9,687,524	490,207	1,127	Mwanza	Misungwi	202	NGAYA	Victoria Lake	24/12/2007	0	37	39.0	4.37	10.60	21	4	10	55.0	11.2	<1.00	0.01	Conditionally OK
	9,742,914	441,850	1,130	Mwanza	Sengerema	204	NYAMISWI	Victoria Lake	28/12/2007	0	36	15.0	7.53	4.90	16	0	0	38.0	7.8	<1.00	<0.01	OK
	9,725,528	464,898	1,131	Mwanza	Sengerema	206	NYAKAHAKO	Victoria Lake	27/12/2007	0	43	16.0	6.56	4.90	24	6	10	38.0	14.4	<1.00	0.01	Conditionally OK
	9,784,198	493,418	1,129	Mwanza	Ukerewe	208	BUKONYO	Victoria Lake	23/12/2007	0	40	17.0	5.59	18.00	23	0	0	37.0	9.1	<1.00	<0.01	OK

: Figure is exceeding project standards

Note: Public faucet schemes using water from Lake Victoria have a water purifier system, and therefore those schemes which exceed project standards of pH, NH_4 and Turbidity shall be accepted on certain conditions.

4) Payable water fees

The payable water fee is set the amount which is 5% of the annual income per household and 80 percent of the total villagers who can pay the amount. In case of the international organizations such as World Bank, the water fee in developing country is 4 to 5 percent of the income.

■ Income survey

➢ Method of survey

There are two methods for statistical survey, complete enumeration is carried out to investigate all subjects of a target research group, and sample survey is carried out to understand the full facts of the group based on investigation results of sample. For the actual survey, the complete enumeration would likely be superior, however the sample survey was conducted due to budgetary and time restrictions in this survey.

➢ Sample collection method

There are two methods for sample extraction: purposive selection and random selection. Purposive selection lacks objectivity since it requires the person conducting the sample to exercise specific intent and experience to limit the extraction, whereas random sampling is objective. Therefore, a random sampling method was adopted in this survey.

➢ Results of income survey

In order to avoid restricting the samples to households with good access conditions in the village, three households from each sub-village were extracted at random to collect an annual cash income record. There were 6,487 households in the Mwanza and Mara regions in 2007 and the number of samples was 255 with a sampling error of ± 6.02%.

Table 2-7: Number of collected samples and standard error

Region	Village ID	District	Ward	Village	Personnel in household	Population 2007	Number of Household in 2007	Number of sampling	Percentage of sampling data
Mwanza	201	MISUNGWI	Busongo	Busongo	6.36	5,035	792	33	4.17%
	202	MISUNGWI	Mbarika	Ngaya	6.18	3,937	637	45	7.06%
	203	SENGEREMA	Nyanzenda	Buswelu	6.51	2,839	436	18	4.13%
	204	SENGEREMA	Nyakasasa	Nyamiswi	6.05	2,451	405	15	3.70%
	205	SENGEREMA	Nyakasasa	Nyakasasa	6.06	4,287	708	27	3.81%
	206	SENGEREMA	Chifunfu	Nyakahako	5.85	5,695	973	24	2.47%
	207	KWIMBA	Hungumalwa	Hungumalwa	5.74	5,694	993	24	2.42%
	208	UKEREWE	Namilembe	Bukonyo	6.89	1,806	263	21	7.98%
	209	UKEREWE	Namilembe	Namilembe	6.20	4,104	663	21	3.17%
Mara	210	MUSOMA	Nyambono	Saragana	6.35	3,913	617	27	4.38%
					Average				4.33%
					Standard error				6.02%

MWANZA	
Number of sample	326
Max. income (Tsh/year/HH)	20,625,000
Min. income (Tsh/year/HH)	32,000
Ave. income (Tsh/year/HH)	840,557

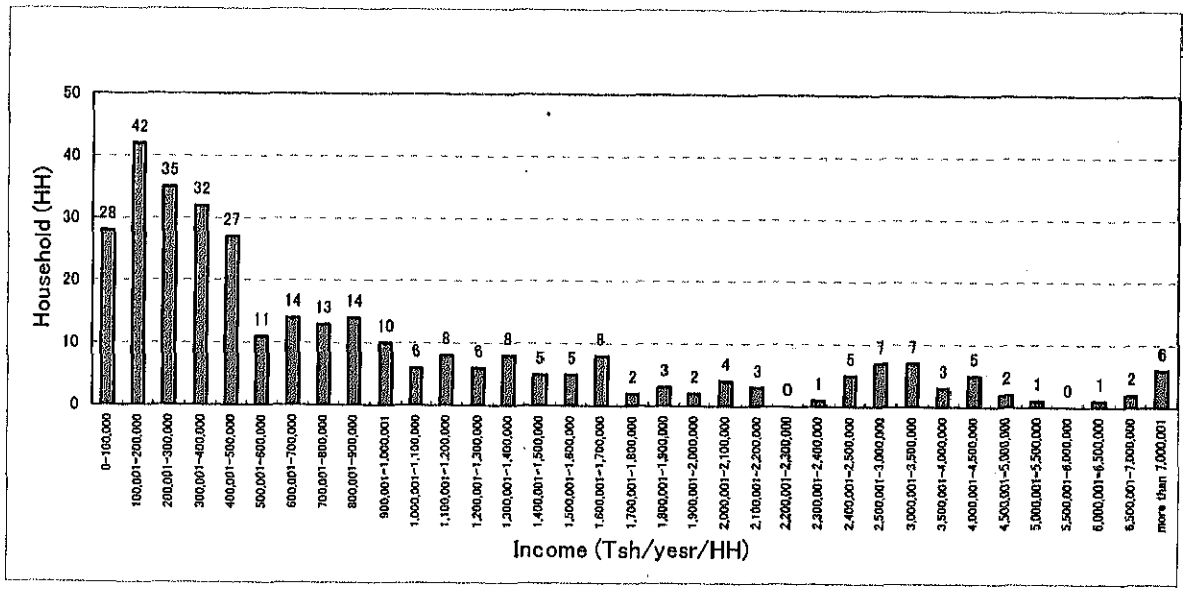


Figure 2-6: Income distribution in Mwanza Region

MARA	
Number of sample	141
Max. income (Tsh/year/HH)	5,965,000
Min. income (Tsh/year/HH)	43,000
Ave. income (Tsh/year/HH)	822,894

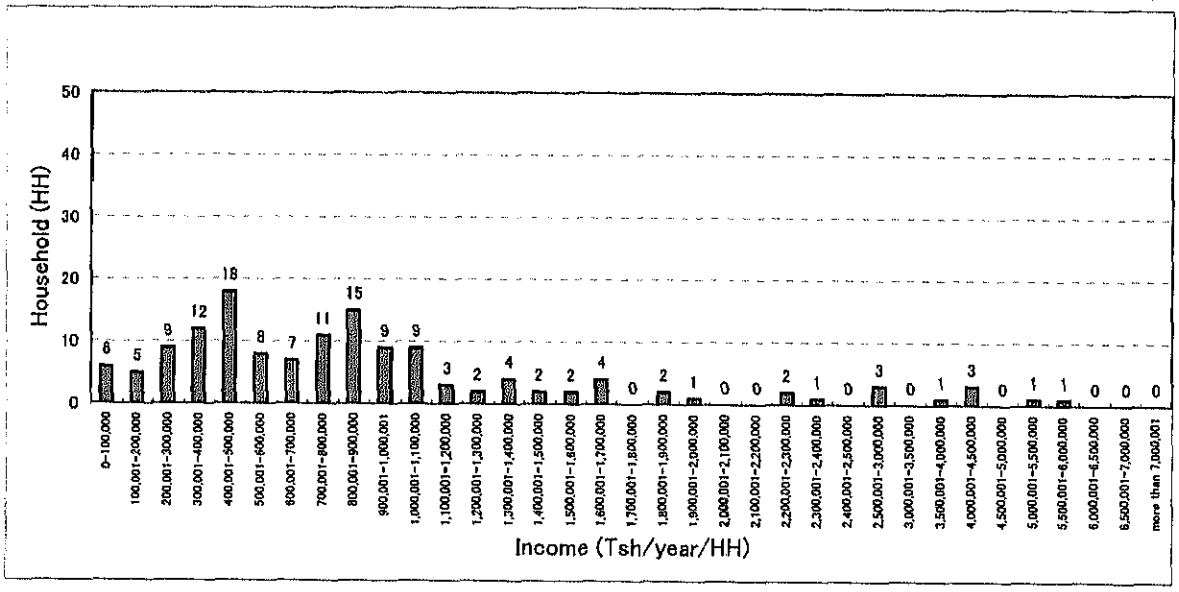


Figure 2-7: Income distribution in Mara Region

Annual incomes per household in 2000 were 977,000 Tanzania shilling (TSH) in Dar es Salaam, 846,000 TSH in other urban areas and 538,000 TSH in rural areas. Considering the price boost ratio since 2000, annual income in 2007 was estimated as follows:

- ✓ Dar es Salaam, 1,400,000 TSH,
- ✓ Other urban areas, 1,213,000 TSH, and
- ✓ Rural areas, 772,000 TSH.

As the result of annual income is 992,000 TSH in Mwanza region and is 932,000 TSH in Mara region, and these results seem to be adequate.

Table 2-8: Average annual income per household (2000)

Region	Average income by capita (TSH/capita)	Average size of household (person/HH)	Average income (TSH)
Dar es Salaam	16,473	4.55	977,055
Other urban	13,810	4.70	846,109
Rural	7,513	5.50	538,655

Source: Household Budget Survey, 2000/2001

Table 2-9: Inflation index

Unit: % / year

	2000	2001	2002	2003	2004	2005	2006	2007
Tanzania	4.9%	5.7%	6.2%	5.7%	6.7%	6.7%	6.2%	6.2%

Source: The Economic Survey, 2001, President's Office, Planning & Privatization, Tanzania, June 2002

Table 2-10: Average annual income per household considering price boost

Unit: TSH / HH / year

Region	2000	2001	2002	2003	2004	2005	2006	2007
Dar es Salaam	977,055	1,032,747	1,096,777	1,159,294	1,236,966	1,319,843	1,401,673	1,488,577
Other urban	846,109	894,337	949,786	1,003,924	1,071,187	1,142,956	1,213,820	1,289,077
Rural	538,655	569,359	604,659	639,124	681,946	727,636	772,750	820,660

- Population and number of households in target villages

Population and number of households in target villages are shown as below.

Table 2-11: Population in target villages

Unit: Capita / village

Region	District	ID	Village	Growth rate of population	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Mwanza	Misungwi	201	Busongo	1.32%	4,470	4,532	4,595	4,659	4,724	4,789	4,856	4,923	4,991	5,060	5,130	5,201	5,273	5,346	5,420	5,495	5,571	5,647	5,725
	Misungwi	202	Ngaya	1.32%	3,188	3,237	3,286	3,336	3,387	3,438	3,490	3,543	3,596	3,650	3,705	3,761	3,817	3,874	3,931	3,990	4,049	4,109	4,170
	Sengerema	203	Buswelu	3.64%	2,046	2,133	2,222	2,315	2,411	2,511	2,614	2,722	2,832	2,947	3,067	3,190	3,318	3,451	3,588	3,731	3,879	4,032	4,191
	Sengerema	204	Nyamiswi	3.64%	2,050	2,125	2,202	2,282	2,365	2,451	2,540	2,633	2,729	2,828	2,931	3,038	3,148	3,263	3,382	3,505	3,632	3,765	3,902
	Sengerema	205	Nyakasasa	3.64%	3,585	3,715	3,851	3,991	4,136	4,287	4,443	4,604	4,772	4,946	5,126	5,312	5,506	5,706	5,914	6,129	6,352	6,583	6,823
	Sengerema	206	Nyakahako	3.64%	4,763	4,936	5,116	5,302	5,495	5,695	5,903	6,117	6,340	6,571	6,810	7,058	7,315	7,581	7,857	8,143	8,440	8,747	9,065
	Kwimba	207	Hungmalwa	2.83%	3,067	3,208	3,352	3,500	3,652	3,809	3,970	4,136	4,306	4,481	4,661	4,847	5,037	5,233	5,435	5,642	5,855	6,074	6,299
	Ukerewe	208	Bukonyo	3.01%	1,479	1,526	1,574	1,624	1,675	1,728	1,782	1,838	1,896	1,955	2,016	2,079	2,144	2,211	2,280	2,351	2,424	2,499	2,577
	Ukerewe	209	Namilemba	3.01%	3,360	3,467	3,576	3,689	3,806	3,926	4,049	4,176	4,307	4,442	4,582	4,725	4,872	5,024	5,181	5,342	5,508	5,680	5,856
Mara	Musoma	210	Saragana	2.11%	3,180	3,256	3,333	3,412	3,493	3,576	3,660	3,746	3,834	3,924	4,016	4,110	4,206	4,304	4,403	4,503	4,604	4,708	4,814
Total				3.03%	31,189	32,134	33,107	34,111	35,144	36,210	37,307	38,439	39,604	40,806	42,044	43,321	44,637	45,993	47,390	48,829	50,313	51,844	53,422

Table 2-12: Number of households in target villages

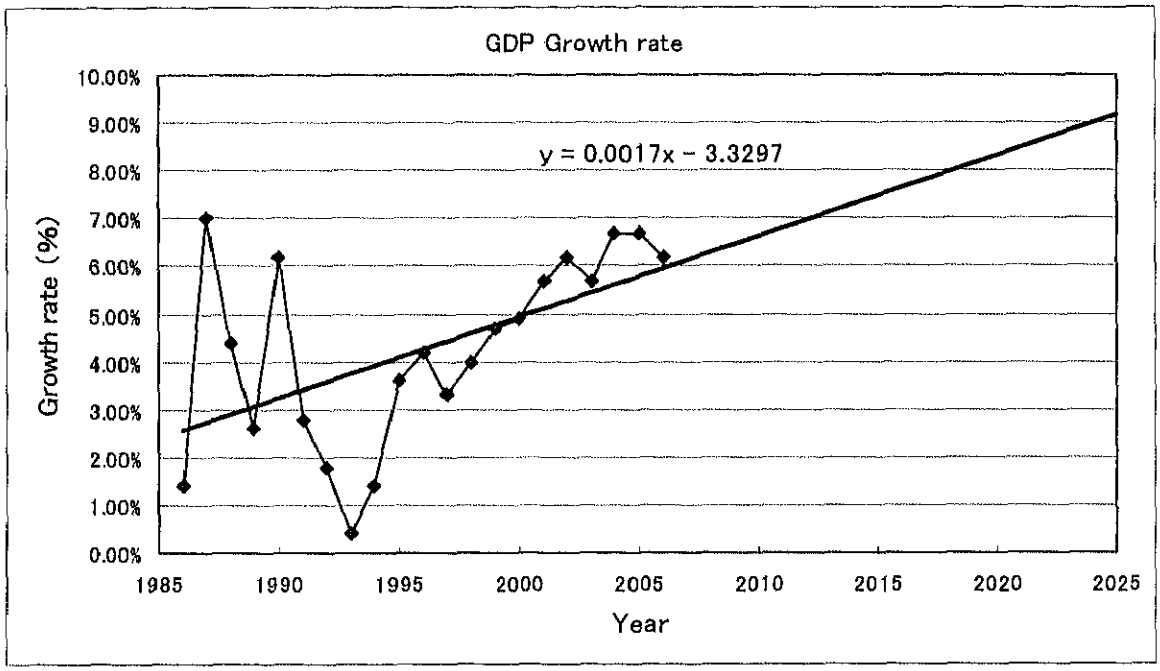
Unit: HH / village

Region	District	ID	Village	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Mwanza	Misungwi	201	Busongo	703	712	722	732	743	753	763	774	785	796	807	818	829	840	852	864	876	888	900
	Misungwi	202	Ngaya	516	523	531	539	548	556	564	573	582	590	599	608	617	626	636	645	655	664	674
	Sengerema	203	Buswelu	314	327	341	355	370	385	401	418	435	452	471	490	509	530	551	573	595	619	643
	Sengerema	204	Nyamiswi	339	351	364	377	391	405	420	435	451	467	484	502	520	539	559	579	600	622	645
	Sengerema	205	Nyakasasa	592	613	636	659	683	708	733	760	788	816	846	877	909	942	976	1,012	1,049	1,087	1,126
	Sengerema	206	Nyakahako	814	843	874	906	939	973	1,008	1,045	1,083	1,122	1,163	1,206	1,250	1,295	1,342	1,391	1,442	1,494	1,548
	Kwimba	207	Hungmalwa	535	559	584	610	637	664	692	721	751	781	813	845	878	912	948	984	1,021	1,059	1,098
	Ukerewe	208	Bukonyo	215	221	228	236	243	251	259	267	275	284	293	302	311	321	331	341	352	363	374
	Ukerewe	209	Namilemba	542	560	577	595	614	634	654	674	695	717	739	763	786	811	836	862	889	917	945
Mara	Musoma	210	Saragana	501	513	525	537	550	563	576	590	604	618	633	647	662	678	693	709	725	742	758
Total				5,071	5,222	5,382	5,546	5,718	5,892	6,070	6,257	6,449	6,643	6,848	7,058	7,271	7,494	7,724	7,960	8,204	8,455	8,711

Table 2-13: Estimated average annual income (2007)

Unit: TSH / HH / year

Region	Village ID	District	Ward	Village	No of Sub-village	Average Annual Cash Income
Mwanza	201	MISUNGWI	Busongo	Busongo	11	1,072,241
	202	MISUNGWI	Mbarika	Ngaya	15	291,774
	203	SENGEREMA	Nyanzenda	Buswelu	6	730,188
	204	SENGEREMA	Nyakasasa	Nyamiswi	5	970,154
	205	SENGEREMA	Nyakasasa	Nyakasasa	9	2,116,630
	206	SENGEREMA	Chifunfu	Nyakahako	8	2,475,000
	207	KWIMBA	Hungumalwa	Hungumalwa	8	733,675
	208	UKEREWE	Namilembe	Bukonyo	7	720,000
	209	UKEREWE	Namilembe	Namilembe	7	1,598,765
Mara	210	MUSOMA	Nyambono	Saragana	9	968,739



Source: TANZANIA National Bureau of Statistics

Figure 2-8: GDP Growth rate

The above data was collected in 2007 and is expected to increase in the future. Assuming future income will follow Gross Domestic Product (GDP), annual income for following years was calculated as shown below.

The World Bank and other international organizations recommend that the water fee shall be set between 4 to 5 percent of income in developing countries. Payable water fee is set as 5% of household income in this project. Monthly average payable water fee is shown as below.

Table 2-14: Average annual cash income

Unit: TSH / HH / year

Region	Village ID	District	Ward	Village	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Mwanza	201	MISUNGWI	Busongo	Busongo	1,072,241	1,140,865	1,216,162	1,297,645	1,387,182	1,485,672	1,592,641	1,710,496	1,840,494	1,982,212	2,138,806	2,312,050	2,501,638	2,711,775
	202	MISUNGWI	Mbarika	Ngaya	291,774	310,448	330,937	353,110	377,475	404,275	433,383	465,454	500,828	539,392	582,004	629,146	680,736	737,918
	203	SENGEREMA	Nyanzenda	Buswelu	730,188	776,920	828,196	883,685	944,660	1,011,730	1,084,575	1,164,834	1,253,361	1,349,870	1,456,509	1,574,487	1,703,595	1,846,697
	204	SENGEREMA	Nyakasasa	Nyamiswi	970,154	1,032,244	1,100,372	1,174,097	1,255,109	1,344,222	1,441,006	1,547,641	1,665,261	1,795,486	1,935,172	2,091,921	2,263,458	2,453,589
	205	SENGEREMA	Nyakasasa	Nyakasasa	2,116,630	2,252,095	2,400,733	2,561,582	2,738,331	2,932,753	3,143,911	3,376,560	3,633,179	3,912,934	4,222,036	4,564,042	4,938,294	5,351,110
	206	SENGEREMA	Chifunfu	Nyakahako	2,475,000	2,633,400	2,807,204	2,995,287	3,201,962	3,429,301	3,676,211	3,948,250	4,248,318	4,575,438	4,936,898	5,336,786	5,774,403	6,259,453
	207	KWIMBA	Hungumalwa	Hungumalwa	733,675	780,630	832,152	887,906	949,171	1,016,563	1,089,755	1,170,397	1,259,347	1,356,317	1,463,466	1,582,007	1,711,731	1,855,517
	208	UKEREWE	Namilembe	Bukonyo	720,000	766,080	816,641	871,356	931,480	997,615	1,069,443	1,148,582	1,235,874	1,331,037	1,436,188	1,552,520	1,679,826	1,820,932
	209	UKEREWE	Namilembe	Namilembe	1,598,765	1,701,086	1,813,357	1,934,852	2,068,357	2,215,210	2,374,706	2,550,434	2,744,267	2,955,575	3,189,066	3,447,380	3,730,065	4,043,394
Mara	210	MUSOMA	Nyambono	Saragana	968,739	1,030,738	1,098,767	1,172,385	1,253,279	1,342,262	1,438,905	1,545,384	1,662,833	1,790,871	1,932,350	2,088,870	2,260,158	2,450,011

Table 2-15: Monthly average payable water fee per household

Unit: TSH / HH / month

Region	Village ID	District	Ward	Village	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Mwanza	201	MISUNGWI	Busongo	Busongo	4,468	4,754	5,067	5,407	5,780	6,190	6,636	7,127	7,669	8,259	8,912	9,634	10,423	11,299
	202	MISUNGWI	Mbarika	Ngaya	1,216	1,294	1,379	1,471	1,573	1,684	1,806	1,939	2,087	2,247	2,425	2,621	2,836	3,075
	203	SENGEREMA	Nyanzenda	Buswelu	3,042	3,237	3,451	3,682	3,936	4,216	4,519	4,853	5,222	5,624	6,069	6,560	7,098	7,695
	204	SENGEREMA	Nyakasasa	Nyamiswi	4,042	4,301	4,585	4,892	5,230	5,601	6,004	6,449	6,939	7,473	8,063	8,716	9,431	10,223
	205	SENGEREMA	Nyakasasa	Nyakasasa	8,819	9,384	10,003	10,673	11,410	12,220	13,100	14,069	15,138	16,304	17,592	19,017	20,576	22,305
	206	SENGEREMA	Chifunfu	Nyakahako	10,313	10,973	11,697	12,480	13,342	14,289	15,318	16,451	17,701	19,064	20,570	22,237	24,060	26,081
	207	KWIMBA	Hungumalwa	Hungumalwa	3,057	3,253	3,467	3,700	3,955	4,236	4,541	4,877	5,247	5,651	6,098	6,592	7,132	7,731
	208	UKEREWE	Namilembe	Bukonyo	3,000	3,192	3,403	3,631	3,881	4,157	4,456	4,786	5,149	5,546	5,984	6,469	6,999	7,587
	209	UKEREWE	Namilembe	Namilembe	6,662	7,088	7,556	8,062	8,618	9,230	9,895	10,627	11,434	12,315	13,288	14,364	15,542	16,847
Mara	210	MUSOMA	Nyambono	Saragana	4,036	4,295	4,578	4,885	5,222	5,593	5,995	6,439	6,928	7,462	8,051	8,704	9,417	10,208

Table 2-16: Monthly average payable water fee per village

Unit: TSH / Village / month

Region	Village ID	District	Ward	Village	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Mwanza	201	MISUNGWI	Busongo	Busongo	2,792,251	3,010,410	3,255,361	3,522,835	3,818,682	4,146,325	4,505,447	4,903,921	5,346,634	5,840,387	6,390,754	7,004,355	7,682,530	8,440,401
	202	MISUNGWI	Mbarika	Ngaya	561,033	605,528	655,794	710,722	770,206	837,473	911,260	993,181	1,084,251	1,186,392	1,298,232	1,425,147	1,563,197	1,720,025
	203	SENGEREMA	Nyanzenda	Buswelu	972,214	1,077,425	1,197,227	1,329,394	1,476,660	1,647,982	1,837,903	2,050,447	2,297,306	2,572,233	2,886,256	3,239,834	3,646,899	4,106,515
	204	SENGEREMA	Nyakasasa	Nyamiswi	1,358,822	1,499,334	1,655,372	1,831,248	2,027,054	2,250,004	2,501,707	2,783,174	3,104,116	3,467,183	3,874,940	4,340,735	4,868,887	5,473,036
	205	SENGEREMA	Nyakasasa	Nyakasasa	5,182,570	5,708,966	6,309,927	6,980,738	7,727,571	8,580,502	9,535,351	10,614,640	11,835,989	13,207,456	14,776,491	16,557,394	18,564,074	20,845,457
	206	SENGEREMA	Chifunfu	Nyakahako	8,328,272	9,180,032	10,145,120	11,218,473	12,424,413	13,792,792	15,332,557	17,067,958	19,026,267	21,234,989	23,749,152	26,614,108	29,834,895	33,509,979
	207	KWIMBA	Hungumalwa	Hungumalwa	1,684,762	1,868,178	2,074,936	2,306,077	2,563,673	2,858,193	3,184,582	3,553,813	3,971,984	4,446,685	4,980,135	5,586,000	6,269,002	7,045,861
	208	UKEREWE	Namilembe	Bukonyo	624,990	686,184	754,066	828,696	914,868	1,010,875	1,116,944	1,235,348	1,371,975	1,523,649	1,693,685	1,889,934	2,108,812	2,355,223
	209	UKEREWE	Namilembe	Namilembe	3,505,425	3,847,430	4,226,785	4,650,498	5,128,750	5,663,432	6,266,155	6,932,717	7,696,868	8,565,061	9,586,871	10,598,826	11,829,125	13,214,306
Mara	210	MUSOMA	Nyambono	Saragana	1,886,175	2,053,231	2,241,943	2,448,916	2,678,571	2,938,379	3,219,609	3,538,027	3,898,927	4,292,046	4,738,041	5,237,407	5,799,753	6,422,499

■ Water demand

Water supply to villagers is set to 25 liter/capita/day. Water demand in each village is shown as below.

Table 2-17: Water demand

Unit: liter/village/month

Region	District	ID	Village	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Mwanza	Misungwi	201	Busongo	3,591,979	3,641,821	3,692,320	3,743,486	3,795,328	3,847,854	3,901,073	3,954,995	4,009,628	4,064,983	4,121,068	4,177,894	4,235,470	4,293,806
	Misungwi	202	Ngaya	2,578,732	2,617,707	2,657,196	2,697,207	2,737,745	2,778,819	2,820,435	2,862,600	2,905,322	2,948,608	2,992,465	3,036,901	3,081,924	3,127,541
	Sengerema	203	Buswelu	1,883,237	1,960,733	2,041,050	2,124,291	2,210,561	2,299,972	2,392,637	2,488,676	2,588,210	2,691,367	2,798,279	2,909,083	3,023,920	3,142,937
	Sengerema	204	Nyamiswi	1,838,451	1,905,371	1,974,727	2,046,607	2,121,103	2,198,311	2,278,330	2,361,261	2,447,211	2,536,289	2,628,610	2,724,292	2,823,456	2,926,230
	Sengerema	205	Nyakasasa	3,215,048	3,332,076	3,453,363	3,579,066	3,709,344	3,844,364	3,984,299	4,129,327	4,279,634	4,435,413	4,596,862	4,764,188	4,937,604	5,117,333
	Sengerema	206	Nyakahako	4,271,485	4,426,967	4,588,108	4,755,136	4,928,202	5,107,588	5,293,505	5,486,188	5,685,885	5,892,852	6,107,351	6,329,659	6,560,059	6,798,845
	Kwimba	207	Hungmalwa	2,856,716	2,977,560	3,101,825	3,229,606	3,361,004	3,496,120	3,635,059	3,777,931	3,924,846	4,075,919	4,231,267	4,391,012	4,555,277	4,724,191
	Ukerewe	208	Bukonyo	1,295,685	1,336,452	1,378,447	1,421,706	1,466,266	1,512,168	1,559,452	1,608,158	1,658,331	1,710,014	1,763,253	1,818,094	1,874,586	1,932,779
	Ukerewe	209	Namilemba	2,944,209	3,036,846	3,132,274	3,230,568	3,331,824	3,436,128	3,543,571	3,654,248	3,768,257	3,885,698	4,006,673	4,131,290	4,259,657	4,391,889
Mara	Musoma	210	Saragana	2,681,703	2,744,962	2,809,585	2,875,600	2,943,039	3,011,931	3,082,308	3,154,202	3,227,646	3,301,090	3,376,084	3,452,659	3,530,851	3,610,692
Total				27,157,244	27,980,494	28,828,891	29,703,251	30,604,415	31,533,255	32,490,669	33,477,587	34,494,972	35,542,233	36,621,914	37,735,072	38,882,804	40,066,242

■ Payable water fees

According to common unit for water fee in Tanzania, payable water fee per 20 liters water tank based on water demand are shown as below.

Table 2-18: Payable water fees per 20 litres

Unit: TSH/20 liter

Region	Village ID	District	Ward	Village	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Mwanza	201	MISUNGWI	Busongo	Busongo	19.43	20.67	22.04	23.53	25.15	26.94	28.87	31.00	33.34	35.92	38.77	41.91	45.35	49.14
	202	MISUNGWI	Mbarika	Ngaya	5.44	5.78	6.17	6.59	7.03	7.53	8.08	8.67	9.33	10.06	10.85	11.73	12.68	13.75
	203	SENGEREMA	Nyanzenda	Buswelu	12.91	13.74	14.66	15.65	16.70	17.91	19.20	20.60	22.19	23.89	25.79	27.84	30.15	32.66
	204	SENGEREMA	Nyakasasa	Nyamiswi	18.48	19.67	20.96	22.37	23.89	25.59	27.45	29.47	31.71	34.18	36.85	39.83	43.11	46.76
	205	SENGEREMA	Nyakasasa	Nyakasasa	40.30	42.83	45.68	48.76	52.08	55.80	59.83	64.26	69.14	74.44	80.36	86.88	93.99	101.84
	206	SENGEREMA	Chifunfu	Nyakahako	48.74	51.84	55.28	58.98	63.03	67.51	72.41	77.78	83.66	90.09	97.22	105.12	113.70	123.22
	207	KWIMBA	Hungumalwa	Hungumalwa	14.74	15.69	16.72	17.85	19.07	20.44	21.90	23.52	25.30	27.27	29.42	31.80	34.41	37.29
	208	UKEREWE	Namilembe	Bukonyo	12.06	12.84	13.68	14.57	15.60	16.71	17.91	19.20	20.68	22.28	24.01	25.99	28.12	30.46
	209	UKEREWE	Namilembe	Namilembe	29.77	31.67	33.74	35.99	38.48	41.19	44.21	47.43	51.06	54.98	59.32	64.14	69.43	75.22
Mara	210	MUSOMA	Nyambono	Saragana	17.58	18.70	19.95	21.29	22.75	24.39	26.11	28.04	30.20	32.50	35.09	37.92	41.06	44.47

5) Operation and maintenance costs

■ Selection of facility type

In principle, there are three methods supply power for pump up ground water a) generator, b) solar and c) windmill. The characteristics of each are shown as below.

Table 2-19: Comparison table of power generation

	Generator	Solar power	Windmill system
Merit	• To be able to supply power stably • Using common equipment, maintenance is relatively easy	• Low operation and maintenance cost	• Low operation and maintenance cost
Demerit	• High running cost • Daily maintenance is necessary	• Generating power is depending on weather and sunshine • Needs high investment cost • Life time of panel about 10 to 15 years. Replacement of panel is required • Generating power is about 60 watt / panel • Solar panel is easily stolen • Inverter often breakdown and it is difficult to get spare parts in market in developing country	• Generating power is depending on winds and unstable • Low generating power for the large facility and high initial cost

Considering large water demand for each scheme of this project, water supply facilities should be planned to satisfy water demand by multiple source of groundwater. In this case, power generators for pump up are necessary at each source. Construction of the facility which is necessary to large power generator such as windmill is not economical, therefore it is not been adopted in this project.

Comparing operation and maintenance costs between generators and solar, the solar requires 2 to 3 times the amount rather than generator. Therefore, in consideration for sustainable utilization of water facilities by the villagers, the water fee shall be as low as possible. The generator system is the most suitable system for this project and therefore was adopted in this project.

Table 2-20: Comparison table of operation and maintenance fee

Solar panel

Region	Scheme	Water demand	Generation	Pump Capacity	Required number	Unit Price	Total	Life Time	Depreciation Cost			O/M cost
		ltr/mth	w	kw	Number	Tsh/Number	Tsh	Year	Tsh/Year	Tsh/ltr	Tsh/20ltr	Tsh/20ltr
Mwanza	Ngaya	3,127,541	60	7.0	117	1,000,000	117,000,000	15	7,800,000	2.49	49.88	49.88
	Nyamiswi	8,043,563	60	18.7	312	1,000,000	312,000,000	15	20,800,000	2.59	51.72	51.72
	Nyakahako	6,798,845	60	14.7	245	1,000,000	245,000,000	15	16,333,333	2.40	48.05	48.05
	Hungmalwa	4,724,191	60	7.5	125	1,000,000	125,000,000	15	8,333,333	1.76	35.28	35.28
	Bukonyo	6,324,668	60	10.5	175	1,000,000	175,000,000	15	11,666,667	1.84	36.89	36.89
Mara	Saragana	3,610,692	60	3.7	62	1,000,000	62,000,000	15	4,133,333	1.14	22.89	22.89

Generator

Region	Scheme	Water Demand	Required Fuel		Unit Price	Total Fuel	Running Cost		Generator Price	Life Time	Depreciation Cost				O/M cost
		ltr/mth	ltr/year	ltr/mth	Tsh/ltr	Tsh/mth	Tsh/ltr	Tsh/20 ltr	Tsh/unit	year	Tsh/year	Tsh/month	Tsh/ltr	Tsh/20ltr	Tsh/20ltr
Mwanza	Ngaya	3,127,541	24,572	2,048	1,500	3,071,500	0.98	19.64	13,500,000	10	1,350,000	112,500	0.04	0.72	20.36
	Nyamiswi	8,043,563	68,503	5,709	1,500	8,562,875	1.06	21.29	27,180,000	10	2,718,000	226,500	0.03	0.56	21.85
	Nyakahako	6,798,845	51,377	4,281	1,500	6,422,125	0.94	18.89	26,797,000	10	2,679,700	223,308	0.03	0.66	19.55
	Hungmalwa	4,724,191	16,926	1,411	1,500	2,115,750	0.45	8.96	14,758,000	10	1,475,800	122,983	0.03	0.52	9.48
	Bukonyo	6,324,668	31,273	2,606	1,500	3,909,125	0.62	12.36	14,758,000	10	1,475,800	122,983	0.02	0.39	12.75
Mara	Saragana	3,610,692	14,147	1,179	1,500	1,768,375	0.49	9.80	13,496,000	10	1,349,600	112,467	0.03	0.62	10.42

Commercial Electricity

Region	Scheme	Water Demand	Electrical fee	Pump Capacity	Running Hours	Electricity fee		Running cost		O/M cost
		ltr/mth	Tsh/kwh	kw	hr/day	Tsh/day	Tsh/mth	Tsh/ltr	Tsh/20ltr	Tsh/20ltr
Mwanza	Ngaya	3,127,541	150	7.0	12	12,600	378,000	0.12	2.42	2.42
	Nyamiswi	8,043,563	150	18.7	12	33,660	1,009,800	0.13	2.51	2.51
	Nyakahako	6,798,845	150	14.7	12	26,460	793,800	0.12	2.34	2.34
	Hungmalwa	4,724,191	150	7.5	12	13,500	405,000	0.09	1.71	1.71
	Bukonyo	6,324,668	150	10.5	12	18,900	567,000	0.09	1.79	1.79
Mara	Saragana	3,610,692	150	3.7	12	6,660	199,800	0.06	1.11	1.11

※ O/M cost=Running cost + Depreciation cost

Table 2-21: Initial cost Comparison table

Solar Panel

Region	Scheme	Solar Panel	Control Panel	Total
		JPY	JPY	JPY
Mwanza	Ngaya	11,700,000	500,000	12,200,000
	Nyamiswi	31,200,000	500,000	31,700,000
	Nyakahako	24,500,000	500,000	25,000,000
	Hungmalwa	12,500,000	500,000	13,000,000
	Bukonyo	17,500,000	500,000	18,000,000
Mara	Saragana	6,200,000	500,000	6,700,000

Generator

Region	Scheme	Generator	
		KVA	JPY
Mwanza	Ngaya	25	1,420,000
	Nyamiswi	100	2,800,000
	Nyakahako	75	2,760,000
	Hungmalwa	35	1,520,000
	Bukonyo	45	1,800,000
Mara	Saragana	20	1,390,000

Commercial Electricity

Region	Scheme	Transformer
		[¥]
Mwanza	Ngaya	500,000 ~ 1,500,000
	Nyamiswi	
	Nyakahako	
	Hungmalwa	
	Bukonyo	
Mara	Saragana	

■ Facility planning

Following matters were considered to plan facilities:

- To minimize operation and maintenance costs, the facility plan will avoid use of a power source as much as possible.

  For example "multiple submerged pumps will be operated with one generator", "not to use a buster pump" and "chemicals for the purifying facility are minimized".

- The facility should be designed with conventional technology and a simple system so be operated and maintained by villagers.

  Lake water purification equipment with a rapid filtration system would apply small reservoir and small filter basin, however it is adopted high performance and complex equipments which is difficult to be repaired by villagers or government staff. Therefore, a slow filtration system is adopted in this project to make it easier to repair and maintain.

- Facility to be planned to adopt local equipments and materials as much as possible to keep low initial cost.

- Secondary products which are available on the local market to keep low initial cost.

Facility plans for each scheme are shown below.

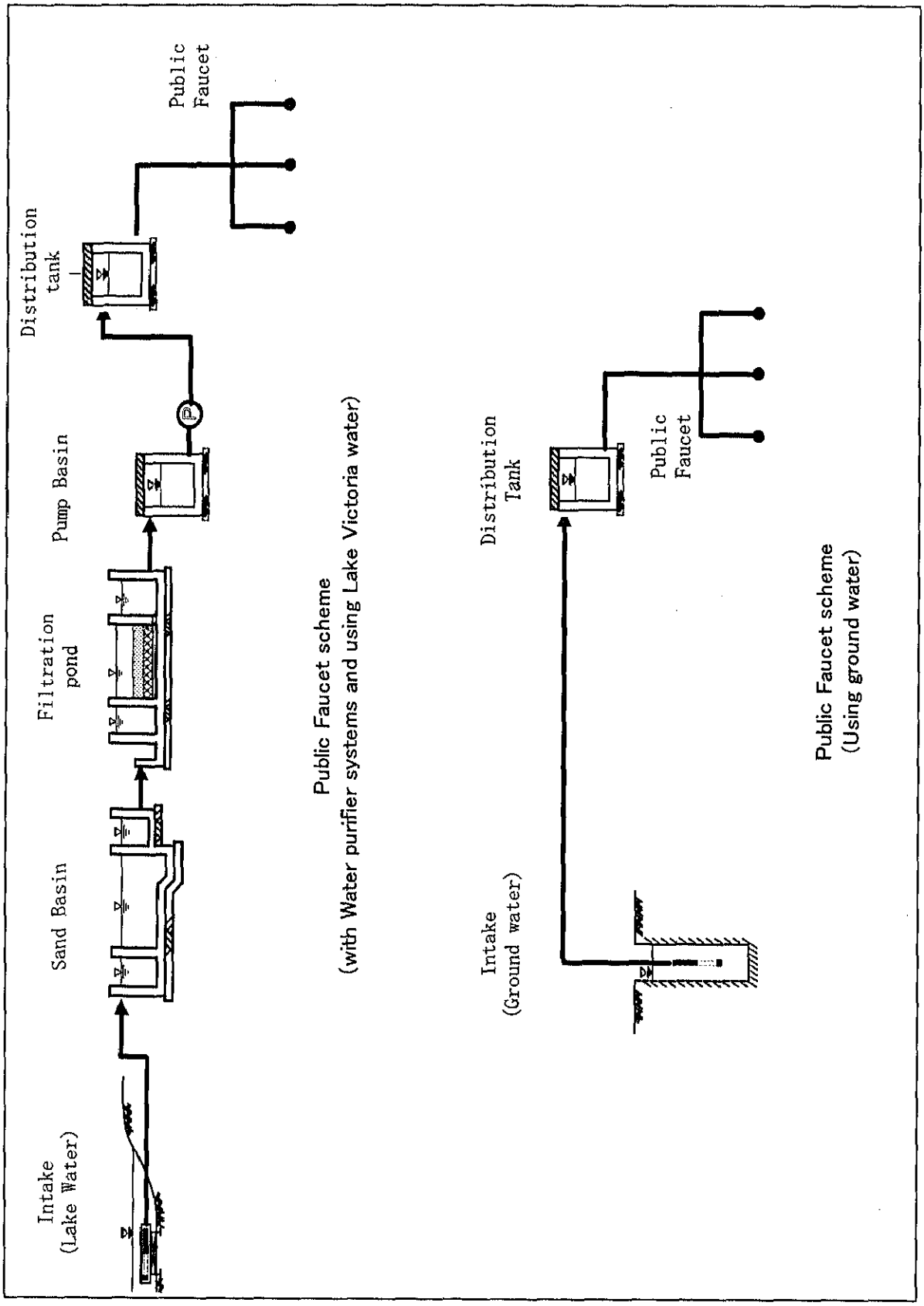


Figure 2-9: Public faucet scheme standard drawing

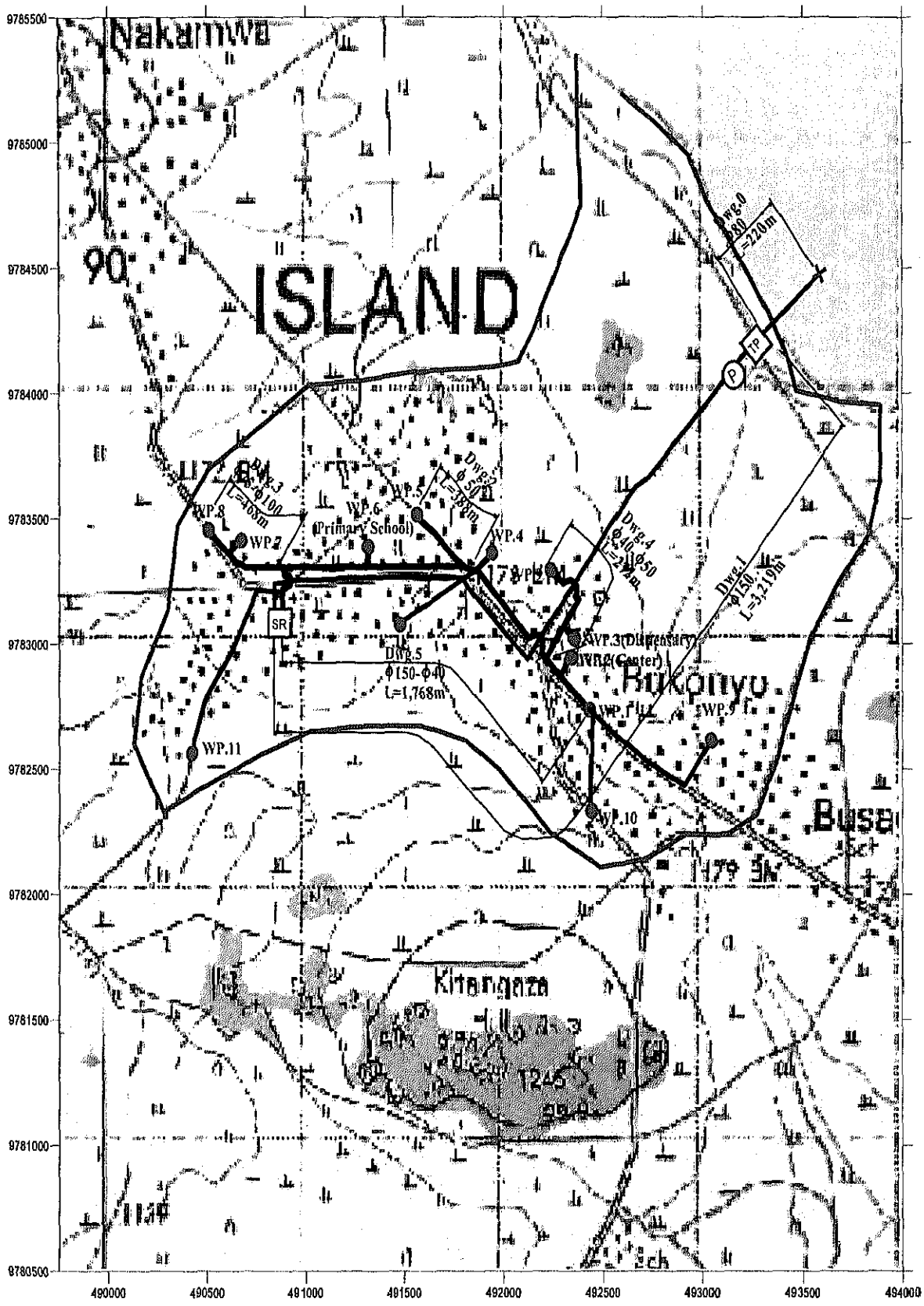


Figure 2-10: BUKONYO Public Faucet scheme (with water purifier system and using Lake Water)

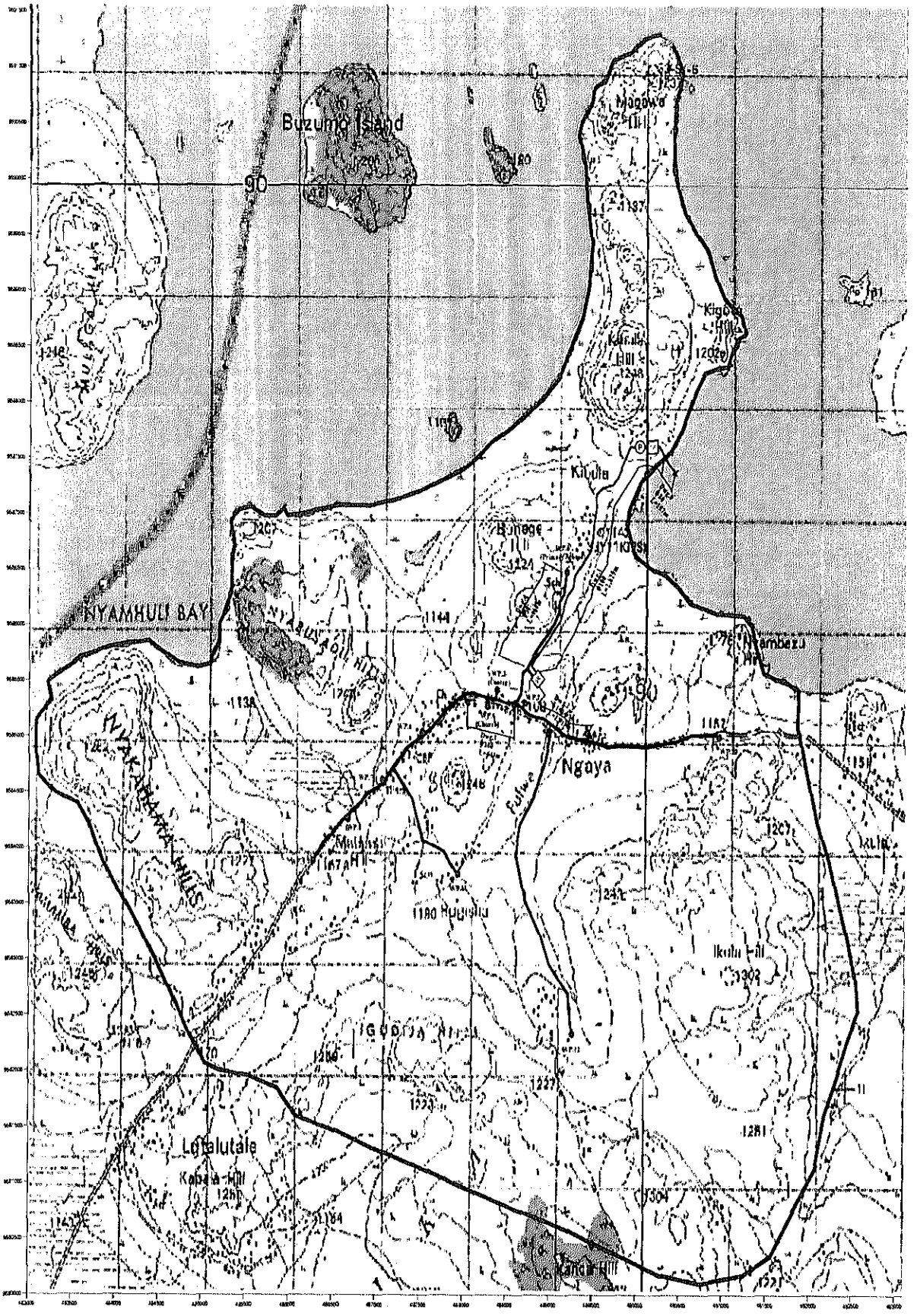


Figure 2-11: NGAYA Public Faucet scheme (with water purifier system and using lake water)

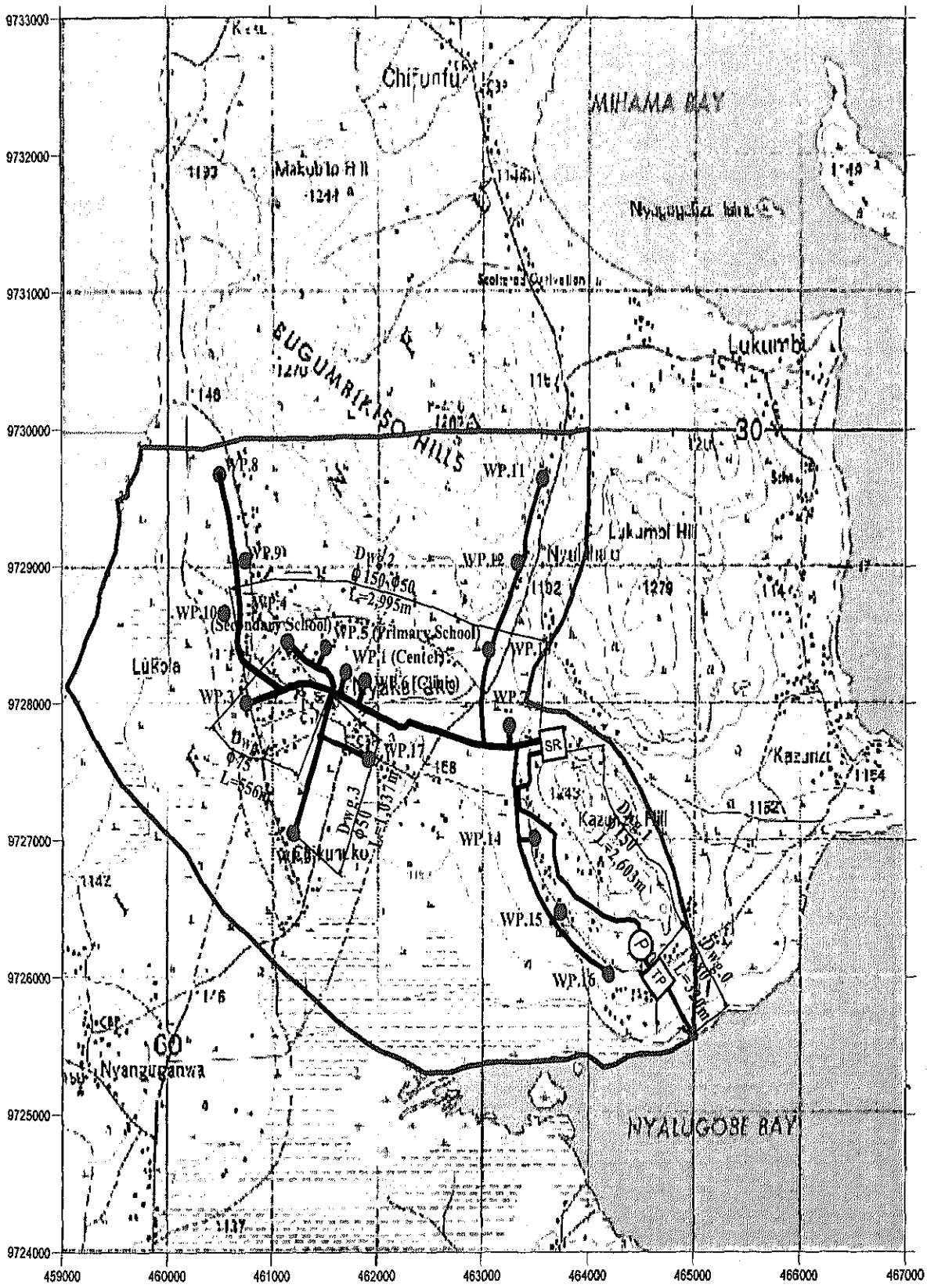


Figure 2-12: NYAKAHAKO Public Faucet scheme (with water purifier system and using lake water)

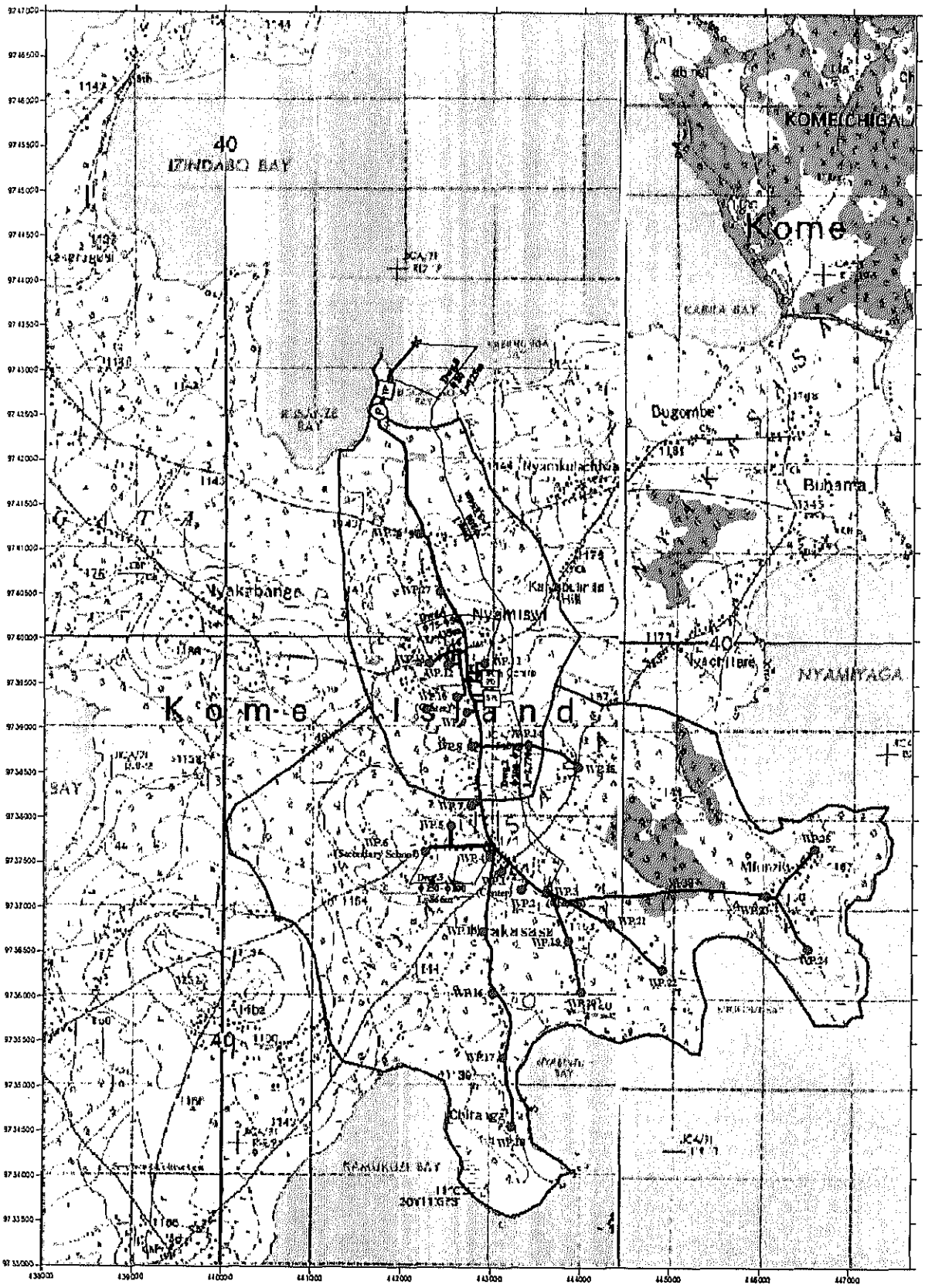


Figure 2-13: NYAMISWI Public Faucet scheme (with water purifier system and using lake water)

■ Operation and maintenance cost

Estimated operation and maintenance cost is shown below. The cost was calculated based on market prices in 2007 and the operation and maintenance cost was calculated in accordance with the "Design Manual for Water Supply and Waste Water Disposal" published by the Tanzanian Ministry of Water in July 1997. Detailed operation and maintenance cost for the schemes are shown as follows.

Table 2-22: Required monthly operation and maintenance cost (based on current market price 2007)

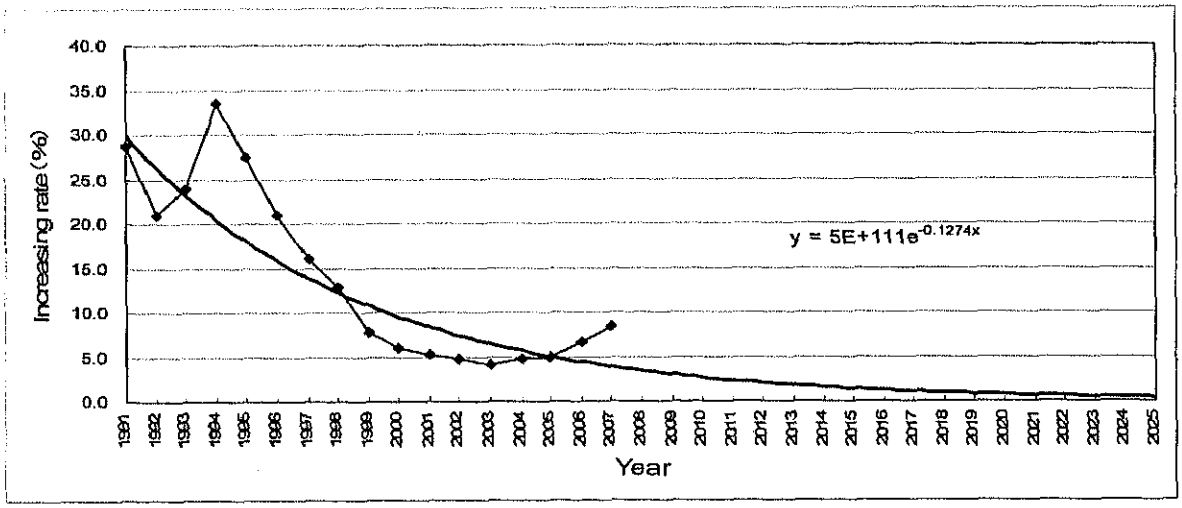
Unit: TSH/month/scheme

Region	Village ID	District	Ward	Village	Amount
Mwanza	201	MISUNGWI	Busongo	Busongo	-
	202	MISUNGWI	Mbarika	Ngaya	5,635,832
	203	SENGEREMA	Nyanzenda	Buswelu	-
	204	SENGEREMA	Nyakasasa	Nyamiswi	12,643,262
	205	SENGEREMA	Nyakasasa	Nyakasasa	
	206	SENGEREMA	Chifunfu	Nyakahako	7,835,851
	207	KWIMBA	Hungumalwa	Hungumalwa	-
	208	UKEREWE	Namilembe	Bukonyo	6,820,384
	209	UKEREWE	Namilembe	Namilembe	
Mara	210	MUSOMA	Nyambono	Saragana	-

Table 2-23: Outline of operation and maintenance cost

Scheme / Description	Lake Victoria							
	Ngaya		Nyamiswi		Nyakahako		Bukonyo	
water supply ratio	25.0	liter/capita/day	25.0	liter/capita/day	25.0	liter/capita/day	25.0	liter/capita/day
water volume supplied	3,127,541	liter/month	11,258,611	liter/month	6,798,845	liter/month	6,324,668	liter/month
Depreciation cost	576,582	10.2%	1,305,071	10.3%	781,580	9.0%	559,005	8.2%
Equipment repairing cost	87,667	1.6%	161,775	1.3%	153,483	1.8%	107,088	1.6%
Fuel cost	3,071,500	54.5%	8,562,875	67.7%	6,422,125	73.7%	3,909,125	57.3%
Chemical cost	10,750	0.2%	21,125	0.2%	17,875	0.2%	17,750	0.3%
Salary	1,889,333	33.5%	2,592,417	20.5%	1,341,833	15.4%	2,227,417	32.7%
Total	5,635,832		12,643,262		8,716,896		6,820,384	

The estimated cost above is based on 2007 prices, and is expected to increase in the future. Operation and maintenance costs are expected to increase in the future, therefore the consumer price index (CPI) is considered to calculate the monthly operation and maintenance cost in each fiscal year.



Source: TANZANIA National Bureau of Statistics

Figure 2-14: Consumer Price Index in Tanzania

Table 2-24: Required monthly operation and maintenance cost

Unit: TSH/month/scheme

Region	Village ID	District	Ward	Village	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Mwanza	201	MISUNGWI	Busongo	Busongo														
	202	MISUNGWI	Mbarika	Ngaya	5,635,832	5,829,772	6,023,595	6,217,427	6,411,410	6,605,263	6,799,125	6,993,151	7,187,034	7,381,090	7,574,995	7,769,081	7,963,007	8,157,123
	203	SENGEREMA	Nyanzenda	Buswelu														
	204	SENGEREMA	Nyakasasa	Nyamiswi	12,643,262	13,078,537	13,513,996	13,949,378	14,384,954	14,820,589	15,256,436	15,692,196	16,128,176	16,564,224	17,000,509	17,436,872	17,873,312	18,309,829
	205	SENGEREMA	Nyakasasa	Nyakasasa														
	206	SENGEREMA	Chifunfu	Nyakahako	7,835,851	8,105,785	8,375,895	8,645,919	8,916,128	9,186,388	9,456,700	9,727,218	9,997,638	10,268,272	10,538,967	10,809,894	11,080,713	11,351,774
	207	KWIMBA	Hungumalwa	Hungumalwa														
	208	UKEREWE	Namilembe	Bukonyo	6,820,384	7,055,290	7,290,365	7,525,483	7,760,643	7,995,847	8,231,093	8,466,382	8,701,874	8,937,254	9,172,844	9,408,486	9,644,180	9,880,106
	209	UKEREWE	Namilembe	Namilembe														
Mara	210	MUSOMA	Nyambono	Saragana														

The required operation and maintenance cost based on water demand and yearly maintenance cost is shown as below.

Table 2-25: Required operation and maintenance cost per 20 litres of water

Unit: TSH/20 liter

Region	Village ID	District	Ward	Village	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Mwanza	201	MISUNGWI	Busongo	Busongo														
	202	MISUNGWI	Mbarika	Ngaya	43.71	44.54	45.34	46.10	46.84	47.54	48.21	48.86	49.47	50.06	50.63	51.16	51.68	52.16
	203	SENGEREMA	Nyanzenda	Buswelu														
	204	SENGEREMA	Nyakasasa	Nyamiswi	50.04	49.94	49.79	49.59	49.34	49.05	48.72	48.35	47.95	47.52	47.06	46.57	46.06	45.53
	205	SENGEREMA	Nyakasasa	Nyakasasa														
	206	SENGEREMA	Chifunfu	Nyakahako	36.69	36.62	36.51	36.36	36.18	35.97	35.73	35.46	35.17	34.85	34.51	34.16	33.78	33.39
	207	KWIMBA	Hungumalwa	Hungumalwa														
	208	UKEREWE	Namilembe	Bukonyo	32.17	32.27	32.32	32.35	32.35	32.32	32.26	32.18	32.07	31.94	31.80	31.63	31.44	31.24
	209	UKEREWE	Namilembe	Namilembe														
Mara	210	MUSOMA	Nyambono	Saragana														

6) Water fees

Required operation and maintenance cost and payable cost

The facilities which are constructed in this project will be completed in 2010 at the earliest. Therefore the scheme was selected based on payable water fee and required operation and maintenance costs from 2010 to 2020. A comparison table is shown as below.

The NYAMISWI and BUKONYO schemes will be provide water to two villages each, and the payable water fee varies according to each village. A decision with lower income results was selected based on the village.

Table 2-26: Comparison table of payable water fee and required O/M cost (Full items)

Included items

1	Depreciation cost for pipe line	1% of construction cost for one year
2	Depreciation cost for facilities	1% of construction cost for one year
3	Repairing cost for equipments	5% of equipment cost
4	Fuel	100% of consumed cost
5	Chemical	100% of consumed cost
6	Staff salary for Maintenance	100% of personnel salary
7	Staff salary for water fee correction	100% of personnel salary

Served water ratio: 25 liter / capita / day

Unit : Tsh/ 20ltr

Scheme	Village	Description	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Ngaya	Ngaya	Payable water fee	6.35	6.78	7.26	7.79	8.36	8.99	9.70	10.45	11.31	12.22	13.25	14.39	15.64	17.05	18.60	20.31
	Required maintenance fee		46.10	46.84	47.54	48.21	48.86	49.47	50.06	50.63	51.16	51.68	52.16	52.63	53.07	53.48	53.88	54.25
Nyamiswi	Nyamiswi	Payable water fee	21.56	23.03	24.66	26.46	28.40	30.56	32.94	35.52	38.39	41.55	45.07	48.91	53.14	57.85	63.20	69.07
	Nyakasasa		47.00	50.20	53.78	57.67	61.94	66.64	71.75	77.46	83.74	90.60	98.16	106.60	115.92	126.24	137.76	150.54
	Required maintenance fee		49.59	49.34	49.05	48.72	48.35	47.95	47.52	47.06	46.57	46.06	45.53	44.98	44.41	43.82	43.23	42.62
Nyakahako	Nyakahako	Payable water fee	56.85	60.75	65.07	69.79	74.97	80.63	86.83	93.70	101.32	109.59	118.77	129.03	140.22	152.74	166.67	182.16
	Required maintenance fee		36.36	36.18	35.97	35.73	35.46	35.17	34.85	34.51	34.16	33.78	33.39	32.99	32.57	32.15	31.71	31.27
Hungmalwa	Hungmalwa	Payable water fee	14.74	15.69	16.72	17.85	19.07	20.44	21.90	23.52	25.30	27.27	29.42	31.80	34.41	37.29	40.52	44.02
	Required maintenance fee		31.09	31.46	31.83	32.19	32.55	32.91	33.26	33.22	32.83	32.43	32.04	31.63	31.23	30.82	30.41	30.00
Bukonyo	Bukonyo	Payable water fee	14.05	15.03	16.11	17.26	18.51	19.94	21.47	23.15	25.05	27.11	29.36	31.92	34.70	37.76	41.23	45.05
	Namilembe		34.69	37.09	39.70	42.61	45.71	49.22	52.99	57.17	61.82	66.92	72.50	78.71	85.63	93.24	101.72	111.18
	Required maintenance fee		32.35	32.35	32.32	32.26	32.18	32.07	31.94	31.80	31.63	31.44	31.24	31.03	30.80	30.55	30.30	30.03
Saragana	Saragana	Payable water fee	21.29	22.75	24.39	26.11	28.04	30.20	32.50	35.09	37.92	41.06	44.47	48.29	52.52	57.21	62.39	68.23
	Required maintenance fee		28.83	29.05	29.24	29.41	29.56	29.69	29.81	29.91	30.00	30.06	30.12	30.15	30.17	30.17	30.16	30.14

Required maintenance fee: Maintenance cost total ÷ (Served population × Served water ratio)

Payable water fee: Payable total amount ÷ (Served population × Served water ratio)

Table 2-27: Comparison table of payable water fee and required O/M cost (Specific items)

Included items

1	Repairing cost for equipment	5% of equipment cost
2	Fuel	100% of consumed cost
3	Chemical	100% of consumed cost
4	Staff salary for Maintenance	100% of personnel salary

Water supply ratio: 25 liter / capita / day

Unit : Tsh/ 20ltr

Scheme	Village	Description	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Ngaya	Ngaya	Payable water fee	6.35	6.78	7.26	7.79	8.36	8.99	9.70	10.45	11.31	12.22	13.25	14.39	15.64	17.05	18.60	20.31
	Required maintenance fee		28.80	28.40	28.00	27.60	27.20	26.80	26.40	26.00	25.60	25.20	24.80	24.60	24.20	23.80	23.40	23.20
Nyamiswi	Nyamiswi	Payable water fee	21.56	23.03	24.66	26.46	28.40	30.56	32.94	35.52	38.39	41.55	45.07	48.91	53.14	57.85	63.20	69.07
	Nyakasasa		47.00	50.20	53.78	57.67	61.94	66.64	71.75	77.46	83.74	90.60	98.16	106.60	115.92	126.24	137.76	150.54
	Required maintenance fee		36.20	35.00	33.80	32.60	31.40	30.40	29.20	28.20	27.20	26.20	25.40	24.40	23.60	22.80	22.00	21.20
Nyakahako	Nyakahako	Payable water fee	56.85	60.75	65.07	69.79	74.97	80.63	86.83	93.70	101.32	109.59	118.77	129.03	140.22	152.74	166.67	182.16
	Required maintenance fee		28.80	27.80	26.80	25.80	25.00	24.00	23.20	22.40	21.60	21.00	20.20	19.40	18.80	18.20	17.60	17.00
Hungmalwa	Hungmalwa	Payable water fee	14.74	15.69	16.72	17.85	19.07	20.44	21.90	23.52	25.30	27.27	29.42	31.80	34.41	37.29	40.52	44.02
	Required maintenance fee		18.00	17.80	17.80	17.60	17.40	17.40	17.40	17.20	17.20	17.00	16.60	16.00	15.40	15.00	14.40	14.00
Bukonyo	Bukonyo	Payable water fee	14.05	15.03	16.11	17.26	18.51	19.94	21.47	23.15	25.05	27.11	29.36	31.92	34.70	37.76	41.23	45.05
	Namilembe		34.69	37.09	39.70	42.61	45.71	49.22	52.99	57.17	61.82	66.92	72.50	78.71	85.63	93.24	101.72	111.18
	Required maintenance fee		23.40	22.80	22.20	21.40	20.80	20.20	19.60	19.00	18.40	17.80	17.40	16.80	16.40	15.80	15.40	15.00
Saragana	Saragana	Payable water fee	21.29	22.75	24.39	26.11	28.04	30.20	32.50	35.09	37.92	41.06	44.47	48.29	52.52	57.21	62.39	68.23
	Required maintenance fee		15.40	15.00	14.60	14.40	14.00	13.60	13.40	13.00	12.80	12.60	12.20	12.00	11.80	11.40	11.20	11.00

Required maintenance fee: Maintenance cost total ÷ (Served population × Served water ratio)

Payable water fee: Payable total amount ÷ (Served population × Served water ratio)

7) Amount of willingness to pay

Generally, in developing countries, amount of willingness to pay is higher than payable water fee. However, in almost villages in the target area, it is less than payable water fee, therefore it is necessary to consider willingness to pay. According to the results, the village where the amount of willingness to pay is higher than operation and maintenance cost which to be required is only NYAKAHAKO village. The table below shows the amount of willingness to pay.

Table 2-28: Amount of willingness to pay for water fee

Unit: TSH

Region	Village ID	District	Ward	Village	Per Bucket	Per Monthly	Per Yearly
Mwanza	201	MISUNGWI	Busongo	Busongo	—	500	—
	202		Mbarika	Ngaya	20	—	—
	203	SENGEREMA	Nyanzenda	Buswelu	—	2,000	—
	204		Nyakasasa	Nyamiswi	20	—	—
	205			Nyakasasa	—	500	—
	206		Chifunfu	Nyakahako	20	—	—
	207	KWIMBA	Hungumalwa	Hungumalwa	50	—	—
	208	UKEREWE	Namilembe	Bukonyo	—	500	—
	209			Namilembe	—	1,000	—
Mara	210	MUSOMA	Nyambono	Saragana	—	600	—
Total					4 villages	6 villages	No village

The result of the survey revealed actual expenditure of the water fee in the dry season, as shown in Table 2-29. Actual expenditure of the water fee in the dry season is 36,000 TSH/month in NYAKAHAKO village. The expected water consumption rate in 2010 which is calculated with consideration to income growth along with GDP is shown in Table 2-30. At this water price, 81.7% of villagers would be supplied with water based on O/M costs, so villagers should be able to afford the water fee.

Table 2-29: Actual expenditure of water fee in dry season

Region	ID	District	Word	Village	Commercial water price per bucket (TSH)	Water consumption in Dry season per day (per 20 litter)	Expenditure of water fee in Dry season per day (TSH/day/Household)	Expenditure of water fee in Dry season per month (TSH/month/ household)	Person per household (capita)	Water consumption (litter/capita/ day)
Mwanza	201	MISUNGWI	Busongo	Busongo	150	8	1,200	36,000	6.36	25.15
	202		Mbarika	Ngaya	200	3	600	18,000	6.18	9.70
	203	SENGEREMA	Nyanzenda	Buswelu	—	6	—	—	6.51	18.42
	204		Nyakasasa	Nyamiswi	100	5	500	15,000	6.05	16.52
	205			Nyakasasa	200	3	600	18,000	6.06	9.91
	206		Chifunfu	Nyakahako	200	6	1,200	36,000	5.85	20.50
	207	KWIMBA	Hungumalwa	Hungumalwa	200	2	400	12,000	5.74	6.97
	208	UKEREWE	Namilembe	Bukonyo	—	2	—	—	6.89	5.80
	209			Namilembe	—	10	—	—	6.20	32.28
Mara	210	MUSOMA	Nyambono	Saragana	—	5	—	—	6.35	15.75

Table 2-30: Expected water consumption in 2010 based on actual expenditure of water fee in 2007

Region	ID	District	Word	Village	Actual expenditure of water fee in 2007 (Tsh/month/ household)	Expected expenditure of water fee in 2010 considering inflation (Tsh/month/	Expected water price in 2010 (Tsh/20litter)	Expected water price in 2010 (Tsh/litter)	Possible purchase water volume based on income (litter/day/ household)	Possible purchase water volume based on income (litter/month/ household)	Peson per household (capita/ household)	Possible purchase water volume (litter/capita/ day)	Target water consumption (litter/capita/ day)	Water consumption rate (%)
Mwanza	206	SENGEREMA	Chifunfu	Nyakahako	36,000	46,000	43.83	2.19	20,990	699.67	5.85	119.52	146.35	81.7%

8) Sustainable operation and maintenance by the beneficiaries

Facilities which to be constructed by Japanese Grant Aid require sustainable operation and maintenance by the beneficiaries. Therefore, the beneficiary's capability will be examined.

a Items for operation and maintenance

The items for operation and maintenance are categorized as operational and technical:

- Operational issues
  - i Village Water Committee
  - ii Collection of O/M fee
  - iii Procurement of spare parts
  - iv Procurement of chemicals
  - v Accounting
  - vi Hygiene education
  - vii Support by upper organization
- Technical issues
  - i Chemical dosage control
  - ii Intake and distribution pump operation
  - iii Operation and maintenance of sedimentation basin
  - iv Operation and maintenance of filtration system

b Current situation in NYAKAHAKO village

- Current situation of existing facility

There are one dug well and 15 spring facilities in NYAKAHAKO village, however the springs dry up and are not used in the dry season with the exception of only three facilities. These water sources utilize shallow dug well and surface water, therefore villagers hope to improve the poor water quality of those facilities.

- Operational issues

i Village water committee (VWC)

VWC is composed 8 people (4 males and 4 females) and hold the meeting once a month. The VWC discusses operation and maintenance of the existing facilities.

ii Collection of O/M fee

The O/M fee is collected at the time of using facilities and is stored TSH 170,000 in a water

fund[1] at present.

iii Procurement of spare parts

Existing water sources are dug well and surface water which do not require any spare parts, and therefore did not require procurement of spare parts.

iv Procurement of chemicals

There is no correspond facility.

v Accounting

O/M fee is collected, however detail information is not provided.

vi Hygiene education

According to a questionnaire, villagers are aware of the dangers of water-borne disease, however education on hygiene is not carried out.

vii Support by upper organization

DWE conducts regular inspection for the facilities twice a year.

- Technical issues

Regular inspection is conducted by DWE however the specialists are not required for simple facilities.

c Evaluation of operation and maintenance, and required technical support in NYAKAHAKO village

- Operational issues

Based on the efforts of the VWC to collect the O/M fee and conduct operations, NYAKAHAKO village is deemed suitable to conduct operations for a public faucet scheme.

- Technical issues

The technical issues related to operation and maintenance items that can be expected are summarized in Table 2-31.

In principle, a water purifier system to be installed in this project is a slow filtration system which is simple to operate, therefore, it would not require many special operation skills. Nevertheless, it is necessary to make technical decisions on the suitable amount of chlorine to add, timing and how much filtration sand to take off. In addition, change of water quality should be monitored throughout the year. Therefore, for this kind of filtration system, it must be operated by

[1] Fund which establishing from water fee for purchasing spare parts and repairing cost

technicians who have a fundamental understanding and received sufficient training. However, VWC members did not have enough knowledge or experience on similar equipment, and thus it is inadvisable to operate for this kind of filtration system on its own.

Table 2-31: Technical issues related Operation and Maintenance

Maintenance Item	Purpose	Maintenance Details	Method	Frequency	Conduct by	Comments
1. Water quality control	To maintain water quality and decide dosage of Chlorine	Daily check items (Color, Turbidity)	To check source water quality	1 time/ day	VWC (Village water committee)	Require turbidity meter in hand
		Daily check items (Color, Turbidity, residual chlorine)	To check purified water quality	1 time/ day	VWC	Require turbidity meter and residual chlorine meter in hand
		Regular check items	To check source water quality	4 times/ year	Order to laboratory	To have water quality laboratory or to assign out source
		(Bacteria, bacillus coli, odor, pH, taste, nitrate nitrogen, nitrite-nitrogen)	To check purified water quality	1 time/ month	Order to laboratory	To have water quality laboratory or to assign out source
		Other drinking water standards	To check purified water quality	1 time/ year	Order to laboratory	To have water quality laboratory or to assign out source
		Filling chlorine	Filling calcium hypochlorite	1 time/ day	VWC, DWE	Compare with the sodium hypochlorite, decrease of the chlorine with storage is little, but when filling it is necessary to melt. In addition, at the time of the chlorine injection rate, the decision which considers the fluctuation of raw water quality th
2. Filtration plant control	To maintain purified water quality	Volume control in the facility	Control Valve (Filtration speed 4m/day)	1 time/ day	VWC	Daily attention is needed for the prevention of drying up of the filtration sand
		Check water level in filtration pond	To check sedimentation tank water level	1 time/ day	VWC	Keep strictly on everyday
			Discharge water for filtration sand maintenance	1 time/ month	VWC	Nil
			Chip off sand in 1~2cm	1 time/ month	VWC	More labor is required in comparison with other work
		Sand refilling	Maintain sand thickness at 40cm	1time/ 1-2 years	VWC, DWE	Nil
		To keep adequate water level in sedimentation pond	De-silting	1time/ 1-2 years	VWC, DWE	To be taken necessary action according to condition
		Prevent algae bloom	Cleaning of sedimentation pond and intake	as necessary	VWC, DWE	As for seaweed propagation in order to obstruct filtration function, as much as possible it is necessary to prevent seaweed influx
3. Intake and Distribution Pump and Generator control	Adequate pump operation	Start and stop	Operate generator and control panel	1 time/ day	VWC	Nil
		Control in and out water volume	To check water volume and control Valve	1 time/ day	VWC	Special attention is needed to control intake water volume according to water flow in plant
		Noise	To check noise	1 time/ day	VWC	Keep strictly on everyday
		Vibration	To check vibration	1 time/ day	VWC	Keep strictly on everyday
		Revolving speed	To check revolving speed	1 time/ day	VWC	Keep strictly on everyday
		Water temperature	To check water temperature	1 time/ day	VWC	Keep strictly on everyday
		Overhaul	To check and replace spare parts	1 time/ 5 years	VWC, DWE Actual work to be assigned	Required out sourcing
4. Discharge volume control	To check Leakage water, efficiency pump running and decide chlorine dosage	Control adequate water volume	To measure water volume on distribution volume meter	1 time/ day	VWC	Nil
5. Measurement of consumed water volume	Water fee collection	Measure consumed water volume	To check on volume meter	1 time/ day	VWC	Nil
	To check water leakage					
		Measure distribute water volume	To check volume on distribution volume meter	1 time/ day	VWC	Nil
6. Water pressure control	To prevent water leakage	Measure water pressure	To measure pressure at pressure meter	1 time/ day	VWC, DWE	Nil
7. Illegal water tapping control	To decrease waste water volume	To check distribute water pipe line	Cyclical check	as necessary	VWC, DWE	More labor is required in compare with other work and transportation is required
8. Recording of running and maintenance results	Planning future maintenance schedule	Record for running duration, check items repairing, cleaning	Record daily report	1 time/ day	VWC	Record keep strictly
			Record daily maintenance report	at activity	VWC	Record keep strictly
			Record daily cleaning report	at activity	VWC	Record keep strictly

9) Conclusion

The consideration on the view of operational aspect, it is possible to be accomplished to operate and maintain the facilities. However, on the view of technical aspect, it should be concluded that the facilities are possible to be operated and maintained on the condition that the staffs who are competent to make technical decisions take part in the tasks continuously.

As mentioned previously, given the current technical aspects of the target village, there is a complete lack of qualified staff. Therefore, in order for the VWC to conduct operation and maintenance of the public faucet scheme, they must first secure the desired staff. However, with few similar facilities in Tanzania and even fewer qualified staff, it is difficult to acquire the necessary personnel. Furthermore, from a financial point of view, even if VWC employs such staffs, their salary and other related expenses would have to be reflected in the water fees. It is considered unlikely that the funds needed to employ such staffs could be covered by the water fee that beneficiaries are able to pay in addition to other operation expenses.

Therefore, the reasons given, there are significant difficulties in allocating full-time technicians for operation of the said facility. Thus NYAKAHAKO is eliminated from the public faucet scheme and instead will be given further consideration to be included in the hand pump well scheme.

(2) Selection results

A summary of selection results are shown in table and the diagram.

Table 2-32: Selection results table of Public faucet scheme

Region	Scheme	Water source	Other Donor Project	Yield	Water Qualities	O/M cost < payable amount	Sustainable maintenance	Result
Mwanza	NGAYA	Lake	Nil	Yes	Yes	No	—	Hand Pump Well
	NYAMISWI	Lake	Nil	Yes	Yes	No	—	Hand Pump Well
	NYAKAHAKO	Lake	Nil	Yes	Yes	Yes	No	Hand Pump Well
	BUKONYO	Lake	Nil	Yes	Yes	No	—	Hand Pump Well
	BUSWELU	Ground Water	Nil	No	—	—	—	Hand Pump Well
	BUSONGO	Ground Water	Nil	No	—	—	—	Hand Pump Well
	HUNGMALWA	Ground Water	Nil	No	—	—	—	Hand Pump Well
Mara	SARAGANA	Ground Water	Nil	No	—	—	—	Hand Pump Well

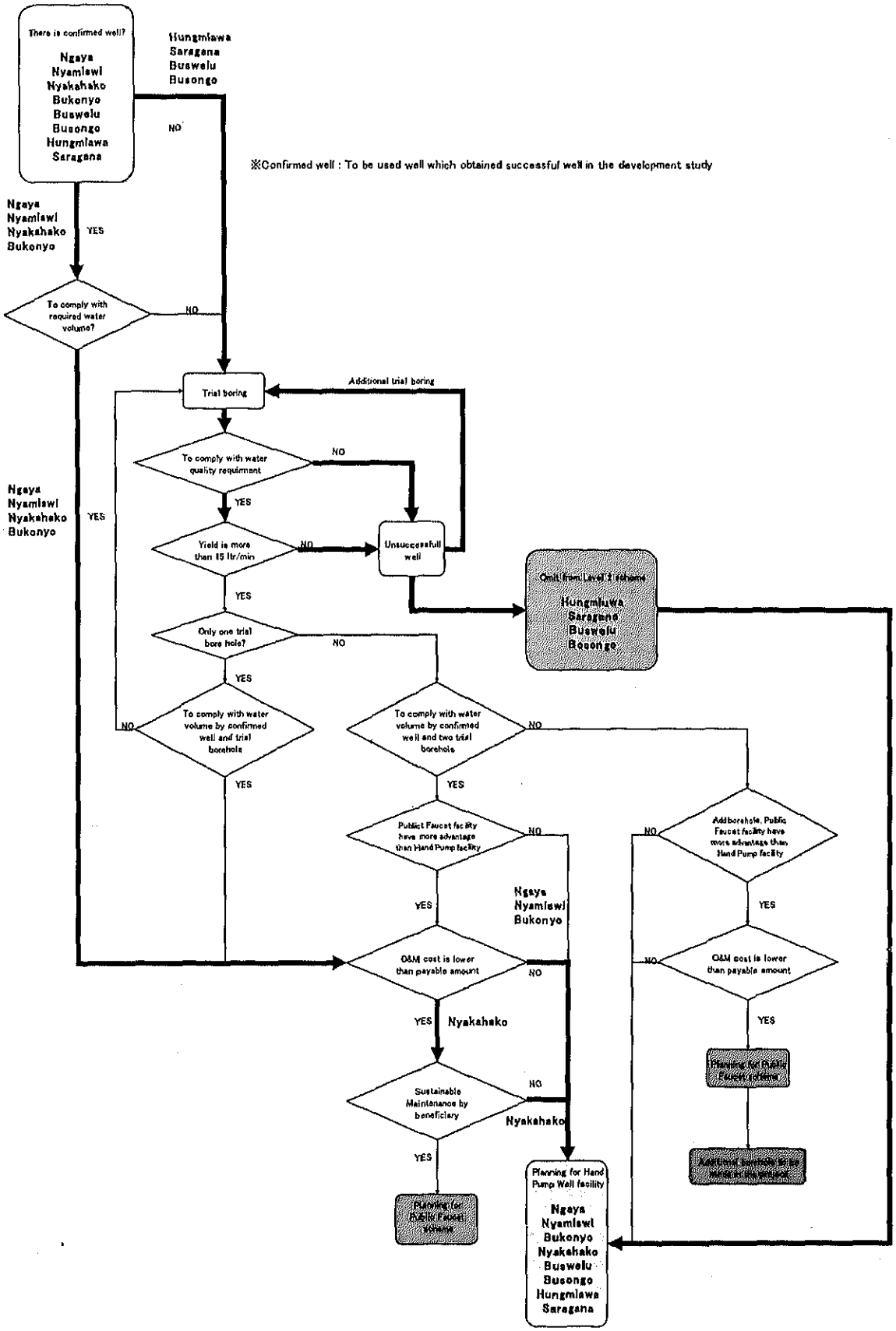


Figure 2-15: Selection results of Public Faucet scheme

2-2-2-2 Selection of Hand Pump Well facility point

(1) Detail of selection process

1) Other Projects planned by the other Donors in the target area

As a result of hearing to the MoWI and RWE in Mwanza and Mara regions, there is no other project in the target villages.

2) Field survey

The geological map produced on the development study shows the geological conditions in the Mwanza and Mara Regions (refer to the survey data). According to the map, geological formations observed in the area can generally be divided into the three units by age. The target villages consist of the above geological division depending on the geological survey in the field. The estimated drilling points in the villages are selected in consideration of the aquifer units supposed on the development study, given below.

- **Stratum aquifer:** unconfined, semi-confined aquifer at a depth range of 20-50m bgsl in the decomposed (weathered) or secondary deposited Precambrian hard rocks (mainly granite)
- **Fissure water:** semi-confined, confined aquifer at a depth range of 20-150m bgsl in the fractures and fissures distributed in the hard rocks (mainly granite).

The target drilling points were selected based on suitable lineament indicating the tectonic line on the geophysical map for groundwater development on the development study, and were expected to have the potential to store groundwater. Site conditions of those points were confirmed by the field survey directly this time. The results of the field survey showed that some points selected on the map may not be suitable for drilling in terms of the items below:

i The points are very far from the center /main area of the village. It is estimated that the villagers do not come to the wells (refer to the villager comments).

ii The points are located behind the mountain and it is very difficult to access those points.

iii The points are located in the bottom of the valley and it is very difficult to access those points.

iv Soft clay is distributed on the access road to the points and the ground conditions are very muddy even in dry season. There is no bypass route and would require extensive road construction to create one.

v The points are very near the other water supply facilities.

In this study, adequate drilling points are selected in consideration of not only the tectonic lineament

on the map, but the topography and geology in the field. Therefore, if some points are eliminated by the above reasons, it is very difficult to select alternative points in the villages.

The results of screening to select drilling points in the target villages based on the field survey are given below, including the above conditions in terms of access:

Table 2-33: Selection result based on field survey

Region	District	Village		Request		Selected well number	Eliminated well number
		ID	Name	Deep well	Middle well		
Mwanza	Sengerema	101	Sogoso	6	3	7	2
		102	Sotta	5	2	6	1
		103	Isole	5	2	6	1
		104	Busekeseke	4	3	6	1
		105	Katoma	5	3	7	1
		106	Magulukenda	6	2	7	1
		107	Nyancheche	5	4	7	2
	Kwimba	108	Mhula	4	4	7	1
	Magu	109	Kijereshi	8	2	8	2
	Geita	110	Bugulala	5	6	7	4
		111	KASOTA	5	4	7	2
		112	Kamena	5	3	6	2
		113	Ndelema	3	7	7	3
		114	Nyashishima	2	3	5	0
		115	Bugogo	6	2	5	3
		116	Ikina	2	5	5	2
		117	Ibondo	7	6	9	4
Mara	Bunda	118	Mcharo	4	1	4	1
	Musoma	119	Shirorisimba	4	4	6	2
		120	Ryamisanga	6	2	6	2
		121	Kisamwene	6	5	6	5
		122	Bugoji	7	3	7	3
		123	Isaba	3	7	7	3
	Tarime	124	Nyankunguru	5	4	6	3
		125	Kiwanji	4	1	5	0
		126	Bisarwi	3	5	6	2
	Rorya	127	Kisumwa	2	3	5	0
		128	Nyankonge	2	3	5	0
		129	Masike	5	6	6	5
		130	Bukama	4	7	5	6
		131	Oliyo	5	4	6	3
		132	Tatwe	5	6	6	5
	Serengeti	133	BUSAWE	3	0	3	0
		134	Nyansurura	3	6	6	3
		135	Kebancha	4	3	5	2
Total				158	131	212	77

3) Result of the water quality analysis

■ Requested Hand Pump Well scheme (Including spring protection scheme)

The water quality analyses for the existing deep tube wells in some of the target villages were conducted and the results of the analyses are shown in Table 2-34. The concentration of Fluoride (F) in the existing wells of Sotta, Isole, Shiroshimba and Oliyo villages exceeds the water quality standard of this project shown in Table 2-5. It is likely that the high content of (F) is affected by the distribution of Nyanzan metavolcanics[II] and dyke[III] rock such as the distribution of Nyanzan formation[IV] in Sotta and Shiroshimba, the distribution of dyke in Isole probably, and the distribution of Nyanzan metavolcanics in the upstream of Oliyo village. Therefore, the target wells which are near the existing wells indicating high content of (F) are eliminated as shown in Table 2-35.

Table 2-34: Results of the water quality analysis (Existing water source)

Category	Northings	Eastings	Elevation (m)	Region	District	ID	Village	Description	Sampling Date	Laboratory Test											
										CN	Fe	Mn	F	pH	Ba	NH_4	NO_3	Color	Turbidity	TSS	TDS
										mg/l	mg/l	mg/l	mg/l		mg/l	mg/l	mg/l	mg/Pt1	NTU	mg/l	mg/l
										0.07	0.30	0.10	1.50	6.5-8.5	0.7	0.50	50.00	15	15	1,500	-
Existing Facility	9,670,729	468,191	1,165	Mwanza	Sengerema	102	SOTTA	Existing Well	27/12/2007	<0.001	0.02	<0.01	2.14	7.68	1	1.14	17.14	0	2	460	432.0
	9,686,739	472,336	1,145	Mwanza	Sengerema	103	ISOLE	Existing Well	27/12/2007	<0.001	0.02	<0.01	6.60	7.59	1	0.81	39.89	0	0	840	1,329.0
	9,697,246	408,733	1,259	Mwanza	Geita	111	KASOTA	Existing Spring	29/12/2007	<0.001	<0.01	<0.01	0.74	6.68	0	0.26	0.74	0	0	40	33.7
	9,808,987	636,454	1,300	Mara	Musoma	119	SIRORISIMBA	Existing Well	21/12/2007	<0.001	0.03	<0.01	1.62	7.28	0	0.15	42.90	0	0	460	380.0
	9,836,895	616,360	1,248	Mara	Tarime	131	OLIYO	Existing Well	22/12/2007	<0.001	0.29	<0.01	9.20	8.08	2	0.27	0.50	7	3	700	662.0
	9,821,915	657,723	1,406	Mara	Serengeti	133	BUSAWE	Existing Spring	21/12/2007	<0.001	1.94	<0.01	1.12	8.51	0	0.08	0.60	0	0	220	276.0

Category	Northings	Eastings	Elevation (m)	Region	District	ID	Village	Description	Sampling Date	Laboratory Test													Judgement
										Coliform	T-Hardness	Ca	Mg	SO_4	Cl	BOD	COD	HCO_3	Na	As	Organic Phosphorus		
										(max/100ml)	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l	mg/l		
										0	500	200.0	150.00	400.00	250	6	10	-	-	1.00	0.50		
Existing Facility	9,670,729	468,191	1,165	Mwanza	Sengerema	102	SOTTA	Existing Well	27/12/2007	6	315	182.0	32.32	24.10	204	0	0	347.0	39.9	<1.00	-	NG
	9,686,739	472,336	1,145	Mwanza	Sengerema	103	ISOLE	Existing Well	27/12/2007	5	239	80.0	38.64	96.00	689	0	0	776.0	52.3	<1.00	-	NG
	9,697,246	408,733	1,259	Mwanza	Geita	111	KASOTA	Existing Spring	29/12/2007	0	23	9.5	3.18	0.60	18	0	0	21.0	7.4	<1.00	-	
	9,808,987	636,454	1,300	Mara	Musoma	119	SIRORISIMBA	Existing Well	21/12/2007	4	358	199.0	38.64	52.60	214	0	0	263.0	27.9	<1.00	-	NG
	9,836,895	616,360	1,248	Mara	Tarime	131	OLIYO	Existing Well	22/12/2007	2	360	215.0	35.24	123.00	229	0	0	361.0	36.3	<1.00	-	NG
	9,821,915	657,723	1,406	Mara	Serengeti	133	BUSAWE	Existing Spring	21/12/2007	0	282	125.0	38.15	3.30	148	0	0	237.0	21.3	<1.00	-	

[ ]: Figure is exceeding project standards

Table 2-35: Eliminated point based on water quality analysis

Region	District	Village	Eliminated well (nos.)
Mwanza	Sengerema	Sotta	1
		Isole	2
Mara	Musoma	Shiroshimba	2
	Rorya	Oliyo	1
Total			6

[II] Transmutation molten rock which constitute of Nyanzan layer or transmutation effusive rock
[III] Vertical platy intrusive rock Same as Dyke rock
[IV] Lower part of Precambrian which distributed geologic stratum on 28 billion years ago at east Africa

■ Testing boreholes on the development study

Location and the results of yield test and water quality analysis of the five testing boreholes which are regarded as successful boreholes constructed during the development study are shown as below.

Table 2-36: Location of wells constructed in the development study

Resion	District	Village		Bore hole Number	UTM		Yeild (ltr/min)
		ID	Name		Easting (m)	Northing (m)	
Mwanza	Geita	116	Ikina	J-1	423,861	9,647,130	15
	Bunda	118	Mcharo	J-1	605,579	9,778,302	83
	Misungwi	201	Busongo	J-1	493,339	9,653,902	58
Mara	Musoma	210	Saragana	J-1	576,858	9,792,662	50
	Musoma	210	Saragana	J-2	576,723	9,792,527	93

Table 2-37: Results of water quality analysis for wells constructed in development study

Category	Northings	Eastings	Yeild	Region	District	ID	Village	Description	Sampling Date	Laboratory Test											
										CN	Fe	Mn	F	pH	Ba	NH_4	NO_3	Color	Turbidity	TSS	TDS
										mg/l	mg/l	mg/l	mg/l		mg/l	mg/l	mg/l	mg Pt/l	NTU	mg/l	mg/l
										0.07	0.30	0.10	1.50	6.5-8.5	0.7	0.50	50.00	15	<15	1,500	-
JICA Well	9,647,130	423,861	15ltr/min	Mwanza	Geita	116	Ikina	JICA Well	18/10/2005	0.001	0.26	0.00	0.80	6.79	0	0.30	9.00	14	14	810	106.2
	9,778,302	605,579	83ltr/min	Mwanza	Bunda	118	Mcharo	JICA Well	14/10/2005	0.001	0.15	0.00	1.40	7.64	0	0.20	4.00	14	14	80	357.0
	9,653,902	493,339	58ltr/min	Mwanza	Misungwi	201	Busongo	JICA Well	02/10/2005	0.001	0.00	0.00	1.50	7.16	0	0.30	38.00	0	0	30	388.0
	9,792,662	576,858	50ltr/min	Mara	Musoma	210	Saragana	JICA Well	27/10/2005	0.000	0.05	0.00	1.10	7.03	0	0.00	20.00	0	0	110	386.0
	9,792,527	576,723	93ltr/min	Mara	Musoma	210	Saragana	JICA Well	22/06/2006	0.001	0.02	0.00	0.47	7.50	0	0.21	7.97	0	0	20	196.1

Category	Northings	Eastings	Yeild	Region	District	ID	Village	Description	Sampling Date	Laboratory Test												Judgement
										Coliform	T-Hardness	Ca	Mg	SO_4	Cl	BOD	COD	HCO_3	Na	As	Organic Phosphate	
										count/100ml	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/l	mg/l	
										0	500	200.0	150.00	400.00	250	6	10	-	-	1.00	0.50	
JICA Well	9,647,130	423,861	15ltr/min	Mwanza	Geita	116	Ikina	JICA Well	18/10/2005	0	38	17.0	5.10	1.60	85	0	0	72.0	22.1	<1.00	0.02	OK
	9,778,302	605,579	83ltr/min	Mwanza	Bunda	118	Mcharo	JICA Well	14/10/2005	0	208	124.0	26.97	22.00	80	0	0	402.0	113.1	<1.00	0.05	OK
	9,653,902	493,339	58ltr/min	Mwanza	Misungwi	201	Busongo	JICA Well	02/10/2005	0	235	124.0	26.97	41.60	124	0	0	597.0	111.1	<1.00	0.02	OK
	9,792,662	576,858	50ltr/min	Mara	Musoma	210	Saragana	JICA Well	27/10/2005	0	97	77.0	4.86	1.60	65	0	0	369.0	52.9	<1.00	0.01	OK
	9,792,527	576,723	93ltr/min	Mara	Musoma	210	Saragana	JICA Well	22/06/2006	0	120	57.6	44.62	17.20	47	0	0	258.0	28.0	<1.00	0.01	OK

: Figure is according project standards

These five testing boreholes are in compliance with requirements for yield and water quality for hand pump wells. Therefore, these boreholes will be used for this project and hand pumps shall be installed and platforms shall be constructed in this project.

4) Selection result based on the geophysical prospecting results

Based on the geophysical survey results, the target points which agree with below 2 basic policies of the Basic Design study were eliminated.

1) the aquifer is located within 20m from the ground level, or

2) the analysis result shows the second layer and third layer are thin and, additionally, encounter a high resistance value.

Finally 57 of the 206 geophysical survey points are eliminated.

5) Results of hydro-geological survey

The potential points for groundwater development are evaluated based on the geological map and groundwater availability map of the development study, geophysical survey of Basic Design Study and in reference to the HESAWA (Health through Sanitation and Water) project by SIDA (Swedish International Development Authority). The main aquifers considered as potential groundwater sources are the decomposed Precambrian rock units (mainly secondary deposits or weathered granite from 20m to 50m in depth from the surface) and granites, NYANZAN rock units (Precambrian rock units) (the target stratum of fissure zone from 20m to 100m).

The character of the aquifer unit is based on the results of the development study and trial boreholes in the Basic Design Study, as follows:

i Potential (productive) aquifers can be divided into two types: 1) stratum aquifers in the weathered or secondary deposits of Precambrian rock units (mainly granite) and 2) fracture type aquifers.

ii High yield areas or aquifers are not identified as a zone, but limited to certain locations.

iii There is quite a high variation of yield by depth and type of aquifer.

iv Granite is the main fissure water source and productive aquifer in the area.

v The static water level varies even in aquifers of the same geology.

The geology of well points in the target villages is classified by the geological structure in consideration of the aquifer units, and the success rate of drilling is estimated as shown in Table 2-38 by analyzing the existing drilling records.

Table 2-38: Category of Geological formation and Expected boring success rate

Zone	Description	Expected success rate	Relevant number of well
Zone 1	It is very important to comprehend the large geological structure in the area where granite is distributed, and to pay attention to the lineament (a linear structure that reflects the possibility of a fault) of similar structure with the large geological structure zone. The clear structure comes up with the Fissure system and Shear zone. Whether to get the groundwater or not will be decided based on the direction of dip of those faults reflecting this structure. In reference to the data of SIDA, the success rate in those areas is 83% (5 success wells /6 drilling wells: same as above)-88% (7wells /8wells). The distribution of 20m weathered layer indicates high potential for the possibility of development for groundwater.	85%	43
Zone 2	The aquifer, so called RUNERE Aquifer, consists of colluvial deposits (thickness 20-30m: secondary deposits of basement) and weathered granite (total thickness 40-60m). The success rate is 88% (7 wells/8 wells) The distribution of those strata is limited in the Mwanza and Mara Regions.	85%	Nil
Zone 3	It is very important to comprehend the whole geological structure and lineament clearly in the area of Precambrian rocks of the NYANZAN System. Focus needs to be given to the geological structure of diagonal / orthogonal faults. The stratum above the NYANZAN System is not distributed in the narrow valley distributing the NYANZAN System. So the success rate is below 10-30% in reference to the SIDA data.	20%	3
Zone 4	The Contact zones between granite and NYANZAN System has a high success rate. Probably the contact zones will be affected by the geological activities. The success rate is 50% (1 well/ 2wells) depending on the SIDA data and also JICA wells in SARAGANA are successful (2wells/ 2wells).	75%	12
Zone 5	It is important to pay attention to the Fissure system and Shear zone reflecting the geological structure activities in the area of thick weathered granite and colluvial deposits (coarse deposits). The success rate of those areas is 40% (2 wells/5 wells) in reference to the SIDA data.	40%	65
Zone 6	It is fairly easy to get the groundwater near the geological structure lines with dolerite dyke and alluvial deposits in the granite area. The success rate is 75% (3 wells/4 wells) in reference to the SIDA data.	75%	Nil
Zone 7	It is very important to comprehend the adequate geological structure in case of the limited area of Fracture zone and the thin weathered granite. The success rate is below 10% (1 well/16 wells) in reference to the SIDA data.	10%	8
Zone 8	It is necessary to pay attention to the diagonal / orthogonal lineament against the lineament developing the strike of strata, and also to comprehend the conditions of Fissure zone fully in case of area of sediment rock of PALEOZOIC. The success rate is 50% (3 wells/6 wells) in reference to the SIDA data.	50%	13
Zone 9	It is necessary to comprehend the adequate Fracture zone in the area of volcanic rock of NEOGENE. The success rate is 14% (1 well/7 wells) in SIDA date.	14%	2
Zone 10	The contact zone between the volcanic rock of NEOGENE and granite has possibility to get the groundwater. It will be considered the access rate of 75%.	75%	2
Zone 11	The contact zone between the METAGABBRO, METADOLERITE dyke and granite has possibility to get the groundwater. It will be considered the access rate of 50-75%.	50%	1

*Lineament is not synonymous with a fault structure, but a linear structure that reflects the possibility of a fault.

The boreholes which success rates are less than 30% are eliminated from this project due to ineffective cost performance.

Screening result of requested Hand Pump Well scheme is shown as follows:

Table 2-39: Screening result of requested Hand Pump Well

Region	District	Village		Request			Eliminated well						Selected Well Number
		ID	name	Deep Well	Middle Depth	Total	Other project	Field survey	Water quality	Electrical Prospecting	Success rate	Total	
Mwanza	Sengerema	101	Sogoso	6	3	9	0	2	0	3	0	5	4
		102	Sotta	5	2	7	0	1	1	1	0	3	4
		103	Isole	5	2	7	0	1	2	1	0	4	3
		104	Busekeseke	4	3	7	0	1	0	3	0	4	3
		105	Katoma	5	3	8	0	1	0	2	0	3	5
		106	Magufukenda	6	2	8	0	1	0	0	0	1	7
		107	Nyancheche	5	4	9	0	2	0	1	0	3	6
	Kwimba	108	Mhula	4	4	8	0	1	0	1	0	2	6
	Magu	109	Kijereshi	8	2	10	0	2	0	4	0	6	4
	Geita	110	Bugulala	5	6	11	0	4	0	2	0	6	5
		111	Kasota	5	4	9	0	2	0	0	0	2	7
		112	Kamena	5	3	8	0	2	0	1	3	6	2
		113	Ndelema	3	7	10	0	3	0	3	3	9	1
		114	Nyashishima	2	3	5	0	0	0	3	0	3	2
		115	Bugogo	6	2	8	0	3	0	1	1	5	3
		116	Ikina	2	5	7	0	2	0	2	1	5	2
		117	Ibondo	7	6	13	0	4	0	1	0	5	8
Mara	Bunda	118	Mcharo	4	1	5	0	1	0	0	0	1	4
	Musoma	119	Sirorisimba	4	4	8	0	2	2	1	0	5	3
		120	Ryamisanga	6	2	8	0	2	0	1	0	3	5
		121	Kisamwene	6	5	11	0	5	0	0	0	5	6
		122	Bugoji	7	3	10	0	3	0	4	0	7	3
		123	Isaba	3	7	10	0	3	0	1	0	4	6
	Tarime	124	Nyankunguru	5	4	9	0	3	0	2	2	7	2
		125	Kiwanji	4	1	5	0	0	0	4	0	4	1
		126	Bisarwi	3	5	8	0	2	0	3	3	8	0
	Rorya	127	Kisumwa	2	3	5	0	0	0	2	0	2	3
		128	Nyankonge	2	3	5	0	0	0	1	0	1	4
		129	Masike	5	6	11	0	5	0	3	0	8	3
		130	Bukama	4	7	11	0	6	0	1	0	7	4
		131	Oliyo	5	4	9	0	3	1	2	0	6	3
		132	Tatwe	5	6	11	0	5	0	2	0	7	4
	Serengeti	133	Busawe	3	0	3	0	0	0	0	0	0	3
		134	Nyansurura	3	6	9	0	3	0	0	0	3	6
		135	Kebancha	4	3	7	0	2	0	1	0	3	4
Total				158	131	289	0	77	6	57	13	153	136

The above average value of estimated success rate for target wells is 53.8% in evaluation of the geological zoning.

- General plan of deep well with hand pump

General plan drawings of deep well with hand pump are shown in "2-2-3 Basic Design Drawing".

6) Spring Protection

- Current conditions

The current condition of the existing springs at KASOTA and BUSAWE villages are shown as below.

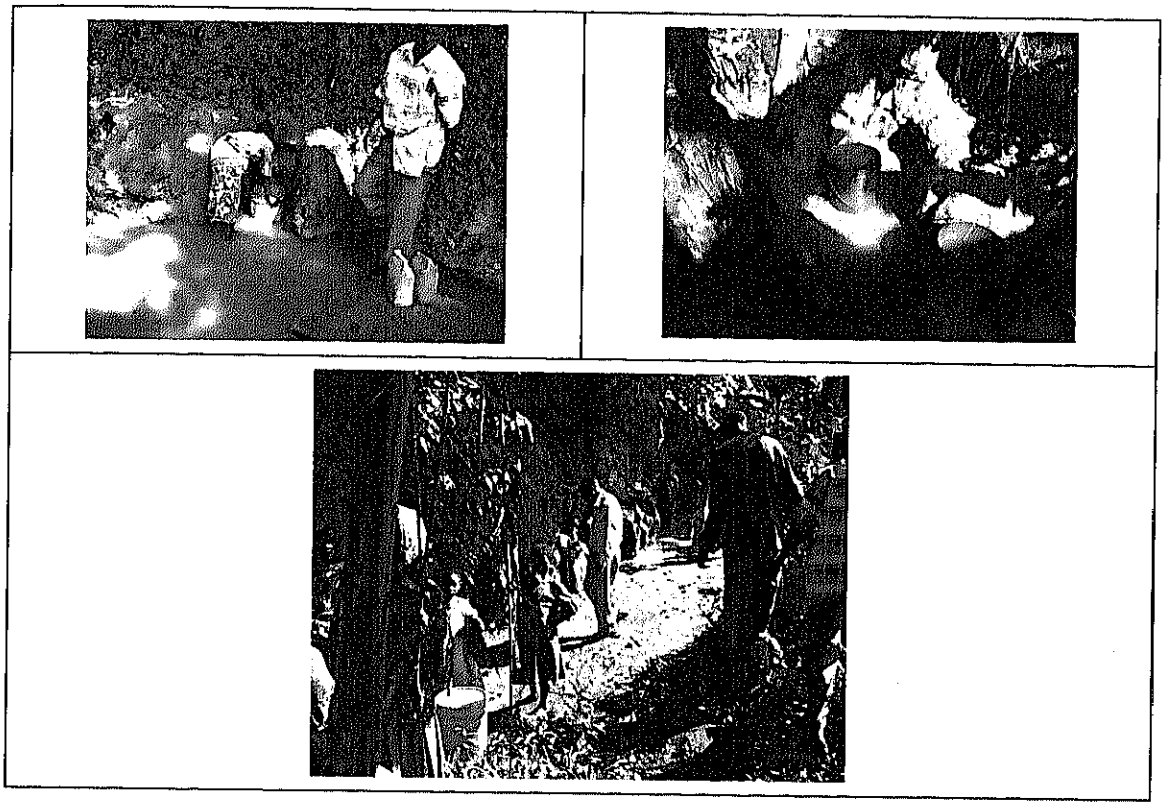


Photo 2-1: Current condition of existing spring at KASOTA village

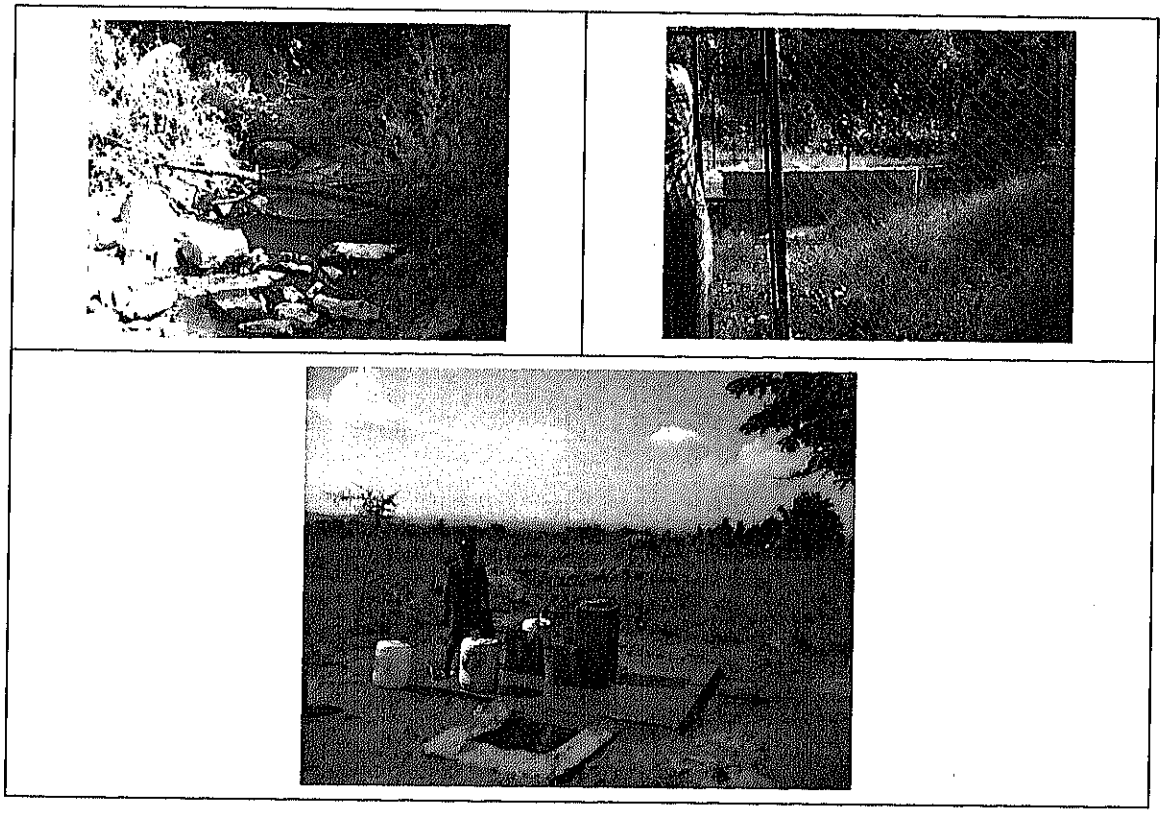


Photo 2-2: Current condition of existing spring at BUSAWE village

Since a facility has already been constructed at a spring in BUSAWE village, the spring protection scheme shall be eliminated from this project. A spring protection scheme shall be planned at KASOTA village.

- General plan of spring protection

General plan drawings of spring protection are shown in "2-2-3 Basic Design Drawing".

(2) Selection results

Selection was made originally requested hand pump well scheme with additional 41 locations. Additional 41 locations are raised from eliminated 7 public faucet scheme which are selected based on hydro logically.

The selection results are summarized in Figure 2-16.

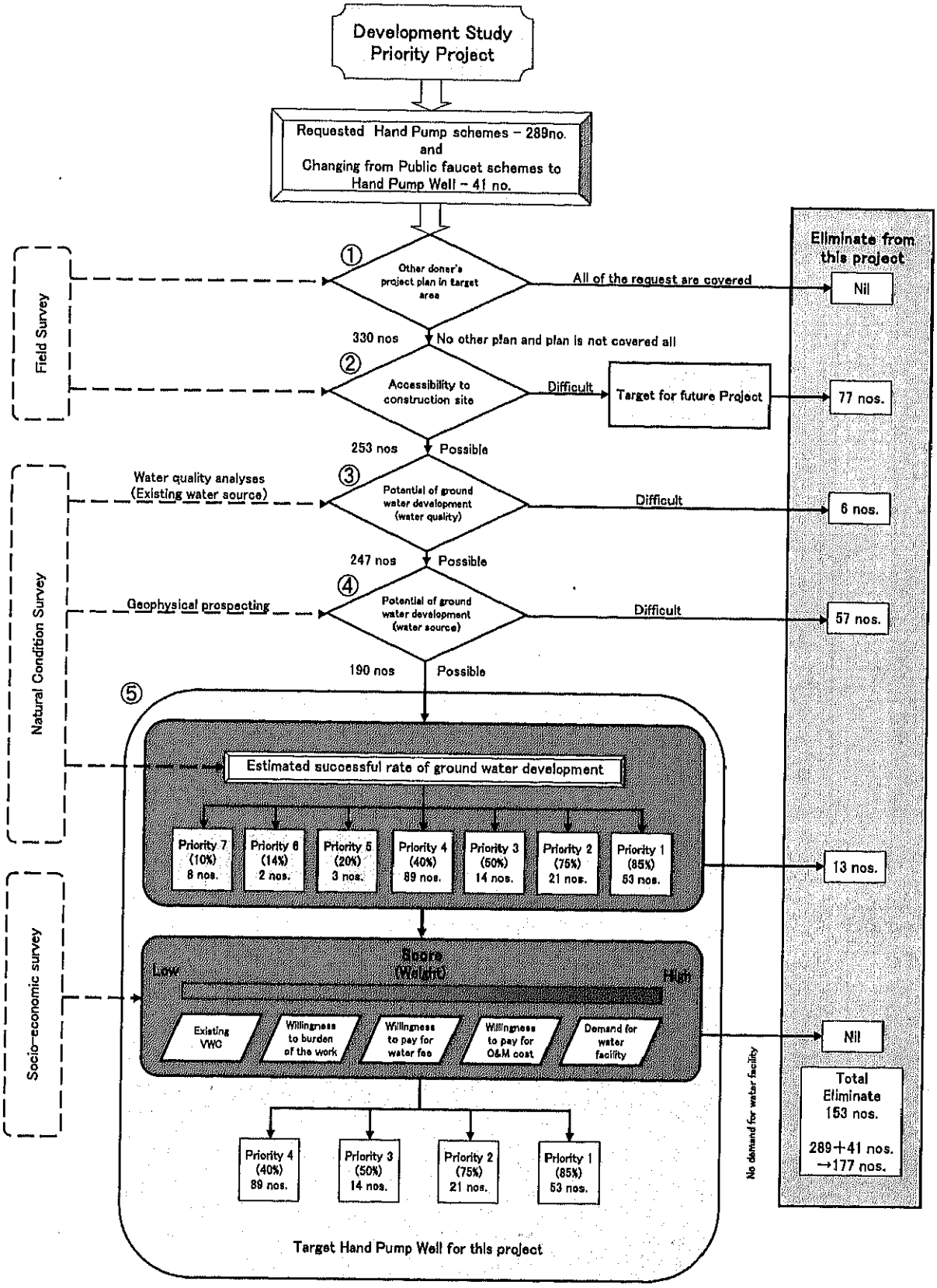


Figure 2-16: Selection result of Hand Pump Well Scheme