4.4 HYDROGEOLOGY

4.4.1 REVIEW OF PREVIOUS HYDROGEOLOGICAL STUDIES

Reports of previous hydrogeological studies in the Tabora region have been collected and reviewed to get the hydrogeological conditions of the region in perspective. The reports collected and reviewed are shown in the following table.

Table 4.4.1 Collected Reports for Previous Hydrogeological Studies in Tabora Region

Title	Author	Publisher / Year	Summary
Tabora Region Water Master Plan Final Report	International Bank for Reconstruction and Development (IBRD)/ Brokonsult AB, Sweden	Ministry of Water Development, Energy and Minerals / 1980	Estimation of Groundwater Potential, Formulation of Water Master Plan of Tabora Region - Hydrogeological survey - Inventory survey of existing water source - Geophysical survey - Test well drilling etc..
Tanzania Tabora Rural Integrated Development Project Land Use Component Land Unit Atlas	Land Resources Development Centre	Overseas Development Administration / 1982	Land unit survey in Tabora Region -Studies for geology, soil, vegetation, land use and so on.
Water Supply Development Project (Tabora-Sikonge-Urambo) Groundwater Development Report	Basler & Hofmann in association with WILALAEX & RWB	Tabora Urban Water Supply and Sewerage Authority (TUWASA) / 2009	Groundwater development survey of water source for urban water supply Listed Borehole data are quoted from Water Master Plan(IBRD)
Study on Groundwater Resources Development and Management in the Internal Drainage Basin in the Republic of Tanzania Final Report	OYO International, Kokusai Kogyo	Japan International Cooperation Agency (JICA) / 2008	-Hydrogeological survey -Geophysical survey -Test well drilling -Estimation of groundwater potential etc..

Some well inventories for the Tabora region were also collected and the data relating to existing wells (mainly boreholes) were reviewed and examined in addition to the above reports.

The data related to hydrogeological conditions in the Tabora region have been used for considering the groundwater in the region. The information about the existing boreholes in the Tabora region are shown in Table 4.4.2.

Table 4.4.2 Collected Data for Borehole Inventory

No.	Title	Publisher / Holder	Number of Boreholes listed
1	Tabora Region Water Master Plan Final Report	Ministry of Water Development, Energy and Minerals	Total 99 48 Test Wells, 51Existing Wells
2	Study on the Groundwater Resources Development and Management in the Internal Drainage Basin in the United Republic of Tanzania Final Report	Japan Internatinal Cooperation Agency (JICA)	Total 50 Test Wells 47, Existing Wells 3
3	Borehole Catalogue of	Ministry of Water and	494 Existing boreholes

	Tabora Region	Irrigation (MoWI)	
4	Tabora Region Some Borehole Catalogue	Internal Drainage Basin Office Shinyanga Sub Office	48 Existing boreholes
5	DDCA Borehole Completion Report (Reports for 243boreholes in Tabora region)	Drilling and Dam Construction Agency (DDCA)	243 Boreholes drilled by DDCA

4.4.2 GROUNDWATER IN THE STUDY AREA

(1) General

Groundwater conditions in the study area were reviewed on the basis of the data of existing boreholes.

The information for the borehole position is not listed in the above data shown in Table 4.4.2 except for No.1, 2 and 4. Therefore the exact position of most boreholes in the Tabora region cannot be identified without additional efforts in locating them. Identification operation of the borehole positions at the village level at least was based on the name of the ward and the village, other location name, building names which were mentioned in the data or inventories, also by reference from the Census and the results of the socio-economic survey in this study.

The boreholes which are doubly listed, or which have lack of information and inaccurate descriptions have been taken off the inventories. The boreholes with the positional coordinates (latitude/longitude or Universal Transverse Mercator System (UTM)), the boreholes with correct names of the villages, the boreholes that can be identified at the village level location from the locational information of the inventories have been selected. 289 boreholes have been selected in this way as of this moment.

But 494 boreholes are listed in the "Borehole Catalogue of Tabora Region" (MoW), the actual number of boreholes in the Tabora region seems to have exceeded 289.

The information that relates to existing boreholes is one of the most important items when reviewing new groundwater development. Verification and updating of the data about existing boreholes including the identifying of the position are proceeding and these data are utilized for the reviewing of groundwater development.

The results of water quality analysis in this study and the results of the previous studies for water quality which were implemented in the region were reviewed from a hydrogeological viewpoint.

(2) Aquifer in the study area

The aquifer in the study area is divided into two main parts as the stratum aquifer and the fractured aquifer. The aquifer of Recent Alluvium and two Pleistocene Layers are categorized as a stratum aquifer. Basement rocks in those consist of the Archean rocks categorized as fractured aquifer. Groundwater potential of each aquifer is described in 4.5.

4.4.3 PRESENT CONDITIONS OF THE EXISTING BOREHOLES IN TABORA REGION

(1) Distribution of the Existing Boreholes

The distribution of the existing boreholes is important information to estimate the groundwater distribution in the target area.

The numbers of boreholes in each district are shown in Figure 4.4.1. This figure shows that 106 boreholes (36.7%) are located in the Nzega district, 24.2% in the Urambo district, and 20.1% in the Igunga district. 83.8% of the boreholes are in these three districts and the boreholes in the Tabora region are distributed nonuniformly.

Figure 4.4.2 shows the distribution of the boreholes in the Tabora region. Many boreholes are distributed over the populated area, the urban areas around the district capitals and the area along the main road. The forest reserves and the game reserves are widely distributed over the Tabora region and most boreholes are situated outside these areas except for a few boreholes.

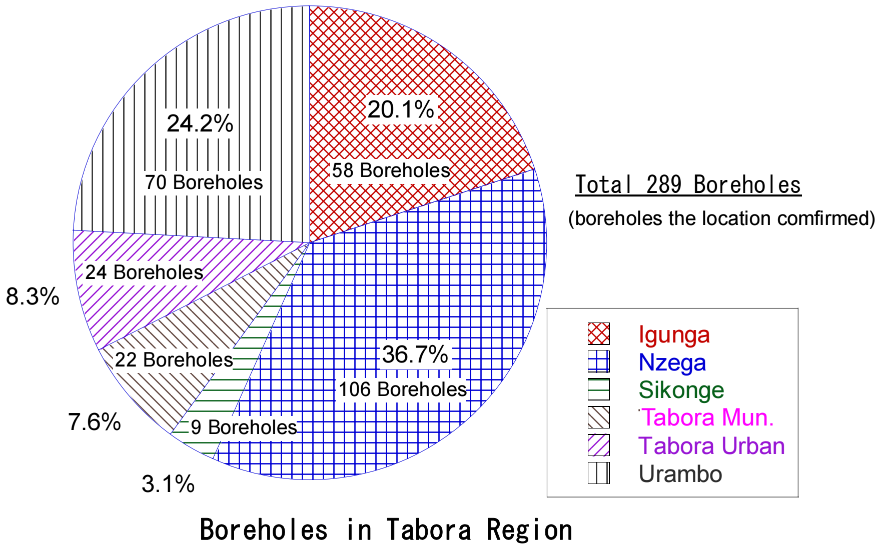

Figure 4.4.1 Number of Boreholes by District in Tabora Region

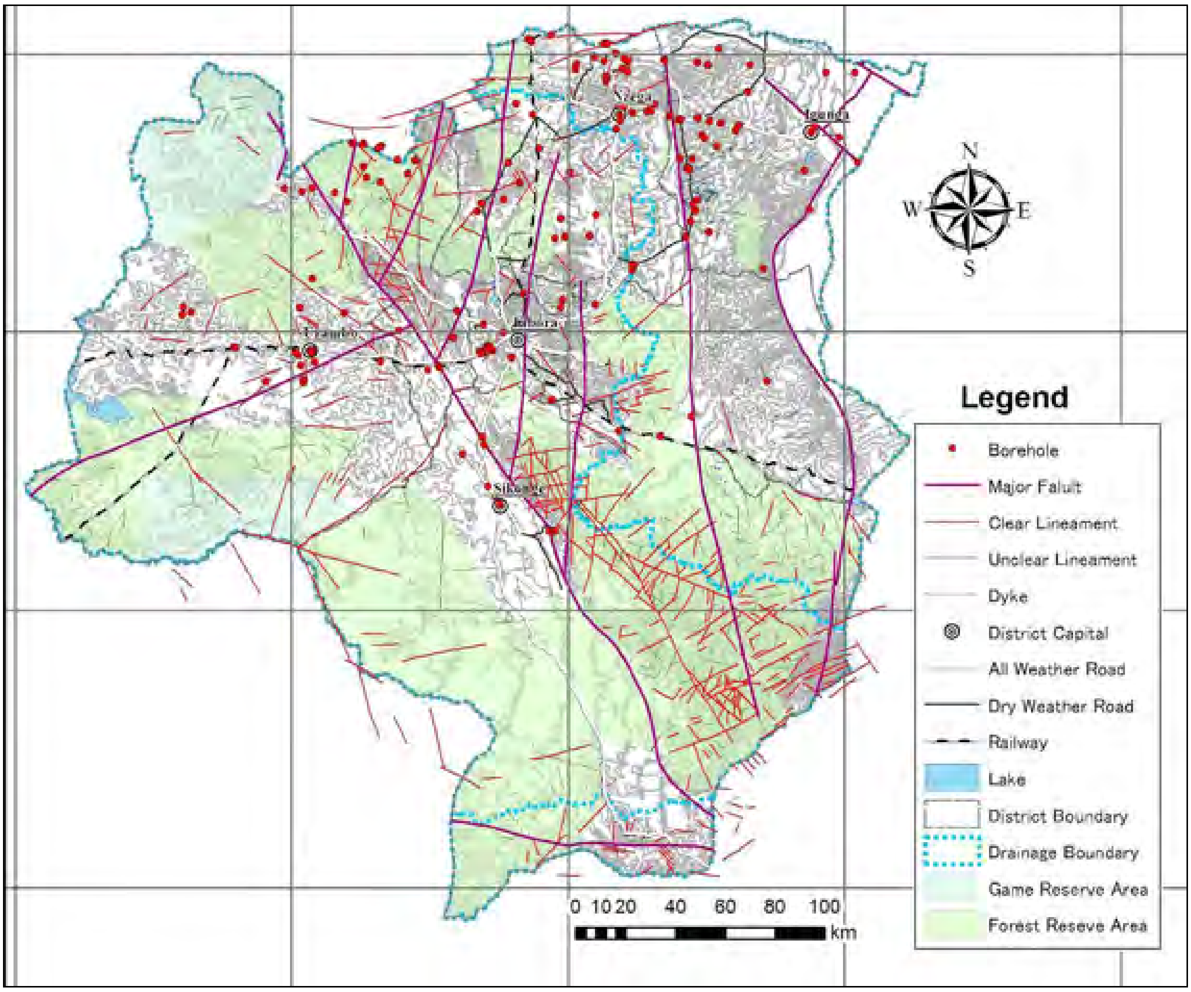

Figure 4.4.2 Distribution of Boreholes in Tabora Region

(2) Depth of Boreholes

The information of the depth of the borehole is important when reviewing the hydrogeological structure because the depth of the borehole reflects the distribution and the structure of the aquifer of the place where the borehole is located. Therefore, the information of the depth was reviewed in addition to its positional data.

277 boreholes have the information of the depth out of the 289 boreholes which have the positional data or village name. The numbers of the boreholes classified by 20m depth are shown in Table 4.4.3. The boreholes that have depths from 40 to 60m are the most frequent, 60 to 80m boreholes are second, 20 to 40m boreholes are third. The boreholes with less than 60m depth account for 56.7 % of the all at 157, and the boreholes with less than 100m depth account for 94.9 % at 263. In the Tabora region, most boreholes have a depth less than 100m. Only one borehole exceeds 200m in depth.

Figure 4.4.3 shows the numbers of the boreholes classified by district and the depth. The ratio of the boreholes with less than 40m depth is large in the Igunga district, the ratio of the boreholes with more than 40m depth is large in the Nzega district and Urambo district. Figure 4.4.4 shows the distribution of the boreholes classified by depth.

Table 4.4.3 Number of Boreholes by Depth

Depth (m)	Number of Boreholes	Ratio (%)	Accumlated Ratio (%)
0 - 20	28	10.1	10.1
20 - 40	42	15.2	25.3
40 - 60	87	31.4	56.7
60 - 80	65	23.5	80.1
80 - 100	41	14.8	94.9
100 - 120	9	3.2	98.2
120 - 140	2	0.7	98.9
140 - 160	2	0.7	99.6
160 - 180	0	0	99.6
180 - 200	0	0	99.6
200 - 220	1	0.4	100
Total	277	100	-
No Data	12	-	-

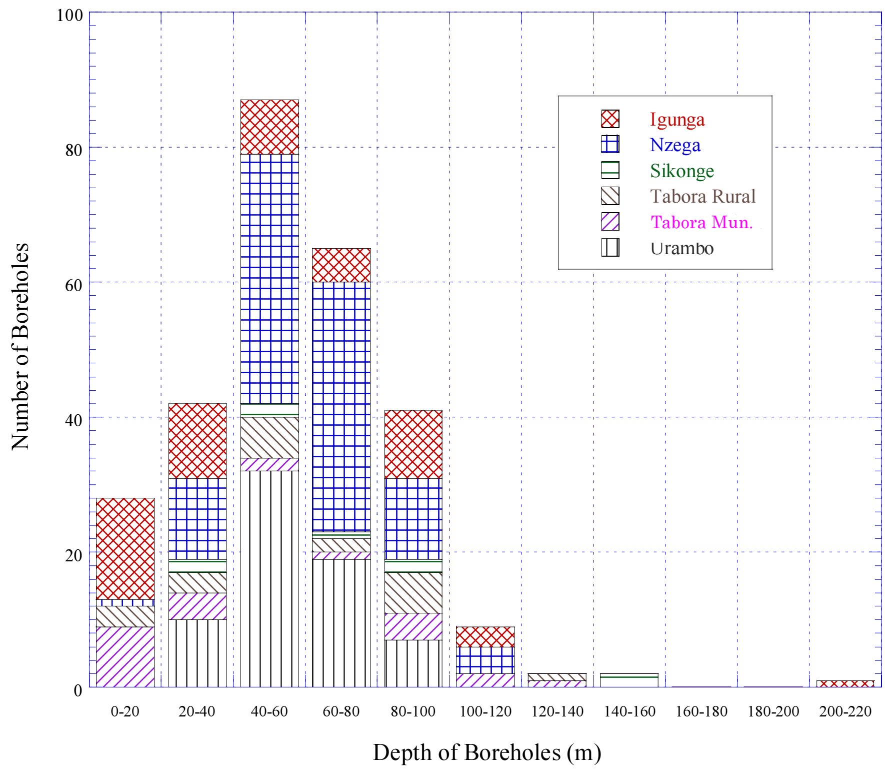

Figure 4.4.3 Number of Boreholes by Depth and District

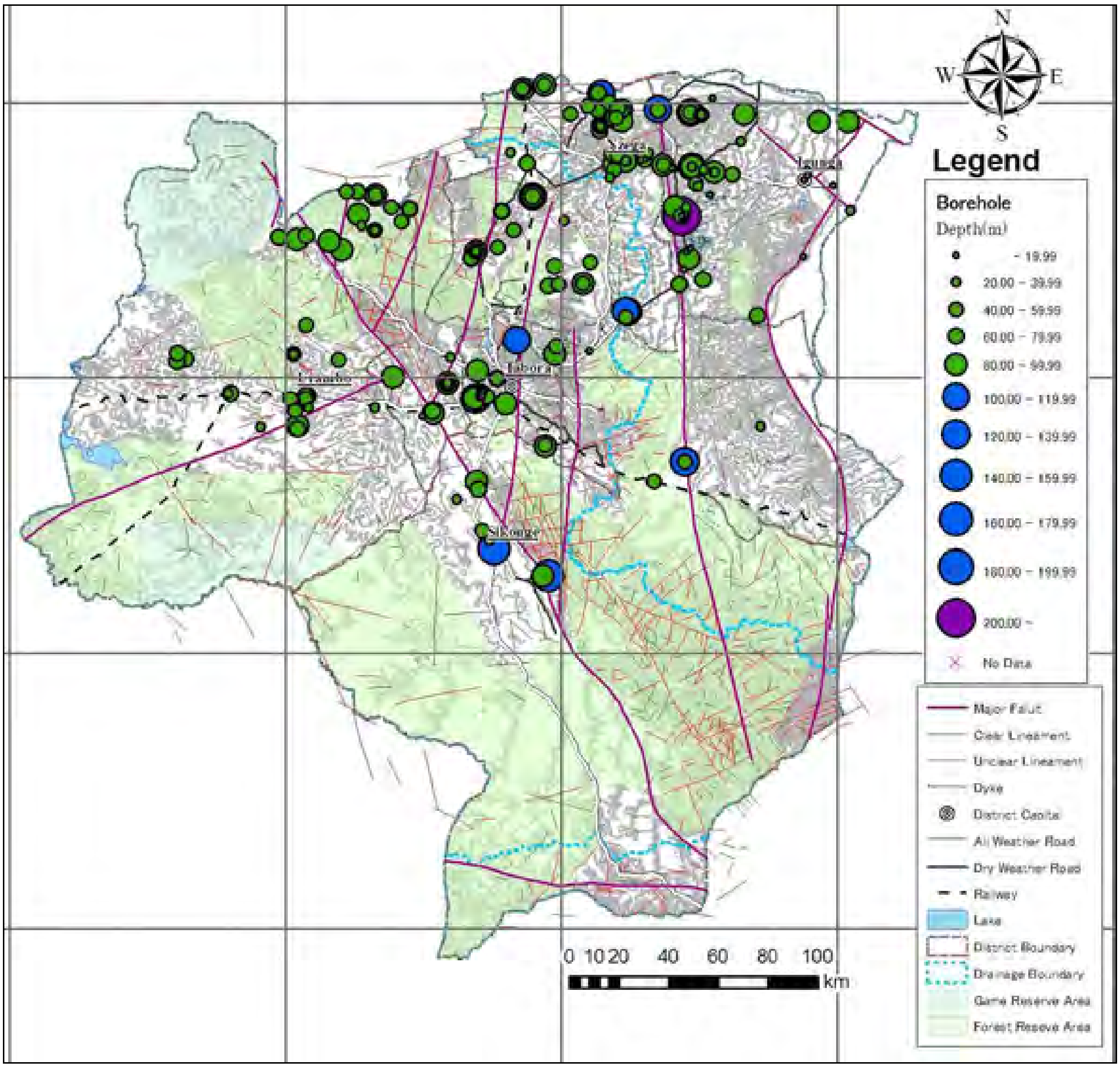

Figure 4.4.4 Distribution of Boreholes by Depth

(3) Yield

177 boreholes have a yield data out of the 289 boreholes that have the positional data or village name. Table 4.4.4 shows the numbers of the boreholes classified by a yield of 1 m^3/hour. The boreholes with a yield less than 1 m^3/hour including dry boreholes account for 37 % of the entire boreholes and are the most frequent. The boreholes with a yield less than 2 m^3/hour account for approximately half of the whole. The largest yield in the Tabora region is recorded for the borehole at Kanolo village in the Nzega district and the value is 15.84 m^3/hour according to the report of DDCA.

The boreholes with a yield of more than 5 m^3/hour account for 20.3 % of the total. Unsuccessful boreholes are not supposed to be recorded often. Therefore, the ratio between the number of the boreholes with a yield of more than 5 m^3/hour and the actual total number of drilled boreholes in the Tabora region seems to be less than 20.3 %.

Figure 4.4.5 shows the number of boreholes classified by district and yield. Most of the boreholes with a yield of more than 5 m^3/hour are located in the Igunga, Nzega and Urambo districts. The boreholes with a yield of more than 10 m^3/hour are concentrated in the Nzega and Urambo districts.

Table 4.4.4 Number of Boreholes by Yield

Yield (m^3/hour)	Number of Boreholes	Ratio (%)	Accumlated Ratio (%)
Dry	38	21.5	21.5
- 1	28	15.8	37.3
1 - 2	25	14.1	51.4
2 - 3	23	13.0	64.4
3 - 4	17	9.6	74.0
4 - 5	10	5.6	79.7
5 - 6	11	6.2	85.9
6 - 7	8	4.5	90.4
7 - 8	0	0	90.4
8 - 9	0	0	90.4
9 - 10	2	1.1	91.5
10 - 11	2	1.1	92.7
11 - 12	1	0.6	93.2
12 - 13	3	1.7	94.9
13 - 14	3	1.7	96.6
14 - 15	2	1.1	97.7
15 - 16	4	2.3	100
Total	177	100	-
No Data	112	-	-

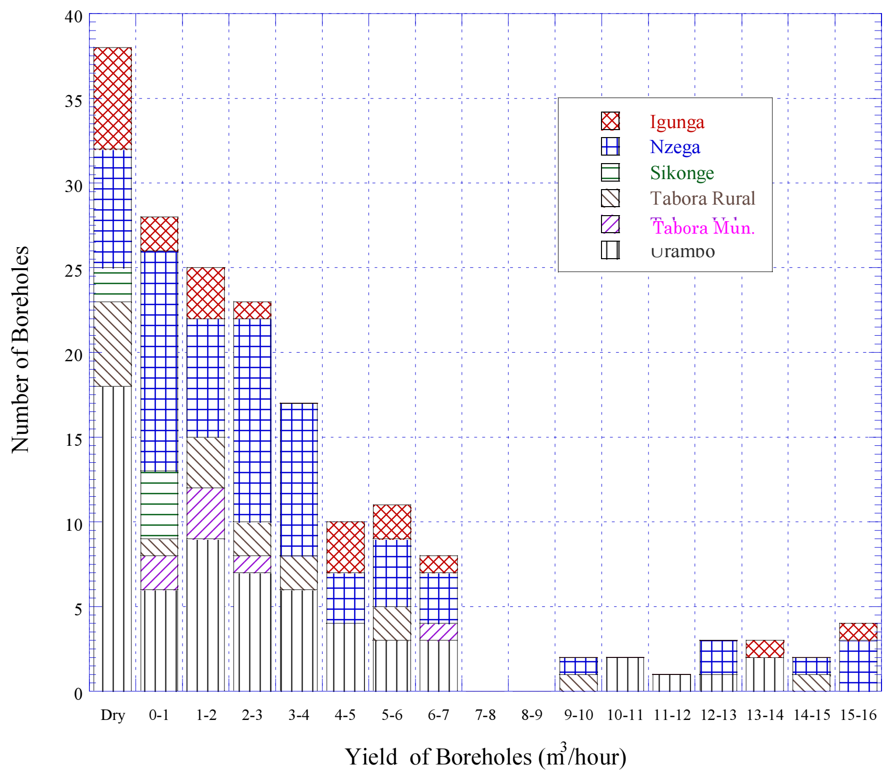

Figure 4.4.5 Number of Boreholes by Yield and District

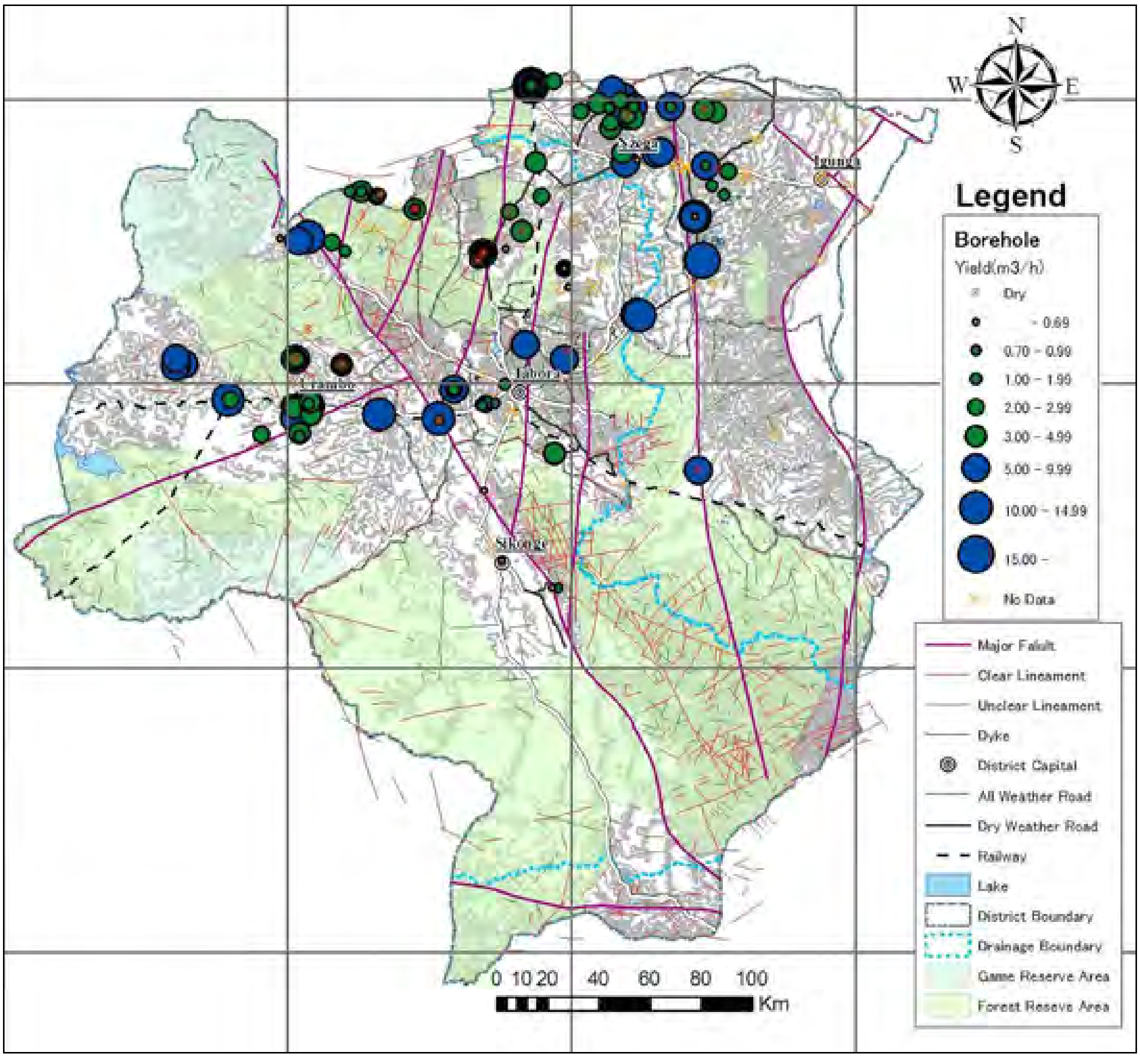

Figure 4.4.6 Distribution of Boreholes by Yield

(4) Relationship between Depth and Yield of Borehole

Figure 4.4.7 shows the relationship between the depth and the yield of the boreholes. A clear relationship or trend is not clearly recognized. There are some boreholes with a yield more than 10 m^3/hour and with a depth less than 50m in the Urambo district, on the other hand, all the boreholes with a yield of more than 10 m^3/hour in the Nzega district have a depth of more than 50m. This indicates that there are good aquifers with relatively shallow depth in the Urambo district.

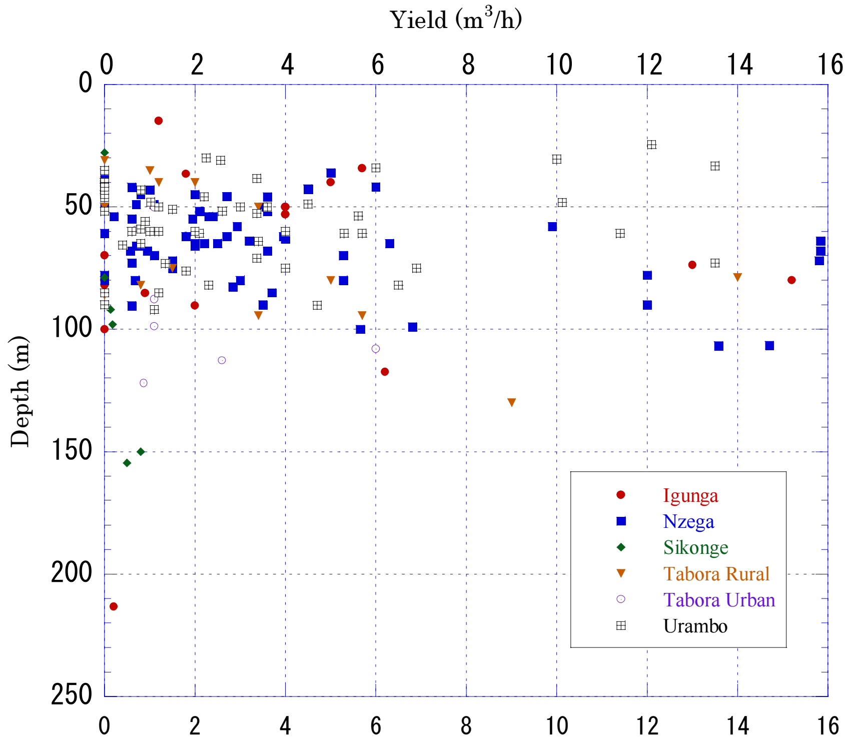

Figure 4.4.7 Relationship between Depth and Yield of Borehole by District

4.4.4 GROUNDWATER LEVEL

The groundwater distribution in the Tabora region was estimated on the basis of the static water level from existing borehole data. The estimated groundwater level seems to be the water head of the artesian aquifer because the collected borehole inventories covered the boreholes or deep wells. If the borehole had no data of the altitude, the altitude of the ground level was estimated from SRTM data based on the positional information and then the altitude of the groundwater level was calculated from the estimated ground level.

A contour map of the groundwater level in the Tabora region is shown in Figure 4.4.8. The groundwater in the study area is supposed to be distributed and flowing along the landscape. In the south and the west part of the region, the data of the groundwater level are not sufficient because of the lack of existing boreholes.

The groundwater level in Tabora seems to have seasonal variation because a year is clearly divided into the rainy season and dry season. The seasonal change of the groundwater level could not be reviewed because the collected data of the groundwater level has insufficient information for the measurement period.

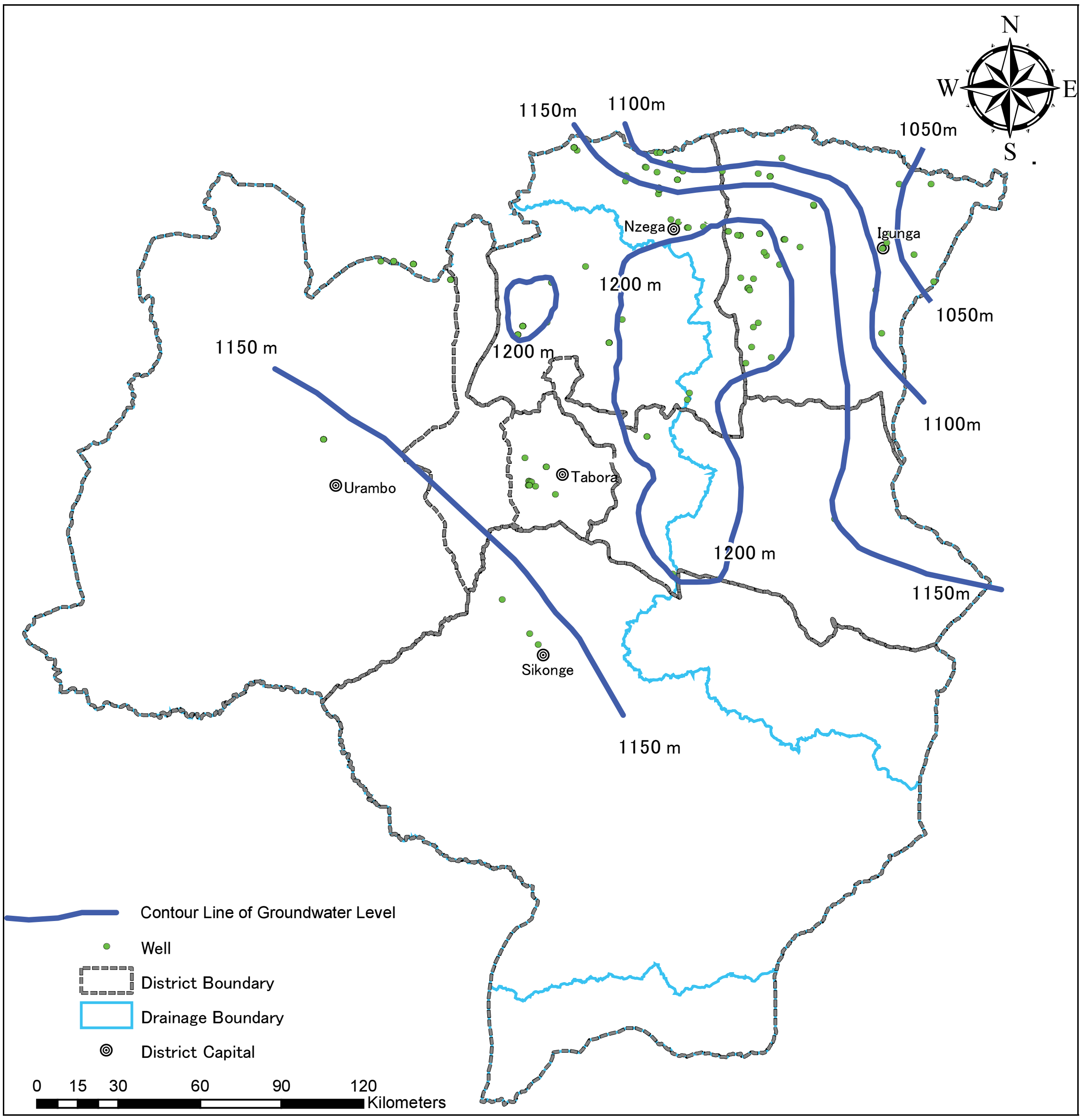

Figure 4.4.8 Contour Map of Groundwater in Tabora Region

4.4.5 WATER QUALITY

(1) General

The water quality of the water source is greatly influenced by the hydrogeological environment around the area. Therefore, the results of the water quality analysis implemented in the Tabora region were collected and reviewed from a hydrogeological viewpoint. Water quality analysis was also carried out for 82 samples (72 existing water sources and 10 test wells) in the entire Tabora region in this study. The method and the detailed results of the water quality survey in this study are described in Chapter 5.

Major items of water quality from the result of the water quality analysis in this study of the 82 samples from the existing water sources and the 42 collected data are shown in *Table 4.4.5* and *Table 4.4.6*.

The trilinear-diagrams were made from the concentrations of seven (7) ions (Na^+, K^+, Ca^{2+}, Mg^{2+}, Cl^-, HCO_3^-, SO_4^{2-}) which are the major dissolved items in groundwater, springs and surface water. The trilinear- diagrams are shown in Figure 4.4.9 and 4.4.10.

According to the classification using the trilinear-diagram, the groundwater and the surface water in the study area are distributed in all types of water quality from type I to type IV. It means there are various types of water in the study area.

The water in the deep wells is different from the water in the shallow wells because the deep wells have deep groundwater and the shallow wells have shallow ordinary groundwater. But there is no clear difference by water source in Figure 4.4.9. In the Nzega district there are many waters of type II which have a high ratio of Na^{+} and HCO_3^{-1} in Figure 4.4.10. On the other hand, there is no such trend in the other five districts.

(2) Fluoride

High concentration of fluoride in water sources in the Tabora region is an important issue. There are some water sources that have a higher concentration of fluoride more than the guideline values of World Health Organization (WHO) in Igunga District, Nzega District, Tabora Rural District and Tabora Municipality.

The distribution of the fluoride contents in the Tabora region is described in the Chapter 5 in detail.

(3) Electric Conductivity (EC)

The measurement values of electric conductivity (EC) range from 1.5 to 986.7 mS/m in the study area. Figure 4.4.11 shows the distribution of EC in the study area. The highest value was measured in the Igunga district. Comparatively high values of EC are detected in the Internal Drainage Basin which includes the Igunga District, north-eastern part of the Nzega District and the eastern part of Tabora Rural District. The distribution of EC is similar to the distribution of the fluoride contents.

Table 4.4.5 Result of Water Quality Analysis of the Water Sources in Tabora Region (1/2)

No.	ID	District	Location	Source Type	Source Type	Latitude	Longitude	EC (mS/m)	pH	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	Cl- (mg/L)	SO4 (mg/L)	HCO3 (mg/L)	F (mg/L)
1	HP-1011	Tabora Urban	Lusangi	Deep Well	Deep Well	-5.14615	32.74447	147.20	7.36	3.06	2.16	21.00	6.66	12.76	61.00	48.80	0.001
2	HP-1016	Tabora Urban	Lusangi	Deep Well	Deep Well	-5.15487	32.72577	11.40	6.49	2.45	0.12	23.64	2.07	15.95	32.00	24.40	0.001
3	HP-1009	Tabora Urban	Lusangi	Deep Well	Deep Well	-5.15472	32.75761	13.83	7.74	4.28	1.43	19.46	4.44	9.93	26.00	61.00	0.001
4	-	Tabora Urban	MTAKUJA	Deep Well	Deep Well	-5.03145	32.75738	42.28	7.90	32.41	15.83	26.83	6.87	41.55	1.00	146.40	0.001
5	HP-1051	Tabora Urban	Ulamba	Deep Well	Deep Well	-5.00258	32.74822	11.48	6.99	3.06	1.51	17.74	3.71	12.34	170.00	24.50	0.001
6	HP-1053	Tabora Urban	Ulamba	Deep Well	Deep Well	-4.99318	32.75680	14.79	7.42	3.67	1.71	22.00	4.36	14.89	60.00	61.10	0.900
7	HP-1058	Tabora Urban	Masagala	Deep Well	Deep Well	-4.91504	32.79809	5.26	8.08	26.29	5.69	91.04	1.95	30.84	14.00	231.80	2.000
8	HP-1057	Tabora Urban	Masagala	Deep Well	Deep Well	-4.93456	32.80143	84.57	7.92	82.65	27.51	63.84	4.09	88.63	20.00	280.60	1.340
9	TuPW-02	Tabora Urban	IGOMBE DAM	Dam	Dam	-4.89563	32.71430	11.22	7.16	7.95	2.61	7.22	2.85	4.25	10.00	48.90	0.001
10	TuPW-01	Tabora Urban	KAZIMA DAM	Dam	Dam	-5.03177	32.81885	24.95	6.55	6.73	2.49	36.06	13.00	16.66	35.00	79.30	0.001
11	HP-1044	Tabora Urban	Kalunde	Deep Well	Deep Well	-4.91509	32.65255	14.30	7.05	3.06	0.91	16.19	1.09	20.21	8.00	12.20	0.660
12	HP-1046	Tabora Urban	Kalunde	Deep Well	Deep Well	-4.95734	32.66961	11.69	6.87	1.22	0.46	14.56	1.44	22.69	12.00	24.30	0.500
13	TrPW-04	Tabora Rural	Kigwa B	Shallow Well	Shallow Well	-5.12164	33.11998	10.29	6.74	0.61	1.71	18.14	3.21	13.83	150.00	18.40	0.001
14	HP-974	Tabora Rural	Uhuru Mbiti	Deep Well	Deep Well	-4.85338	32.95442	51.89	8.13	23.24	7.62	862.88	8.15	28.71	2.00	256.20	0.001
15	TrPW-02	Tabora Rural	Igalula	Charco Dam	Dam	-5.18938	33.01684	8.19	7.41	6.11	3.43	10.03	4.30	5.67	53.00	36.60	0.010
16	TrPW-05	Tabora Rural	Ilolangulu	Shallow Well	Shallow Well	-5.10059	32.63755	11.07	7.14	2.45	1.46	16.63	0.81	12.05	13.00	24.40	0.010
17	HP-964	Tabora Rural	Ugowola	Deep Well	Deep Well	-4.9649	32.35015	13.16	6.40	2.45	0.94	21.76	0.34	18.22	2.00	12.20	0.800
18	HP-953	Tabora Rural	Chessa	Deep Well	Deep Well	-4.93539	32.43251	15.53	6.45	3.68	2.01	21.13	0.57	22.33	1.00	36.70	0.950
19	HP-811	Tabora Rural	Ibiri	Deep Well	Deep Well	-4.92687	32.59654	43.72	7.67	36.08	25.63	23.74	5.70	36.51	4.00	170.80	0.010
20	HP-876	Tabora Rural	Igoko	Deep Well	Deep Well	-4.82347	33.13180	43.94	7.95	20.79	5.19	81.35	3.01	12.41	3.00	268.40	0.990
21	HP-881	Tabora Rural	Italwasimba	Deep Well	Deep Well	-4.80032	33.11219	123.50	7.94	213.40	68.10	457.03	6.09	198.50	0.10	244.00	1.135
22	HP-971	Tabora Rural	Mhogwe	Deep Well	Deep Well	-4.87705	33.04002	6.62	7.26	1.22	0.80	8.85	1.45	6.38	16.00	36.70	0.740
23	HP-804	Tabora Rural	Nsololo	Deep Well	Deep Well	-5.5589	33.14870	120.45	8.18	86.83	20.37	192.94	4.33	129.70	5.00	390.50	0.320
24	TrPW-11	Tabora Rural	Upuge	Deep Well	Deep Well	-4.91448	32.97903	33.34	7.71	8.56	4.06	49.19	25.93	31.55	43.00	85.70	0.660
25	TrPW-05	Tabora Rural	Ilolangulu	Deep Well	Deep Well	-5.10039	32.63768	24.61	8.25	30.57	2.06	16.20	0.36	32.60	12.00	91.50	0.900
26	HP-724	Sikonge	Kilumbi	Deep Well	Deep Well	-6.2962	33.84733	71.92	8.33	91.72	19.41	44.89	2.11	46.44	2.00	378.20	0.400
27	HP-726	Sikonge	Kilumbi	Deep Well	Deep Well	-6.29771	33.84673	17.92	7.64	17.12	3.09	13.90	5.62	11.70	170.00	73.20	0.330
28	HP-788	Sikonge	Mole	Deep Well	Deep Well	-5.4495	32.62111	7.60	6.70	2.45	0.01	8.76	1.28	24.11	10.00	24.40	0.410
29	HP-694	Sikonge	Igigwa	Shallow Well	Shallow Well	-5.41802	32.78498	25.65	8.10	32.41	5.51	8.32	2.26	9.93	11.00	14.30	0.500
30	HP-692	Sikonge	Igigwa	Shallow Well	Shallow Well	-5.37894	32.79106	33.12	7.44	22.01	4.56	30.38	3.32	18.43	24.00	91.50	0.600
31	HP-695	Sikonge	Igigwa	Deep Well	Deep Well	-5.35077	32.77816	7.58	7.18	3.67	1.09	8.23	0.81	14.18	22.00	18.30	0.600
32	HP-676	Sikonge	Chabutwa	Deep Well	Deep Well	-5.69293	32.75064	51.07	8.44	41.58	18.71	36.90	6.07	26.94	9.00	280.70	0.496
33	HP-756	Sikonge	Kisanga	Deep Well	Deep Well	-5.5594	32.81600	75.86	7.62	64.82	20.06	70.19	3.18	48.92	1.00	329.10	0.550
34	HP-757	Sikonge	Kisanga	Shallow Well	Shallow Well	-5.55908	32.84063	20.31	7.91	12.23	1.67	11.32	3.45	10.64	21.00	109.80	0.890
35	SkPW-01	Sikonge	Makazi	Protected Spring	Spring	-5.76761	32.71609	17.86	7.62	18.34	1.42	10.99	1.05	15.60	12.00	24.50	0.800
36	HP-720	Sikonge	Ukondamoyo	Deep Well	Deep Well	-5.80056	32.88279	83.61	8.13	79.49	11.37	92.47	6.78	40.41	37.00	256.20	0.681
37	HP-716	Sikonge	Lembeli	Deep Well	Deep Well	-5.83858	32.90657	50.39	8.39	52.57	12.46	46.89	2.87	17.02	1.00	280.50	0.600
38	SkPW-04	Sikonge	Sikonge	Dam	Dam	-5.60281	32.86046	20.20	7.20	8.56	1.39	27.82	5.20	36.87	6.00	97.90	0.500
39	HP-1321	Urambo	Ugunga	Deep Well	Deep Well	-5.07032	31.75034	36.25	8.28	2.85	7.42	27.60	1.99	28.71	1.00	134.20	0.300
40	HP-1388	Urambo	Usindi	Deep Well	Deep Well	-5.08551	31.84672	33.33	8.05	25.68	19.93	16.50	1.63	18.79	2.00	158.60	0.500
41	HP-1235	Urambo	Usimba	Deep Well	Deep Well	-5.01016	31.92042	96.52	7.67	77.66	47.20	46.77	5.74	142.90	4.00	134.10	0.440
42	UrPW-06	Urambo	Kashishi	Spring	Spring	-4.36622	32.38778	6.59	7.39	2.45	0.01	9.17	1.28	10.64	17.00	36.70	0.382
43	HP-1302	Urambo	Songambele	Deep Well	Deep Well	-4.94265	32.10410	30.19	8.22	31.80	9.46	19.45	8.39	9.22	2.00	183.00	0.574
44	HP-1297	Urambo	Mlangane	Shallow Well	Shallow Well	-4.9412	32.15533	3.73	7.01	1.83	0.01	2.64	0.50	17.72	11.00	36.50	0.600
45	HP-1271	Urambo	Muungano	Deep Well	Deep Well	-5.02755	32.12843	97.08	7.76	76.44	44.06	75.25	3.22	106.40	2.00	298.90	0.600
46	HP-1249	Urambo	Kalemela A	Deep Well	Deep Well	-4.9969	32.05398	17.38	7.69	5.50	2.31	25.05	0.63	17.72	17.00	54.80	0.550
47	UrPW-15	Urambo	Usisya	Spring	Spring	-5.10029	32.23132	10.31	7.52	6.11	2.12	7.04	3.65	10.99	140.00	61.00	0.440
48	HP-1103	Urambo	Itundu	Deep Well	Deep Well	-5.08297	32.15909	69.02	8.02	73.38	34.90	46.16	5.44	54.59	2.00	292.70	0.970
49	UrPW-17	Urambo	-	Deep Well	Deep Well	-5.1013	32.33018	14.50	7.29	13.45	2.84	12.28	2.69	11.34	57.00	48.90	0.620
50	UrPW-19	Urambo	USOKE MLIMANI	Dam	Dam	-5.16363	32.35948	10.42	7.82	8.56	2.26	7.11	4.26	10.28	23.00	54.90	0.650
51	HP-587	Nzega	Upungu	Deep Well	Deep Well	-4.72822	33.16848	21.75	7.60	68.49	19.79	124.56	2.28	63.46	20.00	367.00	0.010
52	HP-471	Nzega	Kigandu	Deep Well	Deep Well	-4.66072	32.98898	36.36	7.50	5.50	4.47	38.46	7.78	17.02	240.00	97.50	0.710
53	HP-381	Nzega	Mbutu	Deep Well	Deep Well	-4.3719	32.80751	68.12	7.52	37.30	8.14	31.22	0.87	22.69	1.00	183.00	1.200
54	HP-128	Nzega	Sojo	Deep Well	Deep Well	-3.94063	32.85178	94.72	7.98	70.32	5.85	69.94	0.14	28.36	0.10	317.20	0.020
55	HP-542	Nzega	Kabale	Deep Well	Deep Well	-4.0158	33.16580	64.08	7.89	55.03	14.87	167.64	0.62	41.48	0.10	500.20	0.500
56	HP-531	Nzega	Mwaguguli	Deep Well	Deep Well	-4.05717	33.02831	18.53	8.05	75.21	13.39	48.09	0.68	22.69	34.00	262.30	0.320
57	NzPW-07	Nzega	Nzega Mjini	Dam	Dam	-4.1947	33.17805	97.86	7.78	9.78	3.06	30.14	6.26	7.44	5.00	128.10	0.200
58	HP-401	Nzega	Mbogwe	Deep Well	Deep Well	-4.14496	33.26336	34.57	8.44	39.75	15.70	235.81	0.01	12.41	56.00	551.10	0.800
59	NzPW-07	Nzega	Nzega Mjini	Dam	Dam	-4.13639	33.23320	134.34	8.17	22.01	5.95	53.62	4.04	13.83	6.00	176.90	0.080
60	HP-567	Nzega	Nzega Mjini	Deep Well	Deep Well	-4.22284	33.19148	76.89	8.14	46.47	23.52	289.51	0.67	74.44	38.00	573.40	0.420
61	HP-105	Nzega	Budushi	Deep Well	Deep Well	-4.79036	33.33170	88.55	8.22	89.89	26.56	77.98	4.16	74.44	13.00	311.10	0.110
62	HP-24	Igunga	Uswaya	Deep Well	Deep Well	-4.6747	33.52219	46.35	8.23	55.03	16.18	104.66	1.58	71.96	3.00	189.10	5.000

Source: Water Quality Analysis in This Study (No 1-62), Low Permeability rocks in Sub-Saharan Africa, Groundwater development in Tabora Region, Tanzania, Groundwater System and Water Quality Programme Commission Report CR/02/19N (No 63-108)
Study on the Groundwater Resources Development and Management in the Internal Drainage Basin(No 109-124)

Table 4.4.5 Result of Water Quality Analysis of the Water Sources in Tabora Region (2/2)

No.	ID	Districct	Location	Source Type	Source Type	Latitude	Longitude	EC (mS/m)	pH	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	Cl- (mg/L)	SO4 (mg/L)	HCO3 (mg/L)	F (mg/L)
63	HP-78	Igunga	Simbo	Deep Well	Deep Well	-4.65556	33.43042	31.76	7.40	1.22	5.32	63.03	5.66	26.59	8.00	36.60	2.500
64	IgPW-06	Igunga	Igogo	Dam	Dam	-4.28929	33.78814	16.76	8.08	18.34	2.89	19.66	3.46	4.61	16.00	122.00	2.500
65	HP-51	Igunga	Isenegeja	Shallow Well	Shallow Well	-4.52457	33.44086	16.76	7.34	9.78	6.40	17.60	9.76	10.99	51.00	61.00	2.350
66	HP-90	Igunga	Sungwizi	Protected Shallow Well	Shallow Well	-4.45826	33.51771	114.59	8.31	29.35	11.52	287.88	0.73	43.96	20.00	628.30	4.160
67	IgPW-02	Igunga	Chomachankola	Deep Well	Deep Well	-4.02369	33.34821	111.44	8.65	34.24	9.13	265.63	3.65	65.23	55.00	329.40	3.240
68	IgPW-02	Igunga	Chomachankola	Deep Well	Deep Well	-3.98736	33.35750	986.70	8.55	11.01	13.91	827.13	6.81	63.81	70.00	884.50	5.200
69	IgPW-11	Igunga	Ziba	Deep Well	Deep Well	-4.25573	33.41169	125.93	9.00	17.12	26.73	342.41	6.07	29.07	33.00	439.20	4.900
70	IgPW-04	Igunga	Igurubi	Deep Well	Deep Well	-3.96095	33.34521	165.49	8.65	6.73	1.17	474.77	5.10	95.36	200.00	585.60	3.980
71	IgPW-01	Igunga	Chibiso	Shallow Well	Shallow Well	-3.96095	33.34521	80.39	8.31	14.69	4.84	188.13	1.64	26.94	170.00	305.00	1.890
72	HP-39	Igunga	Lugubu	Shallow Well	Shallow Well	-4.55522	33.87362	31.86	8.34	20.79	5.83	45.44	4.00	77.99	20.00	134.20	1.170
73	662/2010	Tabora Rural	Mpumbuli	Deep Well	Deep Well	-5.304234	33.44705	120.00	7.70	160.00	6.08	79.81	2.10	159.50	48.00	300.00	1.610
74	663/2010	Tabora Urban	Kakola	Deep Well	Deep Well	-4.860138	32.83841	137.00	7.70	50.00	18.24	220.50	4.90	212.70	250.00	200.00	3.950
75	664/2010	Tabora Rural	Mabama	Deep Well	Deep Well	-5.121115	32.53281	118.30	7.10	100.00	18.24	121.90	1.70	124.07	0.00	325.00	1.500
76	665/2010	Tabora Rural	Mabama	Deep Well	Deep Well	-5.128109	32.53410	118.10	7.20	70.00	6.08	176.41	6.00	141.80	70.00	200.00	2.240
77	669/2010	Sikonge	Mpombwe	Deep Well	Deep Well	-5.376904	32.69118	83.50	7.60	50.00	24.30	86.90	3.30	88.60	1.70	200.00	1.100
78	670/2010	Sikonge	Usunga	Deep Well	Deep Well	-5.716079	32.93254	93.70	7.50	60.00	12.16	119.37	7.70	194.97	8.00	200.00	1.460
79	671/2010	Sikonge	Usunga	Deep Well	Deep Well	-5.714842	32.95253	26.80	7.80	40.00	6.08	3.22	2.20	53.17	9.60	50.00	2.530
80	672/2010	Nzega	Isanga	Deep Well	Deep Well	-4.064059	33.21542	86.40	7.60	80.00	24.30	60.20	1.50	88.60	0.00	300.00	2.400
81	673/2010	Nzega	Isanga	Deep Well	Deep Well	-4.063932	33.21649	68.70	7.40	60.00	36.48	18.80	2.40	53.10	0.00	300.00	1.100
82	675/2010	Igunga	Igumo	Deep Well	Deep Well	-4.563704	33.45989	103.80	7.80	60.00	24.32	121.40	4.60	70.90	18.72	250.00	7.000
83	K1	Nzega	Mwagundu1	Borehole	Deep Well	-4.026167	33.173917	113.70	7.17	83.60	14.70	143.00	3.30	90.00	11.30	489.00	2.54
84	K2	Nzega	Busigili1	Shallow well	Shallow well	-3.962700	33.178000	40.80	6.92	30.80	5.40	31.50	3.30	14.70	9.70	172.00	0.67
85	K3	Nzega	na	Borehole	Deep Well	-4.064567	33.161600	97.90	7.36	108.00	15.70	78.90	2.70	5.50	7.90	441.00	1.72
86	K4	Nzega	Kasela 1-1	Borehole	Deep Well	-4.058567	33.173517	97.00	7.06	137.00	10.70	55.50	3.60	102.00	0.00	392.00	0.82
87	K5	Nzega	Kabele1	Shallow well	Shallow well	-4.016653	33.198633	47.80	7.41	89.50	3.30	9.50	0.00	3.90	5.00	305.00	1.14
88	K6	Nzega	Kabele2	Shallow well	Shallow well	-4.016533	33.198633	285.00	8.09	9.60	2.10	773.00	3.90	110.00	5.60	1780.00	15.26
89	K7	Nzega	Lubaga1	Borehole	Deep Well	-3.999900	33.173400	91.10	7.17	60.00	14.30	130.00	2.70	78.50	15.60	382.00	1.87
90	K10	Nzega	Kabale4	Borehole	Deep Well	-4.014133	33.193150	63.00	7.14	73.20	10.60	53.30	2.80	11.10	0.00	368.00	1.08
91	K11	Nzega	Itonjamandi1	Borehole	Deep Well	-4.018200	33.166517	108.50	7.08	73.10	14.10	161.00	1.30	79.00	9.10	494.00	2.40
92	K12	Nzega	Itonjamandi2	Shallow well	Shallow well	-4.019067	33.165650	109.00	7.39	53.60	5.70	258.00	1.50	90.00	6.70	669.00	3.93
93	K13	Nzega	Mwagundu2	Shallow well	Shallow well	-4.028667	33.173850	11.30	6.35	3.20	0.90	23.80	1.40	6.40	5.50	52.00	0.51
94	I1	Tabora Rural	Ubala	Borehole	Deep Well	-4.892667	33.112967	529.00	6.41	264.00	93.50	680.00	10.20	1770.00	8.30	266.00	2.52
95	I2	Tabora Rural	Ihala	Borehole	Deep Well	-4.904283	33.096033	12.50	5.23	6.10	2.20	29.00	1.30	38.50	0.00	17.00	0.44
96	M1	Tabora Urban	Mtakuja Centre	Borehole	Deep Well	-5.140800	32.746250	225.00	6.60	92.00	62.20	315.00	4.00	553.00	9.30	439.00	2.08
97	M2	Tabora Urban	Kiloleni M2	Borehole	Deep Well	-5.157017	32.758300	15.70	5.76	6.50	2.80	29.60	4.00	19.50	0.90	26.00	0.52
98	M3	Tabora Urban	Kikundi B	Borehole	Deep Well	-5.180867	32.735767	80.40	7.51	5.50	1.00	196.00	3.10	56.40	0.30	409.00	5.51
99	M4	Tabora Urban	Mtapenda	Borehole	Deep Well	-5.183267	32.751717	6.30	5.70	3.50	1.20	12.10	1.20	10.20	0.00	25.00	0.49
100	IB1	Tabora Rural	Kategili A2	Borehole	Deep Well	-4.923950	32.605617	129.00	6.82	101.00	27.50	137.00	3.10	183.00	7.90	476.00	1.23
101	IB2	Tabora Rural	Kategili B1	Borehole	Deep Well	-4.929133	32.596167	59.50	6.47	37.00	37.30	24.40	6.60	80.90	4.60	190.00	0.37
102	IB3	Tabora Rural	Mpungu B1	Borehole	Deep Well	-4.915383	32.579033	96.90	7.25	55.20	34.70	115.00	7.00	92.50	31.40	433.00	1.85
103	IB4	Tabora Rural	Makunguwe B	Borehole	Deep Well	-4.895450	32.594433	6.80	5.50	3.50	1.60	7.80	2.80	8.90	6.10	9.00	0.79
104	L1	Tabora Rural	Mhogwe B	Borehole	Deep Well	-4.879350	33.040817	79.20	6.41	40.50	10.60	142.00	4.40	97.00	4.90	354.00	1.91
105	L2	Tabora Rural	Marudio A	Borehole	Deep Well	-4.862217	33.003750	121.00	10.16	34.50	0.70	210.00	11.90	234.00	76.90	114.00	0.89
106	IB5	Tabora Rural	Mpungu B2	Borehole	Deep Well	-4.918733	32.591983	19.50	6.03	6.70	1.50	41.20	2.70	19.10	8.80	83.00	0.57
107	IB6	Tabora Rural	Mpungu A1	Borehole	Deep Well	-4.912583	32.567517	15.30	6.70	6.60	2.10	25.00	4.70	12.40	2.80	55.00	0.35
108	IB7	Tabora Rural	Mpungu A2	Borehole	Deep Well	-4.915483	32.568833	10.70	6.47	4.80	1.70	14.80	2.40	7.30	3.30	36.00	0.39
109	TB-19	Igunga	Choma	River	River	-4.023530	33.348410	59.80	8.01	35.50	10.72	94.22	6.06	188.00	0.00	359.00	1.50
110	SW-TB-7	Igunga	Mwanzugi	Spring	Spring	-4.353720	33.889410	33.80	7.65	11.66	3.48	57.18	2.54	174.00	22.60	92.00	0.80
111	SW-TB-6	Igunga	Mwanzugi	Dam	Dam	-4.354530	33.878970	15.28	7.51	23.09	4.88	12.83	5.23	45.00	31.70	111.00	0.80
112	TB-1	Igunga	Igunga	Shallow well	Shallow well	-4.260850	33.891960	159.00	8.59	0.18	4.67	315.73	0.60	37.00	0.00	946.00	21.32
113	TB-4	Igunga	Lugubu	Shallow well	Shallow well	-4.560000	33.873640	24.70	7.73	17.00	4.85	7.75	7.79	59.00	0.00	101.00	0.40
114	TB 22-2	Igunga	Itunduru	Dam	Dam	-4.137170	33.649300	28.00	7.85	35.00	3.71	15.25	4.11	49.00	0.00	178.00	0.40
115	TB-23-2	Igunga	Moyofoke	Waterhole	Waterhole	-4.332690	33.537150	15.92	8.19	37.38	32.70	132.16	18.21	779.00	0.00	470.00	0.40
116	TB-25	Igunga	Nkinga	Borehole	Deep Well	-4.411070	33.431590	96.50	7.93	3.71	18.68	119.25	1.57	42.00	0.00	482.00	3.00
117	TB-28-2	Igunga	Ziba	Shallow well	Shallow well	-4.237640	33.406140	43.00	7.10	69.41	1.83	37.59	3.75	20.00	0.00	37.00	0.80
118	SW-TB-16	Nzega	Ikindwa	Shallow well	Shallow well	-4.123470	32.899940	27.60	7.43	5.97	1.90	12.52	3.64	10.00	30.50	114.00	0.00
119	TB-38-1	Nzega	Kabale	Borehole	Deep Well	-3.982510	33.130130	107.90	7.86	0.00	15.76	113.86	1.56	81.00	0.00	286.00	1.50
120	TB-43-2	Tabora Rural	Kimungi	Shallow well	Shallow well	-5.356220	33.184690	12.41	4.35	8.06	1.53	8.95	1.16	13.00	18.10	15.00	0.80
121	SWTB-23	Tabora Rural	Goweko	Borehole	Deep Well	-5.324480	33.151190	21.90	4.60	60.40	0.93	23.88	4.17	38.00	0.00	6.00	0.40
122	SW-TB-25	Tabora Rural	Malongwe	Shallow well	Shallow well	-5.440920	33.643390	65.40	6.68	0.00	7.87	75.55	2.94	459.00	0.00	15.00	0.00
123	SW-TB-24	Tabora Rural	Tura	Shallow well	Shallow well	-5.493320	33.843020	11.30	7.28	19.83	4.50	9.74	4.89	10.00	11.90	43.00	0.40
124	TB-42	Tabora Rural	Latona	Shallow well	Shallow well	-5.175610	33.720050	202.00	7.97	0.00	35.87	352.85	4.49	344.00	23.00	688.00	3.00

Source:Water Quality Analysis in This Study (No.1-82), Low Permeability rocks in Sub-Saharan Africa: Groundwater development in Tabora Region, Tanzania, Groundwater System and Water Quality Programme Commission Report CR/02/19N (No.83-108)
Study on the Groundwater Resources Development and Management in the Internal Drainage Basin(No.109-124)

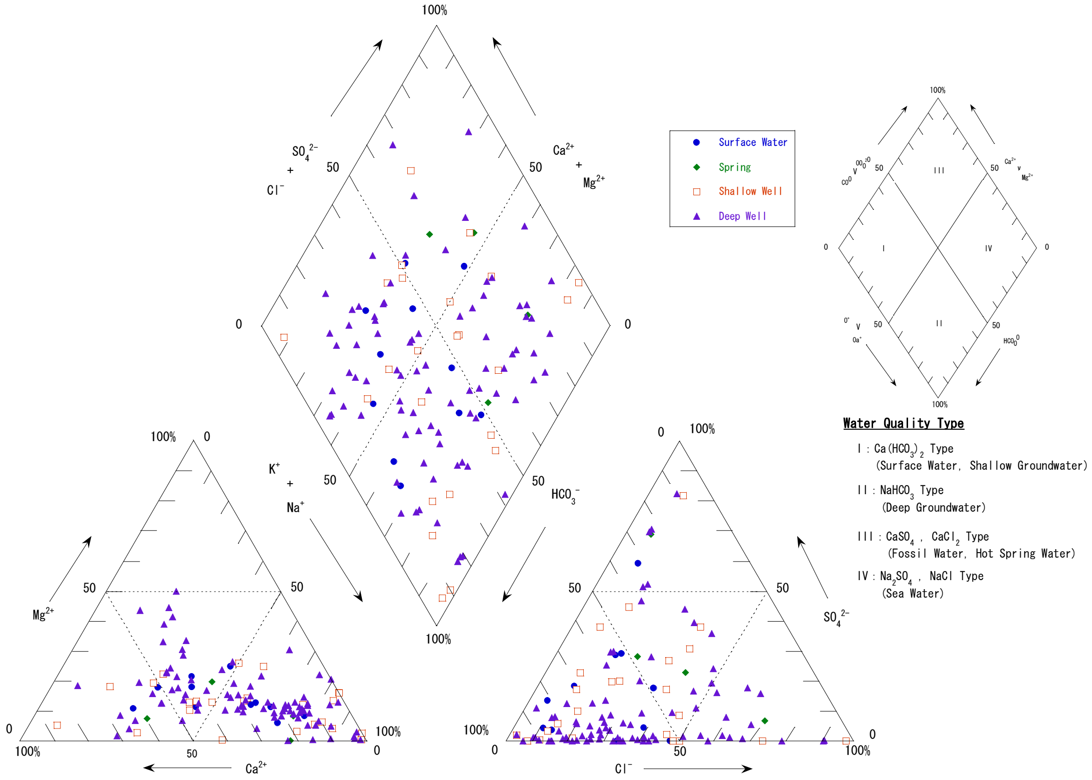

Figure 4.4.9 Water Quality in Tabora Region Classified by Water Source

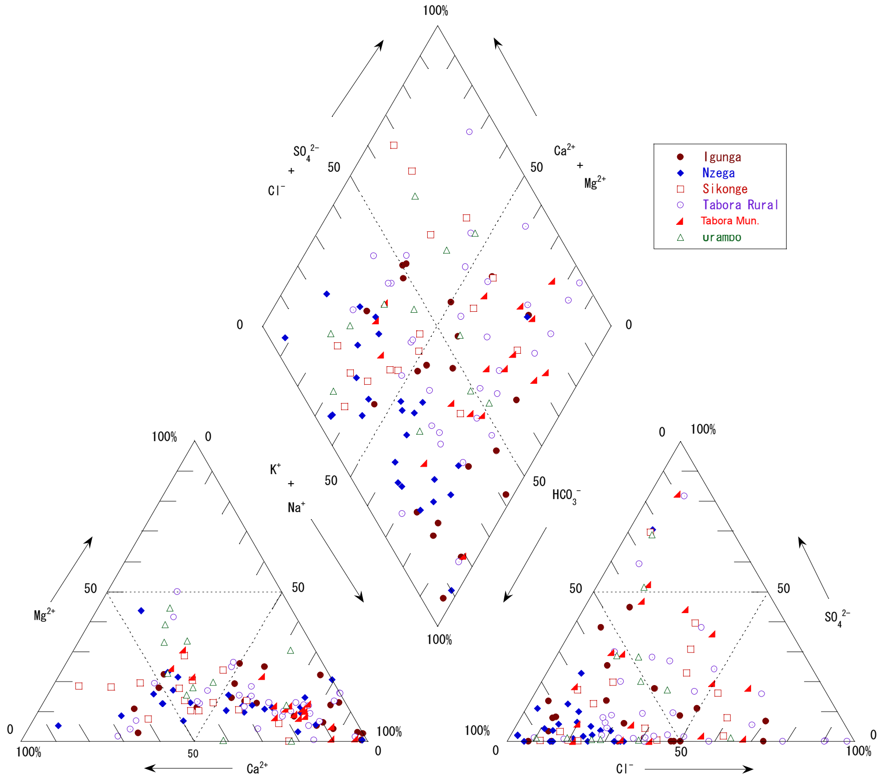

Figure 4.4.10 Water Quality in Tabora Region Classified by District

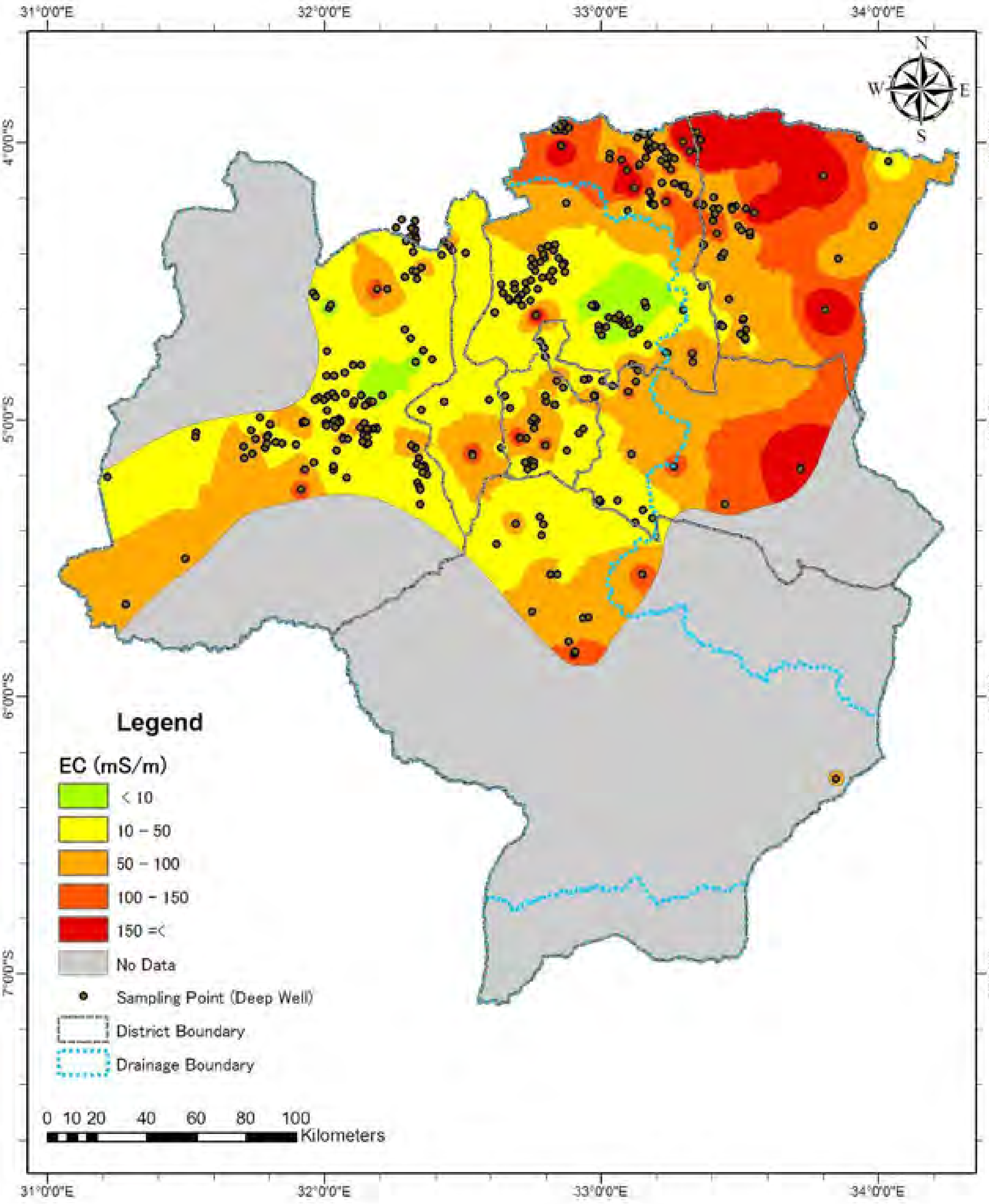

FIGURE 4.4.11 DISTRIBUTION OF EC IN THE STUDY AREA

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4.5 GROUNDWATER POTENTIAL

4.5.1 AQUIFER IN THE STUDY AREA

The numbers of boreholes in each geological formation in the study area are shown in Figure 4.5.1. The aquifer of Recent Alluvium and two Pleistocene Layers are categorized as a stratum aquifer. Basement rocks consisting of Archean rocks are categorized as a fractured aquifer. This figure shows that nearly 90% of the boreholes in the study area were drilled to the fractured aquifers in the basement rocks.

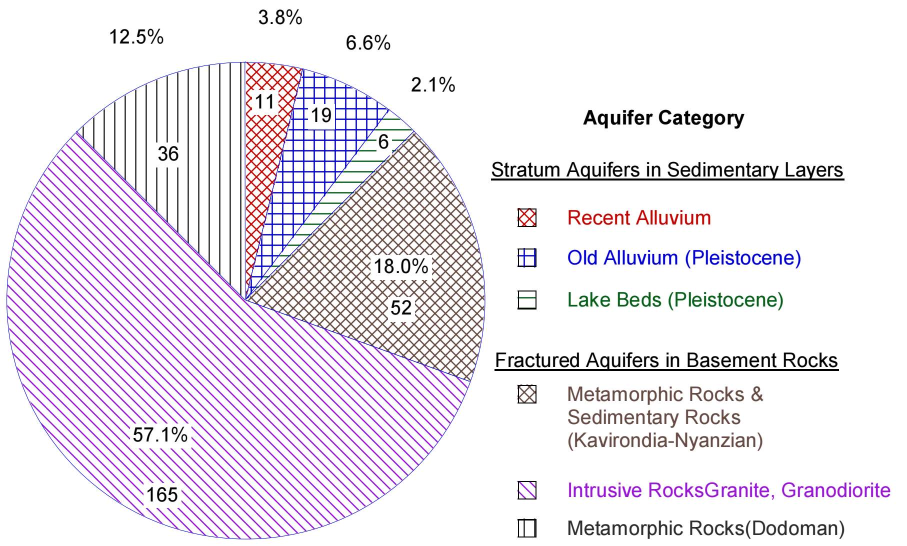

Figure 4.5.1 Number of Boreholes by Geological Formation

Figure 4.5.4 shows the distribution of boreholes by the geological formation in the Tabora region.

4.5.2 GROUNDWATER YIELD BY GEOLOGICAL FORMATION

The distribution of borehole yields in the Tabora region by geological formation is shown in Figure 4.5.2. Figure 4.5.3 shows the average, median, maximum and minimum values of the yield by each geological formation. Old Alluvium in the Pleistocene has the highest value of the average, median and minimum yield. However, the number of boreholes in the Old Alluvium is small so it is difficult to recognize a significant difference of the yield among the geological formations based on the existing data at present.

4.5.3 GROUNDWATER LEVEL BY GEOLOGICAL FORMATION

The depths to the groundwater level by geological formation are shown in Figure 4.5.5. The average and median water levels of all formations are situated about 20 metres below the ground or above. Therefore the water level is not a critical factor to evaluate the groundwater potential except for anomaly values.

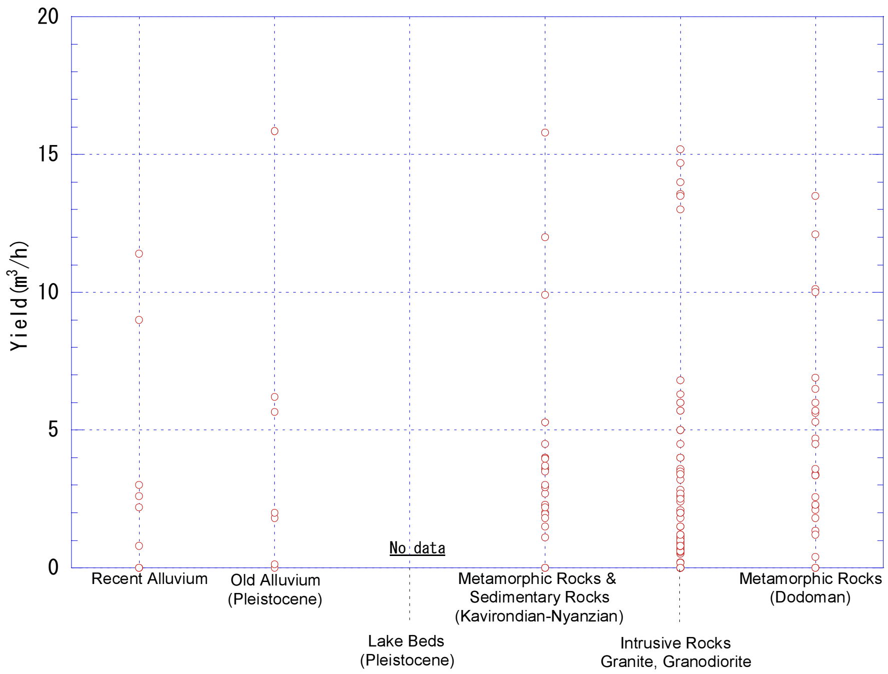

Figure 4.5.2 Distribution of Borehole Yield by Geological Formation

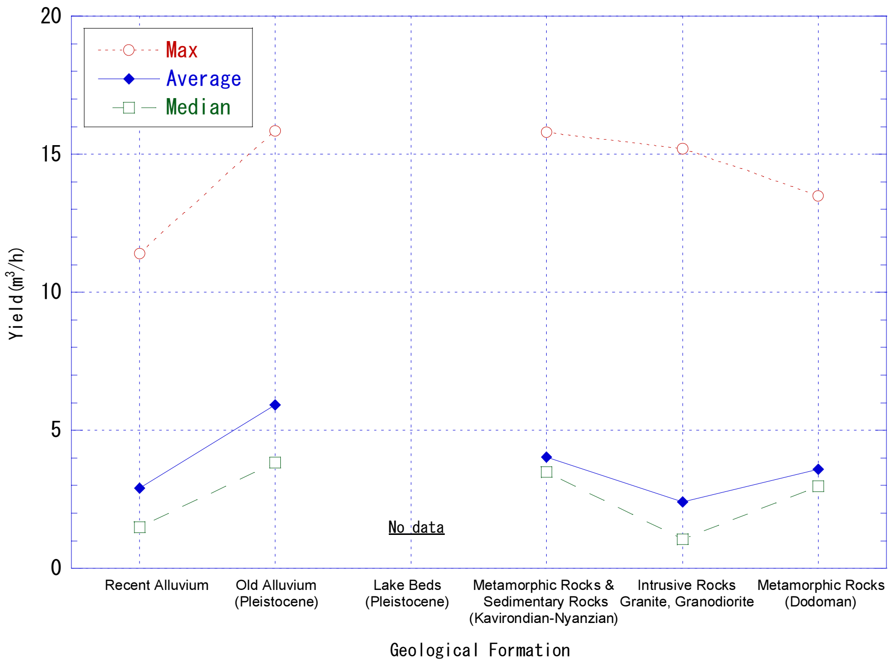

Figure 4.5.3 Borehole Yield by Geological Formation

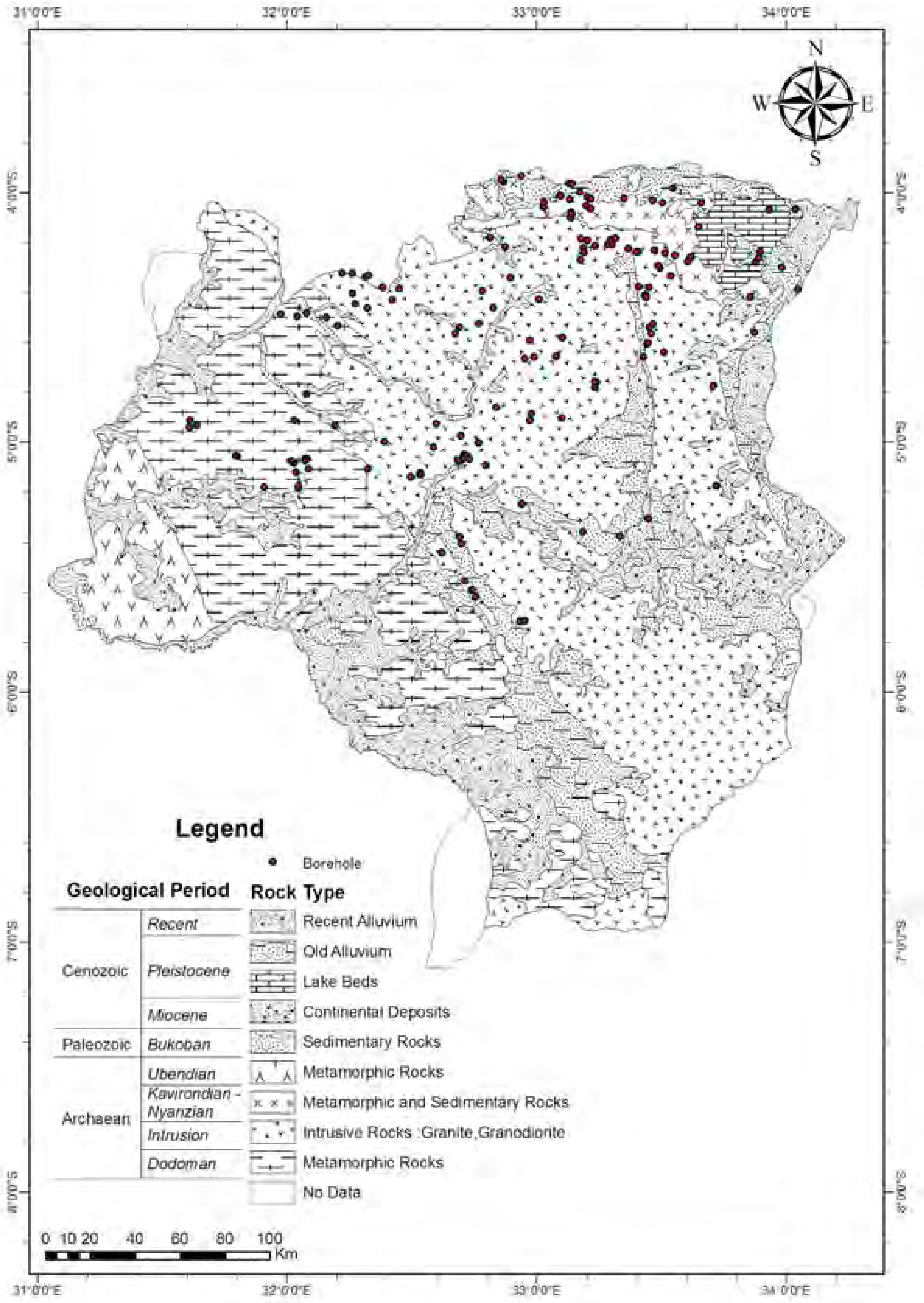

FIGURE 4.5.4 BOREHOLE DISTRIBUTION BY THE GEOLOGICAL FORMATION

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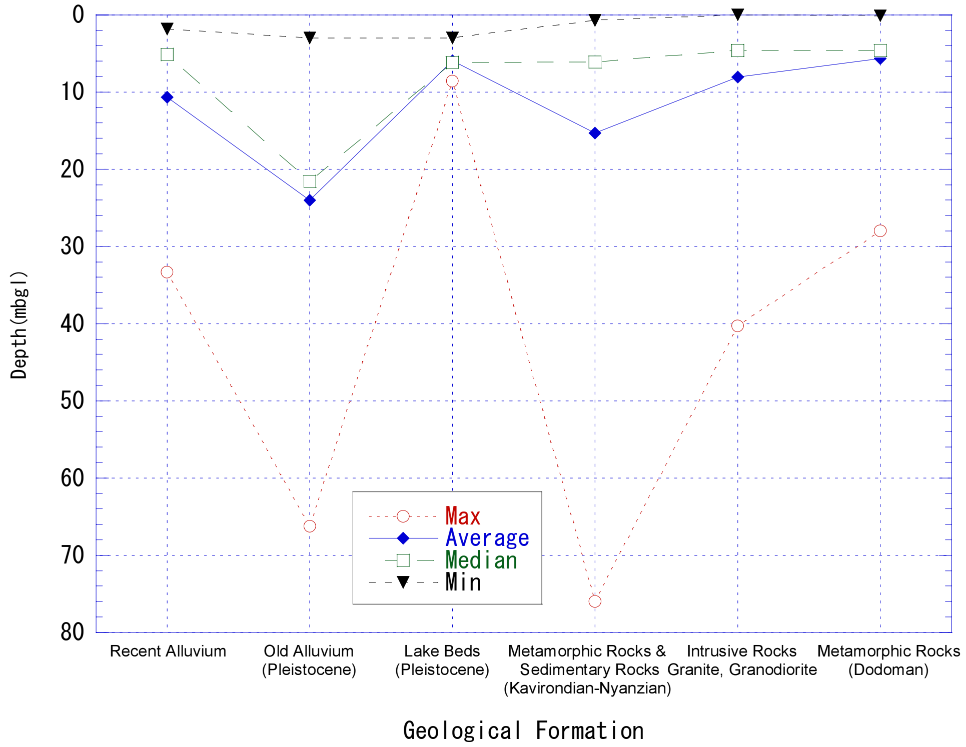

Figure 4.5.5 Groundwater Level by Geological Formation

4.5.4 GROUNDWATER POTENTIAL EVALUATION

(1) Yield

A clear difference of the yield among the aquifers especially in the basement rocks of the study area can not be recognized from the existing data at present. Therefore the groundwater potential was assumed from the existing borehole data and the geological structures that is the result of satellite image analysis.

The groundwater yield is classified into three categories and the study area is divided into the following three areas. Topographical features and geological structures have effects on the groundwater potential. The classification of the area yielding groundwater was modified from the viewpoint of these features. Especially fault zones and lineaments have much effect on the groundwater yield, so these zones of the major fault of an existing borehole that has a yield 5m^3/hour and above are classified as “Area 1”. The area of the forest reserves and the game reserves are excluded from this evaluation.

1) Area which has a yield of 5 m^3/hour and above is assumed

The surrounding areas of the existing borehole that have a yield of 5 m^3/hour and above.

2) Area where a yield of 1 – 5 m^3/hour is assumed

The surrounding areas of the existing borehole that have a yield of 1 – 5 m^3/hour.

3) Area where a yield of below 1 m^3/hour is assumed

This area is an area that is not included in Area 1 and Area-2 as referred to above.

(2) Water Quality

A high concentration of fluoride is the most important issue of water quality in the study area.

The upper limit of fluoride content in drinking water is 1.5 mg/L according to the “WHO Guideline for Drinking Water Quality" and also is 4.0 mg/L according to "Drinking Water Standard in Tanzania". Based on the value of fluoride content from this study and the existing data, the study area is divided into the following three areas.

1) Area where the fluoride content is below 1.5 mg/L

Groundwater in this area is suitable for drinking.

2) Area where the fluoride content is 1.5 – 4.0 mg/L

Groundwater in this area exceeds the upper limit of WHO Guideline but satisfies the Tanzania standard. Precautions against the seasonal variation of fluoride content will be necessary.

3) Area where the fluoride content is 4.0 mg/L or above

Groundwater in this area is unsuitable for drinking.

The hydrogeological map (Figure 4.5.6) shows the above areas for fluoride content.

(3) Water Level (Depth to Groundwater)

The depth to the groundwater is shown in Figure 4.5.6 from the static water level of the existing borehole. The water levels of most boreholes are situated about 20m below the ground or above. Therefore the water level is not a critical factor to evaluate the groundwater potential in the study area.

(4) Hydrogeological Map

The hydrogeological map is shown in Figure 4.5.6. The map contains the information on geological features, groundwater yield, depth to the groundwater table and groundwater quality data especially the fluoride content.

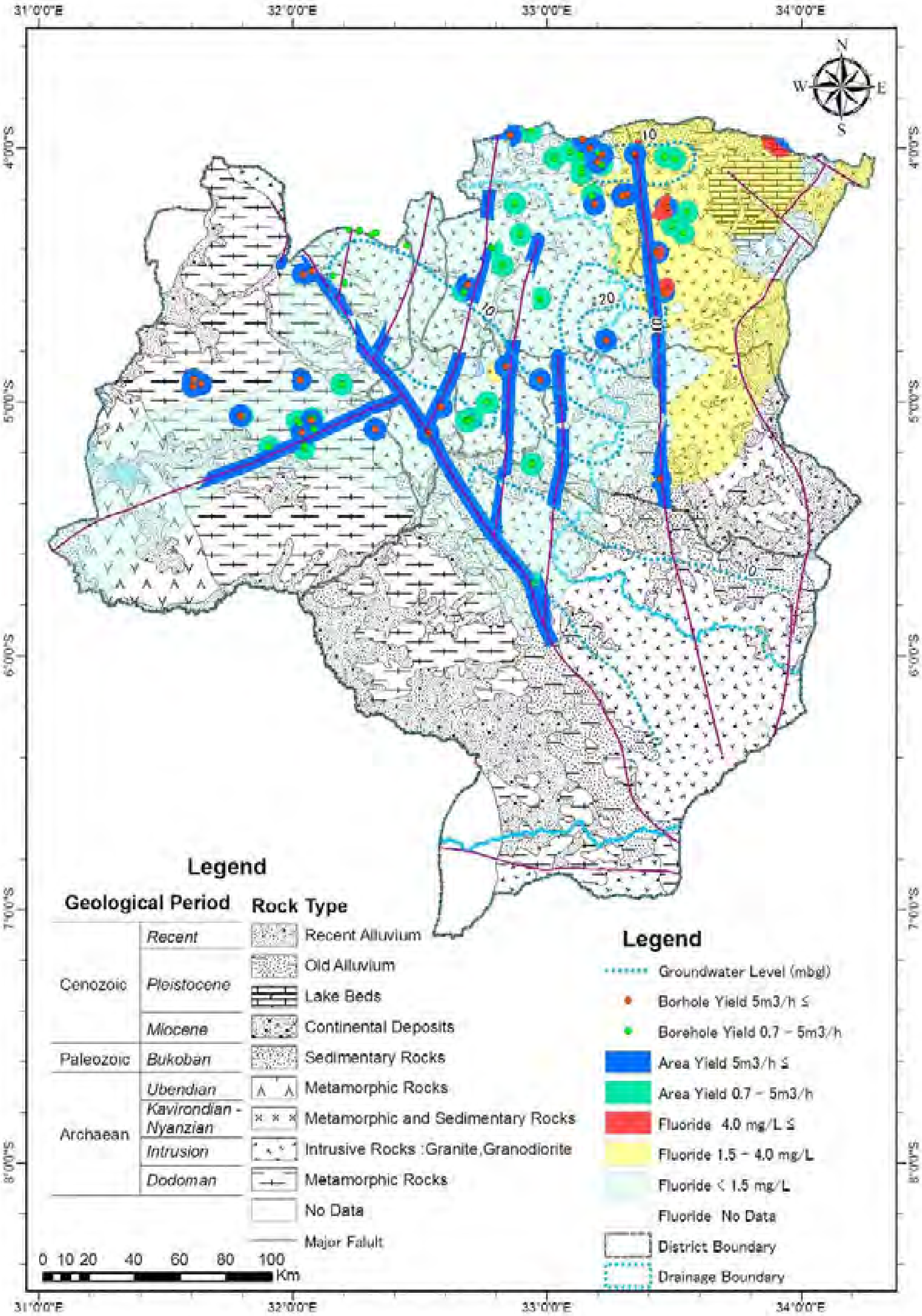

FIGURE 4.5.6 HYDROGEOLOGICAL MAP

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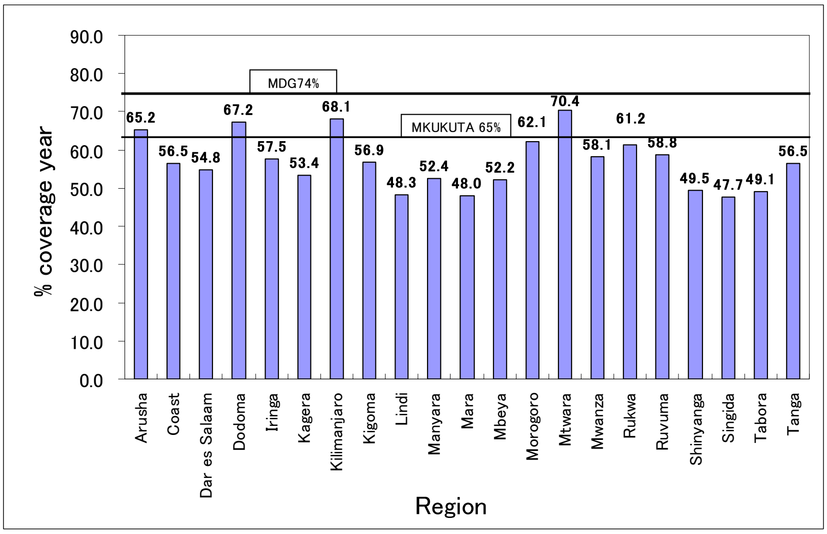
CHAPTER 5 CURRENT CONDITIONS OF RURAL WATER SUPPLY

5.1 GENERAL

The Tabora Region is one of the least developed Regions in Tanzania in terms of water supply. Figure 5.1.1 shows Region-wise water supply coverage presented in the "Water Sector Performance Report (WSPR) (September 2009)".

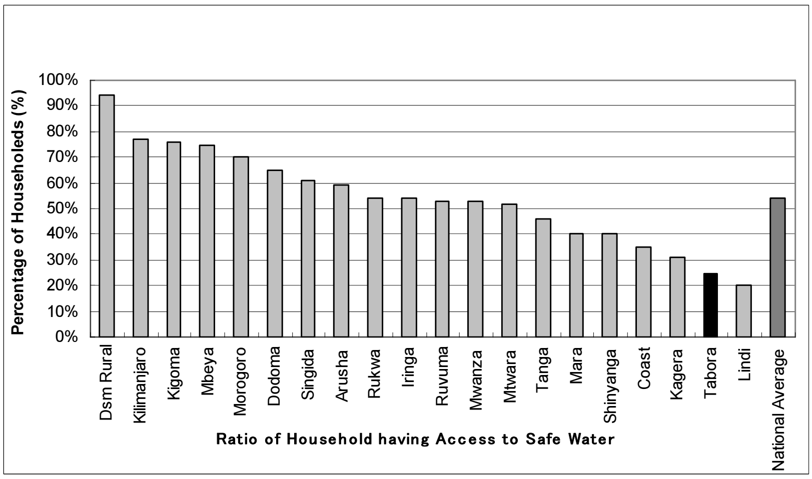


Source: Ministry of Water and Irrigation (2008) Water Sector Performance Report for the Year 2007/2008, 134pp.

Figure 5.1.1 Region-wise Rural Water Supply Coverage in Tanzania

Water supply coverage of the Tabora Region is 49.1%, almost the lowest level in Tanzania, while to attain 65% of water supply coverage in 2010 is the goal of the NSGRP (Vice President's Office, 2005).

Figure 5.1.2 shows the ratio of households using the protected water sources (National Bureau of Statistics, 2002). It is only 25% in the Tabora Region, the second lowest in Tanzania.



Source: National Bureau of Statistics Tanzania (2002) Household Budget Survey

Figure 5.1.2 Ratio of Households using Safe Water

Figure 5.1.1 and 5.1.2 revealed that the current situation of water supply in the Tabora Region was the worst level in Tanzania from the viewpoints of both the number of water supply schemes and safe water sources. This situation is caused by the difficult hydrogeological structure for groundwater development and improper dwelling types, "scattered", for construction of water supply schemes.

It is reported that there are more than 900 rural water supply schemes in the Tabora Region (JICA, 2009). However, the precise number of total schemes, their water sources, working conditions, population served, etc. are not recorded. An inventory summarized by Water Aid in 2005 cited 1,631 water points. It shows that 890 water points are not functioning. The inventory includes public water taps of the piped water supply scheme. No reliable data or information about existing water supply conditions in the Tabora Region is available.

It was requested from the Study to formulate a rural water supply plan in the Region. For this purpose it is necessary to acquire more accurate data on the existing water supply schemes.

Consequently, an inventory survey was carried out by the Study Team in order to comprehend the existing conditions of rural water supply in the Tabora Region. Based on the survey results, the existing conditions of rural water supply in the Tabora Region are described in this Chapter.

5.2 INVENTORY SURVEY ON THE EXISTING RURAL WATER SUPPLY SCHEMES

5.2.1 CONTENTS OF THE SURVEY

A survey on the existing conditions of rural water supply schemes was implemented in order to construct the inventory of water supply schemes distributed in the entire Tabora Region employing a Tanzanian consultant, and to evaluate the groundwater potential. The target of the survey is all the piped water supply schemes (Level-2) and handpump water supply schemes (Level-1). As for other water supply schemes such as shallow wells, dug wells, and charco dams, the number of schemes distributed in the Villages was surveyed.

In parallel with the survey, existing data on the deep well drilling results were collected: They are the "Borehole Catalogue" prepared by MoW, and the drilling reports belonging to DDCA and Local Governments in the Tabora Region.

(1) Target rural water supply scheme of the survey

As mentioned above, the target of the survey is mainly Level-2 and Level-1 water supply schemes. The number of other schemes was also confirmed.

(2) Survey items

1) Confirmation of water source

The locations of the water sources of rural water supply systems were measured by GPS, excluding the locations of public water points of piped water supply schemes.

2) In-situ measurement of water quality

The water quality- Temperature, pH, electric conductivity (EC) and Fluoride were measured at the sites during the survey.

3) Interview

Based on the survey sheet prepared by the Study team, an interview was held with the principal members of the villages, such as VEO, Village Chairman, members of the Village Water Committees, Water User Groups and Water User Associations.

4) Contents of the interview

The following items were interviewed during the survey:

- The type and water source of the water supply scheme
- Population served
- Year of construction and the source of funds
- Current operational condition. Reason, if the scheme is not functioning.
- Organization for operation and maintenance of the scheme.

- Water tariff structure and its collection system
- Willingness and affordability to pay for water tariff
- Yield of the water source, depth of the well, number of public water points
- Others.

5.3 CURRENT CONDITIONS OF RURAL WATER SUPPLY SCHEMES

5.3.1 NUMBER OF RURAL WATER SUPPLY SCHEMES AND THEIR OPERATIONAL STATUS

The inventory survey revealed that there are 49 Level-2 schemes and 1,420 Level-1 schemes, totalling 1,469 schemes in the Tabora Region. The District and type number of the water supply scheme and their operational status are shown in Table 5.3.1. Regarding the Level-2 schemes, two (2) schemes are under construction in the Study Area, a scheme in Igunga and another in Tabora Rural. The total of three (3) Level-2 schemes was abandoned, one (1) is in Nzega and two (2) are in Sikonge (as of November 2009). As for the Level-1 scheme, 13 schemes were abandoned and 42 schemes are under construction (as of November 2009).

Table 5.3.1 Number of Water Supply Scheme and Operational Status

District /Municipality	Level-2			Level-1			Total		
	Total	Functional	Not Functional	Total	Functional	Not Functional	Total	Functional	Not Functional
Igunga Dist.	9	5	4	100	21	79	109	26	83
Nzega Dist.	7	0	7	521	255	266	528	255	273
Sikonge Dist.	2	2	0	127	56	71	129	58	71
Tabora Rural Dist.	10	3	7	189	92	97	199	95	104
Tabora Mun.	2	1	1	85	56	29	87	57	30
Urambo Dist.	19	6	13	398	180	218	417	186	231
Total	49	17	32	1,420	660	760	1,469	678	792
(%)	100	34.7	65.3	100	46.5	53.5	100	46.1	53.9

The number of the Level-2 schemes is 49 and occupies only 3.3 % of all the schemes. The remaining 96.7 % are Level-1 schemes. Most of the schemes in the Study Area are Level-1 schemes.

It was revealed that, among all the schemes, 677 schemes (46.1 %) are functional and 792 schemes (53.8 %) are not functional.

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

There are 49 Level-2 schemes in the Study Area, and 17 schemes (34.7 %) are functioning. Table 5.3.2 shows the water sources of the Level-2 schemes and their operational status.

Table 5.3.2 Water Source wise Number of Level-2 and Operational Status

District /Municipality	Deep Groundwater		Shallow Groundwater, or combined with other water source		Spring		Surface Water (Dam, Charco Dam, etc.)	
	Total	Functional	Total	Functional	Total	Functional	Total	Functional
Igunga Dist.	6	4	1	1	0	0	2	0
Nzega Dist.	3	0	0	0	0	0	4	0
Sikonge Dist.	0	0	1	1	1	1	0	0
Tabora Rural Dist.	3	1	2	1	2	0	3	1
Tabora Mun.	0	0	0	0	1	0	1	1
Urambo Dist.	10	3	0	0	3	2	6	1
Total	22	8	4	3	7	3	16	3
(%)	45	36	8	75	14*	43	33	19

The type of the largest number of water sources of the Level-2 schemes is groundwater, and it is 22 schemes (45 %). Among them, however, only eight (8) schemes (36 %) are functioning. The surface water is second, and has 16 schemes (33 %) and three (3) schemes (28 %) out of 16 schemes are functioning.

On the contrary, the shallow groundwater and spring water are the minor water sources of the Level-2 schemes in the Study Area.

(2) Handpump water supply scheme (Level-1)

It is shown in Table 5.3.1 that a total of 1,420 Level-1 schemes exist in the Study Area, and 660 schemes (46.5%) are functioning and the remaining 760 schemes (53.5 %) are not functioning. Among the not functional Level-1 schemes, 426 handpumps are not working due to mal-function, 27 handpumps have been stolen and 307 schemes have no handpump. The reasons of no handpump are unclear, however, it is supposed that the most of the handpumps were removed from the schemes after their having broken down.

The reasons for unfunctioning of the Level-1 schemes are summarized in Table 5.3.3.

The major reason for unfunctioning is "dried up of water sources" (221 schemes, 48.9 %) followed by "Problems of pump" (152 schemes, 35.6 %). These two (2) reasons occupy 84.5 % of reasons for unfunctioning.

9 types of handpumps are used in the Study Area for the Level-1 schemes. The major types are Tanira (476 schemes), Afridev (369 schemes) and Indian Mark-II (188 schemes). These three (3) types occupy 93.7 % of the total handpumps. The district and type-wise number of handpumps and their operational status are summarized in Table 5.3.4.

Table 5.3.3 Reasons for Unfunctioning of Level-1 Water Supply Schemes

District /Municipality	(1) Dried up	(2) Mal-water quality	(3) Corruption of well	(4) Low dischage	(5) Problems of pump	(6) Unknown	(7) Others	Counting A*	Counting B*	Counting C*	Sum*
Igunga Dist.	0	1	0	0	12	6	0	1	18	0	19
Nzega Dist.	101	0	0	0	49	4	0	101	53	4	150
Sikonge Dist.	27	0	0	3	23	7	1	27	34	0	61
Tabora Rural Dist.	21	0	0	0	27	13	0	21	40	1	60
Tabora Mun.	9	0	0	0	2	8	0	9	10	0	19
Urambo	63	0	2	4	39	11	0	65	54	3	116
Total	221	1	2	7	152	49	1	224	209	8	425
(%)	48.9	0.2	0.4	1.5	35.6	10.8	0.2	49.6	46.2	1.8	100.0

(Researched in October – November, 2009)

- *A: Unfunctioning due to problems on wells (sum of (1) ~ (3))
- *B: Unfunctioning due to problems other than wells (sum of (4) ~ (7))
- *C: Unfunctioning due to both Counting A and B
- *Sum: Counting A plus B minus Counting C

Table 5.3.4 Type-Wise Operational Status of Handpump (Level-1)

	Igunga District					Nzega District					Sikonge District					Tabora Rural District					Tabora Municipality					Urambo District					Total				
	Total	Functioning	Unfunctioning	Stolen	Pump Removed	Total	Functioning	Unfunctioning	Stolen	Pump Removed	Total	Functioning	Unfunctioning	Stolen	Pump Removed	Total	Functioning	Unfunctioning	Stolen	Pump Removed	Total	Functioning	Unfunctioning	Stolen	Pump Removed	Total	Functioning	Unfunctioning	Stolen	Pump Removed	Total	Functioning	Unfunctioning	Stolen	Pump Removed
Afridev	20	14	6	0	0	117	93	24	0	0	1	1	0	0	0	74	49	25	0	0	22	17	5	0	0	135	81	54	0	0	369	255	114	0	0
Tanira	9	2	7	0	0	278	147	121	10	0	49	21	27	1	0	25	12	12	1	0	13	9	4	0	0	102	75	26	0	1	476	266	197	12	1
Indian Mk-II	7	1	4	0	2	16	13	3	0	0	40	24	16	0	0	48	30	18	0	0	39	28	10	1	0	38	21	17	0	0	188	117	68	1	2
Indian Mk-III	5	4	1	0	0	0	0	0	0	0	18	9	9	0	0	0	0	0	0	0	2	2	0	0	0	3	1	2	0	0	28	16	12	0	0
Others	0	0	0	0	0	4	2	2	0	0	12	1	10	1	0	6	1	5	0	0	0	0	0	0	0	19	2	17	0	0	41	6	34	1	0
Pump Removed	59	0	1	1	57	106	0	0	4	102	7	0	0	0	7	36	0	0	1	35	9	0	0	3	6	101	0	0	4	97	318	0	1	13	304
Total	100	21	19	1	59	521	255	150	14	102	127	56	62	2	7	189	92	60	2	35	85	56	19	4	6	398	180	116	4	98	1420	660	426	27	307

5.4 WATER SUPPLY COVERAGE

Water supply coverage means the ratio of population served against the total population in the supply target area. On the one hand, the WSDP aims to cover all the area of the target village, leaving no area unserved. This concept means that every Sub-Village has at least one (1) access to water supply service in the area. Therefore, both water supply coverage against the total population and water supply coverage against the total Sub-Villages are evaluated in this Item.

(1) Water supply coverage against the total population

Water supply coverage, in terms of the ratio of the population who have access to water supply services, is calculated under the following conditions:

- The population of each village in 2009 was obtained through a socio-economic survey. If such data was not obtained, the population was projected by the Study Team using the 2002 Census data (Refer to Chapter 2).
- The population of the areas supplied or to be supplied by the TUWASA is excluded from the calculation.
- The population served in the Small Townships is obtained from each UWSA during the inventory survey of the existing water supply schemes.
- The population served by the Level-2 schemes is quoted from the result of the village socio-economic survey (Refer to Chapter 2).
- The population served by a Level-1 scheme is estimated to be 250 persons.
- If such data are not available, population served by a Level-2 scheme is calculated assuming that a public tap supplies 250 persons.
- If both the population served and the number of public taps of the Level-2 scheme are not available, the population served is estimated comparing the 2009 populations and populations served in other villages served by the Level-2 schemes..

Applying the conditions above, water supply coverage in 2009 was calculated as shown in Table 5.4.1

Table 5.4.1 District-wise Water Supply Coverage (Population Served) (2009)

District /Municipality	Population (2009)*	No. of operating Level-2	Population served by Level-2	No. of operating Level-1	Population served by Level-1	Total population served	Water Supply Coverage (%)
Igunga Dist.	363,188	5	19,800	21	5,250	25,050	6.9%
Nzega Dist.	469,112	0	0	255	63,907	639,07	13.6%
Sikonge Dist.	164,219	2	5,044	56	13,933	18,977	11.6%
Tabora Rural Dist.	393,552	3	11,365	92	21,998	33,363	8.5%
Tabora Municipality.	58,842	1	1,131	56	13,480	14,611	24.8%
Urambo Dist.	435,277	6	20,905	180	45,000	65,905	15.1%
Total	1,884,190	17	58,245	660	163,568	221,813	11.8%
(%)	100	-	3.1%	-	8.7%	11.8%	-

Note: * Population of the Study Area (the rural area), not that of the whole District/Municipality.

The population to be served in the Study Area is 1,884 x 10^3 persons (2009). Among them, 221 x 10^3 persons are receiving the water supply service by the Level-2 and the Level-1 schemes. The water supply coverage is 11.8%: 58,245 persons (26%) are served by the Level-2 schemes and 163,568 persons (74%) are served by the Level-1 schemes.

The figure 11.8 %, the total population served in the Study Area, is the water supply coverage served by the more reliable water sources compared with other sources such as unprotected shallow wells, dams, charco dams, streams, etc.

Table 5.4.2 Population Served and Water Supply Coverage by Level-2, Level-1 and Other Protected Water Supply Facility

District/Municipality	Population (2009)	Population served by Level-2 and Level-1	Populatin served by protected water supply	Total population served	Water supply coverage (%)
Igunga District	363,188	25,050	0	25,050	6.9%
Nzega District	469,112	63,907,	30,182	94,089	20.1%
Sikonge District	164,219	18,977	2,500	21,477	13.1%
Tabora Rural District	393,552	33,363	3,354	36,717	9.3%
Tabora Municipality	58,842	14,611	0	14,611	24.8%
Urambo District	435,277	65,905	10,109	76,014	17.5%
Total	1,884,190	221,813	46,145	267,958	14.2%

Source: Own survey

The total population served and water supply coverage are 267,958 persons and 14.2%, respectively. The water supply coverage is high in Tabora Municipality, Nzega and Urambo: They are 24.8% in Tabora Municipality, 20.1% in nzega and 17.5% in Urambo. In contrary, it is low in Igunga, it is 6.9% as shown in Table 5.4.2.

These data show that the community people in the Study Area are left with a severe lack of water supply.

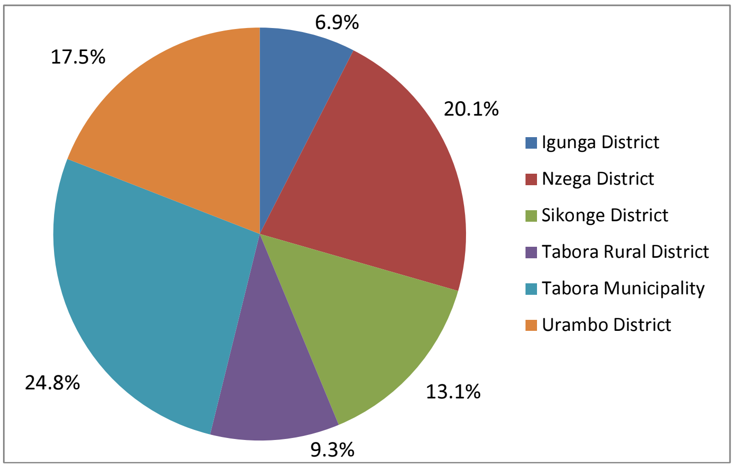


Figure 5.4.1 Water Supply Coverage (Population Served)

(2) Water supply coverage against the total Sub-Village

The percentage, how many percent of Sub-Villages have access to water supply service, was calculated.

- The areas served or to be served by the UWSAs are excluded from the calculation.
- The number of the water supply target area (Sub-Village) is quoted from the result of the village socio-economic survey (Refer to Chapter 2).

- The number of target Villages is 547, and the Villages are subdivided into 2,918 Sub-Villages. Therefore, the 2,918 Sub-Villages are the total number of the water supply target area.

- A Sub-Village is considered to be receiving water supply service if there is at least one (1) public water point (a public tap of a Level-2 scheme or a Level-1 scheme) in the Sub-Village.

The District-wise water supply coverage in terms of access to available water supply service in the Sub-Village, was evaluated as shown in *Table 5.4.3.*

Table 5.4.3 Water Supply Coverage (Sub-Village Served) (2009)

District/ Municipality	No. of total Sub-Village	(A) No. of Sub-Village receiving water supply service	(B) No. of Sub-Village served by Level-2	(C) No. of Sub-Village served by Level-1	Water supply coverage (%)
Igunga	630	39	20	19	6.2%
Nzega	978	210	0	210	21.5%
Sikonge	229	63	16	47	27.5%
Tabora Rural	467	69	5	64	14.8%
Tabora Municipality	117	43	3	40	36.8%
Urambo	497	164	25	139	33.0%
Total	2,918	588	69	519	20.2%

The ratio of Sub-Villages served by the Level-2 schemes and the Level-1 schemes in the Study Area is 20.2%. It is high in Tabora Municipality (36.8%) and in Urambo (33.0%). In contrast to those, it is low in Igunga (6.2%).

5.5 WATER QUALITY

5.5.1 METHODS OF THE STUDY

The water quality investigation in the Study Area was conducted in the following steps:

(1) Collection of Existing Data

The existing reports and data for water quality analysis were collected from the Internal Drainage Basin Water Office in Shinyanga Branch, the Lake Tanganyika Basin Water Office in Tabora Branch, Water Aid and so on by the Study Team. Most of the data had been recorded in reports by the international NGO and governmental organizations 30 to 40 years ago. In the existing reports, it is relatively new data, taken from laboratories by British Geological Survey and on the field and laboratories by JICA for "the Study on the Groundwater Resources Development and Management in the Internal Drainage Basin" (hereinafter referred to as the IDB Project).

(2) Measurement in the Field

The water quality measurement was executed for the water sources of the water supply schemes and the public water points in the existing survey (here after inventory survey). The following items were measured.

– Temperature (℃), Electric Conductivity (EC), pH and Fluoride (F)

(3) Water Quality Analyses in the Laboratory

Water Quality analyses were executed for the water sources of the existing water supply facilities, the public water points and the test wells of this study

1) Target of the Analyses: 90 Existing Water Supply Schemes

- Water sources and public water points of Level-2 schemes

- Water Sources of Level-1 schemes
- Test wells (10 wells)

2) Term of the Analyses: December 2009 for the existing water supply schemes

July to October 2010 for the test wells

3) Items of the Analyses: 30 items (described below)

The standard values of the water quality items were based on "WHO Guideline for Drinking Water Quality Third Edition in 2008" (here after "WHO Guideline") published by the WHO and "National Environmental Standards Compendium in 2008" by the Tanzania Bureau of Standards (here after "Tanzania Standard"). The standard values of water quality items in the above guidelines shows in Table 5.5.1.

(4) Change the Adaptation of Water Quality Standard for Fluoride

By the issue of fluoride distribution in Tabora Region, it has changed to adapt from WHO Guideline (1.5 mg/L) to Tanzania Standard (4.0 mg/L) by the requisition letter from MoW to JICA in December 2010. Therefore, for this report, the Study Team considers both Standards to integrate and analyze for a pile of data.

Table 5.5.1 Analysis Items and Standard Value for Water Quality Evaluation

Items of Water Quality Analysis			Unit	Tanzania Standard (2008)*1	WHO Guideline (2008)*2
Microbial aspects	1	Total Coliforms	count/100ml	0	-
	2	Escherichia Coli.	count/100ml	0	0
Chemicals that are of health significance	3	Cadmium: Cd	mg/L	0.05	0.003
	4	Lead: Pb	mg/L	0.1	0.01
	5	Arsenic: As	mg/L	0.05	0.01
	6	Fluoride: F	mg/L	4.0	1.5
	7	Nitrate: NO_3	mg/L	75	50
	8	Nitrite: NO_2	mg/L	-	3.0 / 0.2 *3
	9	Manganese: Mn	mg/L	0.5	0.4
Acceptability aspects	10	Total Hardness (as $CaCO_3$ mg/l)	mg/L	600	600
	11	Calcium: Ca	mg/L	100	-
	12	Magnesium: Mg	mg/L	100	-
	13	Iron: Fe	mg/L	1.0	-
	14	Zinc: Zn	mg/L	15	-
	15	Copper: Cu	mg/L	3.0	2.0
	16	Chloride: Cl^-	mg/L	800	-
	17	Total dissolved solids	-	2000	-
	18	Ammonium: NH_3+NH_4	mg/L	-	1.5
	19	pH	-	6.5 - 9.2	-
	20	Taste	-	Not Ojectionable	-
	21	Odour	-	Not Ojectionable	-
	22	Colour	TCU mg Pt/l	50	15
	23	Turbidity: Tr	NTU	25	5.0
	24	Temperature	℃	-	-
	25	Conductivity	mS/m	-	-
	26	Residual chlorine: Cl	mg/L	-	-
Water quality items related to the characteristics of groundwater	27	Sodium: Na	mg/L	-	-
	28	Potassium: K	mg/L	-	-
	29	Bicarbonate: HCO_3^-	mg/L	-	-
	30	Sulfate: SO_4^{2-}	mg/L	-	-

Note:
*1: "National Environmental Standards Compendium" Tanzania Bureau of Standards, 2008
*2: "WHO Guideline for Drinking Water Quality Third Edition", World Health Organization, Genova, 2008
*3: Short term / Long term
[shaded box] : Items adopted for water quality evaluation

5.5.2 RESULTS OF THE MEASUREMENT AND ANALYSES

Figure 5.5.1 shows the locations of the water sources where the water quality investigations were executed according to the kind of water source. Table 5.5.2 also shows the summary results of simplified water quality tests in the field by the inventory survey and the resultant lists of the water quality analyses in the laboratory. The data in the dry seasons from the existing reports are shown in Table 5.5.3.

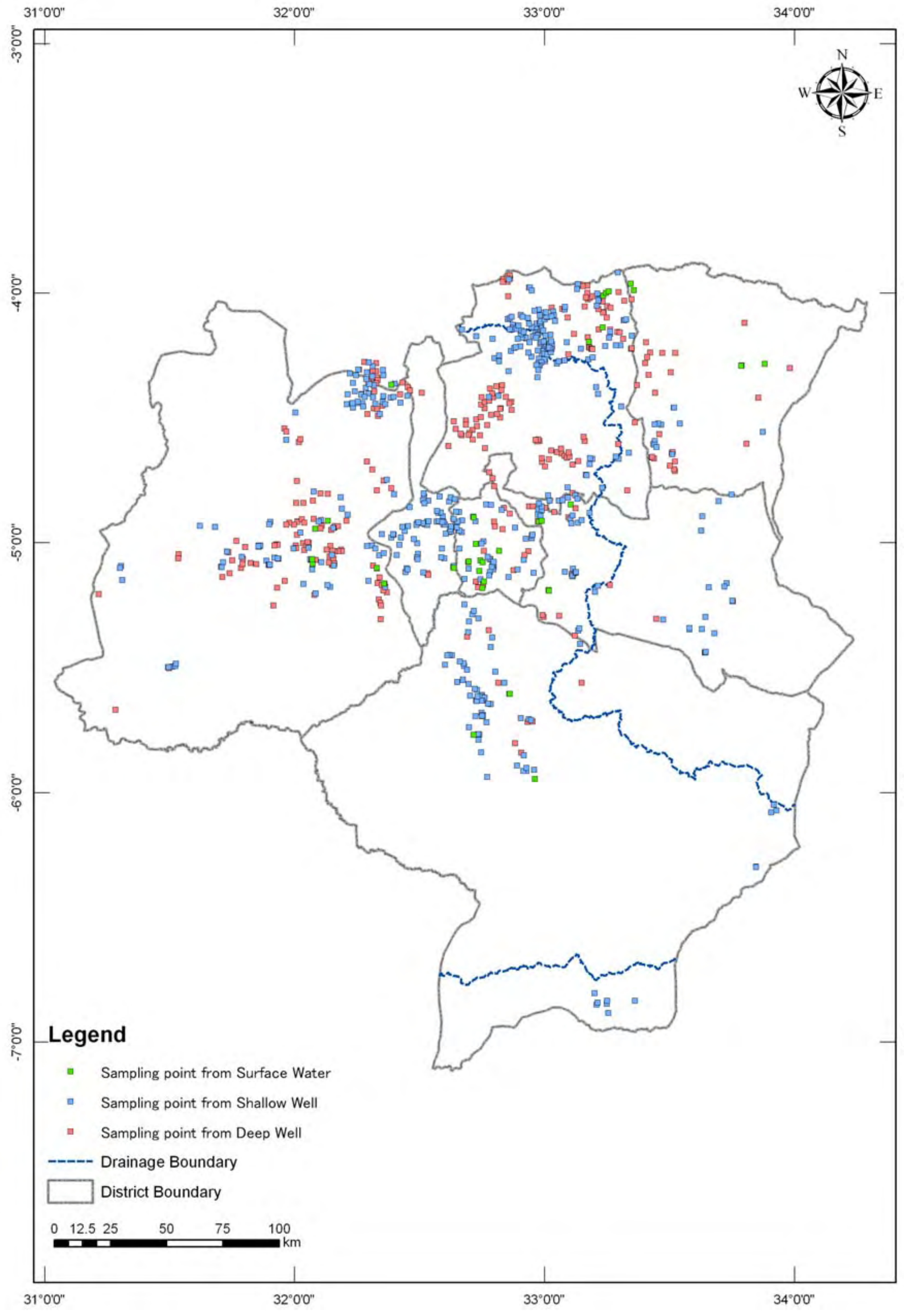


FIGURE 5.5.1 LOCATION OF THE SAMPLING POINTS BY WATER SOURCE

THE STUDY ON RURAL WATER SUPPLY IN TABORA REGION	JICA

Table 5.5.2 Summary of Water Quality Analyses Results

Water Quality Parameter		District/Municipality																	
		Igunga			Nzega			Sikonge			T. Rural			T. Urban			Urambo		
Source		Deep Well	Shallow Well	Surface	Deep Well	Shallow Well	Surface	Deep Well	Shallow Well	Surface	Deep Well	Shallow Well	Surface	Deep Well	Shallow Well	Surface	Deep Well	Shallow Well	Surface
Number of Sample		24	13	3	107	154	4	12	65	2	17	109	4	14	40	10	114	99	3
Temperature (°C)	Maximum	30.8	28.0	29.0	29.7	29.7	26.9	30.0	29.9	29.2	29.7	29.9	27.0	30.0	29.0	30.2	30.0	28.8	28.3
	Minimum	23.0	24.0	23.0	26.0	23.7	26.5	24.0	22.9	28.0	24.0	22.0	22.0	21.9	23.1	25.0	24.1	24.1	25.0
	Average	26.9	26.2	25.5	27.2	27.7	26.7	26.5	26.3	28.6	26.6	26.7	24.6	26.8	26.4	26.9	26.5	26.2	27.0
	Median	27.1	26.4	24.6	27.0	27.8	26.7	26.0	26.3	28.6	26.8	26.6	24.7	27.3	26.8	26.7	26.6	26.3	27.8
pH	Maximum	9.0	8.3	8.5	8.4	9.2	7.7	8.4	7.6	8.1	7.9	8.8	7.7	8.1	7.4	7.9	8.4	8.5	7.8
	Minimum	5.9	5.9	8.1	4.9	4.5	6.2	7.2	4.4	7.6	5.8	4.7	5.9	5.5	5.2	5.2	4.5	4.6	7.4
	Average	7.3	7.0	8.3	6.7	6.3	6.7	7.9	6.0	7.9	6.8	6.3	7.0	6.8	6.2	6.3	6.3	6.1	7.6
	Median	7.3	6.6	8.3	6.7	6.3	6.5	7.9	6.0	7.9	6.7	6.2	7.3	7.0	6.1	6.2	6.2	6.1	7.5
	Over TZ STD	6	6	0	51	109	2	0	47	0	8	73	1	6	32	7	89	87	0
Electric Conductivity (mS/m)	Maximum	239.0	114.6	28.8	399.9	299.1	97.9	93.7	67.7	17.9	123.5	500.0	33.3	147.2	215.0	42.3	132.0	104.0	10.4
	Minimum	8.2	5.1	16.8	4.0	4.2	12.0	7.6	4.6	9.9	6.6	2.0	8.2	5.3	2.6	1.5	4.5	3.3	6.6
	Average	96.7	39.0	21.6	60.8	29.3	41.2	52.0	18.0	13.9	58.7	58.4	17.8	34.8	33.1	16.4	34.3	26.7	9.1
	Median	97.2	18.0	19.2	25.0	11.0	27.4	50.7	11.7	13.9	41.2	43.8	14.8	12.6	15.8	9.7	24.4	18.2	10.3
Fluoride (mg/L)	Maximum	10.30	4.30	4.30	6.21	3.91	0.80	2.53	0.98	0.80	2.24	7.94	1.11	3.95	1.20	0.80	1.11	1.20	0.65
	Minimum	0.24	0.30	2.50	ND	ND	0.40	0.40	ND	0.11	ND	ND	0.26	0.00	ND	ND	ND	ND	0.40
	Average	3.00	1.48	3.43	0.72	0.42	0.52	0.87	0.15	0.46	0.81	0.68	0.74	0.76	0.44	0.42	0.24	0.18	0.50
	Median	2.40	1.10	3.50	0.40	0.40	0.45	0.60	0.08	0.46	0.69	0.42	0.80	0.40	0.40	0.40	0.18	0.14	0.44
	Over WHO GL	16	4	3	14	7	0	1	0	0	3	5	0	2	0	0	0	0	0
	Over TZ STD	7	2	1	2	0	0	0	0	0	0	2	0	0	0	0	0	0	0

<Note> T. Rural: Tabora Rural, T. Municipality: Tabora Municipality

WHO G.L: The number of samples, which exceed the WHO Guideline.

TZ STD: The number of samples, which exceed the Tanzania Standard.

ND: Not detected.

Table 5.5.3 Summary of the Existing Reports

Water Quality Parameter		District/Municipality																	
		Igunga			Nzega			Sikonge			T. Rural			T. Urban			Urambo		
Source		Deep Well	Shallow Well	Surface	Deep Well	Shallow Well	Surface	Deep Well	Shallow Well	Surface	Deep Well	Shallow Well	Surface	Deep Well	Shallow Well	Surface	Deep Well	Shallow Well	Surface
Number of Sample		5	22	12	11	32	18	1	12	7	4	14	5	4	6	1	5	30	2
Temperature (°C)	Maximum	28.6	N/A	29.3	30.1	27.6	30.1	N/A	N/A	26.0	26.0	25.8	27.0	N/A	N/A	N/A	N/A	N/A	N/A
	Minimum	24.3	N/A	22.2	26.5	23.9	20.8	N/A	N/A	26.0	23.1	24.2	27.0	N/A	N/A	N/A	N/A	N/A	N/A
	Average	26.5	N/A	25.5	28.5	25.8	24.4	N/A	N/A	26.0	24.6	25.0	27.0	N/A	N/A	N/A	N/A	N/A	N/A
	Median	26.1	N/A	25.2	28.8	25.8	23.2	N/A	N/A	26.0	24.6	25.1	27.0	N/A	N/A	N/A	N/A	N/A	N/A
pH	Maximum	9.2	9.8	9.4	8.6	8.5	9.5	7.4	7.6	7.5	7.2	7.1	8.2	8.7	6.9	6.2	8.0	8.1	7.9
	Minimum	7.3	4.9	6.0	4.3	4.7	5.8	7.4	6.4	5.8	5.5	4.4	5.9	8.1	6.1	6.2	6.6	4.9	7.6
	Average	7.9	7.7	7.8	7.4	6.6	7.5	7.4	7.0	6.9	6.7	6.2	7.3	8.4	6.5	6.2	7.4	6.6	7.7
	Median	7.7	7.9	7.9	7.5	6.5	7.4	7.4	7.1	7.1	7.0	6.6	7.3	8.3	6.6	6.2	7.5	6.5	7.7
	Over TZ STD	1	4	2	1	16	2	0	2	1	1	6	1	0	2	1	0	15	0
Electric Conductivity (mS/m)	Maximum	179.6	158.3	191.0	189.0	240.0	100.0	310.0	135.0	35.0	202.0	65.4	19.0	142.5	45.0	10.0	148.0	90.0	25.0
	Minimum	20.4	10.0	12.0	6.8	5.0	9.1	310.0	9.8	7.4	8.5	3.4	8.5	61.0	9.5	10.0	24.0	4.8	10.0
	Average	103.6	36.0	117.2	95.4	31.1	29.6	310.0	43.5	15.0	140.8	25.4	13.3	116.9	23.8	10.0	76.8	27.4	17.5
	Median	96.5	27.5	125.0	107.9	14.6	20.0	310.0	29.5	10.5	176.3	20.4	11.8	132.0	22.0	10.0	78.0	18.5	17.5
Fluoride (mg/L)	Maximum	3.00	3.00	21.32	3.00	3.75	1.95	1.65	1.40	0.69	3.00	4.50	0.68	1.70	0.90	0.85	1.45	0.90	0.69
	Minimum	0.80	0.32	0.30	0.40	ND	ND	1.65	0.20	0.10	0.80	ND	ND	1.30	0.10	0.85	0.50	0.15	0.60
	Average	1.68	0.88	3.43	1.18	0.60	0.72	1.65	0.62	0.45	1.50	0.80	0.37	1.53	0.59	0.85	0.90	0.45	0.65
	Median	0.80	0.80	0.80	0.88	0.40	0.68	1.65	0.55	0.50	1.09	0.48	0.30	1.55	0.63	0.85	0.80	0.48	0.65
	Over WHO GL	2	5	4	2	3	1	1	0	0	1	1	0	2	0	0	0	0	0
	Over TZ STD	0	3	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0

<Note> T. Rural: Tabora Rural, T. Urban: Tabora Municipality

WHO G.L: The number of samples, which exceed the WHO Guideline.

TZ STD: The number of samples, which exceed the Tanzania Standard.

ND: Not detected.

N/A: Not Available

(1) Temperature

By the existing reports and the result of the inventory survey, the range of the highest groundwater temperature is in a range from 25.8 to 30.8 °C. The lowest temperature distributed between 20.8 and 28.0 °C. The average and the median temperatures are from 24.3 to 28.6 °C and from 23.2 to 28.6 °C.

(2) pH

The maximum values in each district are in a range from 6.2 to 9.8, and the minimum values are between 4.3 and 8.1. For both data of the existing reports and the inventory survey, it does not satisfied the lower limit of the Tanzania Standard (pH>6.5). The median values in each district distributed in a range between 6.2 and 7.9 in the existing reports, and between 6.1 and 8.3 in the inventory survey. By comparison, they are very similar in range.

Overall data, the total of 524 samples do not satisfy the Tanzania Standard (6.5 - 9.2) in 794 total samples in the Study Area. Especially, the largest percentage above the Tanzania Standard was in Tabora: it was 176 samples (81.5%) in 216 samples in Urambo by the inventory survey and 15 samples (40.5%) in 37 samples in Urambo in the existing report.

(3) Electric Conductivity (EC)

The maximum value of electric conductivity (EC) is in a range between 10.4 and 500.0 mS/m by the inventory survey and between 10.0 and 300.0 mS/m by the existing reports. The largest parameter of the electric conductivity detected from shallow well at Ilalwasimba village in Tabora Rural District by the data of the inventory survey and at Kipanga village in Sikonge District by the data of the existing reports. The distribution of the EC map in the Tabora Region refers to in Chapter 4.

(4) Fluoride (F)

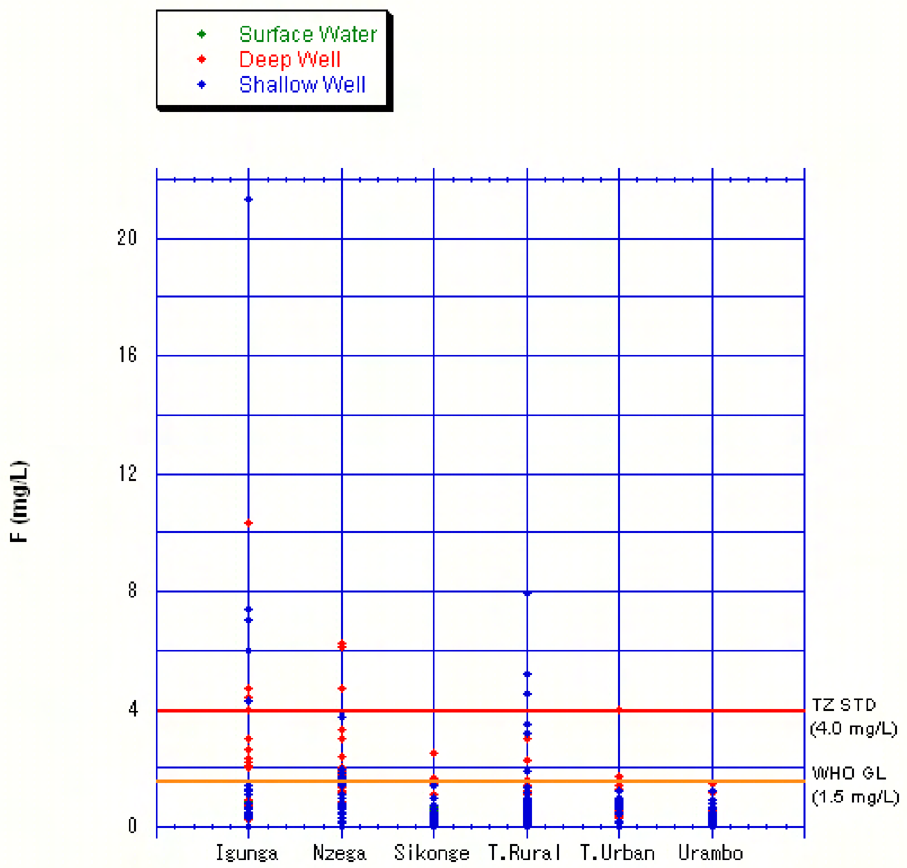
The entire Igunga District, the northeastern part of Nzega District and the east part of Tabora Rural District are included in the Internal Drainage Basin. According to the existing reports such as the report by the IDB Project, groundwater pollution by fluoride is widely spread, especially locates inside the Internal Drainage Basin.

The Study Team accomplished the measurement of the concentration of fluoride to grasp the distributed condition in the Tabora Region. The result of the measurement was 23 in 40 samples in Igunga District and 21 in 265 samples in Nzega District over the WHO Guideline. For the other districts, it exceeds few samples over the WHO Guideline except Urambo District. In addition, ten (10) samples in Igunga District, two (2) samples from deep well in Nzega District and two (2) samples from shallow well in Tabora Rural District exceeded the Tanzania Standard. It considered that outside of the Internal Drainage Basin was relatively safe against fluoride pollution. However, after conducted the water quality analyses for ten (10) samples from the drilling wells by the study team, three (3) wells at Mabama Village in the southern east part of Tabora Rural District, and one (1) well at Usunga Village in Sikonge District are detected the exceeded parameters over the WHO Guideline.

Comparison with all six (6) districts, Igunga District had the highest rate in the Tabora region, and second highest was Nzega District. As well as the parameters from the existing reports, Igunga District indicated the highest rate of fluoride in the other five districts consisting of 11 in 39 samples. Figure 5.5.2 shows the parameters exceeding the WHO Guideline and the Tanzania Standard by water sources that based on the total water quality samples and the data from the existing reports. The data of shallow wells and deep wells in Igunga, Nzega and Urambo District are collected proportionally more than the data in the rest of the districts in Tabora region, it reveals the tendency of detecting fluoride by districts and water sources that most of the deep wells in Igunga and Nzega Districts are over the WHO Guideline.

From the results of the total water quality samples and existing reports, it shows the estimated distribution maps for fluoride by water resources in Figure 5.5.3 (surface water), Figure 5.5.4 (shallow well) and Figure 5.5.5 (deep well). In following three figures, white colored area indicates an undefined area of a concentration for fluoride and has a possibility of detecting a high parameter of fluoride because of no sampling data by covering up a prohibition of the development zone such as, forest reserve and game reserve. Based on the results of the analyzed three figures, although a high concentration of fluoride is such accumulated inside of the Internal Drainage Basin in case of surface water, target water is deeper and deeper from shallow well to deep well, the area of a high concentration of fluoride spreads widely over the Internal Drainage Basin through Lake Tanganyika Basin.

Through the results of the fluoride analysis in Tabora Region, the distribution of the fluoride is apparently unpredictable and discontinuous distribution as spot. Because the exceeding rate of WHO Guideline are detected at the Mabama village in Tabora Rural District, located far away from the Internal Drainage Basin, in contrast, it does not detect a high rate of fluoride in spite of locating the inside of the Internal drainage Basin and detecting way high rate in neighboring villages. Therefore, it is difficult to judge a high rate or low rate from “the perspective of inside or outside of the Internal Drainage Basin”. So that the future analysis to understand the more detail distribution of fluoride and selection for the location of drilling well to get safe water under the WHO Guideline and Tanzania Standard are very important to solve the relation among lithology distribution, geologic structure and mechanisms of groundwater flowing.



Note

T. Rural: Tabora Rural, T. Urban: Tabora Municipality

TZ STD: Tanzania Standard, WHO GL: WHO Guideline

Figure 5.5.2 Detecting Fluoride by Water Sources

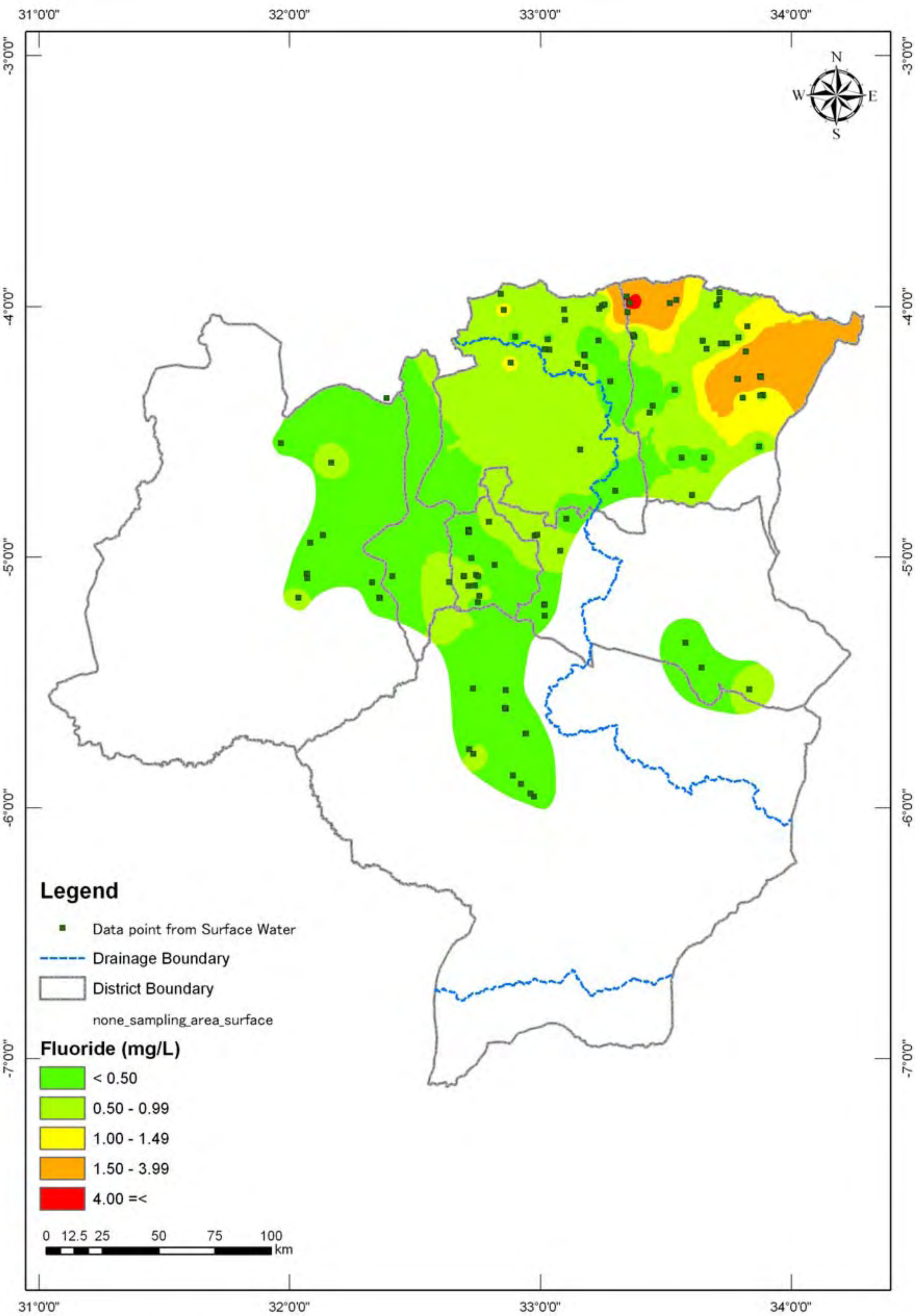


FIGURE 5.5.3 ESTIMATED DISTRIBUTION OF FLUORIDE (F) CONTENTS BY SURFACE WATER

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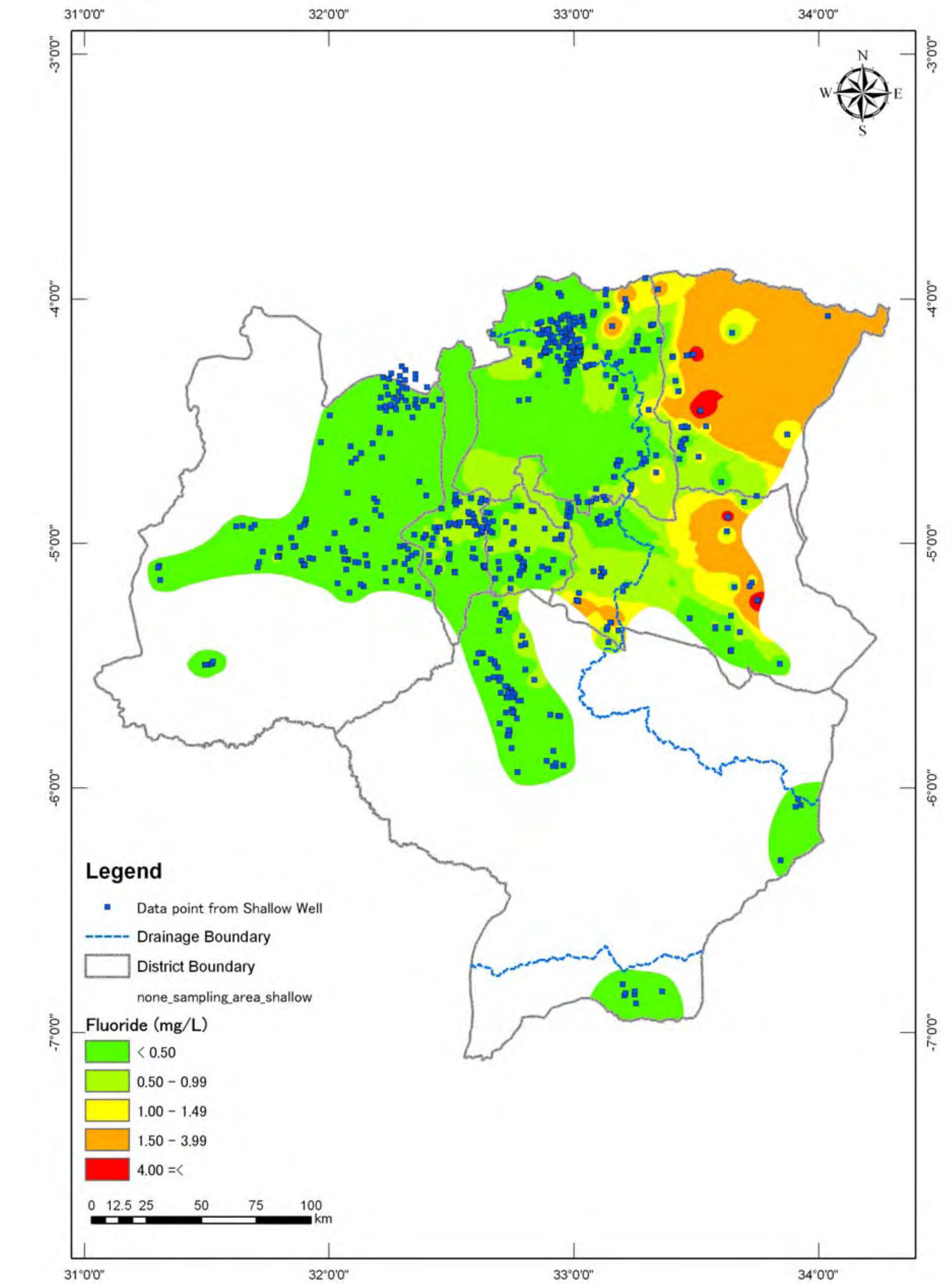

FIGURE 5.5.4 ESTIMATED DISTRIBUTION OF FLUORIDE (F) CONTENTS BY SHALLOW WELL

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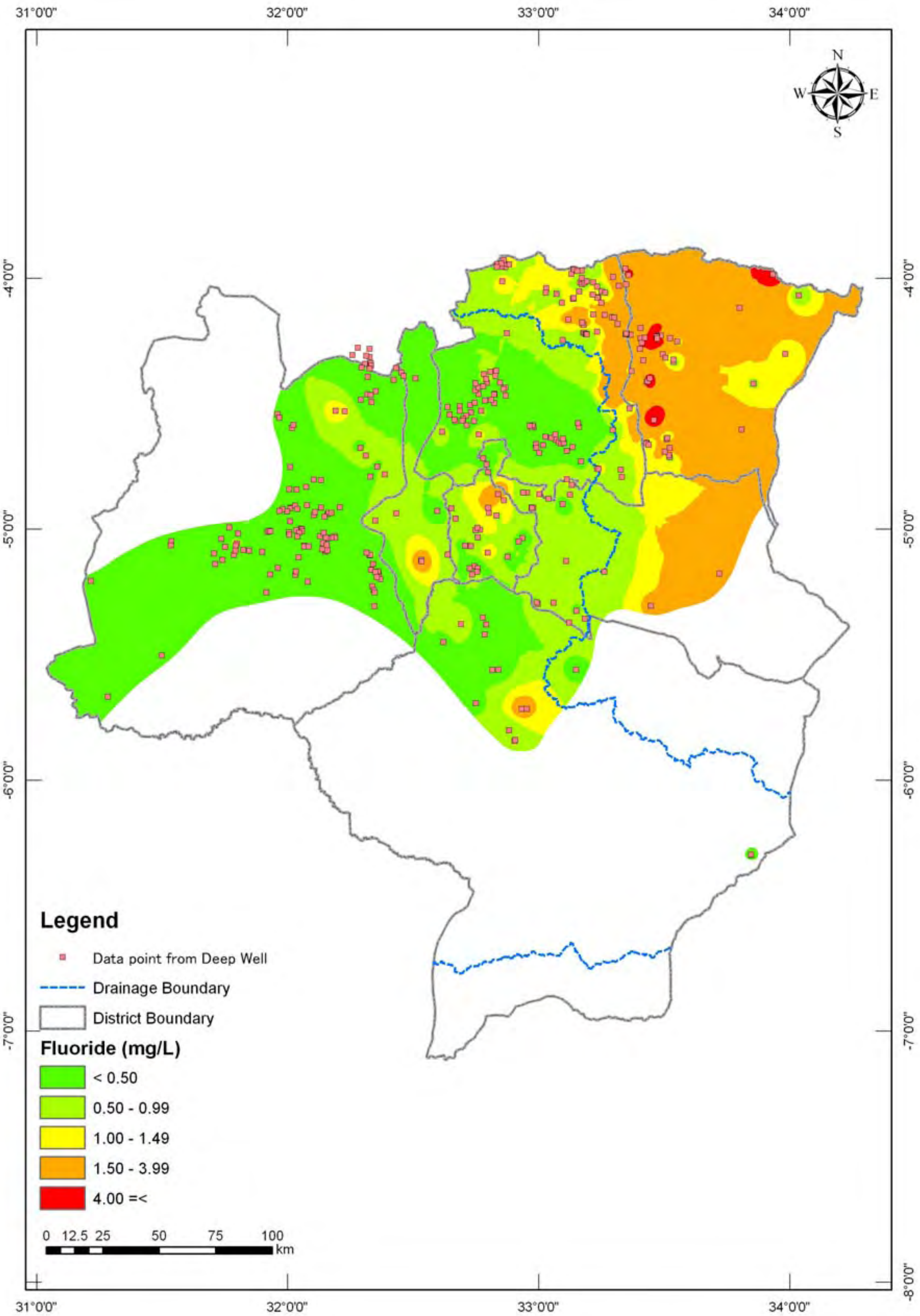

FIGURE 5.5.5 ESTIMATED DISTRIBUTION OF FLUORIDE (F) CONTENTS BY DEEP WELL

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(5) Results of Water Quality Analyses in the Laboratory

From the resultant data of the water quality analyses in the laboratory, it follows that the parameters in each water quality item exceeded the WHO Guideline or Tanzania Standard except the item of fluoride. The items over the guidelines were Total Coliforms, Escherichia Coliforms (hereby in after E.Coli.), Nitrate (NO_3), Turbidity, Total Dissolved Solids (hereinafter TDS), Calcium (Ca), Iron (Fe) and Manganese (Mn).

For the Total Coliforms, approximately half of total samples (51%) were over the Tanzania Standard, and for the E.Coli., it exceeded the 26% of total 90 sampling locations by the WHO Guideline. Generally, E.Coli. was detected from a polluted water source by the excrement of man and animals; however, according to the water quality analyses, not only finding E.Coli. from the source of surface water and shallow wells, but 14 samples of deep well sources were detected as well, which is considered to be caused by the flow of polluted water from surface to the deep well as one of possibilities.

Nitrate found in only one (1) location in Igunga District, which was almost twice as much as the WHO Guideline (50 mg/L).

Turbidity found in 34 samples in total over the WHO Guideline (25 NTU). Most samples of high rate of turbidity were mainly of a milky or brownish color like Figure 5.5.6.

Figure 5.5.6 Milky Colored Water from a Deep Well

In addition, three (3) samples of TDS and one (1) sample of calcium in a total 100 samples exceeded the Tanzania Standard.

Iron spreads widely in the Tabora Region and 27 samples of more than 1.0 mg/L in the Tanzania Standard were detected. In a comparison of each district, Tabora Municipality (50%) and Tabora Rural District (40%) show a noticeably higher rate than the other districts. Water quality items over the guidelines are indicated in Table 5.5.4, and the distribution of iron by each water source is shown in Figure 5.5.7. Projecting from Figure 5.5.7, there is no clear tendency to find each water source and particular area, it appears that both results by water quality analyses in the laboratory and the existing reports indicate quite same locations to detect the high rate of iron in the Tabora Region. One of the possibilities of detecting iron in water samples is from a geological origin. It has already mentioned about Ferricrete (color like reddish and brownish soils) in the geology section on the Chapter Four (4) that distributed widely in the Tabora Region.

For the Manganese (Mn), after carrying out the water quality analyses in the laboratory for sample from a drilled well at Mpombwe village in Sikonge District, it was over approximately four times as much as the WHO Guideline (0.4 mg/L). The other villages do not detect more than the WHO Guideline.

Table 5.5.4 Summary of Water Quality Items Exceeding the Guidelines

District /Municipality	No. of Sample	Total Cliform	Escherichia Coli.	Nitrate	Turbidity	TDS	Ca	Fe	Mn
Igunga District	16	5	1	1	4	1	0	4	0
Nzega District	14	9	1	0	1	0	0	1	0
Sikone District	18	8	6	0	5	0	0	2	1
Tabora Rural District	20	9	3	0	10	2	3	10	0
Tabora Municipality	15	8	6	0	7	0	0	6	0
Urambo District	17	7	6	0	7	0	0	4	0
Total	100	46	23	1	34	3	3	27	1

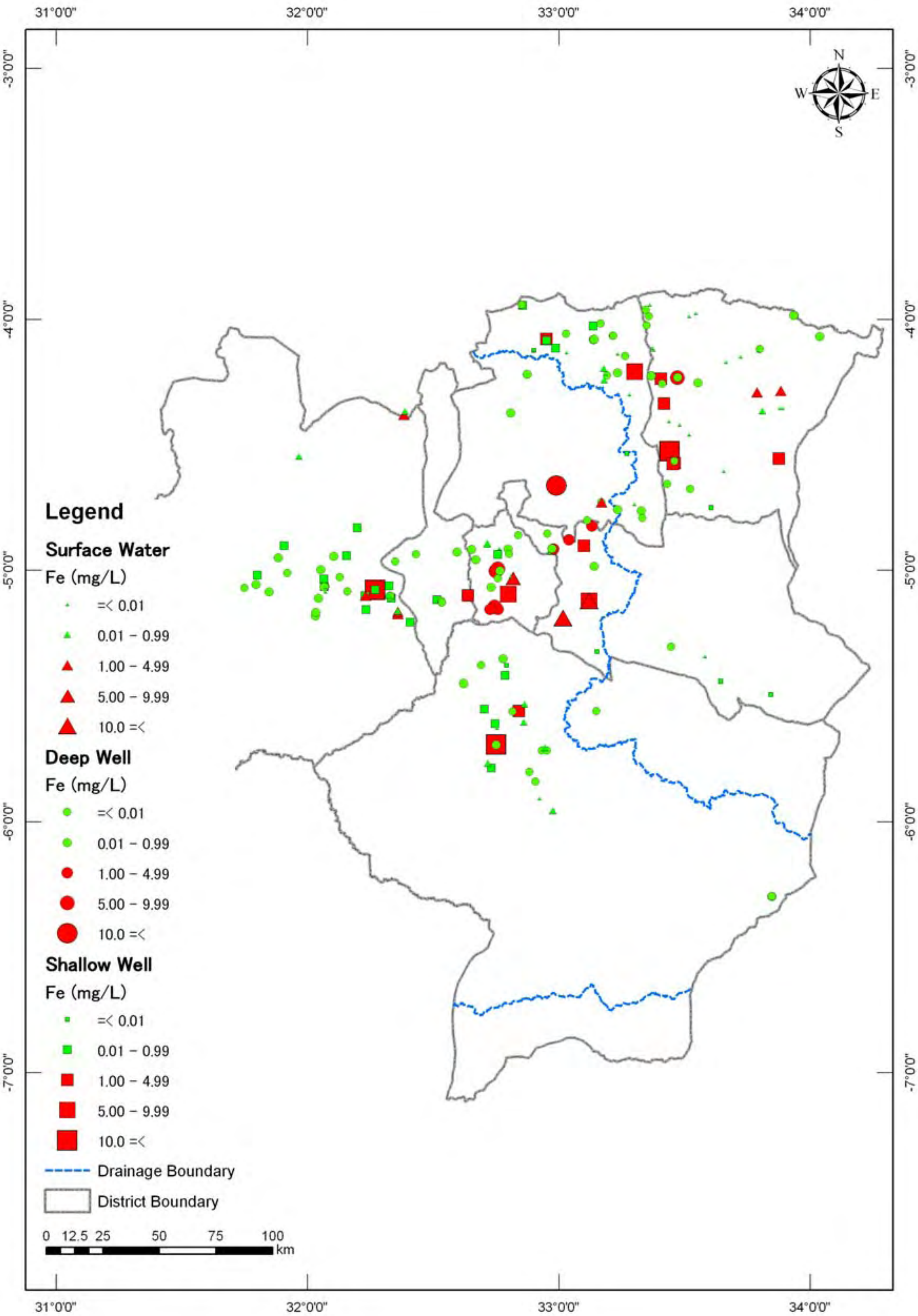

FIGURE 5.5.7 DISTRIBUTION OF IRON (Fe) CONTENTS

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(6) Conclusion

In Tabora Region, water quality data have not been storage enough for a long time, also it is already mentioned in “Collection of Existing Report”, most existing reports are quite old and not included water quality data with the coordination data, thus, after examined carefully by the Study Team, almost half of data could not be used to analyze. For solving a pending fluoride issue as one big step, in the future, water quality data should be attached with all reports in order to accumulate for future analysis by the government and international organizations. In such case, it is necessary to reinforce for the system to be understood the distribution of water quality for each DWE.

5.6 EXISTING PLANS RELATED TO RURAL WATER SUPPLY IN TABORA REGION

5.6.1 WATER SECTOR DEVELOPMENT PROGRAMME (WSDP)

The Water Supply Development Programme (WSDP) is a National development plan to attain the goals of NSGRP and MDG. A basket fund was established in 2006 based on the concept of Sector Wide Approach to Planning (SWAp). WSDP aims to improve rural water supply coverage up to 79% in 2015 and 90% in 2025. The total implementation cost is assumed to be 2,054.12 x 10^9 Tsh. The 26% of the total cost will be borne by the Government of Tanzania and the remaining 76% is expected assistance by the Donors.

Construction of water supply schemes by the WSDP is basically carried out in 10 villages selected in each District after the study by the consultant. The duration of the implementation period from selection of target villages to completion of construction of schemes is about three (3) to four (4) years.

The target villages have already been selected in each District of the Tabora Region. The consultant will start the study soon. More than 10 villages were selected in some Districts. The total of 74 villages were selected in the Region. The target area is not necessarily all the sub-villages of a village, some of the sub-village(s) have been excluded from the target area of WSDP. The target villages for the WSDP are shown in Table 5.6.1.

Table 5.6.1 List of Target Villages for WSDP

District/Municipality	Ward	Village	Sub-Village
Igunga District	Choma	Bulangamilwa	All
	Igunga	Mgongoro	All
	Kinungu	Mwandihimiji	All
	Mbutu	Mwabakima	All
	Mwamashimba	Mwamashimba	All
	Mwashiku	Matinje	All
	Mwisi	Isenegeja	All
	Nguvumoja	Mwalala	All
	Sungwizi	Mwamala	All
	Ziba	Bulumbela	All
Nzega District	Ikindwa	Ikindwa	All
	Itobo	Itobo	All
	Mwamala	Buhondo	All
		Mahene	All
		Nawa	All
	Nata	Kilabili	All
		Mwabangu	All
		Nata	All
	Ndala	Kampala	All

District/Municipality	Ward	Village	Sub-Village
Nzega District	Ndala	Uhemeli	All
	Nkiniziwa	Nkiniziwa	All
	Puge	Isuhna	All
		Upungu	All
	Sigili	Sigili	All
Sikonge District	Kiloli	Majojolo	All
		Mwitikio	All
	Kipili	Kilumbi	All
		Zugimlole	All
		Kiyombo	All
		Matagata	All
	Kitunda	Mgambo	All
		Mwenge	All
	Kiloleli	Kiloleli	All
		Mtakuja	All
	Kipanga	Imalampaka	All
		Lembeli	All
		Ukondomoyo	All
Tabora Rural District	Ibili	Kilungu	All
		Mwakashindye	All
		Isimu	All
	Kizengi	Kizengi	All
		Malongwe	All
	Loya	Lutona	All
		Miswaki	All
	Lutende	Mwakadala	All
	Usagali	Imalauduki	All
		Msimba	All
Tabora Municipality	Itetemia	Lusangi	All
	Itonjanda	Ifucha	All
		Itonjanda	All
	Kakola	Igombe	All
	Kalunde	Kalunde	All
	Misha	Kabila	All
	Ndevelwa	Inala	All
		Itulu	All
		Ndevelwa	All
	Tumbi	Tumbi	All
	Uyui	Imalamihayo	All

5.6.2 District Water and Sanitation Plan (DWSP)

Formulation of the District Water Supply Plan was requested from each District in order to promote the WSDP, however, only Igunga District formulated the plan in 2007.

The DWSP of Igunga District is for the physical years from 2007/2008 to 2009/2010. According to Action Plan, it is planned to construct 59 deep wells or shallow wells, 11 piped water supply schemes (Level-2), eight (8) charco dams and nine (9) rain harvesting tanks and 19 cattle troughs during the three (3) years. In addition, 19 Water and Sanitation (WATSAN) committees will be organized. Rehabilitation of existing water supply schemes is also planned for 11 piped water supply schemes and 15 charco dams.

The total implementation cost is estimated as 6.78 x 109 Tsh. However, 92% of the cost is planned to depend on assistance by the World Bank, African Development Bank and JICA.

5.6.3 Expansion Plan of Urban Water Supply

Tabora Municipality Water Supply Authority (TUWASA) and other Urban Water Authorities (UWSAs) are responsible for the water supply to the urban area. Although they are supplying water by piped water supply schemes, some areas in the urban area are not covered due to insufficient water sources and lack of funds.

Each UWSA has an extension plan of the water supply scheme. However, it seems to take a long period for UWSAs to implement it, except for TUWASA.

5.6.4 Tanzania Social Action Fund (TASAF)

The Tanzania Social Action Fund (TASAF) is a government funded organization. TASAF is assisting the water supply in the villages by constructing mainly handpump water supply schemes. Such schemes can be confirmed in every district. However, detailed information has not been obtained because data and information have not been transferred to each District/Municipal Water Engineer's Office in most cases. Efforts to collect such data and information will be continued during the phase-1 survey.

5.6.5 Assistance by NGO and Others

NGOs such as Water Aid and Africare are supporting the water supply in the Tabora Region. Water Aid is the most active NGO assisting water supply sector both construction of water supply schemes and organizing Water User Groups (WUGs) or Water User Associations (WUAs). The type of water supply schemes is mainly handpumps however piped water supply schemes are constructed in some places where enough quantity of the water source is available. Other NGOs are constructing only handpump water supply schemes and shallow wells.

Although Water Aid had been assisting Nzega and Urambo Districts, their assistance was recently concentrated mainly in the Nzega District.

As for other organizations, the Anglican Church, a mining company, etc. are assisting but are not so active.

5.6.6 Millennium Villages Project

The Millennium Villages Project has been implementing under the assistance by UNDP in Tabora Rural. Mbola village is the cluster village of the project. Other villages are;

- Ilolangulu Ward: Mpenge, Isila, Isenga, Ngokolo, Ilolangulu and Ulimakafu villages
- Mabama Ward: Ideka and Mbiti villages
- Ibiri Ward: Ibiri and Ininela villages
- Usagari Ward: Msimba and Migungumalo villages

Specific objectives are (1) to reduce the incidence of water and environmental health/sanitation related diseases for poor communities in the project areas through effective implementation of the planned activities from 80% to 30% by the year 2011 and (2) to reduce the walking distance to fetch water from 1-3 km to within 400m in the project areas by the year 2011 (UNDP, 2008).

In order to achieve the above, 19 boreholes and 5 shallow wells will be constructed. As of February 2010, three (3) boreholes and two (2) shallow wells were already constructed.

RERFERENCES

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CHAPTER 6 RURAL WATER SUPPLY PLAN AND SELECTION OF PRIORITY PROJECT

6.1 GENERAL

The Water Supply Plan was prepared for 547 target villages based on the results of the analyses results of existing data and field survey from September 2009 to February 2010. The Villages were evaluated considering the population in 2020 (target year) and availability of water sources in or around the village. Alternatives of the water supply plan are (1) Piped water supply scheme (Level-2), (2) Hand pump (Level-1) and (3) Rehabilitation of existing water supply schemes.

6.2 CRITERIA FOR RURAL WATER SUPPLY PLAN

6.2.1 TARGET VILLAGES

The Study covers all the villages in the rural area of Tabora Region. The number of villages to be covered is 547 as described in Chapter 1. The target population is about 1,884 x 10^3 persons. A rural water supply plan is formulated for the villages in the rural area excluding the following villages. The target villages were confirmed in the 2nd Steering Committee held on 22 December 2009.

- Target villages for the WSDP
- Target villages for other projects such as TASAF
- Target villages for projects by NGOs
- Target villages for the Millennium Villages Project
- Target villages for expansion of the Urban Water Supply Schemes
- Villages located in the Forest Reserves and Game Reserves (In case some sub-villages are outside of the Forest Reserves and Game Reserves, such sub-villages will be included in the target of the Study).

All the sub-villages in those villages are not necessarily included in the projects above. If some sub-villages are excluded from the other projects, such sub-villages are included in the target of formulation of the rural water supply plan.

Finally, the number of the target villages became 423 excluding 124 villages as shown in Table 6.2.1.

Table 6.2.1 Number of Target Villages and Population for Rural Water Supply Plan

District/ Municipality	Target of Study			Excluded Vilalge			Target of Rural Water Supply Plan		
	Village	Population (2009)	Population (2020)	Village	Population (2009)	Population (2020)	Village	Population (2009)	Population (2020)
Igunga Dist.	97	363,188	524,687	15	71,122	102,746	82	292,066	421,941
Nzega Dist.	152	469,112	615,589	23	90,494	118,749	129	378,618	496,840
Sikonge Dist.	53	164,219	239,779	25	82,833	120,947	28	81,386	118,832
Tabora Rural Dist.	109	393,552	574,633	20	79,992	116,798	89	313,560	457,835
Tabora Mun.	24	58,842	101,710	11	32,933	56,923	13	25,909	44,787
Urambo Dist.	112	435,277	744,528	30	130,508	223,227	82	304,769	521,301
Total	547	1,884,190	2,800,926	124	487,882	739,390	423	1,396,308	2,061,536

6.2.2 PROJECT TARGET YEAR

The target year for the rural water supply plan was determined as the year 2020 as agreed in the Scope of Work of the Project.

6.2.3 POPULATION TO BE SERVED

Population to be covered by the Study is confirmed as about 1,396 x 10^3 in 2009 and is projected at 2,062 x 10^3 in 2020 as shown in Table 6.2.1.

6.2.4 WATER DEMAND

In the formulation of the rural water supply plan, the unit water demand 25 liter/capita/day is applied following the Design Manual (MoWI, 2009).

Total water demand in 2020 is estimated at 51 x 10^3 m^3/day.

6.2.5 WATER SOURCE

Groundwater sources are mainly considered as the water source of the water supply scheme to be planned in the Study. Potential of groundwater source is evaluated in Chapter 5 whether or not it is suitable as water source for the water supply schemes to be planned in the Study.

In the evaluation of groundwater, two (2) criteria were used, yield and water quality (mainly Fluoride contents). As for the yield, groundwater potential is classified into three (3) categories, less than 10 liter/min, between 10 and 100 liter/min and more than 100 liter/min. The yield of more than 100 liter/min meets the water demand for 2,500 populations under 10 hours operation per day in average (maximum 14 hours operation). It is suitable for the piped water supply (Level-2). The yield of less than 10 liter/min is not suitable for hand pump water supply (Level-1).

Water quality was evaluated using mainly Fluoride contents because wide areas of Igunga Region are known as the deteriorated area by high Fluoride contents. As described in Chapter 5, deteriorated area by Fluoride is wide spread in Igunga District, and a part of Nzega and Tabora Rural Districts. Groundwater development is difficult in such areas. Therefore, shallow wells or rain water harvesting is proposed as the alternative water sources in the deteriorated areas by Fluoride.

6.2.6 CONSIDERATION ON OPERATION AND MAINTENANCE

Consideration on operation and maintenance, from viewpoints of technical issue and cost, is important in the formulation of the rural water supply plan. High yield of one (1) borehole (deep well) is likely capable to supply to about 3,000 persons in maximum under 12 hours operation. If population exceeds 3,000, another borehole will be required. However, operation of two (2) boreholes for a water supply scheme seems to be not feasible from the viewpoint of cost to be borne by community people. Therefore, number of borehole is planned basically one (1) for a piped water supply scheme. Exception was given to two (2) schemes in Urambo District where population is large and high groundwater potential is expected. Detailed survey and evaluation were carried out to assess the possibility of the piped water supply scheme in the second field survey.

It is required a treatment system to use surface water as the source of water supply. However, it is almost impossible for community people to maintain and to bear the cost for operation. Therefore, surface water is not considered as the source of water supply schemes.

6.3 WATER RESOURCES DEVELOPMENT PLAN

Type of water supply scheme highly depends on the availability of water sources in the Study area.

Available water source is mainly groundwater. If development potential of the water sources is adequate, the scheme will cover the total population of the village as required. However, provided that potential of the water source is not adequate, the service population is decided according the available amount of water source potential. At the same time, development of groundwater sources shall avoid negative impact on the environment of the target village and its surrounding area, *i.e.* lowering of groundwater level and land subsidence to overexploitation of groundwater. Therefore, actual exploitable yield and number of wells were technically analyzed. The groundwater is exploited using deep tube wells. Standard design is shown in Section 6.5 of this Chapter.

The results are reflected in the "Rural Water Supply Plan". Design and layout of those facilities are presented in detail in Section 6.5 of this Chapter.

6.4 RURAL WATER SUPPLY PLAN

The "Rural Water Supply Plan" was formulated considering the population of target villages, availability of water sources and technical issues as mentioned in Section 6.2 of this Chapter.

6.4.1 ALTERNATIVE OF TYPIFIED WATER SUPPLY SCHEME

Following four types of water supply schemes were selected as the alternatives of Water Supply Plan.

(1) Piped Water Supply Scheme (Level-2)
(2) Hand Pump (Level-1: Deep Tube Well)
(3) Rehabilitation of existing scheme (Level-1)
(4) Rehabilitation of existing water supply scheme (4 piped schemes in Igunga)

6.4.2 CONCEPT FOR THE FORMULATION OF THE RURAL WATER SUPPLY PLAN

The rural water supply plan should be the one to contribute the implementation of the WSDP. Therefore, the contents of the plan should be harmonious to the concept of the WSDP.

In formulation of the rural water supply plan following concept was applied.

(1) The water source is principally groundwater to be developed by deep well (borehole).
(2) Type of water supply schemes are basically piped water supply scheme (Level-2) and deep well with Handpump (Level-1).
(3) Type of a water supply scheme is decided considering groundwater potential obtained from the results of analyses on existing data and satellite image analysis.
(4) Service population for a Level-1 is 250 persons in principal. The number of Level-1 is decided the groundwater potential and the influence radius of boreholes to avoid interference.
(5) In case of Level-2 water supply scheme, no new scheme is planned as far as its source is surface water. Notwithstanding this concept, there is an exception in four (4) villages in Igunga where transmission lines from the Bulenya Dam were rehabilitated and no alternative water sources are expected. Only rehabilitation of distribution pipelines are planned in the villages.
(6) Deterioration by Fluoride was not confirmed in some villages in Igunga. Level-1 schemes are planned in such villages. However, it seems to be difficult to construct adequate number f Level-1 schemes in such villages. Therefore, a Level-1 scheme is planned in one (1) sub-village. Protected wells and rainwater harvesting are planned as the alternative water sources to compensate the lack of water supply.
(7) Water supply schemes of which water source are surface water, are not planned because they require the treatment systems in the schemes and it will requires high technique and

high cost for operation and maintenance as mentioned in 6.2.6.

6.4.3 RURAL WATER SUPPLY PLAN IN TABORA REGION

Considering the concept described above, the "Water Supply Plan" is formulated as shown in Table 6.1 to Table 6.6 in the Appendix. Summary of the Rural Water supply Plan is given in Table 6.4.1.

Table 6.4.1 Summary of the Rural Water Supply Plan

District /Municipality	New Facility		Rehabilitation Well		Total
	Level-2	Level-1	Level-2	Level-1	
Igunga Dist.	0	117	4	17	138
Nzega Dist.	4	1,143	0	158	1,305
Sikonge Dist.	3	251	0	15	269
Tabora Rural Dist.	6	1,135	0	48	1,189
Tabora Municipality	1	125	0	15	141
Uranbo Dist.	4	1,368	0	79	1,451
Total	18	4,139	4	332	4,493

If the rural water supply plan is implemented the service population is much increased as shown in Table 6.4.2 excluding the population to be served by protected wells and rain water harvesting.

Table 6.4.2 Increasing of Service Population by the Rural Water Supply Plan

District /Municipality	Service Population		District/ Municipality	Service Population	
	2009	2020		2009	2020
Igunga Dist.	25,050	80,816	Tabora Rural Dist.	36,717	337,269
Nzega Dist.	94,089	403,425	Tabora Mun.	14,611	43,764
Sikonge Dist.	21,477	81,773	Urambo Dist.	76,014	406,632
Total				267,628	1,753,679

Note: Service population by the alternative water sources is not included..

(1) Piped Water Supply Scheme (Level-2)

The Level-2 scheme was applied when the population is more than 2,500 (there is some exception) in the target year 2020 and yield of groundwater is more than 100 liter/min.

Finally, 18 schemes are planned in 18 villages. It is planned that a scheme supplies water to one (1) village.

Level-2 schemes will cover approximately 51.7 x 10^3 persons. The service population by Level-2 will cover 2.5% of the target population in 2020. The District/Municipal wise service populations by planned Level-2 are shown in Table 6.4.3.

Table 6.4.3 Service Population by Planned Leve-2 (2020)

District/Municipality	Service Population	District/Municipality	Service Population
Igunga Dist.	0	Tabora Rural Dist.	18,432
Nzega Dist.	11,206	Tabora Mun.	3,064
Sikonge Dist.	8,154	Urambo Dist.	10,794
Total			51,650

Note: Service population in Igunga is not included since only rehabilitation is planned.

(2) Handpump Water Supply Scheme (Level-1)

If groundwater potential is not enough for piped scheme (Level-2) but still adequate for a hand pump, a deep tube well with hand pump (Level-1) was considered in the Study. Number of deep tube wells was decided depending on the water demand in the village and appropriate spacing of wells. In addition, the areas excluded from the service area of Level-2 scheme were planned to be supplied by Level-1 schemes.

In case of the Level-1 water supply scheme, new construction of the scheme and the rehabilitation of the existing Level-1 are considered.

The District/Municipal wise service populations by planned Level-1 are shown in Table 6.4.4.

Table 6.4.4 Population Covered by Level-1 Scheme (2020)

District /Municipality	Service Population			District /Municipality	Service Population		
	New Scheme	Rehabilitation	Total		New Scheme	Rehabilitation	Total
Igunga Dist.	29,030	4,250	33,280	Tabora Rural Dist.	277,466	8,584	286,050
Nzega Dist.	282,586	31,128	391,153	Tabora Mun.	30,711	2,858	33,569
Sikonge Dist.	61,294	3,099	64,393	Urambo Dist.	337,760	15,446	353,206
Total					1,018,847	65,365	1,084,212

(3) Rehabilitation of Existing Water Supply Schemes

The inventory survey of the existing water supply schemes revealed that many piped water supply schemes and hand pumps are not functioning but some of them can be recovered their function by rehabilitation. Therefore, rehabilitation of those schemes was taken into consideration in the rural water supply plan.

1) Piped water supply schemes in Igunga

There are seven (7) piped water supply schemes tapping water from the Bulenya Dam. The aged transmission lines from the dam to each village were already replaced by Igunga District, however, distribution lines in four (4) villages were aged and required replacement. Therefore, replacement of distribution lines in those villages was planned. Such villages are Nanga, Igogo and Blyanbombe villages in Nanga Ward, and Migongwa village in Mwamashiga Ward.

2) Hand pump

A lot of handpumps are left unrepaired after malfunction. The reasons of malfunction are described in Chapter 5. If the reason is only unfunctioning or stolen of pump, it may be possible to recover the function by rehabilitation. Therefore, rehabilitation of such handpump is considered in the rural water supply plan.

6.5 PRELIMINARY DESIGN OF WATER SUPPLY SCHEMES

6.5.1 CONCEPT OF PRELIMINARY DESIGN

In this study, villages are typified by the number of population and dwelling type, and then the preliminary design of water supply facilities, Level-2 (Piped Water Supply System) and Level-1 (Hand pump), is planned. The water source of these facilities will be groundwater.

Regarding Level-2 water supply facilities, water will be supplied by gravity to the service area through public water points in order to minimize the cost of construction and operation.

The design is basically based on the Design Manual made by MoWI (Third edition, March 2009). For certain technical matters, which are not covered by this manual, the Guideline for Design of Water Supply facilities in Japan (2000) is applied.

6.5.2 PRELIMINARY DESIGN

The villages—which are selected previously through the process for the design of water supply facilities Level-1 and Level-2 are preliminarily designed according to the conditions below. The target year is set as 2020 and the water demand of the year 2020 is estimated.

(1) Water Demand

According to Design Manual of MoW, the unit water demand of the consumer category “Low income using kiosks or public taps” in rural area is set as 25 liter/capita/day for both Level-1 and

Level-2. This study also is set as the same.

Some villages have schools, dispensaries and so on, therefore, the water demand of these public facilities are taken into consideration in addition to the unit water demand mentioned above. (refer to Table 6.5.1)

Table 6.5.1 Unit Water Demand in Rural Areas in Tanzania

Consumer Category	Rural Area	Remark
Low income using kiosks or public taps	25 L/capita/day	Most squatter areas, to be taken as the minimum
School (Day Schools)	10 L/student/day	With pit latrine
(Boarding Schools)	70 L/student/day	With water closet
Health care dispensaries	10 L/visitor/day	Out patients only
Health center	50 L/bed/day	No modern facilities
Health center	100 L/bed/day	With water closet and sewer
Administrative Offices	10 L/worker	With pit latrines

Source: Design Manual (Third edition, March, 2009)

The design water demand is shown in below based on the Design Manual of MoWI.

- Average daily supply (m^3/day) = Daily water demand (m^3/day) x (1+System Losses 25%)
- Maximum daily demand (m^3/day) = Average daily demand (m^3/day) x 110%

(2) Water Sources (Deep well)

The water source of the selected villages is underground water (deep well). The design of deep well is shown in Table 6.5.2.

Table 6.5.2 Requirements for the Design of Deep Well

	Level -1	Level -2
1. Discharge	0.72 m^3/hour/borehole (maximum)	6 m^3/hour/borehole (maximum)
2. Depth of borehole	80 m on average	80 m on average
3. Casing		
Material	PVC	PVC
Internal diameter	4”	6”
4. Screen		
Material	PVC	PVC
Internal diameter	4”	6”
Screen length	20% of total length of casing	20% of total length of casing

(3) Requirement for the Preliminary Design

Requirements for Level-2 water supply facilities are shown in Table 6.5.3, and for Level-1 are shown in Table 6.5.4.

Table 6.5.3 Requirements for Level-2 Water Supply Facilities

1. Time period of water consumption: 6 hours (from 6:00 to 9:00a.m. and 3:00 to 6:00p.m.)		
2. Design Flow Daily average flow Daily maximum flow Hourly maximum flow	Daily average flow = Daily water demand + Distribution losses Daily maximum flow = Daily average flow x 110% Hourly maximum flow = Daily maximum flow / 6 hours	
3. Distribution Losses	25% of Daily average flow	
4. Facilities	Specification	
Intake facilities	Water source	Groundwater (Deep well)
	Daily operation hours	Average: 10 hours (=600 min) Maximum: 12 hours (=720 min)
	Discharge rate	Daily maximum flow
	Type of pump	Submersible pump (Centrifugal pump)
	Power source	Generator (diesel engine with generator)
Transmission Line	Design flow	Daily maximum flow (m^3/day)/ 10 (hour/day)
	Method of water supply	Pressure flow
	Material of pipes	PVC pipe
	Earth covering depth	0.9 m (minimum)
Storage tank (Distribution tank)	Capacity (m^3)	Daily maximum flow (m^3/day) x 50%(60 or 100 m^3)
	Type of tank	Elevated Tank (10 m)
	Low water level	Ground Level (G.L.) +10.50 m
	No. of tank	1 tank / scheme
	Material of tank	Reinforced concrete
Distribution Line	Design flow	Hourly maximum flow
	Method of water supply	Gravity flow
	Material of pipes	PVC pipe
	Earth covering depth	0.9 m (minimum)
Public water point (PWP)	Number of tap per PWP	One tap per PWP
	Maximum number of user	250 persons per tap
	Water head at PWP	5～25 m
	Maximum distance of access	Around 400 m from household

Table 6.5.4 Requirements for Level-1 Water Supply Facilities

1. Design Flow Maximum Discharge	0.72 m^3/hour/borehole (maximum)	
2. Facilities Hand Pump	Specification	
	Water source	Deep well
	Daily operation hours	Average: 10 hours (=600 min) Maximum: 12 hours (=720 min)
	Pump head	90 m (maximum)
	Maximum number of user	250 persons per hand pump
	Maximum distance of access	Around 400 m from household

6.5.3 STANDARDIZED DESIGN OF WATER SUPPLY SYSTEM IN EACH TYPE OF VILLAGE

Based on the requirements mentioned above, water supply facilities are preliminarily designed to typified villages by the population and dwelling type. However, even if a village fits the Level-2 design requirements, there is a limit of two deep wells, due to the difficulty of groundwater development. Therefore, these will cover a population up to that specified to be covered by two deep wells, while the rest of village people will be supplied by Level-1 water supply facilities.

The specification of standardized water supply facilities typified into each type of village is shown in Table 6.5.5. The Flow Diagram of Level-2 water supply facilities are shown in Figure 6.5.1.

Table 6.5.5 Specifications of Standardized Water Supply Facilities by Type of Village

Population to be served	Dwelling type	Type of Water Supply Scheme		Specification								
				Deep Well				Water Supply Facility				
				Maximum Pumping Hour	Inner Diameter of Casing	Number of Well	Planned Depth	Transmission Line	Distribution Tank	Distribution Line	Public Water Point	Branch line for PWP
<2500	All*	Level-1		0.72 m^3/hour	4"	Depending on	80m	—	—	—	—	—
2500<,<3001	Linear	Level-2 (A type)	A-Li type	6 m^3/hour	6"	1 well	80m	4km	60m^3	13km	12	20m
	Clustered		A-C ltype	6 m^3/hour	6"	1 well	80m	4km	60m^3	10km	12	20m
	Concentrated, Mixed		A-CM type	6 m^3/hour	6"	1 well	80m	4km	60m^3	8km	12	20m
3000<, <5001	Linear	Level-2 (B type)	B-Li type	6 m^3/hour	6"	2 well	80m	8km	100m^3	15km	20	20m
	Clustered		B-Cl type	6 m^3/hour	6"	2 well	80m	8km	100m^3	13km	20	20m
	Concentrated, Mixed		B-CM type	6 m^3/hour	6"	2 well	80m	8km	100m^3	10km	20	20m

* Including "Other" and "Scattered" of which population more than 2500.

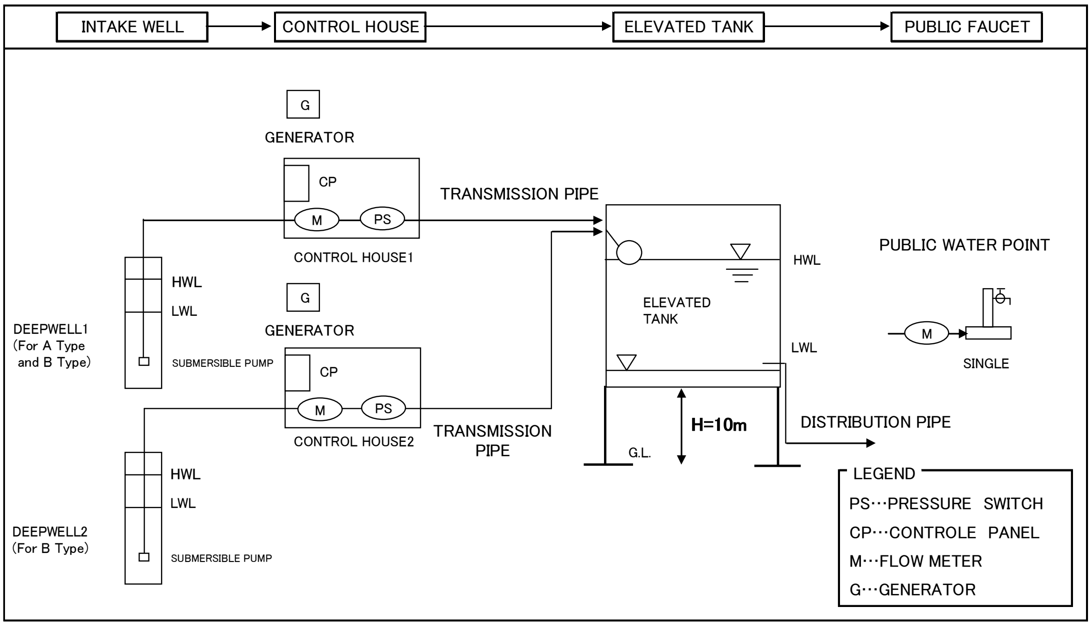

Figure 6.5.1 Flow Diagram of Level-2 Water Supply Facilities

6.5.4 APPLICATION OF THE TYPIFIED WATER SUPPLY SCHEME TO THE SELECTED VILLAGES

The total number of water supply facilities which are formulated by the rural water supply plan is shown in Table 6.5.6. The result of application of the typified water supply system to the selected villages for Level-2 water supply facilities in Table 6.5.3 is shown in Table 6.5.7, and the location of the selected villages are shown in Figure 6.5.2.

Table 6.5.6 The Total Number of Water Supply Schemes

District/Municipality	Level-2	Level-1	Others
Igunga Dist.	0	117	4
Nzega Dist.	4	1,143	0
Sikonge Dist.	3	251	0
Tabora Rural Dist.	6	1,135	0
Tabora Mun.	1	125	0
Urambo Dist.	4	1,368	0
Total	18	4,139	4

*Others・・・Pipe rehabilitation site

Table 6.5.7 The Result of Application of the Typified Water Supply System to the Selected Villages for Level-2 Water Supply Facilities

District	Ward No.	Ward	VS No.	Village/Street	Population		Water Demand (2020) unit: m^3	No of H/H	No. of sub-village	Dwelling type	Distance to the city (km)	Population served by existing and planned schemes	Target Population	Level-2						Level-1						Total pop. Served by Level-2 & 1	Coverage (%)	Total Pop. Served	Coverage (%)	Type
					(2009)	(2020)								New scheme	Rehabilitation	Serial No.	Water source	No.of new well	Total	Pop. to be served	Necessary No.	Rehabilitation	Exploitable No.	New well	Pop. Served					
Igg	13	Mwamashiga	48	Migongwa	3,768	5,443	136	413	10	Linear	25	2,763	2,680	0	2,680	IGR-1/4	BulenyaDam	0	5,328	-	-	-	-	-	-	2,680	100	5,443	100	-
	17	Nanga	62	Bulyang'ombe	3,723	5,378	135	614	6	Clustered	10	3,723	1,655	0	1,655	IGR-2/4	BulenyaDam	0	4,155	-	-	-	-	-	-	1,655	100	5,378	100	-
			63	Igogo	2,695	3,894	97	432	4	Linear	25	2,695	1,199	0	1,199	IGR-3/4	BulenyaDam	0	3,894	-	-	-	-	-	-	1,199	100	3,894	100	-
			65	Nanga	2,985	4,312	108	631	7	Mixed	36	2,985	1,327	0	1,327	IGR-4/4	BulenyaDam	0	4,312	-	-	-	-	-	-	1,327	100	4,312	100	-
Nzg	13	Lusu	47	Isanga	9,084	11,919	298	0	4	Linear	10	250	11,669	3,000	0	NZN-1	GW	1	3,000	8,669	35	1	22	21	5,523	8,523	73	11,919	100	A-Li
			49	Mwaluzwilo	2,754	3,614	90	589	4	Mixed	17	1,250	2,364	2,364	0	NZN-2	GW	1	2,364	0	0	0	14	0	0	2,364	100	3,614	100	A-CM
	15	Mambali	62	Nkindu	6,005	7,880	197	446	4	Linear	85	1,000	6,880	3,000	0	NZN-3	GW	1	3,000	3,880	16	0	23	16	3,880	6,880	100	7,880	100	A-Li
	26	Ndala	111	Mabisilo	2,547	3,342	84	108	5	Mixed	76	500	2,842	2,842	0	NZN-4	GW	1	2,842	0	0	0	30	0	0	2,842	100	3,342	100	A-CM
Skg	4	Kiloleli	17	Kanyamsenga	2,825	4,125	103	0	4	Linear	55	0	4,125	2,888	0	SKN-1	GW	1	2,888	1,238	5	0	129	5	1,238	4,125	100	4,125	100	A-Li
	6	Kipanga	28	Usunga	1,894	2,766	69	421	4	Linear	33	0	2,766	2,766	0	SKN-3	GW	1	2,766	0	0	0	20	0	0	2,766	100	2,766	100	A-Li
	9	Pangale	37	Mpombwe	3,435	5,015	125	494	4	Mixed	28	250	4,765	2,500	0	SKN-4	GW	1	2,500	2,265	10	0	19	10	2,265	4,765	100	5,015	100	A-CM
Tbr	8	Kizengi	51	Kizengi	4,304	6,284	157	900	4	Clustered	102	1,250	5,034	3,524	0	TRN-1	GW	1	3,524	1,510	7	0	6	6	1,510	5,034	100	6,284	100	A-Cl
			54	Mpumbuli	1,820	2,658	66	451	5	Clustered	85	250	2,408	2,408	0	TRN-2	GW	1	2,408	0	0	0	0	0	0	2,408	100	2,658	100	A-Cl
	11	Mabama	68	Kalola	3,268	4,772	119	635	5	Clustered	45	750	4,022	2,500	0	TRN-3	GW	1	2,500	1,522	7	2	6	4	1,522	4,022	100	4,772	100	A-Cl
			69	Mabama	4,329	6,321	158	721	6	Clustered	40	250	6,071	5,000	0	TRN-4	GW	2	5,000	1,071	5	1	4	3	1,071	6,071	100	6,321	100	B-Cl
			70	Maswanya	2,122	3,099	77	289	4	Mixed	30	0	3,099	2,500	0	TRN-5	GW	1	2,500	599	3	2	2	0	599	3,099	100	3,099	100	A-CM
	13	Ndono	85	Nkulusi	2,370	3,461	87	0	5	Mixed	60	0	3,461	2,500	0	TRN-6	GW	1	2,500	961	4	4	4	0	961	3,461	100	3,461	100	A-CM
Tbu	3	Kakola	8	Kakola	2,015	3,483	87	330	3	Clustered	19	250	3,233	3,064	0	TUN-1	GW	1	3,064	169	1	0	21	0	169	3,233	100	3,483	100	A-Cl
Urb	2	Igagala	7	Kazana Upate	1,853	3,170	79	0	3	Linear	67	0	3,170	3,000	0	URN-1	GW	1	3,000	170	1	0	1	1	170	3,170	0	3,170	100	A-Li
			10	Mtakuja Mashariki	2,054	3,514	88	0	4	Concentrated	63	0	3,514	2,500	0	URN-2	GW	1	2,500	1,014	5	0	5	5	1,014	3,514	0	3,514	100	A-CM
	19	Usisya	92	Mabunduku	2,335	3,994	100	0	4	Clustered	32	0	3,994	2,796	0	URN-3	GW	1	2,796	1,198	5	4	5	1	1,198	3,994	100	3,994	100	A-Cl
			93	Sipungu	2,086	3,568	89	313	4	Clustered	28	0	3,568	2,498	0	URN-4	GW	1	2,498	1,070	5	0	5	5	1,070	3,568	100	3,568	100	A-Cl

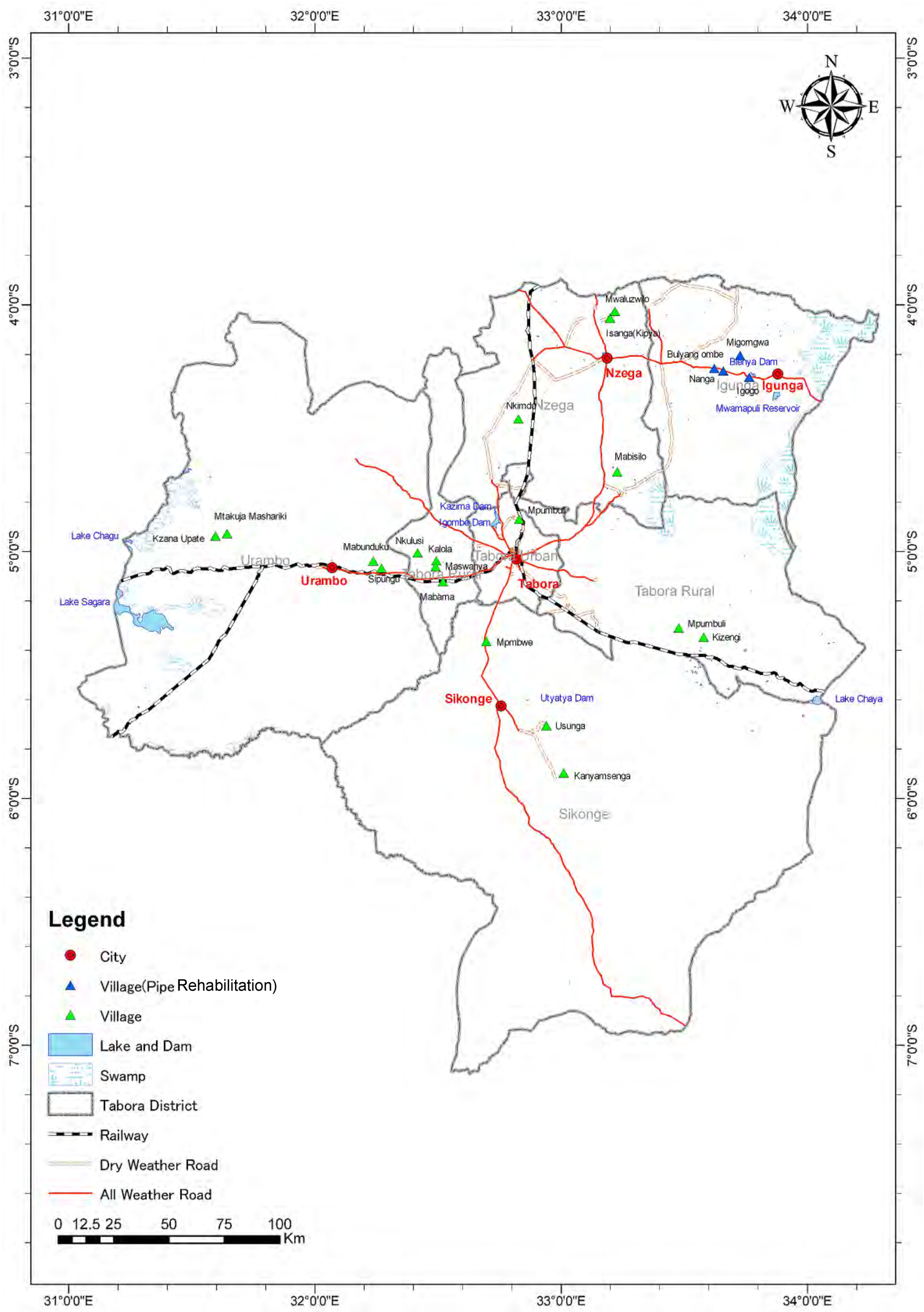

FIGURE 6.5.2 LOCATION OF THE SELECTED VILLAGES FOR LEVEL-2 WATER SUPPLY FACILITIES

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6.5.5 PRELIMINARY DESIGN DRAWINGS

Preliminary design drawings are shown in Figure 6.5.3 – 6.5.10.

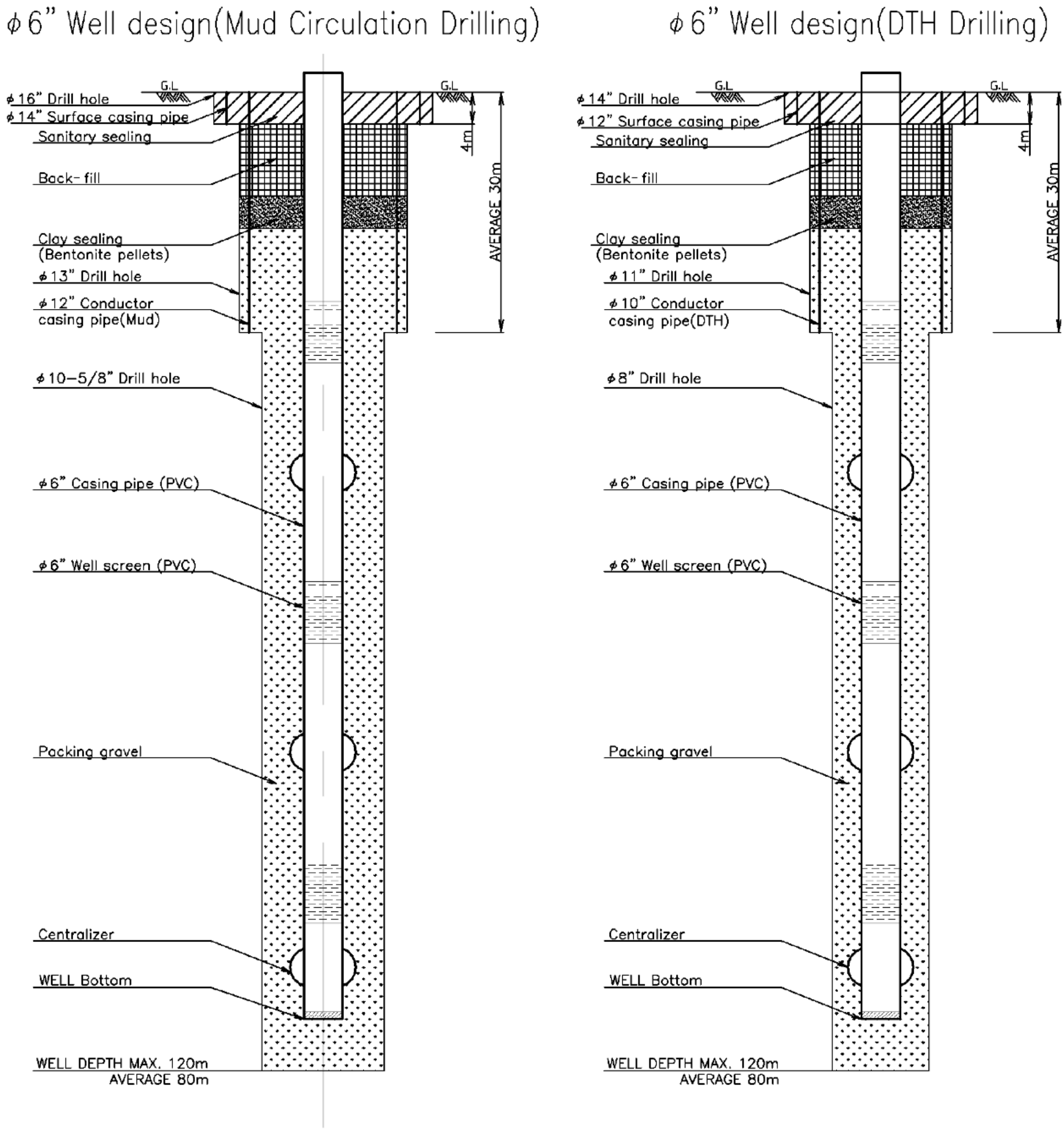

FIGURE 6.5.3 STANDARD DESIGN OF DEEP TUBE WELL (Level-2 Water Supply Facilities)

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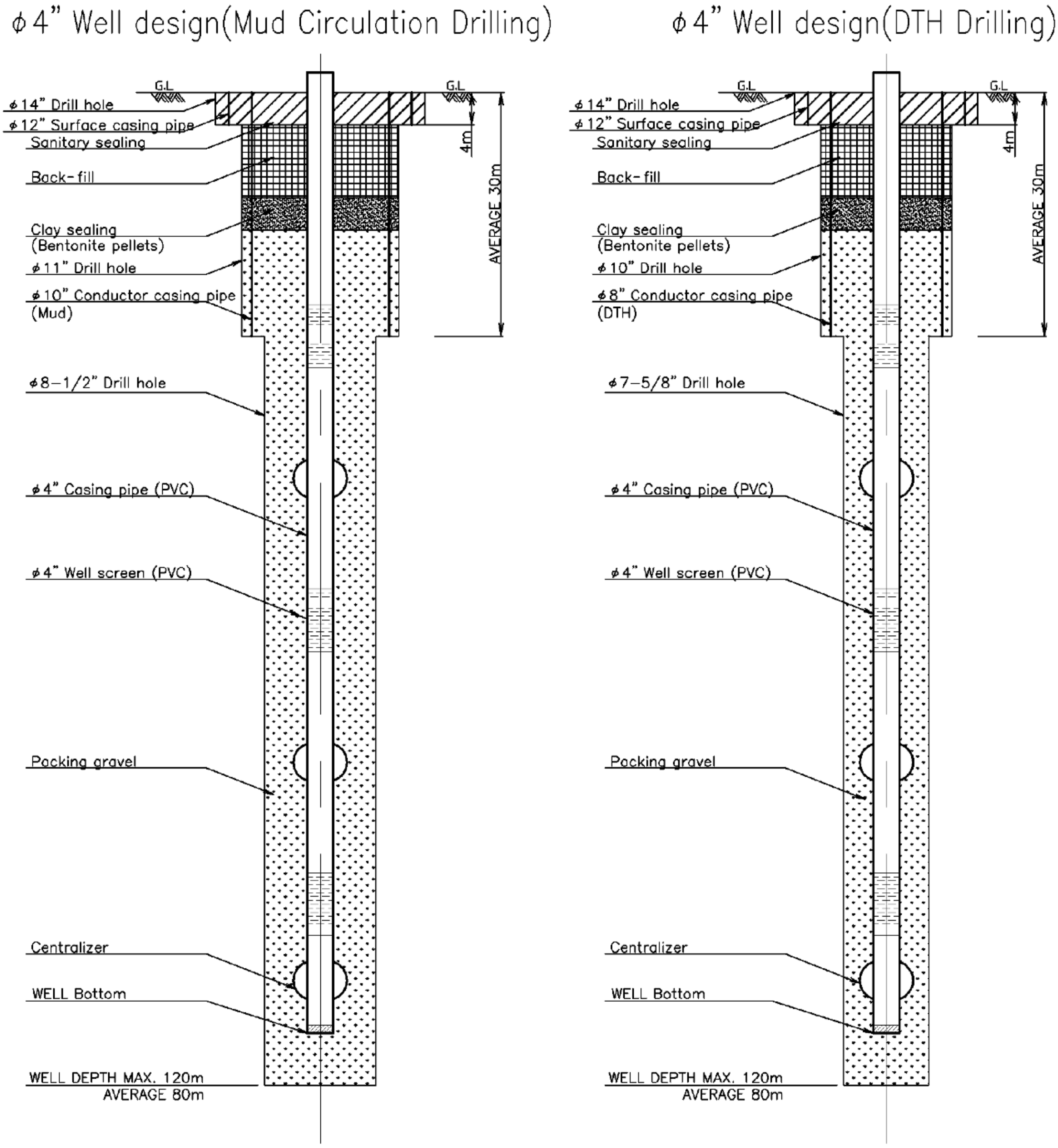

FIGURE 6.5.4 STANDARD DESIGN OF DEEP TUBE WELL (Level-1 Water Supply Facilities)

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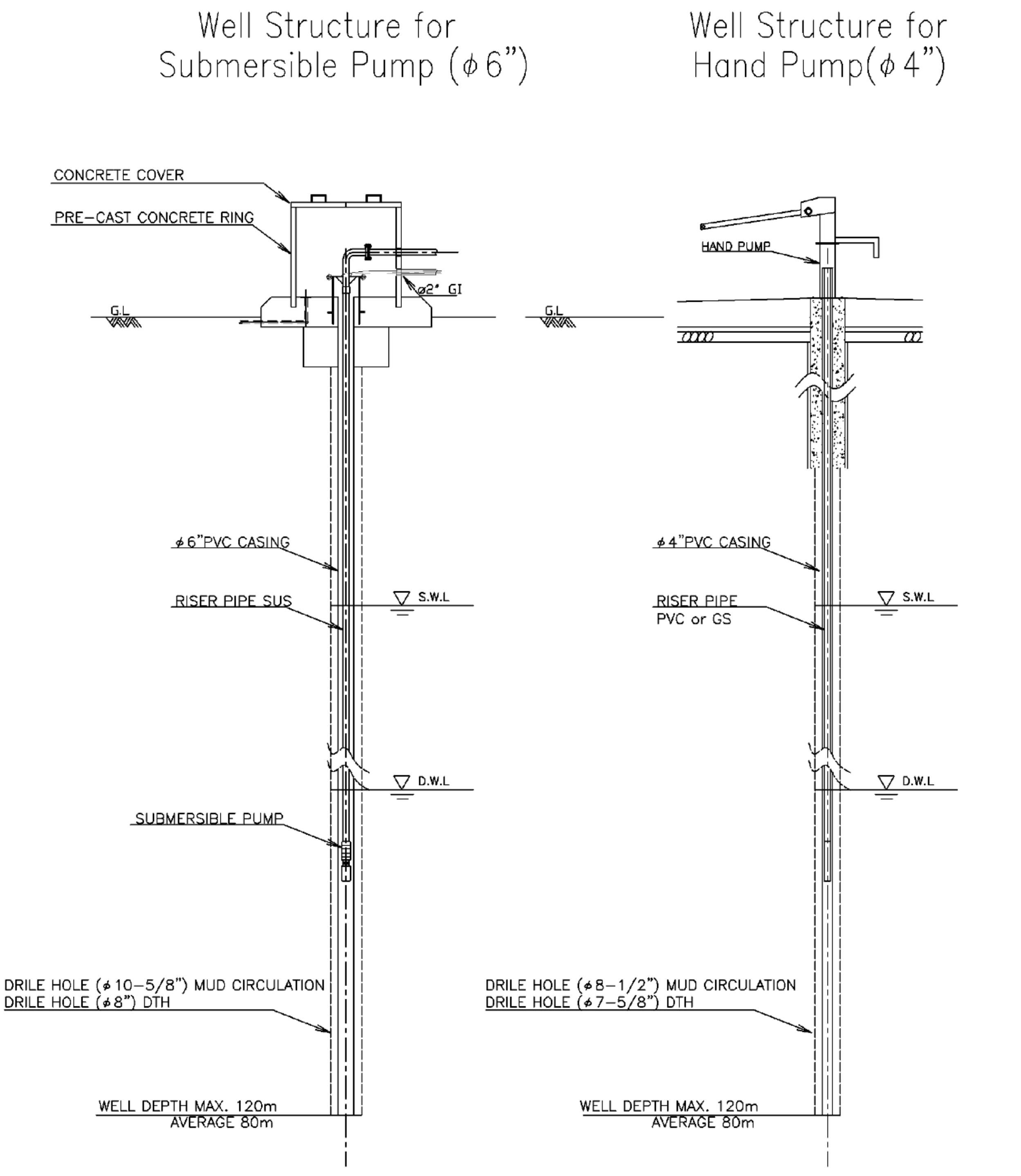

FIGURE 6.5.5 STANDARD DESIGN OF DEEP TUBE WELL (PUMP INSTALATION)

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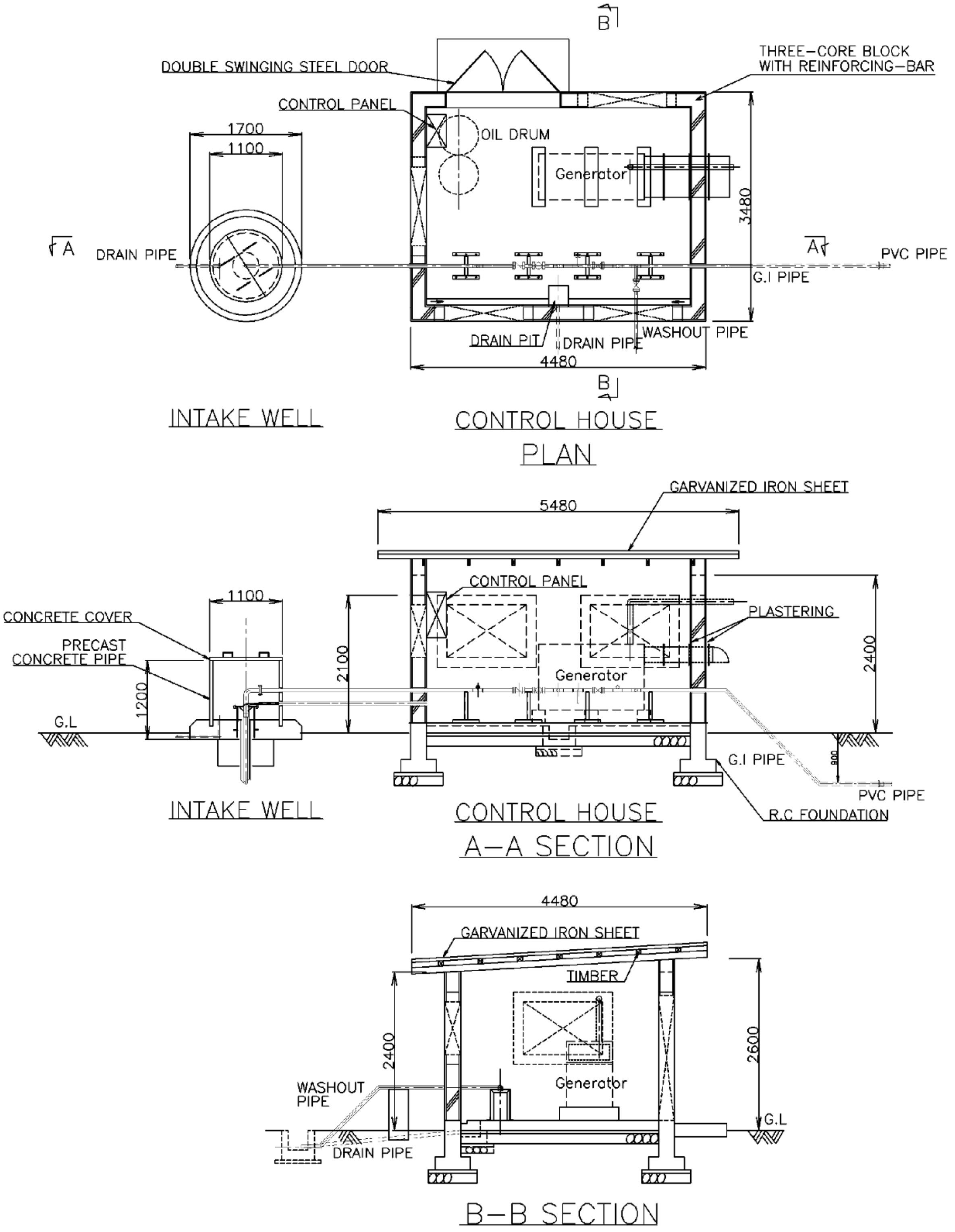

FIGURE 6.5.6 STANDARD DESIGN OF CONTROL HOUSE

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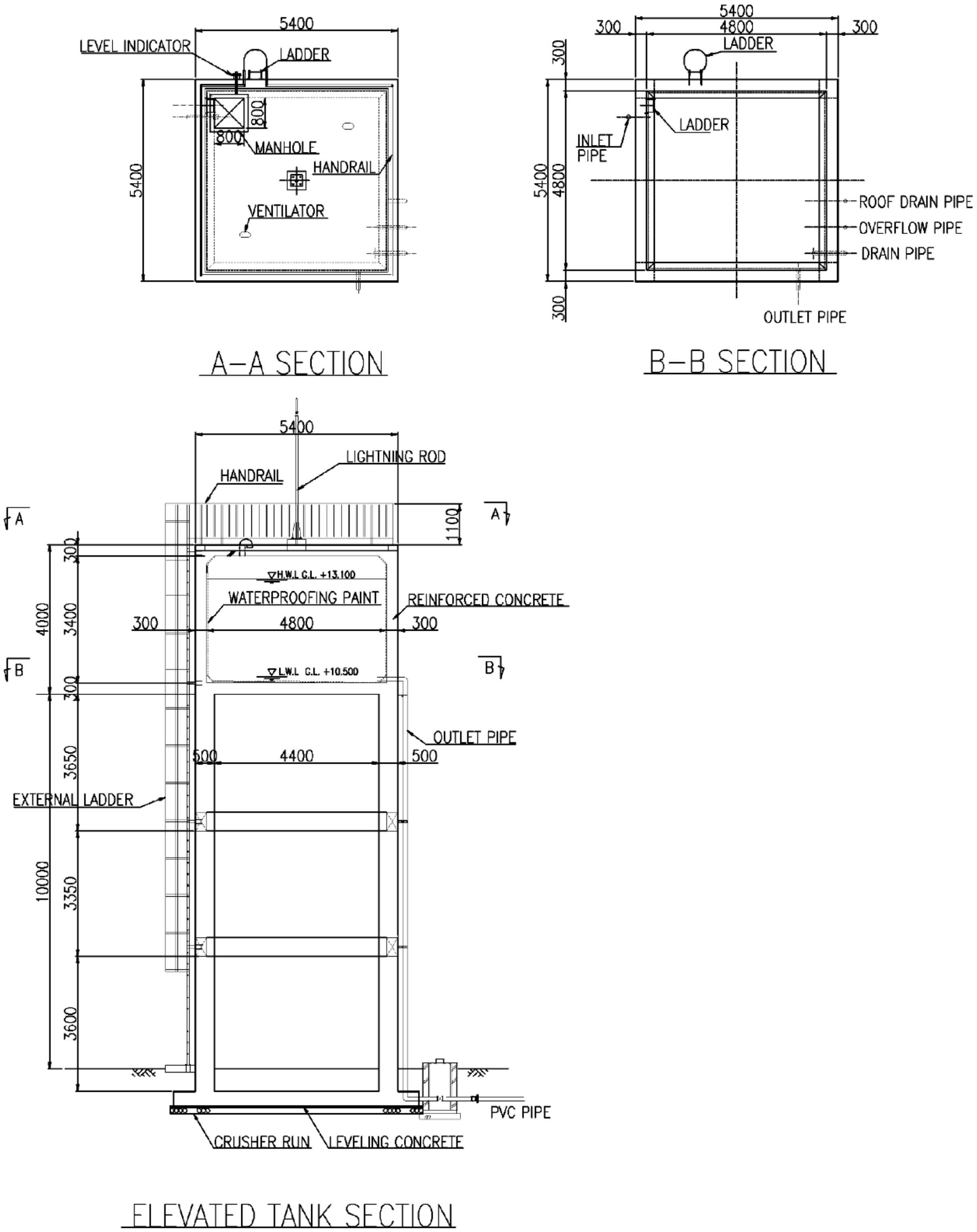


FIGURE 6.5.7 STANDARD DESIGN OF ELEVATED TANK (60 M^3, H=10 M)	
THE STUDY ON RURAL WATER SUPPLY IN TABORA REGION	**JICA**

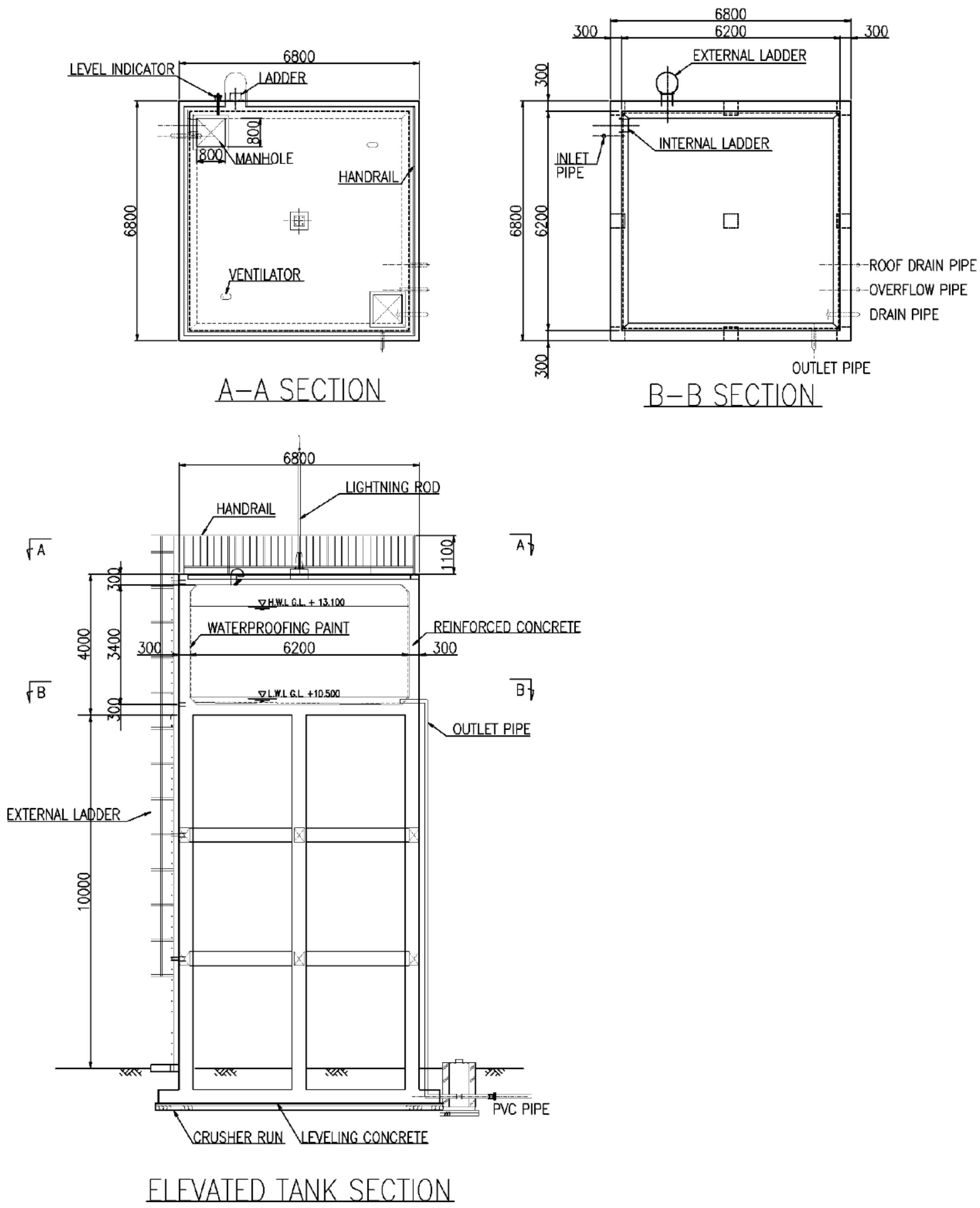
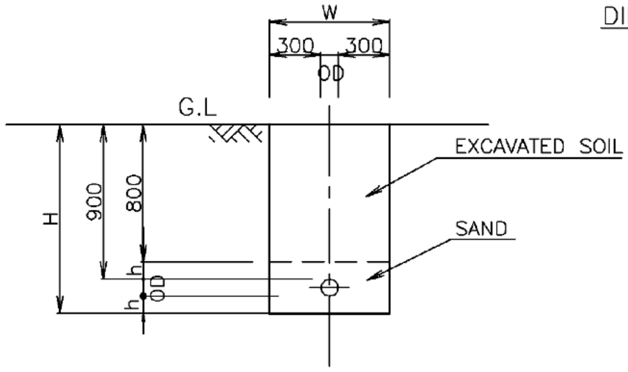


FIGURE 6.5.8 STANDARD DESIGN OF ELEVATED TANK (100 M^3, H=10 M)

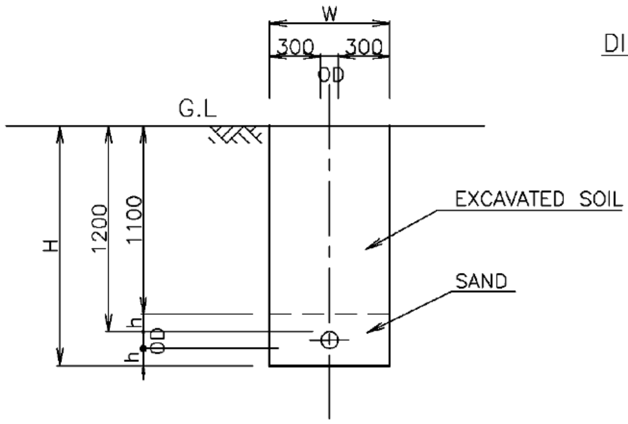
THE STUDY ON RURAL WATER SUPPLY IN TABORA REGION | **JICA**



DIMENSIONS TABLE OF STANDRD PIPE LAYING

OUTSIDE DIA(mm)	h (mm)	W (mm)	H (mm)
32	100	650	1050
40		650	1050
50		650	1050
63		700	1100
90		700	1100
110		750	1150
160		800	1200
200		800	1200

STANDARD (DEPTH=0.90m)



DIMENSIONS TABLE OF STANDRD PIPE LAYING

OUTSIDE DIA(mm)	h (mm)	W (mm)	H (mm)
32	100	650	1350
40		650	1350
50		650	1350
63		700	1350
90		700	1400
110		750	1450
160		800	1500
200		800	1500

CROSSING ROAD & UNDER ROAD (DEPTH=1.20m)

FIGURE 6.5.9 STANDARD DESIGN OF PIPE LAYING

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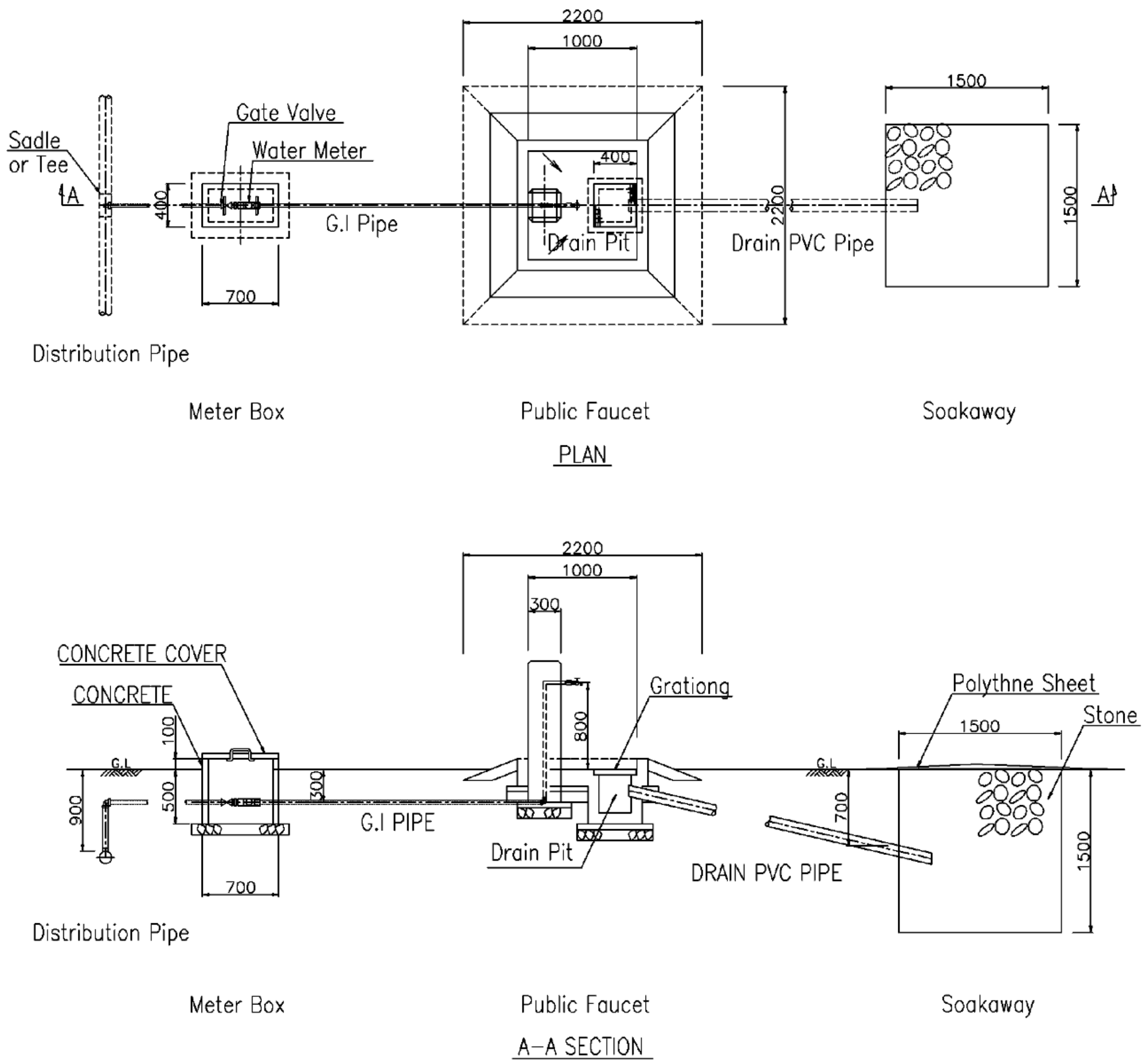

FIGURE 6.5.10 STANDARD DESIGN OF PUBLIC WATER POINT(PWP)

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6.6 APPROXIMATE COST ESTIMATION

The total cost to construct all of water supply facilities is approximately 281 million US$ as shown in Table 6.6.1.

Table 6.6.1 Total Cost Estimation for Construction of Water Facilities

Item	Construction Cost					Engineering Service	Grand Total
	Direct Construction Cost	Common Temporary Works	Field Expenses	Administrative Expenses	Total		
Level-2	18,048	1,444	2,166	1,624	23,282	4,194	27,476
Level-1	158,667	14,280	23,800	15,867	212,614	38,270	250,884
Rehabilitation of existing piped schemes	790	63	95	71	1,019	184	1,203
Rehabilitation of existing hand pump	889	80	133	89	1,191	214	1,405
Total	178,394	15,867	26,194	17,651	238,106	42,862	280,968

6.7 IMPLEMENTATION PLAN

The development plan of new water supply schemes, rehabilitation of the existing water supply facilities, and hand pump schemes shall be coincidentally scheduled. Construction period of these projects are supposed to be nine (9) years from 2012 to 2020, and implementation plan is shown in Table 6.7.1.

For the implementation of priority project, It is recommended to divide into two phases based on the priority of village, priority-1 and priority-2 (As for the priority projects, refer to Item 6.11 of this Chapter). Implementation of project shall be started from priority 1 project and period of project is five years from 2012.

Following preconditions are considered to formulate the implementation plan.

(1) Priority projects will be completed by the year 2016.

(2) Implementation of WSDP will commenced in 2012 for the 1st cycle and it is followed by the 2nd cycle.

(3) Assistance by NGO such as Water Aid, Africare and others will be expected. If such assistance is implemented, the project cost will be reduced.

Table 6.7.1 Implementation Plan of Rural Water Supply Plan

Project	2012	2013	2014	2015	2016	2017	2018	2019	2020
Priority Project (1)	◄──	────	──►						
Priority Project (2)			◄──	────	──►				
Other Level-2 and Level-1					◄──	────	────	────	──►
WSDP	────	────	────	────	────	────	────	────	──►
NGO	·····	·····	·····	·····	·····	·····	·····	·····	···►

6.8 FINANCIAL PLAN OF THE RURAL WATER SUPPLY PLAN

Table 6.8.1 shows "Budget Allocation and Actual Expenditure fiscal year (FY) 2003/04 to FY2007/08". As it is observed, development budget is steadily increasing from FY 2003/04, although slight decreasing of observed in FY 2007/08. Budget of WSDP is not clear for the Study.

The implementation cost of the rural water supply plan prepared by the Study is estimated at about USD 281 million. It is almost twice of the development budget in FY 2007/08. It is apparent that the implementation of the Plan requires additional grants from External Supporting Agencies (ESAs) such as donors and NGOs.

Table 6.8.1 Budget Allocation and Actual Expenditure FY2003/04 to FY2007/08

	2003/04	2004/05	2005/06	2006/07	2007/08
MoWI Recurrent	7,701	20,391	13,510	19,394	22,032
LAG Recurrent	-	10,464	11,500	13,819	14,228
Other Recurrent			400	323	
LGA Development	-	6,603	6,929	9,308	16,236
MoWI Development	34,264	93,375	79,725	148,516	129,702
Regional Development			-	-	35,150
OtherDevelopment				495,137	2,023
Total	41,965	130,833	112,064	686,497	219,371
Recurrent	7,701	30,855	25,010	33,613	36,583
Development	34,264	99,978	86,654	153,319	183,112
Region as % of Total	0.0%	13.0%	16.5%	12.0%	13.9%
Budget Execution Rate	63.4%	86.0%	73.4%	85.4%	55.4%
Recurrent as % of Total	18.4%	23.6%	22.4%	17.3%	16.5%

Unit: million Tsh

6.9 ANNUAL DISBURSEMENT SCHEDULE

In order to raise the water supply level up to 90% by the year 2025 in the rural area, the project shall be implemented as planned in Table 6.7.1. Taking this situation into consideration, the disbursement schedule is planned as shown in Table 6.9.1.

The project period for Level-1 schemes other than those of the priority projects, is planned for five (5) years from 2016 to 2010.

Table 6.9.1 Annual Disbursement Schedule

Project		2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
Priority Project (1)	Engineering	905	647	1,035							2,587
	Construction	5,030	3,593	5,748							14,370
	Total	5,935	4,239	6,783	0	0	0	0	0		16,957
Priority Project (2)	Engineering			1,237	884	1,414					3,534
	Construction			6,872	4,909	7,854					19,634
	Total			8,109	5,792	9,267					23,168
Other Level-2 and Level-1	Engineering	686	679	679	679	679	679	679	679	679	6,121
	Construction	3,808	3,774	3,774	3,774	3,774	3,774	3,774	3,774	3,774	34,004
	Total	4,494	4,454	4,454	4,454	4,454	4,454	4,454	4,454	4,454	40,125

6.10 EVALUATION OF WATER SUPPLY PLAN

6.10.1 ECONOMICAL AND FINANCIAL EVALUATION

Financial plan for the water supply plan is formulated considering the disbursement. The disbursement plan is made, in accordance with the priority of the project and taking the financial status of the Tanzanian side into consideration.

The cost benefit analysis made by the World Bank project of the Water Supply in Kilosa, Mpwapwa and Rufiji District (MoWLD, 2002), evaluated IRR (Internal Rate Return) is 23% for the average of the piped scheme and handpump scheme. Considering the economical situation of the study area, such evaluation is applicable for the plan.

Although the financial assistance by international organization and the donors are essential, the plans are evaluated as feasible from the economical and financial point of view. The detailed IRR of the proposed project shall be examined in the next stage.

6.10.2 INSTITUTIONAL AND ORGANIZATIONAL EVALUATION

Institutional and organizational setup, described in the Institutional, O&M Plan, is taking consideration in the following key issues in its development; 1) current and future institutional setup arranged under Water Policy (2002) and National Water Sector Development Strategy, 2) decentralized functional responsibilities of each stakeholders in the water supply service delivery set in the sector policy and strategies, 3) transition of the role of MoW from service delivery to the ones of policy making, monitoring and regulation, 4) strategy to enhance Community-Owned Water Supply Organizations (COWSOs), which shall be legal entity, to own and manage supply scheme, and 5) current approach to increase private sector participation and contracting-out in the service delivery to increase efficiency and competency in the scheme running.

Among those issues, COWSO management options with technical guidance and monitoring provided by DWST/MWST, is assessed to considerably enhance competency and efficiency in the scheme management particularly for the piped supply scheme (Level-2), of which deficiency in management are further obvious in the past.

From those points of views, the plan can be assessed feasible and efficient in institutional and organizational points aspects.

6.10.3 EVALUATION OF ENVIRONMENTAL AND SOCIAL ASPECTS

Environmental and social consideration was taken into the process of the projects formulation as the form of Initial Environmental Examination (IEE), which is conducted in Phase I. The IEE was undertaken by the Tanzanian side. The responsible person, designated by Tabora Regional Council for this Study was Mr. Shadrack Wilson Yomba, District Environmental Officer/Fisheries officer of Urambo District. There are 30 particulars in IEE, and every one of them is checked with responsible officers in all Districts in Tabora Region.

The planned facilities consist of water intakes (deep wells in most of the case), transmission/distribution pipelines laid down under the ground, elevated distribution reservoirs (tanks) and public water points. These facilities do not affect the surrounding natural and social environment since they produces no pollution except small generators to be installed for submerged pumps in the wells.

There are many forest reserves and two (2) game reserves in the Study area. However, it was agreed in the 2nd Steering Committee held on 22 December 2009 not to implement the project in a village located within a boundary of a forest reserve or a game reserve.

Construction of water supply facilities has profound and positive impacts on gender issues. Fetching water is basically a task of women and small children. Providing water in their proximity area will reduce their burden, and increase extra time for production activities, such as learning and wage works.

One of the social sectors which IEE concerned is economic sector in the project sites. Water vendors are many in Tabora Region, especially in Igunga. The IEE responsible person, Mr. Yomba and JICA Study team assessed future impacts on water vendors with the responsible officers. As the results, no officers pointed out negative impacts on water vendors. Their reasons are: there are many other areas they can do their business other than the project villages; they are not selling drinking water only, but for other purposes by water taken from rivers and reservoirs for less prices, etc.

Taking the results of IEE into account, groundwater balance was evaluated to avoid lowering of groundwater level and interference to wells in proximity distances.

In summary, it is considered that by the implementation of the projects, there would not be any significant negative impact to the surrounding natural and social environment.

6.10.4 TECHNICAL APPROPRIATENESS

The evaluations of the technical appropriateness are examined by the components of the proposed system of piped scheme (Level-2). The appropriateness of the technical aspect is highly depending to the technique of the operation and maintenance. If the water source is selected as groundwater, the technical aspect in the Construction, O&M and Procurement are appropriate. In case of the surface water, the technical appropriateness of the O&M is depending to the water quality. The proposed plan, however in most case, is planned by the groundwater as the water source. The plan, therefore, would be evaluated as appropriate from the technical point of view.

6.11 PRIORITY PROJECT

The Water Supply Plan in the Study Area was formulated as described in 6.4 of this Chapter, proposing different types of water supply schemes like piped water supply schemes (Level-2) and deep well with hand pump water supply schemes (Level-1) schemes in 419 villages.

The Priority Project for implementation was selected by following two steps-wise procedure assuming Japan's Grant Aid.

- 1st step: Evaluation of villages
- 2nd step: Selection of Priority Project

6.11.1 EVALUATION OF VILLAGES FOR PRIORITY

(1) Criteria and Their Weighting for Evaluation

The Socio-Economic Survey revealed the situation of the villages that are unprovided for the accessibility of safe water. In order to overcome such situation, provision of water supply schemes are urgently required. On the one hand, water resource potential in the Study area was evaluated in the Study. High priority for selection of villages for the project shall be given to the villages where water resource is available along with high degree of unprovision of water. From these points of view, urgency to provide safe and stable water, development potential of water source and water quality were applied as the criteria for the selection of priority villages.

In addition, water quality is another factor in consideration of water supply. Each water source of water supply schemes to be planned in the study should satisfy the WHO Guideline (2008) for parameters for health significance and the Tanzanian Drinking Water Standard for other parameters. Deterioration by high contents of Fluoride is severe problem in very wide area in Igunga District, the north-eastern part of Nzega District and the eastern part of Tabora Rural District. Relatively high Fluoride contents are recognized even in other Districts. Therefore, water quality was included in the evaluation factor for priority.

Considering the above, following three (3) criteria were provided for the evaluation of villages for priority.

- Urgency to provide water supply schemes
- Groundwater development potential
- Water quality

(2) Evaluation of Urgency to provide Water Supply Schemes

Factors for evaluation of urgency are (1) time requirement for fetching water from the existing water source even when the sources are unstable, (2) water supply coverage of the village, how many percent of community people are receiving safe drinking water through the reliable water supply schemes. These two (2) factors are represented by water supply coverage, because community people will be obliged to fetch water for long distance if water supply facilities are not properly arranged in the village. Therefore, water supply coverage is selected as the representative factor of urgency to provide water supply schemes.

Scoring for the factor is shown in Table 6.11.1.

Table 6.11.1 Scoring of Evaluation Factors for Urgency

Scoring	1	2	3	4
Water supply coverage (C)	50%≦C	30≦C<50%	10≦C<30%	C<10%

(3) Evaluation of Groundwater Development Potential

Groundwater development potential was evaluated using the existing well data (borehole data), analysis results of satellite image.

Although Tabora Region is situated mostly in the basement rock area where groundwater development is generally difficult, deep wells with relative high yield were identified in some places in the Study area. It seems to have relationship with lineaments. Major and minor lineaments were identified by the satellite images. It is expected that adjacent areas of the lineaments may have high groundwater development potential.

From these points of view, groundwater development potential was evaluated dividing the area into four (4) categories. Categories and their evaluation score are shown in Table 6.11.2.

Table 6.11.2 Scoring of Groundwater Development Potential

Scoring	Yield (m^3/hour)	Note
0	0	No groundwater development is expected or not suitable for drinking
2	0.6≦ Q <1	Can be utilizes for handpump if yield is more than 07 m^3/hour
3	1≦ Q <5	Fair water source for piped scheme to serve 2,500 populations with multi-well system
4	5≦Q	Promising water suorce for piped scheme to serve 2,500 populations with single well

(4) Evaluation of Water Quality

Water quality was studied by the existing data, and in-situ measurement and analyses by the Study. Especially, in-situ measurement was carried out covering all the villages where water supply scheme is available. Evaluation of water quality was made using those data.

As the result, the target villages were classified into following four (4) categories. It is important to ensure the water quality whether it is suitable for drinking or not. Considering this issue, evaluation scores were given to each village as shown in Table 6.11.3.

Table 6.11.3 Scoring of Water Quality

Scoring	Category	Note
0	N	Village where water quality was directly confirmed not suitable for drinking (mainly deterioration by Fluoride)
0	n	Village where water quality was not directly confirmed but evaluated not suitable for drinking using (high possibility of deterioration by Fluoride)
2	a	Village where water quality was not directly confirmed but evaluated suitable for drinking using (possibly no deterioration by Fluoride)
3	A	Village where water quality was directly confirmed suitable for drinking using (no deterioration by Fluoride was detected)

6.11.2 EVALUATION OF VILLAGE

In order to assign District-wise priorities to the target Villages, three (3) criteria were applied as mentioned above. Weighting was given to the criteria, groundwater development potential, because it is impossible to construct water supply schemes without suitable water source. Therefore, score of groundwater development potential was doubled in calculation of evaluation score of each village. The evaluation formula becomes;

(Evaluation point of village) = (Evaluation point for water supply coverage) x 1 + (Evaluation point for groundwater development potential) x 2

The maximum point is 15. Evaluation results are shown in Table 6.1 to Table 6.6 in the Appendix together with the rural water supply plan.

6.11.3 SELECTION OF PRIORITY PROJECT

(1) Criteria for Selection of Priority Project

District wise priority of Village was evaluated. The candidate villages for Priority Project were selected considering the following criteria. Criteria considered are;

- Urgency to provide water supply schemes
- Possibility of groundwater source development
- Appropriate scale of project

1) Urgency to Provide Water Supply Schemes

There are many villages without any safe reliable water supply facilities. They rely on mainly unprotected water sources such as dug wells, spring and shallow wells. Surface water like charco dams and dams are also used without any treatment in most of cases. Using unsafe water will cause water borne diseases and may increase infant mortality. Therefore, it is urgency issue to provide clean and safe water to those villages.

Those situations are reflected in water supply coverage. Villages evaluated as priority-1 and priority-2 are of very low water supply coverage, 0 (zero) or less than 10%.

2) Possibility of Groundwater Source Development

It is very critical issue in the planning of water supply whether groundwater is available or not. Villages evaluated as priority-1 and priority-2 are located near the lineaments and/or near the borehole of which yield is high. Therefore, those village areas are in prospective area of groundwater development.

3) Appropriate Scale of Project

The rural water supply plan was formulated covering all the target villages. Among them, appropriate scale of the priority project should be selected because the priority project is assumed to be requested to the Japanese Government for implementation under Japan's Grant Aid. Considering this situation, appropriate scale of projects is considered.

After all, the villages evaluated as priority-1 and priority-2 is considered to be of high demand of preparation of water supply scheme and of high probability of groundwater development. Therefore, it is proposed that all the villages of priority-1 and priority-2 are the candidate of the priority project.

(2) Alternative of Priority Project

Six (6) alternatives were provided for the selection of the priority project. They are summarized in Table 6.11.4.

Table 6.11.4 Alternatives of Priority Project

Altenative	No. of Village	Level-2 (site)	Level-1 (well)	Service Population	Descripptin/Note
1	42	14	315	117,313	All the priority-1 and priority-2 Level-2 and Level-1 To be sub-divided into 1B and 1C below.
1A	14	14	0	50,667	Level-2 only in priority-1
1B	16	5	157	54,764	Only priority-1. Level-2 and Level-1 (part of Alternative-1: First Priority Project)
1C	26	9	158	62,549	Only priority-2. Level-2 and Level-1 (part of Alternative-1: Second Priority Project)
2	18	18	78	80,983	Level-2 in all the priority. Level-2 and Level-1
3	18	18	0	62,397	Level-2 in all the priority. Level-2 only

Detailed breakdown of the alternatives are given in Table 6.11.5 to 6.11.10.

1) Alternative-1

Alternative-1 includes all the villages evaluated as priority-1 and priority-2. Alternative-1 covers all the District and Municipality: 42 Villages are covered. Each District and Municipality has some priority project. It consists of 14 Level-2 schemes and 315 Level-1 schemes. Service population is 117,313, the largest number in alternatives. Since Alternative-1 is too large for a priority project from the view point of scale, is should be divided into two (2) priority projects, the first priority project (Alternative-1B) and the second priority project (Alternative-1C). Breakdown of divided ones are shown in Table 6.11.7 and Table 6.11.8, respectively.

Table 6.11.5 Alternative-1 of Priority Project

District/Municipality	No. of Village		Type of Water Supply		Service Population		
	Priority		Level-2	Level-1	Leval-2	Level-1	Total
	<1>	<2>	(site)	(well)			
Igunga Dist.	1	1	0	12	0	3,000	3,000
Nzega Dist.	2	5	1	63	3,000	15,355	18,355
Sikonge Dist.	3	3	3	46	8,154	10,748	18,902
Tabora Rural Dist.	2	8	5	46	14,908	11,433	26,341
Tabora Mun.	3	1	1	35	3,064	8,465	11,529
Urambo Dist.	5	8	4	113	10,794	28,392	39,186
Total	16	26	14	315	39,920	77,393	117,313
	42						

2) Alternative-1A

Alternative-1A is the one withdrawn the Level-2 schemes from Alternative-1. Therefore, no Level-1 schemes are included. It consists of 14 Level-2 schemes. Service population is 39,960. In this case, Igunga District is has no priority project.

Table 6.11.6 Alternative-1A of Priority Project

District/Municipality	No. of Village		Type of Water Supply		Service Population		
	Priority		Level-2	Level-1	Leval-2	Level-1	Total
	<1>	<2>	(site)	(well)			
Igunga Dist.	0	0	0		0		0
Nzega Dist.	1	0	1		3,000		3,000
Sikonge Dist.	2	1	3		8,194		8,194
Tabora Rural Dist.	1	4	5		14,908		14,908
Tabora Mun.	1	0	1		3,064		3,064
Urambo Dist.	0	4	4		10,794		10,794
Total	16	9	14		39,960		39,960
	16						

3) Alternative 1B

Alternative-1B is the one withdrawn the villages of priority-1 from Alternative-1, therefore, this alternative is one of the breakdown of Alternative-1. Alternative-1B covers all the Districts and Municipality. It consists of five (5) Level-2 schemes and 157 Level-1 schemes. Service population is 54,764.

Table 6.11.7 Alternative-1B of Priority Project

District/Municipality	No. of Village		Type of Water Supply		Service Population		
	Priority		Level-2	Level-1	Leval-2	Level-1	Total
	<1>	<2>	(site)	(well)			
Igunga Dist.	1		0	7	0	1,750	1,750
Nzega Dist.	2		1	23	3,000	5,750	8,750
Sikonge Dist.	3		2	24	5,266	5,597	10,863
Tabora Rural Dist.	2		1	17	5,000	4,250	9,250
Tabora Mun.	3		1	27	3,064	6,481	9,545
Urambo Dist.	5		0	59	0	14,606	14,606
Total	16		5	157	16,330	38,434	54,764
	16						

4) Alternative 1C

Alternative-1C is the one withdrawn the villages of priority-2 from Alternative-1, therefore, this alternative is another breakdown of Alternative-1. Alternative-1C covers all the District and Municipality. It consists of nine (9) Level-2 schemes and 158 Level-1 schemes. Service population is 62,549.

Table 6.11.8 Alternative-1C of Priority Project

District/Municipality	No. of Village		Type of Water Supply		Service Population		
	Priority		Level-2	Level-1	Level-2	Level-1	Total
	<1>	<2>	(site)	(well)			
Igunga Dist.		1	0	5	0	1,250	1,250
Nzega Dist.		5	0	40	0	9,605	9,605
Sikonge Dist.		3	1	22	2,888	5,151	8,039
Tabora Rural Dist.		8	4	29	9,908	7,183	17,091
Tabora Mun.		1	0	8	0	1,984	1,984
Urambo Dist.		8	4	54	10,794	13,786	24,580
Total		26	9	158	23,590	38,959	62,549
	16						

5) Alternative-2

Alternative-2 includes all the Level-2 schemes, 18 schemes, independently from the evaluation of priority. Population excluded from the service area of Level-2 is served by Level-1 schemes. Such Level-1 schemes are included in this Alternative-2: It is 78 schemes. Service population is 80,983.

Table 6.11.9 Alternative-2 of Priority Project

District/Municipality	No. of Village		Type of Water Supply		Service Population		
	Priority		Level-2	Level-1	Leval-2	Level-1	Total
	<1>	<2>	(site)	(well)			
Igunga Dist.			0	0	0	0	0
Nzega Dist.			4	37	11,206	9,130	20,336
Sikonge Dist.			3	15	18,901	3,503	22,404
Tabora Rural Dist.			6	13	18,432	3,260	21,692
Tabora Mun.			1	1	3,064	189	3,253
Urambo Dist.			4	12	10,794	2,504	13,298
Total			18	78	62,397	18,586	80,983
	18						

6) Alternative-3

Alernative-3 covers 18 villages by only Level-2 schemes, independently from the evaluation of priority. Population excluded from the service area will be left unserved. Igunga District has no project in this case. Service population is 62,397.

Table 6.11.10 Alternative-3 of Priority Project

District/Municipality	No. of Village		Type of Water Supply		Service Population		
	Priority		Level-2	Level-1	Leval-2	Level-1	Total
	<1>	<2>	(site)	(well)			
Igunga Dist.			0		0		0
Nzega Dist.			4		11,206		11,206
Sikonge Dist.			3		18,901		18,901
Tabora Rural Dist.			6		18,432		18,432
Tabora Mun.			1		3,064		3,064
Urambo Dist.			4		10,794		10,794
Total			18		62,397		62,397
	18						

Considering the water supply situation in Tabora Region, it is supposed that the priority project should cover all the Districts and Municipality, if possible and the higher service population will contribute much to improve the water supply situation. In addition, the priority project should be appropriate scale. From this point of view, evaluation of alternatives is made as shown in Table 6.11.11.

Table 6.11.11 Evaluation of Alternatives

Alternative	Coverage of District/Municipality	Service Population	Scale	Sum of Evaluation
1	All District and Municipality are covered. Point: 3	Service population is the largest. Point: 3	Scale is too large. Point: 1	7
1A	Igunga is excluded. Point: 1	Service population is the smallest. Point: 1	Scale is suitable. Point: 3	5
1B	All District and Municipality are covered. Point: 3	Service population is small. Point: 1	Scale is suitable. Point: 3	6
1C	All District and Municipality are covered. Point: 3	Service population is small. Point: 1	Scale is suitable. Point: 3	7
2	Igunga is excluded. Point: 1	Service population is moderate. Point: 2	Scale is large. Point: 2	5
3	Igunga is excluded. Point: 1	Service population is moderate. Point: 2	Scale is large. Point: 2	5

As shown in the Table above, Alternative-1 was ranked the top getting the evaluation score 7 although the scale is too large. On the one hand, Alternative-1B and Alternative-1C were ranked higher than Alternative-2 and Alternative-3. Alternative-1B and Alternative-1C are the breakdown of Alternative-1. Therefore, it is thought that Alternative-1 is suitable as the candidate of the priority project, should it is subdivided into two (2) phases, Alternative-1B and Alternative-1C.

As the conclusion, Alternative-1 (Alternative-1B and Alternative-1C) is proposed as the candidate of the priority project. However, rehabilitation of existing well are not included in the priority project. Populations not served by groundwater will be covered by other water sources such as shallow well, rainwater harvesting, etc. which are not included in the priority project.

Notwithstanding above discussion, it is proposed to add four (4) villages to Alternative 1B considering the balance of the number of the target villages, one (1) village in Igunga, two (2) villages each in Nzega and Tabora Rural Districts.

Finally, the total of 20 villages was selected as the target of the Priority Project which consists of 16 villages of priority-1 and four (4) villages of priority-2. Lists of village included in the priority project are shown in Table 6.11.12 and Table 6.11.13. Location of candidate villages for priority project is shown in Figure 6.11.1.

Table 6.11.12 List of the 1st Priority Project (Alternative-1B: Revised)

No.	Ward	Village	Population 2009	Population 2020	Target Population	No. of Level-2	Served by Level-2 (2020)	No. of Level-1	Served by Level-1 (2020)	Total (2020)
	<Igunga District>									
1	Mwisi	Busomeke	3,618	5,227	4,977	0	0	7	1,750	2,000
2	Mwisi	Kalemela	2,429	3,509	3,509	0	0	5	1,250	1,250
	<Nzega District>									
3	Ijanija	Makomelo	1,005	1,319	1,069	0	0	5	1,069	1,069
4	Lusu	Isanga	9,084	11,919	11,669	1	3,000	22	5,500	8,750
5	Miguwa	Kitangili	2,664	3,496	3,496	0	0	1	250	250
6	Wela	Wela	1,753	2,301	1,801	0	0	7	1,801	1,801
	<Sikonge District>									
7	Igigwa	Kasandalala	2,282	3,332	3,332	0	0	14	3,332	3,332
8	Kipanga	Usunga	1,894	2,766	2,766	1	2,766	0	0	2,766
9	Pangale	Mpombwe	3,435	5,015	4,765	1	2,500	10	2,265	4,765
	<Tabora Rural District>									
12	Kizengi	Mpumbuli	1,820	2,658	2,408	1	2,408	0	0	2,408
10	Mabama	Mabama	4,329	6,321	6,071	1	5,000	4	1,071	6,071
11	Ufuluma	Ufuluma	5,741	8,382	8,382	0	0	13	3,250	3,250
	<Tabora Municipality>									
13	Kakola	Kakola	2,015	3,483	3,233	1	3,064	1	169	3,233
14	Misha	Misha	759	1,312	1,312	0	0	6	1,312	1,312
15	Uyui	Uyui	3,138	5,424	5,174	0	0	20	5,174	5,174
	<Urambo District>									
16	Imalamakoye	Imalamakoye	2,509	4,292	4,292	0	0	12	3,000	3,000
17	Kapilula	Kapilula	1,568	2,682	2,682	0	0	9	2,250	2,682
18	Kiloleni	Kalembela	3,131	5,356	5,106	0	0	21	5,106	5,106
19	Kiloleni	Kiloleni	1,653	2,828	2,828	0	0	10	2,500	2,828
20	Uyowa	Nsungwa	6,911	11,821	11,571	0	0	7	1,750	2,000
	Total		61,738	93,443	90,443	6	18,738	174	42,799	63,047

Table 6.11.13 List of the 2nd Priority Project (Alternative-1B)

No.	Ward	Village	Population 2009	Population 2020	Target Population	Level-2 No. of Level-2	Level-2 Population Served by Level-2	Level-1 No. of Level-1	Level-1 Population Served by Level-1	Total (2010)
	＜Igunga＞									
1	Chabuta	Igumo	3,148	4,548	4,548	0	0	6	1,500	1,500
	＜Nzega＞									
2	Ijanija	Idala	2,123	2,786	1,069	0	0	12	2,786	2,786
3	Lusu	Ifumba	3,226	4,233	3,483	0	0	12	3,000	3,000
4	Wela	Gulumuni	1,077	1,414	1,164	0	0	4	1,000	1,000
	＜Sikonge＞									
5	Kiloleli	Kanyamsen ga	2,825	4,125	4,125	1	2,888	5	1,250	4,138
6	Kipanga	Mwanamka ta	1,228	1,793	1,793	0	0	8	1,793	1,793
7	Kipanga	Urafiki	1,623	2,370	2,120	0	0	9	2,120	2,120
	＜Tabara Rural＞									
8	Ikongolo	Kanyenye	1,442	2,106	2,106	0	0	9	2,106	2,106
9	Ikongolo	Kiwembe	698	1,020	1,020	0	0	5	1,020	1,020
10	Mbama	Kalola	3,268	4,772	4,022	1	2,500	5	1,250	3,750
11	Mbama	Maswanya	2,122	3,099	3,099	1	2,500	1	250	2,750
12	Ndono	Nkulusi	2,370	3,461	3,461	1	2,500	0		2,500
13	Ufuluma	Mfuto	954	1,393	1,393	0	0	6	1,393	1,393
14	Upuge	Kasenga	797	1,164	1,164	0	0	5	1,164	1,164
	＜Tabara Municipality＞									
15	Uyui	Kalumwa	1,292	2,234	1,984	0	0	8	1,984	1,984
	＜Urambo＞									
16	Igalala	Kazana Upate	1,853	3,170	3,170	1	3,000	1	170	3,170
17	Igalala	Mtakuja Mashariki	2,054	3,514	3,514	1	2,500	5	1,014	3,514
18	Itundu	Mongwa	2,211	3,782	3,782	0	0	16	3,782	3,782
19	Kapilula	Ulasa A	1,072	1,834	1,834	0	0	6	1,500	1,500
20	Ukumbisiganga	Zugimole	18,00 0	30,787	30,787	0	0	20	5,000	5,000
21	Usisya	Mabundu ku	2,335	3,994	3,994	1	2,796	1	1,198	3,994
22	Usisya	Sipungu	2,086	3,568	3,568	1	2,498	5	1,070	3,568
23	Usoke	Usongelan i	635	1,087	1,087	0	0	4	1,087	1,087
Total			58,43 9	92,254	88,287	8	21,182	153	37,437	58,619

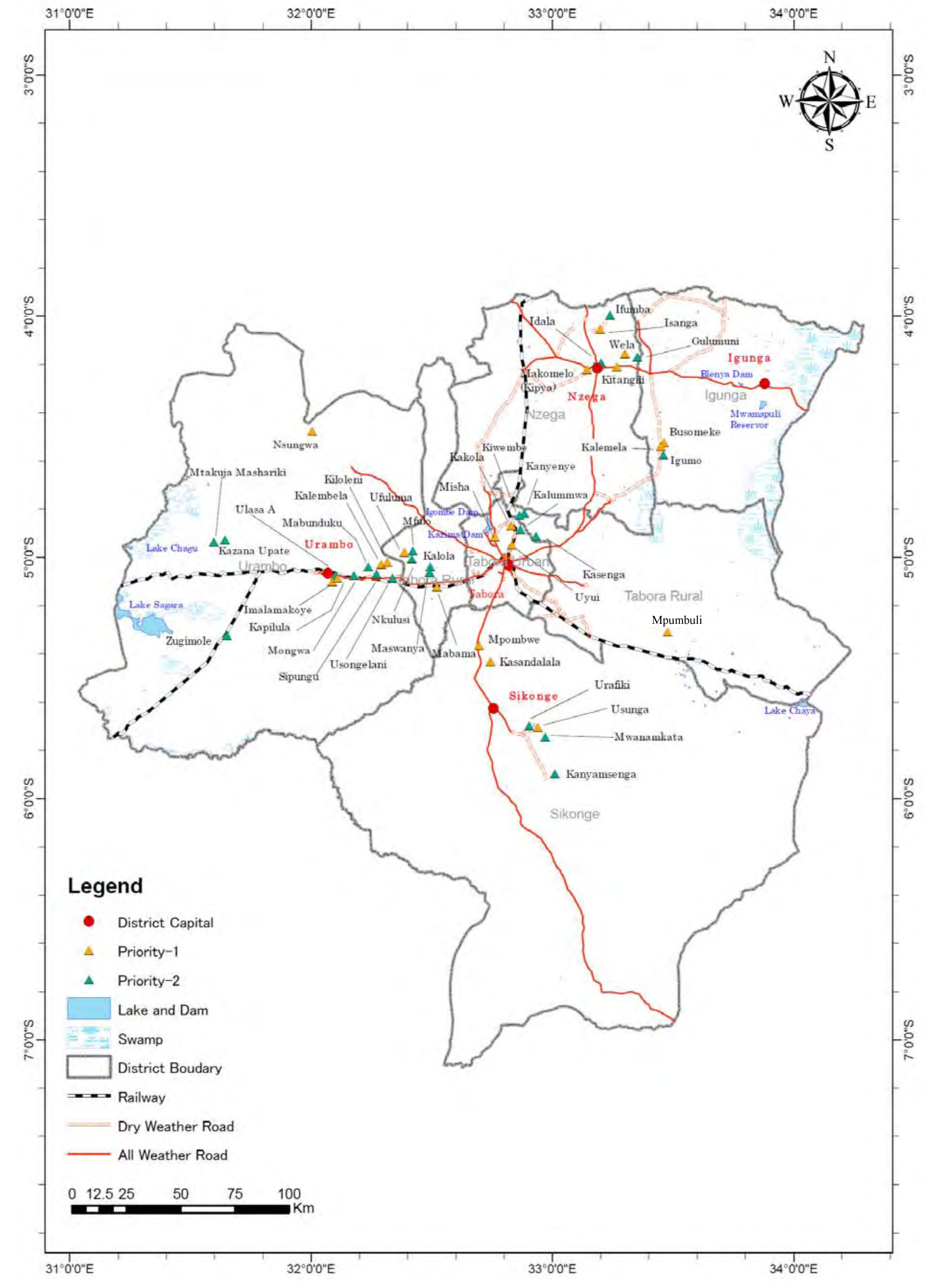

FIGURE 6.11.1 LOCATION OF CANDIDATE VILLAGES FOR PRIORITY PROJECT

THE STUDY ON RURAL WATER SUPPLY IN TABORA REGION	JICA

RERFERENCES

Japan International Cooperation Agency (2005), The Study on Water Supply Improvement in Coast Region and Dar es Salaam Peri-Urban in the United Republic of Tanzania, Final Report

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CHAPTER 7 OPERATION AND MAINTENANCE FOR RURAL WATER SUPPLY SCHEMES

7.1 GENERAL

Sustainability of rural water supply schemes has been a challenging issue in the rural water supply sector in Tanzania. This problem is highly associated with policy and legislative framework of rural water supply sector, and capacity of stakeholders involved in rural water supply, particularly, ability of local authorities in providing technical guidance and monitoring to the communities, as well as capability of communities in operating and maintaining rural water supply schemes. This chapter reviews current policy and legislative framework of rural water supply sector and examines current situation of operation and maintenance for rural water supply schemes, focusing on capability of local authorities and communities. In the latter part of this section, development issues for improved operation and maintenance of rural water supply schemes is discussed, which would be basis for considering and developing operation and maintenance plan in the Study.

7.2 POLICY AND INSTITUTIONAL FRAMEWORK

7.2.1 NATIONAL WATER POLICY AND NATIONAL WATER SECTOR DEVELOPMENT STRATEGY

The National Water Policy (NAWAPO) is the national basic policy for water resource management and water supply, of which principles in operation and maintenance for rural water supply system are to promote decentralization in implementation of water supply and sanitation projects to the lowest appropriate institutions, introduction of user-pay principle to recover the cost for operation and maintenance, and promotion of community-based management (CBM) to sustain the supply system. In NAWAPA, beneficiary communities are defined as users as well as owners of the supply system responsible for its operation and maintenance.

Key macro policies such as the National Development Vision 2025 set the stage for the Poverty Reduction Strategy and the Rural Development Policy that were then supported by the Local Government and Public Sector Reforms. The National Strategy for Growth and Reduction of Poverty or *MKUKUTA* (*Mkakati wa kukuza Uchumi na Kupungza Umasikini Tanzania*) sets operational goals and puts policy in a functional framework, which in the water sector is embodied in the National Water Sector Strategy of 2006.

National Water Sector Development Strategy sets out the main functions and responsibilities of each organization as presented in the following table (see Table 7.2.1).

It is obvious from the redefined functional roles and responsibilities of each institution from the Table 7.2.1, that the following issues are emphasized and consolidated as basic principles in development and reorganization of institutional framework, as stipulated in National Water Sector Development Strategy.

- Government's role will be limited to co-ordination, policy and guideline formulation, and regulation
- Regulatory and executive (i.e. service provision) functions will be separated.
- Responsibility for executive functions will be decentralized to the lowest appropriate level, whilst balancing consumer representation/participation with economies of scale.
- Responsibility for regulation will be separated from the prioritization and allocation of capital investment funds.
- Autonomous entities will be established to manage water supply and sewerage services in urban area.
- Community organizations will own and manage rural water supply schemes.

Table 7.2.1 Roles and Responsibility of Stakeholders in Water Supply Development

Organization	• Functions and Responsibilities
Ministry responsible for Water	– Policy and strategy development. – Advice EWURA in formulation of technical guidelines and standards. – Co-ordinates planning for projects of national importance. – Secure finance for projects of national importance. – Monitors performance and regulate COWSOs. – Provides technical guidance to Councils.
Water Supply and Sanitation Authorities (WSSAs)	– Own, manage and develop water supply and sanitation assets. – Prepare business plans to provide water supply and sanitation services, including capital investment plans. – Secures finance for capital investment, and relevant subsidies. – Contract and manage Service Providers. – Provide services not contracted out. – Formulates by-laws for service provision.
Service Providers	– Provide water supply and sanitation services in accordance with contractual requirements. – Collect revenue for services.
Community-Owned Water Supply Organizations (COWSOs)	– Own and manage water supply assets. – Operate and maintain water supply assets. – Determine consumer tariffs. – Collect revenue for the provision of services. – Contract and manage Service Providers.
Energy and Water Utilities Regulatory Authority (EWURA)	– Approve business plans of WSSAs – Issues operating licenses to WSSAs. – Approve service tariffs. – Publishes technical guidelines and standards. – Monitors water quality and performance of WSSAs. – Collect and published comparative performance data.
President's Office Regional Administration and Local Government	– Co-ordinates planning of projects from local government authorities. – Co-ordinates local government authority budgets. – Co-ordinates capacity building for local government authorities.
Municipal and District Council	– Representation on WSSA Boards. – Co-ordinate WSSA budgets within Council Budgets. – Disburses block grant funds to WSSAs. – Delegated performance monitoring and regulation of COWSOs.

Source：Water Sector Development Program (WSDP) 2006 to 2015

Key stakeholders in the rural water sector include: national government; regional administration; local government authorities; urban water supply and sewerage authorities (if involved in rural water supply), development partners; the private sector; non-governmental organizations; and community organizations. To ensure effective institutionalized linkages between stakeholders, the National Water Policy and National Water Sector Development plan prescribe new roles for different players in the water resources management and water supply and sanitation services as discussed above. In addition, enactment of Water Resources Management Act No.11 of 2009 and the Water Supply and Sanitation Act No.12 of 2009 has empowered different institutions to implement their mandated roles, according to National Water Policy and National Water Sector Development Strategy. This gives way to harmonization and synchronization of other sector laws and regulations to reduce contradictions and duplications.

7.2.2 WATER SECTOR DEVELOPMENT PROGRAM

The development objective of the Ministry of Water and Irrigation, as a sole policy maker in water sector, is to "strengthen water sector institutions in order to improve access to water supply and sanitation services and to ensure an integrated water resources management approach". The Ministry is also responsible for creating enabling environment and regulatory framework that harness the efforts of civil society, non-governmental organizations and international development partners.

To ensure a coordinated and harmonized approach to invest planning and implementation, the Ministry has embarked on a long-term Water Sector Development Program, using a sector wide approach to planning – a framework where financial resources for capital investment, from both Government and development partners, is provided in support of jointly agreed strategies and plans, under the leadership of the Government. Financial year of 2009/2010 is the third year WSDP implementation.

Ministry of Water and Irrigation, on behalf of the Government, is responsible for the implementation of WSDP, which comprises for components, namely: Water Resources Management; Rural Water Supply and Sanitation; Urban Water Supply and Sanitation; and Institutional Development and Capacity Building. Among those components, the objective of Rural Water Supply and Sanitation Component is described as; "to improve the quality of drinking water and sanitation services for the rural population sustained through improved district capacity, effective local water user entities, private sector participation and good hygiene and sanitation practices anchored in comprehensive district water supply and sanitation plans". Thus, as it is observed in its objective, WSDP in Rural Water Supply and Sanitation Component put emphasis on capacity development of district council in planning and implementation of rural water supply project through development and management of district water and supply plan, as well as capacity building of water user entities in operation and maintenance of rural water supply schemes.

7.2.3 INSTITUTIONAL FRAMEWORK FOR COMMUNITY-OWNED WATER SUPPLY

The following sections provide an overview of key rural water sector institution and entities and how these institutions and entities are interrelated.

(1) Ministry of Water (MoW)

Following the provision of National Water Policy and National Water Sector Development Strategy, and the ongoing reforms in the water sector, the Ministry of Water including in particular Directorate of Policy and Planning and Directorate of Administration and Human Resources are key actors in terms of supporting sector level planning, resource mobilization, coordination and implementation follow-up. Implementation management and executive functions are decentralized to the lowest appropriate levels (autonomous entities have been established to manage water supply and sewerage service in urban areas and community organization have been established to own and manage rural water supply schemes) and responsibility for regulation has been separated from the allocation and prioritization of capital investment funds.

(2) Local Government Authorities

Since community water supply services are decentralized to the local government level, local government authorities are expected to execute coordination, financing and facilitation function. Local government authorities are responsible for the planning and management of their rural water and sanitation plans, as well as for the procurement, financing, management and monitoring of contractors, consultations and other local service providers. Local government authorities are required to establish an enabling environment for community and private sector participation in the provision of water and sanitation services. Councils are represented on water resources management boards and committees to ensure the presence of an elected voice of the people during core decision making regarding water resources conservation, management, allocation, development and utilization.

Local government authorities are also responsible for regulation and monitoring of rural water supply services and Community-Owned Water Supply Organizations (COWSOs) on behalf of Ministry of Water and Irrigation. In this set-up, the capacity of local government authorities at the district and village level in supporting COWSOs is crucial for improved water supply and sanitation services in rural areas.

(3) District/Municipal Water and Sanitation Team (DWST/MWST)

District/Municipal Water and Sanitation Teams (DWST/MWST) are established under local government authorities (i.e. Municipal and District Council) in order to support and strengthen the capacity of local government authorities in planning, implementation, and monitoring of water supply services. DWST/MWST shall be composed of; 1) District/Municipal Executive Officer as chairperson, 2) DWE/MWE as Secretary, 3) District/Municipal Planning Officer, 4) District/Municipal Health Officer, and 5) District/Municipal Community Development Officer. This composition and membership can allow the integrated and sector-wide approaches in their planning, activities, and monitoring.

DWST/Municipal is expected to take the following roles and responsibilities in the implementation of water and sanitation project: 1) coordination of the day-to-day project activities in the district, 2) coordination, appraisal of community sub-project proposal, and selection of communities for assistance for presentation to the full council for approval, 3) coordination and provident linkage between partner organization and the communities, 4) providing support for training and capacity building of the private sector, NGOs, CBOs (community-based organizations), and communities, and 5) Assessing communities in letting and managing contract, and 6) providing technical support to communities.

One of important task for DWST/MWST, on behalf of local government authorities, is to provide technical and managerial guidance and monitoring services for Community-Owned Water Supply Organizations (COWSOs) in their organizational management, and operation and maintenance of the rural water supply schemes. In the decentralized framework of operation and maintenance according to the national sector policy and strategy, capacity of DWST in providing guidance and monitoring for COWSOs becomes considerably critical for improved rural water supply services.

(4) Community-Owned Water Supply Organization

Although, in National Water Policy, institutional forms for community-based management of the rural water supply system are not clearly defined, establishment of a Village Water Committee (VWC) placed under Village Government has been necessary in the country to facilitate community-based operation and a maintenance mechanism for rural water supply schemes. However, VWC has preparative and passive characteristics as an organization only receiving benefits from the government through implementation of the project without thorough enhancement of their capacity in operation and maintenance--such as daily operation and repair of the supply facilities, water fee collection, accounting, and organizational management. Indeed, there are considerable numbers of VWCs that are not functioning as expected. Reflecting the status of VWCs established in the past, in the National Water Sector Development Strategy (NWSDS, 2006-2014) developed to determine the strategy for realization of NAWAPO, and in the National Water Sector Development Program (WSDP, 2006-2025) prepared for the strategic implementation of the project according to NWSDS, a Community-Owned Water Supply Organization (COWSO) is advocated. The roles and responsibilities of COWSO set out in the basic strategy and program can be summarized as follows:

- Own and manage water supply assets
- Operate and maintain water supply assets
- Determine consumer tariffs
- Collect revenue for the provision of services
- Contract and manage Service Providers

COWSOs are community-based organizations, which are vested with legal status by registering them under the Local Government Authorities (LGAs) and duly facilitate the community's sense of ownership. COWSO has deferent legal forms. There are several options for rural water supply and sanitation management systems for both small scale and large schemes. These COWSOs are in the form of a Water User Group (WUG), Water User Association (WUA), Water User Trust/Cooperative, Water Company by Guarantee, and Water Company by Share. Among these organizational options, the ones that are most generally introduced for improved community-based management are WUAs and WUGs.

WUA is a general assembly in which all registered users of supply system in the community participate. In the general assembly, executive committee members of WUA are elected or appointed, generally comprised of (vice-) chairperson, (vice-) secretary, treasurer, and ordinary members. In order to be WUA, it shall prepare and submit organizational and operational regulations of the association and be registered by the LGAs. WUA is formed per village which manage the entire community piped water scheme (Level-2) with several numbers of public stand posts. On the other hand WUG are formed per domestic water points, and its representatives are selected among users of the particular domestic point. It is usually composed of a chairperson, secretary and treasurer. Some numbers of WUAs in a particular village manage domestic points, while others are formed as subordinate organizations of WUA.

The following diagram shows institutional framework and interrelationship of each institutions and entities described above.

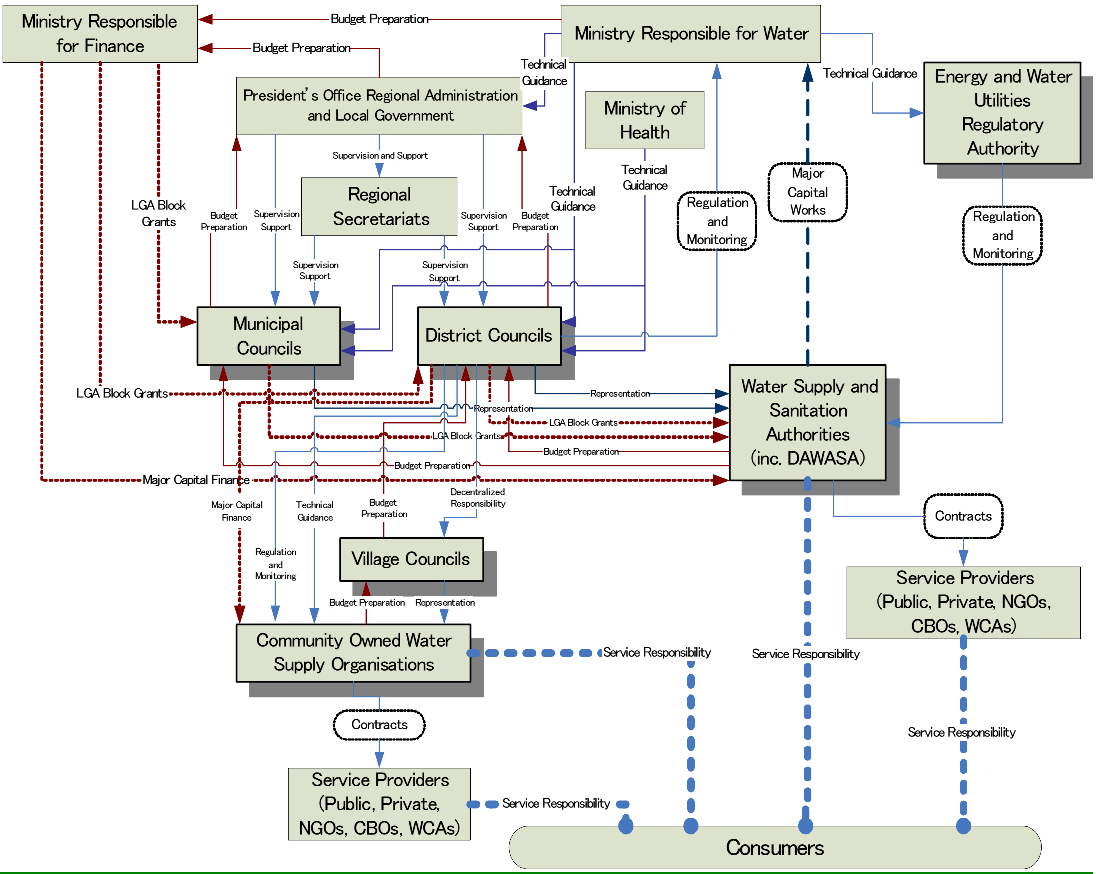
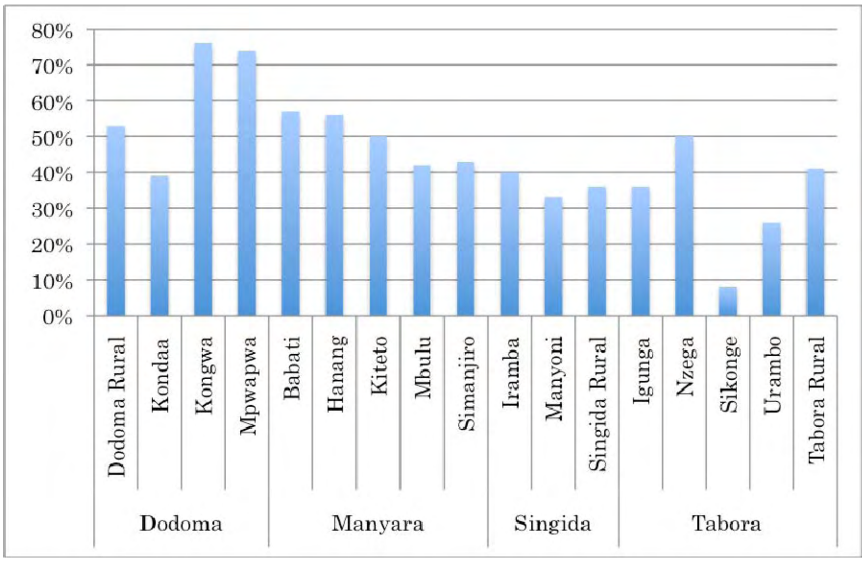


Figure 7.2.1 Institutional Framework for Rural Water Supply Development

7.3 DEVELOPMENT ISSUES FOR OPERATION AND MAINTENANCE

7.3.1 FUNCTIONALITY OF RURAL WATER SUPPLY SCHEMES

Water Aid Study of 2005 in 20 districts in four regions (Dodoma, Manyara, Singida, and Tabora) classified water points that at least yielded water for six (6) months of the year and water used by people as a water source on a daily as functional (World Bank, 2009). The survey found that an average only 54% of the water points surveyed were functional. Yet, functionality varied significantly between regions. Tabora had the lowest functionality rate at 29% while that of Dodoma was 54% (refer to Figure 7.3.1 below). Although it is analyzed in the study that hydro-geological conditions play an important role for lower functionality rate in the regions and particularly in Tabora region, a breakdown rate of between 22 and 46% per year suggests that lack of maintenance is major issues.



Source: Tanzania Public Expenditure Review of Tanzania (World Bank, 2009)

Figure 7.3.1 Percentage of Functional Water Points in 17 Districts and Four Regions

As discussed in Chapter 5, the inventory survey on the existing rural water supply schemes in all six District/Municipality in Tabora Region conducted under the Study (JICA, 2009) revealed that functionality rate of Level-1 schemes amounts to 47% in average, while one of Level-2 schemes amounts only to 35%. Comparing to the results obtained under Water Aid survey mentioned above, functionality rates obtained by JICA Study is relatively higher. It may be due to the selection criteria of water supply scheme, that Water Aid surveyed water points that at least yielded water for six (6) months of the year, while JICA Study covered all the water points with supply facilities irrespective of the water yield. Thus, a considerable number of water points with supply facilities, which have deteriorated hydro-geological conditions, are included into non-functional in JICA inventory survey.

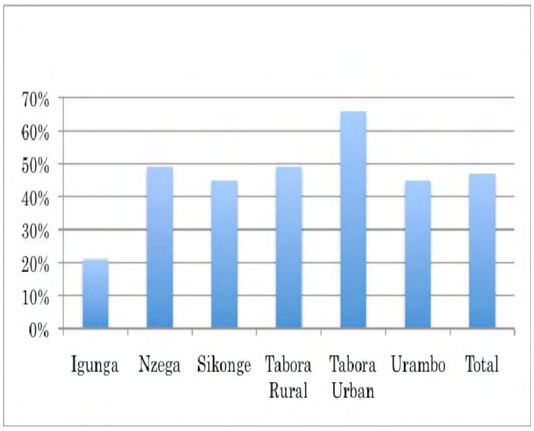
Functionality rate in JICA inventory survey ranges among District/Municipality from 24% in Igunga District to 66% in Tabora Municipality. The following table shows the number and percentage of functional/non-functional Level-1 and Level-2 scheme in each District/Municipality.

Table 7.3.1 Number and Percentage of Functional/Non-Functional Water Supply Scheme and Operational Status (Level-1 and Level-2 Scheme)

District /Municipality	Level-1					Level-2					Total				
	Total Number	Functional (Number)	Functional (%)	Not Functional (Number)	Not Functional (%)	Total Number	Functional (Number)	Functional (%)	Not Functional (Number)	Not Functional (%)	Total Number	Functional (Number)	Functional (%)	Not Functional (Number)	Not Functional (%)
Igunga Dist	100	21	21	79	79	9	5	56	44	40	109	26	24	86	79
Nzega Dist	521	255	49	266	51	7	0	0	100	87	528	255	48	276	52
Sikonge Dist	129	56	43	71	55	2	2	100	0	0	129	58	45	70	54
Tabora Rural Dist	189	92	49	97	51	10	3	30	70	70	199	95	48	104	52
Tabora Mun	85	56	66	29	34	2	1	50	50	50	87	57	66	30	34
Urambo Dist	398	180	45	218	55	19	6	32	68	68	417	186	45	231	55
Total	1,420	660	46	760	54	49	17	35	65	63	1,469	678	46	797	54

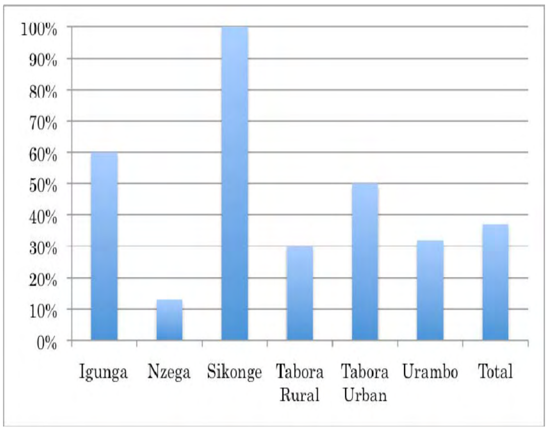
Source: Inventory Survey on the Existing Rural Water Supply Scheme (JICA, 2009)

The following figures show the functionality rate of Level-1 and Level-2 scheme in each District/Municipality in Tabora Region.



Source: Inventory Survey (JICA, 2009)

Figure 7.3.2 Functionality Rate of Level-1 in each District



Source: Inventory Survey (JICA, 2009)

Figure 7.3.3 Functionality Rate of Level-2 in each District

It is observed that functionality rate of Level-1 scheme in Igunga is considerably lower than other districts (Functionality rate of Level-1 scheme in Igunga amounts only to 21%, while average in all six districts/municipality amounts to 46%). It could be attributed that a large number of hand pump in Igunga District were installed from 1970s to 1990s. Hand pumps installed since 1970s up to 1990s in Igunga District is shared at 58%, while one of other District/Municipality ranges from 0 (zero) to 16%.

However, it shall be noted that functionality rates of Level-1 scheme constructed in 2000s in all six districts/municipality are not higher than assumed. Indeed, among 1,093 hand pumps, 475 numbers of hand pump (43%) are reported as not functional. Although, as discussed Chapter 5, there are considerable number of Level-1 schemes are not functional due to less or no yield of well (52% of Level-1 schemes are abandoned or not functional due to dried-up of well), breakdown rate of 43%, all of which hand pumps were installed 2000s, suggests that lack of maintenance is a major issues. Indeed, 36% of non-functional Level-1 schemes attributed its non-functionality to problem with pump. JICA inventory survey (2009) also revealed that only 40 numbers of Level-1 schemes out of 1,420 were experienced with repair (two (2) schemes in Igunga, 10 schemes in Tabora Rural, five (5) schemes in Tabora Municipality, and 23 schemes in Urambo). The following table shows the functionality rate of Level-1 schemes, which were constructed in 2000s in each District/Municipality.

Table 7.3.2 Functional Rate of Level-1 Scheme Constructed in 2000s in each District/Municipality

District /Municipality	Total No. of Level-1 Scheme Constructed in 2000s	No. of Functional Level-1 Scheme	Functionality Rate
Igunga Dist	29	14	48%
Nzega Dist	477	267	56%
Sikonge Dist	119	57	48%
Tabora Rural Dist	119	72	61%
Tabora Mun	86	56	65%
Urambo Dist	263	153	58%
Total	1093	618	57%

Source: Inventory Survey on the Existing Rural Water Supply Scheme (JICA, 2009)

Capacity of communities in each District/Municipality in Tabora Region to operate and maintain Level-1 schemes may differ significantly. It is observed that in Tabora Rural District and Tabora Urban (Municipality) the functionality rate is relatively higher than other districts. It may due to their location that makes it easier to access more skilled labour and spare parts.

Total of 49 Level-2 schemes are confirmed in Tabora Region under JICA inventory survey (2009) (9 schemes in Igunga, eight (7) schemes in Nzega, two (2) schemes in Sikonge, 10 schemes in Tabora Rural, two (2) schemes in Tabora Municipality, and 19 schemes in Urambo). Verifying 17 schemes are functional and other 32 schemes are not functional, functionality rate of Level-2 schemes are lower than one of Level-1 schemes, amounting to only 35%. In comparison to the major reason of non-functionality for Level-1 scheme, dried-up or less yield of well or other water source are not major reason for non-functionality of Level-2 scheme. Major reasons for non-functionality of Level-2 schemes are broken down of mechanical pump unit (12 schemes, 21%), followed by theft of pump (nine (9) schemes, 16%), dried-up or less yield of water sources (seven (7) schemes, 13%), and pipe leakage (four (4) schemes, 7%). The following table shows the reasons for non-functionality of Level-2 scheme in each District/Municipality.

Table 7.3.3 Reason for Non-functionality of Level-2 Scheme

District /Municipality	Water Source Dried-up	Pump Broken	Pump Stolen	Pipe Leakage	Unknown
Igunga Dist	2	1		3	1
Nzega Dist	1	4	2		
Sikonge Dist			2		
Tabora Rural Dist	3	2	1	1	1
Tabora Mun			1		
Urambo Dist	1	5	3		4
Total	7	12	9	4	6
Percentage	13%	21%	16%	7%	11%

Source: Inventory Survey on the Existing Rural Water Supply Scheme (JICA, 2009)

It is obvious that the non-functionality of Level-2 schemes are much attributed to capacity of community in operation and maintenance including security for the scheme rather than the natural conditions.

7.3.2 Community-Owned Water Supply Organization (COWSO)

As described earlier, VWCs have been established under the Village Government as community-based organizations for operation and maintenance of rural water supply schemes in the country. However, without development of their capacity in operation and maintenance, considerable numbers of VWCs have not been functioning as expected. VWC also tends to be interrupted and disturbed by the Village Government since it is a subordinate organ of Village Government. It is often reported that the water fees collected are used by the Village Council for purposes not connected with operation and maintenance of water supply schemes. Currently, the national sector strategy and program advocate introduction and establishment of COWSO has improved the sense of ownership.

Advantages of WUA and WUG in operation and maintenance of rural water supply schemes are that the sense of community ownership is improved through community assistance provided by Service Provider (SP) such as facilitation in preparation of organizational and operational regulation, legal registration, and provision of various sets of training for enhancing capacity of the community in operation and maintenance (system/facility operation, organizational management, fee collection, accounting and financial management).

However, a Socio-Economic Condition Survey conducted under the Study, which was implemented in all the target villages (549 villages in total) in the Study area, revealed 38 villages (6.9% in the total number of villages) formed WUG, while only 16 villages established WUA (2.9% in the total number of villages). Otherwise, most of the villages (73.8% in the total number of villages) own a conventional VWC. In the field survey under the Study, it was observed that VWCs are usually formed in the village of which major water sources are the traditional water source and/or hand pump facilities, but cannot properly cope with breakdowns of supply facilities without collecting water fees for covering operation and maintenance costs.

Table 7.3.4 Form of Community-Based Organization for Water Supply Scheme Management

District /Municipality	Village Water Committee	Water User Group	Water User Association
Igunga Dist	57	6	3
Nzega Dist	73	23	10
Sikonge Dist	42	0	2
Tabora Rural Dist	64	2	0
Tabora Mun	18	0	0
Urambo Dist	84	7	1
Total	338	38	16
Percentage	73.8%	6.9%	2.9%

Source: Socio-Economic Condition Survey (JICA, 2009)

It has also been confirmed that most WUAs and WUGs in the Study area are formed through assistance of NGOs (in particular Water Aid in Nzega and Urambo Districts) with provision of capacity development training. Although DWSTs in the Study area have accompanied NGOs in formation and training of WUA and WUG, they have no experience in providing such assistance to the community only by themselves, thus the basis of the district authority for facilitation of community-based management is not adequately established. These COWSOs established in the Study area through assistance of NGO are provided with the following training according to WSDP guidelines.

- Organizational set up and management
- Facilitation of community participation
- Accounting and financial management
- Operation and maintenance of rural water supply schemes
- Improvement of personnel hygiene practices
- Coordination with stakeholders

In the Study area, formation of COWSO with an improved sense of ownership and establishment of supporting system by DWST for introduction of community-based management are key development issues for better operation and maintenance of rural water supply schemes.

7.3.3 WATER FUND AND WATER FEE COLLECTION

In the country, user-pay principle in operation and maintenance of rural water supply services is introduced in accordance with National Water Policy and National Water Sector Development Strategy. Accumulation of community water fund as well as collection and management of water fee is one of vital capacity area for sustainable operation and management of rural water supply schemes.

Among 545 numbers of communities which owns Level-1 schemes, only 154 communities (28% in total) create water fund, while among 74 communities which possess Level-2 schemes, 35 communities (47% in total) establish their water fund. Amounts accumulated in community water fund is considerably differ among communities, which ranges from Tsh. 50,000 to Tsh. four (4) million. The following tables explain ranges of amounts accumulated in community water fund in each District/Municipality in Tabora Region (community with Level-1 scheme and Level-2 scheme).

Table 7.3.5 Ranges in Amount of Community Water Fund (Level-1 Scheme)

Unit (1,000 Tsh)

District /Municipality	Total No. of Communities with Level-1 Scheme	Total No. of Communities with Water Fund	Ranges in Amount Accumulated in Water Fund				
			<100	100<300	300<500	500<1,000	>1,000
Igunga Dist	94	11		6	1	3	1
Nzega Dist	153	47	16	18	5	7	1
Sikonge Dist	53	13	0	4	1	1	7
Tabora Rural Dist	109	21	2	8	0	1	10
Tabora Mun	24	11	6	4	0	0	1
Urambo Dist	112	51	11	20	6	12	1
Total	545	154	35	60	13	24	21
Percentage		28%	6%	11%	2%	4%	4%

Source: Inventory Survey on the Existing Rural Water Supply Scheme (JICA, 2009)

Table 7.3.6 Ranges in Amount of Community Water Fund (Level-2 Scheme)

Unit (1,000 Tsh)

District /Municipality	Total No. of Communities with Level-2 Scheme	Total No. of Communities with Water Fund	Ranges in Amount Accumulated in Water Fund				
			<100	100<300	300<500	500<1,000	>1,000
Igunga Dist	15	9		2	1	3	3
Nzega Dist	9	2		1	1		
Sikonge Dist	11	5		3		2	
Tabora Rural Dist	11	6	2	1		1	2
Tabora Mun	4	3		3			
Urambo Dist	24	10	2	4	1	2	1
Total	74	35	4	14	3	8	6
Percentage		47%	5%	19%	4%	11%	8%

Source: Inventory Survey on the Existing Rural Water Supply Scheme (JICA, 2009)

On the other hand, among 351 numbers of communities which possess Level-1 scheme, 131 communities (24% in total) carried out periodical or regular fee collection on daily or monthly basis (1 community in Igunga, 57 in Nzega, 30 in Sikonge, 24 in Tabora Rural, 12 in Tabora Rural, and 6 in Urambo), while among 74 communities which own Level-2 scheme, 35 numbers of communities (47% in total) has practice of periodical of regular user fee collection (seven (7) communities in Igunga, one (1) in Nzega, two (2) in Sikonge, one (1) in Tabora Rural, and four (4) in Urambo).

In the most cases where periodical or regular fee collections are practiced in the communities managing Level-1 scheme, Tsh 20 per 20-litre container (i.e. 1 Tsh/L) is charged as user fee. Also, in the communities running Level-2 scheme, most of them are charging water user fee at Tsh. 20 per 20-litre container. However, it is observed that three (3) communities set water user fee at Tsh 50/20 litre container (i.e. 2.5 Tsh/L) and 2 communities sets the one at Tsh 30/20 litre container (i.e. 1.5 Tsh/L).

7.3.4 District/Municipal Water and Sanitation Team

As discussed earlier, an actively involved District/Municipal Water and Sanitation Team (DWST/MWST) is indispensable for successful introduction of COWSO in the Study area. In the introduction and establishment of community-based management for the rural water supply system, the DWST/MWST takes significant roles and responsibilities as the administrative organ. DWST/MWST is also established under local authority according to the operation and maintenance principles of NWSDS and WSDP, of which the objective is to enhance capacity of the district council (district local authority) expected to function as a pivot in planning, implementation and monitoring of water supply and sanitation development in the mainstream of decentralization as well as promote a multi-sector approach in intervention for establishment of community-based management for the rural water supply schemes.

However, some of the DWSTs/MWST in the Study area are inactive, and some of them are not functioning as expected. It is because the officials who are members of the DWST/MWST, such as the DED, are not day-to-day managers of the water and sanitation sector program and project. They may need to be consulted and decisions may need to be referred to these officials, but the technical responsibility for planning and implementing activities rests with the District Water Engineer, Community Development Officer, Environmental Health Officer, etc.

Their activities are often limited in decision making in preparation and implementation of the district development plan that is not accompanied by field operations conducted by the managers themselves. It is also pointed out that lack of human and financial resources and equipment has a negative impact on the activities of DWST. The fundamental problems of the DWST/MWST revolve around its membership and less clarity of task responsibility.

The Program Implementation Manual (PIM) prepared by MoW for the Water Sector Development Program defines tasks of the DWST/MWST, but does not assign specific areas of responsibility to specific individuals and lines of accountability are not clear. These two factors alone make the DWST/MWST a fragile body. The task of DWST are probably complicated by proliferation of committees at village and community level to the extent that these may create confusion, and consequently conflict, because of overlap.

The Local Government Law (Miscellaneous Amendments) Act No.13 of 2006 assigns the Regional Administration Secretariat an advisory and monitoring role for the water sector through Regional Water Engineer, but how the RWE will perform its role is still not clear enough. The Regional Water and Sanitation Team (RWST) are formed in Tabora Region, but not yet effective enough in supporting local government authorities and DWST/MWST due to lack of human and financial resources, and overall clarity of roles and responsibilities.

7.4 Strategy for Development of Operation and Maintenance Plan

Reviewing the current policy and institutional framework as well as development issues for improved operation and maintenance of rural water supply scheme, outline of basic strategies for development of operation and maintenance plan is discussed in this section.

The Community-responsible principles based on a participatory model of community-based management and provision of technical guidance to the communities by local (District/Municipal) Councils, in particular, DWE/MWE Office, has been adopted for the establishment of operation and maintenance system for rural water supply schemes. In this approach, community-based organization has been encouraged to actively participate and develop their capacities in operation and maintenance of the supply schemes, while local government authorities and District/Municipal Water Engineer Office in particular is responsible for provision of training and monitoring to develop capacity of the communities in operation and maintenance of the supply schemes. Following this approaches employed as a sub-sector strategy in the country, the project operation planning under the Study adopts the basic framework of; 1) facilitation of participatory model of community-based operation and maintenance through formation and capacity development of the community-based organization, and, 2) enhancement of preparedness in provision of technical guidance by local councils.

Taking consideration on problems in operation and maintenance of existing water supply scheme, the following issues shall be given significance in preparation of project operation plan.

7.4.1 Formation of Community-Owned Water Supply Organization with Enhanced Awareness on Community Ownership

In the Study area, conventional Village Water Committee (VWC), which is appointed by and formed under Village Council, has been expected functional in operation and maintenance of rural water supply scheme. However, organizational nature of VWC can be regarded as "consumer group", which has less awareness and expertise for the scheme management as "service provider". Thus, in the most cases in the Project area, VWCs are not performing their expected roles and responsibilities in the scheme management.

While the limited capacity of VWCs in operation and management of the supply scheme has been pointed out, various forms of community-based water supply organization has been developed and introduced, among which those organizations become established in the country, such as Water User Group (WUG), Water User Association (WUA), Water Trust/Cooperative, Water Company by Guarantee, and Water Company by Share. Those community-based water supply organizations are established by the beneficiary group and legal ownership of the scheme is vested with, facilitating their awareness and capacity in the scheme management through the processes such as community consensus building on management options, election of executive members, preparation of constitutions, registration of organization under appropriate authority, training provided by local authority or NGOs/local consultant for capacity development of the community-based organization in the scheme management. Through those process of formation, community awareness and capacity in the scheme management and sense of ownership is enhanced, which can be regarded as feature of those community-based water supply organizations. The National Water Sector Development Strategy 2005-2015 advocates establishment of community-based operation and maintenance in rural water supply development, facilitating legalization of community ownership through registration process of the community-based organizations, which are defined as "Community-Owned Water Supply Organization (COWSO)". Concept of COWSO, defined in the National Water Sector Development Strategy, is introduced in the operation and maintenance plan under the Study.

7.4.2 Capacity Building of Community in Operation and Maintenance

While establishment of COWSO is facilitated that is expected to take initiative in operation and maintenance of the supply scheme, capacity development of the organization in the scheme management is also desirable. However, most of the target communities has less experienced in organizational management of the supply scheme. Survey results and findings, gained through the

Study and experiences of NGOs involved in the capacity development community in the Study area identify the training needs for the target communities and suggest provision of training for improvement of their capacity in the following concerns to assure sustainability in the community-based operation and management;

– Leadership skill
– Community communication skills
– Organizational/Institutional management skills
– Tariff setting and collection methods
– Financial management skills such as budget preparation, accounting, and fund management
– Technical operation and maintenance, and trouble shooting
– Participatory monitoring and evaluation with preparation of monitoring check list

7.4.3 INTERFACING COWSO WITH LOCAL ADMINISTRATIONS

Lack of institutional support, such as technical guidance for the community in formation of community-based organization, organizational management, financial management and accounting, and follow-up and monitoring, has been regarded as one of major problem in operation and maintenance of rural water supply scheme, which is also regarded as one of causes for low functional rate of the supply scheme in the Study area. Although MoW is the implementing agency responsible for the Project, in the operation and maintenance stage, District/Municipal Water Engineer office (DWE/MWE) under District/Municipal Council is responsible in provision of technical guidance to the communities. Thus, capacity development of DWE/MWE in provision of technical guidance to the community is indispensable for the sustainability of the Project. Prior to the implementation stage, capacity development of District/Municipal Council is facilitated, through strengthening of and provision of training packages to the District/Municipal Water and Sanitation Team (DWST/MWST). In general, DWST/MWST is formed under each District/Municipal Council and consists of District/Municipal Water Engineer (DWE/MWE), District/Municipal Planning Officer, District/Municipal Health Officer, District/Municipal Community Development, of which composition enables integrated approach for the sub-sector development. In the operation and maintenance plan of the Study, capacity of DWST/MWST is improved to form community-based operation and maintenance structures, and functional roles and responsibilities of the organization to provide technical guidance and monitoring for the communities in the subsequent stages are also enhanced.

7.4.4 COST RECOVERY FOR OPERATION AND MAINTENANCE

User-Pay Principle (UPP) is introduced in the country for operation and maintenance of rural water supply facilities. Inventory survey (JICA, 2009) revealed that only one-third of the communities owing their rural water supply facilities carry out water user fee collection. In circumstances that the most cases where periodical or regular fee collections are practiced in the communities managing Level-1 scheme, and considerably less number of communities operating and maintaining the facilities in a sustainable manner through fee collection are not found in vicinity, JICA inventory survey found that their willingness to pay (WTP) amount only to 0.66 Tsh/L and 0.41 Tsh/L respectively for Level-2 and Level-1, which is less than 1.0 Tsh/L of de-facto standards in the country. The detailed socio-economic survey (JICA, 2010) also confirmed that mean monthly household income in the target communities amounted to 150,000 – 200,000 Tsh. Setting water user fee at 1.0 Tsh/L as standardized in de-facto manner and assuming their water consumption at 25 L/capita/day by average of seven (7) household members, ratio of expenditure for water in total household income amounts to 2.5 to 3.5%, which is less than the limit of 5% to assure their affordability to pay (ATP) for water. Thus, it is become obvious that 1.0 Tsh/L is water user fee affordable for the communities. Thus, considering there is less community regularly and customary collecting water fee and ATP is higher while WTP is lower, component activities to increase their awareness and willingness in user-pay principle is indispensable.

Operation and maintenance cost for Level-1 (borehole fitted with hand pump) is estimated by using experiences from similar projects, dividing into maintenance cost, remuneration for accountants as management cost, replacement cost, and risks and inflation (refer to Table 7.4.1).

Table 7.4.1 Basis of Operation and Maintenance Cost Estimation for Level-1

Cost	Item	Value（USD）/year
Maintenance Cost	Wage (Caretaker)	150
	Tools	10
	Material	40
	Spare parts	100
	Regular Maintenance of Hand Pump	50
Management Cost	Commission (Treasurer)	100
Replacement Cost		130
Inflation and Risks		6.6
Total		586.5

Source：Brikke, F (2001), Key factors for sustainable cost recovery, IRC, Netherlands

Setting served population per Level-1 supply facility at 250 persons, from indicated figure of 586.5 USD/year as entire operation and maintenance cost in above table, it can be converted to 2.34 USD as operation and maintenance cost per person. Assuming average household size at 6.3 person based on the detail socio-economic survey (JICA, 2010), operation and maintenance cost per household becomes 1.23 USD/month, or 1,765 Tsh/month (1 USD = 1,435 Tsh). This amount of operation and maintenance cost per household indicates 1.5% of mean household income (i.e. 121,204 Tsh) in Tabora region, which stays with in 5% of household income recommended by international institutions, such as world bank, as maximum indicator set as amount affordable to pay (ATP) for water by household.

In the estimation of operation and maintenance cost for Level-2 facilities (small-scale piped water scheme with domestic water points), in addition to the operation cost such as fuel and labor cost, remuneration for formed COWSO members and cost for overhaul of motor pump shall be included as maintenance cost, as well as office cost for COWSO and replacement of the facility, in order to calculate realistic cost that assures sustainability of the Level-2 facility. The basis of estimation for operation and maintenance cost is shown in the following table.

Table 7.4.2 Basis of Cost Estimation for Operation and Maintenance (Level-2)

Cost	Item	Approximation/Year
Operation Cost	Fuel/Electricity	Consumption in each scheme is estimated, market price (*1) is applied
	Wage and Allowance	
	Operator	100% of mean annual income / person in Tanzania (*3)
	Kiosk Attendant	25% of mean annual income / person in Tanzania (*3)
	Guards	80% of mean annual income / person in Tanzania (*3)
Management Cost	Commission for COWSO	
	Manager	100% of mean annual income / person in Tanzania (*3)
	Treasurer	100% of mean annual income / person in Tanzania (*3)
	Overhaul of Pump	3% of cost for pump
Maintenance Cost	Tools, Supply	10% of construction cost
	Spare parts	
	Regular Pump Maintenance	
Replacement		Construction cost ÷15 years
Risks and Inflation		5% of replacement cost

*1 : Unit price of diesel: 1,898 Tsh/liter, Unit price of electricity 129 Tsh/Unit

*2 : Unit price of chemical: Tsh/Kg

*3 : Mean Monthly Income 620,136 Tsh/person（Household Budget Survey 2007, National Bureau of Statistics, Tanzania, 2009)

Based on the table above, analysis of each target community on affordability to pay (ATP) and sustainability of operation and maintenance shall be made in preparation stage of the project. The following table shows the ratio of operation and maintenance cost in household income according to the size of served population, based on the calculation basis above and assuming the mean monthly household income at 200,000 Tsh/month.

Table 7.4.3 Ratio of Operation and Maintenance Cost in Household Income (Level-2)

Unit: Tsh

Served Population	Served Household	O&M Cost/Year	O&M Cost /Household /Month	Ratio of O&M Cost in Household Income
1,000	159	25,050,524	13,152	6.6%
1,500	238	31,436,869	11,003	5.5%
2,000	317	37,469,635	9,836	4.9%
2,500	397	43,627,980	9,162	4.6%
3,000	476	49,786,332	8,713	4.4%
4,000	635	62,103,032	8,151	4.1%
5,000	794	74,419,733	7,814	3.9%
6,000	952	86,736,436	7,589	3.8%

As observed in the table above, the more the served population is increased, the higher the construction is. However, it also observed that when the served population exceeds to more than 2,000, the ratio of operation and maintenance cost become less than 5%.

Thus, considering there are less community in the Project area that regularly and customary collects water fee and ATP is higher while WTP is lower, measures, such as advocacy, to increase their awareness and willingness in user-pay principle is incorporated in the operation and maintenance plan.

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