2.2.4 Water Supply Projects

In the Third National Development Plan (1979-83) that was launched in October 1979, the objectives and priority items of the water resources development were set up as follows:

- To secure permanent water sources that satisfy quality and quantity.
- To provide effective preventive measures to protect water sources from contamination.
- To establish an appropriate, effective water supply basic policy and legal system for securing the amounts and quality standards of water demands in all water use sectors.
- To establish water supply administrative organizations at government and provincial levels.
- To maintain accurate water source records.
- To make laws to effectively realize the above objectives.

In the Interim National Development Plan (July 1987-December 1988) that was launched in 1987 as a new economic recovery plan, it was stipulated that for water resources development a permanent supply of acceptable quality water for each water use purpose would have to be secured. To attain the objective, the following two items were specified:

- To collect data related to water resources and evaluate surface water and groundwater potentials throughout the entire country.
- To continuously go forward with water supply projects to provide a supply of safe drinking

water to 100% of the urban population and 50% of the rural population by the year 2,000 (see Table 2-2-5 for the present water supply rates).

Water supply projects that are in progress under 1987 and 1988 fiscal year budgets are listed in Table 2-2-10 (these are rural water supply projects).

Rural water supply projects that have been started with the use of foreign aid since January 1983 are shown on the map in Fig. 2-2-2. From this map it can be understood that these rural water supply projects have been undertaken on a nationwide scale.

In 1985, the Groundwater Development Project (Phase I) in the Southern Province was started with grant aid cooperation from the Government of Japan in an area where no rural water supply project had been planned. Dams and wells, both shallow and deep, that were constructed under the jurisdiction of DWA are listed in Table 2-2-11.

During the period from 1964 through 1986, 5,047 shallow wells (59.3%), 3,363 deep wells (39.5%), and 96 dams (1.1%) were constructed throughout the country. Judging from these figures, and, on the fact that the population density in the rural areas is small, it can be understood that the point water supply facilities of wells that utilize groundwater sources have been mainly adopted for the rural water supply development projects of DWA, and that this tendency will continue even in the future.

Table 2-2-10 ONGOING WATER SUPPLY PROJECT (1)

	Project	Province	Area and Others	Aid-Agency	Aid Condition	Period	Contents	Expenditure Estimates 1987	Expenditure Estimates 1988	Remarks
Under the DWA	Wester Province Water Supply	Western	8 SUT* RA*	NORAD (Norway)	Grant	1979-	Construction of 700 dug wells/boreholes. Establishment of a training school	x1000K 7,562.5	x1000K 2,000	Completed 628 wells/ boreholes.
	Township Water Supply Programe	Northern Luapula	4 SUT RA	WB (World Bank)	Loan	1983-1988	Construction of 670 wells. Rehabilitation of 175 boreholes	4,745	8,000	24 million K has been committed. Completed 391 wells and 23 boreholes.
	"	Southern	5 SUT	EEC	Grant	1985-	Rehabilitation and extention of water supply facilities. Design for new water supply project	14,759	8,740	Total amount of funds committed is 48.18 million K.
	"	Northwestern	7 SUT	KFW (West Germany)	Loan	1985-	Rehabilitation of the existing township water supply scheme.	8,000	5,800	
	Canal Development (Mongu/Kalabo)	Western	Canal Development	NETHERLAND	Grant	1977-	Improvement or construction of canal between Monga and Kalabo	500	1,000	3.38 million K has been committed.
	Public Standpost Water Supply	-	SUT RA	IRC (International Reference Center) (Netherland)	Grant	1984-	Construction of standpost for water supply	100	855	2.03 million K will be committed. (Piped supplies for small communities)
	Central Province Water Supply	Central	RA	KFW (West Germany)	Loan	1985-1988	Rehabilitation of 180-240 boreholes Construction of 50 wells	1,562.5	1,500	Total amount of loan is 6.2 million K.
	Operational Training Course	-	Training Course	EEC	Grant	1980-	Establishment of training center	550	550	
	International Drinking Water Supply and Sanitation Decade	-	Technical Assistance	UNDP	Grant		Technical assistance concerning International Drinking Water Supply and sanitation decade	120	120	Support National Action Committee
	Zambezi River System	-	Planning	GRZ (GOU of Republic of Zambia)	-		Examination and Planning for Zambezi River Basin Development Project	-	200	
	Rural Water Supply Programme	Northern	Kasama District RA	IRISH	Grant	1983-	Construction of more than 100 wells. Rehabilitation of the existing wells.	1,690	650	4.0 million K will be committed.
	Groundwater Supply Development	Southern	RA	JAPAN	Grant	1985-1987	Construction of 102 boreholes	6,250	-	630 million yen has been committed.

Note: * SUT: Small Urban Townships, RA: Rural Area, LUA: Large Urban Area

Table 2-2-10 ONGOING WATER SUPPLY PROJECT (2)

	Project	Province	Area and Others	Aid-Agency	Aid Condition	Period	Contents	Expenditure Estimates 1987	Expenditure Estimates 1988	Remarks
Under the DWA	Water Supply Rehabilitation of Dam and Boreholes			GRZ GOU of Republic of Zambia	-			x1000K 800	x1000k -	
	Provincial Water Works	All Province	SUT* RA*	GRZ	-	1986-	Rehabilitation and improvement of existing water facilities. Maintenance of the existing canals. Construction of wells, boreholes and canals	4,000	4,000	
Under the district councel	Ndola Water Supply	Copperbelt	LUA*	ADB/ADF Africa Development Bank African Develop-ment Fund	Loan		Water Supply for Large Urban Area	13,400	15,100	
	Kalomo Water Supply	Southern	SUT	ADB	Loan		Water Supply for Small Urban Area	910	910	
	Choma Water Supply	Southern	SUT	ADB	Loan		"	2,164	3,500	
	Kabwe Underground Water Supply and Sewerage	Central	LUA	GRZ	-		Water Supply and Sewarage for Large Urban Area	3,000	6,000	
	Kafue Sewerage Treatment Plant	Lusaka	SUT	ADB	Loan		Sewerage Treatment Plant for Small Urban Area	2,131	2,131	
	Livingstone Water Supply and Sewerage	Southern	LUA	ADB/ADF	Loan		Water Supply and Sewerage for Large Urban Area	13,746	13,000	
	Chipata Water Supply	Eastern	SUT	KFW (West Germany)	Loan	1983-	Water Supply for Small Urban Area, Construction of small earth dam and facilities for water supply	810	810	
	Monze Water Supply	Southern	SUT	ADF	Loan		Water Supply for Small Urban Area	5,000	5,000	
	Kabwe Surface Water Supply	Central	LUA	Italia	Loan	1987-1990	Water Supply for Large Urban Area	15,000	15,000	Total Project Cost is 40 million US$.

Note: * SUT: Small Urban Townships, RA: Rural Area, LUA: Large Urban Area

Fig. 2-2-2 RURAL WATER SUPPLY PROGRAMMES
WITH EXTERNAL ASSISTANCE (1983.1)

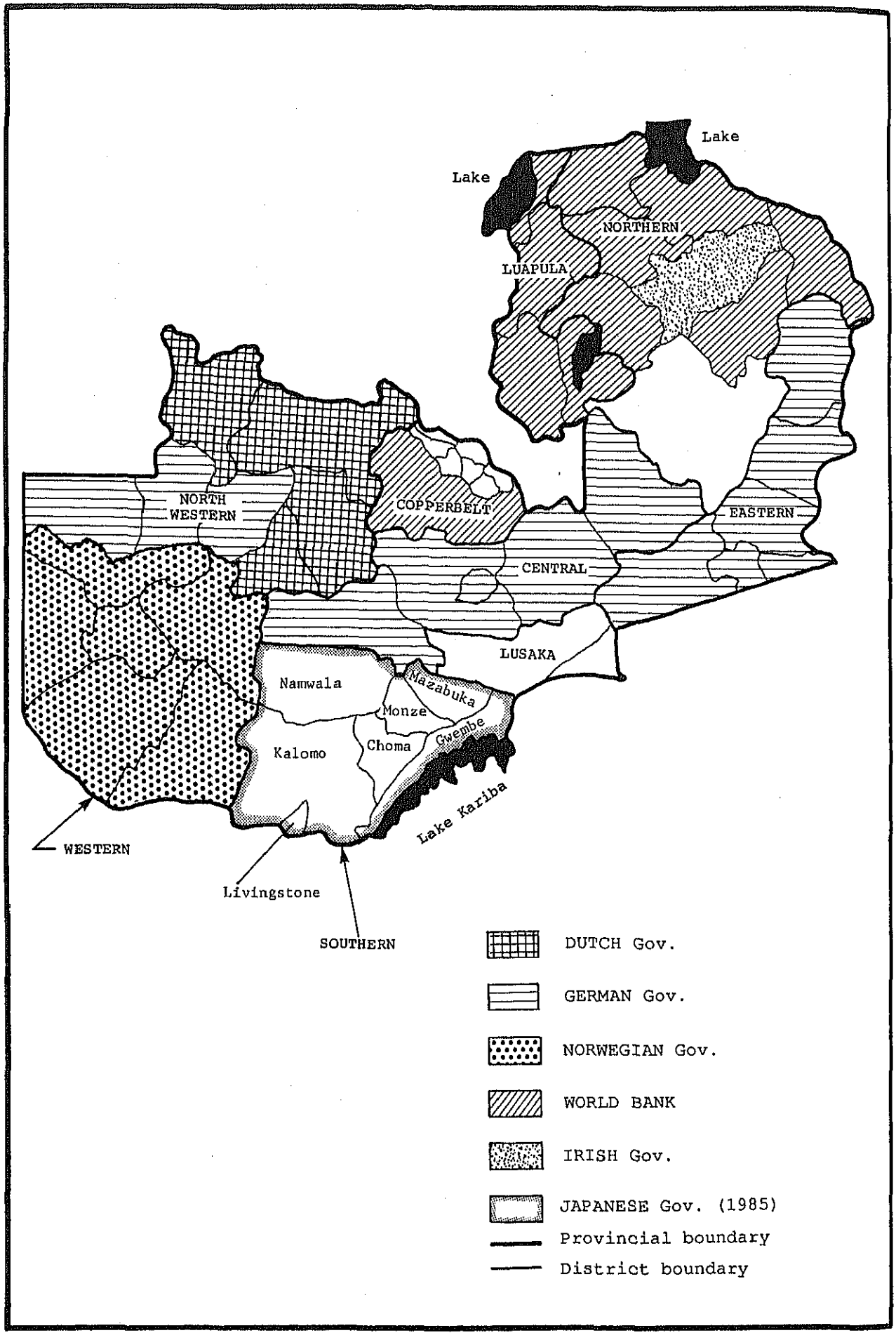


Table 2-2-11 DEVELOPMENT RESULTS OF DAM, WELLS AND BOREHOLES (1964-1986)

Province	Lusaka & Central			Southern			Western			N-Western			Copperbelt			Northern			Luapula			Eastern			Total		
Year	D	W	B	D	W	B	D	W	B	D	W	B	D	W	B	D	W	B	D	W	B	D	W	B	D	W	B
1964 *	2	3	14	1	21	8	1	-	-	-	-	-	-	-	14	1	-	2	-	-	-	3	71	10	8	95	48
1965 *	1	6	15	5	19	11	-	-	-	-	-	-	-	28	15	-	-	2	-	-	-	5	72	10	11	125	53
1966 *	2	19	29	1	5	15	-	-	5	-	-	3	-	14	13	-	-	3	-	-	-	1	22	10	4	60	78
1967	3	38	78	2	4	17	-	-	1	-	-	-	-	15	21	-	-	4	-	4	-	8	121	14	13	182	135
1968	-	22	51	4	2	28	-	-	4	-	5 *	-	-	5 *	16	1	-	-	-	17	-	2	167	9	1	218	108
1969	1	33	53	3	10	49	-	8	133	-	19	-	-	31	25	-	-	-	-	30	-	1	155	18	5	286	278
1970	3	37	51	1	49	31	-	21	114	-	23	-	-	18	8	-	6	1	-	96	-	1	131	46	5	381	251
1971	-	64	95	-	95	76	-	13	135	-	30	2	-	21	22	-	24	-	-	22	-	1	134	48	1	403	378
1972	-	10	23	1	53	31	-	18	112	-	34	2	-	14	20	-	9	-	-	60	1	2	89	52	3	287	241
1973	-	9	14	1	68	17	-	28	55	-	33	8	-	45	4	-	20	3	-	31	19	1	112	57	2	345	177
1974	-	26	25	-	73	23	-	28	157	-	29	4	-	19	25	-	11	1	-	15	10	1	170	39	2	371	284
1975	1	42	32	-	34	79	-	19	77	1	29	-	-	23	24	2	-	-	-	70	11	1	47	39	9	264	262
1976	-	21	25	1	62	24	-	19	35	-	40	8	-	29	20	1	11	2	-	85	4	-	68	29	2	335	147
1977	1	11	12	-	35	26	-	5	35	1	20	16	-	8	8	-	25	6	-	26	2	1	30	13	3	150	118
1978	-	32	9	-	27	14	-	4	17	-	24	1	-	-	10	-	31	-	-	17	3	-	26	16	0	161	70
1979	-	8	8	-	23	16	-	9	29	-	24	6	-	12	4	-	25	9	-	17 *	1	-	50	10	0	158	83
1980	-	17	10	-	14	2	3	52	14	-	10	2	-	-	2	-	10	3	-	13	3	1	27	10	4	143	46
1981	-	1	25	-	-	3	-	36	3	-	15	3	-	1	12	-	-	2	-	2	5	-	9	12	0	64	65
1982	-	12	22	-	18	21	-	76	71	-	15	4	-	16	1	-	17	5	-	-	2	1	12	9	1	166	135
1983	-	12	46	10	55	11	-	54	48	-	20	4	-	4	1	-	28	5	1	-	2	-	27	5	11	190	122
1984	-	8	-	4	4	16	-	46	45	-	36	3	-	14	-	-	14	2	-	22	1	-	4	5	4	148	72
1985	-	6	38	6	1	9	-	9	32	-	63	4	-	40	-	-	78	5	-	48	6	-	12	15	6	257	109
1986				1	-	25	-	23	40	-	133	1	-	66	11				-	25	19	-	11	7	1	258	103
Total	14	437	675	41	672	552	4	468	1162	2	602	71	0	423	276	5	289	55	1	600	89	30	1557	483	96	5047	3363
% of Boreholes			20.0 %			16.4 %			34.5 %			2.1 %			8.2 %			1.6 %			2.6 %			14.4 %	1.1 %	59.3 %	39.5 %

Note: *Estimate D = Dams, W = Wells, B = Boreholes

2.3 BACKGROUND AND CONTENTS OF THE REQUEST

2.3.1 Background of the Request

According the census of 1980, rural population in Zambia was approximately 3.2 million. A figure that represented about 56% of the country's approximately 5.7 million people. Some 1.02 million of the rural population had drinkable water sources near their houses. Other rural residents rely on distant water sources or on sources that become exhausted during dry seasons.

Diseases attributable to unstable water supply conditions or the use of unsuitable drinking water sources and poor sanitation environment worsened residents' living conditions and became major factors hampering social and economic rural development. For these reasons, the Government has been pushing forward with rural water supply projects on a nationwide scale since 1979.

The Southern Province experienced a 3-year continuous drought that began in 1981. During the drought, many wells and streamflows dried up.

At that time, the Province had a population of approximately 686,000. 73% of these people lived in rural areas. Of the rural residents, 220,000 (44%) suffered severely from the drought. For this reason, in 1983, the government of Zambia established the Groundwater Development Project in the Southern Province for constructing 880 new wells and for rehabilitating 250 inoperative wells. For this Project, and in response to the Zambian Government's request, the Government of Japan sent the Basic Design Study Team to the Southern Province in February 1985. As a result, a report for the Basic

Design Study was prepared in June and the Exchange of Notes was signed by both governments in October 1985.

The Rural Water Supply Project that called from the construction of 102 wells was implemented with grant aid from the Japanese government. The project was completed in October 1987.

For the continuation of the Groundwater Development Project (Phase I), the Government of Zambia requested grant aid cooperation from the Government of Japan in order to proceed with the Groundwater Development Project (Phase II) in the Southern Province.

In response to the request, the Government of Japan decided to conduct the Basic Design Study for the Groundwater Development Project (Phase II) in the Southern Province. Based on the government's decision, the Japan International Cooperation Agency sent a study team, headed by Mr. Keiji Abe, the Sub Director of Kagawa Prefecture's Waterworks Bureau, to Zambia for a 27 day period (13 March to 8 April 1988). The Study Team held a series of discussions pertaining to the Project with the officials concerned of the Government of Zambia, conducted field surveys in the Project Area, investigated the background of the request and the contents and objectives of the Project, and carried out the studies necessary for the basic design.

On 22 March 1988, the Minutes of Discussions, that described the major points agreed upon, was signed by Mr.Namukolo Mukutu, the Permanent Secretary of the Ministry of Agriculture and Water Development, and by Mr.Keiji Abe, the Study Team leader.

2.3.2 Contents of the Project

1) Outline of the Request's Contents

The Groundwater Development Project (Phase II) in the Southern Province (hereinafter referred to as the Project) was established to construct 120 new boreholes by using three drilling machines (two were provided by the Phase I Project and one is to be provided by the Project), to provide hand pumped water supply facilities to the boreholes, and to rehabilitate 100 wells having malfunctioning hand pump -- these wells were constructed prior to the Phase I Project in the seven districts of the Southern Province.

The following is an outline of the request's contents:

①.	Construction of new boreholes having hand pumps	120 sites
②	Rehabilitation of malfunctioning hand pumps	100 sites
③	Provision of drilling machine	1 set
④	Provision of other equipment and materials necessary for the project	1 set

2) Contents of the Munites of Discussions

①. Name of the Project: The Groundwater Development Project (Phase II) in the Southern Province

② Object of the Project: To reduce the number of diseases related to drinking water and to improve and stabilize the livelihood and social conditions of rural areas by supplying safe

drinking water to the rural people in the Southern Province.

③ The content of the Project: To construct new boreholes and well facilities and to rehabilitate mal-functioning hand pumps that were installed prior to the Phase I Project in order to supply safe, clean drinking water.

④ Project Sites: Seven districts of the Southern Province: Gwembe, Mazabuka, Choma, Namwala, Monze, Kalomo, and Livingstove (see Fig. 2-3-1)

⑤ The Zambian implementation agency: The Department of Water Affairs of the Ministry of Agriculture and Water Development.

⑥ Equipment and materials to be provided:
The following items were requested by the Government of Zambia under grant aid assistance:

A. Consumable materials for new construction, and spare parts for previously donated drilling rigs and vehicles:
1. Drill bits
2. DTH Hammer
3. Guide pipe

4. Casing pipe
5. Screen pipe
6. Chemical agents
7. Hand Pumps
8. Spare parts for previously donated vehicles
9. Spare parts for previously donated drilling rigs and other supporting equipment

B. New equipment for one additional drilling rig and other related equipment:
1. Truck mounted drilling machine with standard accessories.
2. High-pressure air compressor
3. Vehicles
4. Testing equipment
5. Other related equipment
6. Spare parts for above machines and equipment

⑦ Responsibilities to be borne by the Government of Zambia

The following arrangements are to be taken by the Government of Zambia:

1. To ensure customs clearance at entry point in Zambia

   (1) Tax exemption and customs clearance of products at Lusaka.

   (2) Internal transportation from Lusaka to Project sites.

2. All goods, equipment, and personal effects of the Japanese consultants and contractors brought in under the

Project shall be exempted from all duties and taxes.

3. To bear the following commissions to the Japanese foreign exchange bank for the banking services based upon the Banking Agreement:
   (1) Advising commission of the Approval of Payment
   (2) Payment commission.

4. To accord Japanese nationals, whose services may be required in connection with the supply of products and services under the verified contract, such facilities as may be necessary for their entry and stay in Zambia to perform their work.

5. The Zambian Government shall provide all of local personnel and will bear all their expenses under the Project.

6. To provide the convenience allowing all Japanese consultants and contractors to be used freely by the workships and other facilities/ equipment of DWA not covered by the grant -- when necessary -- and to provide consumed materials for the equipment.

7. To organize the Project team having a sufficient number of personnel who possess the knowledge and techniques needed in the management, planning and technical fields (siting, boring, installation of well materials, etc.)

well in advance of the commencing of the Project. Members for the three boring equipment unites are especially necessary.

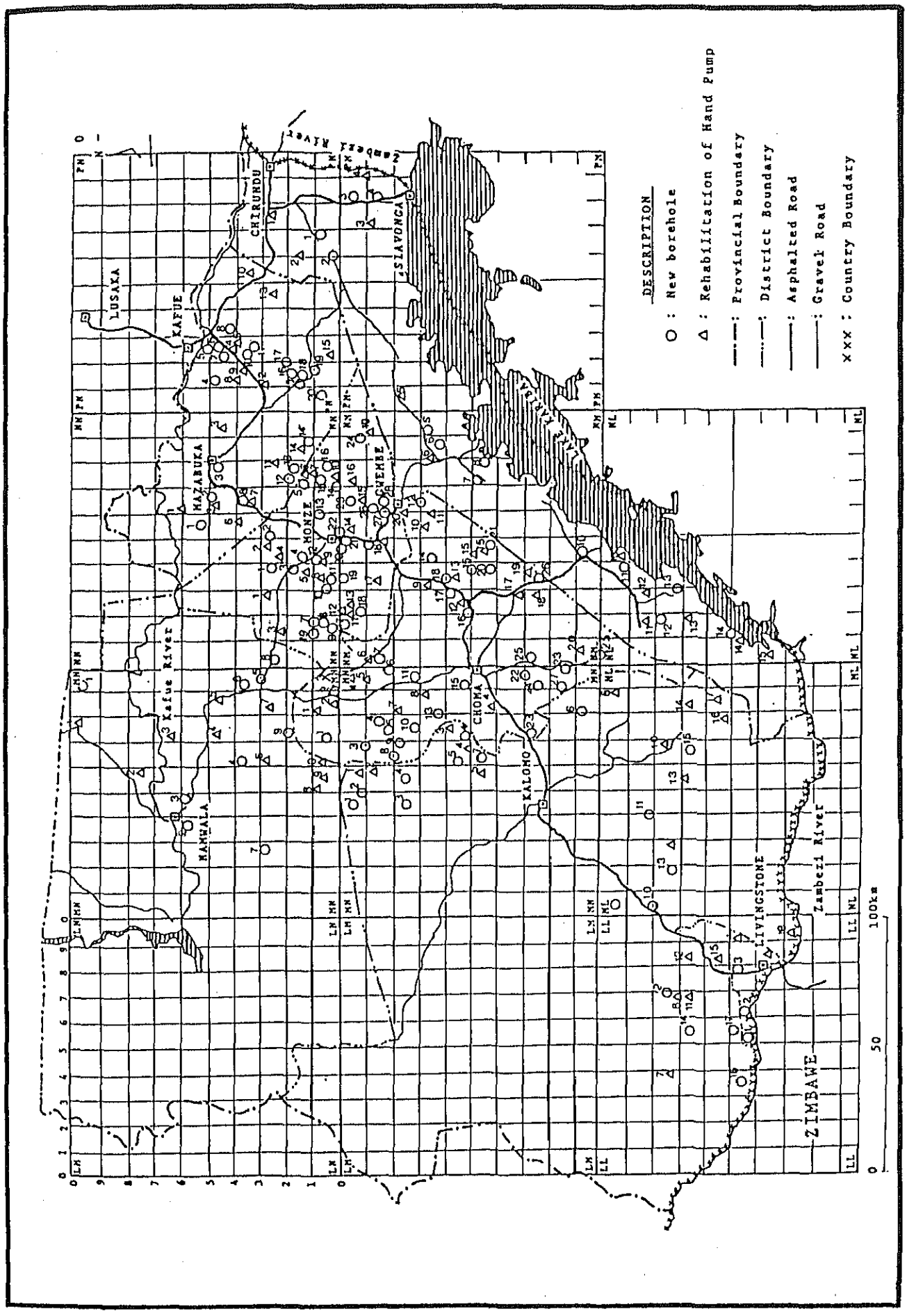
8. To carry out geo-electric surveys prior to the commencement of the Project.

9. To use the equipment and materials given under the grant exclusively for the Project.

10. To maintain and use properly and effectively the equipment and materials purchased under the grant and arrange the budget and personnel for the operation / maintenance of the *equipment and for the construction of* boreholes after Japanese construction aid has been terminated.

11. To bear all the expenses, other than those to be borne by the grant, necessary for the Project.

Fig. 2-3-1 LOCATION MAP OF THE PROPOSED SITES



CHAPTER 3. DESCRIPTION OF THE PROJECT AREA

CHAPTER 3 DESCRIPTION OF THE PROJECT AREA

3.1 PROJECT SITES AND THE PROJECT AREA

3.1.1 Project Sites

The Project contain 220 sites in all districts of the Southern Province -- 120 sites for new borehole construction, and 100 sites for the rehabilitaion of the malfunctioning wells that were constructed prior to the Phase I Project. The locations of these sites are listed in Table 2-3-1 . A summary of the sites is given in Table 3-1-1.

Table 3-1-1 SUMMARY OF THE PROPOSED SITES

District	Numbers of New Borehole Sites	Numbers of Rehabilitated Borehole Sites
1. Gwembe	14 Sites	15 Sites
2. Mazabuka	20	15
3. Monze	28	20
4. Choma	29	20
5. Namwala	9	10
6. Kalomo	17	18
7. Livingstone	3	2
Total	120 Sites	100 Sites

3.1.2 Project Area

The Southern Province, the Project Area location, covers 11% of the country's total area.It is 85,283km2 (more than the area of the Japanese island of Hokkaido which is 83,519km2).The Southern Province is contiguous to Zimbabwe by making the Zambezi River its southern and eastern border.The Kafue River,a tributary of the Zambezi,is the Province's northern border with the Lusaka Province.The Kafue River,together with the Zambezi River,have formed the lowlands in the area.

A large part of the Province consists of plateaus that are from 1,000 to 1,300 m high There is an insignificant amount of erosion on the plateaus.

The Southern Province has a population about 686,000 This represents about 12% of the country's total population figure Most of the Province's people live on the plateaus made of hard rocks.

The annual precipitation in the Province is in the range of from 750 to 850 mm. The rainy season is from November through April. As precipitation in Zambia decreases from the north to the south,the Province is subjected to droughts.

The world famous Victoria Great Falls of the Zambezi River is located near the border city of Livingstone. The man-made Lake Kariba stretches for a considerable distance in the downstream section of the Zambezi. The Lake itself has an area that is 7.7 times that of Lake Biwa,the largest lake in Japan.

A railroad and a highway run between the country's capital of Lusaka and the tourist city of Livingstone in a southwesterly direction. The distance from Lusaka to the border of the Southern Province is 40 km. From Lusaka to the border city of Livingstone is 375 km. These are straight line distances.

3.2 Natural Conditions

3.2.1 Weather

The Southern Province is located in the tropical zone at 15° to 18° S latitude and 25° to 29° E longitude. As the Province is located on a plateau that is from 1,000 to 1,300 m high,the weather is comparable to that found in a mild tropical savanna.

The climate of the Southern Province can be classified into the following three seasons:
Hot rainy season:November through April
Cold dry season:May through August
Hot dry season:September through October

Temperatures in the Provinces are from 21° to 28°C in the lowland areas and from 17° to 24°C on the plateau during the hot dry season. During the cold dry season temperatures are from 16° to 18°C in the lowland areas and from 13° to 16°C on the plateau.

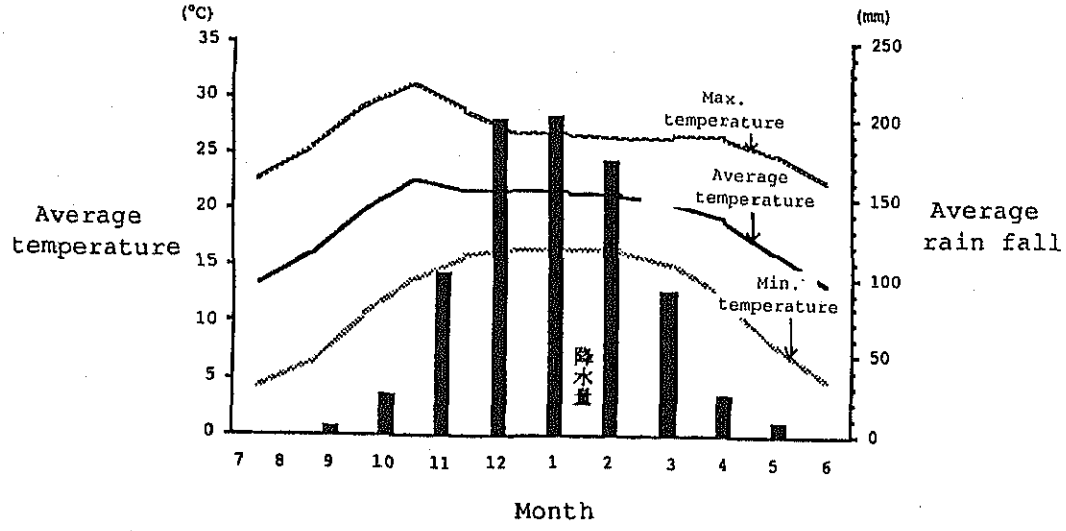
More than 95% of the precipitation occurs during the period of October through May. In the northern part of the country,the precipitation sometimes reaches 1,400 to 1,600 mm per year. In the Southern Province,however,the average precipitation is in the range of 750 to 850 mm per year. Fig 3-2-1 shows the average monthly precipitation and the average monthly maximum,mean, and minimum temperatures(1950-1980)of Choma (1,267 m above sea level) that is located in the center of the Southern Province.

Fig 3-2-2 is a map showing the average annual precipitation distribution throughout the country. From this map,it can be clearly seen that the precipitation in the country decreases from the north to the south,and that the southern part of the country is more likely to be subjected to drought effects than is the northern part.

Table 3-2-1 and Fig 3-2-3 show the annual precipitation recorded in the Southern Province.

From the table and the figure,it is evident that the recent annual precipitation has been less than the average annual precipitation of the 30-year period from 1950 through 1980.

Fig. 3-2-1 MONTHLY MEAN RAINFALL AND MEAN TEMPERATIRE
(Choma Average between 1950-1980)



(source: Meteorological Dep. 1985)

Fig. 3-2-2 DISTRIBUTION OF THE ANNUAL RAINFALL

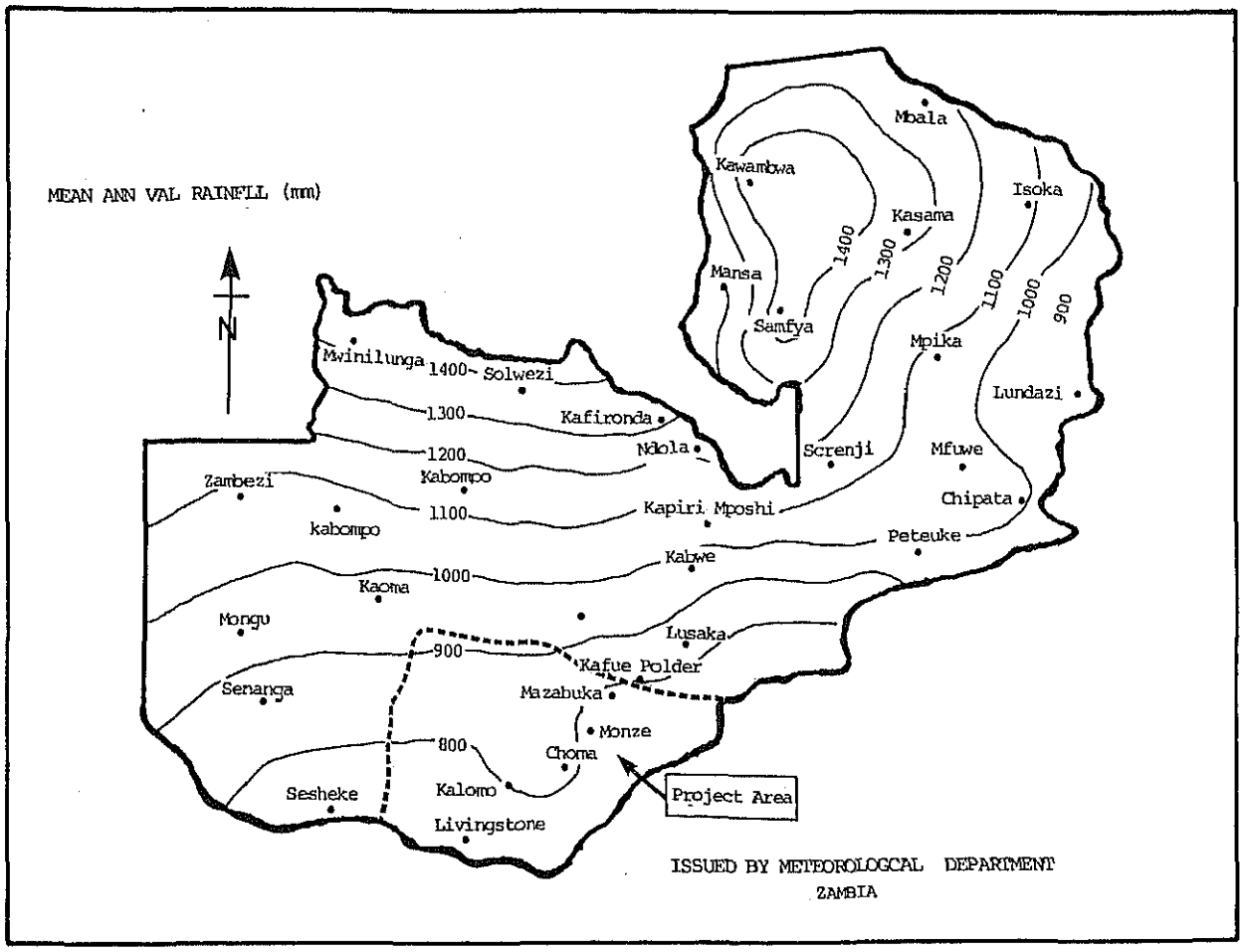
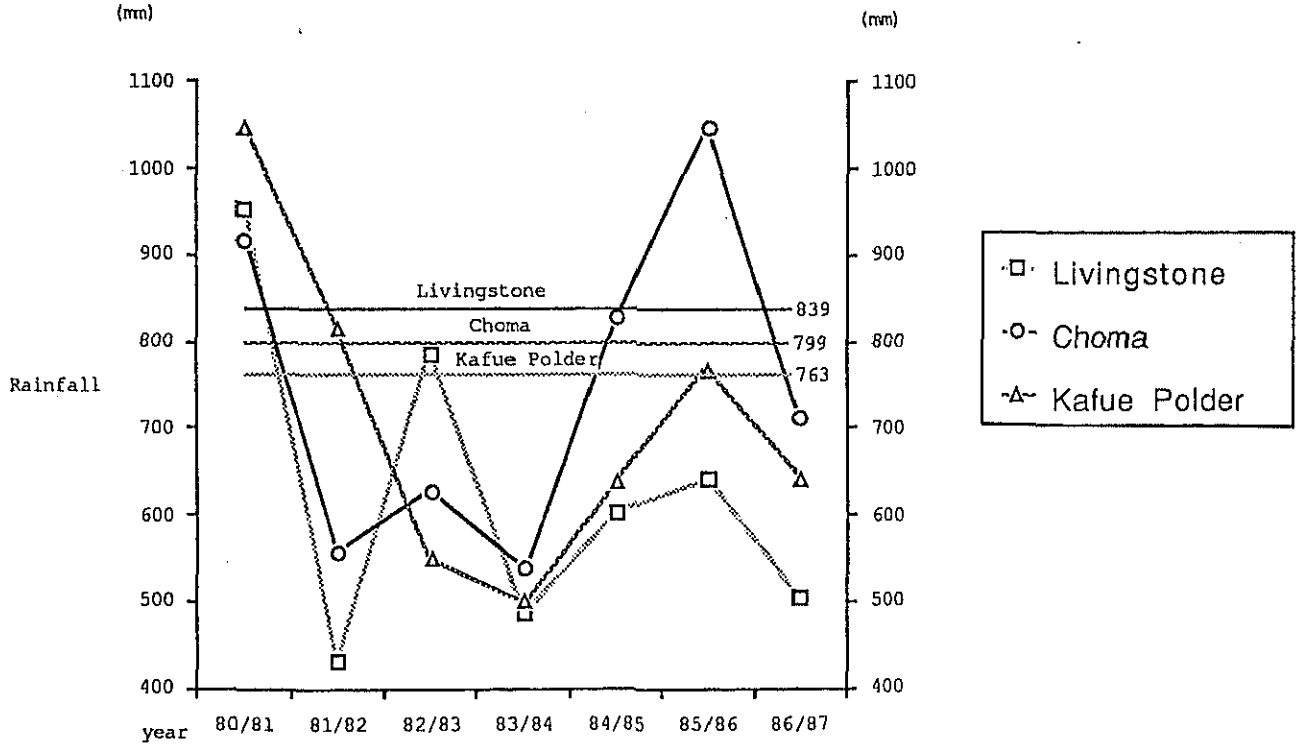


Table 3-2-1 ANNUAL RAINFALL IN SOUTHERN PROVINCE

Station / Year	Livingstone	Choma	Magoye	Kafue-Polder
1980/81	953.0 mm	918.0 mm	890.0 mm	1,047.0 mm
81/82	430.0	556.0	615.0	817.0
82/83	787.0	628.0	629.0	549.0
83/84	486.0	539.0	589.0	500.0
84/85	603.0	827.5	748.6	639.0
85/86	641.7	1,047.7	721.9	768.5
86/87	503.2	711.9	682.3	643.4
Average Annual Rainfall	763.0	839.0	-	799.0

Note: Average annual: Average of 30 years from 950 50 1980
Hydrogeological year: From July to June

Fig. 3-2-3 ANNUAL RAINFALL IN SOUTHERN PROVINCE



3.2.2 Hydrology

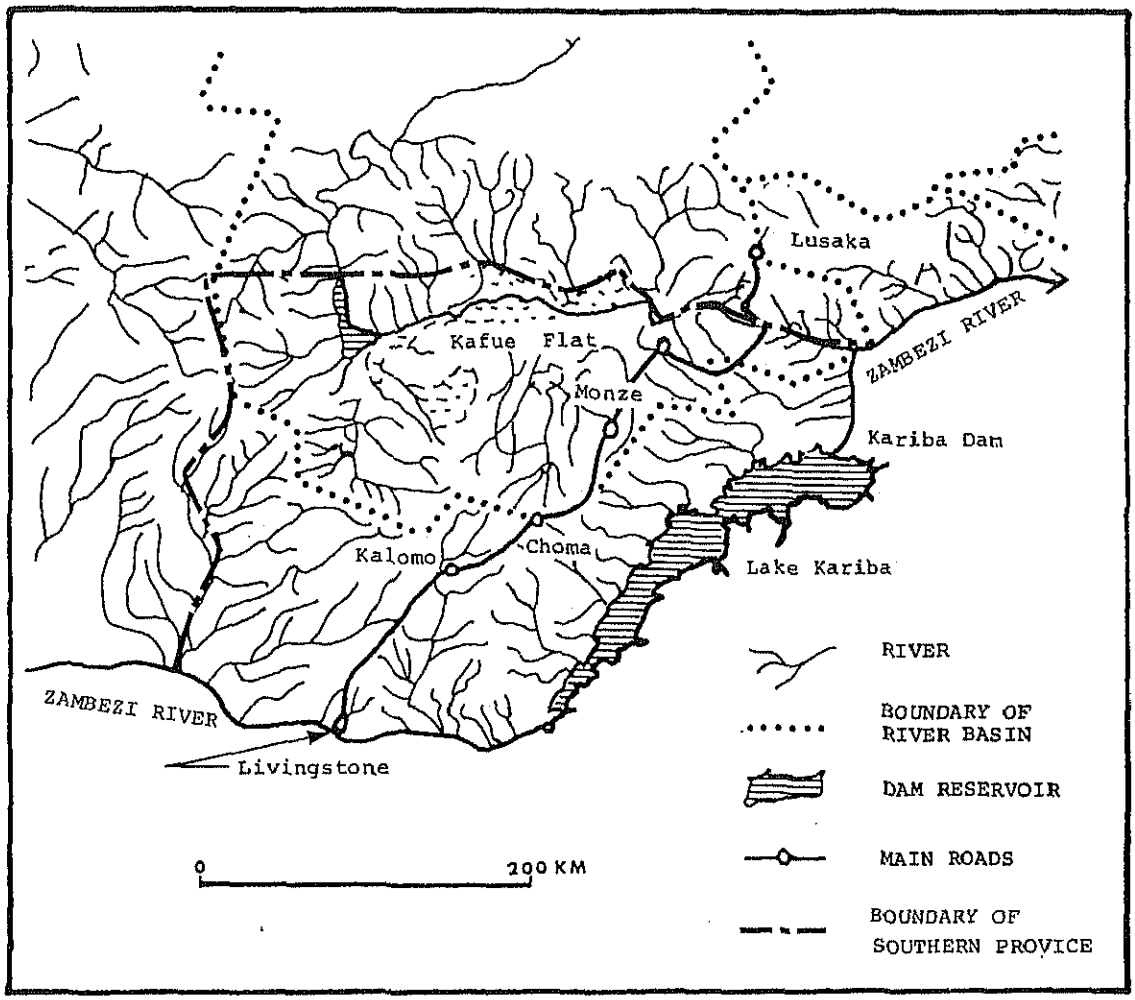
The Zambezi and Kafue rivers flow along the southern and the nouthern borders of the Southern Province in an west to east direction. The streamflows of the rivers never dry up through the year The discharges of the rivers are as follows:

River Name	Observation Point	Maximum Discharge m3/sec	Minimum Discharge m3/sec	Observation Period
Zambezi	Livingstone	9,741	249	1930-1969
Kafue Riv.	Kasaka	1,948	14	1954-1969

These two rivers have many tributaries. The divide of the rivers' basins is a mild ridge that separates the Southern Province into two parts. Along the mild ridge,a railroad and a highway run. Most of the Province's people live along the railroad and the highway. Even though there are many small rivers near their residences,most of the streamflows become exhausted during dry seasons because the area is located near the upper end of the river basins.

In the Project Area, there are two large dams-- the Kariba Dam on the Zambezi River,and the Itezhi-tezhi Dam on the Kafue River. Also there are several hundred other medium or small-size earth dams. The water stored by these dams is used for urban water supply and as drinking water in rural areas. Most of the small river water sources dry up during the dry season.

Fig. 3-2-4 DRAINAGE SYSTEM IN SOUTHERN PROVINCE



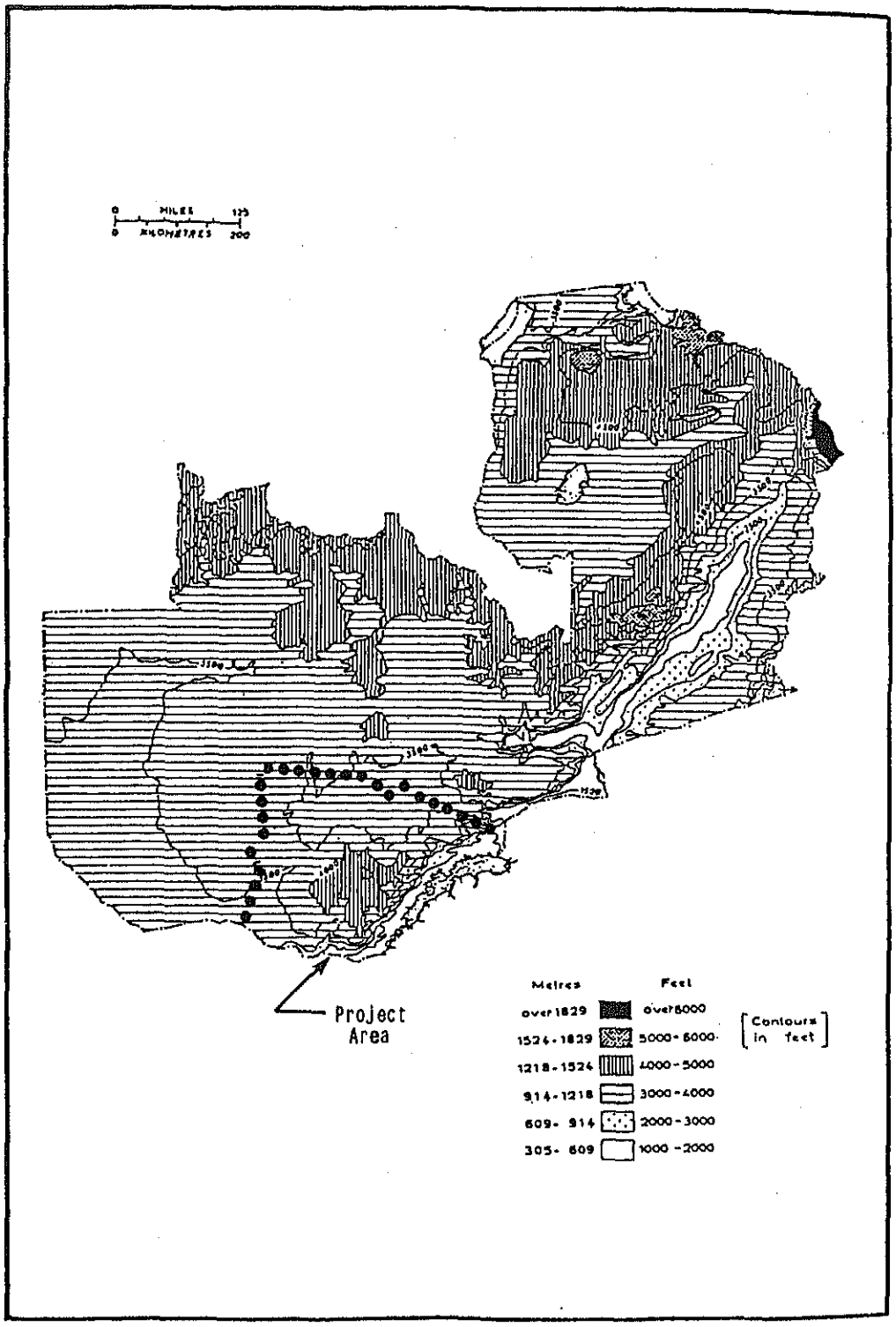
3.2.3 Topography

The Southern Province is located in the southern part of Zambia. Its shape is roughly rectangular, stretching about 300 km in a north-south direction and about 350 km in an east-west direction. It has an area of 85,283 km2.

As Fig 3-2-5 shows,the rough topography of Zambia has mild mountain ranges of more than 1,200 m in height that run in a northeast-southwest direction. The eastern slopes of the mountain ranges are very steep and fall into the Kariba Rift.

A gently waved plateau,having a mild slope, stretches from the western side of the mountain ranges to the lowlands along the Kafue and Zambezi river midstream sections. The lowland along the midstream section of the Kafue River forms a large marshy area.

Fig. 3-2-5 RELIEF



3.2.4 Geology

The geology of the Southern Province consists of pre-Mesozoic deposit rock,basalt, metamorphic rocks (schist, gneiss), and granite--these are all hard rocks. The field survey of the exposed rocks and the boring results of the Phase I Project revealed the existence of thin soil layers of weathered rocks. In

some areas,hard rocks are exposed above the mild ground surface.

In the northern,northwestern, and western parts of the Southern Province, unsolidified deposits of the Quarternary period are distributed. Most of the Project sites are in the hard rock zone.

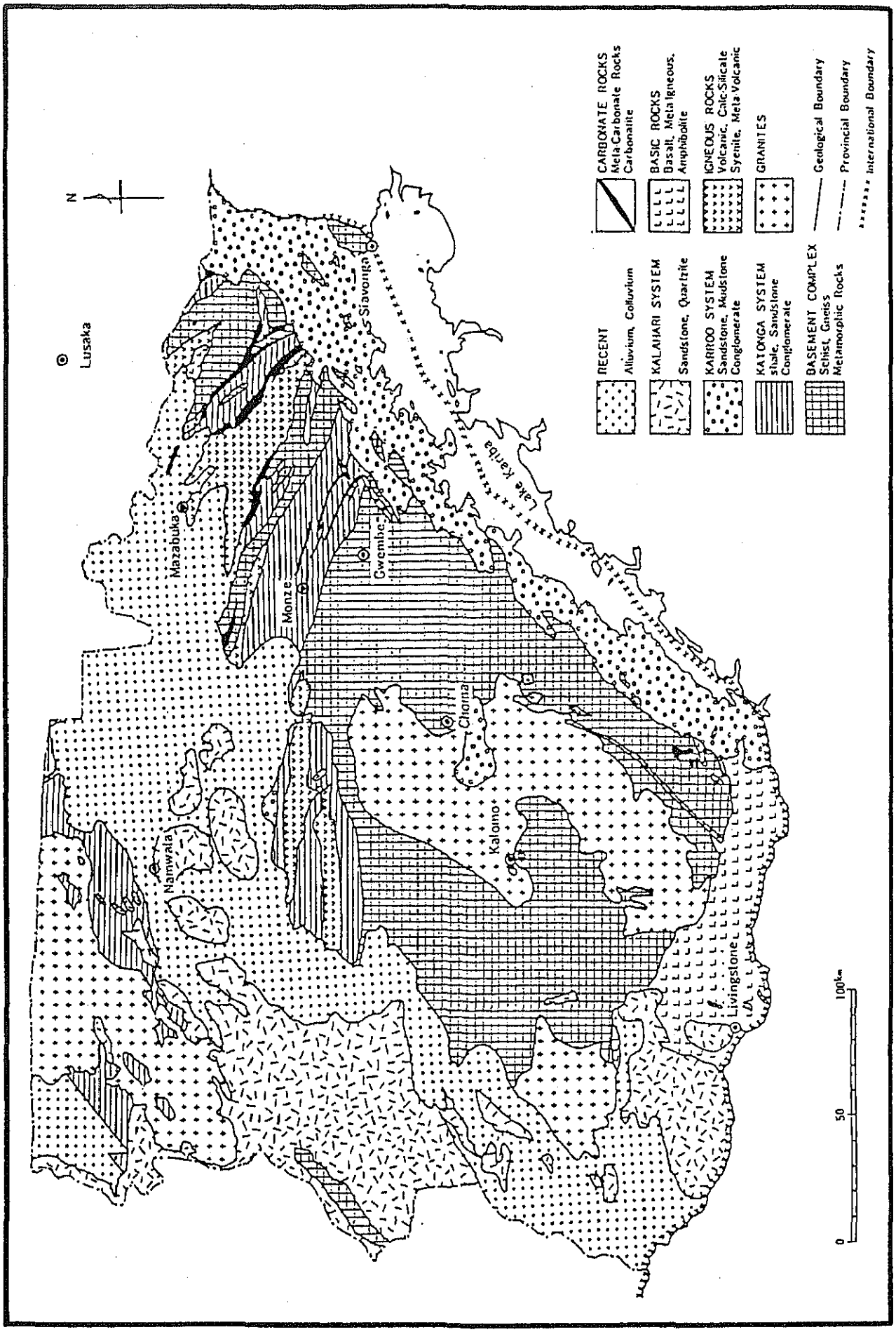
Table 3-2-2 shows the geologic structure of the Southern Province. The soil map is shown in Fig 3-2-6.

The distribution rate of the geological strata is 50% pre-Cambrian base rock, 10% Katonga system, 10% Karroo system, and 20% Cenozoic period rocks. It is evident that pre-Cambrian rocks are predominant.

Table 3-2-2 GEOLOGY OF SOUTHERN PROVINCE

Geological Age	Formation	Lithology	Locality	Aquifer
Cenozoic	Recent Deposits	Clay, silt, sand	Along the kafue	Sand Layer
	Kalahari System Mongu sands Barotse Sandsone	Sand Sandstone	Border area to Western Province	Sand layer Water level: 40-50m Generally speaking, little information about groundwater
Mazoic Palozoic	Karoos system Upper Karoo Lower Karoo	Basaltic Lava Red Sandstone Alternate sandstone-mudstone Mudstone Coal Sandstone, conglomerate	Around Livingstone Escarpment along the Zambezi River	Fissured sandstone depth: 40-60m Water table: about 25m
Paleozoic Pre-Cembrian	Katanga System	Mica schist, phylite Limestone, quartzite	Monze, Gwenbe and western part of Choma and Kalomo	Weathered zone and fissured rock
Pre-Combrian	Basement Complex	Gneiss, schist granite	Around Choma	Thickness of weathered zone: 10-25m

Fig. 3-2-6 GEOLOGICAL MAP OF THE SOUTHERN PROVINCE



3.2.5 Hydrogeology

Groundwater is created by precipitation infiltrating into the ground and forming permeable water-saturated strata, "aquifers."

(1) Aquifers

The characteristics of the geology and aquifers distributed in the Southern Province are shown in Table 3-2-3.

The groundwater bearing strata (aquifers) are the Recent epoch deposits and the Kalahari system -- unsolidified sand strata and sandstone. As the Karroo system, Katonga system, Basement complex are well solidified rocks, aquifers in these rock formation areas are developed in the weathered rock strata having depths of up to 25m from the ground surface. The fissure zones of unweathered rock are in a yet deeper strata.

The water-bearing capacities of weathered rock aquifers vary depending upon the characterists of their parent rocks. Weathered gneiss, granite, and limestone create soils having course particles. Coarse soils have large groundwater storing capacities.

The thicknesses of the weathered rock strata vary depending upon the locations of their parent rocks. Judging from boring data, they are at most up to 25m from the ground surface.

Table 3-2-3 was made to show the water table in each rock stratum, the thickness of each weathered rock stratum, and groundwater pumping rates based on data of the boreholes constructed by DWA during the 1975-84 periled in the Southern Province.

Table 3-2-3 GROUNDWATER CONDITION IN RESPECTIVE LITHOLOGY IN THE SOUTHERN PROVINCE

Lithology	Drilled Depth (m)	Static Water Level (m)	Thickness of weathered zone (m)	Aquifer depth		Pumping Rate (per borehole) (l/min)
				Upper limit (m)	Major part (m)	
Gneiss	46	15	14	25	38	70.4
Schist	51	16	15	29	41	74.6
Granite	53	14	26	23	34	58.0
Basic Rock	50	17	26	27	33	45.0
Quartzite	34	14	13	20	28	144.0
Calcious Rock	49	13	25	25	31	112.8
Basaltic Lava	46	26	20	14	42	156.0
Sedimentary Rock	55	16	26	25	46	142.5
Alluvial Strata	40	19	-	25	28	60.0

(Mehta 1985)

Note: Above figures are on an average basis.

From Table 3-2-3, it can be understood that the major aquifers are the fissure zones of the base rocks that are located further below the weathered rock strata.

The static water levels, except in basalt, are at about 15m from the ground surface. From this fact it is appropriate to judge that groundwater exists even in the weathered rock strata. As a matter of fact, groundwater in the weathered rock strata is obtained from hand-excavated wells that are about 10m deep.

(2) Groundwater Yield

The groundwater pumping rate from each rock stratum is outlined in Table 3-2-3. According to the Table, the pumping rate of more than 100 liters/min was recorded from limestone strata that have many cavities. The well having the largest pumping rate was constructed in the

limestone stratum at Monze. The pumping rate from this well was recorded as being 1,320 liters/min.

Table 3-2-4 lists the average values of the static water levels and the 8-hour continuous possible pumping rates of the 51 boreholes constructed by DWA during the 1975-84 period. The pumping water levels in the right column are the values obtained from the relative water yield for the pumping rate of 30 liters/min.

Since the pumping rates of the hand pumps to be installed in wells for the rural water supply project will be at most 15 liters/min. Their pumping water levels will not exceed 18m from the ground surface.

Table 3-2-4 SUMMARY OF GROUNDWATER CONDITION IN THE SOUTHERN PROVINCE (AVERAGE OF 51 BOREHOLES)

Borehole Depth (m)	Static Water Level (m)	Pumping Rate (m3/day)	Specific Capacity (m3/day/m)	Pumping Water Level 30 L/min (m)
60	16	216	18.9 (13.1 L/min/m)	18.6

(3) Summary of the Groundwater Levels Obtained from the Results of the Phase I Project

The Groundwater Development Project (Phase I) in the Southern Province -- completed in July 1987 with grant aid from the Government of Japan -- constructed 102 new boreholes in almost the same area as this Project (Phase II). Therefore, data obtained by the Phase I Project will provide the

most useful information for the Project. Table 3-2-5 gives the data summary.

From the comparison between the above summary and the information outlined in the previous paragraphs (1) and (2), it is evident that the depths of the aquifers are in the range of 20 to 35m from the ground surface. The weathered rocks having many fissures are the aquifers.

The average groundwater level and the average relative water yield of the Phase I Project deviate greatly from those previously obtained. It is assumed that the deviation was caused by the difference in the averaging methods, the number of borehole locations. Figs. 3-2-7 and 3-2-8 show the details of the groundwater levels and the relative water yields obtained during the Phase I Project. These figures reveal that about 66% of the boreholes have relative water yields of less than 4.0 liters/min/m -- it can be understood that the hydrogeological conditions in the Project Area are not very good. However, boreholes having such low relative water yields, except dry holes, have been used satisfactorily for water supply by hand pumps without creating any problems.

Table 3-2-5 SUMMARY OF GROUNDWATER CONDITION BY THE RESULTS OF PHASE-I PROJECT

Item	Quantity or Contents	Remarks
Number of Boreholes	102	Mazabuka, Monze, Namwala, Gwembe, Choma, Kalomo district
Average drilled depth	49.2m	Total drilled length: 5,014m Maximum depth: 79m Minimum depth: 26m
Number of dry holes	19 (18.6%)	Maximum depth: 79m No groundwater table
Depth of Aquifer	20 ~ 35m	Many springs at depths of between 23m and 35m are found.
Average depth of groundwater table	app. 8m	Depth of groundwater tables varies widely from 1.2m to 40.1m.
Average specific capacity	1.5 L/min/m	Most of the specific capacities have small values, though they vary widely from 0 L/min/m to 357.1 L/min/m.
Geology	Hard rock	Most of the geological composition around the boreholes are sedimentary rocks, metamorphic rocks, ranites, basalts, etc. before the Mesozoic geological age.
Aquiferous Conditions	Fissure water in weathered rock zone	Generally, the thickness of the soils derived from extremely weathered rocks is thin. Aquifers can be found within the zone developing many fissures derived from weathering, shearing, etc.

Fig. 3-2-7 RESULT OF SPECIFIC CAPACITY
Percent of numbers of deep well

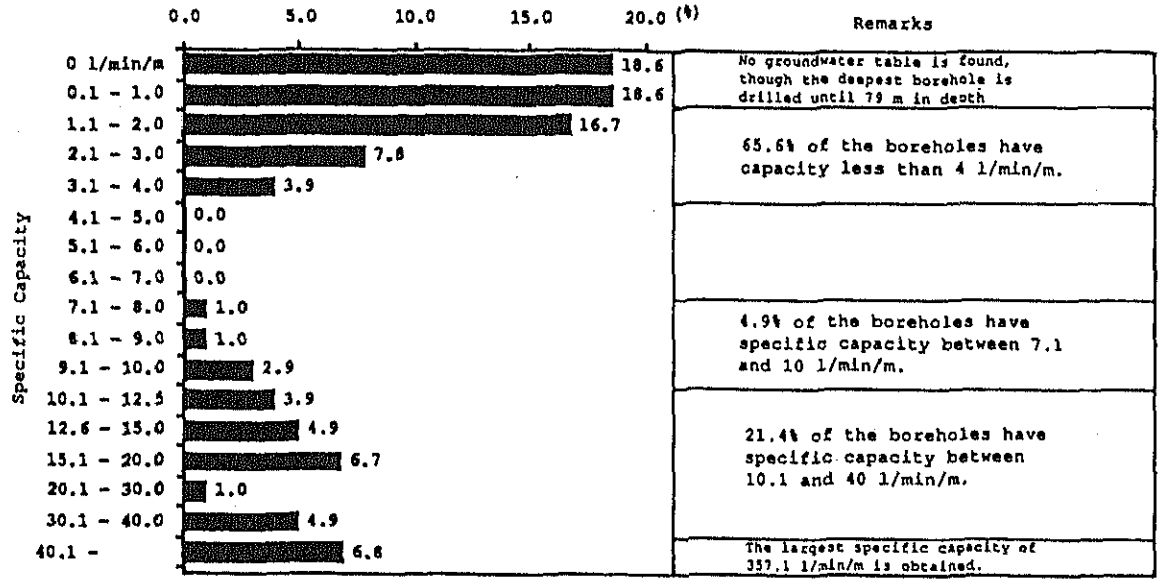


Fig. 3-2-8 RESULT OF GROUNDWATER TABLE
Percent of numbers of deep well

3.2.6 Electrical Prospecting

During the period of the Project's basic design study, the Study Team conducted electrical prospecting of a total of 10 exploration lines. During the Phase I Project's construction period, electric (resistivity) loggings of boreholes were conducted. The analyses of both the electrical prospecting and loggings are described herewith:

(1) Relationship between the Relative Resistivities and the Ground Strata obtained during PhaseI construction:

Electric loggins of 68 boreholes were conducted during Phase I Project's borehole construction period. The relationships between the relative resistivities and the ground strata are listed in Table 3-2-6.

The maximum values of the relative resistivities of the Basement Complex and the Katonga system were recorded in their weathered rock strata. Each of these strata showed the resistivity of slightly higher than 200Ω-m (generally, it is more than 300Ω-m) -- an indication that the strata are made up of hard rock. Aquifers exist in the strata of 2 to 105Ω-m.

In each ground stratum, granite, quartz schist, and limestone showed relatively higher resistivities than other types of rocks. The phenomena are general cases attributed to by the differences of rock quality. The Karroo system indicated low resistivity. Basalt and sandstone in the Karroo system showed higher resistivities than mudstone -- this is common tendency. The measured resistivity values in the sandstone

indicates the possible existence of other aquifer in addition to the water in the fissure zone.

The Kalahari system and alluvium showed even lower resistivities than the Karroo system. This indicates that they have a high clay content.

Table 3-2-6 RELATIONSHIP BETWEEN GEOLOGY AND RESISTIVITY (ELECTRIC LOGGING)

Formation	Lithology	Number of boreholes	Depth (m)	Resistivity			
				Weathered rocks	Fissured rocks	Others	Aquifer
Basement Complex	Granite	8	50	5~45	32~140	60~160	18
	Quartzite	3	43	20~100	32~157	20~140	52
	Gueiss	6	55	3~41	80~200	10~86	2
	Schist	15	72	7~54	50~130	30~108	24
Katanga System	Quartzite	1	31	10~200	-	-	105
	Gueiss	2	40	13~105	-	-	30
	Schist	4	42	10~146	-	8~97	50
	Limestone	4	48	75~200	70~200	3~200	8
Karoo System	Basalt	1	37	15~140	-	-	55
	Slate	17	82	4~19	10~25	5~21	8
	Sandstone		76	6~66	-	13~56	19
Kalahari System	Sandstone	3				2~15	
Recent Deposits	Clay, Silt Sand	4				3~13	

(2) Result of Electrical Prospecting

① Summary

a. Object

To obtain the basic data necessary for planning Project (Phase II) by conducting electrical prospecting in the Project Area as well as utilizing the results of Phase I Project's electric loggings.

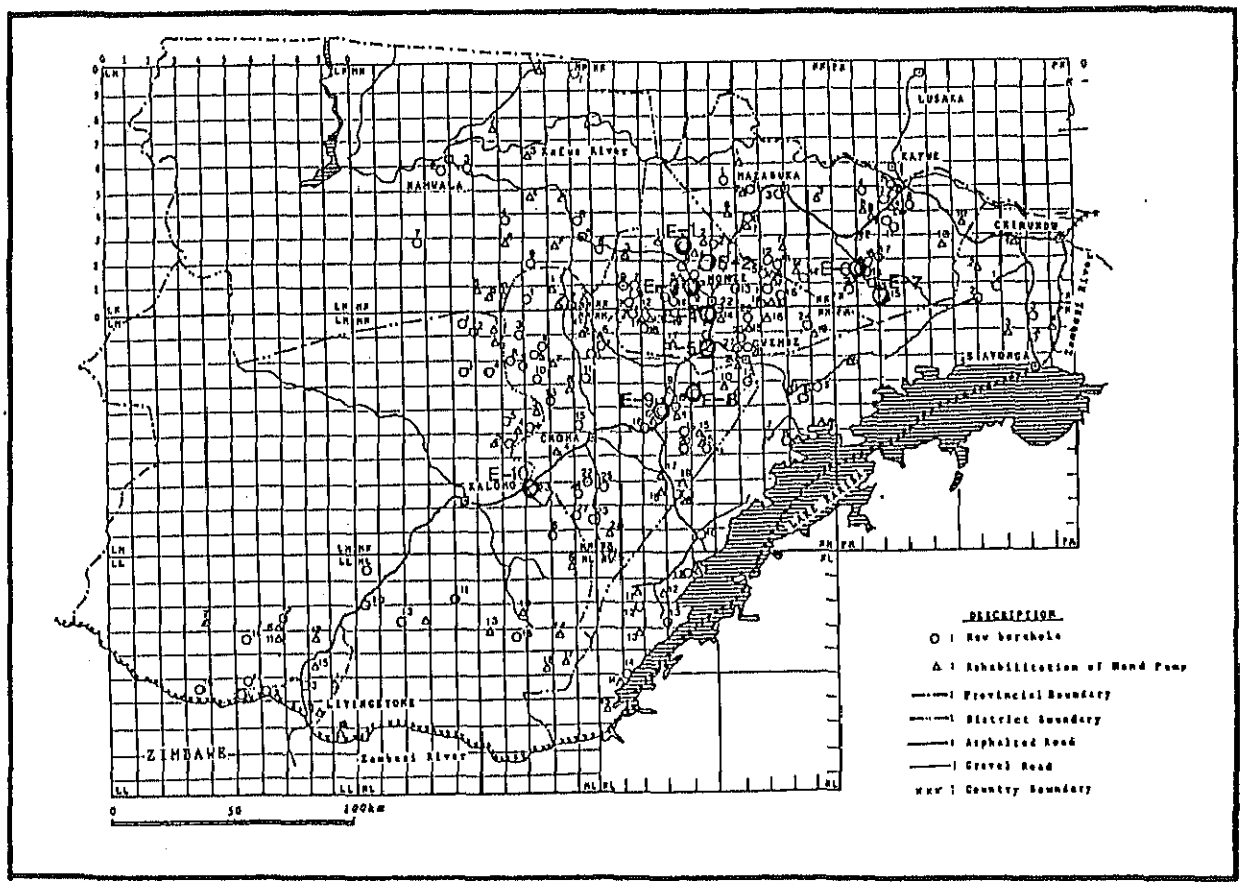
b. Number of exploration lines: 10 (total of 16 measurements were made -- two measurements were made on each of six lines).

c. Measurement method used: The Wenner method.

d. Measure depth: a=80m

e. Equipment used: Yokokawa model 3244 (Made in Japan).

Fig. 3-2-9 LOCATION MAP OF THE SITES CARRIED OUT BY ELECTRIC PROSPECTING IN THIS STUDY



② Results of Analysis

The results of the analysis are listed in Table 3-2-7, and the resistivity logs are shown in Fig. 3-2-10.

Judging from the geological conditions and water qualities and from the relationships between the electrical resistivities and aquifers in the Project Area, aquifers seem to exist roughly in the 10-300Ω-m zone of the Paleozoic-pre-Cambrian period strata and in the 10-500Ω-m zone in the granite formation. It is assumed that the high possibility of aquifer existence is in the zone of about 50Ω-m.

③ Conclusion

Electrical prospecting was conducted in the Katonga system and Basement Complex areas. The locations having weathered rock strata of 20 to 30m or much deeper form the ground surface were six out of th ten exploration lines. Better aquifers exist in the thicker strata of weathered rocks than in the thinner ones. Practically no aquifers exist in the rock strata that are not weathered.

Fig. 3-2-10 RESISTIVITY LOG

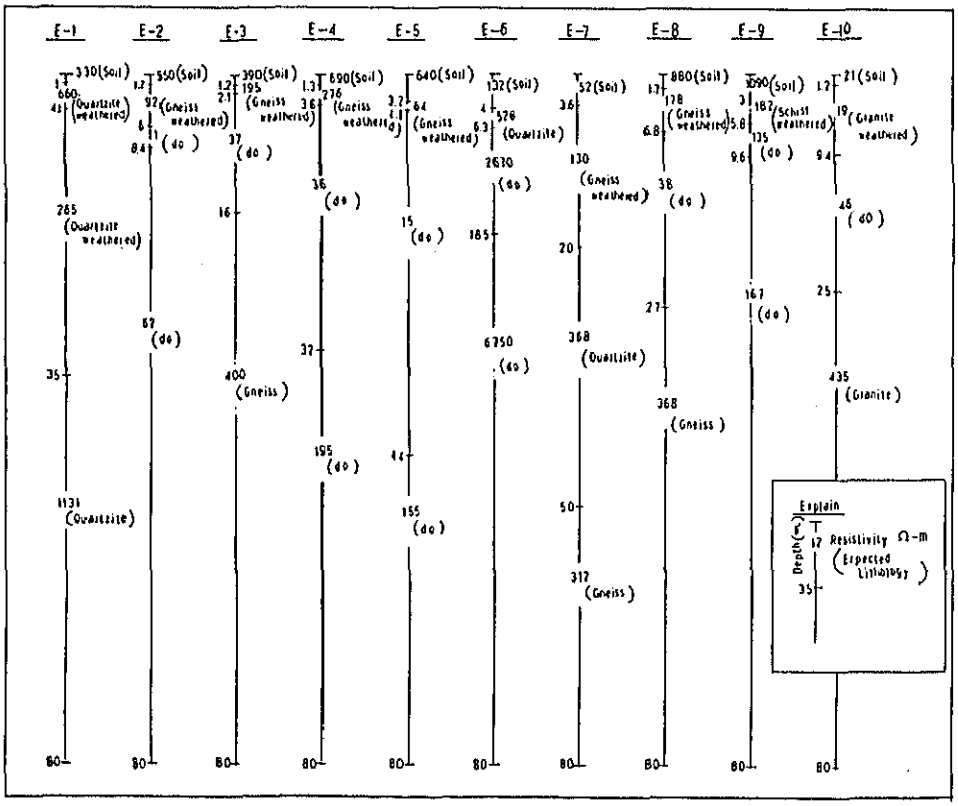


Table 3-2-7 RESULTS OF ANALYSIS OF ELECTRICAL PROSPECTING

Site No.	Location	Formation	Resistivity				Remarks
			First Layer	Second Layer	Third Layer	Fourth Layer	
E-1	Monze (Site No. 1 in Phase II)	Basement Complex	0~1m 300Ω -m	1~4.1m 660Ω -m	4.1~35m 265Ω -m	More than 35m 1,132Ω -m	The data shows the possibility of small aquifers between 4.1 and 35m in depth, but with small expectation.
E-2	Monze (500m away from the Dry hole No. Moj-1 in Phase I)	Basement Complex	0~1.2 550	1.2~5 92	5~8.4 11	More than 8.4 62	The possibility of aquifers below 8.4m in depth.
E-3	Monze (Site No. 12 in Phase II)	Katanga System	0~1.2 390	1.2~2.1 195	2.1~16 37	More than 16 400	The possibility of aquifers between 2.1 and 16m in depth, but with small expectation because of the existence of fresh massive rock at a shallow depth.
E-4	Monze (Site No. 22 in Phase II)	Katanga System	0~1.3 690	1.3~3.6 276	3.6~32 36	More than 32 195	The expectation of aquifers below 3.6m in depth.
E-5	Monze (Site No. MOJ-14 in Phase I)	Basement Complex	0~3.2 640	3.2~4.1 64	4.1~44 15	More than 44 155	The expectation of aquifers below 4.1m in depth. In fact, this bore-hole is good for a well.
E-6	Mazabuka (Site No. 15 in Phase II)	Basement Complex	0~4 132	4~6.3 528	6.3~18.5 2,670	More than 18.5 6,750	Little possibility of aquifers, because of fresh massive rock with less fissure showing large resistivity.
E-7	Mazabuka (Dry hole No. MAJ -8 in Phase I)	Basement Complex	0~3.6 52	3.6~20 130	20~50 368	More than 50 312	Less possibility of aquifers, because of the existence of fresh massive rock at a shallow depth and the site of hilltop. MAJ-8 was dry hole.
E-8	Choma (Site No. 14 in Phase II)	Basement Complex	0~1.7 880	1.7~6.8 178	6.8~27 38	More than 27 368	The expectation of aquifers below 3.4m in depth.
E-9	Choma (Site No. 17 in Phase II)	Basement Complex	0~3 1,090	3~5.8 182	5.8~9.6 135	More than 9.6 167	The possibility of small aquifers below 3m in depth.
E-10	Choma (Site No. 23 in Phase II)	Granite	0~1.2 21	1.2~9.4 19	9.4~25 46	More than 25 435	The possibility of aquifers below 9.4m in depth.

3.2.7 Water Quality

Since one of the Project's objectives is to reduce the number of cases of illness that are caused by diseases contained in insanitary drinking water, the Study Team conducted the water-quality examinations of the 37 samples obtained from the boreholes of the Phase I Project and from the areas in the vicinity of Project sites throughout the entire Southern Province. The results of the water-quality examinations and of previously examined data are described herewith.

(1) Water-quality Data Obtained by Previous Examinations

a) Surface Water

The quality of the surface water samples obtained from the reservoirs of the water supply sources in the rural townships are listed in Table 3-2-8.

Using WHO's standards that have been adopted by DWA, the water quality of these samples were found to be suitable for drinking.

Table 3-2-8 WATER QUALITY OF RURAL TOWNSHIP WATER SUPPLY (SURFACE WATER)

Item		Monze Dam	Kunsma River (Choma)	Kacha Dam	Pambe Tank	WHO Standard*
PH		7.4	7.2	7.4	6.8	6.5~9.2
EC	(μ.moh/cm)	115	82	84	216	N.S
Ca	(ppm)	13	13	11	18	N.S
Mg	(ppm)	5	3	2	11	50
Na	(ppm)	8	1	6	15	50
K	(ppm)	5	-	2	2	12
CO3	(ppm)	40	27	30	66	N.S
Cl	(ppm)	4	1	2	7	600
SiO2	(ppm)	10	-	-	-	250
Fe	(ppm)	Nil	-	-	-	1.0

(Mehta 1985)

* Maximum allowance for drinking water/N.S = Not specified

b) Groundwater

The quality of groundwater in the Southern Province is shown in Table 3-2-9.

Water quality in the plateau area is good. Water obtained from the alluvial flood plains of the Zambezi and Kafue rivers have some of the following problems:

Water samples obtained from the alluviums had distilled residues of 470 to 24,800 ppm/liter.

This is higher than the 550 ppm/liter that is standard for drinking water.

Groundwater in the Kafue lowland area contains more nitric acid and chlorine than water standards call for.

Water samples obtained from the Karroo system in the eastern part of Gwenbe contained more than 4.5 ppm/liter of fluorine which is excessively higher than standard (0.7 to 1.1 ppm/liter).

Groundwater near the Zambezi River in the western part of Livingstone contains excessive salinity.

Table 3-2-9 QUALITY OF GROUNDWATER

(Unit: ppm, EC: .moh/cm)

District of Sampling	PH	Ca	Mg	Na	K	CO3	Cl	SO4	SiO2	EC
Livingstone	7.6	54	40	18	2	150	16	Nil	-	500
Namwala	-	30	3	65	2	130	10	Nil	24	350
Mazabuka	6.2	22	17	21	8	96	16	Nil	-	530
Kalomo	7.2	59	28	62	3	234	8	Nil	32	525
Monze	7.2	34	28	19	13	2	54	124	-	425
WHO Standard	6.5~9.2	N.S	50	50	12	N.S	600	400	250	-

N.S = NOT SPECIFIED (Mehta, 1985)

(2) Results of the Water-quality Examinations

Of the 37 water samples examined, 7 were from water supply lines in various urban areas and townships, 6 were from rivers, 4 were from ponds and reservoirs, 10 from shallow wells, and 10 from deep wells. The results of water sample examinations are shown in Table 3-2-10 and Fig. 3-2-12. Also, the study results of the examinations are discussed below:

a) *Surface Water*

- Large Urban Area and Small Urban Township Supply Water (7 samples)

  Supply water in Livingstone (sample No.14) and Mazabuka (sample No.25) showed a high level of hue, 20 and 40 respectively. Other test items of all supply water samples, including the aforementioned samples, were within the rages of WHO, Japan, and Zambian water-quality standards. Therefore, it can be understood that the supply water is safe for drinking purposes. Some supply water is simply treated by the rapid filtration method of merely by chlorination.

- River Water (6 samples)

  Sample No.36 had a nitric ion content that exceeded WHO's standards. The distilled residues in samples No.36 exceeded Japanese standards -- the hardness, number of dissolved particles, and the Na-value were high.

  Waste from the Maamba Mine that is located in the upstream area of the sampled point seems to affect the river water quality; the water is not suitable for drinking.

Sample No.21 showed a slightly high PH value; its hardness exceeded Japanese standards, but was within WHO's and Zambian standards. The water quality is not good, but it is acceptable for drinking.

Sample No.34 had a PH value of 8.5 which is close to the Japanese standards of 8.6.

Other river water samples were within drinking water standards.

- Pond and Reservoir Water (4 samples)
  Sample No.31 showed a high level of hue, but the other three samples were within the standards for drinking water and were considered acceptable for drinking purposes.

  Sample No.35 contained many suspended particles.

  Only a small number of samples from ponds and reservoirs were tested; there fore, to generalize, the water quality was within drinking water standards and appears to be acceptable for drinking.

  The water quality examinations of the surface water were conducted at the end of the rainy season when the surface water cycle was frequent. Thus, water quality during the dry season may be different from those examined here.

b) Groundwater

Shallow Wells (10 samples)

High levels of nitrite and nitrate nitrogen were found in samples 3, 28 and 29. Two of the samples were higher than Japanese standards, but were within Who's standards.

Sample No.27 and 29 had a high level of chlorine, but were within the range of drinking water standards.

The existence of high levels of nitrogen and chlorine indicates artificial water contamination, such as sewage.

Samples 28 and 29 had large K-values.

Sample 15 showed a high hue of 40. Sample No.18 had a large number of suspended particles. Samples 3 and 4 showed PH values of 5.8 which is very close to Japanese standerds.

The water quality values of the shallow water samples deviated from their mean values. However, they were all within the ranges of the Japanese, WHO, and Zambian standards. The well water is acceptable for drinking.

- Deep Wells (10 samples)

  Sample No.37 was taken from a location close to the Maamba Mine and a river, and the water might be affected by the mine in the same manners as river water sample No.36.

  The other deep well water samples contained far less nitrogen, chlorine, and

suspended particles and had smaller hue values than did the shallow well water samples.

Sample No.22 contained more nitrogen than Japanese standards, but was within WHO's standards.

Sample No.12 contained 3.48 ppm/liter of fluorine and was higher than Japanese, WHO, and Zambian standards.

Water having a high fluorine content can cause Schmelt Hypoplasia which first appears as white spots on tooth enamel that eventually, due to the adherence coloring matter, turns the teeth dark brown.

The maximum limit of the fluorine content is 0.8 ppm/liter in Japan. However, since fluorine prevents tooth cavities, WHO adopts a relatively higher maximum of 1.0 to 1.5 ppm/liter.

Deep well water that is affected by mine waste and contains large amounts of fluorine is not acceptable for drinking purposes, but other deep well water is suitable for drinking.

c) Conclusion

Only a limited number of water samples were examined, but, as a results of the water quality examinations, the water in the area contaminated by mine waste is not suitable for drinking.

The qualities of shallow well water and surface water are lower than that of deep well water.

Water supplied by pipe lines is treated by the rapid infiltration method or by chlorination and it presents no problem in using it for drinking.

Water samples from rivers, ponds, and reservoirs were examined at the end of the rainy season when the water cycle is frequent. The qualities of these examined samples may be higher than that of the dry season water. Therefore, it is necessary to judge the water qualities based on the results of the water examinations, including bacteriological examinations, during the dry and drought seasons.

The quality of deep well water is stable throughout the year as compared to that of shallow wells and surface water. It is also superior if taking micro-organisms into consideration. Furthermore, deep well water is available in all seasons.

Tested water samples contained higher values of hardness, electrical conductivity, chlorine, distilled residue and hue than Japanese standards. Some samples showed a high content of fluorine while others were affected by mine wastes. It is necessary, therefore, to examine the water qualities at Project Sites during the period of the Project (Phase II) construction.

Fig. 3-2-11 Map of Water Sampling Locations for Water Quality Examination

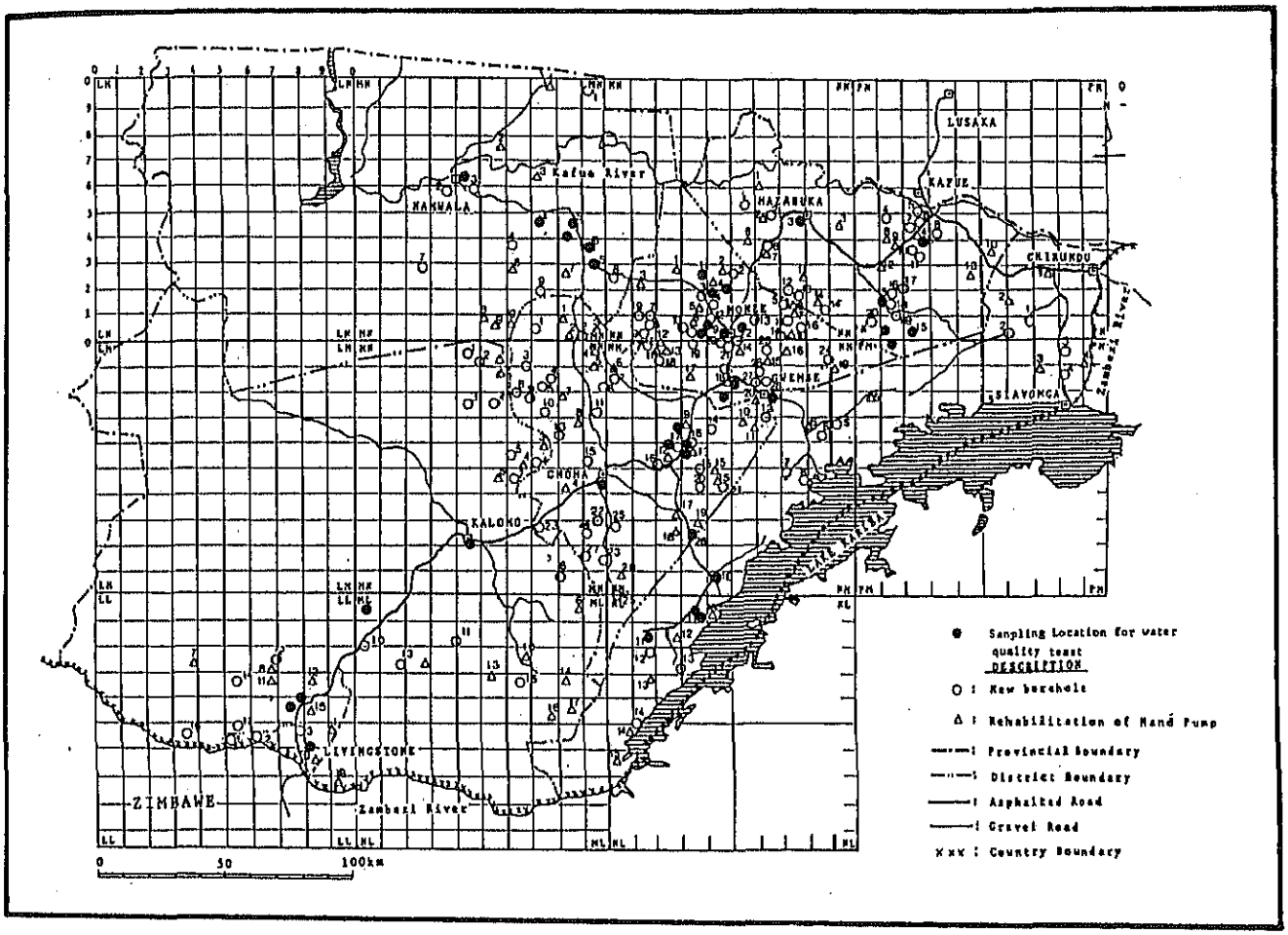


Table 3-2-10 RESULTS OF WATER QUALITY TESTS IN THIS STUDY

Location	District	No.	ph	Color Units	EC (umho /cm)	Total Alkali (ppm)	Chloride (ppm)	Silica (soluble) (ppm)	Sulphate (ppm)	Fluoride (ppm)	Calcium Hardness (ppm)	Total Hardness (ppm)	Nitrate N (ppm)	Nitrate NO3 (ppm)	TDS (ppm)	TSS (ppm)	Total Solids (ppm)	Sodium Na (ppm)	Potas-sium K (ppm)	Calcium Ca (ppm)
Piped water in town																				
Monze town	Monze	1	7	10	79	40	27.99	10.40	1.00	0.20	40.00	88.00	0.09	0.40	60.00	24.00	84.00	3.00	4.00	16.00
Choma town	Choma	5	7.1	5	204	120	41.98	60.40	1.00	0.20	60.00	108.00	0.12	0.53	132.00	0.50	132.00	20.00	1.30	24.00
Livingstone town	Livingstone	14	6.85	40	61	156	25.99	14.20	1.00	0.20	12.00	64.00	0.05	0.22	56.00	10.00	66.00	2.00	1.00	5.00
Kalomo town	Choma	19	7.3	15	45	156	31.98	7.80	1.00	0.20	24.00	48.00	0.01	0.04	20.00	10.00	30.00	2.00	2.00	9.60
Mazabuka	Mozabuka	25	7.7	20	250	252	27.99	13.25	1.00	0.20	56.00	140.00	0.23	1.02	192.00	2.00	194.00	12.00	2.50	22.44
Namwala town	Namwala	30	7.7	10	215	100	23.99	8.60	18.90	0.20	68.00	136.00	0.05	0.22	144.00	2.00	146.00	4.50	3.50	27.25
Gwembe town	Gwembe	32	7.4	5	87	28	33.98	2.20	12.60	0.20	32.00	80.00	0.23	1.02	64.00	8.00	72.00	1.50	1.00	12.80
River or stream																				
Musokotwane	Kalomo	8	7.55	15	310	228	33.98	26.40	1.00	0.20	104.00	176.00	0.03	0.13	158.00	10.00	168.00	22.50	4.00	41.68
Cheelo school	Choma	16	6.95	10	460	224	27.99	28.40	1.00	0.20	12.00	32.00	0.39	1.73	230.00	42.00	272.00	5.00	2.30	5.00
Chikankata	Mazabuka	21	8.1	10	500	336	27.99	37.00	1.00	0.88	60.00	328.00	1.65	7.31	238.00	24.00	262.00	6.00	4.00	24.00
Siazwela school	Choma	33	7.35	10	29	48	27.99	18.35	6.30	0.20	28.00	88.00	0.13	0.58	76.00	16.00	92.00	6.00	4.50	11.22
Syamamanga Village	Gwembe	34	8.5	15	610	312	45.98	13.35	102.80	0.46	80.00	260.00	0.05	0.22	398.00	4.00	402.00	36.00	3.00	32.00
Sinakasikili school	Gwembe	36	7.5	15	650	44	29.99	21.65	281.00	0.54	216.00	376.00	1.13	5.01	658.00	32.00	690.00	136.00	1.50	70.00
Pond or Dam stprage																				
Simnani	Kalomo	6	6.3	10	37	20	33.98	13.20	1.00	0.20	28.00	32.00	0.03	0.13	18.00	18.00	36.00	4.00	1.30	11.22
Kambaza school	Monze	13	6.8	10	35	36	25.99	8.10	1.00	0.20	16.00	44.00	0.55	2.44	328.00	4.00	332.00	2.00	1.30	6.40
Kabulamwands Dam	Namwala	31	7.6	31	540	40	33.98	4.40	1.00	0.20	32.00	48.00	0.14	0.62	62.00	36.00	98.00	4.00	3.50	12.80
Sinakasikili school	Gwembe	35	6.85	5	33	152	29.99	23.35	50.60	0.36	64.00	120.00	0.73	3.23	270.00	72.00	342.00	25.00	5.00	25.65
Shallow well																				
Malame	Monze	3	5.82	5	60	44	41.98	34.90	1.00	0.20	20.00	44.00	2.46	10.90	30.00	10.00	40.00	5.00	4.00	8.00
Malame	Monze	4	5.95	10	75	48	29.99	34.90	1.00	0.20	24.00	44.00	0.98	4.34	32.00	8.00	38.00	5.30	2.00	9.60
Chamoka Villege	Monze	11	6.75	10	48	344	33.98	9.10	1.00	0.20	24.00	56.00	0.10	0.44	142.00	32.00	174.00	3.00	4.00	9.60
Dema school	Choma	15	6.78	40	250	24	35.98	28.40	1.00	0.20	132.00	184.00	0.06	0.27	148.00	16.00	164.00	2.00	3.00	53.00
Chilundu school	Choma	18	7.15	5	126	40	27.99	32.15	1.00	0.34	20.00	76.00	0.01	0.04	168.00	112.00	280.00	11.00	2.00	8.00
Dundu school	Mazabuka	23	7.2	5	450	280	23.99	19.50	1.00	0.20	76.00	308.00	0.28	1.24	252.00	2.00	254.00	3.00	1.00	30.46
Chingangauka school	Mazabuka	24	6.85	10	265	136	27.99	38.95	1.00	0.20	64.00	152.00	0.93	4.12	170.00	2.00	172.00	16.00	10.00	25.60
Mangwe	Namwela	27	7.2	10	670	304	77.96	25.35	1.00	0.20	24.00	300.00	1.15	5.09	410.00	46.00	456.00	36.00	20.00	9.62
Kabulamwanda school	Namwela	28	7.25	15	350	136	33.98	52.95	6.30	0.20	96.00	140.00	3.50	15.51	218.00	18.00	236.00	28.00	14.50	38.48
Namusoude school	Namwela	29	6.25	10	390	28	109.95	46.30	1.00	0.20	32.00	56.00	1.85	8.20	246.00	8.00	254.00	37.50	2.00	12.80
Deep well																				
Moj-14	Monze	2	6.7	10	190	92	29.99	66.00	1.00	0.20	68.00	92.00	0.07	0.31	108.00	1.00	109.00	18.00	2.30	27.25
Musokotwane	Kalomo	7	7.1	5	304	375	33.99	60.40	1.00	0.20	108.00	192.00	1.70	7.53	174.00	0.50	174.00	9.00	2.30	43.00
DWA Monze office	Monze	9	7.3	5	410	136	35.98	61.80	1.00	0.20	136.00	232.00	0.92	4.09	284.00	0.50	284.00	30.00	7.00	54.50
Moj-9	Monze	10	6.4	10	224	36	37.98	44.60	1.00	0.20	56.00	112.00	1.02	4.52	132.00	8.00	140.00	16.00	4.00	22.00
Kambaza school	Monze	12	7.09	5	620	12	37.98	50.70	1.00	3.48	104.00	312.00	0.07	0.31	394.00	0.50	394.00	4.00	3.00	40.50
Chilundu school	Choma	17	6.7	10	390	76	27.00	37.00	3.20	0.46	32.00	188.00	0.01	0.04	204.00	12.00	216.00	25.00	3.00	12.83
Moj-13	Mazabuka	20	6.8	15	220	308	29.99	58.45	3.20	0.20	72.00	144.00	1.38	6.11	172.00	4.00	176.00	10.00	2.00	28.86
Chikankata school	Mazabuka	22	7.2	5	730	416	33.98	59.40	1.00	1.00	84.00	432.00	3.00	13.29	468.00	2.00	470.00	23.00	9.00	34.00
Mangwele school	Namwala	26	7.12	5	230	132	29.99	54.05	1.00	0.20	48.00	108.00	1.08	4.78	172.00	50.00	172.00	27.00	15.00	19.00
Mamba Coumcei	Gwembe	37	7.73	5	960	652	33.98	59.20	47.00	0.20	152.00	268.00	0.41	1.82	666.00	2.00	668.00	12.50	0.50	60.92

Fig. 3-2-12 RESULTS OF WATER QUALITY TESTS (1)

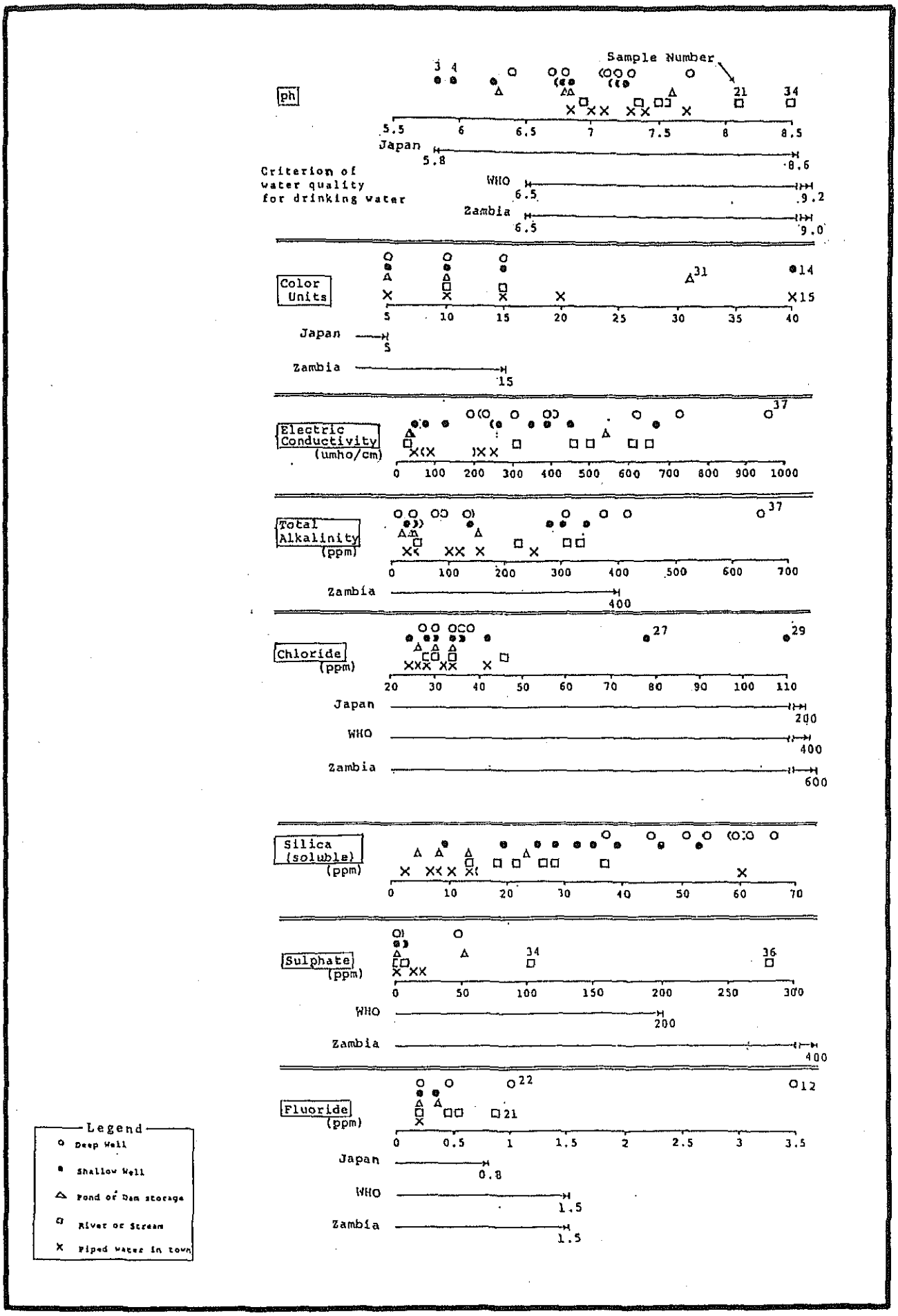
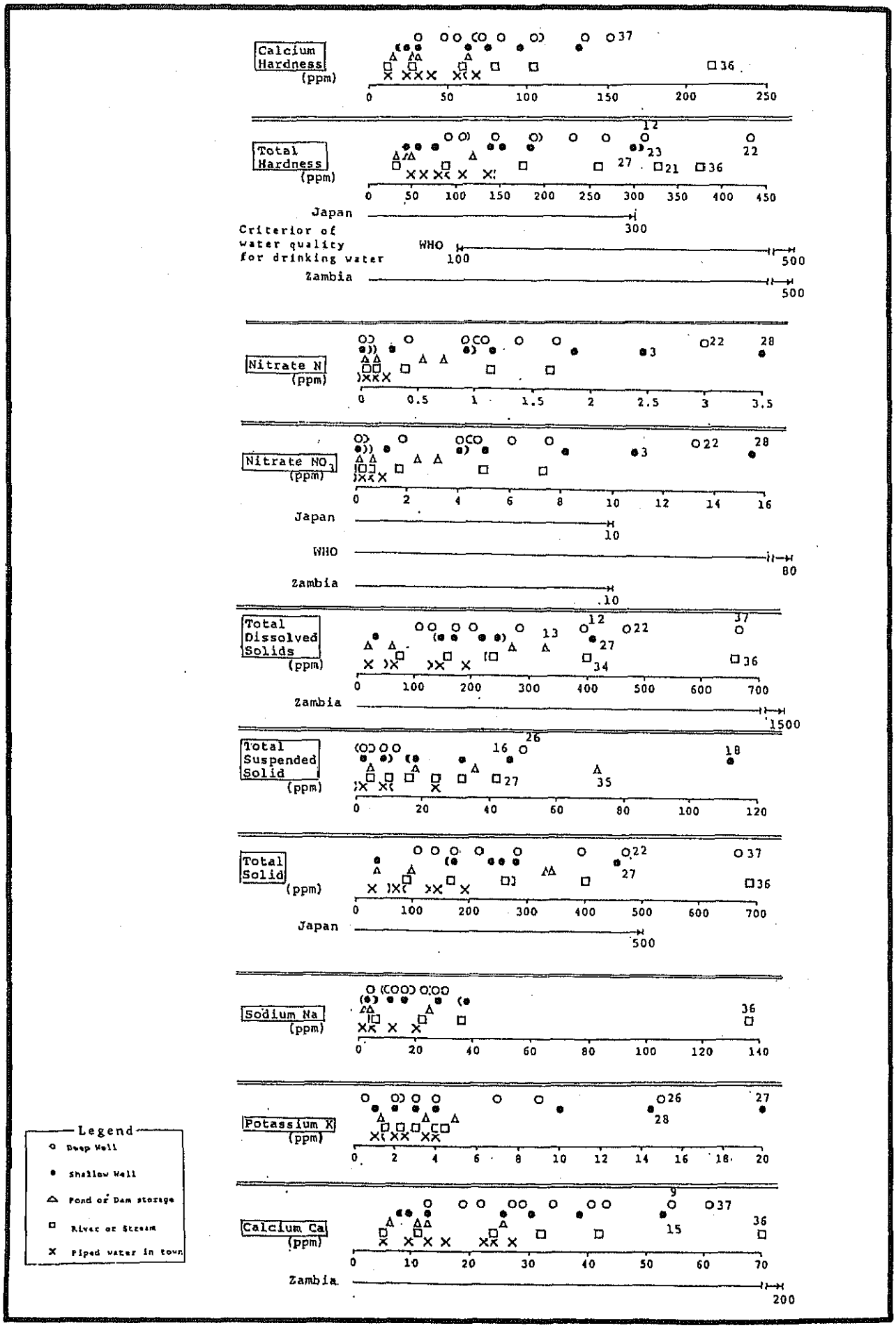


Fig. 3-2-12 RESULTS OF WATER QUALITY TESTS (2)



3.3 Social and Economic Conditions

3.3.1 Population

The population of the Southern Province is 671,923. It represents 11.9% of the country's total population (see Table 3-3-1).

24.8% of the people in the Province live in the urban areas, while 75.2% of its people live in rural areas.

The Southern Province's area is 85,283km2 (about 22% of Japan's total area) and represents 11.3% of the country's total area.

The population density is about 7.9 persons/km2 (see Table 3-3-2)

The age structure of the Province's population is about the same as for the entire country's population. As shown in Table 3-3-3, the younger generation rate is quite high.

During the 1969-80 period the population of the Southern Province increased 35.5%. The average annual increase rate was about 3.0% (see Table 3-3-4).

There are about nine tribes in the Southern Province, the most predominant being the Tonga tribe. Their language belongs to the Tonga-Ira group.

Table 3-3-1 POPULATION OF DISTRICT BY RURAL/URBAN AND SEX (1980)

District	Total			Rural			Urban		
	Total	Male	Female	Total	Male	Female	Total	Male	Female
TOTAL	671,923	328,342	343,581	505,368	245,377	259,991	166,555	82,965	83,590
CHOMA	130,416	62,942	67,474	98,124	47,091	51,033	32,292	15,851	16,441
GWEMBE	20,666 (94,070)	7,948	10,918	15,319	7,191	8,128	5,347	2,557	2,790
KALOMO	97,177	46,952	50,225	88,171	42,691	45,480	9,006	4,261	4,745
LIVINGSTONE	71,521	36,632	34,889	10,225	5,326	4,899	61,296	31,306	29,990
MAZABUKA	112,258	56,660	55,598	95,958	48,025	47,933	16,300	8,635	7,665
MONZE	110,423	53,535	56,888	96,344	46,804	49,540	14,079	6,731	7,348
NAMWALA	56,058	27,546	28,512	53,049	26,093	26,956	3,009	1,453	1,556
SIAVONGA*	29,633	13,983	15,650	22,498	10,346	12,152	7,135	3,637	3,498
SINASONGWE*	43,771	20,344	23,427	25,680	11,810	13,870	18,091	8,434	9,557
%	(100%)			(75.2%)			(24.8%)		

Table 3-3-2 CHANGE OF POPULATION DENSITY OF DISTRICT

District	Area (km2)	Population Density (Numbers/km2)		
		1963	1969	1980
TOTAL	85,283	5.5	5.8	7.9
CHOMA	7,296	13.2	13.4	17.9
GWEMBE	12,611 (20,189)	5.5	6.1	4.1
KALOMO	31,103	2.5	3.5	3.1
LIVINGSTONE	1,427	26.5	34.4	50.1
MAZABUKA	6,842	22.5	23.3	16.4
MONZE	4,854	-	-	22.8
NAMWALA	21,751	1.5	1.7	2.6
SIAVONGA*	2,614	-	-	11.3
SINASONGWE*	4,964	-	-	8.8

Table 3-3-3 POPULATION COMPOSITION BY AGE IN SOUTHERN PROVINCE

AGE	Less than 10	10 - 19	20 - 29	30 - 39	40 - 49	50 - 59	60 - 69	More than 70	Un-known
POPULATION PERCENTAGE	36.4	25.2	13.8	8.8	6.8	4.2	2.5	1.7	0.6

Table 3-3-4 CHANGE OF POPULATION AND ANNUAL POPULATION INCREASE RATE BY DISTRICT (1963, 1969, 1980)

District	Population			Annual Incerase Rate (%)	
	1963	1969	1980	1963-1969	1969-1980
TOTAL	466,327	496,041	671,923	1.0	2.8
HCOMA	96,024	97,980	130,416	0.3	2.6
GWEMBE	69,013	76,451	20,666 (94,070)	1.7	
KALOMO	76,538	76,571	97,177	0.0	2.1
LIVINGSTONE	37,801	49,063	71,521	4.4	3.5
MAZABUKA	154,177	159,376	112,258	0.6	
MONZE	-	-	110,423	-	-
NAMWALA	32,774	36,600	56,058	1.9	4.0
SIAVONGA*	-	-	29,633	-	-
SINASONGWE*	-	-	43,771	-	-

* Siavonga and Sinazongwe are, at present, included in Gwembe district.

DWA made the list of urban and rural population distribution in the Southern Province for planning purposes for its water supply project. (see Table 3-3-5)

Table 3-3-5 POPULATION BY DISTRICT (DATE FROM DWA)

Items \ District	GWEMBE	MAZABUKA	CHOMA	NAMWALA	MONZE	KALOMO	LIVING-STONE	TOTAL
Total Population	96,831	115,384	132,737	56,826	110,650	102,000	72,000	686,428
Population in Urban Area (Number of Townships)	16,918 (5)	39,006 (5)	28,564 (4)	5,000 (2)	14,526 (2)	10,000 (2)	72,000 (1)	186,014 (21)
Population in Rural Area (%)	79,913 (82.5)	76,378 (66.2)	104,173 (78.5)	51,826 (91.2)	96,124 (86.9)	92,000 (90.2)	(-)	500,414 (72.9)

Note: Populations in this table are a little bit different from those of the 1980 census

Additional details pertaining to the urban and rural population are listed in Table 3-3-6. Judging from this table, there is one large urban area (LUA), Livingstone, and a total of twenty small urban townships (SUT) and rural townships (RT) in the Southern Province.

The total urban population of the LUA, SUT, and RT is 186,000. The population in rural areas totals 500,000. 76% of the Province's people live in rural areas.

The population in SUT, excluding Livingstone (LUA) which has 72,000 people, is distributed as follows: about 30,000 in Mazabuka; 18,000 in Choma; 13,000 in Monze; 872 (the lowest SUT population figure) in Magoye of the Mazabuka District.

Houses in the SUT and RT are relatively crowded together forming a single block or a few blocks. In rural areas, the traditional African houses are sparsely distributed -- the crowding together of house is vary rare.

Table 3-3-6 POPULATION IN URBAN AND RURAL AREA

District	Urban/Rural		Population			Water Resources*
GWEMBE	Township in Urban Area	Gwembe	1,518	16,918	96,831	SW
		Chirundu	1,513			SW
		Siavonga	3,528			SW
		Maamba	6,639			SW
		Sinazongwe	3,720			SW
	Rural Area		79,913	79,913		SW & GW
MAZABUKA	Township in Urban Area	Kafue Gorge	2,833	39,006	115,384	GW
		Kaleya	2,728			GW
		Magoye	872			GW
		Mazabuka	29,602			SW
		Nega Nega	2,971			GW
	Rural Area		76,378	76,378		SW & GW
CHOMA	Township in Urban Area	Batoka	4,906	28,564	132,737	GW
		Choma	17,943			SW
		Mbabala	1,533			SW
		Pemba	4,182			GW
	Rural Area		104,173	104,173		SW & GW
NAMWALA	Township in Urban Area	Namwala	3,008	5,000	56,826	SW
		Iteshi-teshi	1,992			SW
	Rural Area		51,826	51,826		SW & GW
MONZE	Township in Urban Area	Chisekesi	1,385	14,526	110,650	GW
		Monze	13,141			SW
	Rural Area		96,124	96,124		SW & GW
KALOMO	Township in Urban Area	Kalomo	5,878	10,000	102,000	SW
		Zimba	4,122			SW
	Rural Area		92,000	92,000		SW & GW
LIVING-STONE	Large Urban Area	Livingstone	72,000	72,000	72,000	SW & GW
	Rural Area		-	-		-
Total	Urban Area		186,014	(27.1%)	686,428	
	Rural Area		500,414	(72.9%)		

NOTE: SW: Surface water
GW: Groundwater

3.3.2 Social Situations and Development Projects

Throughout Zambia, the Southern Province is well known for its high agricultural production. It produces large amounts of maize, sugarcane, and wheat. Also, the Southern Province raises the country's largest number of cattle. It is depicted that the plateau in the Southern Province is the most suitable agricultural and cattle-raising area.

As for forest resources, the Province is the country's fourth largest forest area. Forests in the Province are used mainly for protecting natural resources than for producing timber.

In Zambia, the development potentials for agriculture, cattle raising, fisheries, forestry, and tourism are highest along railroads and major roads. The Southern Province has one of the highest potentials for development in the country.

As described in the previous section, the objectives of the Third National Development plan (1979-83) were as follows;

(1) To expand agricultural production:
The purpose of making the expansion of agricultural production the highest objective of the Plan is to stabilize farmers' income, create employment opportunities, and to reduce food imports.

(2) To drive forward with rural development:
To correct income differences in urban and rural areas, and to increase the productivity of the traditional self-supporting farmers.

(3) To diversify mining industries:
To correct the copper inclined economic structure, and to promote export oriented

industries for the purpose of reducing imports. Also, to raise domestic copper processing methods to a higher degree and to diversify the copper related industries into becoming cobalt related industries.

(4) To emphasize labor intensive industries to increase employment opportunities.

Due to the changes of the international economic environment, the Government of Zambia, in May 1987, discontinued the International Monetary Fund (IMF) programme. In July of the same year, it launched the Interim National Development Plan (a new economic recovery plan). The basic objectives of the above Plan's rural development project are listed below:

(1) To correct economic imbalances in rural areas.

(2) To give preference to rural development over other projects.

Regarding the above objectives, the development projects set up in 1988 for the Southern Province are:

(1) Rehabilitation of the present economy and infrastructures.

(2) Implementation of the existing plans.

The Province's budget for each sector is as follows:

Agriculture and water resources development;	22%
Public works;	17%
District council budget;	17%
Education and cultural sector;	11%
Natural resources development;	11%
Health and Welfare;	10%

It can clearly be seen, from the above budget rates, that emphasis is being placed on the agricultural development policy.

3.3.3 Infrastructure, Public Health and Other Situations

(1) Infrastructures

- Railroad:

  The Southern Province is about 40km south of the country's capital, Lusaka.

  A railroad runs from Lusaka to the southern tip of the Southern province. It travels along a mild northeast-southwest oriented ridge until it reaches the tourist city of Livingstone that is near the Zimbabwe border. The straight line distance from Lusaka to Livingstone is about 370km. This railroad, having a famous historical background, reaches all the way to South Africa.

  There is a branch line that extends from Choma, which is in the center of the Province, in a south-southeasterly direction to the coal mining city of Maamba. The distance between these two cities covers a straight line distance of about 60km.

- Roads:

  Parallel to the railroad, there is a two-lane paved highway that runs from Lusaka to Livingstone.

  Other paved roads includes one that runs from Kafue to Kariba Dam via Chirundu (a straight line distance of approximately 100km), a 15km road from Chisekesi to Gwembe, and a road from Batoka to Maamba that is about 80km long. All other roads are unpaved.

- Airports:
  At Livingstone there is an international airport.
  Direct domestic flights to Lusaka originate at this airport.

  Additionally, there is one domestic and commercial service airport, and seven authorized and seven unauthorized airports.

- Power Plants:
  The major Zambian hydroelectric power plants are located along the Kafue and Zambezi rivers. The electricity generated at Kafue Gorge, Victoria Falls, and Kariba North is transmitted to various areas through 33 kv, 220kv, and 330kv transmission lines.

  In 1984, a total of 9,490.4 million kw of electricity was generated -- 4,912.2 million kw at Kafue George; 3,837.1 million kw at Kariba North, and 741.1 million kw at Victoria Falls.

- Employment and Industries
  Based on official statistics, the number of *persons employed in the Southern Province was* approximately 42,000 (in 1980). This was about 11% of Zambia's total employed persons (see Table 3-3-7). Tables 3-3-8 and 3-3-9 show the number of employed persons in different industries in 1978.

  Comparing the statistics for the entire country, persons employed in agriculture, forestry, and fisheries outnumbered those in all other employment sectors.

The Southern Province's manufacturing industries' production index of 1984 was only 59.6 (see Table 3-3-10) of the 1973 base of 100. The index has shown an overall decline since 1976.

Approximately one half of the country's maize was produced in the Southern Province during the 1977-78 season (see Table 3-3-11). Although not listed in this Table, most of the country's sugarcane was grown in the Province in 1982.

Livestock farming is well developed in the Province (see Table 3-3-12). According to the Table (1977-88 figures), the Southern Province ranked first in the country for the number of cattle and chickens.

Table 3-3-7 EMPLOYMENT BY PROVINCE (1980)

PROVINCE	Employment			Labour Force	
	Zambian	Total Population	%	Total Population	%
	(x1000)	(x1000)		(x1000)	
Central (including Lusaka)	119	125	33	401	22
Copperbelt	141	152	40	379	21
Eastern	14	15	4	207	12
Luapula	8	8	2	141	8
Northern	17	17	5	186	10
N-Western	9	9	2	100	6
Southern	41	42	11	200	11
Western	11	11	3	182	10

Table 3-3-8 EMPLOYMENT BY SECTOR IN SOUTHERN PROVINCE (1978)

SECTOR	Population		
	Zambian	Non-Zambian	Total
Public	13,030	560	13,590
Semi-public	12,730	170	12,900
Private	9,210	330	9,540
Total	34,970	1,060	36,030

Table 3-3-9 EMPLOYMENT BY INDUSTRIAL DIVISION IN SOUTHERN PROVINCE (1978)

Industrial Division	Population 1978			
	Zambian	Non-Zamblan	Total	%
Agriculture, Foresty and Fishers	12,890	130	13,020	36.1
Mining and Quarrying	1,170	60	1,230	3.4
Manufacturing	3,080	100	3,180	8.8
Electricity and Water	300	-	300	0.8
Construction and Allied Repairs	2,820	40	2,860	7.9
Hotel, Restaurant and Distribution	1,660	70	1,730	4.8
Transport and Communication	2,510	30	2,540	7.0
Insurance, Real Estate, Finance and Business Service	1,220	40	1,260	3.5
Community, Social and Personal Service	9,320	590	9,910	27.5
Total	34,970	1,060	36,030	100.0

Report of Employment and Earings (1978)

Table 3-3-10 INDEX OF INDUSTRIAL PRODUCTION

	Total Zambia	Copperbelt Province	Central Province (1)	Southern Province	Northern Province	Western Province	Eastern Province	North-western Province	Luapula Province
Weights	1.000	.604	.323	.058	.002	.003	.003	.001	.006
1972	94.5	93.4	105.3	77.1	52.4	88.2	48.0	209.2	78.1
1973	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1974	110.6	110.4	108.0	115.0	98.6	470.8	101.6	124.7	93.0
1975	105.5	105.1	106.3	105.8	85.5	114.5	120.3	184.5	105.9
1976	101.6	102.2	100.6	100.0	90.1	65.2	92.9	348.4	96.8
1977	99.2	100.6	101.5	75.4	50.9	81.3	80.3	363.9	57.1
1978	103.5	97.0	121.6	73.1	65.5	71.4	82.5	353.2	77.7
1979	104.9	100.4	119.6	77.1	50.8	39.9	82.0	244.1	72.7
1980	95.1	89.5	110.1	77.5	41.6	62.9	57.7	126.3	45.6
1981	107.8	108.9	113.6	78.0	51.9	112.8	69.1	242.6	42.5
1982	100.8	95.3	119.1	62.5	73.3	111.9	73.3	171.5	4.1
1983	95.1	85.9	119.1	60.6	73.2	108.3	65.9	210.8	29.5
1984	95.3	89.8	113.7	59.6	71.4	110.7	47.3	183.4	20.5
1985 Jan.	106.7	106.1	120.5	49.4	65.2	130.5	43.4	191.7	8.0

TAble 3-3-11 AGRICULTURAL PRODUCTS BY PROVINCE (1977-1978)

Province	Maize (Bags)	Groundnuts (Bags)	Beans (Bags)	Millet (Bags)	Sorghum (Bags)	Cassava (Bags)
CENTRAL	1,752,800	29,600	7,900	103,400	124,100	134,300
COPPERBELT AND NORTHWESTERN	139,900	15,300	14,100	124,600	161,200	276,100
EASTERN	2,291,400	198,000	2,500	19,900	25,500	-
LUAPULA	40,600	42,500	4,600	44,400	-	406,800
NORTHERN	392,300	51,400	53,700	172,800	51,200	41,000
SOUTHERN	4,076,400	31,000	800	3,800	1,400	-
WESTERN	197,400	4,100	400	44,000	18,300	94,400
Total	8,890,900	371,700	83,800	513,000	381,800	952,600

Source: Agricultural and Pastoral producer (Non-Commercial Section) 1977-78

Table 3-3-12 LIVESTOCK NUMBERS BY PROVINCE (1977-1978)

Province	Cattle	Sheep and Goats	Pigs	Chichen
CENTRAL	226,300	60,800	8,100	1,052,200
COPPERBELT AND NORTH-WESTERN	22,800	38,100	26,900	386,100
EASTERN	271,300	198,400	239,300	922,300
LUAPULA	3,100	23,700	-	326,500
NORTHERN	55,300	31,300	400	959,400
SOUTHERN	612,400	41,700	31,400	1,220,700
WESTERN	367,700	-	2,200	341,600
Total	1,559,000	394,300	308,300	5,190,800

Source: Agricultural and Pastoral producer (Non-Commercial Section) 1977-78

(2) Education

In 1982,there were 476 elementary schools (7-year system) having 155,216 pupils in the Southern Province. This averages out to be 326 pupils per school and 41 pupils per class.

In 1980, there were 1,611 elementary school teachers.

In 1982, there were 15,883 highschool (5-year system) students -- about 10% of the number of elementary school students. The simple calculation 15,883/155,216 shows that 14.3% of elementary school graduates go to highschools. The David Livingstone College, a two-year school, having 313 students (1984) is located in Livingstone.

Statistics relating to the schools are listed in Tables 3-3-13, 3-3-14, and 3-3-15.

Table 3-3-13 NUMBERS OF PRIMARY SCHOOLS AND CLASSES BY PROVINCE, 1982

Province	Primary School	Classes
Copperbelt	248	5,638
Central	264	2,506
Lusaka	141	2,548
Southern	476	3,769
Luapula	247	2,136
Northern	518	3,571
Eastern	438	3,026
N-Western	223	1,504
Western	331	2,332
Total	2,886	27,030

Source: Ministry of General Education and Culture.

Table 3-3-14 ENROLMENT IN PRIMARY SCHOOL BY AGE AND PROVINCE, 1982

Province	Under 7		7 - 14		Over 14		Total	
	Numbers	%	Numbers	%	Numbers	%	Numbers	%
Copperbelt	1,432	0.6	230,907	94.4	12,283	5.0	244,622	21.8
Central	375	0.4	99,622	93.7	1,270	5.9	106,267	9.5
Lusaka	138	1.1	113,743	93.4	6,605	5.4	121,730	10.9
Southern	619	0.4	147,175	94.8	7,422	4.8	155,216	13.8
Luapula	149	0.2	80,900	95.6	3,512	4.2	84,621	7.5
Northern	1,026	0.7	135,850	94.5	6,893	4.8	143,769	12.8
Eastern	624	0.5	109,349	93.2	7,343	6.3	117,316	10.5
N-Western	569	1.0	53,508	-	3,613	6.0	57,960	5.2
Western	301	0.3	86,977	96.4	2,990	3.3	90,268	8.0
Total	6,777	0.6	1,058,001	94.3	56,991	5.1	1,121,769	100

Source: Ministry of General Education and Culture.

Table 3-3-15 ENROLMENT IN SECONDARY SCHOOL BY PROVINCE, 1984

Province	Enrolment		Percentage of Girls (%)
	Numbers	%	
Copperbelt	35,012	27.8	38.3
Central	10,429	8.3	38.7
Lusaka	17,169	13.6	36.1
Southern	15,883	12.6	33.5
Luapula	8,868	7.0	42.4
Northern	12,902	10.3	33.1
Eastern	10,577	8.4	32.3
N-Western	5,939	4.7	31.5
Western	9,032	7.2	35.3
Total	125,811	99.9	36.2

Source: Ministry of General Education and Culture.

(3) Public Health

In 1984, there were 11 hospitals and a total of 104 health centers and clinics in the Southern Province. There were 3.9 hospital beds per population of 1,000. In 1982, the number of hospital beds per 1,000 population was 9.6 units in the urban areas and 1.7 units in the rural areas.

In 1980, 81% of the rural population lived in areas that were within a radius of 12km from health centers. The remaining 19% lived in areas that were further distances away from health centers.

As described in Chapter 2, the occurrence rate of diarrhoea, a disease attributed to insanitary drinking water, is very high in Zambia. In 1982, 734 peoples died of diarrhoea in the country. This figure was 4.1% of the total death toll, and diarrhoea was the 8th highest death cause in the country. In particular, the number of children who die as a result of having diarrhoea is very high. Table 3-3-19 lists the number of diarrhoea patients and death cases in the Southern Province.

In 1986, there were 186,081 diarrhoea outpatients (27.7% of the Province's population), 5,829 inpatients (0.868%), and 114 (0.017%) death cases.

Table 3-3-19 PATIENTS AND DEATHS BY DIARRHOEA IN SOUTHERN PROIVINCE

Item / Year	Diarrhoea in Southern Province			Remarks	
	Outpatients	Inpatients	Deaths	Total Deaths in Southern Province	Total Deaths in All Zambia
1981	133,470	2,946	64	789	
1982	157,006	4,523	69(732) *	1,902	17,887
1983	167,239	5,077	119	2,116	
1984	170,231	4,218	113	2,231	
1985	192,144	4,657	108	2,323	23,541
1986	186,081	5,829	108	2,462	

One of the objectives of the Project is to reduce the number of diseases resulting from insanitary drinking water.

Regarding the occurrence rates and death cases from diarrhoea, one of the diseases caused by insanitary drinking water, the figures of the Southern Province were compared with those of the entire country (see Table 3-3-20). Outpatients in the Southern Province were 23.4% of the population (29.9% were child cases).
Inpatients were 0.673%, and death cases were 0.0103 to 0.0129% (for child cases it was 0.0148%).

Table 3-3-16 NUMBERS OF BEDS PER 1,000 POPULATION BY PROVINCE (1984)

Province	Nmber of beds per 1000 population
Central	2.8
Copperbelt	2.8
Eastern	3.5
Luapula	3.1
Lusaka	2.8
Northern	3.2
Northwestern	6.2
Southern	3.9
Western	3.9

Source: Ministry of Health : Statistics Unit.

Table 3-3-17 NUMBERS OF BEDS BY PROVINCE AND URBAN/RURAL AREAS (1981)

Province	Rural Health Centers	Hospitals and Urban Health Centers	Population (x 1000)		Beds per 1000 Population	
			Rural	Urban	Rural	Urban
Central	398	962	337	201	1.2	4.9
Copperbelt	339	3,860	107	1,195	3.3	3.2
Eastern	899	1,547	607	68	1.5	22.8
Luapula	538	852	349	80	1.5	10.7
Lusaka	100	2,187	119	620	0.8	3.5
Northern	1,148	1,228	563	143	2.0	8.6
Northwestern	690	1,284	267	38	2.6	33.7
Southern	846	1,965	507	205	1.7	9.6
Western	493	1,452	428	74	1.2	19.6
Total	5,431	15,337	3,279	2,623	1.7	5.8

Table 3-3-18 RURAL POPULATION OUTSIDE THE 12 KM RADIUS OF A HEALTH CENTER,1980

Province	%	Uncovered Rural Population (x 1000)
Central	39	128
Copperbelt	17	18
Eastern	11	64
Luapula	19	65
Lusaka	23	26
Northern	43	244
Northwestern	26	69
Southern	19	94
Western	38	161
Total	27	870

Table 3-3-20 PATIENTS AND DEATHS BY DIARRHOEA (1982)

Items	Outpatients		Inpatients		Death		Population Numbers
	Numbers	(%)	Numbers	(%)	Numbers	(%)	
Southern Province	157,006	23.4	4,523	0.673	69	0.0103	671,923
All Zambia (Under 15)	828,349	29.9	(9,746)	(0.351)	411	0.0148	2,772,689
All Zambia	-	-	-	-	732	0.0129	5,661,801

3.4 Water Supply Situations

3.4.1 Situations of Water Supply Projects

As described in Chapter 2,the water supply projects of Zambia are classified into different water supply areas:

① large urban areas; ② small urban townships and rural townships; ③ rural areas.

This Project is a water supply project for rural area.

Situations of the Southern Province's water supply projects are described below:

① Large Urban Area (LUA):

Livingstone is the only city in this category. The Municipal Council undertakes water supply projects.

The population of Livingstone was 72,000 in 1980.

In 1977, a project was implemented to supply water, via pipe line, from a surface water source. Its capacity is 22,000m^3/day.

Presently, the Livingstone Water Supply and Sewerage Project is being constructed with a loan from the African Development Bank.

People not benefiting from the pipe line water supply must rely on deep wells, shallow wells, or river for drinking.

② Small Urban Townships (SUT) and Rural Townships (RT)

In the Southern Province there are a total of 20 SUT and RT (see Tables 3-3-5 and 3-3-6). Water

is supplied to these SUT and RT through pipelines that are under the jurisdiction of the District Councils or the DWA.

The water supply rates in SUT and RT are not available, but it is assumed to be about 45% (per Zambian Government statistics) as described in the previous chapter.

82.6% of the water supply comes from surface water sources. The remaining water supply comes from groundwater sources.

As a general rule, the surface water is chlorinated. Depending upon water quality, the slow or rapid sand filtration method is used in some areas. In some other areas, surface water having a high hue value is supplied, especially in the Mazabuka area.

Table 3-4-1 lists the new water supply projects that are either in the planning stage or are being constructed in SUT and RT with 1988 foreign aid budgeted funds.

Table 3-4-1 ONGOING WATER SUPPLY PROJECTS FOR SMALL URBAN OR RURAL TOWNSHIPS

District	City or Town	(1980) Population	* Agency	** Division	Water*** Resource	Design Population	Design Water Supply	Total Year	Estimated Cost	Aid Agency
GWEMBE	Gwembe	1,518	DWA	SUT	SW	1,750	272m3/day	1993		EEC
	Chirundu	1,513	DWA	SUT	SW	2,300/3,000	300	1993/2000	[1]	EEC
	Siavonga	3,528	DWA	SUT	SW	5,400/6,200	700	1993/2000	[1]	EEC
	Sinasongwe	3,720	DWA	SUT	SW	10,300	1300	1993/2000	[1]	EEC
CHOMA	Choma	17,943	DC	SUT					2,164,000	ADB
	Mbabala	1,533	DWA	SUT	GW	2,295/2,822	279/418	1998/2000	[1]	EEC
NAMWELA	Namwela	3,008	DWA	SUT	SW	7,375/9,323	947/1,455	1993/2000	[1]	EEC
MONZE	Monze	13,141	DC						5,000,000	ADB
KALOMO	Kalomo	5,878	DC						610,000	ADB
	Zimba	4,122	DWA	SUT	SW	4,500	466	1993	-	EEC
	Mambova	2,530	DWA/DC	RT	SW	2,451/2,974	237/370	1993/2000	[1]	EEC

Notes) * Responsible Agency DWA: Department of Water Affairs
DC : District Council
OT : Others

** Division of Water supply SUT: Small Urban Township
RT : Rural Township

*** Water Resource SW: Surface Water
GW: Groundwater

Estimate Cost of [1] (1988) : 8,740,000 (K)
ADB : African Development Bank

③ Rural Areas (RA)

RA are those areas other than LUA (Livingstone), SUT, and RT in the Southern Province.

The total population in RA is about 500,000. About 220,000 of these people (44% of the rural population) must rely on shallow wells or surface water sources for drinking water. During dry or drought seasons these water sources become exhausted and the residents cannot obtain safe drinking water. In order to get drinking water some people are obliged to travel 7 km by oxcart to reach water sources during these seasons.

The number of water sources in each district of the Southern Province is listed in Table 3-4-2.

Table 3-4-2 NUMBER OF PRESENTLY USED WATER SOURCES BY DISTRICT

	Population (x1000)	Cattle (x1000)	Dam	Dug Well	Borehole (Deep well)	Population/ Resource
Choma	133	216	47	560	195	166
Kalomo	102	173	105	440	157	145
Monze	111	263	87	808	150	106
Mazabuka	115	152	77	375	115	269
Gwembe	97	70	17	607	174	121
Namwala	57	147	25	379	98	113
Livingstone	72	53	-	-	22	-
Total	687	1,074	358	3,169	911	

Note: Number of water sources include those in both urban and rural areas

The figures shown in the right-hand column are the quotients of each district's population divided by the number of water sources in the district. The figures indicate how many people rely on one water source in each district.

Most boreholes are located in a small number of relatively large farms. 44% of the rural population are not benefiting from these boreholes and they must rely on dug wells or river water. The dug wells are less than 10m deep and most of them dry up during dry seasons.

As described in Chapter 2, there were no rural water supply projects, other than Groundwater Development Project (Phase I) that was financed by grant aid from the Government of Japan, financed by foreign aid.

Presently, DWA's drought relief projects and rural water supply project are being implemented with government financing. The Cooperative and Village Water Supply Project is being undertaken by the District Council.

Due to budget limitations, the progress of these projects is slow.

Table 3-4-3 provides details concerning the Southern Province's drought relief projects.

Table 3-4-3 DEVELOPMENT RESULTS OF DROUGHT RELIEF PROGRAMME IN SOUTHERN PROVINCE

Items / Year	Wells		Boreholes		Dams	
	Repairs	New Construction	Repairs	New Construction	Repairs	New Construction
1982	305	10	109	27	-	-
1983	215	55	109	3	-	10
1984	17	4	8	16	3	7
1985	-	-	(17)	8	2	5
Total	537	69	243	54	5	22

3.4.2 Present Conditions of the Project Sites

The Project is a drinking water supply project for the groundwater development plan in rural areas. It was requested to construct new deep wells at 120 sites and to rehabilitate malfunctioning wells at 100 sites under the Project.

The sites requested by the Zambian side were selected by the following procedure:

1) A leader from each village not being able to obtain domestic and drinking water during drought seasons appealed to District Concils.

2) The District Councils evaluated and classified the appeals made by the village leaders and then requested well construction to DWA.

3) DWA evaluated and classified the requests made by the District Councils. They determined the priority of each requested and then requested the budget necessary for well construction.

4) Upon receiving the budget, DWA commenced the well construction work. Some District Councils used their own budgets for well construction work.

5) Because of the 3-year continuous drought that began in 1981, there was a sharp increase in the number of requests for constructing or rehabilitating wells. In order to overcome drought damage and to take urgent measures to solve drought problems, the Government of Zambia, after classifying the request, launched the Groundwater Development Project in the Southern Province to construct 880 new deep wells.

6) The construction wells having the highest priority, as far as urgency was concerned, at 120 sites was requested under the Phase I project; 102 new deep wells were completed.

7) Since the Government of Zambia has been suffering from the lack of funds for constructing the remaining wells, it requested grant aid from the Japanese Government to accomplish this under the Project (Phase II).

A similar procedure was used to select the sites where malfunctioning wells are to be rehabilitated under the Project.

The Study Team conducted the surveys of the requested well sites. The survey results are shown in Tables 3-4-4 through 3-4-7 (the requested well sites are shown in Fig. 2-3-1). An outline of the survey results follows:

① Area Conditions of the Requested New borehole Construction Sites (Table 3-4-4 & 3-4-5):

There are 120 borehole drilling sites: 36.7% are in school yards; 4.2% in hospital compounds; 55% in rural community centers; 4.2% in market or open field area. 93% of the boreholes are in schoolyards and rural community centers.

67.7% of the water sources presently being used in drilling site areas are groundwater. The remaining 32.3% are surface water. 3.6% of the groundwater sources are deep wells; 96.4% are shallow wells.

No intake facility exists to handle surface water -- the people get their water directly from streams using buckets.

Groundwater intake methods are the manual hand-cranking chain and bucket method (66.7%), the rope and bucket method (29.7%), hand pump method (2.7%), and the powered pump method (0.9%).

The water supply methods are: carried manually (65.8%); hauled by animals (31.7%); conveyed by pipelines, stand pipes, and hand pumps (2.6%). Water supplied by stand pipes or by hand pumps must be carried manually to each home.

When people obtain their water from distant sources, they utilize animals for transportation.

Table 3-4-4 SUMMARY OF THE PRESENT CONDITIONS OF THE PROPOSED HAND PUMP WELL SITES

District		Mazabuka	Monze	Namwala	Gwembe	Choma	Kalomo	Livingstone	Total	%
Number of Proposed Sites		20	28	9	14	29	17	3	120	
Site	School	6	13	3	3	17	2	0	44	36.7 %
	Hospital, Clinic	3	2	0	0	0	0	0	5	4.2 %
	Village	10	13	6	11	9	14	3	66	55.0 %
	Others	1	0	0	0	3	1	0	5	4.2 %
Population	Total Population around the proposed sites	8,986	25,028	12,221	11,266	18,302	9,359	1,337	86,499	
	Average population around one present water source	449	642	815	351	481	551	446	528	
	Average population around one newly proposed site	449 (428) **	894	1,358 (1,109) **	805	632	551	446	721	
Type of Present Water Resources	Groundwater	19	27	15	18	31	0	1	111	67.7 %
	Surface water	1	12	0	14	7	17	2	53	32.2 %
Intake Facilities	Deep well (Borehole)	1	0	3	0	0	0	0	4	2.4 % (3.6%)
	Shallow well (Dug well)	18	27	12	18	31	0	1	107	65.2 % (96.4%)
	Direct from river	1	12	0	14	7	17	2	53	32.3 %
Intake Method	Power Pump	1	0	0	0	0	0	0	1	0.6 % (0.9%)
	Hand Pump	0	0	3	0	0	0	0	3	1.8 % (2.7%)
	Bucket by hand with pulley	12	17	11	8	25	0	1	74	45.1 % (66.7%)
	Bucket by hand with rope	6	10	1	10	6	0	0	33	20.1 % (29.7%)
	Direct from river	1	12	0	14	7	17	2	53	32.3 %
Service Method	Service pipe	1	0	0	0	0	0	0	1	0.5 %
	Stand pipe	0	0	0	0	0	0	0	1	0.5 % 2.6%
	Hand pump	0	0	3	0	0	0	0	3	1.6 %
	Vehicle	0	0	0	0	0	0	0	0 *	
	Animals	9	14	0	10	6	17	2	58	31.7 %
	Man power	20	28	9	14	29	17	3	120	65.6 %

** Potable water might be supplied by District Council vehicles during dry seasons and drought periods.
* Including the existing deep wells.

Table 3-4-5 PRESENT CONDITION OF PROPOSED HAND PUMP WELL SITE (1)

Site Name	Grid Ref.	Site				Population	Water resource		Intake facilities			Intake method					Service method						Remarks
		School	Hospital, Clinic	Village	Others		Groundwater	Surface water	Deep well	Shallow well	Direct from river	Power pump	Hand pump	Well bucket by pulley	Well bucket by hand	Direct from river	Service pipe	Stand pipe	Hand pump	Vehicle	Animals, etc.	Man power	
Mazabuka District																							
1. Kabanje East	NN 56-53			•		315	1			1				1							•	•	
2. Mugwagwa	NN 65-48			•		320	1			1				1							•	•	
3. Mazabuka Hospital	NN 78-47		•			660	1		1			1					•	•				•	
4. Kanyele	PN 10-50			•		372	1			1					1						•	•	
5. Mambula	PN 25-46			•		400	1			1					1						•	•	
6. Kasengo School	PN 24-47	•				289	1			1					1						•	•	
7. St.Michael School	NN 85-13	•				524	1			1				1								•	
8. Lusale Village	PN 32-41			•		261	1			1				1								•	
9. Mbiya School	NN 66-37	•				357	1			1				1								•	
10. Kaoma Village	PN 23-36			•		312	1			1					1						•	•	
11. Naluama Hospital	PN 24-35		•			950		1			1					1						•	
12. Munjile Clinic	NN 70-20		•			338	1			1				1								•	
13. Munzuma	NN 78-20			•		240	1			1				1								•	
14. Kasengo Village	PN 23-46			•		921	1			1					1							•	
15. Dundu School	PN 17-14	•				367	1			1				1								•	
16. Mukwela School	PN 17-14	•				842	1			1				1								•	
17. Namembo	PN 20-20			•		632	1			1				1							•	•	
18. Mulawbo School	PN 14-14	•				250	1			1				1								•	
19. Malambo Depot	PN 16-16				•	315	1			1				1							•	•	Site: Market
20. Munjile	PN 08-09			•		321	1			1					1						•	•	
	Total	6	3	10	1	8,986	19	1	1	18	1	1		12	6	1	1	1			9	20	
Monze District																							
1. Keemba H/center	NN 40-20		•			954	2			2					2						•	•	
2. Hakwaambwa school	NN 53-25	•				1,250	2			2				2							•	•	
3. Luyaba Clinic	NN 38-17		•			474		1			1					1					•	•	
4. Chilezya	NN 43-14			•		541	1			1				1							•	•	
5. Namazoka School	NN 73-14	•				1,241	2			2				2								•	
6. Njola School	NN 10-10	•				228	1			1				1								•	
7. Hamangaba School	NN 14-14	•				1,600	1			1				1							•	•	
8. Mankonka School	NN 15-09	•				1,621	1	1		1	1				1	1					•	•	
9. Mutali School	NN 14-05	•				1,578	1	1		1	1				1	1					•	•	
10. Kazungula School	NN 31-06	•				1,215	1			1				1							•	•	
11. Kimbela/Dabali	NN 33-04			•		694	1			1				1							•	•	
12. Sigubu School	NN 42-09	•				1,240	1	1		1	1			1		1					•	•	
13. Chiyonga	NN 60-09			•		432	1	1		1	1			1		1					•	•	
14. Nabukuyu School	NN 71-02	•				1,306	2			2				2								•	
15. Nangwelika	NN 76-07			•		510	1			1				1								•	
16. Mwenenjola	NN 79-05			•		653	1			1					1							•	
17. Milele/Kachango	NM 19-96			•		828	1			1					1							•	
18. Hambalamatu	NM 21-94			•		1,010	1	1		1	1				1	1					•	•	
19. Kanundwa School	NM 37-99	•				971	1			1					1							•	
20. Simwete	NM 49-99			•		337	1			1				1								•	

Table 3-4-5 PRESENT CONDITION OF PROPOSED HAND PUMP WELL SITE (2)

Site Name	Grid Ref.	Site: School	Site: Hospital, Clinic	Site: Village	Site: Others	Population	Water resource: Groundwater	Water resource: Surface water	Intake facilities: Deep well	Intake facilities: Shallow well	Intake facilities: Direct from river	Intake method: Power pump	Intake method: Hand pump	Intake method: Well bucket by pulley	Intake method: Well bucket by hand	Intake method: Direct from river	Service method: Service pipe	Service method: Stand pipe	Service method: Hand pump	Service method: Vehicle	Service method: Animals, etc.	Service method: Man power	Remarks
Monze District																							
21. Hachiko	NM 50-99			•		273		1			1					1					•	•	
22. Malozilozi	NM 51-99			•		470		1			1					1					•	•	
23. Hachizangwa	NN 65-96			•		349	1			1					1							•	
24. Mafulo/Nachisaka	NM 90-09			•		868	1	1		1	1				1	1						•	
25. Simukale School	NM 51-90	•				1,347		1			1					1						•	
26. Chikuni	NM 61-88			•		256		1			1					1						•	
27. Nahicha School	NM 61-84	•				1,321	1	1		1	1			1		1						•	
28. Singonya School	NM 64-82	•				1,461	1			1				1								•	
	Total	13	2	13		25,028	27	12		27	12			17	10	12					14	28	
Namwala District																							
1. Mauluzhi	MN 96-97			•		1,111	2		1	1			1	1					•			•	
2. Mungaila	MN 73-62			•		1,530	2			2				1	1							•	
3. Baambwe	MN 48-57			•		2,335	2		1	1			1	1					•			•	
4. Umbuuzu School	MN 64-37	•				824	1			1				1								•	
5. Mangwelw School	MN 94-28	•				3,100	2		1	1			1	1					•			•	
6. Mangwe	MN 92-34			•		622	1			1				1								•	
7. Baunza	MN 24-64			•		741	1			1				1								•	
8. Moomba School	MN 02-23	•				931	2			2				2								•	
9. Nakamboma	MN 75-14			•		1,027	2			2				2								•	
	Total	3		6		12,221	15		3	12			3	11	1				3			9	
Gwembe District																							
1. Makumbi Village	PN 69-08			•		472	1	1		1	1			1		1					•	•	
2. Jalaula Village	PN 60-19			•		617	1	1		1	1			1		1					•	•	
3. Bendele Village	PM 85-95			•		346	1	1		1	1				1	1					•	•	
4. Nambela Village	PM 83-85			•		512	1	1		1	1				1	1					•	•	
5. Kalangwa Village	NM 92-67			•		1,552	2	1		2	1			2		1					•	•	
6. Hanchilimba Village	NM 86-62			•		764	1	1		1	1				1	1						•	
7. Syamuluwa Village	NM 74-48			•		852	1	1		1	1				1	1					•	•	
8. Minziyabantu Vge.	NM 79-44			•		732	1	1		1	1				1	1					•	•	
9. Chipepo Pri. School	NM 88-42	•				632	1	1		1	1				1	1						•	
10. Syamamanga Village	NM 46-02			•		541	1	1		1	1				1	1					•	•	
11. Sinakasikili Sch.	NL 39-93	•				1,061	2	1		2	1			2		1					•	•	
12. Sinakoba Sch.	NL 18-68	•				1,517	2	1		2	1			2		1					•	•	
13. Mweenba Village	NL 30-72			•		1,050	2	1		2	1				2	1						•	
14. Dengeza Village	NL 12-49			•		618	1	1		1	1				1	1						•	
	Total	3		11		11,266	18	14		18	14			9	10	14					10	14	

Table 3-4-5 PRESENT CONDITION OF PROPOSED HAND PUMP WELL SITE (3)

Site Name	Grid Ref.	Site				Population	Water resource		Intake facilities			Intake method					Service method						Remarks
		School	Hospital, Clinic	Village	Others		Groundwater	Surface water	Deep well	Shallow well	Direct from river	Power pump	Hand pump	Well bucket by pulley	Well bucket by hand	Direct from river	Service pipe	Stand pipe	Hand pump	Vehicle	Animals, etc.	Man power	
Choma District																							
1. Mayobo P/School	MN 72-04	•				872	1	1		1	1			1		1					•	•	
2. Chibwe P/School	MN 90-02	•				961	2			2					2						•	•	
3. Nemfe P/School	MM 69-89	•				642	1	1		1	1			1		1					•	•	
4. Macha Central School	MM 78-85	•				456	1			1					1							•	
5. Mizinga Sikuchoma	MM 76-83			•		650	1			1					1							•	
6. Nalube P/School	MM 99-81	•				566	1	1		1	1			1		1					•	•	
7. Hansingo	NM 01-85			•		458	1	1		1	1				1	1					•	•	
8. Katambwakolo	MM 64-80			•		458	1	1		1	1				1	1					•	•	
9. Mundundu	MM 70-78			•		342		1			1					1					•	•	
10. Kabimba P/School	MM 76-72	•				666		1			1					1						•	
11. Ndambo	MM 95-72			•		432	1			1				1								•	
12. Mayasano P/School	MM 65-70	•				761	1			1				1								•	
13. Haluba P/School	MM 81-63	•				821	1			1				1								•	
14. Demu P/School	NM 41-65	•				718	1			1				1								•	
15. Kabwe Kasala Scheme	MM 92-51				•	647	1			1				1								•	Site: Scheme
16. Bbombo P/School	MM 22-50	•				833	2			2				2								•	
17. Cheelo P/School	NM 29-57	•				710	1			1				1								•	
18. Chimuka	NM 35-60			•		416	1			1				1								•	
19. Nachibanga P/School	NM 37-50	•				517	1			1				1								•	
20. Siadabboka P/School	NM 38-42	•				657	1			1				1								•	
21. Chief Moyo's Palace	NM 47-42				•	811	2			2				2								•	Site: Palace
22. Hapande	MM 95-30			•		310	1			1				1								•	
23. Tawa Compound	MM 76-28				•	561	1			1				1								•	Site: Compound
24. Mutandalika P/School	MM 91-27	•				822	2			2				2								•	
25. Gamela	MM 02-29			•		460	1			1				1								•	
26. Skaawola P/School	NM 34-22	•				486	1			1				1								•	
27. Nakeempa P/School	MM 98-13	•				716	1			1				1								•	
28. Siamakando	MM 98-13			•		722	1			1				1								•	
29. Chuulu P/School	NM 02-00	•				831	1			1				1								•	
	Total	17		9	3	18,302	31	7		31	7			25	6	7					6	29	

Table 3-4-5 PRESENT CONDITION OF PROPOSED HAND PUMP WELL SITE (4)

Site Name	Grid Ref.	Site				Population	Water resource		Intake facilities			Intake method					Service method						Remarks
		School	Hospital, Clinic	Village	Others		Groundwater	Surface water	Deep well	Shallow well	Direct from river	Power pump	Hand pump	Well bucket by pulley	Well bucket by hand	Direct from river	Service pipe	Stand pipe	Hand pump	Vehicle	Animals, etc.	Man power	
Kalomo District																							
1. Mabombo School	MM 45-94	•				513		1			1					1					•	•	
2. Chikanta	MM 50-91			•		507		1			1					1					•	•	
3. Mulyambeba	MM 45-75			•		515		1			1					1					•	•	
4. Siantete	MM 54-75			•		463		1			1					1					•	•	
5. Kamuseka	MM 62-55			•		633		1			1					1					•	•	
6. Nakabanga	MM 71-51			•		512		1			1					1					•	•	
7. Katete Co-op.	MM 63-46				•	509		1			1					1					•	•	Site: Market
8. Sindambi	MM 82-07			•		504		1			1					1					•	•	
9. Mantanyani	ML 05-94			•		621		1			1					1					•	•	
10. Sikanchele	ML 02-80			•		617		1			1					1					•	•	
11. Dunka	ML 40-82			•		510		1			1					1					•	•	
12. Mankoondi School	LL 69-72	•				519		1			1					1					•	•	
13. Namadula	ML 18-73			•		521		1			1					1					•	•	
14. Kakena	LL 56-64			•		457		1			1					1					•	•	
15. Chalimongela	ML 65-65			•		916		1			1					1					•	•	
16. Kaoma	LL 35-45			•		524		1			1					1					•	•	
17. Misika Misika	LL 54-46			•		518		1			1					1					•	•	
	Total	2		14	1	9,359		17			17					17					17	17	
Livingstone District																							
1. Sakubita	LL 54-30			•		833		1			1					1					•	•	
2. Simoonga	LL 63-31			•		317		1			1					1					•	•	
3. Natebe	LL 80-37			•		187	1			1				1								•	
	Total			3		1,337	1	2		1	2			1		2					2	3	

Usually the distance from a house to a water source is from 1 to 2 km -- the minimum case is 100m; the maximum case is about 5km.

The population in the drilling site areas is 86,499. The people in these areas use 164 water sources: 32% are rivers (one river is counted as one water source), 65% are shallow wells, and 2.4% are deep wells. An average of 528 people (86,499/164) rely on one water source.

The average number of people who rely on one water source in each district is in the range of 228 to 1,600 persons.

The average number of people who will use the new boreholes will be 86,449/120 = 721 persons/borehole.

Traditional African houses are scattered singly or in groups. Generally, about ten houses from one group. The average household in rural areas of the Southern Province consists of 5.9 members (per the 1980 census).

The average number of households relying on one water source is 528/5.9 = 89.5. The average number of households that will use the new boreholes will be 721/5.9 =122.2.

Presently, plans call for constructing boreholes having hand pumps in central location from every 90 to 120 houses.

Schools and hospitals are generally located at the center of the traditional villages. These villages are not formed of a concentration of traditional houses. Instead, they are made up of

houses that are scattered singly or in groups of ten.

② Area Conditions of the Requested Well Rehabilitation Sites and the Conditions of Malfunctioning Wells (Table 3-4-6 & 3-4-7):

a) Area Conditions of the Requested Well Rehabilitation Sites:

There are 100 rehabilitation sites -- 49% of the sites are in schoolyards, 3% are in hospital complexes, 44% are in village centers, and 4% are in other areas. 92% of the sites are in schoolyards and village centers.

Of the malfunctioning wells, it is known when 28 of them were constructed and when they began to malfunction. For the most part, they were constructed during the 1960 - 1970 period; the average construction year being 1967. The average year when malfunctioning started is 1979. Therefore, it can be assumed that the wells were used for approximately 12 years and have been malfunctioning for 9 years.

When the wells began malfunctioning, residents had to rely on other groundwater or surface water sources. It is not known how many people use one or both of these water sources as an alternative water supply.

The people who rely upon surface water obtain it directly from streams with the use of buckets.

The population in the well rehabilitation site areas is 72,475. Therefore, the average

number of people who will rely on one well will be 725.

b) Conditions of Malfunctioning Wells

As described in the previous sub-section, the hand pump operated wells that are presently malfunctioning were used for about 12 years, but have not been in use for the past nine years.

The average depth of the malfunctioning wells is 61.6m. The average well diameter is 150mm. The static water levels of the wells are in the range of from 4.1 to 30m; most of them are from 9 to 17m.

Their dynamic water levels are in the range of 12.0 to 70.6m; most of them are from 26 to 40m.

Their relative water yields are in the range of from 0.2 to 163.0 liters/min/m; most are less than 2 liters/min/m. About 89% of the mulfunctioning hand pumps are inoperable while the remaining are operating at a very low rate of efficiency.

Hand pump types are: Standard Pumps (68.7%); National Pumps (26.7%); Mono Pumps (2.7%); Indian Mark II Pumps (1.3%); Windmill Pumps (1.3%).

Causes of pump breakdowns:

Part Breakdown	%
Handle breakdown:	11.2
Bolts for handle connector:	14.2
Discharge outlet:	10.5
Pump stand:	7.9

Rod, cable, or cylinder:	19.0
Suction check valve:	17.7
Strainer clogging:	19.0
Well casing:	0.4

Reasons for pump breakdowns are analyzed below:

Reason	%
Improper use:	1.3
Deterioration of materials:	59.2
Poor material quality:	39.5

Table 3-4-6 SUMMARY OF THE PRESENT CONDITIONS OF THE MALFUNCTIONING HAND PUMP WELL SITES

District			Mazabuka	Monze	Namwala	Gwembe	Choma	Kalomo	Livingstone	Total	
Number of Proposed Sites			15	20	10	15	20	18	2	100	
Site	School		9	10	5	8	12	5	0	49	49%
	Hospital, Clinic		0	0	0	0	1	2	0	3	3%
	Village		6	7	5	6	7	11	2	44	44%
	Others		0	3	0	1	0	0	0	4	4%
Population	Total Population around the proposed sites		7,350	8,440	12,000	20,450	11,990	11,745	500	72,475	
	Average population around one newly proposed site		490	422	1,200	1,364	600	653	250	725	
Malfunctioning Hand Pump Well	Average year of completion		1968	1968	- *	-	1964	-	-	-	(1967)
	Average year of trouble		1979	1982	-	-	1977	-	-	-	(1979)
Type of Present Water Resources	Deep well (Borehole)		-	-	-	-	-	-	-	-	-
	Shallow well (Dug well)		-	8	6	-	-	1	-	(15)	(32%)
	Surface water		8	7	-	5	4	6	1	(31)	(68%)
Present Conditions of Malfunctioning Hand Pump Well	Deep well (Borehole)		15	18	0	15	20	15	2	85	
	Shallow well (Dug well)		0	2	10	0	-	-	0	(12)	
	Average, Depth (m)		52	83.0	31	58	59	70	63	61.6	
	Well diameter (mm)		150	150	1,200	150	150	150	150	(150)	
	Average casing depth (m)		16.2	16.0	-	-	(44.7)	-	-		
	Average static water table (m)		9.5	36.6	-	-	14.4	-	-		
	Average dynamic water table (m)		26.6	30.1	-	-	39.3	-	-		
	Average specific capacity (l/min/m)		21.6	1.69	-	-	1.19	-	-		
Present Conditions of Malfunctioning Hand Pump	Completely failed/trouble		15	16	1	15	20	17	2	86	88.7%
	Failed but can be used		0	4	7	0	0	-	0	11	11.3%
	Name of Hand Pump	National	3	8	1	14	-	8	0	(34)	38.2%
		Standard	12	10	1	-	19	7	2	(51)	57.3%
		Zamb	0	0	-	-	-	-	0	-	(-)
		Indian Mark II	0	1	-	-	-	-	0	(1)	(1.1%)
		Mono	0	1	-	-	-	1	0	(2)	(2.3%)
		Mindwill	0	0	-	-	-	1	0	(1)	(1.1%)
		Average length of suctional pipe	38.5	38.5	-	-	(48.2)	-	-	-	-
	Kind of Trouble	Breakdown of Handle	11	6	2	7	18	5	2	51	(11.2%)
		Bolts for Handle connector	12	7	3	14	17	12	0	65	(14.2%)
		Discharge outlet	12	3	1	12	15	3	2	48	(10.5%)
		Pump stand	5	3	1	9	9	7	2	36	(7.9%)
		Suction pipe or cable or cylinder	14	18	2	14	20	17	2	87	(19.0%)
		Strainer clogging	14	18	2	15	20	17	1	87	(19.0%)
		Suction check valve	13	18	2	15	15	16	2	81	(17.7%)
		Caused by well structure or casing	0	1	0	1	0	0	0	2	(0.4%)
	Reason of Trouble	Inadequate use of villages	0	1	0	0	1	0	0	2	(1.3%)
		Deterioration of materials because of long use	15	19	2	15	20	17	2	90	(59.2%)
		Less quality of material	15	5	1	15	19	4	1	60	(39.5%)
		Others	0	0	0	0	0	0	0	0	

* Note) -: Unclear

Table 3-4-7 PRESENT CONDITION OF UNFUNCTOINAL HAND PUMP WELL SITE (1)

Site Name	Grid Ref.	Site: School	Site: Hospital, Clinic	Site: Village	Site: Others	Population	Year of completion	Year of failure/ trouble	Present water resource: Ground water: Deep well	Present water resource: Ground water: Shallow well	Present water resource: Surface water: River	Type of Well: Deep well	Type of Well: Shallow well	Well: Depth	Well: Well diawater	Well: Depth of casing	Well: Static water level	Well: Dynamic water level	Well: Specific capacity	Hand Pump: Completely failed	Hand Pump: Failed but can be used	Name of Hand Pump: National	Name of Hand Pump: Standard	Name of Hand Pump: Zamb	Name of Hand Pump: Indian Mark II	Name of Hand Pump: Mono	Name of Hand Pump: Windmill	Length of suction pipe	Kind of troubles: Breakdown of Handle	Kind of troubles: Bolts for Handle Connector	Kind of troubles: Discharge Outlet	Kind of troubles: Pump stand	Kind of troubles: Rod or Cable or Cylinder	Kind of troubles: Strainer, Clogging	Kind of troubles: Suction Check Valve	Kind of troubles: Caused by well structure, or well casing	Kind of troubles: Others	Reasons for troubles: Inadequate use of villagers	Reasons for troubles: Deterioration of materials	Reasons for troubles: Less quality of materials	Reasons for troubles: Others	Remarks
Mazabuka District														m	mm	m	m	m	L/min/m									m														
1. Naleza School	NN 60-60	•				500	1965	1977			•	•		40	150	12.0	9.20	33.00	1.34	•			•					38.5	•	•		•	•	•					•	•		
2. Mukuyu School	NN 63-48	•				450	1972	1980			•	•		45	150	15.0	7.20	29.40	0.95	•			•					38.5		•	•		•	•	•				•	•		
3. Lubombo	NN 94-46			•		550	1970	1981			•	•		50	150	16.0	16.93	32.50	0.35	•			•					38.5		•	•		•	•	•				•	•		
4. Kasengo School	PN 24-47	•				450	1966	1978				•		50	150	16.0	5.40	19.00		•			•					38.5	•		•	•	•	•					•	•		
5. Ching'ang'auka	PN 28-41			•		500	1964	1976			•	•		60	150	44.5	4.60	33.10	1.90	•			•					38.5	•		•	•	•	•	•				•	•		
6. Kalama School	NN 54-38	•				450	1970	1984				•		50	150	12.0	7.83	21.20	2.60	•			•					38.5	•	•	•		•		•				•	•		
7. Siawamba School	NN 63-36	•				450	1962	1978				•		50	150	12.0	11.30	24.60	1.43	•			•					38.5	•	•	•		•	•	•				•	•		
8. Chilembe	PN 13-40			•		450	1968	1977			•	•		50	150	12.0	6.47	22.25	0.74	•			•					38.5	•	•		•	•	•	•				•	•		
9. Mugoto School	PN 19-37	•				400	1960	1980			•	•		60	150	16.0	7.40	28.10	1.40	•			•					38.5	•	•	•		•	•	•				•	•		
10. Mubanga	PN 54-36			•		450	1978	1984				•		50	150	12.0	5.00	36.34	13.50	•			•					38.5		•				•	•				•	•		
11. Sianjalika	NN 80-25			•		450	1971	1981			•	•		50	150	12.0	20.33	21.35	163.00	•		•						38.5	•	•	•		•	•	•				•	•		
12. Hakantu School	PN 10-29	•				450	1977	1980				•		60	150	16.0	5.27	17.80	1.50	•		•						38.5		•	•	•	•	•	•				•	•		
13. Nansenga School	PN 46-26	•				600	1970	1979				•		55	150	16.0	6.56	20.55	1.09	•			•					38.5	•		•		•	•	•				•	•		
14. Chivuna	NN 85-12			•		600	1969	1976			•	•		60	150	16.0	20.33	29.40	111.30	•		•						38.5	•	•	•		•	•	•				•	•		
15. Chikankata School	PN 21-05	•				600	1971	1983				•		50	150	16.0	8.34	30.00	1.08	•			•					38.5	•	•	•		•	•	•				•	•		
	Total	9		6		7,350	1968	1979			8	15		52	150	16.2	9.47	26.57	21.58	15		3	12					38.5	11	12	12	5	14	14	13				15	15		
Monze District																																										
1. Malundu	NN 30-28			•		400	1972	1982			•	•		108	150	16.0	10.50	25.00	2.79	•		•						38.5	•	•			•	•	•				•	•		
2. Nachibuli School	NN 50-26	•				400	1972	1985			•	•		108	150	16.0	20.40	31.40	0.75	•		•						38.5		•	•		•	•	•				•	•		
3. Bwengwa School	NN 15-20	•				400	1966	1980			•		•	15	(1000)		4.10	12.00	2.60	•					•																	
4. Mulambo	NN 41-22			•		600	1970	1983				•		108	150	16.0	14.00	35.00	0.20	•			•					38.5		•	•		•	•	•				•	•		
5. Halubobya	NN 38-12			•		400	1965	1983		•		•		78	150	16.0	20.60	34.90	2.98	•			•					38.5					•	•	•				•	•		
6. Nkaba School	NN 73-13	•				400					•	•		80	150						•		•					38.5	•		•	•	•	•	•				•	•		
7. Kasaka School	NN 75-11	•				460						•		75	150					•			•						•				•	•	•				•			
8. Hufwa School	NN 36-06	•				600	1965	1979				•		108	150	16.0	30.00	42.00	0.84	•						•						•	•	•	•				•			
9. Kanundwa School	NN 42-09	•				400				•		•		90	150					•		•											•	•	•				•			
10. Hampande	NM 50-84			•		200				•		•		90	150					•		•											•	•	•				•			
11. Shihubwa	NM 21-97			•		500				•		•		60	150					•		•							•				•	•	•				•			
12. Mayaba local court	NM 20-96				•	460				•		•		78	150						•		•										•	•	•				•			Site:Local coart
13. Malama	NM 23-97				•	500				•		•		108	150						•		•							•			•	•	•				•			
14. Miyoba School	NM 53-98	•				360				•		•		75	150					•			•										•	•	•				•			
15. Habenga Store	NM 65-90				•	200					•		•	15	(1000)					•			•																•			Site:Store
16. Chona School	NM 72-34	•				450				•		•		100	150					•		•											•	•	•				•			
17. Mugoti	NM 34-85			•		450					•	•		90	150					•		•							•	•			•	•	•			•	•			
18. Kayola School	NN 75-02	•				360						•		90	150						•		•										•	•	•				•			
19. Moomba School	NN 92-59	•				500						•		108	150					•			•						•	•		•	•	•	•	•			•			
20. Chikonga	NM 60-79			•		400					•	•		75	150					•		•								•			•	•	•				•			
	Total	10		7	3	8,440	1968	1982		8	7	18	2	83	150	16.0	16.60	30.10	1.69	16	4	8	10		1	1		38.5	6	7	3	3	18	18	18	1		1	19	5		

Table 3-4-7 PRESENT CONDITION OF UNFUNCTIONAL HAND PUMP WELL SITE (2)

Site Name	Grid Ref.	Site: School	Site: Hospital, Clinic	Site: Village	Site: Others	Population	Year of completion	Year of failure/ frouble	Present water resource: Ground water: Deep well	Present water resource: Ground water: Shallow well	Present water resource: Surface water: River	Well: Type of well: Deep well	Well: Type of well: Shallow well	Well: Depth (m)	Well: diawater (mm)	Well: Depth of casing (m)	Well: Static water level (m)	Well: Dynamic water level	Well: Specific capacity	Hand Pump: Completely failed	Hand Pump: Failed but can be used	Hand Pump: Name of Hand Pump: National	Hand Pump: Name of Hand Pump: Standard	Hand Pump: Name of Hand Pump: Zamb	Hand Pump: Name of Hand Pump: Indian Mark II	Hand Pump: Name of Hand Pump: Mono	Hand Pump: Name of Hand Pump: Windmill	Hand Pump: Length of suction pipe	Hand Pump: Kind of troubles: Breakdown of Handle	Hand Pump: Kind of troubles: Bolts for Handle Connector	Hand Pump: Kind of troubles: Discharge Outlet	Hand Pump: Kind of troubles: Pump stand	Hand Pump: Kind of troubles: Rod or Cable or Cylinder	Hand Pump: Kind of troubles: Strainer, Clogging	Hand Pump: Kind of troubles: Suction Check Valve	Hand Pump: Kind of troubles: Caused by well structure of well casing	Hand Pump: Kind of troubles: Others	Reasons for troubles: Inadequate use of villagers	Reasons for troubles: Deterioration of materials	Reasons for troubles: Less quality of materials	Reasons for troubles: Others	Remarks
Namwala District														m	mm	m	m																						
1. Muunga School	MN 79-96	•				2,000				•			•	35	1,200					•			•																
2. Bayangwe	MN 59-75			•		750				•			•	40	1,200					•					•			•	•	•	•				•			
3. Mungaila	MN 73-62			•		1,400				•			•	30	1,200																							
4. Namusonde School	MN 75-46	•				1,000				•			•	30	1,200														•									
5. Kabulamwanda School	MN 88-46	•				1,000				•			•	30	1,200																							
6. Ichila	MN 62-28			•		950				•			•	30	1,200																							
7. Makaba School	MN 84-26	•				1,000				•			•	30	1,200																							
8. Nkomba	MN 51-09			•		1,500				•			•	30	1,200																							
9. Muchila School	MN 56-06	•				900				•			•	30	1,200																							
10. Shababwa	MN 66-05			•		1,500				•			•	30	1,200																							
	Total	5		5		12,000				6			10	31	1,200					1	7		1		1			2	3	1	1	2	2	2			2	1	
Gwezbe District																																							
1. Syangwemu School	PN 79-28	•				1,500						•		75	150					•		•								•	•	•	•					
2. Chikanzaya School	PN 60-15	•				1,600						•		50	150					•		•								•	•	•	•					
3. Manchavwa School	PM 62-88	•				2,000						•		65	150					•		•								•	•	•	•					
4. Bakasa School	PM 90-90	•				400					•	•		45	150					•		•								•	•	•	•					
5. Ntanga School	PM 04-77	•				2,000						•		45	150					•		•								•	•	•	•					
6. St. Patrick School	NM 82-63	•				1,000						•		60	150					•		•								•	•	•	•					
7. Madonda	NM 88-42			•		1,000						•		55						•		•								•	•	•	•					
8. Chiyabi Village	NM 72-23			•		2,000					•	•		65	150					•		•								•	•	•	•					
9. Sinanjola School	NM 65-15	•				2,050						•		60	150					•		•								•	•	•	•					
10. Sinakasi Village	NL 41-93			•		1,700						•		45	150					•		•								•	•	•	•					
11. Mweemba Village	NL 28-75			•		1,700					•	•		60	150					•		•								•	•	•	•					
12. Mamba Councel	NL 28-83				•	800						•		60	150					•		•								•	•	•	•					
13. Simakoba Village	NL 18-68			•		600					•	•		65	150					•		•								•	•	•	•					
14. Nyanga Village	NL 10-48			•		1,100					•	•		65	150					•		•								•	•	•	•					
15. Siampondo School	NL 02-31	•				1,000						•		65	150					•		•								•	•	•	•					
	Total	8		6	1	20,450					5	15		58	150					15		14						7	14	12	9	14	15	15	1		15	15	
Choma District																																							
1. Mpinda P/School	MN 81-09	•				500						•		60	150					•			•						•	•	•		•	•			•	•	
2. Sinaubi P/School	MN 83-03	•				500						•		75	150					•			•							•	•	•	•				•	•	
3. Kabanga Village	MN 95-02			•		850						•		65	150					•			•							•	•	•	•				•	•	
4. Mutongwa P/School	MM 94-90	•				450						•		60	150					•			•							•	•	•	•				•	•	
5. Handondo Village	MM 98-37			•		740						•		50	150					•			•							•	•	•	•				•	•	
6. Haokola P/School	NM 01-90	•				600						•		60	150					•			•							•	•	•	•				•	•	
7. Halala P/School	NM 81-79	•				400						•		60	150					•			•						•	•	•		•	•			•	•	
8. Malinda Village	MM 89-68			•		600					•	•		55	150					•			•							•	•	•	•				•	•	
9. Chilundu P/School	NM 32-65	•				500						•		65	150					•			•						•	•	•		•	•			•	•	
10. Kanchomba P/School	NM 53-69	•				500						•		50	150					•			•						•	•	•		•	•			•	•	

Table 3-4-7 PRESENT CONDITION OF UNFUNCTIONAL HAND PUMP WELL SITE (3)

Site Name	Grid Ref.	Site: School	Site: Hospital, Clinic	Site: Village	Site: Others	Population	Year of completion	Year of failure/ trouble	Present water resource: Ground water: Deep well	Present water resource: Ground water: Shallow well	Present water resource: Surface water: River	Well: Type of well: Deep well	Well: Type of well: Shallow well	Well: Depth	Well: Well diawater	Well: Depth of casing	Well: Static water level	Well: Dynamic water level	Well: Specific capacity	Hand Pump: Completely failed	Hand Pump: Failed but can be used	Hand Pump: Name of Hand Pump: National	Hand Pump: Name of Hand Pump: Standard	Hand Pump: Name of Hand Pump: Zamb	Hand Pump: Name of Hand Pump: Indian Mark II	Hand Pump: Name of Hand Pump: Mono	Hand Pump: Name of Hand Pump: Windmill	Hand Pump: Length of suction pipe	Hand Pump: Kind of troubles: Breakdown of Handle	Hand Pump: Kind of troubles: Bolts for Handle Connector	Hand Pump: Kind of troubles: Discharge Outlet	Hand Pump: Kind of troubles: Pump stand	Hand Pump: Kind of troubles: Rod or Cable or Cylinder	Hand Pump: Kind of troubles: Strainer, Clogging	Hand Pump: Kind of troubles: Suction Check Valve	Hand Pump: Kind of troubles: Caused by well structure or well casing	Hand Pump: Kind of troubles: Others	Reasons for troubles: Inadequate use of villagers	Reasons for troubles: Deterioration of Materials	Reasons for troubles: Less quality of Materials	Reasons for troubles: Others	Remarks
														m	mm	m	m	m	m																					
11. Naambo P/School	NM 58-67	•				500						•		65	150					•			•																	
12. Maluma P/School	NM 25-51	•				500						•		55	150					•			•																	
13. Muzoka Clinic	NM 34-56		•			800						•		60	150					•			•																	
14. Sibanyati	MM 82-41			•		950	1939	1975			•	•		55	150		12.00	35.00	1.15	•			•				45.0	•		•		•	•	•						
15. Muntu wabulongo	NM 43-49			•		500	1972	1982			•	•		55	150		9.00	40.00	1.09	•			•				48.0	•		•		•	•	•						
16. Moyo P/School	NM 45-44	•				500	1975	1980				•		60	150	35.0	20.00	50.00	1.45	•			•				50.0	•		•	•	•	•	•						
17. Chanzangwe Village	NM 29-31			•		700	1950	1960			•	•		60	150	55.0	18.00	32.00	0.94	•			•				45.0	•		•		•	•	•						
18. Habanyuka P/School	NM 26-25	•				500	1972	1981				•		60	150	44.5	16.93		0.39	•							50.0	•		•		•	•	•						
19. Siamuleya	NM 37-27			•		900	1970	1983				•		60	150	44.5	18.00	44.00	1.80	•			•				44.5	•		•		•	•	•						
20. Siasikabole P/School	NM 05-08	•				500	1970	1982				•		55	150	44.5	7.40	35.00	1.54	•			•				(55)	•		•		•	•	•						
	Total	12	1	7		11,990	1964	1977			4	20		59	150	44.7	14.40	39.30	1.19	20			19				48.2	18	17	15	9	20	20	15		1	20	19		
Kalomo District																																							
1. Chikanta	MM 59-91			•		900					•	•		75	150					•		•																	
2. Chilala	MM 58-88			•		700					•	•		64	150					•			•																
3. Chifusa School	MM 76-38	•				1,500				•		•		65	150					•		•																	
4. Bilibizi	MM 68-50			•		500						•		70	150					•		•							•										
5. Katundulu	MM 55-40			•		500					•									•		•																	
6. Mapatizya School	ML 89-44	•				500					•	•			150					•		•																	
7. Rural H/centre	LL 39-71		•			400														•		•																	
8. Matengu	LL 68-70			•		500						•		75	150					•		•																	
9. Muzya School	ML 28-72	•				500						•		75	150					•		•																	
10. Luyaba	ML 67-75			•		500						•		75	150					•		•																	
11. Sihumbwa	LL 68-66			•		600						•		75	150					•				•				•		•									
12. Musamumuyumu	LL 83-64			•		600						•		60	150					•			•					•		•									
13. Siamafumba School	ML 54-68	•				1,145						•		80	150					•			•																
14. Siakumba	ML 83-68			•		500					•	•		75	150					•			•																
15. Muzokotwane	LL 82-52			•		600					•	•		60	150					•			•																
16. Sinde R.H/Centre	ML 78-52		•			800														•			•																
17. Mizika School	ML 75-55	•				500						•			150					•			•																
18. Kamwi	LL 92-24			•		500						•		62	150					•			•																
	Total	5	2	11		11,745				1	6	15		70	150					17		8	7		1	1		5	12	3	7	17	17	16			17	4	
Livingstone District																																							
1. Bwiketo	LL 90-45			•		400					•	•		61						•			•					•		•	•	•	•						
2. Ngwenya	LL 85-21			•		100						•		65	150					•			•					•		•	•	•	•						
	Total			2		500					1	2		63	150					2			2					2		2	2	2	1	2			2	1	

3.4.3 Conditions of Previously Implemented Groundwater Development Project (Phase I)

The Groundwater Development Project (Phase I) -- the Exchange of Notes for the project was signed in October 1985 -- was a rural water supply project for supplying drinking water by constructing 102 hand pump operated boreholes having an average depth of 50m.

The Phase I project also provided two drilling rigs, equipment and materials needed for well construction, vehicles, and other related items.

(1) Project Equipment

① Equipment Utilization

The construction of 102 hand pump operated boreholes was completed in October 1987. After the project's completion, the equipment provided for the project construction work continued to be used for DWA's well construction work.

The introduction of Top head drive drilling rigs was the first case for the Zambian drilling team. The Zambian team learned basic operating procedures from the Japanese team. However, the wear and tear rates for drill bits are high, and the Zambian team's technique application capabilities, such as changing the number of bit rotations according to the different geological conditions, and their techniques for handling equipment failures are still lower than satisfactory. It will be necessary, therefore, for the Japanese engineers to continue providing technique transfer to the Zambian team even in the future.

Through investigations of daily reports covering the drilling work, and discussions with Zambian workers, it became evident that there were cases of improper equipment operation, frequent overuse of equipment, and equipment troubles -- often requiring operation shutdowns -- caused by inadequate skill in the handling of the high-pressure air compressor and the DTH hammer. For these reasons it is not only necessary to transfer drilling techniques, but to transfer mechanical repair, maintenance, and operating techniques as well. The transfer of techniques is also strongly requested by DWA.

As for the wear and tear to DTH hammer drill bits, there were frequent cases of drill chips falling from the bit body making the bit's service life extremely shorter than normal. No problems were encountered when the weathered soft rock on the surface layer was drilled. However, when hard unweathered rocks, such as schist and gneiss, that are located deeper than 10m from the ground surface, especially in the Monze and Mazabuka areas, were drilled, drill chips fell frequently.

The average service life of one bit was only 176m of drilling for a 6 inch bit, and 95.8m drill for an 8 inch bit. It is assumed that the short bit service life might be caused not only by poor drilling techniques, but by the material quality of the bit and chip connection. The selection of drill bits to be provided by the Project should therefore be carefully made.

The operability, maintenance and management, and maintenance costs of the major equipment provided under the Phase I project are listed in Table 3-4-8.

Table 3-4-8 OBSERVATION OF MAJOR EQUIPMENT SUPPLIED BY PHASE-I PROJECT

	Description	Quantity Supplied	Quantity at work	Observation of Zambian Side			Observation by study team
				Operability	Management and Maintenance	Maintenance Cost	
1	Drilling Rig KOKEN FSW-7T	2	2	Excellent	Excellent	Excellent	Full used at good conditions
2	High-pressure Air Compressor ATLAS "XRH-350D"	2	2	Excellent	Good machine, but difficult to repair	Good machine, but difficult to keep cost	It became often breakdown caused by improper operation and frequent overuse. Therefore repair work must be done in Lusaka.
3	DTH Hammer tools	2	*	No problem	No problem	-	Operation and maintenance are no problem however, strength of Hammer itself is weak.
4	Rotary drilling tools	2	*	No problem	No problem	-	-
5	Cargo Truck with 5 ton Crane HINO ZC141E	1	1	Excellent	Good	High fuel expence (2.7km/ L)	Only one unit was provided for the two drilling team. The crane was subjected to overuse, and the spare parts were consumed at much faster than other vehicles.
6	Cargo Truck with 3 ton Crane HINO HZ227KA	1	1	Excellent	Good	High fuel expence (3.0km/ L)	It is too big body beside it's freight.
7	Cargo Truck HINO HZ227KA	2	2	Excellent	Good	Good	Full used at good conditions.
8	Pick up Jeep TOYOTA BJ75PR-KR	3	2	Excellent	Good machine, but difficult to repair	Excellent	One unit is out of use due to accident, other 2 units are full used at work. However, they were haggarded by over work.
9	Wagon Jeep TOYOTA BJ75RV-KR	2	1	Excellent	Good machine, but difficult to repair	Too much expenses	One unit is out of use due to accident. Other one is full used at work. However, it was also haggarded by over work.
10	Hand pump [1] NISSAKU NSB-100	43	43	Good	Good machine, but difficult to repair	Good	All hand pump have been in use for 15 months, and, thus far, no problems has been reported.
	[2] PUMPENFOESE PB Mark-II	59	59	Excellent	Good	Good	
11	Testing equipment [1] Submerseble Motor Pump EBARA 40DH522-3.7	2	2	Out of order	Out of order	Good	For the time being, it is at work by Zambian motor due to breakdown of original motor. Therefore it is necessary to supply spare motor at this project
	[2] Generator DENYO DCA 14AH	2	2	Good	Good	Good	No problem
12	Welder DENYO PCX-270SSI	2	2	Excellent	Good machine, but difficult to repair	Excellent	No problem
13	Workshop equipment	1	1	Excellent	Good	Good	No problem
14	Casing and Screen Pipe	for 102 wells	for 102 wells	Excellent	Excellent	-	Full used at good conditions.

* These are consumption items.
The consumption rates were very high and there were only small number of stocks at the field survey time.

② Maintenance and Management Conditions

Most of the equipment provided under the Phase I project are kept and maintained at the Monze Office of DWA. The Office has a stockyard containing drilling equipment materials, a spare parts storage, and a repair shop. The equipment is relatively well-maintained.

The spare parts and drilling tools provided under the Phase I project are kept in good order on shelves marked with reference numbers. The assigned warehouse manager takes careful inventories of the spare parts.

Although the repair shop has sufficient space, there is an insufficiency of repair tolls and equipment.

Only minor repair work is performed at this shop. Large-scale repair work for trucks and high-pressure air compressors must be done in Lusaka.
In light of the above, the supply of repair tools will be required under the Project (Phase II).

③ Conclusion

Judging from the use conditions of the provided equipment, and the maintenance and management systems, it appears that the equipment was used satisfactorily.
However, since some differences in construction methods occurred between the project planning stage and the actual construction period, there was some imbalance in the provision of spare part

items, and in the amount estimated for wear and tear on equipment. For example, the use rate for the DTH hammers had been planned as being 80%, but it was actually 91% -- 93 out of 102 boreholes were drilled by the DTH hammers -- and, therefore, all of the provided 6 and 8 inch bits were used up. The spare parts needed most for the DTH hammers were not supplied in sufficient quantity. Presently, all of the five provided DTH hammers are inoperative.

Only one 5-ton truck crane was provided for the two drilling machines (two drilling teams). The crane was subjected to overuse, and the spare parts were consumed at a much faster rate and there was greater wear and tear on the equipment than originally planned.

Considering the above, well-balanced equipment and material plans must be made for the Project (Phase II).

(2) Borehole Conditions

① Use Conditions

The Study Team visited several hand pumps operated borehole sites that were constructed under the Phase I project.

The Team was highly impressed that the residents really appreciated the wells for providing the safe drinking water that is a necessity in their daily lives.

The Team also realized that the residents were taking care of the wells. They have erected wooden fences around the wells -- a

feature not included in the original design -- to prevent animal intrusions.

The wells are used quite frequently. In fact,they are being used practically all day long. The wells have been in use for fifteen months, and, thus far,no damage no problems have been reported.

② Management and Maintenance Situations

The District Offices of DWA manage and maintain the wells. Each Office has Borehole Follow-up Data Sheets on which to keep records of well utilization, water levels, pump conditions, and problems related to wells in their administrative areas. Entries are supposed to be made into the record 3 months after a well is constructed and,after the initial entries are made,they are to be made at 3 months intervals. However,as the District Offices do not have vehicles for well management and maintenance purposes,only the initial records were made. The periodic three month recordings have not been made. Some initial recording sheets have yet to be collected.

③ Conclusion

The wells constructed by the Phase I Project are at most fifteen months old. At the present time, these wells are being utilized efficiently without any major problems. However, there are many inoperative wells in the Project Area that were constructed prior to the Phase I project. It was requested that these malfunctioning wells be rehabilitated.

During the field survey period, the Study Team heard that the District Offices repaired a number of wells every year, but that, shortly afterwards, the wells began to malfunction once again. Wells found to have minor repair problems or damages were left unrepaired or improperly repaired if they were operable. Proper repair and maintenance work is not provided until a well becomes completely inoperable.

To successfully implement the Project, equipment repair, equipment management and maintenance techniques in addition to well management and maintenance techniques--all of which may greatly effect the serviceable life of the wells--must be provided. To this end,a request was made to provide vehicles for well management and maintenance purposes. The Study Team believes that it is not only necessary to provide equipment and vehicles,but to establish a well management and maintenance system by forming teams comprised of DWA personal and residents who benefit from the wells. Also,the Study Team feels it is important to impart knowledge concerning the wells to the residents.

CHAPTER 4. PROJECT DESCRIPTIONS

CHAPTER 4 PROJECT DESCRIPTIONS

4.1 OBJECTIVES

The objectives of the Project are to reduce the number of diseases related to insanitary drinking water, to minimize drought damage, and to stabilize the livelihood and social condition in the rural area by supplying safe, reliable drinking water throughout the year to rural residents. For these purposes, the project is to construct new hand pump operated boreholes and rehabilitate malfunctioning hand pump wells with grant aid cooperation from the Government of Japan.

4.2 EVALUATION OF THE REQUEST

4.2.1 Contents of the Request

The Southern Province experienced a 3-year continuous drought that began in 1981 when many of the wells and streams in the rural areas dried up. Because of this, the Government of Zambia launched the Groundwater Development Project in the Southern Province to construct 880 new wells.

For this project, the Government of Japan, in 1985, provided grant aid cooperation to implant the Groundwater Development Project (Phase I) which called for constructing the most urgently needed 102 boreholes.

Groundwater Development Project (Phase II) in the Southern Province is a continuation of the Phase I project, and calls for (1) the construction of 120 new hand pump operated boreholes, and (2) for the rehabilitation of the malfunctioning hand pump wells at 100 sites that were constructed prior to the Phase I project in the seven districts of the Southern Province.

The contents of the request are as follows:

① To construct hand pump operated boreholes 120 sites
Cooperation Construction by Japanese side: 80 sites
Construction by Zambian side: 40 sites

② To rehabilitate malfunctioning hand pump wells 100 sites
Cooperation Construction by Japanese side: 100 sites
Construction by Zambian side: 0 sites

③ To provide a drilling rig 1 unit

④ To provide other necessary equipment and materials for drilling wells 1 set

Table 4-2-1 lists the population and the number of planned well construction and rehabilitation sites in the Project Area.

Table 4-2-1 POPULATION AND NUMBER OF PROPOSED SITES IN THE DISTRICTS

Items \ District		GWEMBE	MAZABUKA	CHOMA	NAMWALA	MONZE	KALOHO	LIVING-STONE	TOTAL
Total Population		96,831	115,384	132,737	56,826	110,650	102,000	72,000	686,428
Population in Urban Area		16,918	39,006	28,564	5,000	14,526	10,000	72,000	186,014
Population in Rural Area		79,913	76,378	104,173	51,826	96,124	92,000	-	500,414
Drought Population		28,600	39,600	46,200	19,800	37,400	46,200	2,200	220,000
Rural Water Project in Southern Province (Breakdown of 880 New Borehole)		114	158	185	79	150	185	9	880
Phase II	Number of newly proposed boreholes	14	20	29	9	28	17	3	120
	Number of the proposed boreholes for rehabilitation	15	15	20	10	20	18	2	100
Phase I	Numbers of the constructed boreholes	22	14	14	14	14	24	0	102

4.2.2 Evaluation of the Project

Approximately 3.2 million people live in the rural areas of Zambia. This figure represents roughly 56% of the country's total population (about 5.7 million per the 1980 census).

Some 1.02 million rural residents have drinkable water sources near their homes. Other rural residents must rely on distant water sources or on those that become exhausted during dry seasons.

Diseases resulting from insanitary drinking water sources and poor sanitary conditions worsen the living conditions of the rural residents and become a major factor contributing to the hinderance of social and economic development in the rural areas. For this reason, the Government of Zambia has been pushing forward with its water supply projects on a nationwide scale since 1979.

Beginning in 1981, the Southern Province experienced a 3-year continuous drought. During that drought many wells and streams dried up. To overcome this type of situation, the Government of Zambia launched the Groundwater Development Project in the Southern Province (a rural water supply project) to construct 880 new wells.

The Southern Province's rural population is approximately 500,000 (see Table 4-2-1). About 56% of the rural residents have water sources in the vicinities of their homes that do not dry up even during dry seasons. The remaining 44% of the people, some 220,000 residents, do not have hand operated deep wells and must rely on shallow wells or streams that become exhausted during dry or drought seasons. These people can not obtain reliable, safe drinking water near their homes. To solve these problems, the

Zambian Government established the Groundwater Development Project in the Southern Province to construct 880 new deeps wells that would not be affected by drought.

The above project was set up based on the following design criteria:

Water sources: 60 to 65 m deep boreholes, hand pump water intake system

Number of beneficiaries: 220,000 persons (44% of the rural population)

Water supply rate: 30 liters/day/person (based on WHO's recommendation)

Hand pump pumping rate: 750 liters/hr

Hand pump operating time: 10 hours/day

Based on the above criteria, the number of people who would be relying on one well was calculated to be 250. Thus DWA proposed constructing 880 (220,000/250 =880) boreholes to supply a sufficient amount of water to the 220,000 people.

In response to the Zambian Government request for the Phase I project, the Japanese Government constructed 102 of the 880 boreholes under a grant aid programme. It took approximately one year to complete the drillings.

Prior to the implementation of the project, the basic design study for the Phase I project recognized the appropriateness of the objectives -- to provide emergency relief and reduce the diseases related to insanitary drinking water.

Project (Phase II) is a continuation of the Phase I project. The appropriateness of the Project for receiving grant aid cooperation from the Government of Japan is evaluated below:

① To Reduce the Number of Diseases Related to Insanitary Drinking Water:

Diarrhoea is one of the diseases caused by insanitary drinking water. As shown in Table 3-3-19, the occurrences of diarrhoea in the Southern Province are very high. 1986 figures show that there were 186,081 outpatients (27.7% of the Province's population), 5,829 impatients (0.868%), and 114 death cases (0.0170%).

The number of the beneficiaries of the Project wells at the 220 sites will be 55,000 persons. It can be assumed that roughly 15,235 persons (27.7% of the 55,000 people) will visits hospitals for diarrhoea and 478 persons (0.868%) will be hospitalized, and 10 persons (0.0170%) will die in one year period if the Project wells would not be constructed in the future.

By providing safe, reliable drinking water the number of diarrhoea cases can be substantially reduced. For this reason, the need for implementing the Project is extremely high.

② Urgency:

Starting in 1981, the Southern Province suffered a drought that lasted continuously for three years. This prolonged drought caused agricultural production to decrease. The drought was also responsible for such social problems as the spread of diseases and the increase in the death rate that were due directly to insanitary drinking water.

The Government of Zambia launched the Groundwater Development Project to overcome the problems cited above; however, due to the lack of budgetary funds, and equipment and materials, the Government could not undertake the project immediately.

As shown in fig. 3-2-3, annual precipitation since 1981 in the Southern Province was generally less than the average annual precipitation during the past thirty years, and resulting droughts had a tremendous effect on the society. during the 1981-86 period, the death tool from diarrhoea reached 587; more than one million people were treated at hospitals for this ailment.

Judging from the recent climatic conditions, the number of diseases, the Zambian Government's lack of funds, equipment and materials for project implementation, it will be necessary to undertake the Project as soon as possible with grant aid from the Japanese Government.

The evaluation made above gives the direct appropriateness of implementing the Project. Set forth below is the evaluation of the indirect appropriateness of Project implementation:

③ Rural Water Supply Project from the Viewpoint of Foreign Aid:

The rural water supply projects being implemented by foreign aid were previously described as shown in Fig. 2-2-1. In most of the Zambian Provinces, except the Southern Province, various rural water supply projects are being undertaken by foreign aid from West Germany, Ireland, Norway, etc. In 1985, the Japanese Government provided the grant aid for implementing the Phase I project; project construction was completed successfully.

As there is a definite need to implement water supply projects as well as the need to promote the spirit of international cooperation, it is considered to be appropriate that the Project (Phase II) be implemented with grant aid from the Government of Japan.

④ Budget for Water Supply Projects

Most of the Zambian Government's budget is allocated to current expenditures, including the maintenance costs of water supply works. The money needed for water supply projects mostly comes from foreign aid (about 84%). Furthermore, there is an insufficient amount of equipment and materials for undertaking projects.

For these reasons, it is impossible for the Zambian Government to implement the Project on its own. In order to implement the Project, it will be necessary for the Japanese Government to provide grant aid.

In view of the above, the necessity and urgency of Project implementation could be clearly understood, and it can be considered appropriate for the Project to be implemented with grant aid cooperation from Japan.