GOVERNMENT OF JAPAN
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

STATE OF ERITREA
MINISTRY OF LAND, WATER AND ENVIRONMENT

STUDY
ON
GROUNDWATER DEVELOPMENT AND WATER SUPPLY
FOR
SEVEN TOWNS IN SOUTHERN REGION
OF
ERITREA

FINAL REPORT

ADIQUALA

VOLUME II APPENDIX

JANUARY 1999

SANYU CONSULTANTS INC.

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SOCIO-ECONOMY

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CHAPTER 1 HOW TO USE THE APPENDICES ON SOCIO-ECONOMIC CONDITIONS

The final report on the study of Water Supply and Sanitation Project of the seven towns in Debub Region has four major components: the descriptions of the Natural Conditions in the Debub Region (including topographical, geological, hydro-geological and meteorological conditions), hygiene and sanitation, and finally financial and socio-economic conditions.

Following the contents developed for the final report, the socio-economic aspects of the study are dealt in all chapters. In particular, Chapter 2 exclusively deals with the economic and social aspects of Eritrea, and the regions economic and social conditions are also dealt in detail in Chapter 3. In Chapters 6 and 7 , the social and economic aspects of the porgramme and project development are dealt even in greater detail.

In order to enable us to concentrate on the most substantive aspects of the report, we have opted to make wide use of the appendices for the socio-economic part of the report. For example, all tables and data secured from the study survey or from region and/or sectoral ministries, have been included in the appendices and only the analysis of the these data and information have been highlighted in the main report. In like manner, all organizational charts pertaining to relevant ministries and the Debub Region have been included in the appendices.

All appendices of the final report are to be found in Volume II. As there are separate reports for each town, there are also separate appendices for each town. For example, Volume II-I is assigned for Debarewa, and Volume II-II is for Mendefera, etc. In Appendices Volume II-I of Debarewa, for example, all appendices related to socio-economic conditions can be referred to in part A which, has its own contents and arrangements. In the common chapters and main reports of individual towns, reference to a table from Chapter 3 is written as table---(Table no.) appendix A, and reference to a table in Chapter 4 is written as Table---(table no.) appendix A, etc.

CHAPTER 2 ASPECTS OF DECENTRALIZED ADMINISTRATION IN ERITREA

2.1 Introduction

Following the liberation of the Eritrea in May 1991, one of the tasks of the Government was to begin rehabilitation and reconstruction of the socioeconomic infrastructures of the country. Indeed, water was and still remains one of the top priorities in this continuous task. In seeking the active participation communities in this endevour, the rich experience of community participation attained during armed struggle became an added advantage. Community participation was raised to a higher level by strengthening village/kebabi and town assemblies or "Baitos" in all structures of the regional administration. Additionally, the publication of the macro-policy of the government towards the end of 1994 (which defined the long term vision of what the Eritrean economy, and indeed, its people would be like after 20 years), was clearly and unambiguously articulated. Thus, the need not to only systematise the planning tolls – approval, review and up-dating mechanisms and procedures – became apparent; but along with this effort also arose the need to to decentralize the regional administrations by establishing an efficient, accountable and lean civil service.

Concomitantly, the Government promulgated the Constitution of the country in early 1997 which ***provides that Eritrea is a unitary state***. In its two years for its making, the wide and active participation of the people was ensured, both inside and outside the country.

As part of this process, decentralisation of public institutions via Proclamation No. 86/96, was enacted earlier in 1996. This Proclamation provided for the establishment of Regional Administrations. It defines the functional aspects of decentralization, focusing on **responsibilities** or **authority** of regional administrators. The Proclamation, *inter alia*, empowers the "Zoba Baitos" (Regional Assemblies) to prepare and implement their own regional plans and programmes with the active participation and collaboration of communities themselves. Indeed, in the preamble of the Proclamation, it is stated:

> "...from its inception , the leadership of the struggle for the rights of the people have advocated that in order for the people to enjoy the resources of the country more equally, their participation in the political, social and economic areas should be enhanced"[own translation].

Before we deal with the organizational structures of the Zoba and Neus-Zoba Administrations, we shall devote some few pages on aspects of decentralisation in Eritrea as per the spirit of Proclamation No.86/96 in order to set the right context for Oragnizational and management issues and water and sanitation related issues in particular latter in this section.

2.2 Functions of Zoba Administrations

On the whole, the Proclamation encompasses aspects of deconcentration, devolution, top-down principal agency, bottom-up principal agency and delegation/semi-autonomous agency models of decentralisation reflecting the country's unique cultural, historical, economic and sociopolitical circumstances.

The Zoba "Baito" and the Adi/Kebabi level "Megabia" are community representatives, who are democratically elected legislative bodies at two of the three sub national levels established in terms of the Proclamation. The Zoba Baito will have a degree of discretionary power, including the authority to enact

revenue-raising measures and to approve the budget for the use of such funds. These powers represent a transfer from the national government and thus, devolution. More importantly, to complement this revenue raising power, the Zoba Baito has the duty of ensuring that all taxes and revenues are collected from the Zoba, including those accruing to the national level. This brings to the fore the democratic goal of accountability of the elected to the electorate. Only when the electorate see that their taxes and fees being paid in will they be in a position to hold the elected acountable and, in turn, demand a higher level of services. The downward linkage is directed in that the Zoba Baito has the power to approve the expenditure of "locally" generated revenues. The upward linkage is indirect in that the Zoba Baito has the duty to ensure the collection of national revenues, but it can bring direct demands on the national Baito, the supreme legislative body, if it has, in turn successfully discharged its duty to ensure the collection of all national revenue. This appears to be an exclusive duty of the Zoba Baito and is vital in participatory democratic terms.

The Zoba Baitos, can pass resolutions requesting the regional executive to direct the expenditure of certain non-national "locally" generated revenues. To accomplish this implementing function the Region executive could to indulge in the bottom-up principal agent type of decentralisation. That is, it can approve that contracts with a national level agency, such as the Ministry of Construction, to construct a social service facility, such as a health station on its behalf. Acting as its principal agent, (though the Baito could also contract directly with a private sector contractor on a turn-key basis).

2.3 Aspects of Discretion

The following are the exclusive functions of the Central Government as set out in Article 35 of the Proclamation:

- defense and internal security
- foreign affairs
- preparation national economic polices and plans
- citizenship, passport, asylum, refugees, extradition, and the like
- administration of justice and general audit; banking and related services
- administration and follow-up of economic and social infrastructures and services that cross two or more bounderies of regions, viz., central referal hospitals and higher education and training establishments
- transport and communication infrastructures(land, sea, air), viz., airports, ports
- determination of public holidays, working hours, and related national matters.

Article 36 defines responsibilities and duties of central government institutions which include:

- prepare and implement sectoral policies , plans(including capital and recurrent budgets), sector regulations, instruments and parameters

- undertake research and studies, collect and analyse statistical data and information related to the sector
- render to regional administrations technical and advisory services
- based on national rules and regulations, and considering the capacity of regional administrations, deploy human and material resources as well as recruit, train, promote/demote and fire workers
- effect chief administrators' requets for the transfer of workers, following the agreement of the MOLG and concerned ministry
- conduct training and render technical assistance in specialised areas
- seek external assistance for programmes and projects

The delineation of the main domains of regional administrations is articulated in Article 37:

- perform general administration, and implement social and economic projects and activities
- prepare regional development plans and budget, and implement when approved
- ensure that central government's policies, guidelines and procedures are followed-up and adhered to in every stage of programme/project preparation, implementation and monitoring
- collect and aggregate statistical data and information
- without prejudice to article.35 and art. 36, recruit workers when approved by the MOLG, strengthen regional administration's manpower capacity
- prepare monthly progress reports concerning programme and project implementation, and half year monitoring report to MOLG
- perform any other tasks provided for in the Proclamation

Considering the fact that decentralisation is a process to be implemented over time, it is too early to discern any absolute degree of discretion, given that the Proclamtion was enacted very recently. However, objective assessment of the track record since the country's legal independence in 1993, one has reason to confidently anticipate a high level of discretion. Indeed, there is a compelling, good faith and commitment on the part of the national government to ensure that the new decentralised decision making system works, at least based on the achievements to-date.

The act of physically deploying national civil service staff to posting outside the national capital is clearly deconcentration. In the spirit of Proclamation No. 86/96, once the national civil servants are so posted, their lines of operational responsibility then take on aspects of both deconcentration and **top down principal agency.** While the Office of the Zoba Administrator is deconcentrated from the **MOLG** and as such functions as a "branch office" virtually all of the civil service staff in the three major departments of the Zoba Administration as a whole are themselves deconcentrated from their sector/function ministries, but are responsible in line, operational terms to the authority of the Zoba Administrator.

Nonetheless, they must also look to their sector ministry for cadre specific professional guidance and supervision and career development generally.

2.4 Aspects of Access

One prime objective of the decentralisation policy is to deconcentrate many national civil service staff to the Zoba level and below, leaving a lean core of policy level professional staff of ministries at the national level. This process has already began in earnest. Moreover and the administrative and political leverage the Zoba Administrator is vested upon is an added advantage. This, indeed, is a high degree of access. The degree and level of this privilege will not be lost on any official between the Adi/Kebabi and National level. Given the level of manpower granted to the Zoba Administrtor and the apparent discretion he has in utilising this power, very little challenge this authority could face little challenge.

A critical access issue, at least in the short to the medium term, is the ability of the Zoba planners and managers to obtain financial and other information from the national level in a timely and regular manner. Valid planning requires a steady and timely flow of information on resource availability, including financial, human and physical resources. Limitation of access to such information lowers both the "certainty" level and confidence level. There is a need, at the earliest possible point in the annual planning process to furnish the Zoba Administration with at least indicative or "best guess" ceiling of capital/development expenditure, preferably on a sector by sector basis to enable a better match between likely availability of resources and expectations. Initiating such a flow of information may not be possible immediately, but institutionalising such a flow of information should be a monitored goal. The same argument and reason is valid for recurrent funds and for the supply of new, additional resources. Valid planning in a resource scarce environment involves hard choices and prioritisation. But the absence of access, or limited and delayed access to such information as noted above can have a very major impact on the effectiveness of functions and discretion, the other major dimension of the decetralisation process.

On the whole, the Proclamation encompasses aspects of deconcentration, devolution, top-down principal agency, bottom-up principal agency and delegation/semi-autonomous agency models of decentralisation reflecting the country's unique cultural, historical, economic and socio-political circumstances.

Chart 3.1:

Organizational Chart of Zoba

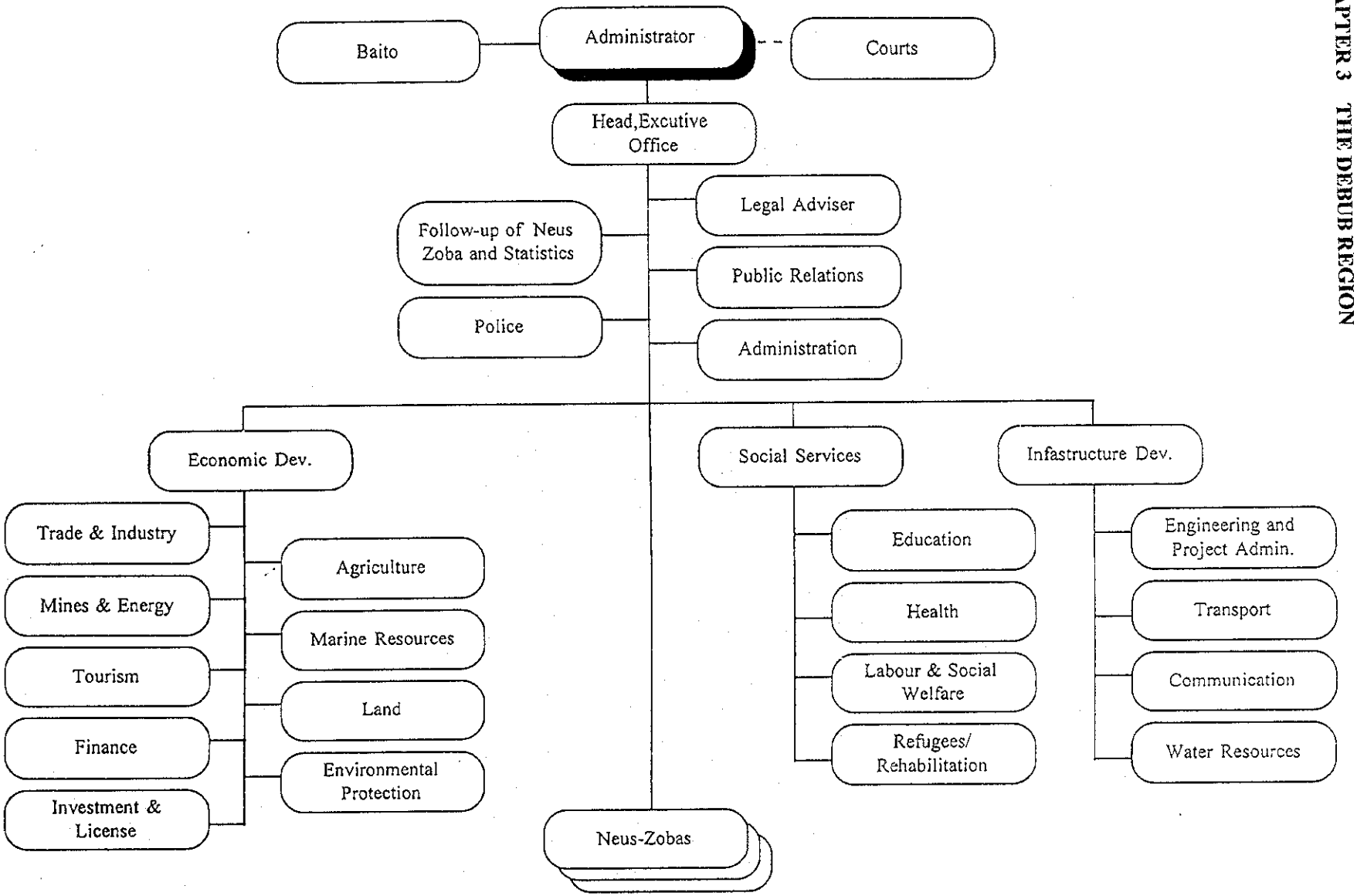


Chart 3.2:

Organizational Chart of Neus Zoba

1. Mendefera
2. Adi keyih

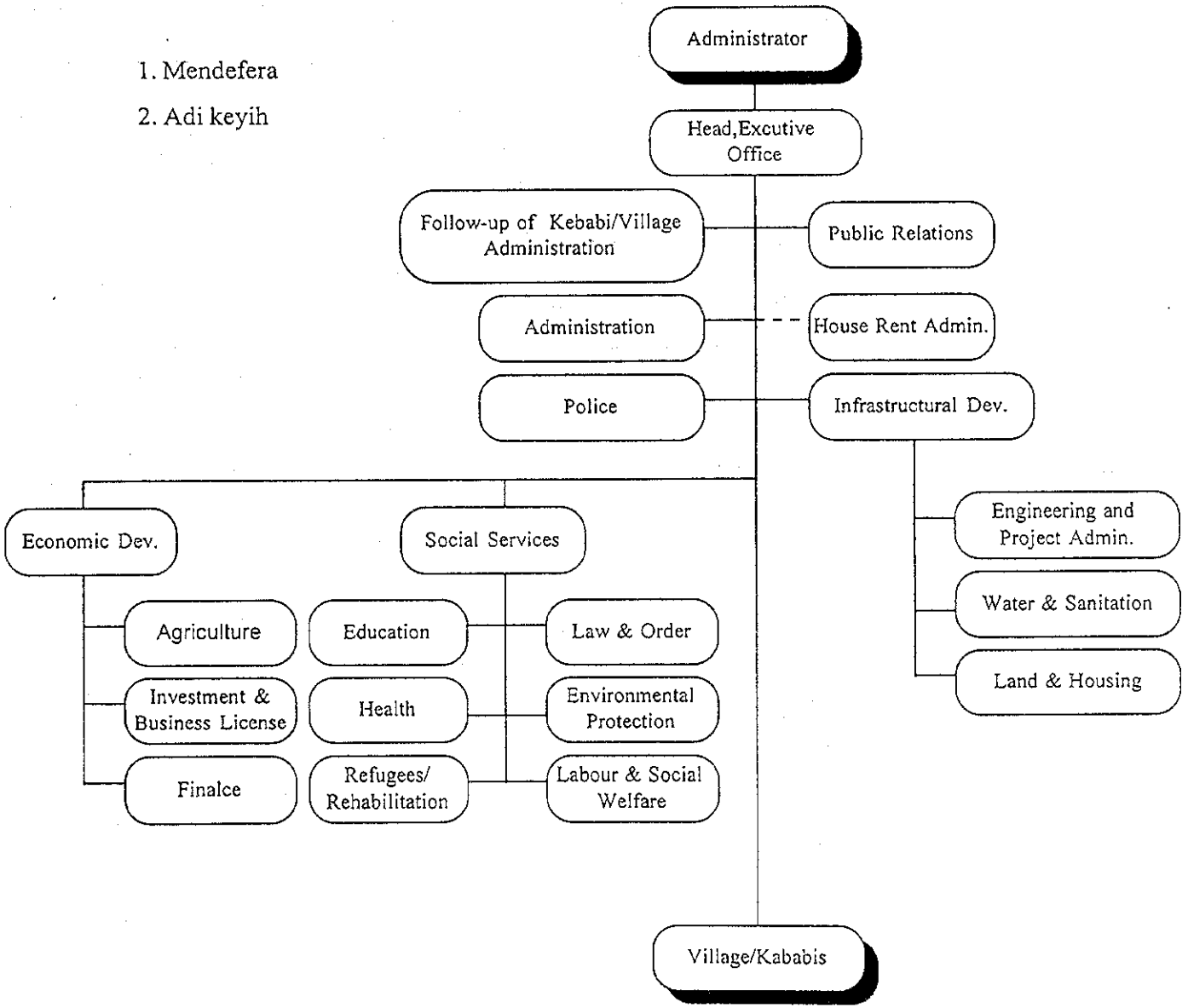


Chart 3.3: **Organizational Chart of Town Administration**

1. Debarwa
2. Adiquala
3. Dekemhare
4. Segeneiti
5. Senafe

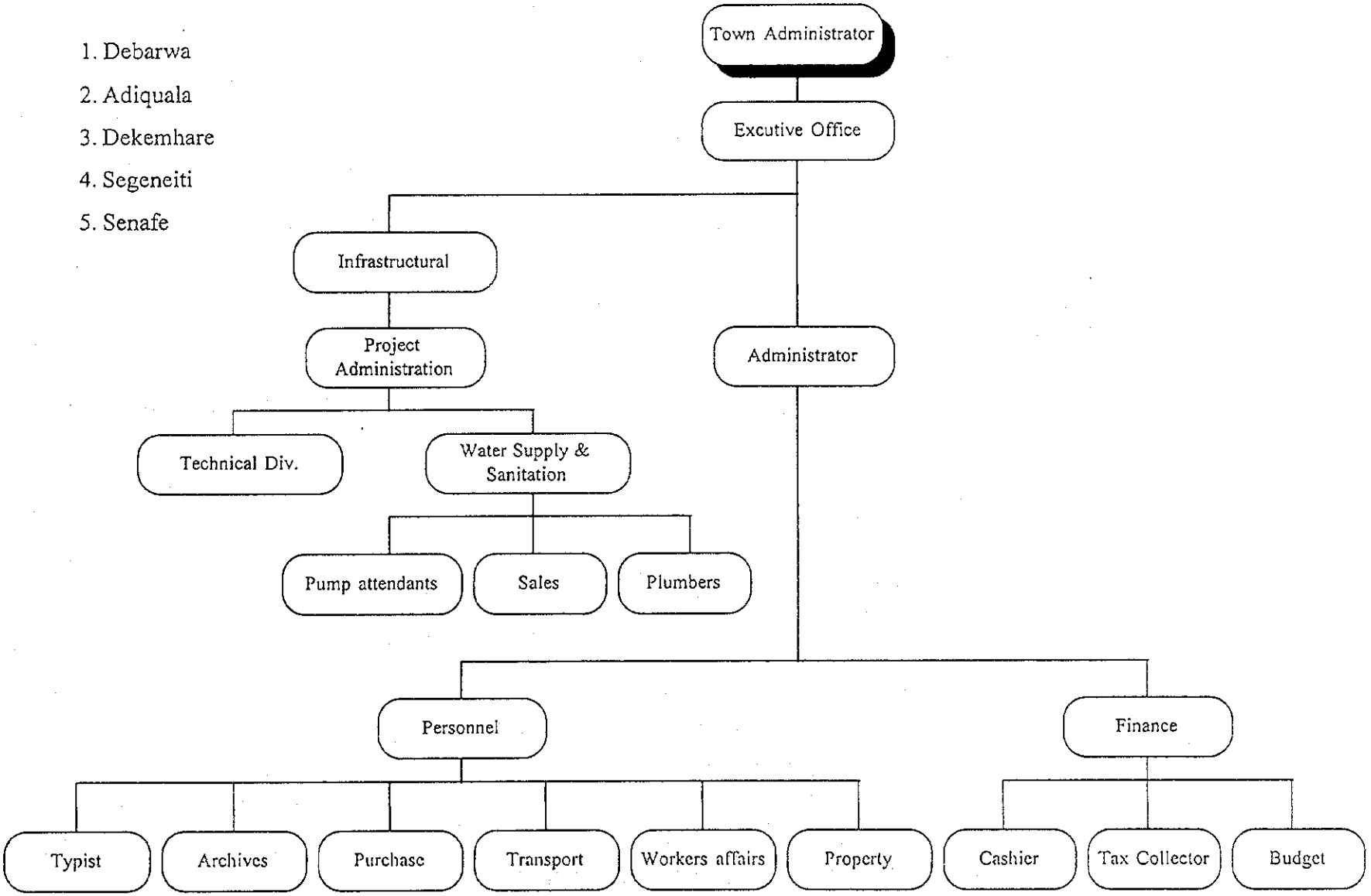


Table 3.1: Number of Neus Zobas, Village Administrations and Villages in Debub Region

Sub-Region	Main Town of Neus-Zoba	Number of Village Admin.	No. of Villages
Tsorena	Tsorena	21	116
Dekemhare	Dekemhare	19	67
Segeneiti	Segeneiti	16	44
Adi Keyih	Adi Keyih	21	54
Senafe	Senafe	22	90
Mai Aini	Mai Aini	NK	NK
Mai Mine	Mai Mine	19	80
Adiquala	Adiquala	21	113
Debarwa	Debarwa	25	69
Mendefera	Mendefera	15	89
Kudobur	Kudobur	13	78
Areza	Areza	20	84
Total	**11**	**212**	**884**

Source: Ministry of Local Government, Town Town Administration Departments, 1997

Note: NK stands for not known

Table 3.2: Population and Household Size of Debub Region

Neus-Zoba	Area of Neus Zoba in km^2	No. of Households	Total Population	Density/km^2	Average HH Size
Tsorena	116	12736	41886	361.09	3.3
Dekemhare	850	19187	65510	77.07	3.4
Segeneiti	380	12612	44628	117.44	3.5
Adi Keyih	1239	15957	58377	47.12	3.7
Senafe	597	26027	88718	148.61	3.4
Mai Mine	865	14272	59266	68.52	4.2
Adiquala	858	22840	90990	106.05	4.0
Debarwa	660	22325	71578	108.45	3.2
Mendefera	867	18462	66077	76.21	3.6
Kudobur	1039	11989	44282	42.62	3.7
Areza	878	16615	71190	81.08	4.3
Total	**8349**	**193022**	**702502**	**84.14**	**3.6**

Source: Ministry of Local Government, Town Administration Department, 1997

Table 3.3: Composition of Ethnic and Religious Groups in Debub Region

Neus-Zoba	Tigrigna	Saho	Tigre	Total Population
Tsorena	26320	6797	1128	41886
Dekemhare	41234	3198	3233	65510
Segeneiti	29116	654	1	44628
Adi Keyih	29725	13917	5	58377
Senafe	42889	11231	1	88718
Mai Mine	45363	656	801	59266
Adiquala	53649	915	43	90990
Debarwa	42239	175	0	71578
Mendefera	40581	1188	619	66077
Kudobur	38231	1302	259	44282
Areza	50551	264	851	71190
Total	**439898**	**40297**	**6941**	**702502**

Source: Debub Zoba Administration, Social Department 1997

Table 3.4: Percentage Distribution of Ethnic Groups in Debub Zoba

Neus-Zoba	Tigrigna	Saho	Tigre
Tsorena	62.84	16.23	2.69
Dekemhare	62.94	4.88	4.94
Segeneiti	65.24	1.47	0.00
Adi Keyih	50.92	23.84	0.01
Senafe	48.34	12.66	0.00
Mai Mine	76.54	1.11	1.35
Adiquala	58.96	1.01	0.05
Debarwa	59.01	0.24	0.00
Mendefera	61.41	1.80	1.0.
Kudobur	86.34	2.94	0.58
Areza	71.01	0.37	1.20
Total	**62.62**	**5.74**	**0.99**

Source: Debub Zoba Administration, Social Department 1997

Table 3.5: Manpower Status of Debub Zoba Admnistration and the Towns

Level	Total Positions in the organizational structure	Filled	Unfilled
Debarwa	21	13	8
Mendefera	22	12	10
Adiquala	21	13	8
Dekemhare	21	17	4
Segeneiti	21	13	8
Adi Keyih	22	12	10
Senafe	21	13	8
Debub Zone	**29**	**24**	**3**

Source: Debub Zoba Administration and Respective Town Administrations

Table 3.6: Administrative Status of the Seven Town

Town	Administrative Status
1. Dekemhare	Town Administration
2. Segeneiti	Town Administration
3. Adi Keyih	Sub-zone Main Town - "Baito"
4. Senafe	Town Administration
5. Debarwa	Town Administration
6. Mendefera	Region and Sub-zone Town-"Baito"
7. Adiquala	Town Administration

Table 3.7: Enrolment in Debub Zoba

Level/grades	Total	Females	M/F Ratio
1. Primary (1-5)	83289	36150	57:43
2. Junior sec. (6-7)	9901	3728	62:38
3. Senior sec. (8-11)	7750	2433	69:31
Total/average	**100,940**	**42,311**	**58:42**

Source: Ministry of Education, Eritrea: Basic Education Statistics and Essential Indicators (1995/96), Asmara, November, 1996.

Table 3.8: Health Personnel in Debub Region

Health Personnel	Number	People Served
Medical Doctors	14	37,886
Eye Doctors	3	176,803
Maternity Nurses	15	35,803
Nurses	65	8,160
Laboratory Technicians	15	35,360
X-Ray Technicians	12	44,200
Pharmacists	3	176,803
Health Assistants	194	2,734
Others	16	------

Source: Debub Zoba Social Development Department, 1997

Table 3.9: Number of Seats and Occupancy Rates of Hotels and Restaurants

Item	Hotels	Restaurants
1. No. of rooms	14	-
2. No. of seats	-	15
3. Occupancy rate	8	-
4. Turnover	-	15

Table 3.10: Number of Workers in Non Household Institutions

Type of Institution	Number of workers	
	Male	Female
1. Hotels	1	2
2. Restaurants	1	2
3. Shops	1	1
4.Gov. offices	182	90
4.1. Municipal	22	4
4.2. Sub-Zonal	69	15
4.3. Central Gov.	25	9
4.4. Pimary school	10	18
4.5. Senior secon.	23	7
4.6. Hosiptals	33	44
4.7. Others	0	3
Total	**185**	**195**

Table 3.11: Percent of Power Failure, Average Capacity of Own Generator by Type of Establishment (for all towns)

Establishment	Capacity of own generator (Kw)	Power failure (%)
1. Hotels	7	0
2. Restaurants	6	17
3. Institutions	20	30
4. Shops	6	0
5. Factories	29	27
Total	**17**	**14**

Table 3.12: Women' Organizations by Type of Establishments (percentage)

Establishment	Existence of Organization	Mahber	Ukub	NUEW	NUEY	Others (Ethio.)	No. of women Members
1. Hotels	50	0	0	27	0	10	2
2. Restaurants	67	0	0	64	0	9	2
3. Institutions	75	0	8	58	0	0	16
4. Shops	33	0	0	40	0	0	1
5. Factories	38	0	0	33	0	0	25
Total	**55**	**0**	**2**	**45**	**0**	**4**	**9**

Table 3.13: Average Daily Water Consumption by Type of Establishments (in M3)

Establishment	House connection	Well	River/ spring	Water tanker	Water vendor	Rain water
1. Hotels	4.22	0.20	-	1.63	0.06	0.03
2. Restaurants	2.86	-	-	1.00	0.13	0.02
3. Institutions	11.77	4.36	30.00	0.52	-	0.03
4. Shops	2.41	-	-	0.02	0.31	-
5. Factories	24.35	0.06	-	15.73	-	-
Average	9.34	0.92	6.00	3.76	0.01	0.03
Total	**45.61**	**4.62**	**30.00**	**18.90**	**0.50**	**0.08**

Table 3.14: Percentage of Household Average Daily Water Consumption in Dry and Rainy Seasons

Item	D	M	AQ	DK	SEG	AK	S
1. Dry Season							
1.1. <20 lit.	0	1.3	0	0.7	0	2.2	0
1.2. 20-39 lit.	13.9	10.7	9.1	16.6	10.4	20.1	24.7
1.3. 40-59 lit.	19.4	10.7	10.9	35.8	17.9	33.5	29.4
1.4. 60-79 lit.	27.8	32.0	21.8	11.3	23.9	22.9	28.2
1.5. 80-99 lit.	13.9	12.7	21.8	17.9	25.4	7.8	2.4
1.6. 100-119 lit.	5.6	11.3	14.5	6.6	10.4	3.4	10.6
1.7. 120-139lit.	2.8	2.0	5.5	0.7	3.0	2.8	2.4
1.8. >140	16.7	18.7	12.7	9.9	6.0	1.8	0
1.9. All D.season	100	100	100	100	100	100	100
2. Rainy Season							
2.1. <20 lit.	0	0	0	0	0	1.1	0.3
2.2. 20-39 lit.	5.6	6.7	7.3	9.3	7.5	13.4	10.4
2.3. 40-59 lit.	22.2	10.0	9.1	17.2	11.9	25.1	17.2
2.4. 60-79 lit.	25.0	16.7	21.8	25.8	16.4	29.1	23.2
2.5. 80-99 lit.	11.1	18.7	18.2	17.9	23.9	16.8	17.6
2.6. 100-119 lit.	8.3	16.0	25.5	12.6	23.9	6.7	16.5
2.7. 120-139lit.	5.6	4.0	3.6	2.6	4.5	3.4	5.9
2.8. >140	22.3	26.7	12.8	14.5	10.5	2.3	1.2
2.9. All season (Av.)	34.5	31.6	37.8	24.8	20.2	15.8	12.9

D= Debarewa; M= Mendefera; AQ= Adiquala; DK= Dekemhare; SEG= Segeneiti; AK= Adikeyih; S= Senafe

CHAPETER 4 CURRENT SITUATION IN ADIQUALA

Table 4.1: Percentage Distribution of HH Heads by Sex, Size and Religion

Item	Average
1. Size (person)	4.89
2. Gender (%)	
2.1. Male	58.2
2.2. Female	41.8
3. Religion (%)	
3.1. Muslims	12.7
3.2. Christians	87.3
4. Ethnic (%)	
4.1. Tigrigna	98.2
4.2. Saho	-
4.3. Tigre	-
4.4. Others	1.8

Table 4.2: Occupation of HHs

Occupation	Percentage of Households		
	Male	Female	HHs
Agriculture	3.13	17.39	9.09
Animal Husbandry	0.00	0.00	0.00
Commerce	37.50	26.09	32.73
Industry	9.38	4.35	7.27
Government	21.88	13.04	18.18
Construction	3.13	.00	1.82
Daily laborers	6.25	4.35	5.45
Drivers	9.38	.00	5.45
Other	3.13	.00	1.82
Unemployed	6.25	34.78	18.18

Table 4.3: Crop Production (Qtls) and Consumption (Percentage)

Type of crop	Production	Consumption
Sorghum	1.3	70.0
Millet	-	-
Barley	-	-
Taff	-	-
Wheat	0.9	86.3
Maize	-	-
Dagussa	-	-
Vegetables	-	-
Others	-	-

Table 4.4: Livestock and Agricultural Land Position of HHs

Item	Number owned	Percentage of HHs
A. Livestock number		25.5
1. Cows/ox	2.2	
2. Sheep/goat	6.5	
3. Horse/mule	1.0	
4. Donkey	-	
5. Camel	-	
6. Chicken	4.4	
7. Others	-	
B. Agricultural Land	Average hectare cultivated	Percentage of HHs
	0.6	16.4

Table 4.5: Average HH Income by Occupation, Ethnic Group and Religion

Income by Occupation		Income by Ethnic background		Income by religion		Average HH Income
1.Agriculture	492.0	1.Tigrigna	751.9	1.Muslims	564.3	739.3
2.Animal husb.	1336.0	2. Saho		2.Christians	768.4	
3.commerce	1112.0	3. Tigre		3.Others	600.0	
4.Industry	680.0	4.Others	60.0			
5.Government	865.0					
6.Construction	729.0					
7.Others	1003.0					
8.unemployed	558.0					

Table 4.6: Percentage of HHs by Income Group Average HH Expenditure by Item

HH income group (Nfa/Month)	Percentage	Expenditure Item (Nfa/month)	Amount (Nfa)
< 299	12.70	Food and beverages	36.00
300-599	13.40	Cloth and foot wear	6.20
600-999	29.10	Rent	2.40
1000-1499	14.50	Savings and repayment	20.90
1500-1999	3.60	Electricity and energy	12.40
000-2999	1.80	Water	2.20
>3000	1.80	Education	1.80
		Health	1.70
		Transport	2.30
		Toiletries	4.00
		Culture/Travel, etc.	5.70
		Others	3.20

Table 4.7: Education Status of HHs

Status	
1. Student attendance rate	100
2. HH literacy status	
2.1. Literate	60.0
2.2. Illiterate	40.0
3. HH head educ. Level	
3.1. elementary school	33.3
3.2. junior secondary	18.2
3.3. senior secondary	24.2
3.4. college and above	3.0
3.5. other informal educ.	21.2

Table 4.8: Percentage of HHs by Daily Activity of Women and Girls

Activities	Percentage	
	Women	Girls
House keeping	100	38.2
Tending Livestock	0.0	0.0
Cottage industry	0.0	0.0
Commerce	23.6	3.6
Daily workers	3.6	-
Factory workers	00	-
Government workers	1.8	-
School	-	45.5

Table 4.9: Percentage of Participation of Adult Women on Educational Session of Social Services

Type of session	Percentage
Water use	32.7
Sanitation	34.6
Child care	34.6
Family planning	23.6
Literacy	0.0

Table 4.10: Percentage of HH Members Participating in Community Organization

Activities	Percentage participation
Communal water points	0
Community toilets	0
Cottage indus.	0
Commercial activities	0
Social/cultural activities	78.7
Savings association	6.4
Others (PFDJ/NUEW)	70.2
Total	**85.5**

Table 4.11: Percentage of Participation of Adult Women in Communal Activities

Road	29.09
Public water point	0.00
Public toilet	0.00
Building	0.00
Crop harvest	0.00
Attending comm. Meetings	36.36
Soil and water conservation	23.64
Others (mainly cleaning street)	7.27

Table 4.12: Percentage of Households by Major HH Problems

Type of problem	Percentage		
	Male	female	Total
1. No problem	12.5	0.0	7.3
2. Shortage of income	56.3	73.9	63.6
3. Inadequate medical service	6.3	0.0	3.6
4. Not enough schools	0.0	4.3	1.8
5. Shortage of water	12.5	17.4	14.5
6. Lack of electricity	3.1	0.0	1.8
7. Inadequate transport services	0.0	0.0	0.0
8. Lack of sanitation	6.3	4.3	5.5
9. Family relationships	0.0	0.0	0.0
10. Others (housing)	3.1	0.0	1.8

Table 4.13: Percentage of HHs by Problems related to the Existing Water Supply Facilities

Problems of existing water supply facilities	Percentage of HHs
1. Not enough water	5.3
2. Water never reach house	2.6
3. Sometimes water stops	26.3
4. Deteriorating facilities	7.9
5. Not good water quality	21.1
6. Water price too expensive	55.3
7. Too distant water facility	42.1
8. Too long queuing time	21.1
9. Other (Labour needed to fetch)	0.0

Table 4.14: Per Capita Water Consumption from All Sources by Income Group

Income group	Per capita consumption
< 299	28.5
300-599	22.6
600-999	47.1
1000-1499	23.0
1500-1999	40.9
2000-2999	40.9
>3000	61.3
Average	37.8

Table 4.15: Percentage of HHs Affording to Pay for Water by Income Group

Income group	Percentage of HH willing to pay(Nfa/month)							
(Nfa/month)	**<5**	**5-9**	**10-14**	**15-19**	**20-29**	**30-49**	**35-39**	**>50**
< 299	7.5	1.9	3.8	-	-	-	-	-
300-599	5.6	11.2	13.0	3.8	3.7	-	-	-
600-999	2.9	5.7	25.7	-	-	-	-	-
1000-1499	-	-	16.7	5.6	5.6	-	-	-
1500-1999	-	-	1.9	-	1.9	-	-	-
2000-2999	-	-	-	5.7	-	-	-	1.9
>3000						1.9		
Total	**16.0**	**18.8**	**61.1**	**15.1**	**11.2**	**1.9**	**-**	

Table 4.16: Percentage of HHs Affording for Community Toilet by Income Group

Income group	Percentage of HHs affording to pay (Nfa/month)						
	<2	2-3	4-6	7-9	10-14	15-24	>25
< 299	4.3	8.6	4.3	-	-	-	-
300-599	8.6	13	17.3	-	4.3	4.3	4.3
600-999	-	4.3	8.6	-	4.3	-	-
1000-1499	-	-	4.3	-	-	-	8.7
1500-1999	-	-	-	-	-	-	-
2000-2999	-	-	-	-	-	-	-
>3000	-	-	-	-	-	-	-
Total	**13**	**26.1**	**34.8**	**-**	**8.7**	**4.3**	**13.0**

Table 4.17: Communal Water Points

Item	Percentage of HHs
1. Distance from comm. Water point	
1.1. < 90 m	-
1.2. 100-199 m	15.0
1.3. 200-399 m	25.0
1.4. > 400	60.0
2. Average Frequency (trips/week)	
2.1. Men	3.0
2.2. Women	18.3
2.3. Boys	16.2
2.4. Girls	15.1
3. Satisfaction with comm. Water point	
3.1. Satisfied	35.0
3.2. unsatisfied	65.0
4. Preference of unsatisfied houses	
4.1. House connection	46.2
4.2. Yard connection	53.8
4.3. Community water point	-

CHAPTER 5: STRATEGY ON PLANNING

Based on the assumptions developed in Chapter 5, section 5.2. the following is the result of the projected population for the town of Adiquala.

Table 5.1: Population Projection for the Town of Adiquala

Year	Growth rate (%)	Base Population	No. of returnees	Total population
1997				9488
2000	4.5	10827	750	11577
2005	4.5	14428	1000	15428
2010	3.5	18323	1000	19323
2015	3.5	22950	750	23700

Chart 6.1. : Organisational Structure of the MoLWE

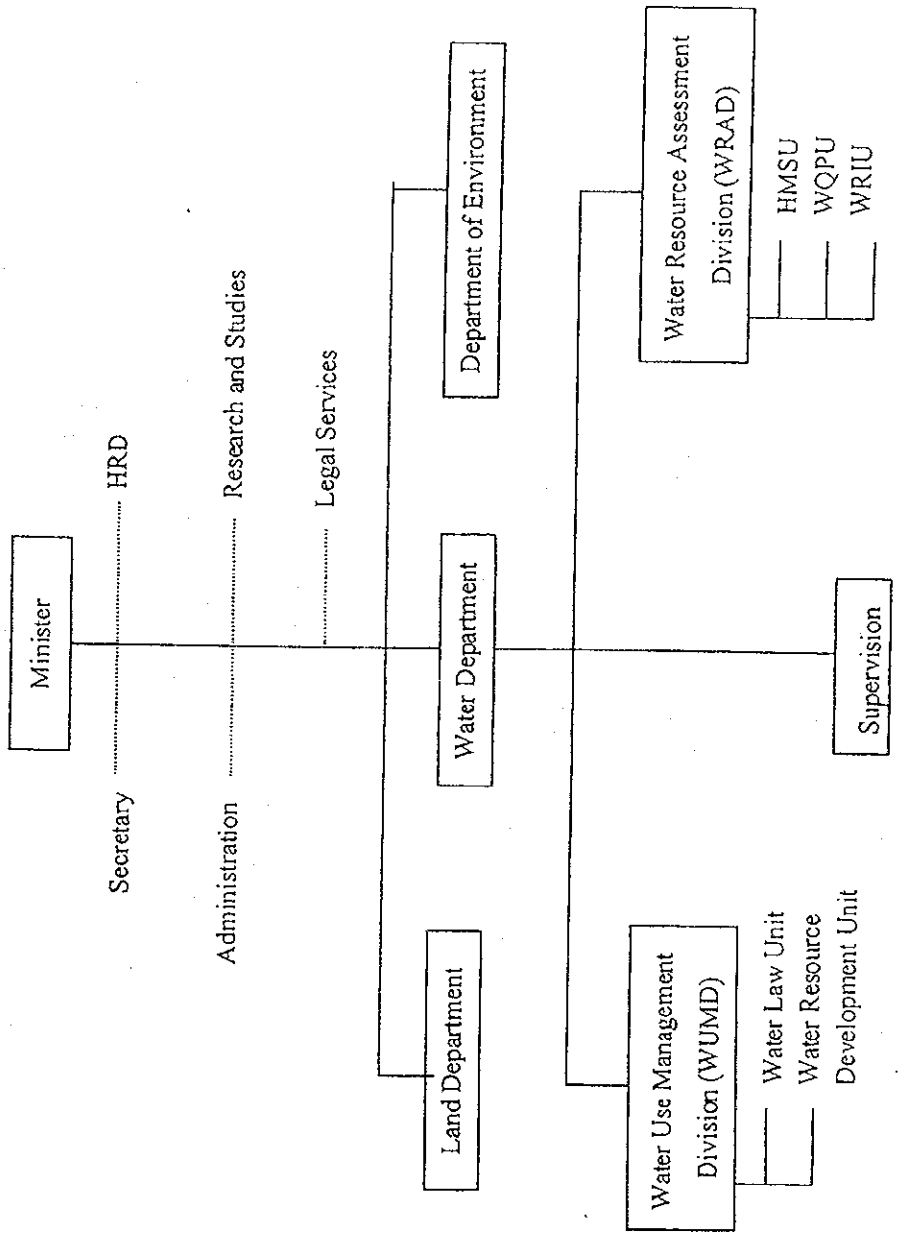
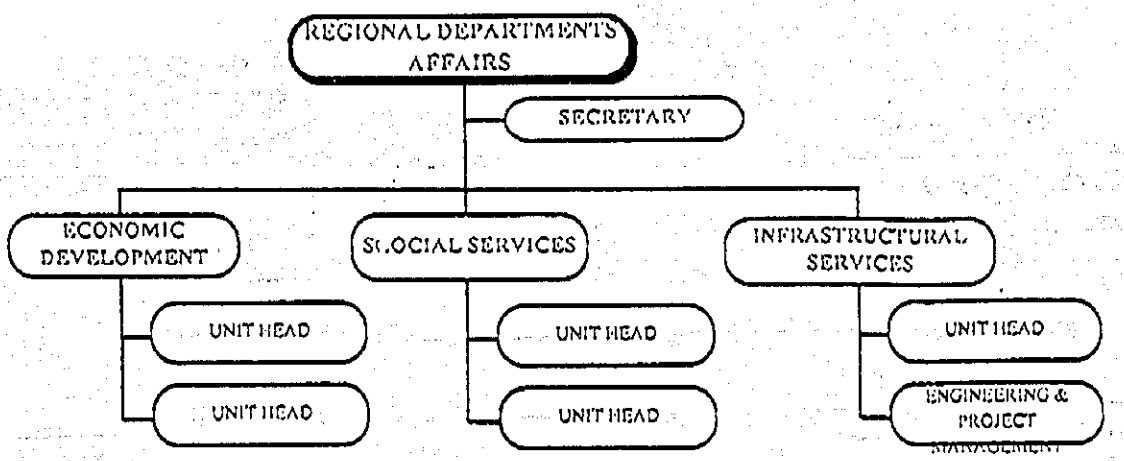


Chart 6.2: Organisational Structure of Regional Affairs Department, MoLG



Economic Development	1	Social Services	1	Infrastructural Services	1
*Unit Head	1	*Unit Head	1	*Unit Head	1
*Unit Head	1	*Unit Head	1	Eng. & Project Mgt.	1
Total	3	Total	3	Expert (Economist)	1
				Architect Planner	1
				Civil Engineer (structural)	1
				Total	6

(*Unit Head - Concernes with Agriculture, marine Resources, Land, & Environmental Protection)

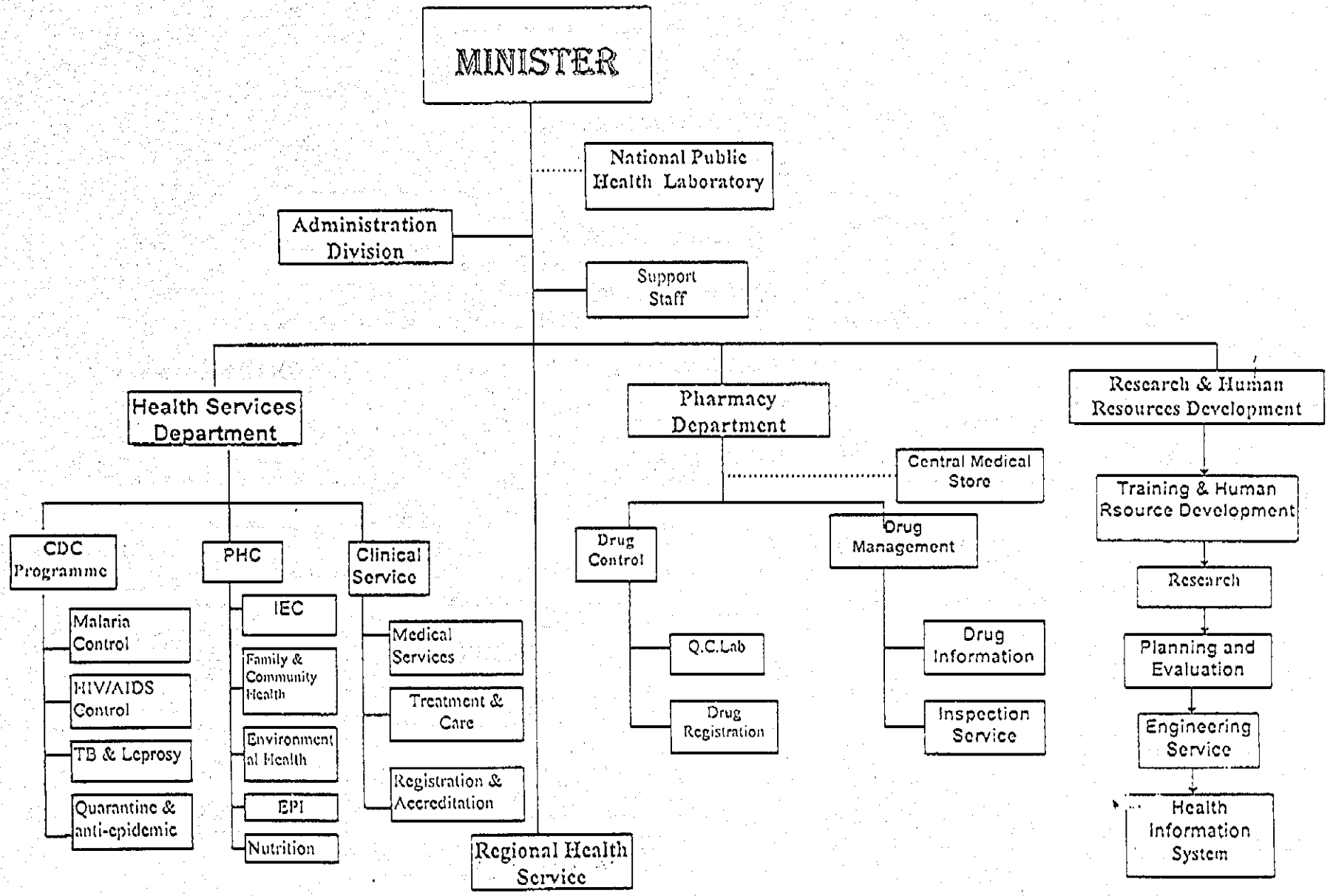
(*Unit Head - Concerns with Trade & Industry, Energy & Mines, Tourism, Finance, Investment & Lisence)

(*Unit Head - Concernes with Education, Health)

(*Unit Head - Concerns with Labour & Human Welfare, Refugee & Rehabilitation).

(*Unit Head - Concernes with Transport, Communications & Water Resources).

Chart 6.3: Organisational Structure of The Ministry of Health



APPENDIX B

METEOROLOGY AND HYDROLOGY

List of Tables

Table B-1 Monthly and Annual Rainfall(Adi Quala)

Station: Adi Quala

Unit: mm

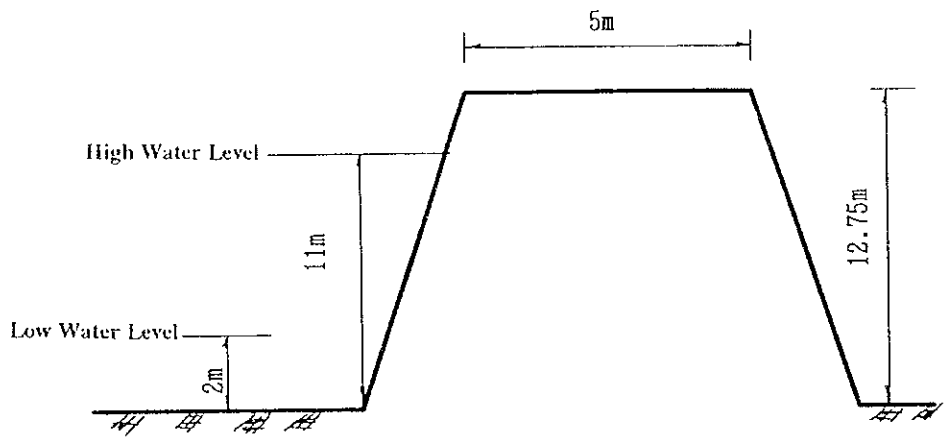
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1905	na	na	na	na	na	11.2	286.6	386.6	209.0	40.0	14.0	0.0	na
1906	na	na	na	na	na	na	237.5	193.5	41.5	2.5	2.0	0.0	na
1907	0.0	1.8	0.0	na	na	na	na	na	na	na	na	na	na
1933	0.0	0.0	0.0	24.0	25.0	100.0	188.5	315.0	144.2	0.2	0.0	0.0	796.9
1934	0.0	0.0	2.0	15.7	0.0	96.0	185.0	328.5	106.0	0.0	9.0	0.0	742.2
1935	0.0	0.0	9.0	32.0	103.0	68.0	170.0	318.0	0.0	0.0	0.0	0.0	700.0
1936	0.0	0.0	30.0	26.0	26.5	131.5	277.5	229.0	146.5	0.0	0.0	0.0	867.0
1937	0.0	12.5	0.0	12.5	60.0	72.5	127.5	170.0	37.5	0.0	55.0	0.0	547.5
1938	0.0	3.8	6.5	3.0	2.5	20.7	306.5	179.0	65.0	na	0.0	0.0	na
1939	0.0	0.0	0.0	44.5	7.5	115.0	279.5	244.5	67.5	10.0	7.0	0.0	775.5
1940	0.0	10.0	0.0	0.0	30.0	65.0	215.0	267.0	34.5	0.0	0.0	0.0	621.5
1942	na	na	na	5.8	58.8	44.7	408.3	229.3	41.2	23.3	0.0	0.0	na
1943	0.0	0.0	12.5	63.0	41.7	na	342.4	203.2	50.5	16.1	0.0	0.0	na
1944	0.0	0.0	23.2	81.6	52.4	123.6	437.5	268.6	43.3	0.0	11.0	0.0	1041.2
1945	0.0	0.0	4.0	0.0	66.0	22.8	396.8	193.7	18.0	0.0	0.0	0.0	701.3
1946	0.0	0.0	10.0	52.7	21.5	173.0	188.0	24.3	100.5	80.0	0.0	0.0	650.0
1947	0.0	0.0	5.0	18.5	34.5	42.1	na	189.6	61.9	0.0	37.8	na	na
1948	0.0	0.0	6.0	29.5	51.8	127.6	90.6	185.4	100.1	6.3	na	na	na
1949	0.0	0.0	17.1	0.0	91.1	12.5	195.0	123.7	47.1	7.0	0.0	33.7	527.2
1950	0.0	0.0	2.0	19.3	73.8	22.0	313.4	144.5	51.0	0.0	0.0	0.0	626.0
1951	0.0	0.0	0.0	na	6.5	45.0	210.2	204.0	9.0	na	na	na	na
1953	0.0	0.0	0.0	82.5	0.0	100.5	na	na	na	na	na	na	na
1965	na	na	na	na	12.0	18.0	164.0	180.1	5.0	13.0	na	na	na
1966	na	na	na	na		90.2	na	na	na	na	na	na	na
1967	na	na	18.0	60.0	20.0	50.5	184.5	206.0	na	na	na	na	na
1973	na	na	na	na	na	na	307.6	198.2	110.4	na	na	na	na
1974	na	na	na	na	na	na	97.4	198.5	0.0	0.0	na	na	na
1992	0.0	0.0	1.8	39.4	5.4	93.0	289.2	196.5	71.5	32.1	33.0	0.0	761.9
1993	0.0	0.0	0.0	0.0	87.5	135.6	249.0	199.3	24.0	100.0	0.0	0.0	795.4
1994	0.0	10.0	0.0	16.0	37.0	73.2	236.5	234.5	102.9	8.0	0.0	0.0	718.1
1995	0.0	0.0	18.0	38.0	67.5	18.5	190.0	152.8	39.5	0.0	0.0	0.0	524.3
1996	0.0	0.0	47.9	92.4	68.3	91.3	248.6	163.9	40.0	0.0	29.5	0.0	781.9
Mean	0.0	1.6	8.5	31.5	40.4	72.8	243.7	210.7	63.1	13.5	8.6	1.5	695.9

Source: Sector Study, WRD

Table B-2 Salient Features of Semomo Dam

1. Construction year	: 1997
2. Financed by	: Swiss Support Committee for Eritrea
3. Purpose	: Drinking water supply
4. Responsible agency	: Water Resources Department(WRD)
5. Dam type	: Earth Dam
6. Catchment area	: 25 sq.km
7. Reservoir capacity	: 2 MCM
8. Reservoir loss(all)	: 25%
9. Operational(net) capacity	: 1.5 MCM
10. Dead storage(at 2m)	: 23,636 cum
10. Dam height	: 12.75 m
11. Crest length	: 350 m
12. Crest width	: 5 m
13. Basement width	: 68 m
14. Inflow rate	: 25% of the rainfall
15. Assumed rainfall	: 650mm/year
16. Sediment load	: 2% of the inflow rate.

Schematic Diagram of Semomo Dam



APPENDIX C

HYDROGEOLOGY

CHAPTER 3 THE DEBUB REGION

3.1 Natural Conditions

CHAPTER 4 CURRENT SITUATION (Adiquala)

4.1 Natural Conditions

CHAPTER 7 PROJECT FEASIBILITY STUDY

7.1 Groundwater Development Plan

ADIQUALA

N

to Mendefera

Adewhi

Mihtsaw

Adi Tefa Nefas

Adi Andiel

Ruba Sheka

Eyand

Adi Dongofo

Dongofo

Kusmo

Adi Kofoto

Adi Arkay

Mek'a Shet

Gerih Ruba

Feyayu

Ruba Berabir

Dambamich

Adelges

Kutur

Adi Bahrs

Mai Lars

Debre Brhan

Mai Semomo

Timie

SEMOMO DAM

Adi Akielo

Ona Gaebien

Gaebien

Mai Zeru

Mai Tafo

ADIQUALA

Adenfi

Tsaede Wataka

Kolakul

Adi Atal

Daero Kuna't

Mai Gume

to Ethiopia

Mai Tsetsi

14°44'

14°43'

14°42'

14°41'

14°40'

14°39'

14°38'

14°37'

14°36'

14°35'

8°48'

8°49'

8°50'

8°51'

8°52'

8°53'

8°54'

AgC

Tba

c-i

a-i

Pes

Gt

Q

d-i

PCph

Appendix C-1

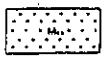
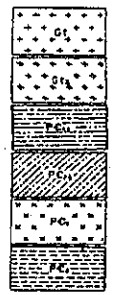
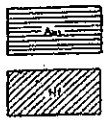
HYDROGEOLOGICAL MAP

1.0 0 1.0 2.0 3.0 4.0 5.0km

Scale 1 : 50,000 (approx.)

C-2 Legend on HYDROGEOLOGICAL MASP

Geological Legend

	: Alluvial deposits	Quaternary
	: Laterite covers	Quaternary
	: Basaltic volcanics	Tertiary
	: Trachytic volcanics	Tertiary
	: Adigrat Sandstone	Mesozoic
	: Sandstone	Paleozoic
	: Chart	Paleozoic
	: Granite	Precambrian
	: Granite (marginal phase)	Precambrian
	: Schist, Gneiss	Precambrian
	: Phyllite, Slate	Precambrian
	: Metavolcanic	Precambrian
	: Dolomite	Precambrian
	: Alkaline Intrusives	Tertiary
	: Hornfels	Precambrian

Hydrogeological Legend

(a) Fissured aquifer of Basements

- a-i : Granite
- a-ii : Metamorphics
- a-iii : Meta-volcanics

(b) Fissured aquifer of Sedimentary rocks

- b-i : Adigrat Sandstone
- b-ii : Paleozoic sandstone

(c) Fissured aquifer of volcanics

- c-i : Basaltic volcanics

(d) Intergranular aquifer of Sediments

- d-i : Alluvial deposits
- d-ii : Colluvial deposits

Aquitard and Aquiclude

- AqC : Trachytics, Alkaline intrusives, Hornfels, Chart, and a part of basaltic volcanics.

- ● : Existing borehole
- ○ : Test/Observation Well
- : Basin boundary

Report

On

WATER QUALITY ANALYSIS

For

SEVEN TOWNS IN DEBUB REGION

Fikremariam Kahsai
Department of water resources
Asmara, Eritrea
Oct.24,1997

Introduction

As per request of Japan international co-operation agency (JICA) study team, the laboratory of WRD has conducted water quality analysis for seven target towns in the southern region of the country. These towns are, Debarwa, Mendefera, Adi-Quala, Dekemhare, Segeneiti, Adi-Keyih, and Senafe. The study encompasses chemical, bacteriological and physical assessment of water samples. To accomplish the task, ten sampling points were chosen from each town.

Water source intended for drinking should fulfil requirements which are essential for the well being of the consumer. It should be safe, as well aesthetically acceptable. The basic aspect of water quality which should be examined are:

1. Chemical quality: Chemically, water for public supply should hold optimum concentration of ions and trace metals.
2. Bacteriological quality: It should be free from pathogenic micro-organisms.
3. Physical quality: Aesthetically it should be acceptable to consumers. Meaning, its taste should be palatable, its color and odor acceptable.

The bacteriological and physical examination of water points was carried out in the field, and the technique used for the enumeration of coliforms was membrane filtration. Concerning chemical analysis, water samples were brought to the WRD water laboratory in Asmara and analysed

The analytical results and location of of the sampling points (in UTM coordinates) are annexed within this report.

Evaluation of analytical data

Water for public water supply should be free from any pathogens, chemically safe for human consumption and aesthetically acceptable.

To meet the intended purpose some countries set their own drinking water standards which comply with their own specific conditions. Most countries in the world follow WHO guidelines. Inspite of this, there are no measure differences between standards of some developed countries and that of WHO.
For practical purposes of this report, all references and evaluations of analytical data are given on WHO guidelines.

1. Physio-Chemical characteristics:

A. Electrical conductivity (EC)

EC is a measure of the ability of salts in solution to carry an electric current. The EC value rises with the rise in the degree of mineralisation or salinity.
Potable water should consist optimum concentration of dissolved substances, to serve as feasible source. Consideration of EC value as water quality is mainly due to its effect on taste. WHO has not set a standard for EC value, but the guideline value for TDS(total dissolved solids) which is directly related to EC (TDS = kEC, Where k ranges 0.55 to 0.7 for natural waters) is 1000ppm.
Among the seventy samples analysed from the seven towns, a borehole in Adiquala (AD-06), a well in (SG-09), borehole and a well in Dekemhare (DK-04), (DK-10), have electrical conductivity value greater than 1200 μs/cm to impart disagreeable taste.

B. pH Value

The pH value which is a measure of the concentration of the hydrogen ion is used as indicator of either acidic or basic pollution. The pH value of all the waters in the towns lie within the range of 6.5-8.5 units, which is a recommended limit for drinking.

C. Turbidity

Clarity is an important water quality parameter of water supply. Turbidity in water is caused by suspended matter, such as clay, silt, finely divided organic and inorganic matter, and plankton and other microscopic organisms. If the turbidity exceeds 5NTU, then it is clearly visible in a glass of water and usually rejected by consumer on aesthetic grounds.

Turbidity higher than the recommended value was registered in Segeneyti, Kilowlie(Mendefera),Sememo(Adiquala), and Adi-Keyih dams. This is mainly caused by silt and clay materials transported with the flowing water during raining.
The other sources which are mainly ground water, have value less than 5NTU which meets the standard of WHO.

D. Total Hardness

Total hardness is the sum of calcium and magnesium concentrations, both expressed as calcium carbonate, in milligrams per litre. The hardness or softness of water varies from place to place and reflects the nature of the geology of the area with which the water has been in contact. In general, surface waters are softer than ground waters. Hard waters are associated with chalk and limestone catchment areas, whereas soft waters are associated with impermeable rocks such as grinite.

Very hard water, greater than 350 mg/l as CaCO3, causes scale deposition in pipelines and scum formation in boilers. Soft Waters, less than 75 mg/l as CaCO3 causes leaching of metals and corrosion.
The dams in Adi-Keyih(AK-09), Adi-Quala(AD-01), and Mendefera (Kilowlie)(MN-01) has 62, 54, and 48 mg/l total hardness as Calcium Carbonate, hence classified as soft water. Whereas, nine sampling points which are coded as SN-02, SN-08, AD-06, MN-06, MN-08, DB-06, SG-09, DK-04 and DK-10 has registered hardness value ranging 350 to 743 mg/l as Calcium Carbonate. Therefore, classified as very hard waters.

E. Nitrogenous Compounds

The chemical compounds nitrate, nitrite, and ammonia play a major role in evaluation of water quality. Three of them are interconnected by nitrogen cycle, hence one is a precursor of the other. oxidation of ammonia gives rise to nitrite and further to nitrate. The main concern of nitrate presence in excess is that it is linked to a condition known as blue baby syndrome or infant methaemoglobinemia. Due to its toxicity effect on human body, an upper limit value of 45mg/l has been set.

As the analytical results show, boreholes in Adi-Keyih (AK-10), Adi-Quala (AD-06), and Dubarwa (DB-05), a borehole(DK-04) and a well (DK-10) in Dekemhare, registered 45.2, 89.5, 64.2, 97.4, and 51.8 mg/l nitrate respectively.
Besides, in Senafe at consumer's tap (SN-06), the levels of nitrite was 5.16mg/l . This is exceedingly high in relation to WHO guideline value, which is 3mg/l as nitrite. This could be due to old pipeline system which permits intrusion of contaminants.
The possible source of nitrate contamination is organic matter broken down by bacteria in the soil.

F. Chloride

Chloride is widely distributed in nature in the form of varied salts. Its presence in natural waters can be attributed to dissolution of salt deposits, sewage discharges and sea water intrusion in coastal areas.
The taste threshold for chloride in drinking water is dependent upon the associated cation, but is usually within the range 200-300mg/l. WHO recommends a guideline value of 250mg/l .
Among the seventy samples analysed, with the exception of a bore hole in Dekemhare (DK-04) which was found 260mg/l, all were found to contain less than 250mg/l, hence in the desired limit.

G. Sulphate

High sulphate concentrations in water may contribute to the corrosion of metals in the distribution system. Due to the cathartic effect of sulphate, a guideline value of 400mg/l is set.

The sulphate content of all the analysed samples is far less than the recommended guideline value, therefore there will not be any sulphate related problem with the water supplies.

H. Sodium

The recommended guideline value is 200mg/l which is based on taste thresholds. With the exception of a borehole in Dekemhare (DK-04) which is found to be 215mg/l, all the analysed samples showed a sodium level in the range of acceptable quantity.

I. Iron and Manganese

Both chemical elements are related with staining of laundry and sanitary ware. For this reason a guideline value of 0.3mg/l and 0.1mg/l is set for iron and manganese respectively. For health related reasons a 0.5mg/l guideline value is set for manganese.
Among the analysed samples, a borehole in Senafe (SN-10), a dam in Mendefera (MN-01), and a well in Segeneyti (SG-07) were found to contain 0.39mg/l, 0.41mg/l and 0.61mg/l of iron. The rest samples are free from iron which can cause staining.
Furthermore, four water sources are found to consist 0.2mg/l of manganese. These are, a spring and a hand dug well in Dubarwa (DB-09, DB-10), a well in Segeneyti (SG-07) and a borehole in Dekemhare (DK-05). The rest are found to be free from manganese induced staining problems.

J. Fluoride

Fluoride levels in excess of 1.5mg/l lead to an increase in the occurrence and severity of dental fluorosis (teeth become mottled and brittle). Normally, 1 to 2mg/l fluoride is mentained in public drinking water supplies for the prevention of dental carries in children.
All the analysed samples of water showed that the sources contain optimum concentration of fluoride.

K. Copper

As Debarwa was a copper mining site, analysis of water points for copper was done to evaluate the water chemistry of the town.
The guidelines value for copper for health related considerations is 2mg/l.
All the samples analysed contain copper in the limits of the recommended value.

Conclusion Concerning Pysio-Chemical Characteristics

Generally the physio-chemical characteristics of water sources in the seven towns is evaluated as good . The few exceptions being a borehole in Adiquala (AD-06), a well in Segeneyti (SG-09), borehole and a well in Dekemhare (DK-04), (DK-10), which have electrical conductivity value greater than 1200 µs/cm to impart disagreeable taste.

In addition, boreholes in Adi-Keyih (AK-10), Adi-Quala (AD-06), and Dubarwa (DB-05), a borehole(DK-04) and a well (DK-10) in Dekemhare, were found to contain 45.2, 89.5, 64.2, 97.4, and 51.8 mg/l nitrate respectively, which could be potentially health hazard to consumers.

2. Bacteriological Characteristics

The basic requirement for any water source to be considered as an acceptable source for drinking is that it should be freed from bacteria, virus and protozoan.

In evaluation of bacteriological safety of water, routinely testes are done to identify for organisms indicators of pollution. The coliform group of bacteria which are found in sewage, animal and human excrement are the accepted indicators of pathogenic micro-organisms.

WHO standard recommends drinking water must not contain faecal coliform bacteria. Otherwise, it is unsafe for human consumption.

Out of seventy samples analysed from the seven towns, 29 were found to be contaminated with bacteria which are faecal in origin. This shows that the sanitary conditions of the water sources and reservoirs is not well mentained. The most probable source of contamination is human and animal waste which adds up to dams, ground water sources and pipeline systems with run off, percolation and infiltration respectively.

Total coliform bacteria should not occur repeatedly in water samples in regular water quality monitoring programme. Thier presence in a single analysis, as in the case of this study, does not necessarly imply the water sources are unsafe.

Conclusion Concerning Bacteriological Characteristics

As twenty nine of the seventy sampling points were found to be bacteriologically contaminated, it can be concluded that some of the people in these towns is getting unsafe water. However, it is noteworthy to mention that high rate of contamination may be due to unusual rainfall in the area before sampling which may helped to carry/percolate human and animal waste to the sources.
To improve the situation:

- The sanitary condition of the surroundings of the water points should be improved.
- Open wells should be covered with slab and a pump installed.
- Supplies from surface water should be treated before distribution.
- Regular water quality monitoring programme should be introduced.
- Public awareness on hygiene and sanitation should be increased.

I. Physical Quality

Date Sampled 02/10/97

Date Analysed 03/10/97

II. Bacteriological Quality

T.C.B = Total Coliform Bacteria

F.C.B= Faecal Coliform Bacteria

Well	Description	EC	pH	Temp	Odor	Taste	Turb.	Color	T.C.B		F.C.B		Remarks
Ident		us/cm		°c			TU		count/100ml,35°c		count/100ml,44.5°c		
AD-01	Sememo Dam	145	6.9	24.5	agreeable	disagree	500	Muddy		12		Many	Contaminated
AD-02	HDW,Sememo No1, Behind Dam	811	6.9	24.5	agreeable	agreeable	<5	Clear		6		80	Contaminated
AD-03	HDW,Semomo N02, Well Fields	883	6.8	23.3	agreeable	agreeable	<5	Clear		9		73	Contaminated
AD-04	Reservoir, 15cum	789	7.0	25.1	agreeable	agreeable	<5	Clear		2		0	Safe
AD-05	Tap water	706	6.9	24.1	agreeable	agreeable	<5	Clear		5		0	Safe
AD-06	BH,In the park	1541	6.9	22.3	agreeable	disagree	<5	Clear		0		Many	Contaminated
AD-07	BH, Mai Ferensai	614	6.7	21.5	agreeable	agreeable	<5	Clear		0		0	Safe
AD-08	Taps, Mai Ferensai	620	6.9	20.1	agreeable	agreeable	<5	Clear		0		55	Contaminated
AD-09	HDW, Mai Zeru, Open	515	7.0	21.5	agreeable	agreeable	<5	Clear		4		200	Contaminated
AD-10	Tap Water, Sec School	727	6.8	25.9	agreeable	agreeable	<5	Clear		7		Many	Contaminated

III. Chemical Quality

Date Sampled 10/02/97

Date Analysed 10/14/97

Well	Description	Ca	Mg	Na	K	Fe	Mn	HCO3	SO4	Cl	NO3	N-NH3	NO2	F	Hard.
Ident		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	* G.d.h
AD-01	Sememo Dam	12	6	9	2.2	0.14	0.0	83	0	10	0.0	2.00	0.00	0.00	3.0
AD-02	HDW,Sememo No1, Behind Dam	86	32	41	10.0	0.01	0.0	373	32	40	9.7	0.24	0.01	0.29	19.4
AD-03	HDW,Semomo N02, Well Fields	118	8	46	3.1	0.00	0.0	422	37	20	11.5	0.22	0.01	0.30	18.3
AD-04	Reservoir, 15cum	88	13	50	7.0	0.02	0.0	368	31	38	11.5	0.19	0.01	0.33	15.3
AD-05	Tap water	92	15	50	5.7	0.03	0.0	368	33	36	14.6	0.20	0.02	0.33	16.2
AD-06	BH,In the park	150	53	57	4.4	0.01	0.1	337	26	245	89.5	1.05	0.02	0.51	33.1
AD-07	BH, Mai Ferensai	70	20	35	2.6	0.01	0.1	332	1	24	19.9	0.10	0.00	0.51	14.4
AD-08	Taps, Mai Ferensai	90	18	35	2.6	0.02	0.1	329	2	26	19.9	0.13	0.10	0.55	16.9
AD-09	HDW, Mai Zeru, Open	72	15	35	4.0	0.04	0.1	327	0	12	6.2	0.11	0.04	0.36	13.4
AD-10	Tap Water, Sec School	86	12	44	7.9	0.02	0.0	361	33	12	10.6	0.17	0.01	0.28	14.6

* G.d.h= German degree hardness, 1G.d.h=17.9 mg/l hardness as CaCo3

* Note: HDW = Hand dug well
BH = Borehole

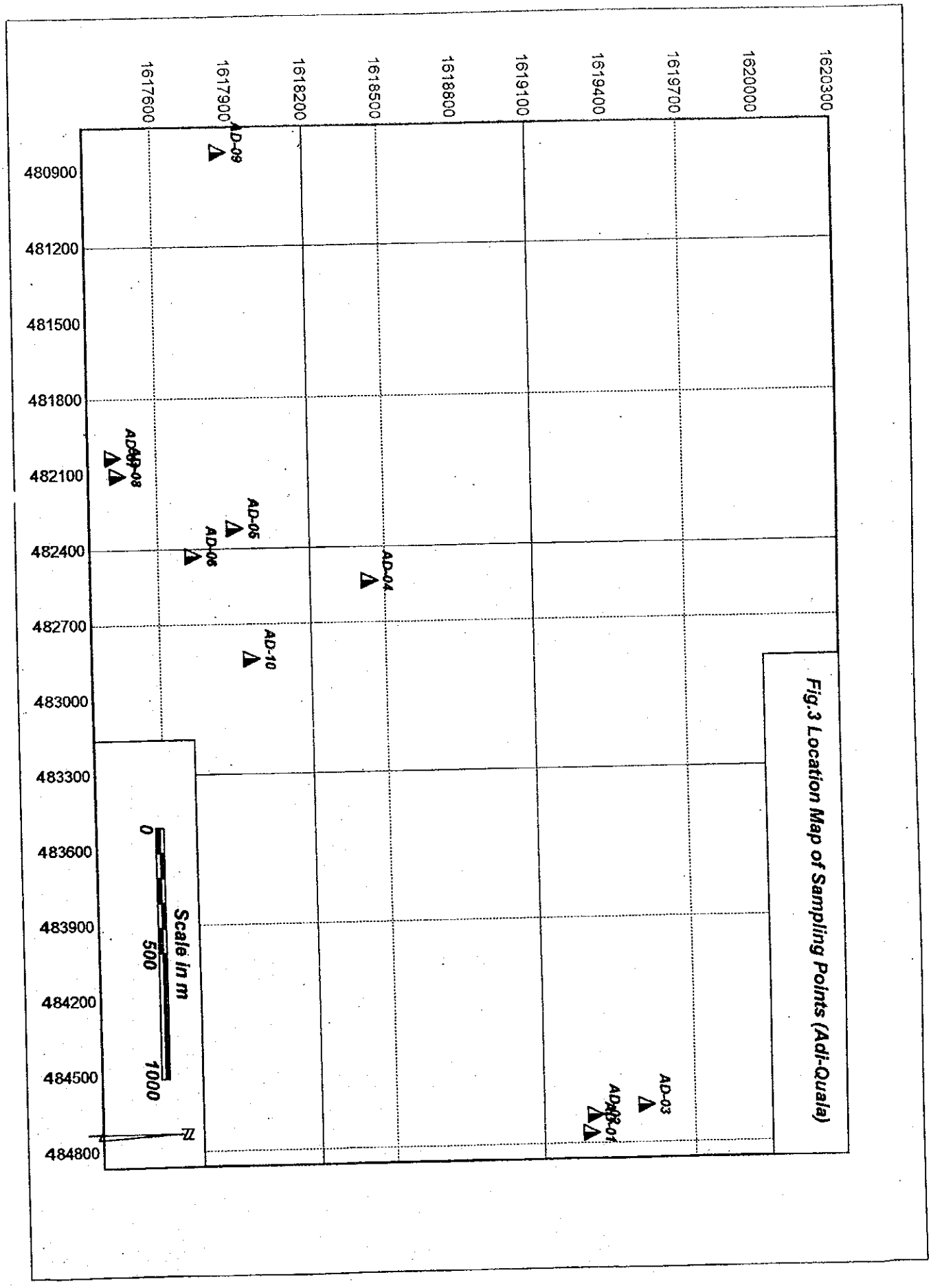


Fig.3 Location Map of Sampling Points (Adi-Quala)

Appendix C-4 Well Inventory Study

C-4.1 Well Inventory

Table -.-.3 Well Inventory 3 -1 ADIQUALA

<Well Ident>	<Location>	<Altitute> (m)	<Latitude: deg	min	sec	<Longl.> deg	min	sec	<Wateruse>	<Constr. year>	<Depth> (m)	<Diameter (m)	<Water level(m)>	<Yield> (l/min)	EC(micro S/cm)	<pH>	<Pump system>	<Pump status>	<Remarks>	<Well ident. of WRD>
DW-1	Sememo	1980	14	38	51	38	51	30	Public W/S Adiquala	1974	9.15	5.7(4.7)	2.7		559	6.85	Motor	Functional		
DW-2[2]	Sememo	1978	14	38	57	38	51	30	Public W/S Adiquala	1973	3.7	3.95	1							
DW-3	Sememo	1977	14	38	57	38	51	26	Public W/S Adiquala	1973	5.8	4.3	0.8[1]							
DW-4	Mai Yemane	2055	14	37	55	38	49	57	Collapsed											
DW-5	Mai France	2055	14	37	55	38	49	43	Livestock		8.15	4.4(3.3)	6.19		636	7.4	Bucket	Functional		
BH-6	Mai France	2056	14	37	53	38	49	56	Domestic	1988	18	0.1524			668	7.53	Motor (LESTER)	Functional	8 hrs/day operating	
DW-7	Mai Lafo	2050	14	38	5	38	49	57			2.5	1.7 x 2.3	1.43		4090	6.83		Functional		
DW-8	Mai Zeru	2049	14	38	8	38	49	20	Domestic	1971	4.95	3.3(2.65)	1.63		566	7.34	Bucket	Functional		
DW-9	Mai Zeru	2047	14	38	12	38	49	14	Out of use	1992	3.15	3.2(2.3)	2.3		698	7.11	Hand	Out of use		
DW-10	Mai Zeru	2045	14	38	14	38	49	10	Domestic	1959	2.5	2.2(1.3)	2.15		694	7.22	Bucket	Functional		
DW-11	Mai Tiem	2054	14	37	58	38	50	0	Out of use	1997	9.7	2.65					Hand (KARDIA)	Out of use		
DW-12	Mai Tilian	2052	14	38	2	38	49	58	Out of use		3.8	4.5(3.6)	2.1					Out of use		
BH-13	Adiquala public pa	2055	14	38	2	38	50	10	Domestic	1996	46			120	1746	7.06	Hand (KARDIA)	Functional		
DW-14[2]	Sememo	1976	14	38	58	38	51	29	Public W/S Adiquala	Italian period	5.1	4 x 4	1.2		879	7.06	Motor (LESTER)	Functional		

1) : Database of WRD 2) : Spring-type

(continue)

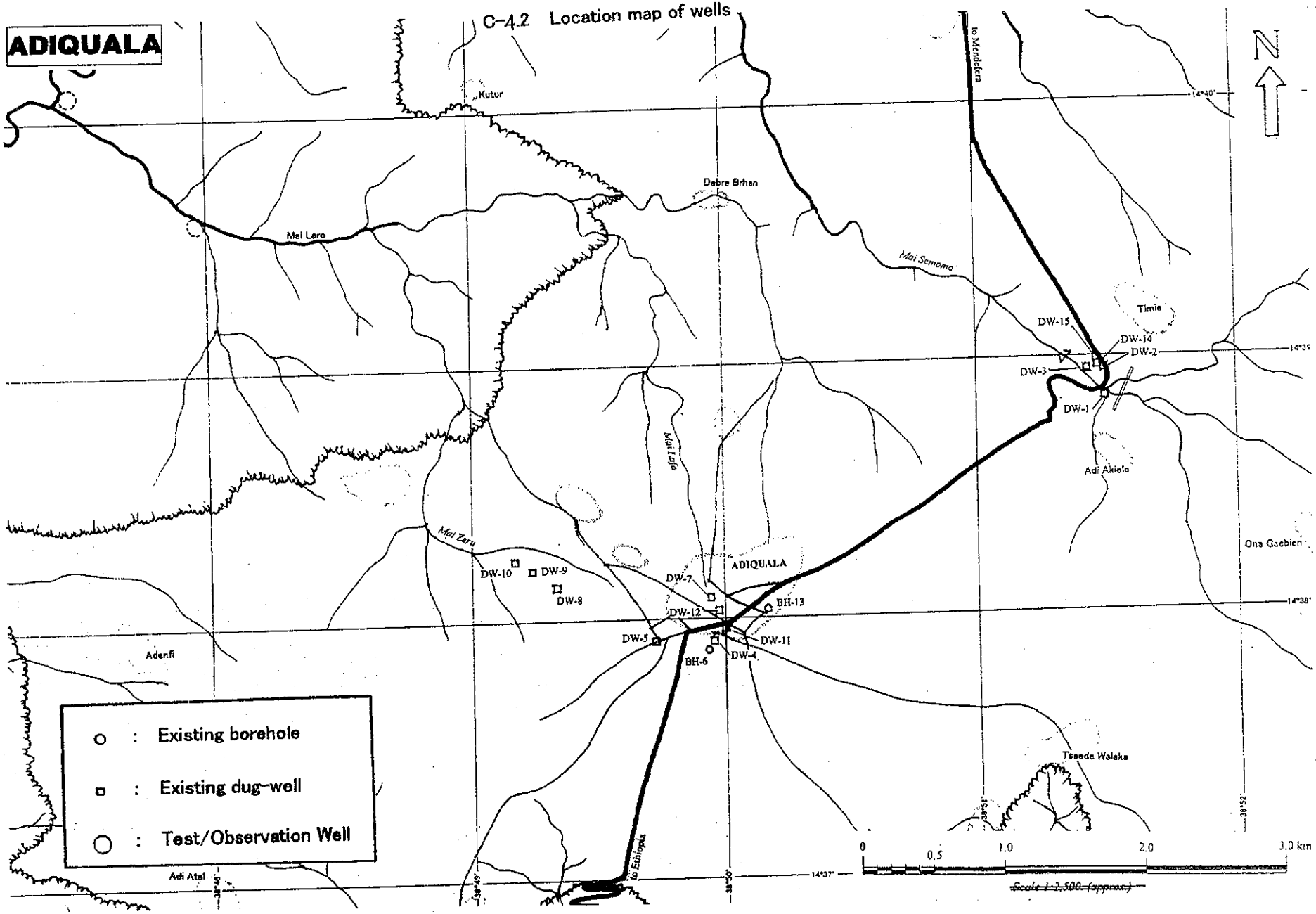
3 -2 (Adiquala)

<Well Ident>	<Location>	<Altitute> (m)	<Latitude: deg	min	sec	<Longi.> deg	min	sec	<Wateruse>	<Constr. year>	<Depth> (m)	<Diameter (m)	<Water level(m)>	<Yield> (l/min)	EC(micro S/cm)	<pH>	<Pump system>	<Pump status>	<Remarks>	<Well ident. of WRD>
DW-15[2)]	Sememo	1977	14	38	59	38	51	28	Public W/S Adiquala	Italian period										

Date surveyed : mainly 17 Oct., 1997
Well ident. : BH:Borehole, DW:Dug well, R:Reservoir
Bracket of construction year : year of repair

1) : Database of WRD
2) : Spring-type
Bracket of Wpt. Diameter : inside diameter

C-4.2 Location map of wells



Appendix C-5 Technical Specification of Production Well

1. SCOPE OF WORKS

1.1. OBJECTIVES OF WORKS

The objectives of works are to establish production well(s) for one of the water sources of _____ town. The detail of specifications will be mutually adjusted between the Engineer and the Contractor during the course of work.

1.2. CONTENTS OF WORKS

The content of works under this Contract consists of as below:

(1) Mobilization and Demobilization to/from the survey area, inclusive of moving from the Site to Site, and Site preparation.

(2) Production Well Drilling;
Drilling works, inclusive of a drilling, borehole logging, casing installation, gravel-packing, grout-sealing, development, head works, etc.

(3) Pumping Test, composed of Preliminary, Step-drawdown, Constant discharge, and Recovery tests, inclusive of water sampling and water quality analysis.

(4) Reporting, inclusive of daily drilling records, borehole and lithological logs, pumping test records, photographs, sketches, and so forth.

1.3. MEASUREMENT AND PAYMENT

The measurement and payment for the works carried out by the Contractor shall be made in accordance with the quantity actually worked out by the Contractor and confirmed by the Engineer's (Consultant's supervisor) measurement; and the unit or lump sum price specified in the Bill of Quantities, APPENDIX-__ of the Contract.

The unit or lump sum price specified in the Bill of Quantities shall be deemed to involve every costs necessary for the appropriate item of work inclusive of personnel, machinery amortization, consumable and permanently installed materials, overhead, profit, tax, duties and so forth. No extra payment shall be made for the lump sum price in case the quantities of works specified in the Bill of Quantities may be increased or decreased.

2. LOCATION OF WORKS

The works under this Contract are to be carried out in and around the six (6) towns as shown in the Figure-A "Location Map of the Drilling Works" attached.

The exact well drilling sites are to be indicated in-situ to the Contractor by the Engineer prior to the mobilization of drilling equipment.

3. EQUIPMENT, TOOLS, DEVICES AND MATERIALS TO BE EMPLOYED

3.1. GENERAL

The equipment, sampler, tools, measuring devices, and materials to be employed to the works under this Contract shall be provided by the Contractor, excepting water sampler for water quality analysis, and water quality meters for in-situ water quality test which are to be provided by the Study Team.

The Contractor shall submit, prior to the mobilization to the area, a list of equipment, samplers, and major tools, describing the model, type, capacity, specification, quantities to the Engineer for his approval.

3.2. SCREEN AND BLANC CASING

Blank casing pipes for the wells shall be made of PVC with inner-diameter of 6 inches.

Screen pipes to be installed in the wells shall also be made of PVC with 6 inches diameter and of open ratio of more than ten percent (10%).

3.3. CENTRALIZER AND BOTTOM PLUG

Centralizer and bottom plug shall be of the same material and diameter of above mentioned pipes.

4. WORKS

4.1. MOBILIZATION AND DEMOBILIZATION

The Contractor shall mobilize and demobilize the personnel, equipment, tools, devices, and materials necessary for the works under this Contract to/from the work area under the Project from/to the Contractor's base within Eritrea.

The Contractor shall prepare the drilling sites to suite for the erection of equipment, working space, and others.

Further, the Contractor shall make moving the drilling equipment and others from a site to another site.

4.2. DRILLING OF WELLS

4.2.1. DRILLING

(1) Drilling Site

The exact site of well to be drilled is indicated in-situ to the Contractor by the Engineer prior to the mobilization to the area.

Upon the Engineer's indication, the Contractor shall mark out the point by means of wooden

or stone stake with the Well Number.

(2) Type of Well

The standard type of well is shown as the Figure-__ "Standard Well Structure", and explained as follows:

The well shall consist of blank casing, slotted screen, and bottom plug of PVC pipes in 150 mm (6 inches) diameter.

The drilling diameters, the bit size, shall be good enough for the casing and gravel-packing, and be not less than 240 mm (9-5/8 inches) except surface casing portion which required to drill by 317 mm (12-1/2 inches) or more larger size bit.

The depth of the well shall be just covering the aquifer portion and as instructed by the Engineer.

(3) Quantities of Drilling Works

The work quantities in the initial plan are as shown in the Table-__ "Summary of the Works" and Table-__ "Drilling Site and Plan" attached. The depth of each well and the total quantities are to be modified on the course of works in accordance with the Engineer's instruction.

The unit and lump sum prices in the related items of the Bill of Quantities (APPENDIX-__ of the Contract) shall never be revised even if the said modification may take place.

(4) Drilling Works

The drilling of well shall be carried out by fluid-circulating direct rotary and/or the down-the-hole method or other method approved by the Engineer. The circulating fluid shall be as thin as possible except under an artesian condition.

The surface casing pipe at the top six (6) meter portion of all wells shall be installed to control sloughing and to ensure good condition to make the grout-sealing.

(5) Sampling

The drill-cut sampling about a half (0.5) kg in weight shall be collected at an interval of every one (1) meter and every change of formation encountered. The sample collected shall be put into a plastic bag together with a tag marked the Well Number and the depth collected.

The sample corrected shall be submitted to the Engineer for his inspection for casing program immediately after the completion of well drilling.

(6) Daily Drilling Record

The Contractor shall provide the daily drilling record in a form approved by the Engineer

describing water level before and after the daily drilling work, drilling rate, characteristics of drill-cut, loss or increase of drilling fluid, and so forth. The record shall be submitted to the Engineer upon the completion of drilling of any well.

4.2.2. BOREHOLE LOGGING

Immediately after the completion of well drilling to the designated depth, the Contractor shall make borehole logging.

The logging items shall be of 1) resistivity (long and short) and 2) Spontaneous Potential (SP).

The borehole log thus measured shall be submitted to the Engineer, immediately after completion of the logging, for his examination and formulation of the casing program.

4.2.3. INSTALLATION OF CASING AND SCREEN PIPES

On the basis of the results obtained from lithological and borehole logs; and so forth, the casing program shall be finally decided by the Engineer. In accordance with the Engineer's instruction on casing program, the Contractor shall install, in the center of the borehole, bottom plug, screen and blank casing pipes into the drilled hole. The centralizer shall be attached to the said pipes at every twelve (12) meters interval from the bottom or as instructed by the Engineer.

4.2.4. GRAVEL-PCKING AND GROUT-SEALING

(1) Gravel-packing

Immediately after the casing installation is over, gravel-packing shall be carried out into the annular space between the pipes installed and the hole.

The packing gravel shall be composed of siliceous materials and selected gradation, approved by the Engineer prior to the installation work.

The most care shall be paid dropping gravel at equal rate and shaking the pipes to avoid sticking and bridging of gravel at the annular apace and/or the centralizer.

Upon the Engineer's instruction, drill-cut or impervious materials may be packed at the blank casing portion.

(2) Grout-sealing

The Contractor shall seal by means of cement or mortar grouting the annular space between the hole and casing pipes at the upper-most six (6) meters portion of the borehole.

4.2.5. DEVELOPMENT

Immediately after the gravel-packing is over, the borehole shall be developed by means of

jetting, surging by water or air, and water lifting by air or other appropriate manners.
Borehole development shall be lasted when the lifted water is judged to be free from mud, sand, and other suspensions, and otherwise instructed by the Engineer, but for at least 24 hours.

4.2.6. PUMPING TEST

(1) Equipment and devices

The Contractor shall provide a proper pump and its attachment to be utilized for the pumping test. The type, name, capacity, and its specification shall be noticed to the Engineer for his approval prior to carry it to the site.
For measurement of discharge, the Contractor shall provide a calibrated wear, orifice or venture meter and/or accurate associated piezometer.
Water level in the well shall be measured by electric detective devices.
The pumped water shall be led and released at the position enough far from the teat well, not to disturb the test by re-infiltration, by proper conduit or through other suitable means.

(2) Preliminary Test

After setting of all equipment and devices, the pumping equipment shall be calibrated at various pumping rates in order to ensure that all the equipment are properly functioning and to select the pumping rate for the subsequent step-drawdown test, the drawdown and yield shall be presumed through the test.
The pumping rate shall be modified according to the drawdown at the pumping well, and the preliminary pumping shall be continued at least four (4) hours.
The static water level of both pumping and observatory well (if exist) shall be measured carefully before any pumping, and the tests described below shall be started after the water level recovered to the original water level.

(3) Step-drawdown Test

The borehole shall be pumped continuously at least three (3) increasing and two (2) decreasing discharge rates, maintaining each rate at a water level to be stable, but at least more than 180 minutes.
The pumping rate of each step shall be instructed by the Engineer based on the result of preliminary test.

For each pumping discharge, the water level at the borehole shall be measured and recorded in the manner shown below;

Period	*Interval of recording*
0 – 5 min.	30 sec.
5 – 15 min.	1 min.
15 – 30 min.	5 min.
30 – 90 min.	10 min.
after 360 min.	30 min.

(4) Constant Discharge Test and Recovery Test

Pumping shall be continued at least 48 hours without any interruption. The constant discharge rate shall be instructed by the Engineer.

Water level of the borehole shall be measured and recorded during full pumping and recovery period. The measurement of recovery can be stopped when the recovery attains to the static water level.

The water level shall be measured and recorded as following time interval;

Period	*Interval of recording*
0 – 5 min.	30 sec.
5 – 15 min.	1 min.
15 – 30 min.	5 min.
30 – 180 min.	15 min.
180 – 360 min.	30 min.
360 – 900 min.	60 min.
after 900 min.	120 min.

(5) Test Record

The Contractor shall submit the pumping test records, in a proper forms of hard-printed and floppy-disk-base approved by the Engineer, within three (3) days after the completion of any pumping test to the Engineer.

(6) In-situ Water Quality Analysis

The Contractor shall make a series of in-situ water quality test of water temperature, pH, EC, and so forth, and take water sample for laboratory water quality analysis, during the constant discharge test.

(7) Laboratory Water Quality Analysis

The Contractor shall send water samples to the laboratory of WRD, immediately after the

sampling. The items to be analyzed are as follows, and the cost on the analysis shall be born by the Contractor.

Cations: Ca, Mg, Na, K, Fe

Anions: HCO_3, CO_3, SO_4, Cl, NO_3

Others: Mn, NO_2, PO_4, F, B, SiO_2, N-NH_3

Physical Properties: TDS, Hardness, Conductivity, pH

Bacteriologic properties: Total coliform bacteria, Faecal coliform bacteria

4.2.7. HEADWORK

Upon the completion of all the works specified above, the Contractor shall place the concrete pad and well-cap to the wells as the following manners;

(1) Concrete Pad

The dimension of concrete pad for the well shall be 1.00 m of wide, 1.00 m of long, both centered by the drilled well, and 0.50 m of deep, or otherwise instructed by the Engineer. The concrete mix of the Portland cement, fine and coarse aggregates, by volume ratio, shall be of 1:2:4 or as instructed by the Engineer.

(2) Well-cap

All the wells completed shall be covered by cap. The design, dimension, size and type of cap shall be approved by the Engineer prior to actual providing.

(3) Installation of Automatic water-level recorder

The Contractor shall install total ____ of automatic water-level recorders provided by WRD into ___ monitoring wells existing or drilled under this Contract. Details on hook, wire, method to set, etc., shall be proposed by the Contractor for Engineer's approval prior to the installation work.

4.2.8. SITE CLEARANCE

On the completion of all the works in the field, the Contractor shall remove all equipment and materials concerned, clean up the site as almost same as original states before the commencement of the works.

4.2.9. REPORTING

The Contractor shall provide the following reports and records, and on all occasions submit them to the Engineer;

(1) Daily Reports

- Daily drilling record
- Daily work record

(2) Results

- Drilling logs
- Lithological logs
- Borehole logs
- Pumping tests

(3) Color photograph (or sketch by the instruction)

- Typical work operation
- Site views
- Equipment, measuring devices and materials
- Other related to the execution of the works and indicated by the Engineer.

C-6 Standard Design of Production Well