JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

ETHIOPIA
WATER WELL DRILLING AGENCY

BASIC DESIGN STUDY REPORT
ON
GROUND WATER DEVELOPMENT PROJECT
IN
ETHIOPIA

FEBRUARY 1993

PACIFIC CONSULTANTS INTERNATIONAL

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PREFACE

In response to a request from the Transitional Government of Ethiopia, the Government of Japan decided to conduct a Basic Design Study on the Ground Water Development Project in Ethiopia and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent a study team to Ethiopia headed by Mr.Hisatoshi Okubo, First Basic Design Study Division, Grant Aid Study and Design Department, JICA and composed of members of Pacific Consultants International from September 26th to October 23rd, 1992.

The team held a series of discussions with the officials concerned of the Transitional Government of Ethiopia and conducted a field survey in the study area. After the team returned back to Japan, further studies were made and this report was prepared.

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

I wish to express my sincere appreciation to the officials concerned of the Transitional Government of Ethiopia for their close cooperation extended to the study team.

February, 1993

Kensuke Yanagiya
President
Japan International Cooperation Agency

February 10th, 1993

Mr. Kensuke Yanagiya,
President,
Japan International Cooperation Agency,
Tokyo, Japan

Letter of Transmittal

We are pleased to submit the Basic Design Study Report on Ground Water Development Project in Ethiopia.

This study has been made by Pacific Consultants International based on a contract with JICA from September 22nd, 1992 to February 10th, 1993. Throughout the study we have taken into full consideration the present situation in Ethiopia and have planned the most appropriate project in the scheme of Japan's grant aid.

We wish to take this opportunity to express our sincere gratitude to the officials concerned of JICA and the Ministry of Foreign Affairs. We also wish to express our deep gratitude to the officials concerned of the Water Well Drilling Agency, Ministry for External Economic Cooperation, the Transitional Government of Ethiopia, JICA Ethiopia office and the Embassy of Japan in Ethiopia for their close cooperation and assistance during our study.

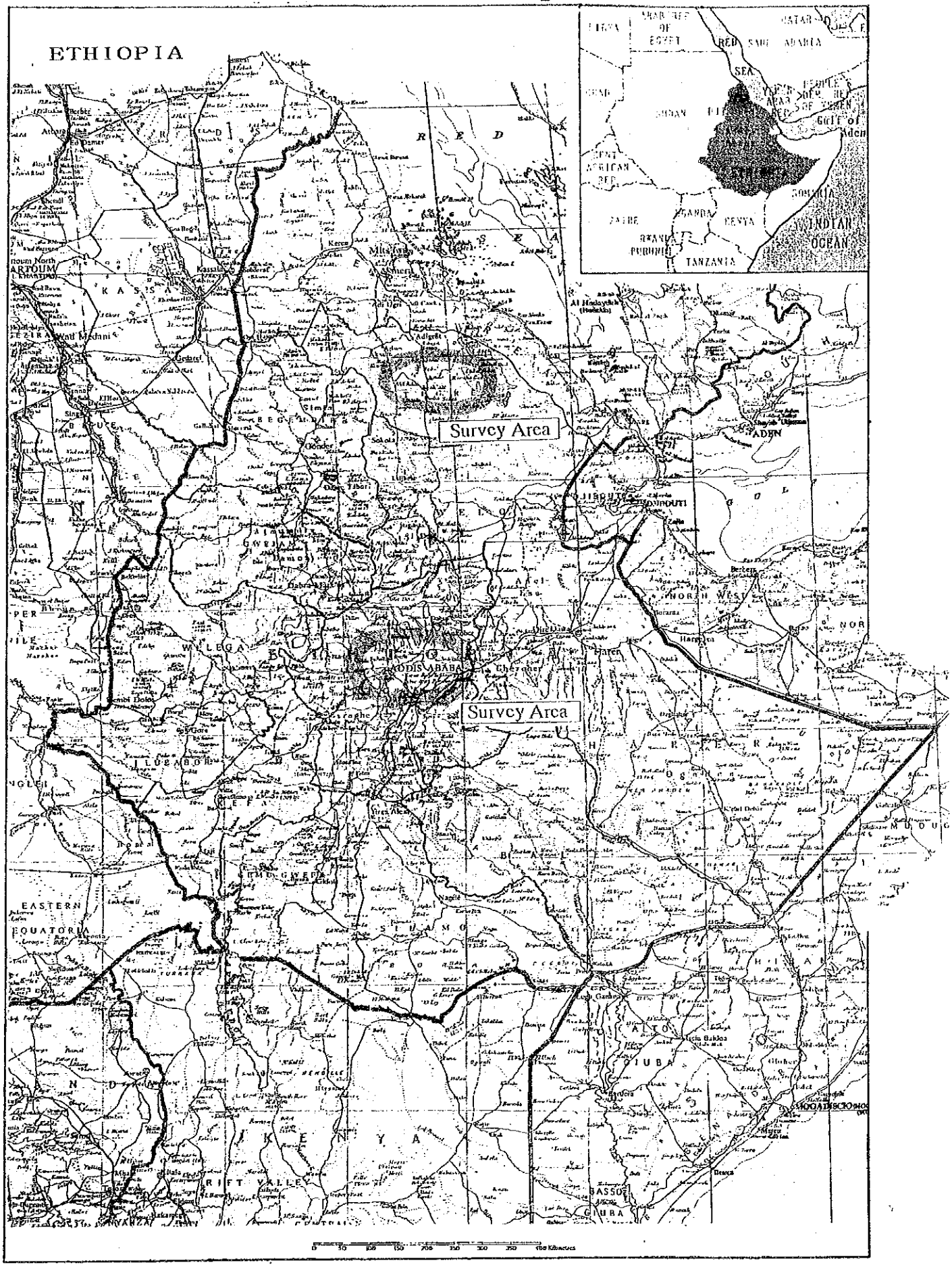
At last, we hope that this report will be effectively used for the promotion of the project.

Very truly Yours,

T. Sakamoto

Takao Sakamoto, Team leader
Basic Design Study Team on
Ground Water Development Project
in Ethiopia,
Pacific Consultants International

Location Map



Summary

SUMMARY

Ethiopia is situated in the North East Africa between latitudes 3° to 18° N and longitudes 33° to 48° E. It borders four African countries namely Sudan, Kenya, Somalia and Djibouti. The northern state Eritria has a 1000 km coast line along the Red Sea. The country covers an area of 1,250,000 sq.km and has an estimated population of 49.5 million (1991). It has a rugged, mountainous topography and exhibits linguistic and cultural diversities with different ethnic groups.

The country has suffered serious droughts in 1974 and 1984. After the revolution in 1974, the continuous civil war and conflicts with the neighboring countries lead to the collapse of national economy. The Gross Domestic Product (GDP) in 1988 was estimated to be 10 billion Birr (U.S $ 5 billion) and its Gross National Product (GNP) per capita was US$ 120.

At present about 19% of Ethiopia's 45.2 million rural population and about 80% of the 5.8 million urban population has the services of clean, adequate and potable water supply. The overwhelming majority yet suffers from the hazards of drinking water from unsafe and unprotected surface and ground water supplies.

In general, all possible efforts are made by the Water Resources Commission (WRC) for the development of water resources to alleviate the water shortage problem in drought affected areas and to meet the growing needs to use ground water for domestic, municipal and industrial uses. In this undertaking of life saving and development programs, the Ethiopian Government seeks for the external aid to develop the ground water potential of the country.

One of the responsible agencies to undertake drilling of water wells is the Water Well Drilling Agency (WWDA), which is affiliated to WRC. WWDA was established in 1974 through a loan from the Government of Japan. By now approximately 500 wells were drilled through this agency. But the drilling rigs and the associated equipment and vehicles procured by the loan are already depreciated and need to be renewed.

Although WWDA has good experience in providing water supply from wells, it is facing problems in the water supply projects because of its current low capability. WWDA formulated a plan to drill 270 wells in a 5 year period. Therefore, the Government of Ethiopia requested for the grant aid assistance from the Government of Japan in order to strengthen the drilling capability of WWDA.

In response to this request, the Government of Japan decided to conduct the Basic Design Study on the Ground Water Development project. A study team held a series of discussions with the officials concerned of the Transitional Government of Ethiopia, and conducted a field survey in the study area.

The study team confirmed the rationality and necessity of the project and the Transitional Government of Ethiopia understood the conditions of the Japanese grant aid system. By the site investigation, the study team also confirmed the contribution of the drilling rigs and associated equipment procured in 1974 through the Japanese loan. The study team found out the shortage of spare parts for the equipment procured from Japan and they were kept in WWDA's garages for repairs.

After the study team returned back to Japan, further studies were made on the requested Project based on the field survey and the basic design study report was prepared. The report confirms the Project liability and the selection of equipment and materials for the Project. The Project aims to procure the additional construction equipment and materials which will be necessary for the implementation of drilling 270 wells in 6 year period in various parts of the country. The necessary equipment and materials to be procured under the Project are shown in Table S.1. The features of the WWDA's drilling plan are as follows ;

- Project area : Various parts of the country
- Planned number of wells : 270 wells
- Planned drilling period : 6 years
- Pumping rate : 2,299,500 m^3/year (10 hrs. of operation/day)
  : 3,212,000 m^3/year (14 hrs. of operation/day)
- Population served : 210,000 persons/year (10 hrs. of operation/day)
  : 293,300 persons/year (14 hrs. of operation/day)

On completion of the project of drilling 270 wells, the quantity of drinking water available and the beneficiary population will be as follows :

Operation Hours	10 hours	14 hours
Amount of Water Supply	12,417,300 m^3	17,344,800 m^3
Population Served	1,134,000 persons	1,584,000 persons

The Project will be implemented by the Water Well Drilling Agency. WWDA will be responsible for the recruitment of additional operation and maintenance staff for the equipment to be procured under this Project. WWDA is also responsible for providing the existing equipment and for the maintenance of existing equipment and the new equipment to be procured under this Project.

WWDA will be responsible for preparing Exchange of Notes, banking arrangement, and obtaining import permits and custom clearance. It also needs to make arrangements for the Japanese engineers to enter Ethiopia. The administration procedure needed for the implementation of the project with the related governmental agencies should also be carried out by WWDA.

The procurement will be divided into two stages; the first and the second stages. The implementation period for each stage including the detailed design and preparation of tender documents will be 15 months after signing the Exchange of Notes.

The drilling capability of WWDA will be increased by the additional equipment and materials to be procured by the Project. The direct effects of the Project are as follows :

- Minimize the drought damage
- Minimize the diseases resulting from the use of insanitary water
- Reduce household work by eliminating the need to carry drinking water from remote water resources
- Stabilize the livelihood of the people and
- Improve the social conditions in the rural areas.

In view of the points outlined above, it is deemed to be appropriate and extremely worthwhile to carry out the Project with the grant aid cooperation from the government of Japan.

Table S.1 List of Equipment and Materials to be Procured under the Project

No.	Description	Quantity			
		Unit	Phase I	Phase II	Total
I.	Equipment for well drilling				
1.	Truck mounted top head type rig and tools	Set	1	1	2
2.	Tools and accessories for existing rigs, TBM171	Set	0	1	1
3.	Tools and accessories for existing rigs, SM22T	Set	1	0	1
4.	Welder	Nos.	6	0	6
II.	Casing and pipe				
1.	Steel pipe for casing	Pes.	0	1,700	1,700
2.	Steel pipe for water distribution	Pes.	0	100	100
III.	Vehicles				
1.	Station wagon	Nos.	2	0	2
2.	Pick up	Nos.	6	0	6
3.	Cargo truck	Nos.	1	0	1
4.	Cargo truck with crane	Nos.	1	0	1
5.	Dump truck	Nos.	1	0	1
IV.	Survey instruments				
1.	Portable electric water level meter	Nos.	0	5	5
2.	Electric conductivity meter	Nos.	0	2	2
3.	Stereoscope	Nos.	0	1	1
4.	Resistivity meter	Nos.	0	1	1
V.	Pumps and generators				
1.	Submersible motor pump	Nos.	0	7	7
2.	Diesel engine generator	Nos.	0	7	7
3.	Dewatering pump	Nos.	4	0	4
VI.	Others				
1.	Radio transceiver	Nos.	10	0	10
2.	Workshop equipment and hand tools	L. Sum	1	0	1
3.	Welding electrode	Kg	1,300	0	1,300
4.	Mild steel sheet	Pcs.	300	0	300
5.	Repairing parts and emery discs for slotting machine	L. Sum	1	1	1
6.	Spare parts	L. Sum	1	1	1

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ABBREVIATIONS

AAWSSA	–	Addis Abeba Water Supply and Sewage Authority
DTH	–	Down the Hole
E/N	–	Exchange of Notes
EWWCA	–	Ethiopian Water Works Construction Authority
JICA	–	Japan International Cooperation Agency
JOCV	–	Japanese Overseas Cooperation Volunteers
NGO	–	Non-Government Organization
ODA	–	Official Development Assistance
PC	–	Percussion
UNDP	–	United Nations Development Program
UNICEF	–	United Nations Children's Fund
WRC	–	Water Resources Commission
WWDA	–	Water Well Drilling Agency

Chapter 1 Introduction

CHAPTER 1 INTRODUCTION

At present only 19% of Ethiopia's 45.2 million rural population and about 80% of 5.8 million urban population has the services of clean, adequate and potable water supply. Because of the recurrent droughts, an overwhelming majority of the population suffers from the hazards of drinking water from unsafe and unprotected water supplies.

This situation has been seriously noted by the Ethiopian Government and the highest priority is given to the development of water resources in order to provide safe drinking water. To alleviate the water shortage problem all possible efforts are being made by the Water Resources Commission (WRC) for the development of water resources in various parts of the country.

One of the responsible agencies to undertake drilling of water wells and associated water supply construction works in the country is Water Well Drilling Agency (WWDA). WWDA was established in 1974 through a loan from the Government of Japan. By now approximately 500 wells were drilled through this agency. But the drilling rigs and associated equipment and vehicles procured through the loan are already depreciated and need to be renewed. However because of shortage of funds, the Government of Ethiopia requested for grant aid assistance from the Government of Japan in order to strengthen the drilling capability of WWDA.

The Government of Japan decided to execute a basic design study on the ground water development project in Ethiopia and the Japan International Cooperation Agency (JICA) dispatched a study team headed by Mr.Hisatoshi Okubo from September, 26 to October 23, 1992.

The Study Team held a series of discussions on the Project with the officials concerned of the Government of Ethiopia and conducted field surveys and data collection in the study area which were necessary for the basic design study as well as for understanding the background of the request, the objectives and contents of the Project, and the water supply situations in the study area.

The major points agreed upon as a result of the discussions and field surveys were written up as the Minutes of Discussions. On October 5, 1992, the document was signed by Ato.Geremew Getahum, Head, Department of Americas and Asia, Ministry for External Economic Cooperation and Ato.Berhanu Tamrat, General Manager of Water Well Drilling Agency and Mr.Hisatoshi Okubo, Team Leader of the JICA study team.

Upon returning to Japan, the study team conducted the Project analysis based on the field survey and examined the feasibility and contents of the Project, the equipment needed for the Project and the Project implementation plan. The result of the Study was compiled in this report on the "Basic Design Study on the Ground Water Development Project in Ethiopia".

The list of the study team members, the field survey schedule, the list of organizations and persons contacted, and the Minutes of Discussions are shown in the Appendix.

Chapter 2 Background of the Project

CHAPTER 2 BACKGROUND OF THE PROJECT

2.1 Background of the Project

Ethiopia is situated in the North East Africa between latitudes 3° to 18° N and longitudes 33° to 48° E. It borders four African countries namely Sudan, Kenya, Somalia and Djibouti. The northern state Eritria has a 1000 km coast line along the Red Sea. The country covers an area of 1,250,000 sq.km and has an estimated population of 49.5 million (1991). It has a rugged, mountainous topography and exhibits linguistic and cultural diversities with different ethnic groups.

Its physiography is characterized by coastal lowlands on the east and highland plateau on the west. Rainfall distribution is related to altitude differences at various locations. Generally the highlands receive more rainfall than the lowlands. The annual rainfall varies widely, which ranges from 100 mm on the eastern lowlands to 2400 mm on the western part of the country.

The country suffered serious droughts in 1974 and 1984. After the revolution in 1974, the continuous civil war and conflicts with the neighboring countries lead to the collapse of the national economy. The Gross Domestic Product (GDP) in 1988 was estimated to be 10 billion Birr (U.S $ 5 billion) and the Gross National Product (GNP) per capita was US$ 120.

At present about 19% of Ethiopia's 45.2 million rural population and about 80% of the 5.8 million urban population has the services of clean, adequate and potable water supply. The overwhelming majority yet suffers from the hazards of drinking water from unsafe and unprotected surface and ground water supplies.

The situation has been seriously noted by the Ethiopian Government and the highest priority is given to solve the problem together with the international aid and long term development programs. Water supply project activities constitute a part of the long term development programs.

In general, all possible efforts are made by the Water Resources Commission (WRC) for the development of water resources to alleviate the water shortage problem in the drought affected areas and to meet the growing needs to use ground water for domestic, municipal and industrial uses.

In 1983, Water Resources Commission (WRC) specified, with reference to the now defunct 10 year development plan (1984-1993). In the 10 year development plan, the specific objectives are stated as mentioned below :

1. To provide safe, adequate and reliable water supply services to at least 35% of the rural population

2. To educate, promote and mobilize the rural population towards the full participation in water development tasks and sanitation

3. To provide safe, adequate and reliable water supply services to at least 85% of the urban population

4. To provide safe, adequate and reliable water supply services to governmental and mass organizations, towns, commercial centers and settlement areas

5. To make sufficient effort to enable urban and rural centers to acquire waste disposal services and adequate sanitation respectively

The rural water supply target was later reduced to 18% as it appeared to be unrealistic.

One of the responsible agencies to undertake drilling of water wells is the Water Well Drilling Agency (WWDA), which is affiliated to WRC. WWDA was established in 1974 through a loan from the Government of Japan. The purpose of the establishment of the agency was to provide reliable water to farmers, peasant communities, industries and municipalities. From November 1974 to September 1992, WWDA has drilled approximately 500 water wells with a total depth of 49,500 meters. The yearly breakdown of the drilled wells and their respective depth is shown in Table 2.1.1.

The drilling rigs and associated equipment and vehicles procured by the loan are getting old and all of them are already depreciated. Although WWDA has good experience in providing water supply from wells, it is facing the problems in the water supply projects because of its current low capability. WWDA formulated a plan to drill 270 wells in 5 year period. However under this situation, it would not be possible to execute the plan. It is for this reason that the Water Resources Commission has given high priority to strengthen the agency with the urgently required drilling equipment and materials so that the drilling activities will be undertaken effectively

to provide potable water supply in rural and urban areas as well as the agricultural, industrial and private sectors. Therefore, the Government of Ethiopia requested for the grant aid assistance from the Government of Japan in order to strengthen the drilling capability of WWDA.

2.2 Outline of the Request

At present most of the drilling rigs and associated equipment and vehicles used by WWDA were procured in 1974 through the Japanese loan. WWDA has used these drilling rigs and equipment nearly for the past 20 years by carrying out the necessary repairs. However because of their continuous usage, these drilling rigs and equipment has depreciated and the efficiency has fell down. The cost of the repairs are also becoming expensive.

Although WWDA has a plan to drill 270 wells in 5 year period, it would not be possible to execute the plan with its present capability. In this situation it is necessary to strengthen WWDA's drilling capability by procuring the needed drilling rigs and equipment.

The request is made to the Japanese Government to procure the drilling rigs, associated equipment, vehicles and materials for the construction of 270 wells in 5 year period. The requested equipment and materials are mentioned in Section 3.3.5 and are shown in the Appendix.

The original request was made by the previous government before the establishment of the present Transitional Government of Ethiopia. In response to this request, JICA studied the contents of the request in March 1990. However the implementation was postphoned mainly due to the civil war.

After normalization in Ethiopia, the request for the drilling equipment and materials was pursued once again. However, considering the scale of the Japanese grant aid cooperation, the quantities of the requested equipment and materials were very large. Besides, the Ethiopian Government was also changed. Hence the Government of Japan decided to execute a basic design study for examining the necessity of the requested Project and its contents.

Table 2.1.1 WWDA's Drilling Achievement

As of July, 1991

Year	Rotary Rig (2)		Percussion Rig (4)		DTH Rig (2)		Total	
	No.	Depth	No.	Depth	No.	Depth	No.	Depth
1974	2	151	11	1,156	1984-86: Porta		13	1,307
1975	8	767	11	1,259	1987-: Porta & TH60		19	2,026
1976	10	1,204	16	1,843			26	3,047
1977	11	592	19	1,136			30	1,728
1978	26	1,742	12	790			38	2,532
1979	19	1,741	18	1,119			37	2,860
1980	11	1,317	13	898			24	2,215
1981	13	1,725	21	1,633			34	3,358
1982	29	1,626	5	821			34	2,447
1983	19	2,116	15	1,449			34	3,565
1984	15	1,661	7	1,048	1	115	23	2,824
1985	8	1,011	12	1,285	4	625	24	2,948
1986	6	622	20	1,646	3	423	29	2,691
1987	9	830	10	901	6	762	25	2,493
1988	9	1,081	11	1,128	5	900	25	3,109
1989	2	198	8	970	19	2,102	30	3,270
1990	4	271	3	416	1	195	8	882
1991	3	299	9	1,117	10	909	22	2,325
Total	204	18,954 m	221	20,615 m	49	6,058 m	474	45,627 m

2.3 Outline of the Project Area

2.3.1 Topography

Topography of Ethiopia is divided into two parts by the Great Rift Valley which penetrates almost at the center of Ethiopia from the northeast to the southwest. The Central Highland of elevation between 2000 and 3000 m a.s.l. is also divided into Western and Southeastern Highland by the Great Rift Valley.

The Rift Valley starts at the mouth of the Zambezi River in south, and is divided into eastern and western valley at the Victoria Lake. The Eastern Rift Valley runs towards the northeast through the border between Ethiopian and Somalian Highlands, Red Sea, Dead Sea Depression and can be traced up to the Orontes River in Syria with a total length of 6,500 km.

In the southwestern part of Ethiopia, the Rift Valley formulates a long and 100 km-wide depression zone bounded by the normal faults on both the edges. In the northern part of Ethiopia, the Rift Valley is widened to east and west up to the Red Sea and the Aden Bay and formulates Afar Lowland. The Afar Lowland spreads over 300 to 700 m a.s.l formulating a triangle of 300 km and 600 km to east-west and south-north. It is surrounded by normal faults dropping 1500 to 3000 m from plateau. The Danakile Depression with an elevation of -110 m a.s.l. is located in this Lowland. The Wonji Fault runs at the center of the Lowland, and volcanic and seismic activities appears along the Fault.

The Western Highlands continue from western part of the Rift Valley with an average height of 2000 to 2500 m a.s.l. The slope gradually moves towards the west. The elevations are generally high at 3000 to 4000 m a.s.l. and is steep towards the Rift Valley in the east. Gondar Region of the highlands is at the highest elevation and Mt. Ras Dejen, the highest mountain in Ethiopia, raises up to 4,620 m a.s.l. In the highlands there are several basins such as Tana depression at 1800 m elevation. The Abay River (Blue Nile) runs for 1,500 meters below the general level of the plateau. The highlands include many sub-divisions or blocks separated by the deep, steep-sided valleys of major rivers, such as Mereb, Tekeze, Abey, Baro, and Gibe (Omo) Rivers. These rivers, except the Gibe(Omo) River, flow towards the west and conjunct to the Nile River.

The Southern Highlands (Somalia Highlands) lay at the eastern end of the Rift Valley having a continuous slope towards the south-eastern lowlands. The highlands have the highest elevation on their western rim, and Mt. Batu (4,308m) is located in the region.

The highlands are separated by the Wabe Shebele and the Genala rivers and their tributaries. The Genala River has rich water flow and drains into the Indian Ocean through the Somalia deserts. The Wabe Shebele River runs for 2,000 km length in Ethiopia and Somalia, and joins to the Genala River near its river mouth in Somalia.

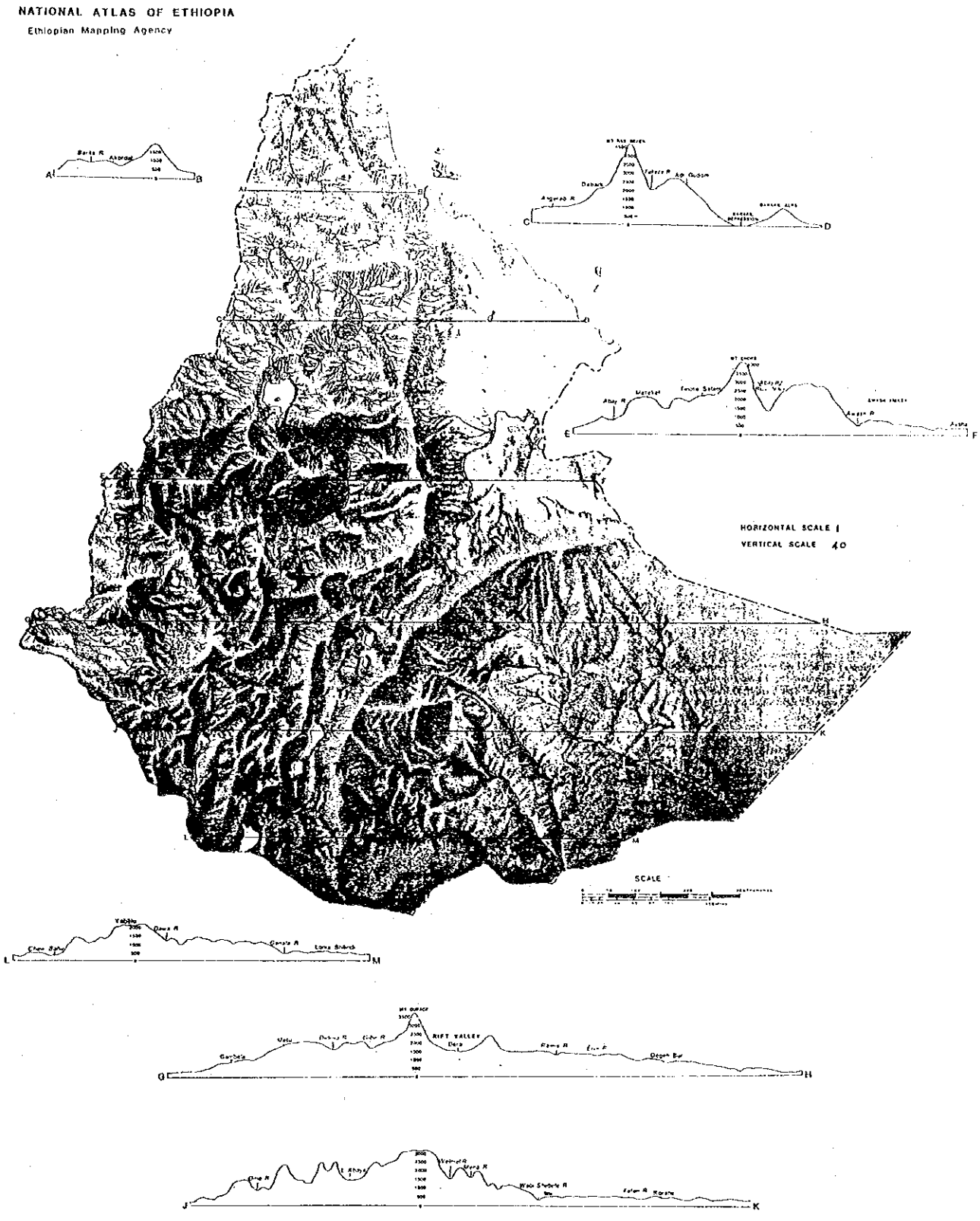
The drainage system of the Lower Rift Valley consisted of the Rift Valley Lakes, the Awash and Gibe (Omo) rivers. The Gibe (Omo) River originates from Southwestern plateau, and flows southward into Lake Rudolf. Rivers in the Rift Valley Lake drainage system terminate in lakes such as Abaya, Ziway, Langeno and Awasa. Some of these lakes are salty lakes. The Awash River originates near Addis Ababa and flows northward in the Afar Lowlands into Lake Abe near the Ethio-Djibouti border. The Lake Abe is a salty lake and has no outlet. The water resources of Awash is utilized most effectively having three hydro-power stations and two modern irrigation systems supplying sugar and cotton plantations.

Fig. 2.3.1 shows the relief map of Ethiopia.

2.3.2 Geology

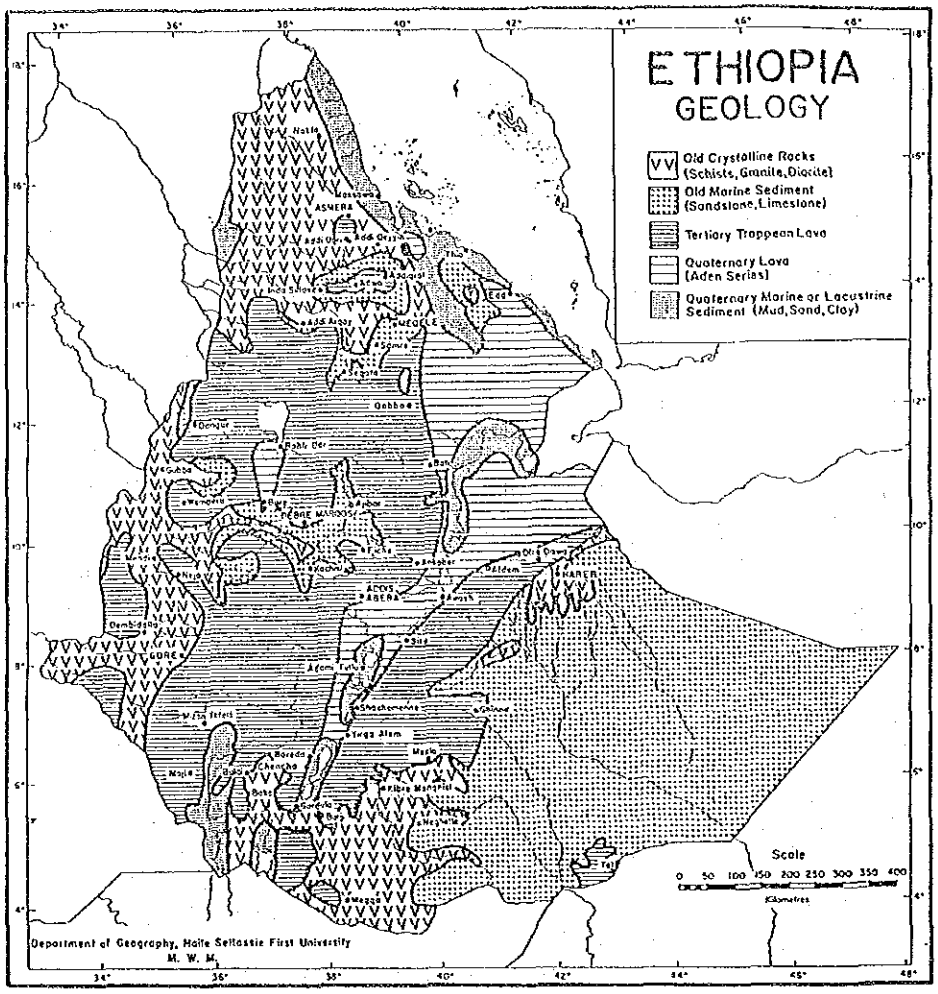
Generally speaking, the geology of Ethiopia consisted of Precambrian metamorphic basement rock, marine sedimentary rock of Mesozoic covering the basement non-uniformly and Tertiary volcanic rocks formulating the Highland Plateau. The lower Rift Valley is covered with Quaternary volcanic and sedimentary rocks.

Geological map of Ethiopia and the geological cross sections are shown in Fig.2.3.2 and Fig. 2.3.3.



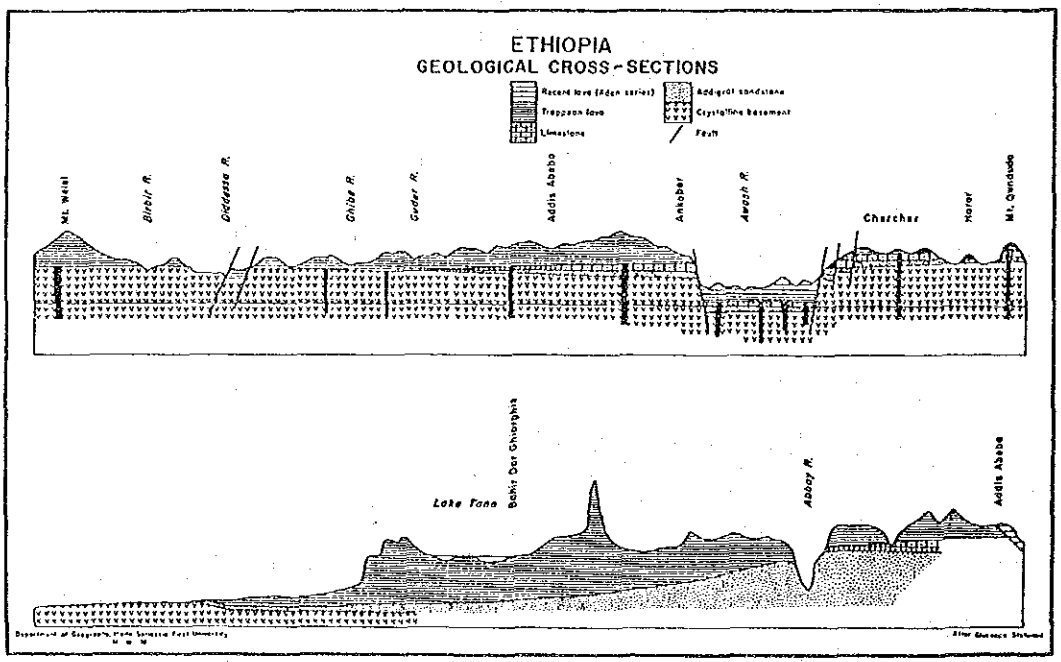
Source: National Atlas of Ethiopia, 1988

Fig. 2.3.1 Relief Map of Ethiopia



Source: Introductory Geography of Ethiopia, 1972

Fig. 2.3.2 Geological Map of Ethiopia



Source: Introductory Geography of Ethiopia, 1972

Fig. 2.3.3 Geological Cross Section

Precambrian metamorphic rocks forming the basement of Ethiopia spreads widely in the lower elevation of highlands plateau. The Precambrian basement contains a wide variety of sedimentary, volcanic and intrusive rocks. The basement in the south and west of the country, where granitic rocks and gneiss predominate, has been strongly metamorphosed and the Precambrian sequences in the north. These rocks contain most of the presently known metallic deposits in Ethiopia. In particular, the copper and nickel have been found in the ultra basic volcanic rocks or weakly metamorphosed volcanic facies (green schists) of these old rocks. From the hydrogeological point of view, these basement rocks are impermeable layers and have less possibility of ground water development except for a small amount of ground water in the fracture zones.

In Ethiopia, the Paleozoic rocks are rare and can be said that any sediments which were deposited during the Paleozoic interval have been largely removed by erosion and peneplain was formulated during the Precambrian period.

Subsidence occurred in the Mesozoic and a shallow sea spread initially over the Ogaden and then extended farther north in Tigrey and west of the Abey basin as the land continued to subside. Sand, now sandstone, was deposed on the old land surface.

Mesozoic sedimentary rocks consists of red sandstone, limestone, dolomite, gypsum, and siltstone. Thickness of these rocks are generally deposited to several thousand meters in eastern Ogaden and they become thick towards the west. Their layer is deposited horizontally, but sometimes shows folding which have higher potential for oil and gas deposits. Hydrogeologically, these rocks have less possibility of ground water resources based on their quality and quantity except for limestone which has the possibility of containing ground water in their fracture zones.

The earliest and the most extensive group of volcanic rocks are the Trap Series, erupted from fissures above the sedimentary rocks of Mesozoic and metaphoric basement rocks during the early and middle Tertiary of Cenozoic era. This group consists predominantly of alkaline basalt with inter bedded pyroclastics and rare rhyolites erupted from fissures. They are injected by dolerite silts, acidic dykes and gabbro–diabase intrusions. The flow ranges from 6 to 50 in various sections with a thickness of up to 1,200 meters. The

thickest exposed section occurs close to the Rift escarpment, and the upper contaminates the more pyroclastic materials and some contaminates the lacustrine sediment.

These volcanic rocks of Trap Series formulated by the volcanic activities between the Eozoic and Miocece of Palaeogene period, their distribution corresponds to rather high rainfall area. Therefore, hydrogeologically, they have high potential to contain the rich fracture vein of ground water.

Sedimentary rocks between Tertiary and Quaternary occur in the eastern Ogaden, the Red Seacoast, the Danakil Depression, lower Omo valley, etc. They consisted of limestones, sandstones, evaporite and conglomerate containing some volcanic rocks.

In between the later stage of the Tertiary and the Quaternary, Aden Series volcanic rocks, mainly consisted of basalt lava and welded tuff spread in the Afar Rift. And sedimentary rocks such as sandstone, conglomerate, reef limestone, and lacustrine evaporites accumulated thickly in the Afar Rift.

These younger rocks are considered to be good aquifer but they usually show the high salt concentration and sometimes show high temperature influenced by the volcanic activities.

2.3.3 Hydrogeology and Aquifer Water Quality

Hydrogeological condition is influenced by the climatological factors such as evaporation, rainfall, topography, geology and tectonic conditions. In Ethiopia, hydrogeological condition is correlated to these conditions, and it is summarized as a hydrogeological map prepared by the Ethiopian Institute of Geological Surveys in 1988, as shown in Fig. 2.3.4.

The Hydrogeological Map of Ethiopia is divided into the following five zones;

1. Highland I: The region extends at the central–south part of the Western Highlands and western part of South–east Highlands. The area is covered mainly by volcanic rocks of the Trap Series. The approximate altitude is 2,000 m a.s.l. and water availability of the region is surplus

because of high rainfall. Therefore both of surface water and ground water, is wide spreaded. Ground water table ranges from 0 to 100 m below the ground. Chemical quality of aquifer is usually good with the TDS less than 1500 ppm.

2. Highland II: The region extends at the northern part of the Western Highlands. The area is covered mainly by sedimentary rocks or metamorphic base rocks of the Mesozoic composed with sandstone. The approximate altitude is 2,000 m a.s.l. and water available in this region is insufficient because of low annual rainfall (800 mm). Water resources, both of surface water and ground water, is widespread but the quantity is moderate to low. Ground water table ranges from 0 to 100 m below the ground. The aquifer water quality is usually good to fair with TDS less than 3,000 ppm.

3. Lowland I: The region lays on the lake zone of central part of Lower Rift Valley including a part of Abey and Baro valleys. The area is covered mainly with lacustrine river sedimentary rocks of the Quaternary. Water resources, both of surface water and ground water, is spreaded widely. Chemical quality varies from location to location, especially the salt concentration in lake zone of Rift Valley is very high. Ground water table ranges from 0 to 150 m below the ground. Aquifer water quality is usually fair to poor with TDS ranges between 1,000 to 3,000 ppm.

4. Lowland II: The region extends in northwestern and southern part of the Western Highlands, southern to central-east part of South-east Highlands, and Afar lowlands of Rift Valley. The area is covered by metamorphic base rock, sedimentary rocks of the Mesozoic and volcanic rocks of the Quaternary. The area shows low elevation and arid climate. Therefore surface water and ground water are limited. Some area along the valleys has rich ground

water supply. Ground water table is rather deep ranging from 0 to 270 m below the ground. Aquifer water quality is generally fair to poor with TDS ranging from 1,000 to 3,000 ppm.

5. Lowland III: The region extends in the Red Sea coastal area of Afar Lowlands and the eastern party of Ogaden. These area is covered by sedimentary rocks of the Mesozoic and volcanic rocks and sedimentary rocks of the Quaternary. The area shows lowland with less elevation than 1,000 and arid climate, annual rainfall of less than 400 mm. Therefore surface water and ground water are limited. Ground water table is deep ranging from 0 to 300 m below the ground level. Chemical quality is fair to poor with TDS ranging 1,000 to 3,000 ppm and has a high fluoride content of more than 1.5 ppm.

WWDA has completed 500 wells in Ethiopia by September, 1992. Based on these results, the average drilling depth of each administration region is summarized in Table 2.3.1. And the average depth of well in each hydrogeological region is shown in Table 2.3.2. As shown in these tables, the average depth of all WWDA wells is 103 m, and Highland II is 76 m shallower than average well depth of the region and well depth in Lowland III is 155 m which is deeper than the average well depth of the region.

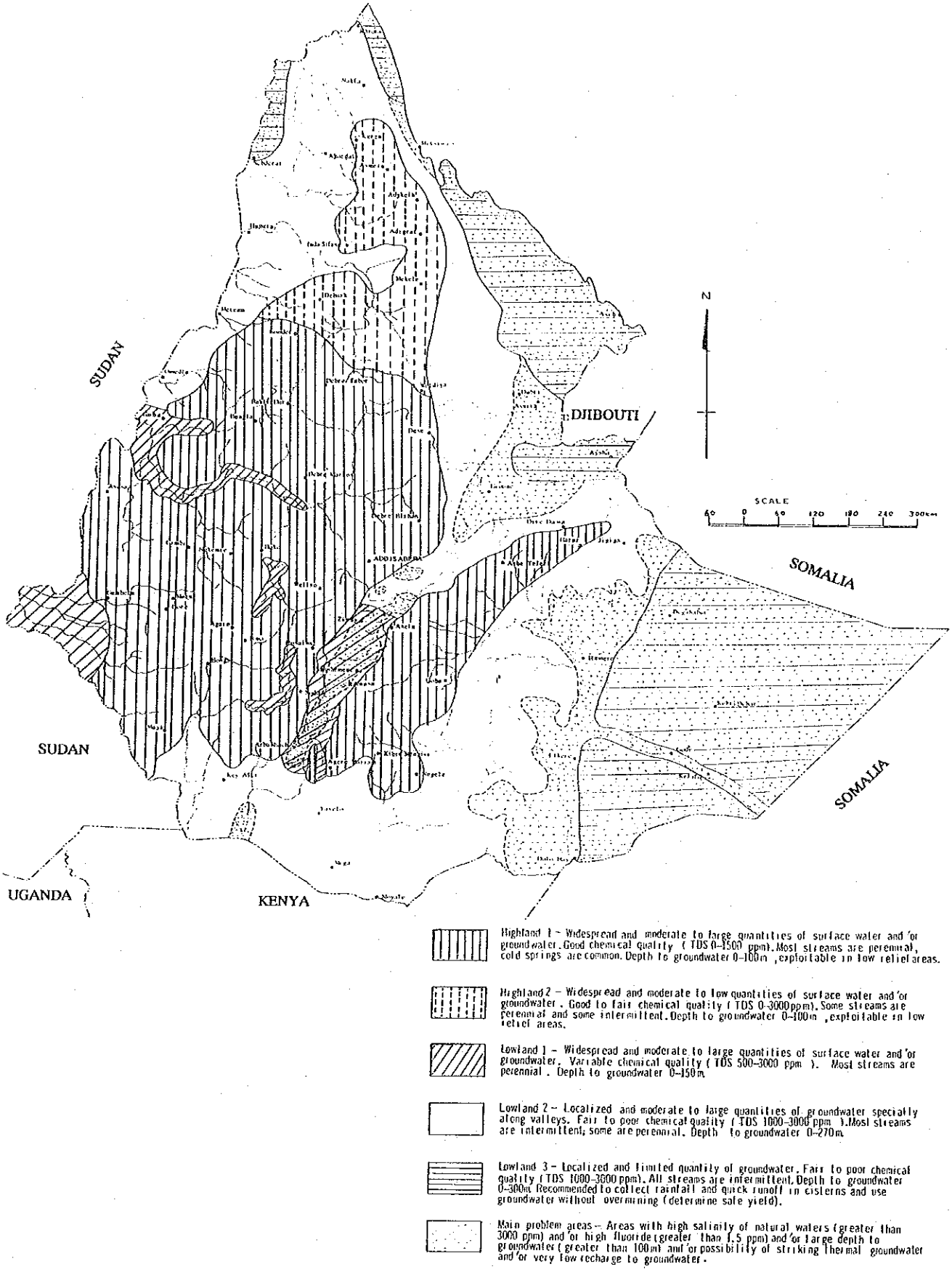
The results of Aquifer ground water chemical analysis of WWDA's wells are summarized in Table 2.3.3. In these analyses the Highland I is divided into the Western and Eastern highlands. And these chemical data are plotted on key diagram and hexadiagram as shown in Fig. 2.3.5 and Fig. 2.3.6.

These figures show that the chemical characteristics of the Eastern and Western highlands of Highland I are not so much different, and they are similar to the characteristics of surface water because of relatively speedy water circulation. Also the chemical characteristics of aquifer in Highland II is similar to Highland I but they are rather same as ground water in Dire Dawa and Harrarge which contain aquifer of Mesozoic sediment rocks.

Chemical characteristics of Lowlands I shows a carbonate alkali type which shows a low circulation speed. Ground water in the lake zone of Rift Valley has rather high concentration of salt and fluorides.

Ground water in Lowland II and Lowland III in Afar Lowlands is originated from sea water or related to the sea water. From the chemical characteristics, the ground water in Jijiga and Alem Maya in Harar area can be considered as fossil water.

According to the pumping test results of WWDA's wells combining with chemical analysis, the wells in Highland I and II which draw carbonate hardness type of ground water show high permeability, and wells in Lowland I which draw a carbonate alkali type of ground water shows low permeability together with wells in Highland I and II with stagnant type of ground water.



Source: Hydrogeological Map of Ethiopia, 1988

Fig. 2.3.4 Hydrogeological Map of Ethiopia

Table 2.3.1 Average Drilling Depth by Administrative Region

As of September, 1992

Admini. Region	No. of wells	Drilling Depth (m)	Average Depth (m)
Eritria	19 (18)	911.46	50.6
Tigray	37 (30)	2,499.34	83.3
Wollo	56 (52)	4,638.92	89.2
Gondar	13	1,453.39	111.8
Gojjam	14	1,341.8	95.8
Hararghe	75 (72)	7,773.14	107.9
Wollega	21	979.5	46.6
Keffa	31	3,602.0	116.2
Illubabor	3	218.0	72.7
Shewa	205(202)	22,866.36	113.2
Arssi	1	114.0	114.0
Bale	14	1,748.9	124.9
Sidamo	8	1,142.0	142.7
Gamo Goffa	3	229.8	76.6
Total	500(482)	49,518.61	102.7

Source: WWDA Drilling Report

Table 2.3.2 Average Drilling Depth by Hydrogeological Region

As of September, 1992

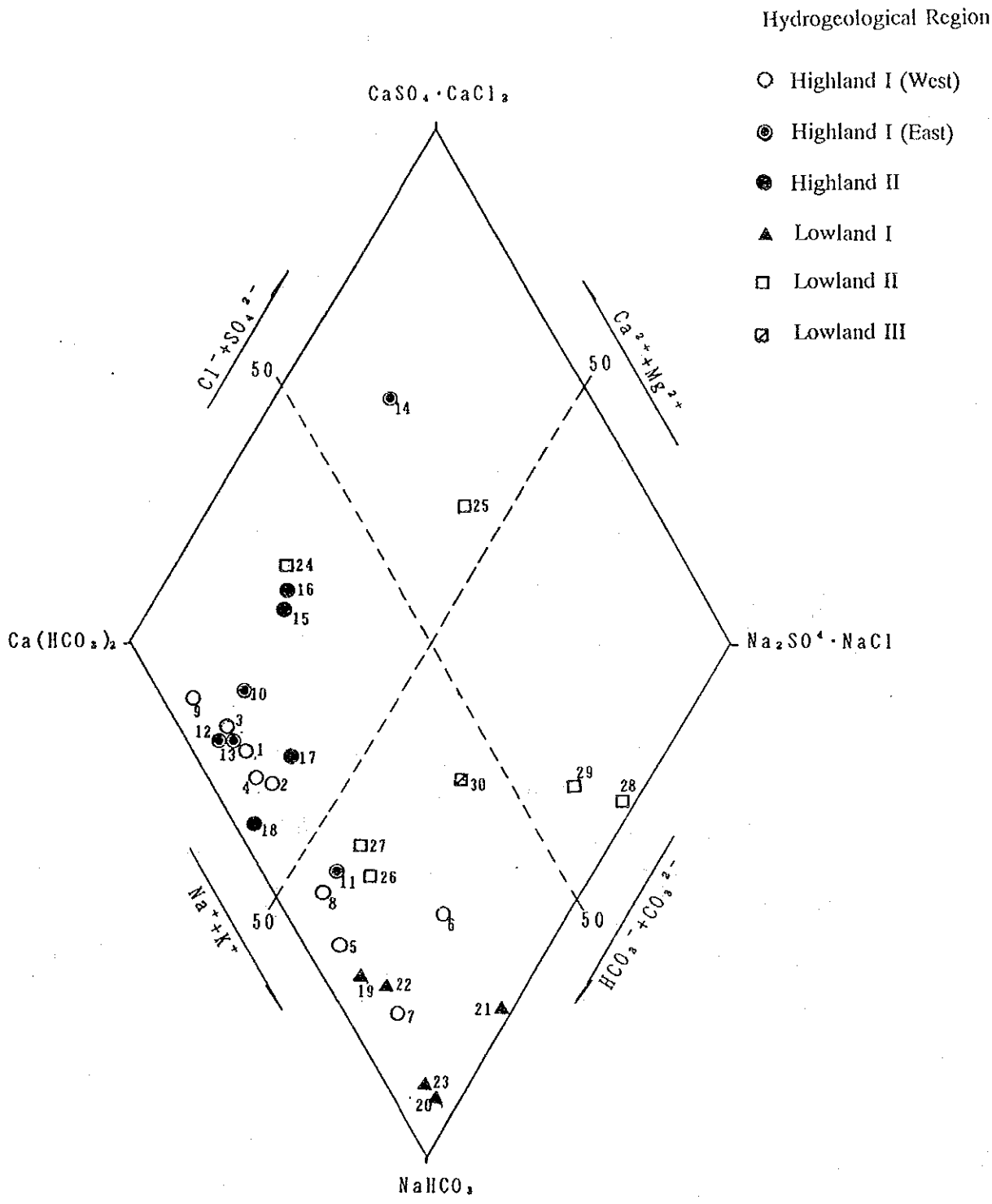
Hydro. Region	No. of wells	Drilling Depth (m)	Average Depth (m)
1 : Highland I	220(219)	23,820.85	108.8
2 : Highland II	56(47)	3,567.21	75.9
3 : Lowland I	50	5,530.3	110.6
4 : Lowland II	157(153)	14,586.78	95.3
5 : Lowland III	17(13)	2,013.47	154.9
Total	500(482)	49,518.61	102.7

Source: WWDA Drilling Report

Table 2.3.3 Ground Water Chemical Analysis of the Drilled Wells

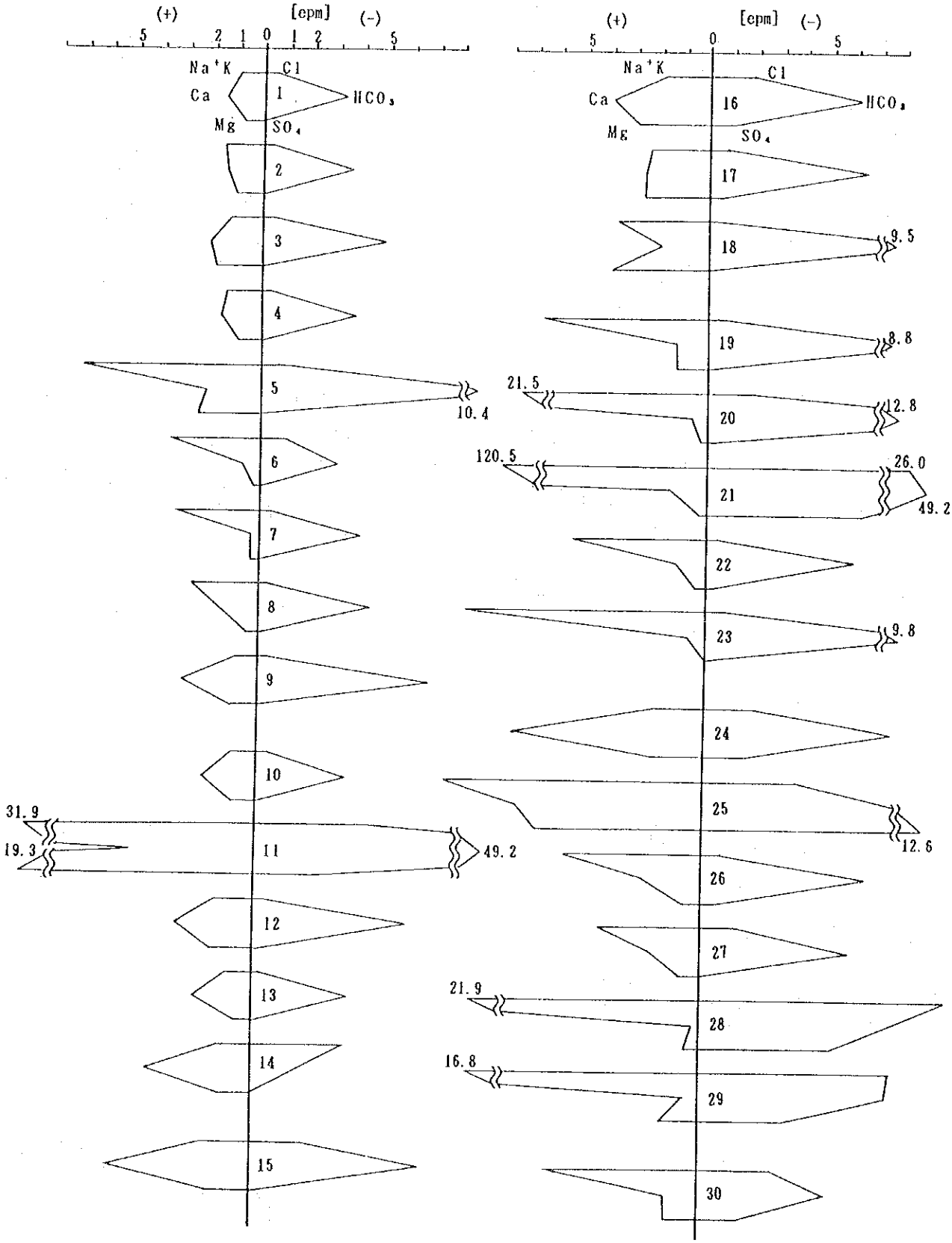
Zone	No.	Region	Site	Depth	p H	HCO_3^-	CO_3^{2-}	SO_4^{2-}	Cl^-	Ca^{2+}	Mg^{2+}	Na^+	K^+	Remarks
1 (WEST)	1	Shewa	Addis Ababa	128	7.5	195.2	Nil	Nil	11.3	35.3	9.7	23.8	2.0	No_3:10.8, F:0.37
	2	Shewa	Addis Ababa	115	8.2	219.6	Nil	Nil	14.2	28.9	12.7	34.5	2.0	No_3: 1.8, F:0.15
	3	Shewa	Akaki	150	7.5	292.8	Nil	Nil	14.2	41.7	23.3	28.9	3.3	No_3:14.2, F:0.67
	4	Gojjam	Debre Markos	95	7.5	225.5	Nil	Nil	11.0	32.7	12.6	29.9	5.3	No_3: Nil, F:0.55
	5	Gonder	Bahar Dar	89	7.8	109.8	Nil	Nil	24.1	25.7	31.1	160.5	7.3	No_3: 6.4, F:0.45
	6	Gonder	Gondar	108	8.2	183.0	6.0	Nil	35.6	15.7	2.4	79.7	2.3	No_3: 1.3, F:0.95
	7	Keffa	Jimma	137	7.7	244.0	Nil	Nil	14.2	8.0	4.9	80.0	-	No_3: Nil, F:1.01
	8	Wollo	Combolcha	114	7.6	268.4	Nil	Nil	14.2	30.5	5.8	61.2	1.3	No_3: 0.5, F:0.10
	9	Wollo	Dese	54	7.7	409.0	Nil	Nil	7.1	80.0	14.0	22.0	1.9	No_3: ?, F: ?
1 (EAST)	10	Bale	Ardaita	151	7.9	214.0	Nil	Nil	16.0	44.1	12.2	20.4	5.3	No_3:3.2, F:0.05
	11	Bale	Goba Robe	115	6.7	3001.2	Nil	105.0	156.0	101.0	235.3	724.0	33.0	No_3: -, F:0.30
	12	Arssi	Arisi Robe	114	7.0	366.0	Nil	Nil	14.2	62.5	22.4	32.7	7.6	No_3: -, F:0.30
	13	Arssi	Chilalo 7	120	7.7	231.8	Nil	Nil	7.1	46.0	8.8	21.5	6.0	No_3: ?, F: ?
	14	Harargha	Alem Maya 5	35	8.3	115.0	Nil	Nil	130.0	85.0	15.0	30.0	Nil	No_3: ?, F: ?
2	15	Tigray	Wukuro 3	109	7.2	414.0	Nil	Nil	70.9	115.4	21.4	47.6	7.9	No_3:48.2, F:0.20
	16	Tigray	Mehonny 1	96	7.4	366.0	Nil	41.2	63.8	81.8	35.0	40.8	2.0	No_3: 1.2, F:0.40
	17	Tigray	Axum 1	73	7.1	390.4	Nil	19.8	28.4	52.9	33.0	54.4	4.6	No_3:15.0, F:0.32
	18	Tigray	Axum	32	7.7	579.0	Nil	Nil	7.3	39.6	49.0	86.0	3.0	No_3: ?, F: ?
3	19	Gamo Goffa	Arba Minch	81	7.8	536.8	Nil	Nil	22.7	27.3	16.5	153.3	-	No_3: 4.3, F:0.65
	20	Shewa	Zuway	132	8.6	781.0	240.0	2.0	59.7	14.4	2.9	483.7	18.8	No_3: 0.2, F:4.36
	21	Shewa	Langano 1	36	8.4	3001.2	1152.0	299.0	925.0	32.0	4.6	2750.7	31.0	No_3: 0.4, F:50.7
	22	Shewa	Alaba Kulito 8	84	7.6	366.0	Nil	12.8	17.7	26.5	4.4	115.6	14.9	No_3: 0.8, F:4.20
	23	Sidamo	Awasa 10	67	8.3	598.0	Nil	Nil	24.9	15.2	Nil	220.0	11.0	No_3: ?, F: ?
4	24	Harargha	Dire Dawa-Meat F.	81	7.0	463.6	Nil	84.8	70.9	155.5	27.2	47.6	3.6	No_3:43.9, F:0.51
	25	Harargha	Jijiga - WSSA	70	7.8	475.8	Nil	605.0	134.0	152.0	83.0	238.0	4.0	No_3:35.0, F:0.7
	26	Shewa	Nazret - 1987	190	8.1	402.6	Nil	24.5	31.2	48.1	9.7	115.6	19.6	No_3:30.3, F:1.45
	27	Shewa	Awash - 1987	148	7.7	366.0	Nil	Nil	48.2	43.3	10.7	91.8	9.9	No_3: 2.5, F: -
	28	Harargha	Gawane	78	8.0	451.4	Nil	250.0	354.5	6.4	6.8	484.8	32.3	No_3: 7.9, F:1.2
	29	Wollo	Dubti 1	66	7.6	463.6	Nil	171.2	277.0	13.6	19.7	383.0	4.6	No_3: 0.2, F:1.8
5	30	Eritria	Assab 1978-A5	54	7.8	317.0	Nil	40.0	106.0	26.0	18.0	136.0	12.0	No_3: 8.0, F:0.7

Source: WWDA Drilling Report



Source: WWDA Drilling Report

Fig. 2.3.5 Key Diagram of Ground Water Chemical Analysis



Source: WWDA Drilling Report

Fig. 2.3.6 Hexadiagram of Ground Water Chemical Analysis

Chapter 3 Outline of the Project

CHAPTER 3 OUTLINE OF THE PROJECT

3.1 Objective

The objective of this Project is to acquire the drilling equipment and materials necessary for strengthening the drilling capacity of WWDA. WWDA formulated a plan to drill 270 wells in 5 year period at various parts of the country based on the Ethiopian Government's policy to enhance the development of water resources.

However most of the WWDA's equipment procured in 1974 were used nearly for the past 20 years, carrying out the necessary repairs. The equipment needs to be renewed and a supply of new equipment and materials is necessary for implementing WWDA's drilling plan.

3.2 Examination of the Project

3.2.1 WWDA's Drilling Plan

WWDA's original drilling plan is shown in Table 3.2.1.

Table 3.2.1 WWDA's Original Drilling Plan

	1993	1994	1995	1996	1997	Total
Wells to be drilled by new drilling rigs	24	24	24	24	24	120
Wells to be drilled by existing drilling rigs	33	33	33	33	33	165
Total	57	57	57	57	57	285

Note : 1. About 5% of unsuccessful wells are assumed
2. Average drilling depth is taken as 100m

1) In order to accomplish the target of drilling 270 wells in 5 years, WWDA plans to drill 57 wells per year with 3 new drilling rigs and 8

existing drilling rigs.

2) At present WWDA manages 8 drilling rigs among which 4 percussion rigs and 2 rotary rigs were procured in 1974 through the Japan's loan project and two used DTH drilling rigs were procured from EWWCA and NGO in 1984 and 1987 respectively.

Since these drilling rigs are depreciated the drilling capacity has reduced and an average of 22–25 wells are drilled every year. However through proper repairing and renewing with necessary spare parts, the drilling capacity can be increased and it is assumed that 33 wells can be drilled in one year.

3) At present most of the drilling supporting equipment used by WWDA were procured in 1974 through the Japan's loan project. WWDA has used these equipment for nearly 20 years, carrying out the necessary repairs. However because of the depreciation of these equipment, the repair costs have become bigger and it takes much time for repairing. Under this situation, it is necessary to strengthen WWDA's drilling capability by supplying needed repairing equipment, vehicles and survey equipment.

4) After WWDA was established in 1974, nearly 500 wells were constructed. Recently because of the lack of funds, the construction materials have been depleted and this is having a negative effect on the progress of the drilling activities. In order to carry out the drilling activities, WWDA needs to be provided with casing pipes, submersible pumps, generators and other necessary materials.

3.2.2 Problems in WWDA's Drilling Plan

During the joint discussion with WWDA, the following problems were recognized in the above mentioned WWDA's drilling plan.

1) Although WWDA plans to drill 270 wells in 5 year period, the drilling plan can be executed only based upon the request from the other organizations which include Water Supply and Sewerage Authority (WSSA), Addis Abeba Water Supply and Sewerage Authority

(AAWSSA), and other public and governmental organizations. The drilling plan of 270 wells were formulated mainly based on the WWDA's maximum drilling capability. However the execution of the WWDA's drilling plan may be limited by the drilling site and the implementation schedule.

2) In WWDA's plan of drilling 270 wells in 5 year period, 3 new drilling rigs and 8 existing drilling rigs with other supporting equipment like vehicles, radio transceivers etc. become necessary. However, the supporting equipment is not sufficient for 8 drilling rigs because of the repairs and shortage of the supporting equipment.

   At present, the supporting equipment can be arranged for a maximum of 5 to 6 drilling rigs. Even if all the supporting equipment requested will be available, the supporting equipment will not be arranged for all the drilling rigs. So it is required to share the supporting equipment with some other drilling teams along the progress of the drilling work.

3) In the WWDA's plan, the drilling sites for the water supply projects of WASSA and AWSSA supported by foreign assistance are also included. In such cases, a part of the well construction materials like casing pipes, submergible pumps, generators etc. will be supplied through the assistance of these organizations.

   Moreover, the repayment period of the Japan's loan will be completed in 1993. Therefore, WWDA may have surplus funds to procure the materials.

3.2.3 Study Team's Conclusions

The study team examined the Project considering the points mentioned above. The main conclusions are as follows :

1) At present most equipment used by WWDA is already depreciated and the well construction materials have been depleted. In order to implement WWDA's drilling plan, it is indispensable to supply the new rigs and renew the construction equipment and materials. Hence implementation of the Project is considered appropriate for the

Japanese grant aid system.

However, the equipment and materials requested are very large in quantity. Therefore, the requested equipment and materials are classified in a priority according to the urgency and necessity of WWDA's drilling plan. The priority order of the equipment and materials is shown in the Technical Notes in Appendix.

The criteria of the classification of the priority are as follows :

1. New drilling rigs and supporting drilling equipment such as vehicles and radio transceivers are added for strengthening the drilling capability.

2. Necessary spare parts, drilling tools and workshop's equipment for repairing and maintaining the existing drilling rigs are added for increasing the drilling efficiency of existing rigs.

3. The quantity of the well construction materials such as casing pipes, submergible pumps etc., is adjusted according to the scale of the Japanese grant aid system.
   Besides all the implementation sites and the schedule for WWDA's drilling plan is not yet fixed and at this situation the construction materials is not considered as urgent.

2) As mentioned above, it is considered as appropriate to utilize 8 existing drilling rigs and 2 additional drilling rigs for drilling 270 wells, taking into account of the present drilling capability, the number of drilling supporting equipment and the scale of the Japanese grant aid system.

WWDA has maintained 8 drilling rigs in good condition. Hence if the spare parts are readily available, all the 8 rigs can be used effectively.

For the 2 sets of additional drilling rigs, truck mounted tophead drilling rigs which can be used for rotary drilling and DTH (Down The Hole Hammer) drilling are proposed considering the geological conditions and the suitable drilling method.

3) At present the drilling capability of existing drilling rigs have been depreciated. As a result, among 6 drilling rigs purchased from Japan, 2 sets of rotary rigs can drill only 2 to 4 wells per year (in the past, 29 wells per year was the maximum) and 4 sets of percussion rigs can drill only 3 to 9 wells per year (in the past 21 wells per year was the maximum).

If these rigs are maintained and supplied with the necessary spare parts, the troubles can be reduced and the time for the repair can be minimized.

Therefore, when the present maintenance and repairing period of 3 to 6 months can be reduced to 2 months per year, the drilling capability will be doubled. Hence 2 sets of rotary rigs can drill 6 wells per year and 4 sets of percussion rigs can drill 16 wells per year.

4) Assuming that the project areas with hard rock formations will be drilled by rotary or DTH drilling method and gravel formations will be drilled by percussion drilling method, the time required for each drilling rig is shown in Table 3.2.2.

Table 3.2.2 Time Required for Drilling Work Unit : days

Work	WWDA's Existing rigs			New rigs
	Percussion	Rotary	DTH	DTH
1. Mobilization	5	5	5	5
2. Drilling	30	25	15	10
3. Casing	2	2	2	2
4. Finishing	1	1	1	1
5. Pumping test	4	4	4	4
6. Demobilization	3	3	3	3
Total	45	40	30	25

Assuming that 8 drilling rigs are maintained with the requested spare parts and that 2 drilling rigs are added, the drilling schedule of 270 wells including the maintenance period and national holidays is shown in Table 3.2.3.

Table 3.2.3 Drilling Schedule of Proposed Drilling Plan

Year	WWDA's Existing rigs			New rigs	Total
	Percussion 4 Nos.	Rotary 2 Nos.	DTH 2 Nos.	DTH 2Nos.	
1st year	16	6	12	18	52
2nd year	16	6	12	18	52
3rd year	16	6	12	18	52
4th year	12	5	10	16	43
5th year	12	5	10	16	43
6th year	12	5	10	16	43
Total	84	33	66	102	285

Note : 1. About 5% of unsuccessful wells are assumed
2. Average drilling depth is taken as 100m

It can be concluded that WWDA's plan of drilling 270 wells can be executed in 6 years using 8 existing drilling rigs and 2 new drilling rigs.

3.2.4 Benefits of the Project

The beneficial effects expected as a result of the execution of the Project are discussed below :

Although the discharge capacity of drilled wells mainly depends upon the type of geological formations and the capacity of the submergible pump, WWDA through its past record has found out that an average yield of 3.5 l/sec can be exploited from one well. Using 10 drilling rigs, 50 wells are expected to be drilled in one year. The quantity of water which is expected to be exploited

from these wells were calculated for two kinds of pumping operation (12 hrs/day and 14 hrs/day) on the basis of daily potable water demand of 30 l/day. The results of calculation is shown in Table 3.2.4.

Table 3.2.4 Estimated Water Supply and Population Served for One Year

Operation Hour	12 Hours	14 Hours
Pumping rate	3.5 l/sec x 3600 sec x 10 h = 126 m^3/well 126 x 50 wells = 6300 m^3 6300 x 365 = 2,299,500 m^3	3.5 l/sec x 3600 sec x 14 h = 176 m^3/well 176 x 50 wells = 8800 m^3 8800 x 365= 3,212,000 m^3
Population served	210,000 persons	293,300 persons

The total amount of ground water developed from 270 planned wells, assuming the successful completion of the drilling work by WWDA is shown in Table 3.2.5.

Table 3.2.5 Estimated Water Supply and Population Served after Completing the Project

Operation Hour	12 Hours	18 Hours
Water Supply	12,417,300 m^3	17,344,800 m^3
Population Served	1,134,000 persons	1,584,000 persons

Through implementation of the Project, every year drinking water will be newly supplied to 290,000 persons and 1,580,000 persons will be benefitted at the end of the Project. Thus the unsanitary and unsuitable drinking water supply will be reduced by providing safe and reliable drinking water which will not be exhausted at any time during the year.

3.3 Project Description

3.3.1 Executing Agency and Operational Structure

The project is to be executed by Water Well Drilling Agency (WWDA), which is affiliated to the Water Resources Commission (WRC). WWDA is one of the responsible governmental organizations engaged in drilling of water wells and associated water supply construction works in the country.
WWDA was established in 1974 under Ground Water Resources Development Project with a loan obtained from the Government of Japan.

WWDA has already played significant roles in the drilling of numerous wells for drought affected areas, rural and urban communities and for the agricultural and industrial sectors. In line with this its present objectives are outlined as follows :

1) Develop groundwater resources of the country to meet the needs of the public and private sectors.

2) Alleviate the water problems of both urban and rural communities.

3) Accelerate water development for agricultural and industrial use.

WWDA is a semi-autonomous organization that undertakes both groundwater and surface water development work. Its activities are oriented to meet the requests of applications for well drilling as well as surface water construction works. To this effect its services are made available to urban & rural communities, industrial and private sectors, and settlement areas.

WWDA has maintained 8 drilling rigs among which 4 percussion rigs and 2 rotary rigs were procured in 1974 through Japan's loan program and 2 used drilling rigs were procured by EWWCA and NGO in 1984 and 1987.

The agency is headed by a manager with 5 departments to handle the project execution, operation and maintenance. At present WWDA has 220 staff members. The general organizational chart is shown in Fig. 3.3.1.

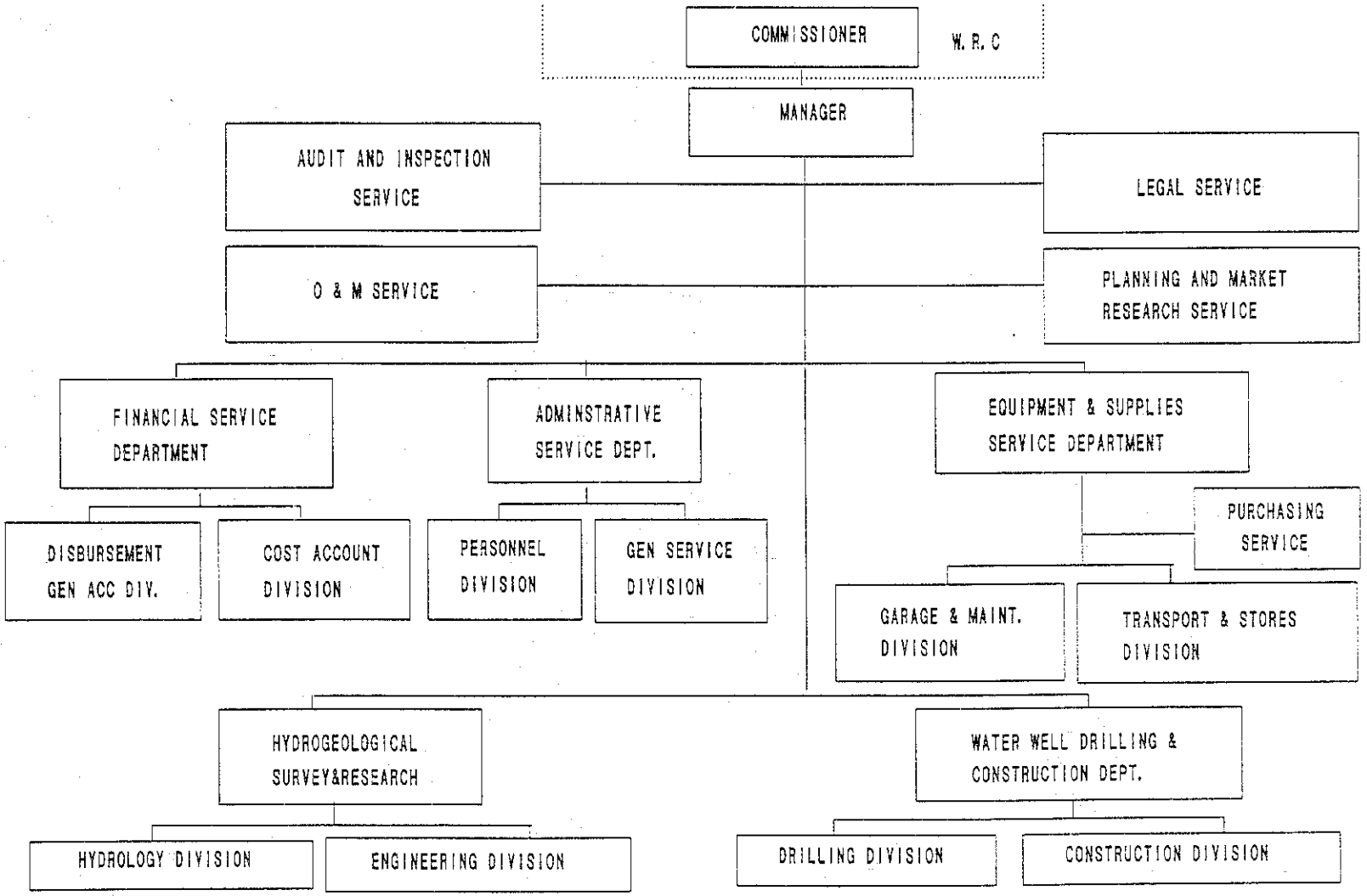


Fig. 3.3.1 Organization Chart of WWDA

3.3.2 Operation Scheme

It is planned to drill 270 wells in various parts of the country. The location of the planned drilling sites is shown in Fig. 3.3.2.

A summary of the planned drilling site by administrative region is shown in Table 3.3.1.

Table 3.3.1 Planned Drilling Site by Administrative Region

Region	Number of Wells
Tigray	69
Addis Abeba	38
Wollo	30
Gondar	19
Ogaden	18
Hararge	15
Shoa	15
Gojam	12
Illubabor	5
Kaffa	4
Welaga	2
Various regions	43
Total	270

WWDA will execute the drilling based upon requests from governmental and non-governmental organizations. Governmental wells will be mainly drilled for water supply projects of WSSA and AAWSSA. There are also a number of wells drilled for government factories and institutions such as schools and hospitals.

The non-governmental wells are mainly drilled for the private sector to be used for cattle farms and small factories. There are also a few community wells which can be categorized as non-governmental wells.

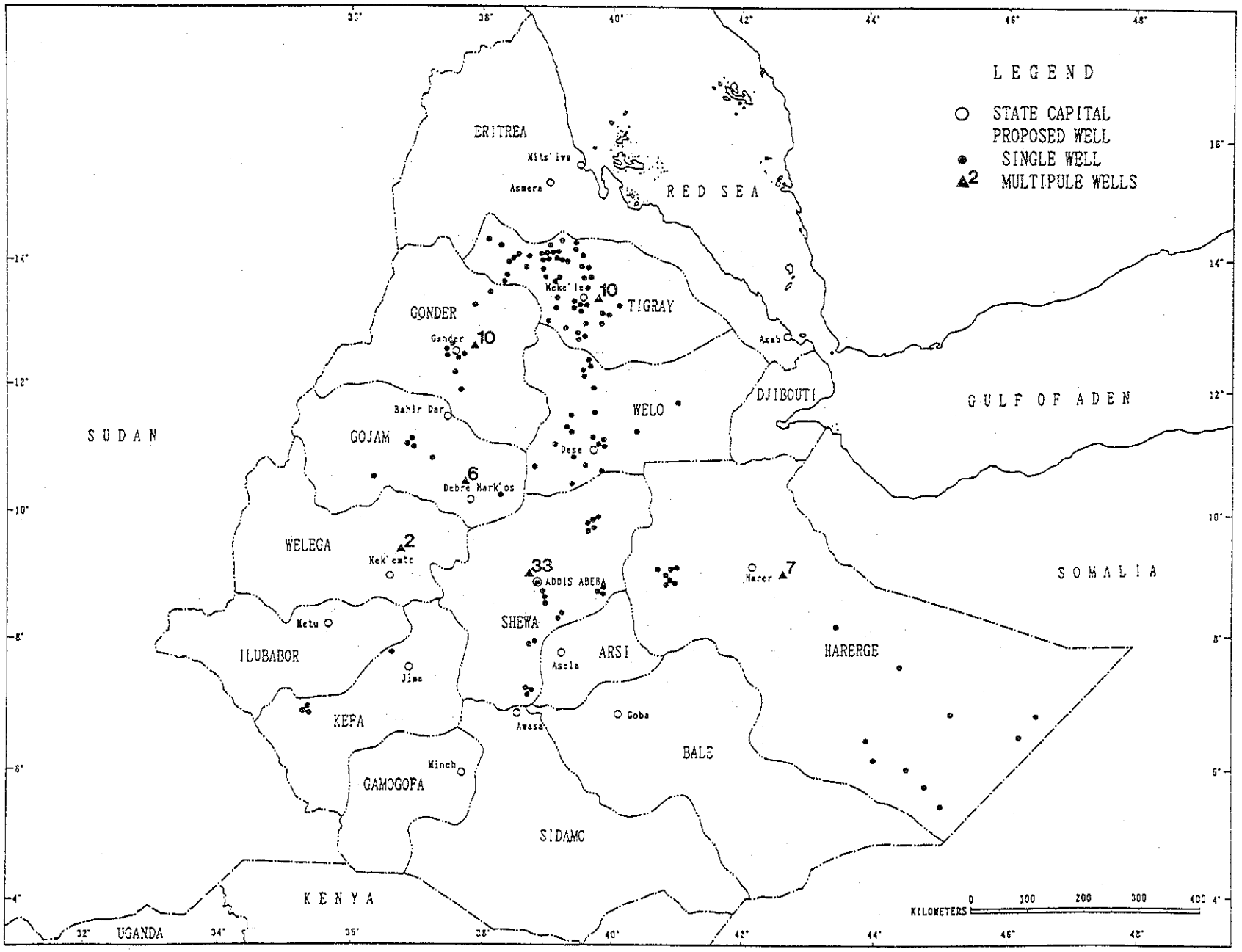


Fig. 3.3.2 Location of Planned Drilling Sites

The project of drilling 270 wells can be broadly classified into the following 3 categories :

1. Water Supply Project of WSSA
2. Water Supply Project of AAWSSA
3. The Projects of other governmental and non-governmental organizations

In principle, WWDA will work on the request basis. The 270 wells of the planned drilling sites can be classified into three categories in a priority order as shown in Table 3.3.2.

Table 3.3.2 Priority Order of Planned Drilling Sites

Priority	A	B	C	Total
WSSA	49	73	57	179
AWWSSA	33	0	0	33
Others	8	17	33	58
Total	90	90	90	270

Priority A : Projects already requested to WWDA
B : Projects expected to be requested in the future
C : Projects under preparation

The detailed drilling program and their priority is shown in Annex I of the Minutes of Discussion in the Appendix.

3.3.3 Staffing Plan

The total number of staff in WWDA as of September, 1992 is 220, and the number of staff in various departments is shown in Table 3.3.3.

Table 3.3.3. Number of Staff in WWDA

Title	Number of Staff
Manager's Office	4
Financial Service Dept.	10
Administrative Service Dept.	50
Equipment & Supply Dept.	74
Hydrological Survey Dept.	7
Drilling & Construction Dept.	75
Total	220

The number of staff has increased by 50 since 1982 when it was 170. If new rigs and supporting equipment will be provided under this Project, the number of staff will be increased again since WWDA executes drilling work on their own without employing any contractors. Through the field survey, it is confirmed that the WWDA has a proper staffing plan.

3.3.4 Budget Plan

The expenditures of WWDA in 1988 to 1991 is shown in Table 3.3.4. Although there is some fluctuation in the annual income and expenses, the income has been higher than the expenses during these four years.

About 80% of the WWDA's income is collected through contracts of drilling work carried out for WSSA, AAWSSA and other related organizations. The remaining 20% of the income is received as the government salary for the staff of WWDA.

When the repayment for Japanese Government's loan project will be completed, WWDA may have surplus funds to support for its drilling plan.

Table 3.3.4 Yearly Budget of WWDA

Unit in Birr

No.	Item	1988	1989	1990	1991
	Expenses				
1	Staffs Salary	798,122.61	803,636.23	803,526.68	867,232.13
2	Fuel and lubricants	386,232.25	457,599.49	199,617.76	390,086.69
3	Labor wages	222,309.22	244,030.39	126,187.94	247,250.37
4	Administration expenses	438,256.09	527,519.94	600,685.51	731,462.06
5	Cost of materials including pumps, generators and others	259,675.54	1,094,907.17	187,841.22	233,560.96
6	Loan Repayment	910,699.06	774,793.27	270,297.58	246,676.47
	Total	3,015,294.77	3,902,486.49	2,188,156.69	2,716,268.68
	Income				
1	Drilling income	2,208,439.25	2,524,514.85	1,732,932.70	2,551,580.29
2	Construction income	20,262.07	379,592.76	30,696.50	61,753.94
3	Income from services like assisting surveys etc.	127,954.06	49,811.96	192,866.60	171,944.47
4	Government subsidy	1,225,388.57	449,946.33	480,040.99	506,710.29
5	Miscellaneous income	411,771.08	1,233,850.66	102,488.37	94,852.38
	Total	3,993,815.03	4,637,716.56	2,539,025.16	3,386,841.37

Source : WWDA Financial Report 1992

3.3.5 Outline of the Requested Equipment and Materials

The outline of the equipment and materials requested by the Ethiopian Government is as follows :

I. Machineries, Tools and Accessories

1. Heavy duty multipurpose truck mounted DTH and mud rotary drilling rig with compressor, tools and accessories
2. Truck mounted hoisting rig
3. Tools & accessories for rotary model TMB 171 drilling rig
4. Tools & accessories for percussion model SM22T drilling rig
5. Welding plant with spare parts
6. Concrete mixers
7. Concrete vibrators
8. Hand compactors

II. Casings & Pipes

9. Mild steel casing
10. PVC casing
11. Heavy duty G.I 2" pipe

III. Vehicles

12. Station Wagon
13. Pick up single cab
14. Cargo trucks
15. Cargo trucks with crane
16. Dump trucks
17. Heavy duty mobile workshop
18. Fork lift truck
19. Spare parts for existing vehicles

IV Drilling Chemicals

20. C.M.C.High viscosity type
21. Bentonite

22. Well cleaning chemical

V Hydrogeological Instruments

23. Portable electrical water level
24. Electric conductivity meter
25. Water analysis kit
26. Table stereoscope
27. Resistivity meter

VI Pumps & Generators

28. Deep well water pumps
29. Generating sets
30. Dewatering pumps

VII Others

31. Photocopier
32. Blue print machine
33. Radio transceiver
34. Workshop equipment & tools
35. Pipe wrench
36. Welding electrodes
37. Emery discs
38. Mild steel sheets
39. Slotting machine

The specifications and quantities shall be examined and determined in the following chapter on Basic Design.

Chapter 4 Basic Design

CHAPTER 4 BASIC DESIGN

4.1 Design Policy

This project aims at granting necessary funds to purchase drilling equipment and materials. Using these equipment and materials, WWDA plans to drill 270 wells within 6 year period in various parts of the country to supply safe drinking water.

At present, the drilling equipment used by WWDA was purchased in 1974 through the Japanese loan. These equipment was used nearly for the past 20 years period and WWDA has gained enough experience in using these equipment and carrying out the necessary repairs. Therefore, proper compatibility with these equipment should also be considered.

Additionally, the conditions of the project area and the rules of the Japanese grant aid system were considered as prerequisites for the basic design. As a result, the following design policies were established for the basic design.

1) To confirm the Ethiopian ground water development policies, rules and standards.

2) To design economical facilities which will suit the standards of the project site.

3) To make project planning by taking into account of the project area's climatic conditions, and the situation and usual practices of WWDA's drilling division.

4) To select the equipment suitable for Ethiopian climatic conditions and long distance transferral conditions.

5) To make a project implementation plan which can be adapted to WWDA's plan and operational conditions, such as the number of technical staffs and their technical levels.

6) To select equipment considering the standardization of WWDA's equipment, provision of spare parts, management and maintenance, ease of operation, and the efficiency of the grant aid.

7) To exclude the equipment, if any, which will not be necessary for the implementation of WWDA's drilling plan. To consider the equipment, even if the fund is not requested for, which will be indispensable for the implementation of WWDA's drilling plan to see that to include it in the Project's equipment provision program.

4.2 Study and Examination on Design Criteria

4.2.1 Geology of Planned Drilling Well

Location of the planned drilling wells under the Project spread over the whole Ethiopia and they are shown in Fig. 3.3.2. They can be divided into the following five areas; 1) western part of Tegray Province, 2) Welo, Gojjam and Gondar Provinces, 3) Central Rift Valley, 4) Ogaden region, and 5) Addis Ababa. General geology of these five areas are described as follows;

1) Western Tigrey Province (Hydrogeological Zone : Highland II)

Sedimentary rocks of Mesozoic (sandstone, shell and limestones) and crystalline schists and volcanic rocks of Precambrian mainly spread in the area and partially covered with volcanic rocks of Trap Series (basalt lava). They are mostly hard rocks which are sometimes intruded by medium hard rocks.

2) Welo, Gojam and Gondar Provinces (Hydrogeological Zone : Highland I)

These areas are covered with volcanic rocks of Trap Series (basalt lava). Mostly, they are hard rocks, and partially covered with medium hard rock.

3) Central Rift Valley Area (Hydrogeological Zone : Lowland I)

Volcanic rocks of the Quaternary are dominant in this area, and partially covered with the lacustrine sediments. Lava rocks, clastic volcanic rocks and lacustrine sediments show hard, medium hard and soft rocks, respectively.

4) Ogaden area (Hydrogeological Zone : Lowland III)

Sedimentary rocks of Mesozoic (sandstone, limestone and gypsum) and sandstone of the Tertiary cover the area. They are mostly hard rocks and sometimes contain medium hard rock.

5) Addis Ababa (Hydrogeological Zone : Highland I)

Basaltic lava, agglomerate and welded tuff occupy the area, and sometimes they are intruded by sand gravel layers. Mostly they are hard rocks.

Down-the-hole hammer (DTH) type rigs will be used for the hard rocks drilling, and rotary type or percussion type rigs will be used for soft rock drilling.

4.2.2 Standard Design of Planned Well

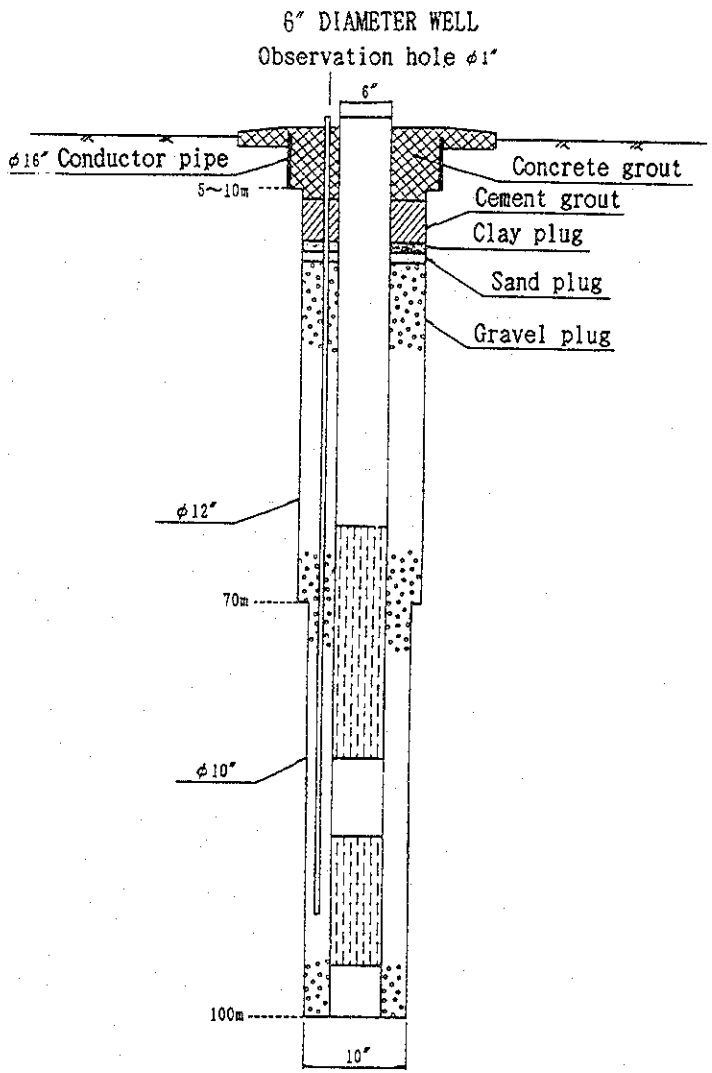
In order to select the proper rig and tools, at first the design of well structures needs to be decided. Based on the results of the previous drilling works, the maximum drilling depth and the average drilling depth are considered to be 300 m and 100 m.

Well diameters shall be 6 inches, 8 inches, 10 inches and 13 inches by considering the geological conditions, planned extraction and the casing diameter.

The conductor pipe will be installed near the top of the bore hole at the upper 5 m to 10 m of the wells. However the actual drilling depth for the conductor pipe shall be decided upon by the driller who will take into account of the hardness and weathering condition of the surface strata.

The arrangement of the screen can be selected corresponding to the geological conditions and planned extraction.

The standard well structure designs are shown in Fig.4.2.1.



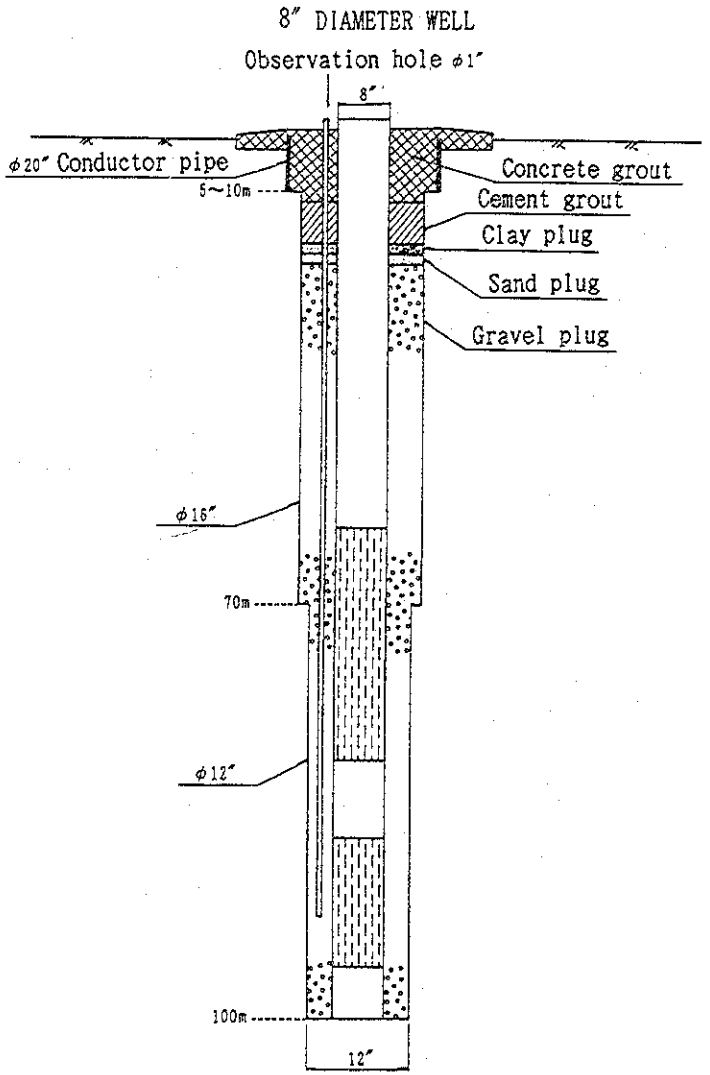


Fig. 4.2.1 Well Standard Design

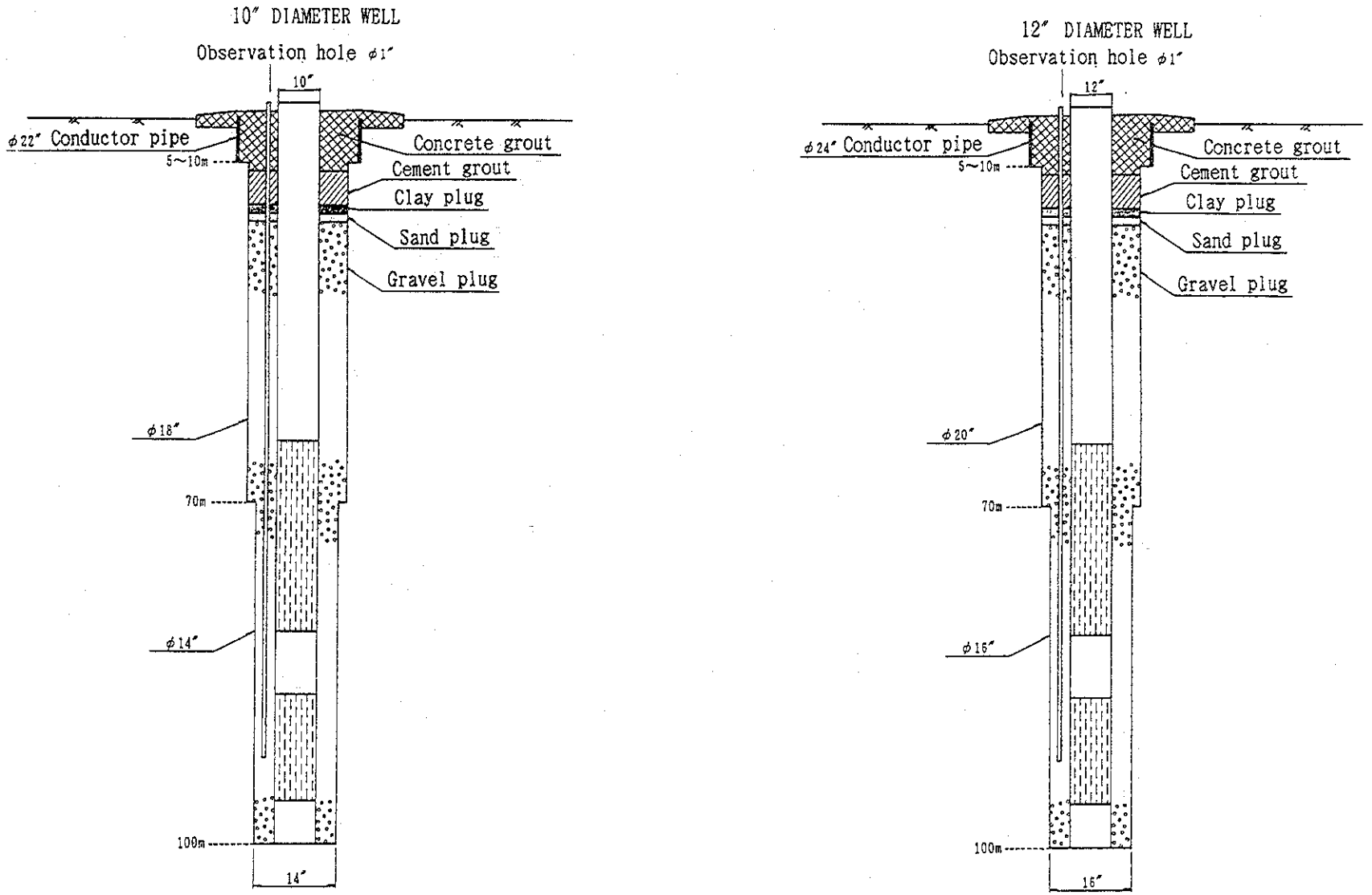


Fig. 4.2.1 Well Standard Design

4.3 Equipment plan

4.3.1 Selection of Main Equipment

In accordance with the design conditions and the basic plan described in the previous section, the selection of the main equipment necessary for the execution of the project are mentioned below :

(1) Equipment for well drilling

1) Truck mounted top head type drilling rig and drilling tools
2) Tools and accessories for existing drilling rigs, TBM171 & SM22T.
3) Welder

(2) Casing and pipe

1) Steel pipe for casing
2) Steel pipe for water distribution

(3) Vehicles

1) Station wagon
2) Pick up
3) Cargo truck
4) Cargo truck with crane
5) Dump truck

(4) Survey instruments

1) Portable electric water level meter
2) Electric conductivity meter
3) Stereoscope
4) Resistivity meter

(5) Pumps and generators

1) Submersible motor pump
2) Diesel engine generator

3) Dewatering pump

(6) Others

1) Radio transceiver
2) Workshop equipment and hand tools
3) Welding electrode
4) Mild steel sheet
5) Repairing parts and emery discs for slotting machine
6) Spare parts

The equipment appropriate for the execution of the Project plan is discussed below:

(1) Equipment for well drilling

1) Truck mounted top head type drilling rig and drilling tools

There are several types of drilling deep wells and each type has both advantages and disadvantages in the aspects of difficulties of drilling works, drilling methods which depend on the formations, size and depth of wells, and economical operation. At present the types of drilling prevailed may be classified broadly into two, a hammering type and a rotary type. The hammering type is a percussion type drilling rig and the rotary type is divided into a spindle type drilling rig, a turn table type drilling rig and a top head type drilling rig capable of using a DTH hammer, etc. Table 4.3.1 shows the comparison of these drilling types, their features and applicable formations.

Considering the formations of the project area and the previous drilling data, the rotary type drilling rig which is capable of using a DTH hammer is the most suitable rig to meet the design conditions. Therefore the selection of the rig is made based on the following items :

a) Underground water is stored along the efflorescent layer and in the fractured layer above rock bed. So the rig

shall match with these variable formations.

b) The rig shall be capable of drilling comparatively larger diameter hole in the soft and fractured formations and hard formation by means of direct fluid circulation.

c) The rig shall be capable of drilling hard formations with high efficiency by means of DTH hammer.

d) The rig shall have a better drilling efficiency than the percussion type or spindle type which is similar to the type possessed by WWDA.

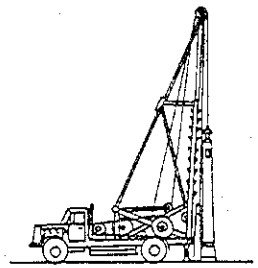
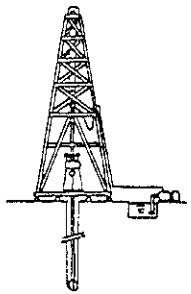
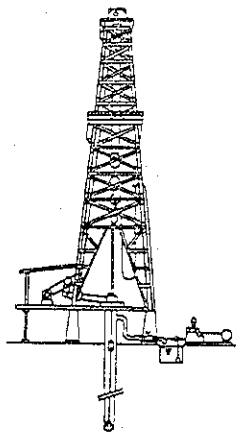
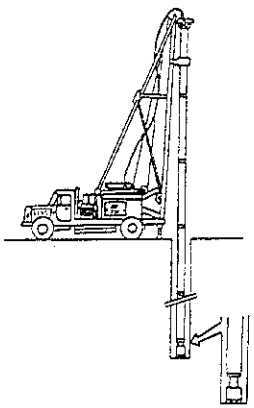
e) Considering the large project area, the rig shall be of mobile truck mounted type equipped with a mud pump, an injection pump used for foam drilling of DTH hammer, and a hydraulic reclining type mast.

The truck mounted top head type drilling rig is the most suitable one which complies with the above conditions. Also, taking into consideration of the average drilling depth of 100 m of 482 wells which were constructed by WWDA in between 1974 and 1991, the rig shall be capable of drilling the bottom hole of 12-1/4" diameter and 100 m depth by DTH hammer drilling, and drilling of not less than 300 m depth by rotary drilling. Furthermore, the power supply shall have sufficient capacity considering the project areas at high altitudes.

The DTH hammer is used for hard formation. The air compressor is necessary to remove the cuttings from bottom of the hole. The air compressor shall have the following requirements to comply with a maximum drilling depth of 100 m by DTH hammer.

Free air delivery	: Not less than 21.0 - 22.0 m^3/min.
Rated operating pressure	: Not less than 17.5 kg/cm^2

Table 4.3.1 Comparison of Well Drilling Type

Drilling Type	Hammering Type	Rotary Type		
Rig Type	Percussion Type	Spindle Type	Turn Table Type	Top Head Type (with DTH Hammer)
Applicable Formations	Sand/gravel, Non or slightly solidified formations	All formations	All formations, except non-solidified formations	All formations, specially hard rock formation
Features	- Low operation cost - Suited for sand/ gravel formations - Much fluid is not necessary - Not applicable for hard rock formation	- Comperatively high operation cost - Fast drilling speed - Capable of using for geological survey - Fluid is necessaary	- High drilling capacity - Suited for drilling fault - Fluid is necessary	- Suited for hard formation - Capable of drilling at 200-300m depth - Applicable for various formations - Fluid is necesary - Capable of air-drilling
Outline Drawings				

The compressor shall be mobile truck mounted type so as to move quickly in a large project area.

Two units of drilling rigs are necessary to execute this project plan as described in the section 3.2.

2) Spare parts for the existing rigs (for 6 units)

At present WWDA possesses 2 units of truck mounted spindle type drilling rigs, Tone TBM-171, and 4 units of cable percussion type drilling rigs, both of which were procured through Japanese loan in 1974. As described in the section 3.2, it is required to supply drilling tools and spare parts to repair these existing rigs.

The wear and tear of drilling tools and spare parts of the equipment supplied under Japanese loan have priority over other equipment in the selection. Based on the inventory lists, as of September 1992, of the warehouse in WWDA's workshop, tools and spare parts shall be selected through evaluation of each equipment.

Regarding the DTH drilling rigs made in USA supplied through EWWCA and NGO both in 1984 and 1987, the spare parts for these rigs shall be excluded from the Project since WWDA is expected to provide the necessary spare parts through EWWCA and NGO.

3) Welder

The welder shall be used for maintenance work at the workshop and at each job site. The welder shall be used for simultaneous welding with alternating current power and capable of welding 5 mm electrode. The necessary accessories shall be included. The welder shall be 4 units of 280A capacity for welding drilling tools and 2 units of 500A capacity for hard facing the tooth of bits.

(2) Casing and pipe

1) Casing pipe

There are two kinds of materials of casing pipe, steel and polyvinyl chloride (PVC), which have their own advantage and disadvantage depending on the type of well and the location.

Considering the conditions of the project plan, it is necessary to consider the following items :

a) Considering the road condition in Ethiopia, it should be strong enough to withstand possible damages during installation or transportation.

b) It should be able to resist the chemical pollution so as to develop potable drinking water which is an aim of the project plan.

c) It should be economical

PVC pipe is comparatively cheaper and resist chemical pollution, but weak in strength to withstand well cleaning maintenance service, etc. Steel pipe complies with the above conditions and is also widely used in Ethiopia. Therefore, the steel pipe shall be applied for the project plan. The steel pipe is also used for screening pipe by making slots with slotting machine which is possessed by WWDA.

Each size of casing pipes shall be divided into 4 kinds, 6" (150mm), 8" (200mm), 10" (250mm) and 13" (330mm) as per the basic design.

The total length of pipes in a well shall be 102 m (6 m x 17 pcs) which is the average depth of wells in the basic design.

The number of casing pipes to be supplied in this project plan shall be proposed as follows for the newly developing 100 wells

among WWDA's 270 wells drilling plan, considering the client's supply for casing pipes through WSSA and AAWSA etc.

6" (150mm) casing pipe	:	1,200 pcs (l = 6m) for 7,200m
8" (200mm) casing pipe	:	300 pcs (l = 6m) for 1,800m
10" (250mm) casing pipe	:	100 pcs (l = 6m) for 600m
13" (330mm) casing pipe	:	100 pcs (l = 6m) for 600m

2) Steel pipe for water distribution, 6m length

The steel pipe shall be used for water lifting and distributing purposes. 100 pieces of 2" galvanized steel pipes with screw type coupling shall be proposed for 600m.

(3) Vehicles

1) Station wagon

Two units of station wagon shall be supplied at WWDA head office for the surveys of drilling site selection as well as for transportation of workers and communications between the head office in Addis Ababa, the workshop and each site.

2) Pick up

Pick up is used for daily transportation of personnel and small equipment between the site and the camp, and as an alternative vehicle of fuel tank lorry since the fuel of the rig is supplied by a drum can. Six units of pick up shall be supplied.

3) Cargo truck

Cargo truck is used for transportation of equipment and materials such as tent for the construction camp, drill pipe and casing pipe, etc. to the site.

One unit of cargo truck shall be supplied for the project plan to distribute at the material management division in Addis Ababa.

Considering the road conditions at the project area, a cargo truck of 6x4 drive with a capacity of over 12 ton is considered in view of the weight of drilling tools and equipment.

4) Cargo truck with crane

Cargo truck with crane is used for loading and unloading heavy equipment such as generator and welder. It is also used for various purposes such as assembling a drilling rig at the site and supporting work on water development test.

One unit shall be supplied for the project plant to distribute at the material management division in Addis Ababa and utilized at each site in accordance with the working progress of each site. The loading capacity is over 12 ton in view of the weight of the drilling tools and equipment.

5) Dump truck

In well drilling work, gravel needs to be filled in bore hole to fix the casing pipe and increase quantity of water.

WWDA is collecting gravel from rivers around Addis Ababa and stocks them after selecting to deliver at each site. Dump truck is used for the transportation of these gravel. One unit of dump truck shall be supplied for the project plan to distribute at the material management division in Addis Ababa.

(4) Survey instrument

The following instruments are necessary for selecting drilling site, surveying hydrogeological features, water development volume and water quality analysis after completion of bore hole drilling :

1) Portable electric water level meter

It is used to confirm water level in a well and to measure water level during pumping test. Five sets shall be supplied.

2) Electric conductivity meter

It is used for measurement of electrical conductivity as a part of water quality inspection in a well and is of portable type with digital display, powered by dry cells. Two sets are supplied for the project plan to distribute at the hydrogeological survey division.

3) Stereoscope

It is used in facilitating stereoscopic view of air photograph to determine a well drilling point. One set shall be supplied to the hydrogeological survey division.

4) Resistivity meter

It is an indispensable instrument for selecting a well drilling point in the ground water development plan. It is capable of judging the underground conditions by measuring the specific earth resistance. It is also capable of measuring voltage, electric current, earth resistance and natural electricity, etc. in not less than 200m depth. One unit shall be supplied to the geological survey division.

(5) Submersible motor pump and generator

1) Submersible motor pump

It is used for pump test after completion of drilling a well and is of motor driven type applicable for deep wells.

Taking into account of the head and volume of the previous drilling data, the specification and number of submersible pumps are proposed as follows :

Type	Volume (l/min)	Head (m)	Quantity
A	120	150	1
B	180	150	1
C	180	200	1
D	350	150	1
E	900	100	1
F	900	150	1
G	1400	100	1

2) Generator

It is used to drive the aforementioned submersible motor pump and is of diesel engine driven type. The specification and quantity are as follows ;

Type	Output (KVA)	Quantity
A	27	3
B	37	1
C	70	1
D	100	2

3) Dewatering pump

It is used for pumping untreated and treated water. The following quantity shall be proposed :

Type	Volume (m^3/hr)	Head (m)	Quantity
A	10	25	2
B	25	10	2

(6) Others

The following equipment becomes necessary as a supporting equipment for maintenance and management of well drilling :

1) Radio transceiver

To execute the project plan, it is essential to communicate between WWDA head office and each site for the purpose of periodic reporting, business communication and emergency cases, etc. Since the telecommunication system is not developed in rural area, a radio transceiver is necessary. Ten sets of radio transceivers shall be supplied for the head office in Addis Ababa and each site.

2) Workshop equipment and hand tools

These are used for repair and maintenance services of drilling rig and vehicles to be used at WWDA's workshop. The most suitable equipment and tools are selected considering the kinds of WWDA's equipment and hand tools. with minimum quantity.

3) Welding electrode

The following volume of welding electrode is proposed for welding the equipment and for hard facing the bits for percussion drilling rigs.

For welding equipment (3 – 5mm) : 300 kg
For hard facing (5mm) : 1,000 kg

4) Mild steel sheet

It is used as the cover of well and as an alternative material of conductor pipe. 300 pcs. of 2mx1mx4mm shall be proposed.

5) Repairing parts and emery discs for slotting machine

Slotting machine is used for making slots around casing pipe to use for screen pipe. Since the existing equipment procured in 1974 have been depreciated, the components necessary for repairing the existing machine and emery discs are supplied. The necessary quantity of emery discs to make slots on screen pipes is proposed for two years on the assumption that five screen pipes are used in one well.

4.3.2 Specifications of Main Equipment

Based on the evaluation of the previous section, the specifications and quantities of main equipment are specified as follows :

(1) Equipment for water well drilling

1) Truck mounted top head driven drilling rig and tools – 2 SETS

i) Drilling rig – 2 Sets

- Capacity : The rig shall be capable of drilling 300 m depth with 4-3/4" rod and 12,000 kg pull down capacity.

- Structure: It shall be driven by a truck engine PTO and equipped with the following components;- Mast, drill head, pull-down, draw works, sand reel, mud pump, injection pump, power tong, 4 pcs. of levelling jacks, lightings for night operation and control box. The rig shall be applied to a percussion drilling by DTH hammer.

- Truck:
  GVW : Not less than 22,000 kg
  Engine : Water-cooled diesel, not less than 300 PS

Drive system : 6 x 4
Steering : Left hand
Accessories : Spare tire, hydraulic jack and standard hand tool kit
(To accommodate driving at an altitude of 2,500 meters)

ii) Drilling tools and accessories 2 Sets

a) Drilling tools 2 sets

	(Q'ty for 1 set)
- Drill pipe (120.7mm)	82 pcs
- Drill collar (9-1/2", 7")	6 pcs
- Stabilizer (17-1/2", 14-3/4", 12-1/4", 9-5/8")	8 pcs
- Wing bit (21", 17-1/2", 14-3/4", 12-1/2", 9-5/8")	15 pcs
- Three cone bit, tooth type (17-1/2", 14-3/4", 12-1/4", 9-5/8")	30 pcs
- Three cone bit, tip insert type (14-3/4", 12-1/4", 9-5/8")	14 pcs
- Sub (3-1/2")	9 pcs
- Bit sub (7-5/8", 4-1/2", 3-1/2")	15 pcs
- DTH hammer (12-1/4", 9-5/8")	4 sets
- Button bit (12-1/4", 9-5/8")	14 pcs
- Shock absorber (4-1/2")	3 pcs
- Bit grinder with grinding wheels	1 set
- Disassembling tools for DTH hammer (for 12-1/4" and 9-5/8")	1 set

b) Casing tools 2 sets

- Surface casing (20", 16", 14", 10")	8 pcs
- Work casing (14", 10")	66 pcs
- Casing swivel (3-1/2")	3 pcs
- Casing head (14", 10")	6 pcs
- Casing metal shoe (14", 10")	15 pcs
- Casing band (20", 16", 14", 10")	4 sets
- Casing band w/jaw (13", 10", 8", 6")	4 sets

- Casing swivel (13", 10", 8", 6") 4 sets

c) Fishing tools 2 sets

- Taps (120.7mm) 2 pcs
- Rod band (120.7mm) 1 pce
- Hydraulic jack (30 ton) 1 set
- Drive hammer ass'y (130 kg) 1 set
- Fishing magnet (3-1/2") 1 pce

d) Miscellaneous equipment and tools 2 sets

- Miscellaneous equipment and tools for operation and maintenance
(Pipe wrench, chain tong, hammer etc.) 1 set

iii) High pressure air compressor, truck mounted 2 Sets

- Compressor:
Type : Rotary screw type
Rated operating pressure : Not less than 17.5 kg/cm^2
Free air delivery : 21-22 m^3/min
Rated rpm : Approx. 2,200 rpm

- Engine : Water-cooled diesel, not less than 340 PS

- Truck :
GVW : Not less than 15,000 kg
Engine : Water-cooled diesel, not less than 170 PS
Drive system : 4 x 4
Steering : Left hand
Accessories : Spare tire, hydraulic jack, standard hand tool kit

2) Tools and accessories for existing rig 1 SET

- Tools for 2 rotary TBM171 drilling rigs 1 set
- Spare parts for 2 rotary TBM171 drilling rigs 1 set

	- Tools for 4 percussion SM22T drilling rigs	1 set
	- Spare parts for 4 percussion SM22T drilling rigs	1 set
3)	Diesel engine welder	6 SETS
	Welding generator : Inductor, brushless type Rated output not less than DC 18kw Current range 60 - 500A AC supply : Rated output not less than 3.2kw Engine : Water-cooled diesel, not less than 48 PS Accessories : Welding earth cable 30m, welding mask, apron, gloves, leg cover, arm cover, hammer, wire brush each in 1 set	
(2)	Casings and pipes	
1)	Steel pipe for casing	1 SET
	- Casing pipe 6-5/8", L=6m	1,200 pcs
	- Casing pipe 8-5/8", L=6m	300 pcs
	- Casing pipe 10-3/4", L=6m	100 pcs
	- Casing pipe 13-3/8", L=6m	100 pcs
2)	Steel pipe for water distribution	
	- Heavy duty 2" G.I. pipe, L=6m	100 pcs
(3)	Vehicles	
1)	Station wagon	2 SETS
	GVW : Not less than 2,800 kg Engine : Water-cooled diesel, not less than 115 PS Drive system : 4 x 4 Steering : Left hand Dimensions : (L)4.8m x (W)1.8m x (H)1.8m Seating capacity : 5 - 9 persons Accessories : Spare tire and standard hand tool kit	

2) Pick up, single cab — 6 SETS

GVW : Not less than 2,700 kg
Engine : Water-cooled diesel, not less than 75 PS
Drive system : 4 x 4
Steering : Left hand
Dimensions : (L)4.8m x (W)1.7m x (H)1.7m
Seating capacity : 3 persons
Accessories : Spare tire and standard hand tool kit

3) Cargo truck — 1 SET

GVW : Not less than 25,000 kg
Engine : Water-cooled diesel, not less than 250 PS
Drive system : 6 x 4
Steering : Left hand
Body dimensions : (L)7.6m x (W)2.3m x (H)0.45m
Loading capacity : Not less than 12 ton
Accessories : Spare tire, hydraulic jack and standard hand tool kit

4) Cargo truck with crane — 1 SET

- Truck:
  GVW : Not less than 25,000 kg
  Engine : Water-cooled diesel, not less than 250 PS
  Drive system : 6 x 4
  Steering : Left hand
  Body dimensions : (L)6.4m x (W)2.3m x (H)0.45m
  Loading capacity : Not less than 14 ton
  Accessories : Spare tire, hydraulic jack and standard hand tool kit
- Crane:
  3 ton capacity, 3 stage boom, 360° slewing range

5) Dump truck — 1 SET

GVW : Not less than 22,000 kg

Engine : Water-cooled diesel, not less than 250 PS
Drive system : 6 x 4
Steering : Left hand
Body dimensions : (L)4.9m x (W)2.3m x (H)0.7m
Loading capacity : Not less than 8 m^3
Accessories : Spare tire, hydraulic jack and standard hand tool kit

(4) Survey instruments

1) Portable electric water level meter 5 SETS

Type : Dry cell type
Measuring depth : 200 m

2) Electric conductivity meter 2 SETS

Type : Dry cell, drip proof construction against water splash
Display method : LCD digital display
Measuring range : 0 - 20 mS/cm (1cm-1)

3) Table stereoscope 1 SET

Type : Mirror stereoscope
Binocular eyepiece : 3X
Multi view attachment : Swing arm movement type

4) Resistivity meter 1 SET

Type : AC potentiometer
Measuring range : 0-0.3/3/30/300 ohm
Tolerance : ±3% at 10 - 30
±3% below 10
Measuring voltage range : 150/300/600 V
Measuring frequency : 10 - 40 Hz
Power supply : Dry cell

(5) Pumps and generators

1) Deep well water pump 7 SETS

Submersible water pump with motor for pumping ground water from deep wells, equipped with cable, pipe and control panel
Water level : 100m – 200m
Capacity : 120 lit/min – 1,400 lit/min

2) Diesel generator 7 SETS

Diesel engine driven generator to be used for driving submersible water pump
Capacity : 27 KVA – 100 KVA

3) Dewatering pump 4 SETS

– 10 m^3/h – 15 m	2 sets
– 25 m^3/h – 10 m	2 sets

(6) Others

1) Radio transceiver 10 SETS

Type : HF/SSB
Frequency coverage : 1.6 – 18 MHz
Number of channels : 6 simplex or 3 semi-duplex
Equipped with AC power supply and wide band antenna

2) Workshop equipment and tools 1 SET

i) Workshop equipment

– Air blow gun	1 pce
– Tire inflator	1 set
– Battery charger	1 pce
– Nozzle tester	1 pce
– Hydraulic garage jack, 10T, 15T	1 set

- Arc welder	1 set
- Portable crane, 2T	1 set
- Oiler	1 pce
- Spray gun set	1 set
- Battery tester	1 set
- Battery hydrometer set	1 set
- Blow torch	1 pce
- Drum pump	1 pce
- Bench vise	1 set
- Pipe vise	1 set
- Compression tester	1 pce
- Piston ring compressor	1 pce
- Piston ring tool	1 pce
- Valve lifter & compressor	1 set
- Circuit tester	1 pce
- Tap & die set	1 set
- Torque wrench set	1 set
- Depth gauge set	1 set
- Vernier caliper set	1 set
- SAE screw pitch gauge	1 pce
- Screw pitch gauge	1 set
- Outside micrometer caliper set	1 set
- Inside micrometer caliper set	1 set
- Automotive puller set	1 set
- Body & fender tools set	1 set
- Flaring tools	1 pce
- Pipe wrench (36", 48")	36 pcs
- Chain tong (2"-6", 6"-12")	20 pcs

ii) Hose assemble equipment 1 SET

- Hose cutter:
  Dimensions : (L)0.5m x (W)0.9m x (H)0.7m
  Equipped with turn table, measuring table & cutting oil
- Cripping machine:
  Dimensions : (L)1.0m x (W)0.6m x (H)1.0m
  Capacity : Hose size ID 1/4" upto 2"

Power source : 3 phase, 220 V
Equipped with electrical pump, table, limit tool, cripping piston tool

–	Accessories : Hose cutter	1 set
	Standard die	8 sets
	Hand tool	1 set

3) Welding electrode 1 SET

– Mild steel 3 – 5 mm	300 kg
– Hard facing 5 mm	1,000 kg

4) Mild steel sheets 300 PCS

Size : 2m x 1m x 4mm

5) Repairing parts and emery discs for slotting machine 1 SET

i) Parts for Repair 1 set
Consisting of cutting machine, hydraulic equipment and slot measuring equipment, 1 set each.

ii) Emery discs for slotting machine

– 2.0mm thickness	2,000 pcs
– 2.5mm thickness	8,000 pcs

6) Spare parts 1 LOT

For 2 year's normal operation.

– For drilling rig	1 lot
– For high pressure air compressor	1 lot
– For engine welder	1 lot
– For station wagon	1 lot
– For pick up, single cab	1 lot
– For cargo truck	1 lot
– For cargo truck with crane	1 lot

– For dump truck	1 lot
– For deep well water pump	1 lot
– For diesel generator	1 lot
– For dewatering pump	1 lot
– For workshop equipment	1 lot
– For repair components of slotting machine	1 lot
– For existing vehicles	1 lot

4.4 Implementation Plan

4.4.1 Project Implementation Structure

(1) Water Well Drilling Agency (WWDA)

The implementation agency of the Project is the Water Well Drilling Agency (WWDA) of the Government of Ethiopia. After the Government of Ethiopia and the Government of Japan sign the Exchange of Notes, WWDA will secure the personnel necessary for the Project. It also procures the equipment and materials, which are not provided by the Japanese side. It will conduct the construction of deep wells at its own expense by using the equipment and materials provided under the Project.

With the cooperation of other Ethiopian agencies concerned, WWDA will sign the Exchange of Notes together with the Government of Japan, and will smoothly carry out various procedures, such as banking arrangements, tax exemption and custom clearance for imported equipment and materials for the Project, site procurement, tax exemption and customs clearance for Japanese engineers required for Project implementation.

(2) Consultant

Immediately after the Exchange of Notes for the Project signed by the Japanese and Ethiopian governments, the consultant will make a contract with WWDA to proceed with the following services:

(i) Assisting with the equipment and material procurement, in the

preparation of the detailed design and tender documents.

(ii) Assisting with the tendering and evaluation of tender documents

(iii) Witnessing the contract agreement and assisting the Ethiopian Government and the contractor in its preparation.

(iv) Supervision of procurement and transporting equipment and materials, and of the Japanese engineers dispatched for Project implementation and technique transfer.

(v) Other related services

(3) Contractor

The contractor shall procure the equipment and materials specified in the contract and transport them to the WWDA's Workshop located at Addis Abeba. The contractor shall dispatch engineers to Ethiopia for the contract period. The contract will result in the transfer of techniques related to the installation of drilling rigs and other equipment.

4.4.2 Boundary of Responsibility of the Project

The project work is to provide necessary equipment including 2 truck mounted type drilling rigs.
Since the project is very much important for Ethiopia, it may be possible to implement within the limitations of the Japanese Grant Aid Program. The responsibilities of the Ethiopian and Japanese government in relation to the Project are as follows:

(1) Items to be covered by Grant Aid from the Japanese Government

i) Procurement, transportation and delivery of major equipment and materials described in Section 4.3.2 "Specifications of Main Equipment".

ii) Dispatch drilling engineers and transfer techniques to the Ethiopian team.

iii) Design management services related to the above Project items including the dispatch of design engineers.

(2) Items to be borne by the Government of Ethiopia

i) Payment of bank commissions

ii) Ensuring that the customs clearance and tax exemption for equipment and materials related to the Project to be taken care of at the port of entry.

iii) Securing land and passage necessary for commissioning of equipment

iv) Securing the smooth entry and reentry, ensuring customs clearance and tax exemptions, and providing for the security of Japanese engineers working on the Project.

v) At its own expense, secure sufficient number of counterpart for implementing the Project

vi) Management and maintenance of granted equipment

vii) Bearing costs that will not be provided by grant aid from the Government of Japan.

4.4.3 Engineers' Dispatch Plan

Japanese engineers shall be dispatched to assist the Ethiopian personnel in the implementation of the Project within the limits of the Japanese grant aid cooperation system.

The dispatched Japanese engineers will provide technical advice to the Ethiopian personnel. After arriving at Ethiopia, they will carry out the transfer of techniques, particularly in the following fields:

i) Installation of equipment

ii) Making a trial run of equipment

iii) Operation of equipment

iv) Technical guidance for repair, maintenance, and management of drilling rigs and supporting equipment.

The Japanese side shall dispatch 2 drilling engineers for a period of 4 months (2 months x 2 times) to achieve the above objective.

4.4.4 Project Implementation Schedule

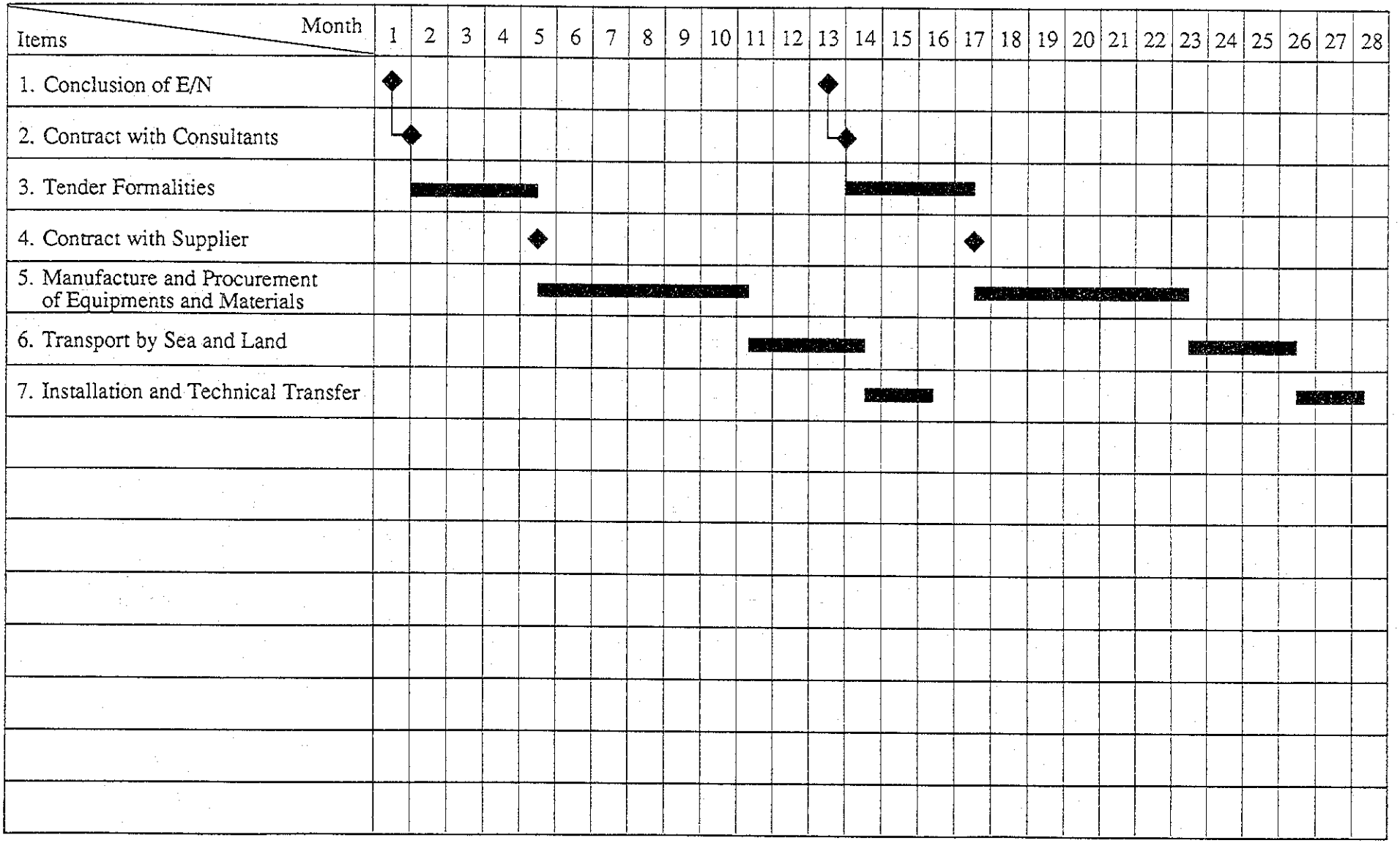
The project will be divided into two phases, Phase I and Phase II. Both of these phases will start after the governments of Japan and Ethiopia sign the Exchange of Notes (E/N) of the project's grant aid cooperation agreement. After signing the Exchange of Notes, Water Well Drilling Agency (WWDA) and a Japanese Consultant company will make a contract concerning the project's design and management services. After approval of the contract agreement by the Japanese Government, the Consultant will prepare the detailed design and tender documents. After approval of the detailed design and tender documents by the Japanese and Ethiopian governments, the Consultant will conduct the tendering of the Project of Japanese contractors for the Government of Ethiopia, and will evaluate the tender documents.

The Consultant will witness the contract agreement between the prospective Japanese contractor and the Government of Ethiopia. This contract will also come into effect after approval by the Japanese Government.

After the signing the Exchange of Notes, it will take approximately four months to reach contract agreement.

After the contract agreement, the Japanese contractor will procure equipment and materials necessary for the Project. It may take about six (6) months to manufacture, procure and pack the new drilling equipment and materials. It will take approximately three (3) months for the land and sea transportation of the equipment and materials. Two more months will be necessary for installation. The implementation schedule is shown in Table 4.4.1.

Table 4.4.1 Project Implementation Schedule



4.4.5 Equipment Procurement

The equipment and material procurement, within the rules of the Japanese grant aid system, is limited to either Japanese or Ethiopian products. The equipment and materials that are unobtainable in Ethiopia must therefore be procured in Japan and exported to Ethiopia.

Upon the expiration of the Exchange of Notes, additional materials required to complete the Project are to be procured by the Ethiopian side at its own expense.

4.5 Maintenance and Management Plan

4.5.1 Maintenance and Management Plan

WWDA will be responsible for the maintenance and management of the drilling rigs and equipment.

Equipment, tools, and spare parts which will be provided under the Project for workshop use shall be maintained at the workshop of WWDA. The items must be properly managed. The spare parts are limited and any replacement of the spare parts must be borne by WWDA after two years.

4.5.2 Maintenance and Management of Drilling Rigs and Supporting Equipment

The drilling rigs and supporting equipment to be provided under the Project will be maintained and managed at the WWDA's Workshop at Addis Abeba.

At present, WWDA's workshop maintains and manages the drilling rigs and supporting equipment purchased by Japanese loan fund in 1974.

Theses rigs and equipment are well maintained and managed because the workshop has well trained experts.

Equipment to be provided by the project will be maintained and managed in the same manner.

Fig. 4.5.1 shows an organization chart of WWDA's Equipment & Supplies Department which consists of electric workshop, mechanical workshop and machine workshop.

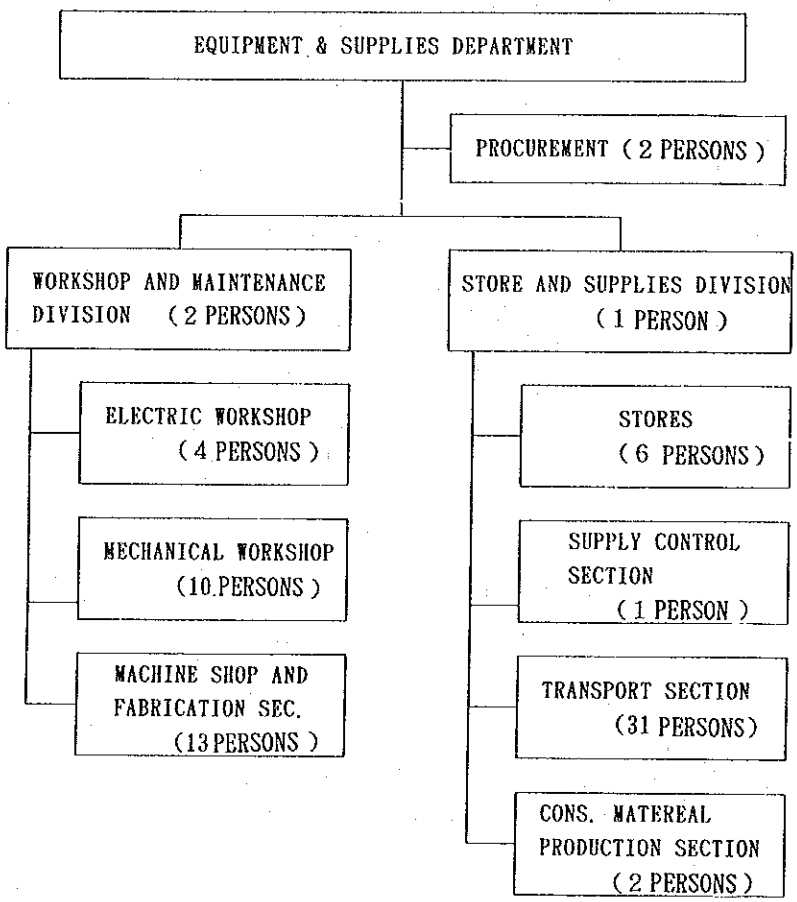


Fig. 4.5.1 Organization Chart of WWDA's Equipment and Supplies Department

While providing the drilling rigs and supporting equipment, it is considered that WWDA's workshop has enough space for a stockyard, stores, and garages. However the number of staffs in the workshop may not be sufficient for the maintenance and management of the equipment. An increase in the number of staffs becomes necessary for the proper maintenance and management of the equipment. The additional number of staff required is shown below :

i) Store and Supplies Division

(i)	Assistant storekeeper	–	1 Person
(ii)	Technical operator	–	2 Persons

ii) Workshop and Maintenance Division

(i)	Mechanic	–	1 Person
(ii)	Electrician	–	1 Person
(iii)	Technical operator	–	3 Persons

4.5.3 Maintenance and Management Cost

(1) Basis of Cost Estimate

Maintenance and management costs are the expenditures necessary to cover the periodic inspection and repair works of the 2 drilling rigs and the supporting equipment. The cost was estimated for maintaining the 2 drilling rigs and supporting equipment for a 6 year period. The cost estimate was made as follows :

i) Scope of work

(i) Conservation and management of parts and tools
(ii) Periodic inspection of equipment
(iii) Repairing equipment in the workshop and drilling sites

ii) Formation of staff and equipment

(i) Store and Supplies Division

- Assistant storekeeper	-	1 person
- Technical operator	-	2 persons

(ii) Workshop and Maintenance Division

- Mechanic	-	1 person
- Electrician	-	1 person
- Technical operator	-	3 persons

(iii) Vehicles for workshop and maintenance division - 3 vehicles

iii) Cost of parts and repair equipment

The cost for a two year period is included in equipment to be provided by the project.

iv) Fuel (per one car)

(i) repair work : 500 km/time x 3 times/month = 1,500 km/month
(ii) daily use : 50 km/time x 30 days/month = 1,500 km/month

Total 3,000 km/month

v) Lubricant oil for repairing equipment

Actual cost of workshop : 1,680 EB / year

(2) Management and Operation Cost Estimate

i) Personnel costs:

(i) Assistant storekeeper (1) :
820 EB x 12 months = 9,840 EB

(ii) Technical operator of the store (2) :
480 EB x 2 x 12 months = 11,520 EB

(iii) Mechanic (1) :
640 EB x 12 months = 7,680 EB

(iv) Electrician (1) :
640 EB x 12 months = 7,680 EB

(v) Technical operator of the workshop (3) :
480 EB x 3 x 12 months = 17,280 EB

Subtotal (8 persons) = 54,000 EB

EB 54,000 x 6 years = 324,000 EB

ii) Costs of parts and repair equipment
180,000 EB/year x 4 years = 720,000 EB

iii) Fuel

- Fuel

3,000 km/month x 3 vehicles x 12 months = 108,000 km / year
108,000 km / 10 l/km x 1.2 EB/l = 12,960 EB / year
12,960 EB / year x 6 years = 77,760 EB / 6 years

- Oil

108,000 ÷ 3000 km/time x 10 l/time x 4 EB = 1,440 EB / year
1,440 EB x 6 years = 8,640 EB / 6 years

iv) Workshop maintenance cost
1,680 EB x 6 years = 10,080 EB / 6 years

Total cost = i) + ii) + iii) + iv) = 1,140,480 EB / 6 years

Total management and operation costs for 6 years will be 1,140,480 EB. Therefore, the average maintenance cost for 1 year will be 190,080 EB.

4.5.4 Problems and Recommendations Related to Management and Maintenance

Equipment purchased by Japanese Loan Project in 1974 are well managed and maintained by WWDA. WWDA has enough facilities, organization and staff for the equipment that will be provided under the project.

If the drilling equipment to be provided under the project are properly maintained and repaired and if there is adequate supply of consumable parts, it should be possible to utilize the equipment even after the Project completion. Thus, WWDA should establish an equipment and material management system which will be solely operated by WWDA. For the above reasons, the following recommendations are given by the Study Team;

(1) Inspection and maintenance should be carried out periodically for effective use of the equipment. A good coordinating system should be established with the users for quick response.

(2) The drilling rigs at the drilling site should have routine maintenance. Whenever there is problem at the site, the head office should be contacted through wireless phone and a mobile workshop should be kept ready for such purpose.

(3) The materials and spare parts should be classified properly and stored in the warehouse. Their use and consumption rate must be recorded for two years which will be used for reordering purpose.

Chapter 5 Project Evaluation and Conclusion

CHAPTER 5 PROJECT EVALUATION AND CONCLUSION

5.1 Project Evaluation

The WWDA's plan of drilling 270 wells in various parts of the country was established based on the Ethiopian Government's policy to increase the development of water resources. The objective of this plan is to supply reliable and safe drinking water and to improve and stabilize the social conditions of the rural people. This plan is also important to reduce the drought situation and minimize the regional imbalances.

At present, most of the equipment and machinery used by WWDA were procured in 1974 through the Japan's loan project. WWDA has used this machinery nearly for the past 20 years, carrying out the necessary repairs. But the drilling rigs and associated equipment procured by the loan project are already depreciated and need to be renewed. At this difficult situation, it is necessary to strengthen the WWDA's drilling capacity.

Under this Project, 2 drilling rigs and supporting equipment are to be newly procured for strengthening the WWDA's drilling capacity.

The following benefits will be achieved through the implementation of the Project :

(1) Safe and reliable drinking water will be newly supplied to 293,000 persons every year and the supply of unsanitary and unstable drinking water will be reduced. These water resources will not become exhausted during any time during the year. Compared to the rivers and springs which can not be used in the dry season, deep wells planned by this Project will contribute greatly for providing stable water supply throughout the year.

(2) This Project will be carried out in areas which are mostly affected by drought and hence the Project will have a significant effect on these areas. More over, many of the water resources in these areas are exhausted during the dry season and many families bring drinking water by transporting from distant locations. This Project will reduce this burden on these families.

(3) The Livelihood of the people will be stabilized and social conditions will be

improved by safe drinking water supply. Moreover because of the reduction in the burden in transporting water from remote areas, the public welfare will be improved.

If the equipment provided under the Project is properly maintained and managed and if the consumable tools, spare parts and materials will be available continuously after completion of the drilling plan, WWDA can go forward with the groundwater development in the country.

Considering the number of beneficiaries in the Project area, the equipment to be supplied in the Project will contribute greatly for the improvement in the area as summarized in Table 5.1.1.

For humanitarian, social and economic reasons, the implementation of the Project by grant aid cooperation from the Government of Japan will be highly worthwhile. Project implementation will contribute significantly in strengthening Japanese and Ethiopian relationships.

In view of the points outlined above, it is deemed to be appropriate and extremely worthwhile to carry out the Project with grant aid cooperation from the Government of Japan.

5.2 Recommendation

It is recommended that the persons concerned with this Project should execute the following items as well as the items agreed upon in the Minutes of Discussions prepared during the Basic Design Study.

(1) Scope of the Project

The Project will be completed when the equipment arrives in Ethiopia. The Ethiopian Government must come forth with a budget and personnel which will be necessary to complete WWDA's drilling plan.

(2) Equipment and Materials

The equipment and materials to be provided under the Project shall be used exclusively for the WWDA's drilling plan.

Among the 270 wells of WWDA's drilling plan, some drilling sites for non-governmental organizations such as factories and hotels are also included. The well construction materials such as casing pipes and submergible pumps to be provided under the Project shall not be used for these non-governmental organizations.

(3) Spare Parts

It was determined that a two year supply of spare parts would be sufficient for the Project use. During the two year period, the Ethiopian side must take necessary steps to establish the method for obtaining additional spare parts which will be necessary for future use after 2 years.

By proper use of the equipment and the transferred techniques WWDA's drilling plan can be carried out efficiently.

(4) Technical Transfer

Considering Ethiopia's short experience with a large-sized tophead drilling rig, which will be supplied with various kind of equipment and materials, it is necessary to transfer the operation and maintenance techniques for upgrading the technical level of the Ethiopian engineers. This may be carried out by dispatching 2 Japanese drilling engineers for a period of 4 months (2 months x 2 times).

Table 5.1.1 Project Benefits

Present Situation and Problems	Proposed Countermeasures	Project Benefits
1. At present only about 26% of Ethiopia's 51 million population has the services of clean, adequate and potable water supply. Due to its rugged topography, more emphasis is given on developing ground water.	Additional Drilling equipment necessary to carry out WWDA's plan of drilling 270 wells will be supplied.	It will contribute for the Ethiopian govenment's policy to increase the development of ground water resources for the supply of reliable and safe drinking water. After completion of drilling 270 wells, drinking water will be newly supplied to 1,580,000 persons.
2. At present most of the drilling equipment used by WWDA are already depreciated. In order to implement WWDA's drilling plan, it is necessary to strengthen WWDA's drilling capability by supplying the needed drilling equipment.	Two new drilling rigs, necessary spare parts, supporting and repair equipment will be supplied to strengthen WWDA's drilling capability.	If new drilling rigs are added, and the existing drilling rigs are repaired, WWDA's drilling capability will increase. The drilling capability will be doubled, and approximately 50 wells can be drilled in one year instead of the present drilling capability of 20–30 wells per year. Drilling efficiency and safety will be increased by the supply of drilling supporting equipment such as vehicles, radio transceiver and survey instruments.
3. Because of the lack of funds, the well construction materials have been depleted and this is having a negative effect on the progress of the drilling activities.	Casing pipes and other necessary materials will be supplied.	After completion of the new wells, the livelihood of the people will be stabilized and the social conditions will be improved by the supply of reliable and safe drinking water.

APPENDIX

MEMBER LIST OF THE STUDY TEAM

Mr. Hisatoshi OKUBO	Team Leader First Basic Design Study Division Grant Aid Study and Design Department Japan International Cooperation Agency
Mr. Takao SAKAMOTO	Chief Engineer/ Ground Water Development Planning Pacific Consultants International
Mr. Kazuo MOROISHI	Equipment and Material Planning Pacific Consultants International
Mr. Ichiro MAKUTA	Cost Estimate (Home Office Work) Pacific Consultants International

SCHEDULE OF FIELD SURVEY

No.	Date	Activities
1	Sep. 26 Sat.	LV. Tokyo AR. London
2	27 Sun.	LV. London
3	28 Mon.	AR. Addis Abeba 08:00 by ET771
		Courtesy Call to Embassy of Japan and JICA office
4	29 Tue.	Courtesy Call to WRC and WWDA
5	30 Wed.	Courtesy Call to MEEC and Meeting with WWDA
6	Oct. 1 Tue.	Field Survey (WWDA Workshop and Drilling sites)
7	2 Fri.	Meeting with WWDA
8	3 Sat.	Ditto (Discussion on Minutes of Meeting)
9	4 Sun.	Inner Meeting
10	5 Mon.	Signing of Minutes of Meeting
11	6 Tue.	Report to Embassy of Japan and JICA Office
		(Mr.Okubo leaves Addis Abeba by LH591)
12	7 Wed.	Meeting with WWDA
13	8 Thu.	Meeting with WRC and AAWSSA
14	9 Fri.	Meeting with WSSA and EWWCA
15	10 Sat.	Meeting with WWDA
16	11 Sun.	Move to Tigray and Field Survey (Mekele Drilling site)
17	12 Mon.	Field Survey (Drilling site and Water supply project)
18	13 Tue.	Field Survey (Drilling site and Water supply project)
19	14 Wed.	Move to Addis Abeba
20	15 Thu.	Meeting with WWDA
21	16 Fri.	Meeting with WWDA
22	17 Sat.	Meeting with WWDA
23	18 Sun.	Inner Meeting
24	19 Mon.	Meeting with WWDA (Signing of Technical Note)
25	20 Tue.	Report to Embassy of Japan and JICA office
		LV. Addis Abeba 22:40 by LH591
26	21 Wed.	AR. Frankfurt
27	22 Thu.	LV. Frankfurt
28	23 Fri.	AR. Tokyo

LIST OF ORGANIZATIONS AND PERSONS CONTACTED

MINISTRY FOR EXTERNAL ECONOMIC COOPERATION (MEEC)

Dr. Abdulmojid Hussien	Minister
Ato Israel K/Mariam	Vice Minister
Ato Geremew Getahun	Head of Americas and Asia Dept.
Ato Yeshitila Amare	Senior Officer
W/t Abebawerk Abebe	Junior Officer

Water Resource Commission (WRC)

Ato Tilahum G/Tsadik	Commissioner
Ato Abera Aguma	Vice Commissioner

Water Well Drilling Agency (WWDA)

Ato Berhanu Tamrat	Manager
Dr. Tesfai Gebre Hanna	Head of Planning Surveying & Consultancy Service Dept.
Ato Arefaine Gebre Hawariat	Head of Technical Operations Dept.
Ato Asfaw Edessa	Acting Head, Plan and Market Research Services Dept.
Dr. Gezahegn Belay	Head of Administration Dept.
Ato Negussie Sime	Head of General Service Division
Ato Fikru Tilahun	Acting Head, Equipment & Supplies Division
Ato Germa Gebre Selassie	Drilling Supervisor
Ato Tsegaye Nemomssa	Workshop Superintendent
Ato Abebe G/Hiwot	Hydrogeologist
Mr. Masahiro Tamura	Member of JOCV
Mr. Katsumi Maeda	Member of JOCV

Water Supply & Sewerage Authority (WSSA)

Ato Yohannes G/Medhin	General Manager
Ato Menhasebo Gebre Hiwot	Tigray Regional Manager

Ethiopian Water Works Construction Authority (EWWCA)

Ato Alebachew Beyene	General Manager
Ato Feleke Dejene	Head of Specification & Analysis Unit

Addis Ababa Water Supply & Sewerage Authority (AAWSSA)

Ato Melaku Mulgeta	Head of Water Supply Dept.

Embassy of Japan

Mr. Katsuhiro Imaya	Counsellor
Mr. Katsumi Kobayashi	First Secretary
Mr. Tomio Ota	Second Secretary

JICA Ethiopia Office

Mr.Takeo Sakata	Resident Representative
Mr. Kimiaki Jin	Assistant Resident Representant
Mr. Shinichiro Hisada	JOCV Coordinator

MINUTES OF DISCUSSIONS
ON THE BASIC DESIGN STUDY
ON GROUND WATER DEVELOPMENT PROJECT
IN ETHIOPIA

In response to the request from the Transitional Government of Ethiopia, the Government of Japan decided to conduct a Basic Design Study on Ground Water Development Project (hereinafter referred to as "the Project"), and entrusted the study to the Japan International Cooperation Agency (JICA).

The JICA sent to Ethiopia a study team headed by Mr. Hisatoshi Okubo, Staff, First Basic Design Study Division, Grant Aid Study and Design Department, JICA, from 28th September to 20th October, 1992.

The Team held a series of discussions with the authorities concerned of the Transitinal Government of Ethiopia and conducted a field survey. In the course of discussions and the field survey, both parties have confirmed the main items described on the attached sheets. The Team will proceed to further work and prepare the Basic Design Study Report.

Addis Ababa 5th October, 1992

Mr. Hisatoshi Okubo
Leader
Basic Design Study Team, JICA

Ato Geremew Getahun
Head, Dept. of Americas and Asia
Min. for External Economic Cooperation
Transitional Government of Ethiopia

Ato Berhanu Tamrat
General Manager
Water Well Drilling Agency (WWDA)
Transitional Government of Ethiopia

ATTACHMENT

1. Objective of the Project

The objective of the Project is to provide necessary equipment and materials for ground water well construction schemes, thus contributing to the improvement of safe water supply in the country.

2. Project Areas

The project aims to establish 270 wells in various areas in the country, which are shown in a priority order in Annex I. However, as the executing agency works in principle on the request basis, the list serves as a tentative one and a change may happen according to future requests.

3. Responsible Agency and Executing Agency

(1) The Ministry for External Economic Cooperation (MEEC) will serve as the focal point for facilitating the Project implementation, on condition that the Japan's Grant Aid is extended to the Project.

(2) The Water Well Drilling Agency (WWDA) is responsible for procurement, utilization and maintenance of the equipment procured under the Grant.

4. Items requested by the Transitional Government of Ethiopia

The items requested by the Ethiopian side are listed in Annex II. However, the final component of the items, both types and quantity, will be decided after a further study in Japan, based upon in principle the criteria described in Annex III. The conditons on the use of the items are also listed in Annex III.

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5. Japan's Grant Aid Programme System

(1) The Ethiopian side has understood Japan's Grant Aid system explained by the Team.

(2) The Ethiopian side will take necessary measures described in Annex IV for smooth implementation of the Project, on condition that the Grant Aid by the Government of Japan is extended to the Project.

6. Technical Cooperation

The Ethiopian side has expressed the need for Japan's technical cooperation in connection with the Project; namely, dispatch of Japanese experts and Japan Overseas Cooperation Volunteers, and technical training of counterpart personnel in Japan. The list of requests for technical cooperation is shown in Annex V. The Ethiopian side will make separate official requests through diplomatic channels.

7. Schedule of the Study

Based upon the Minutes of Discussions and technical examination of the study results, JICA will complete the final report and will send it to the Transitional Government of Ethiopia by the end of February, 1993.

Annex I

WWDA WATER WELL DRILLING PROGRAMME

ITEM No.	REGION	SITE NAME	No.OF WELLS	PRIORITY	OWNER
1	Gondar	Gondar	4	A	WSSA
2	Wollo	Dessie	4	A	WSSA
3	Tigray	Mekele	5	A	WSSA
4	Shoa	Nazreth	1	A	WSSA
5	Shoa	Debre Brhan	5	A	WSSA
6	Kefa	Mizan Teferi	3	A	WSSA
7	Kefa	Agaro	1	A	WSSA
8	Shoa	Metahara	3	A	WSSA
9	Shoa	Meki	2	A	WSSA
10	Hararge	Asebe Teferi	6	A	WSSA
11	Shoa	Arsi Negelle	3	A	WSSA
12	Gojam	Dangela	3	A	WSSA
13	Tigray	Axsum	2	A	WSSA
14	Wollo	Kobo	2	A	WSSA
15	Tigray	Enda Selassie	3	A	WSSA
16	Tigray	Maichew	2	A	WSSA
17	Addis Ababa	Akaki	3	A	AWSSA
18	Addis Ababa	Addis Ababa	30	A	AWSSA
19	Shoa	Nazreth	1	A	Nazret Cattle Farm
20	Addis Ababa	Addis Ababa	1	A	Handicraft Development Agency
21	Addis Ababa	Addis Ababa	2	A	Gadera Hotel
22	Addis Ababa	Addis Ababa	2	A	Addis Tyre Factory
23	Tigray	Adigrat	1	A	Petololeum Corporation
24	Gondar	Gondar	1	A	Civil Aviation
Sub Total			90		

ITEM No	REGION	SITE NAME	No. OF WELLS	PRIORITY	OWNER
25	Tigray	Axsum	3	B	WSSA
26	Tigray	Adwa	3	B	WSSA
27	Tigray	Zalambessa	2	B	WSSA
28	Tigray	Wukro	1	B	WSSA
29	Tigray	Maichew	1	B	WSSA
30	Tigray	Mehoni	2	B	WSSA
31	Tigray	Alamata	2	B	WSSA
32	Tigray	Hagere Selam	2	B	WSSA
33	Tigray	Chercher	2	B	WSSA
34	Tigray	Dela	1	B	WSSA
35	Tigray	Samre	1	B	WSSA
36	Tigray	Gijet	1	B	WSSA
37	Tigray	Shiket	1	B	WSSA
38	Tigray	Debub	1	B	WSSA
39	Tigray	Mai Tsebri	1	B	WSSA
40	Tigray	Hewane	1	B	WSSA
41	Tigray	Agula	1	B	WSSA
42	Tigray	Senkata	2	B	WSSA
43	Tigray	Bizet	1	B	WSSA
44	Tigray	Seleklaka	1	B	WSSA
45	Tigray	Enda Aba Guna	1	B	WSSA
46	Tigray	Adi Dairo	1	B	WSSA
47	Tigray	Adi Hagerai	1	B	WSSA
48	Tigray	Shiraro	1	B	WSSA
49	Tigray	Work Amba	1	B	WSSA
50	Tigray	Abergele	1	B	WSSA
51	Tigray	Wukro Mariam	3	B	WSSA
52	Tigray	Fedir	1	B	WSSA
53	Tigray	Adi Abur	1	B	WSSA
54	Tigray	Amba Sekko	1	B	WSSA

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ITEM No	REGION	SITE NAME	No. OF WELLS	PRIORITY	OWNER
55	Tigray	Adi Gebru	1	B	WSSA
56	Tigray	Mai Kintal	1	B	WSSA
57	Tigray	Zana	1	B	WSSA
58	Tigray	Rama	1	B	WSSA
59	Ogaden	Shilabo	1	B	Ogaden Islamic Union
60	Ogaden	Deghabur	1	B	" "
61	Ogaden	Warder	1	B	" "
62	Ogaden	Kelafo	1	B	" "
63	Ogaden	Kebridehar	1	B	" "
64	Ogaden	Gode	1	B	" "
65	Ogaden	Dolo	1	B	" "
66	Ogaden	Merkan	1	B	WSSA
67	Ogaden	Dubub	1	B	WSSA
68	Ogaden	Kaya Kobe	1	B	WSSA
69	Ogaden	Kelewan	1	B	WSSA
70	Harargie	Assebot	1	B	WSSA
71	Harargie	Adeb Tulle	1	B	WSSA
72	Wollo	Mendefera	1	B	WSSA
73	Wollo	Hara	1	B	WSSA
74	Wollo	Mekan Selas	1	B	WSSA
75	Wollo	Wereilu	1	B	WSSA
76	Wollo	Tenta	1	B	WSSA
77	Wollo	Wegel Tena	1	B	WSSA
78	Wollo	Golosha	1	B	WSSA
79	Wollo	Dahna	1	B	WSSA
80	Wollo	Agibar	1	B	WSSA
81	Wollo	Kemisie	1	B	WSSA
82	Wollo	Tebelat	1	B	WSSA
83	Wollo	Wuchale	1	B	WSSA
84	Wollo	Bati	1	B	WSSA
85	Wollo	Dubti	1	B	WSSA
86	Gondar	Yifag	1	B	WSSA
87	Gondar	Amba Meda	1	B	WSSA
88	Gondar	Enfranz	1	B	WSSA

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ITEM No	REGION	SITE NAME	No. OF WELLS	PRIORITY	OWNER
89	Gondar	Zarima	1	B	WSSA
90	Gojam	Bichena	1	B	WSSA
91	Gojam	Gunda Wayn	1	B	WSSA
92	Gojam	Dibate	1	B	WSSA
93	Various Regions	Various Sites	10	B	Industries. Municipalities & Institutions
SUB TOTAL			90		
94	Tigrai	Various Sites	10	C	WSSA
95	Wello	" "	10	C	WSSA
96	Gondar	" "	10	C	WSSA
97	Gojam	" "	6	C	WSSA
98	Wollega	" "	2	C	WSSA
99	Illubabor	" "	5	C	WSSA
100	Ogaden	" "	7	C	WSSA
101	Harargie	" "	7	C	WSSA
102	Various Regions	" "	10	C	Livestock
103	Various Regions	" "	10	C	Agriculture
104	Various Regions	" "	13	C	Industries
SUB TOTAL			90		
TOTAL			270		

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PROJECT EQUIPMENT & MATERIAL REQUIREMENT BILL OF QUANTITY

ITEM	DESCRIPTION	UNIT	QUANTITY	REMARK
	I. MACHINARIES, TOOLS & ACCESSORIES			
1	Heavy Duty Multi purpose truck mounted DTH (down the hole hammer) and mud rotary drilling rig with compressor, tools and accessories.	Set	3	
2	Hoisting rig truck mounted 4 x 4 drive	Set	1	
3	Tools & accessories for Rotary Model TMB 171 Drilling Rig.	L.S		
4	Tools & accessories for Percussion SM22T Sankyo kogyo drilling rig	L.S		
5	Welding plant with spare parts	Set	4	
6	Concrete Mixers 0.50m^3 capacity	Nos.	2	
7	Concrete Vibrators	Set	2	
8	Hand Compactors	Nos	2	
	II. CASINGS & PIPES			
9	Mild steel casing			
	Category A	Pcs.	3000	
	Category B	Pcs.	1000	
	Category C	Pcs.	200	
	Category D	pcs.	150	

ITEM No.	DESCRIPTION	UNIT	QTY.	REMARK
10	PVC casing Ø 7"			
	Category A	pcs.	850	
	Category B	pcs	300	
11	Heavy duty G.I. 2" pipe	pcs.	1000	
	III. VEHICLES			
12	Station Wagon 4 x 4 drive	Nos.	5	
13	Pick up single cab 4x4 drive	Nos.	10	
14	Cargo trucks 12 ton 6 x 4 drive	Nos.	3	
15	Cargo trucks 10 tons with crane of 3 tons, 6 x 4 drive	Nos.	2	
16	Dump truck 8m^3 capacity, 6 x4 drive	Nos.	2	
17	Heavy duty mobile workshop mounted on 4 x 4 drive truck	Unit	1	
18	Fork Lift truck	Nos.	1	
19	Spare parts for existing vehicles & Rigs	L.S.		List of spare part will be prepared in due course
	DRILLING CHEMICALS			
20	C.M.C., High viscosity type	Tons	5	
21	Bentonite Sacks of 25kg.	Tons	50	
22	Well cleaning Chemical / polyphosphate/	Barrel	10	

ITEM	DESCRIPTION	UNIT	QTY	REMARK
	HYDROGEOLOGICAL INSTRUMENTS			
23	Portable electrical water level & temp. indicator, 300mts	Nos	5	
24	Electric Conductivity meter	Nos	2	
25	Water analysis kit with enough reagents	Kit	2	
26	Table Stereoscope	Nos	1	
27	Resistivity Meter	Set	2	
	PUMPS & GENERATORS			
28	Deep well water pumps			
	Category A	Nos	3	
	Category B	Nos	6	
	Category C	Nos	6	
	Category D	Nos	25	
	Cagegory E	Nos	20	
	Cagegory F	Nos	20	
	Category G	Nos	14	
	Cagegory H	Nos	1	
	Cagegory I	Nos	1	
	Cagegory J	Nos	1	
	Cagegory K	Nos	1	
	Category L	Nos	1	
	Cagegory M	Nos	1	
29	Generating Set			
	Category A	Nos	2	
	Category B	Nos	4	
	Category C	Nos	4	
	Category D	Nos	17	
	Category E	Nos	14	
	Category F	Nos	14	
	Category G	Nos	9	
	Category H	Nos	1	
	Category I	Nos	1	
	Category J	Nos	1	
	Category K	Nos	1	
	Category L	Nos	1	
	Category M	Nos	1	

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ITEM	DESCRIPTION	UNIT	QUANTITY	REMARK
30	Dewatering Pumps	Nos	4	
	VII. OTHERS			
31	Photocopier	Nos	2	
32	Blue print machine	Nos	1	
33	Radio Transreceiver	Set	10	
34	Workshop Equipment & Tools	L.S		
35	Pipe wrench 36"	Nos	18	
37	Pipe wrench 48	Nos	18	
38	Chain tong 2" - 6"	Nos	16	
39	Chain tong 6" - 12", heavy duty	Nos	4	
40	Welding Electrodes a. Mild Steel b. Hard facing	 kg. kg.	 1,000 3,000	
41	Emery discs/center hole dia 3.8mm/ a. 2 .0mm thick b. 2.5mm thick	 pcs. pcs.	 3,000 10,000	
42	Mild Steel Sheets 2mx1mx4mm	pcs.	1,000	
43.	Hose Assy Equipment			

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Annex III Criteria and conditions for provision of equipment

The following criteria will be used to decide the final component of equipment:

1. Financial and technical viability of the Project

2. Past performance of well drilling projects utilizing the equipment procured under Japan's assistance

3. Technical and managerial capacity of the authority responsible for equipment maintenance and operation

4. Hydrogeological, topographical and infrastratural conditions of project sites

5. Current stock level and status of equipment, spare parts and materials and possible procurement in prospect from other sources

The following conditions will be applied on the equipment procured under the Japan's Grant Aid:

1. The items to be procured by the Japan's Grant Aid are for exclusive use for the Project.

2. The necessary budget for operation and maintenance of the deployed equipment is to be borne promptly by the Ethiopian side.

3. An appropriate monitoring and evaluation system is to be established in order to avoid misuse of the equipment and materials procured.

Annex IV Necessary measures to be taken by the Transitional Government of Ethiopia

The Transitional Government of Ethiopia, where the laws and regulations permit, takes necessary measures as stipulated as follows, in case Japan's Grant Aid is extended to the Project.

1. To ensure prompt unloading and customs clearance at the Port of Asseb in Ethiopia and to bear the cost of internal transportation of the products under the Grant from the Port to the Project sites

2. To exempt Japanese nationals from or bear the cost of customs duties, internal taxes and other fiscal levies which may be imposed in Ethiopia with respect to the supply of the products and services under the Verified Contracts financed by the Grant Aid

3. To accord Japanese nationals whose services may be required in connection with the supply of the products and services under the Verified Contracts such facilities as may be necessary for their entry into Ethiopia and stay therein for the performance of their work

4. To ensure that each equipment under the Grant be maintained and used properly and effectively

5. To bear all the expenses necessary for the Project, other than those convered by the Grant

Annex V Technical Cooperation in connection with the Project

The following are the requests for Japan's technical cooperation made or being prepared by the Ethiopian side:

1. long-term expert

equipment maintenance	one

2. acceptance of trainees for training courses in Japan

hydrogeology	several
mechanics	several

3. Japan Overseas Cooperation Volunteers (JOCV)

mechanic	one
civil engineering	one
electrician	one
ground water development	one

TECHNICAL NOTES
ON
GROUND WATER DEVELOPMENT PROJECT

The Minutes of Discussions on the Basic Design Study on Ground Water Development Project (hereinafter referred as "the Project") was concluded between the JICA Basic Design Study Team (hereinafter referred as "the JICA Team") and Ministry for External Economic Cooperation of Transitional Government of Ethiopia on October 5, 1992.

Following the conclusion of Minutes of Discussions of the Project, the JICA Technical Team continued technical discussions and field survey in Ethiopia up to October 20, 1992.

The JICA Technical Team and the Water Well Drilling Agency (hereinafter referred as "the WWDA), the Transitional Government of Ethiopia made several discussions as described hereinafter.

These discussion results will be studied carefully by the JICA Team and concluded in the basic design report which will be delivered by the end of February 1993.

1. Equipment and Material List with priority

   The Equipment and Material requested by WWDA is as shown in Annex II of the Minutes of Discussions. Considering the possibility of staging of Grant Aid for the Project and discussion results between the JICA Team and WWDA, the quantity of some equipment are added by WWDA with priority of each equipment and material. The amended items are 1 set of sloting machine and 15 set of radio transreceivers. They are shown in Table 1.

2. Port of Entry for the Equipment

   As stated in item 2 of Annex IV of Minutes of Discussions, the Transitional Government of Ethiopia ensured the prompt unloading and customs clearance at the Port of Asseb in Ethiopia and to bear the cost of internal transportation of the equipment from the Port to the Project sites by the responsibility of the Transitional Government of Ethiopia.

The JICA Team explained to WWDA that Japanese Grant Aid shall cover all costs up to the entry to Ethiopia. And the JICA Team requested to WWDA to reconfirm the port of entry with consciousness of future circumstance change.

This clause was confirmed by the Water Resource Commission to the JICA Team and WWDA on October 17, 1992. Also this confirmation was reported to the Ministry for External Economic Cooperation.

Addis Ababa, October 19,1992

Mr. Takao Sakamoto
Chief Engineer
Basic Design Study Team,
JICA

Ato Berhanu Tamrat
Manager
Water Well Drilling Agency
Transitional Government of
Ethiopia

TABLE 1

LIST OF EQUIPMENT & MATERIAL WITH PRIORITY

ITEM	DESCRIPTION	UNIT	QUANTITY (Requested)	PRIORITY		
				I	II	III
	I. MACHINARIES, TOOLS & ACCESSORIES					
1	Heavy Duty Multi purpose truck mounted DTH (down the hole hammer) and mud rotary drilling rig with compressor, tools and accessories.	Set	3	1	1	1
2	Hoisting rig truck mounted 4 x 4 drive	Set	1	-	1	-
3	Tools & accessories for Rotary Model TMB 171 Drilling Rig.	L.S	)	1	-	-
4	Tools & accessories for Percussion SM22T Sankyo kogyo drilling rig	L.S	)	1	-	-
5	Welding plant with spare parts	Set	4	-	2	2
6	Concrete Mixers 0.50m^3 capacity	Nos.	2	-	-	2
7	Concrete Vibrators	Set	2	-	-	2
8	Hand Compactors	Nos	2	-	-	2
	II. CASINGS & PIPES					
9	Mild steel casing					
	Category A	Pcs.	3000	-	1,200	1,800
	Category B	Pcs.	1000	-	350	650
	Category C	Pcs.	200	-	-	200
	Category D	pcs.	150	-	100	50

For TMEC

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ITEM	DESCRIPTION	UNIT	QUANTITY (Requested)	PRIORITY		
				I	II	III
10	PVC casing 0 7"					
	Category A	pcs.	850	-	-	850
	Category B	pcs	300	-	-	300
11	Heavy duty G.I. 2" pipe	pcs.	1000	-	300	700
	III. VEHICLES					
12	Station Wagon 4 x 4 drive	Nos.	5	5	-	-
13	Pick up single cab 4x4 drive	Nos.	10	10	-	-
14	Cargo trucks 12 ton 6 x 4 drive	Nos.	3	3	-	-
15	Cargo trucks 10 tons with crane of 3 tons, 6 x 4 drive	Nos.	2	2	-	-
16	Dump truck 8m^3 capacity, 6 x4 drive	Nos.	2	2	-	-
17	Heavy duty mobile workshop mounted on 4 x 4 drive truck	Unit	1	1	-	-
18	Fork Lift truck	Nos.	1	1	-	-
19	Spare parts for existing vehicles & Rigs	L.S.	1	1	-	-
	DRILLING CHEMICALS					
20	C.M.C., High viscosity type	Tons	5	-	-	5
21	Bentonite Sacks of 25kg.	Tons	50	-	-	50
22	Well cleaning Chemical / polyphosphate/	Barrel	10	-	-	10

ITEM	DESCRIPTION	UNIT	QUANTITY	PRIORITY		
				I	II	III
	HYDROGEOLOGICAL INSTRUMENTS					
23	Portable electrical water level & temp. indicator, 300mts	Nos	5	-	5	-
24	Electric Conductivity meter	Nos	2	-	2	-
25	Water analysis kit with enough reagents	Kit	2	-	2	-
26	Table Stereoscope	Nos	1	-	1	-
27	Resistivity Meter	Set	2	-	2	-
	PUMPS & GENERATORS					
28	Deep well water pumps		119	-	70	49
	Category A	Nos	3			
	Category B	Nos	6			
	Category C	Nos	6			
	Category D	Nos	25			
	Cagegory E	Nos	20			
	Cagegory F	Nos	20			
	Category G	Nos	14			
	Cagegory II	Nos	1			
	Cagegory I	Nos	1			
	Cagegory J	Nos	1			
	Cagegory K	Nos	1			
	Category L	Nos	1			
	Cagegory M	Nos	1			
29	Generating Set		70	-	20	50
	Category A	Nos	2			
	Category B	Nos	4			
	Category C	Nos	4			
	Category D	Nos	17			
	Category E	Nos	14			
	Category F	Nos	14			
	Category G	Nos	9			
	Category H	Nos	1			
	Category I	Nos	1			
	Category J	Nos	1			
	Category K	Nos	1			
	Category L	Nos	1			
	Category M	Nos	1			

ITEM	DESCRIPTION	UNIT	QUANTITY (Requested)	PRIORITY		
				I	II	III
30	Dewatering Pumps	Nos	4	2	2	-
	VII. OTHERS					
31	Photocopier	Nos	2	-	2	-
32	Blue print machine	Nos	1	-	-	1
33	Radio Transreceiver	Set	15	-	15	-
34	Workshop Equipment & Tools	L.S		-	1	-
35	Pipe wrench 36"	Nos	18	-	18	-
37	Pipe wrench 48	Nos	18	-	18	-
38	Chain tong 2" - 6"	Nos	16	-	16	-
39	Chain tong 6" - 12", heavy duty	Nos	4	-	4	-
40	Welding Electrodes			-	1,000	-
	a. Mild Steel	kg.	1,000			
	b. Hard facing	kg.	3,000	-	3,000	-
41	Emery discs/center hole dia 3.8mm/					
	a. 2 .0mm thick	pcs.	3,000	3,000	-	-
	b. 2.5mm thick	pcs.	10,000	10,000	-	-
42	Mild Steel Sheets 2mx1mx4mm	pcs.	1,000	-	1,000	-
43	Hose Assy Equipment	Nos	10	-	10	-
44	Sloting Machine	Set	1	-	1	-

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