

BASIC DESIGN STUDY REPORT  
ON  
THE PROJECT  
FOR  
THE IMPROVEMENT OF RURAL WATER SUPPLY  
IN  
THE REPUBLIC OF THE SUDAN

MAY, 1989

JAPAN INTERNATIONAL COOPERATION AGENCY



**BASIC DESIGN STUDY REPORT  
ON  
THE PROJECT  
FOR  
THE IMPROVEMENT OF RURAL WATER SUPPLY  
IN  
THE REPUBLIC OF THE SUDAN**

1997  
JICA LIBRARY



107636211

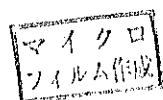
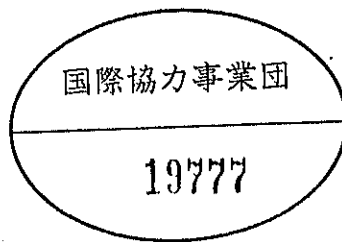
MAY, 1989

**JAPAN INTERNATIONAL COOPERATION AGENCY**

G R F

CR (2)

89-83



## PREFACE

In response to a request from the Government of the Republic of the Sudan, the Government of Japan has decided to conduct a Basic Design Study on the Project for the Improvement of Rural Water Supply and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to the Sudan a survey team headed by Mr. TAKUYA SATO, Chief of Construction Office, Construction Dept., Water Supply Bureau, Nagoya City from January 25 to February 28, 1989.

The team exchanged views on the Project with the officials concerned of the Government of the Sudan and conducted a field survey in the northern, central, and Kordofan Regions. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of the Sudan for their close cooperation extended to the team.

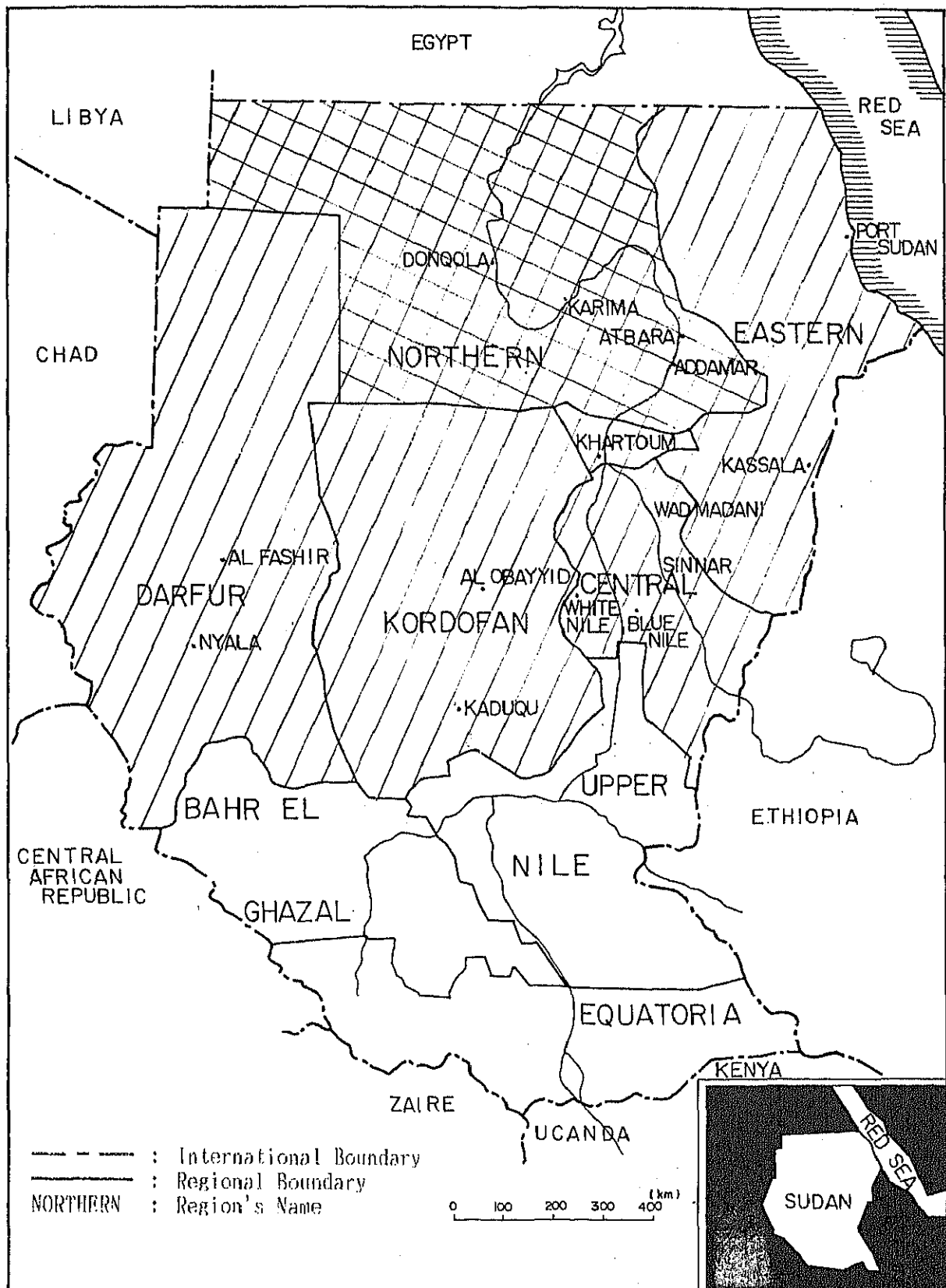
May 1989

A handwritten signature in black ink, reading "Kensuke Yanagiya". The signature is fluid and cursive, with the first name "Kensuke" and last name "Yanagiya" clearly distinguishable.

Kensuke Yanagiya  
President  
Japan International Cooperation Agency



Fig. 1 Project Area  
in Sudan







## PHOTOGRAPHS



PHOTOGRAPHS OF SURVEY SITES

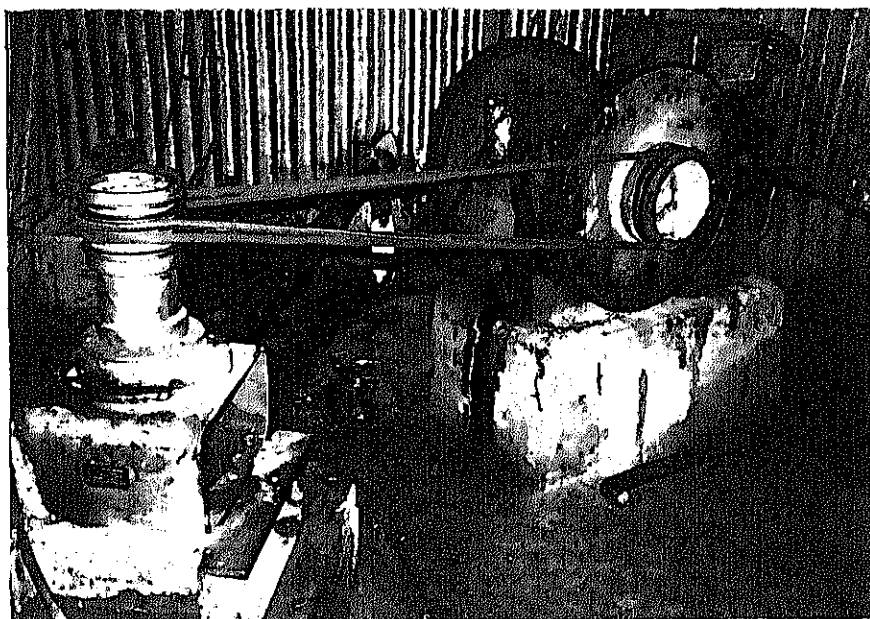


TEMPORARY BARRIER (MADE BY SAND BAGS) FOR  
FLOOD PROTECTION AT HOSH BANAGA VILLAGE, SHANDI

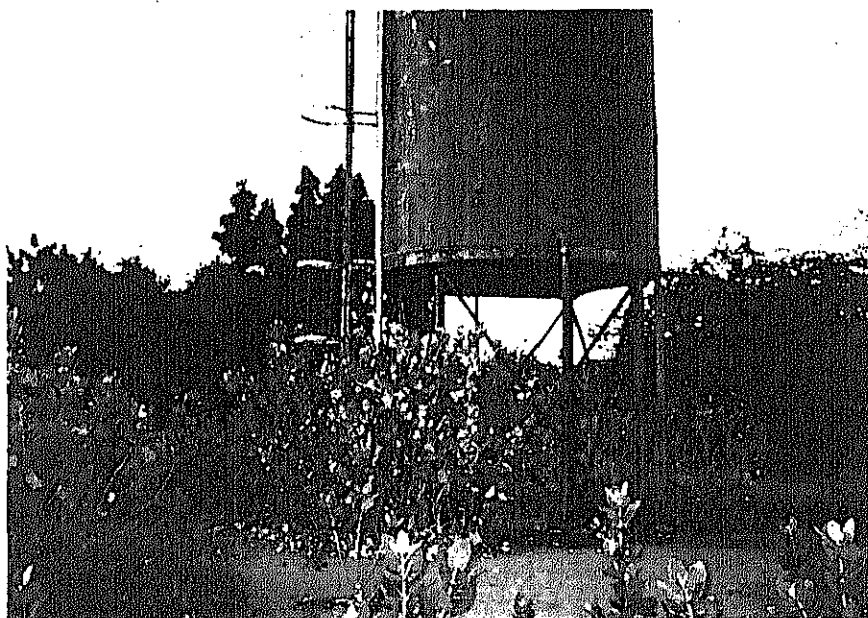


SITUATION OF FLOOD DAMAGE AT HOSH BANAGA VILLAGE, SHANDI





EXISTING WATER YARD INSTALLED AT HOSH BANAGA VILLAGE, SHANDI  
(PUMPING SYSTEM WHICH REHABILITAION FOR FLOOD DAMAGE IS NECESSARY)



EXISTING WATER YARD INSTALLED AT HOSH BANAGA VILLAGE, SHANDI  
(INCLINATION OF ELEVATED TANK DUE TO FLOOD DAMAGE)





EXISTING WATER YARD INSTALLED AT HOSH BANAGA VILLAGE, SHANDI  
BURIED BASE OF ELEVATED TANK DUE TO INFLOW OF SAND CAUSED  
BY FLOODING OF THE NILE



THE VILLAGE DAMAGED BY FLOOD IN MATAMMA AREA





## SUMMARY



## SUMMARY

Adopting in 1981 "The United Nation's International Drinking Water Supply and Sanitation Decade Plan (1981 - 1990)", the Government of the Republic of the Sudan has engaged in the improvement of water supply conditions by initiating the 7th 4 Year Salvation Recovery & Development Programme (1988/89 ~ 1991/92) with the aim of supplying safe and hygienic drinking water to 80% of the rural inhabitants by 1990, and to all the people of the Sudan by the year 2000. In line with the Programme construction works for water supply facilities are currently under way and the National Corporation for Development of Rural Water Resources (Execution Agency) has been strengthened for the effective implementation of the projects.

However, the Ethiopian Highlands, which is the headstream area of the Nile, and its middle basin, the Central to Northern Region, suffered an unprecedented heavy rainfall in August to September 1988, and caused a month-long flood of the Nile in the Northern Region. The flood caused serious damage to houses, public facilities (including schools), agricultural products, and existing water supply facilities in the residential areas scattered along the riverbanks of the Nile in the Northern Region. The damage was immense, and the team found that the reconstruction was extremely in slow progress half a year after the disaster. Inhabitants were forced to live in tents and to drink unsanitary muddy water of the Nile or to use traditional hand-dug shallow wells that are easily polluted from the ground surface.

After investigating the conditions of damage in seven Regions including the Northern Region, the "Emergency Flood Reconstruction Program" was prepared by the Delegation of the Multinational Aid Agency headed by the World Bank. Based upon the above Programme, the result of survey conducted by the Government of the Republic of the Sudan made a request for Grant Aid to the Government of Japan in the following fields:

- 1) supply of equipment and materials to reconstruct the existing water supply facilities in the Northern Region; and 2) supplying spare parts for operation and maintenance of the existing equipment distributed in the Northern, the Central, Darfur, and the Eastern Regions.

Following the request, the Japanese government decided to undertake a Basic Design Study on the Project for the Improvement of the Rural Water Supply in the Republic of the Sudan, for which JICA dispatched a Basic Design Study Team for 35 days between January 25 and February 28, 1989.

In the course of discussions with the appropriate authorities of the Republic of the Sudan, the team confirmed the content of the request, the background and content of the project, and conducted a field survey of the project area of the Northern, Central and Kordofan Regions.

The project has the following two goals: 1) rehabilitation of the existing water supply facilities (water yards and water supply facilities utilizing surface waters) in the Northern Region seriously damaged by the flood; and 2) establishment of new water supply facilities in safe residential areas for the evacuees of damaged villages. By achieving these two goals, the project will seek to restore water supply conditions and living conditions of rural inhabitants, while upgrading the

overall workability of the National Corporation in the fields of construction, maintenance, and management of water supply facilities by renovating existing machines and vehicles for the construction of water supply facilities.

To meet the urgency of the Project, the basic design laid down a 2-year project execution period, with the estimate of the feasible working term to be 6 months per year in view of the nation's natural environmental conditions. And also, the magnitude and scale of the planned equipment and materials were laid down as follows, taking into consideration the ability of the executing agency: 1) equipment and materials to reconstruct the existing water supply facilities in the Northern Region (engine-driven vertical turbine pumps for water wells, elevated tanks, service pipe/pipe fittings for water supply facilities using surface water, casings and screens for constructing wells, etc.; 2) equipment and materials to construct water yards and water supply facilities for using surface water in the Northern Region (casing and screens for construction of water wells, engine-driven vertical turbine pumps for water wells, elevated tanks, pump house materials, booster pumps for water supply facilities using surface water, service pipe/pipe fittings, etc.); 3) water well construction machinery (drilling rig and other materials related to well construction, well development equipment and materials, well logging equipment and materials, etc.); 4) vehicles to transport construction materials and laborers; 5) spare parts required to operate and maintain the equipment owned by the National Corporation.

In view of its scale and magnitude, the project will be carried out in two phases. The cost to be borne by the government of the Sudan in the actual construction work is estimated to be LS 1,580,000 (¥4,517,000) in the first-year phase and LS 2,860,000 (¥81,670,000) in the second-year phase, the amount of which will be sufficiently covered by the annual development budget of the Government of the Sudan.

The cooperation of the National Corporation for smooth customs clearance at Port Sudan, and the efficient transport of equipment and materials are essential to enable completion of the project within the limited work term. Also, the establishment by the Sudanese side of a powerful execution system for the construction is the prerequisite for the smooth implementation of the Project.

As for the process of work execution, a consulting contract will be signed to follow the detailed design after the Exchange of Notes is concluded between the Governments of the Sudan and Japan. In each phase, approximately 4.5 months are estimated for Detail Design and Tender evaluation, and approximately 8.5 months for procurement and delivery of equipment and materials.

After the project has been completed, the necessary operation and maintenance will be performed by regional and provincial offices of the National Corporation. Workability in this aspect is regarded sufficient, with technical staff, repair and processing equipment and materials stationed at the operation and maintenance centers and the headquarters.

Located in a dry zone, the target Northern Region is naturally scarce in water, with the water source being the Nile crossing the region and groundwater. However, the muddy water of the Nile cannot be used without water purification facilities. All these factors indicate that the damage of existing water supply facilities caused after the recent flood means a matter of life or death to local inhabitants. In view of urgency of the situation, Japan's grant aid in the project is regarded valid and appropriate.

With a total of 68 project sites covering the entire Nile and Northern Provinces of the Northern Region, the project will be of an immense benefit to 390,000 people (= total population of the target villages). The project will also need a short-term practical effect in view of its urgency. Considering the fact that the feasible work term of construction is limited to 6 months in the winter period, efficient and well-organized customs clearance at Port Sudan and the smooth inland transportation and delivery of machinery and equipment are strongly needed in cooperation with the National Corporation.





## ABBREVIATION



## ABBREVIATION

A	: Ampere
DM	: German Mark
EEC	: European Economic Commission
GNP	: Gross National Product
GDP	: Gross Domestic Product
HP	: Horse Power
Hz	: Hertz
Hafir	: Water Supply Facilities with reservoir
IMF	: International Monetary Fund
JICA	: Japan International Cooperation Agency
KW	: Kilowatt
KVA	: Kilo volt ampere
KD	: Kuwait Dinar
LS	: Sudan Pound
MFEP	: Ministry of Finance and Economic Planning
MIWR	: Ministry of Irrigation and Water Resources
NCDRWR	: National Corporation for Development of Rural Water Resources
NUWC	: National Urban Water Corporation
pH	: Hydrogen Ion Concentration
rpm	: Revolutions per minute
UNICEF	: United Nations Children's Fund
USD	: United States of America's Dollars
UNDP	: United Nations Development Program
V	: Volt
WHO	: World Health Organization
Water Yard	: Water Supply Facility consisting of water well, pumping machinery, elevated tank, transmission pipe line and public faucet
World Bank	: International Bank for Reconstruction and Development, International Development Association



## TABLE OF CONTENTS



BASIC DESIGN STUDY REPORT  
ON  
THE PROJECT  
FOR  
THE IMPROVEMENT OF RURAL WATER SUPPLY  
IN  
THE REPUBLIC OF THE SUDAN

TABLE OF CONTENTS

	Page
MAP	
PHOTOGRAPHS	
SUMMARY	
ABBREVIATION	
CHAPTER 1 INTRODUCTION .....	1
CHAPTER 2 BACKGROUND OF THE PROJECT .....	5
2.1 Outline of the Republic of the Sudan .....	5
2.1.1 Geography and Population .....	5
2.1.2 National Economy .....	6
2.2 Outline of Rural Water Supply Conditions in the Republic of the Sudan .....	6
2.2.1 Executing Agency for Rural Water Supply .....	6
2.2.2 Operation State and Financial Conditions .....	9
2.2.3 Operation and Maintenance System .....	15
2.2.4 Existing Water Supply Facilities .....	16
2.2.5 National Development Plan in the Rural Water Supply Sector .....	23
2.3 Damage Caused by Heavy Rain and Flood .....	27
2.3.1 Damage of Water Supply Facilities and Necessity of Reconstruction .....	27
2.4 Present Status and Trends of International Cooperation in Rural Water Supply .....	33

	Page
2.5 Process and Content of Request .....	38
2.5.1 Process of Request .....	38
2.5.2 Content of Request .....	40
CHAPTER 3 GENERAL CONDITIONS OF THE PROJECT AREA .....	45
3.1 Project Area .....	45
3.2 Natural Conditions .....	46
3.3 Socioeconomic Conditions .....	46
3.4 Conditions of the Infrastructure .....	47
3.4.1 Roads and Transportation .....	47
3.4.2 Electric Power, Others .....	48
CHAPTER 4 PROJECT CONTENT .....	49
4.1 Objectives of Project .....	49
4.2 Examination of Content of Request .....	50
4.2.1 Outline of Content of Request .....	50
4.2.2 Examination of Content of Request .....	54
CHAPTER 5 BASIC DESIGN .....	63
5.1 Policy of Basic Design .....	63
5.2 Examination of the Conditions for Basic Design .....	65
5.2.1 Equipment and Materials owned by the Regional Office of the National Corporation for Development of Rural Water Resources (NCDRWR) in the Northern Region ...	65
5.3 Basic Design .....	66
5.3.1 Basic plan of Water Supply Facilities .....	66
5.3.2 Plan for Equipment and Materials .....	84
CHAPTER 6 PROJECT EXECUTION PLAN .....	89
6.1 Execution Plan .....	89
6.1.1 Execution System .....	89
6.1.2 Execution Plan .....	90
6.1.3 Execution Schedule .....	91
6.2 Estimated Project Cost .....	92



	Page
6.3 Technology Transfer Plan .....	96
CHAPTER 7 OPERATION AND MAINTENANCE PLAN .....	99
7.1 Operation and Maintenance System .....	99
7.2 Operation and Maintenance Expenses .....	102
CHAPTER 8 PROJECT EVALUATION .....	105
8.1 Beneficiary .....	105
8.2 Appropriateness and Feasibility of Executing the Project .....	107
CHAPTER 9 CONCLUSION AND RECOMMENDATIONS .....	109
9.1 Conclusion .....	109
9.2 Recommendations .....	110

#### APPENDIX

- Appendix 1. Members of the Study Team
- Appendix 2. Itinerary of Field Survey
- Appendix 3. List of Competent Individuals Interviewed
- Appendix 4. Minutes of the Meeting
- Appendix 5. List of Collected Data
- Appendix 6. 7th 4-Year Salvation Recovery & Development Plan



## CHAPTER 1. INTRODUCTION



## CHAPTER 1 INTRODUCTION

In the Republic of the Sudan, one-thirds of its entire land is desert. Excluding some of the southern area, the majority of the land has an annual rainfall below 1,000 mm with semi-desert and desert covering the central to the northern part of the country. Agriculture is the key industry of the nation, with the most highly populated Central Region forming an agricultural stronghold backed up by irrigation from the Nile River. Urban areas with high population density include the Khartoum Region (the area surrounding the capital Khartoum), the Central Region, regional capitals, and other key cities of trade and transport, each of which represent an extremely limited area in the vast country (approximately 2.5 million km<sup>2</sup>) (see Fig. 2. Population Distribution Map). Besides these urban areas, rural areas occupy the majority of Sudan's land.

The total population in the Sudan is approximately 20.6 million (as of 1983 statistics). Approximately 80% (= 16.48 million) of the total population is occupied by the rural population, of which approximately 11% (= 1.81 million) is occupied by nomads residing in the Northern Region. The rural population is expected to increase until 1990 at a ratio of 2.5%, which is forecasted to drop to 1% thereafter and continue on this level until the year 2000. Consequently, the rural population is estimated to reach 19.8 million by 1990 and 20.9 million by 2000.

Adopting in 1981 "the United Nation's International Drinking Water Supply and Sanitation Decade Plan (1981 - 1990)", the Government of the Republic of the Sudan has engaged in the improvement of water supply conditions by initiating the Salvation Recovery & Development Programme featuring improvement of the present conditions of the rural water

service, with the aim to supply safe and hygienic drinking water to 80% of the rural inhabitants by 1990, and to all the people of the Sudan by 2000. However, the present ratio of water supply to rural inhabitants remains low, with approximately 75% in the Khartoum Region, below 80% in the Southern Region, and approximately 50% in the Northern, Kordofan, Darfur, and the Eastern Regions, resulting in the national average ratio of water supply of approximately 55%. To counter the situation, the Government of the Sudan has initiated the 7th 4-Year Salvation Recovery and Development Programme, thus striving to secure the living infrastructure of its people including the domestic water supply.

The Japanese Government has supplied to the Government of the Sudan the equipment and materials including a drilling rig and related materials, through a series of grant aid (e.g. ¥2 billion aid during 1982 to 1983 to improve rural water supply conditions; ¥3.1 billion aid in 1986 to improve water supply conditions in the Eastern Region receiving an inflow of Ethiopian refugees).

Contrary to the notorious drought that has caused continuing damage to the Sahel nations, a globally abnormal climate in recent years caused extremely heavy rainfall from August to September of 1988. Coupled with flooding of the Nile, each region of the Sudan (the Northern, Darfur, Kordofan, the Central, the Eastern, and Khartoum Regions) suffered serious damage to housing, public facilities (bridges, schools, etc.), agriculture (crops, irrigation facilities), as well as water yards (water supply facility consisting of water wells, pumping machines, pump houses, elevated tanks, distribution pipes and public faucets), hafirs (water supply facility with reservoir), and water supply facilities using surface water. Reconstructing these is the most urgent task faced by the Government of the Sudan at present.

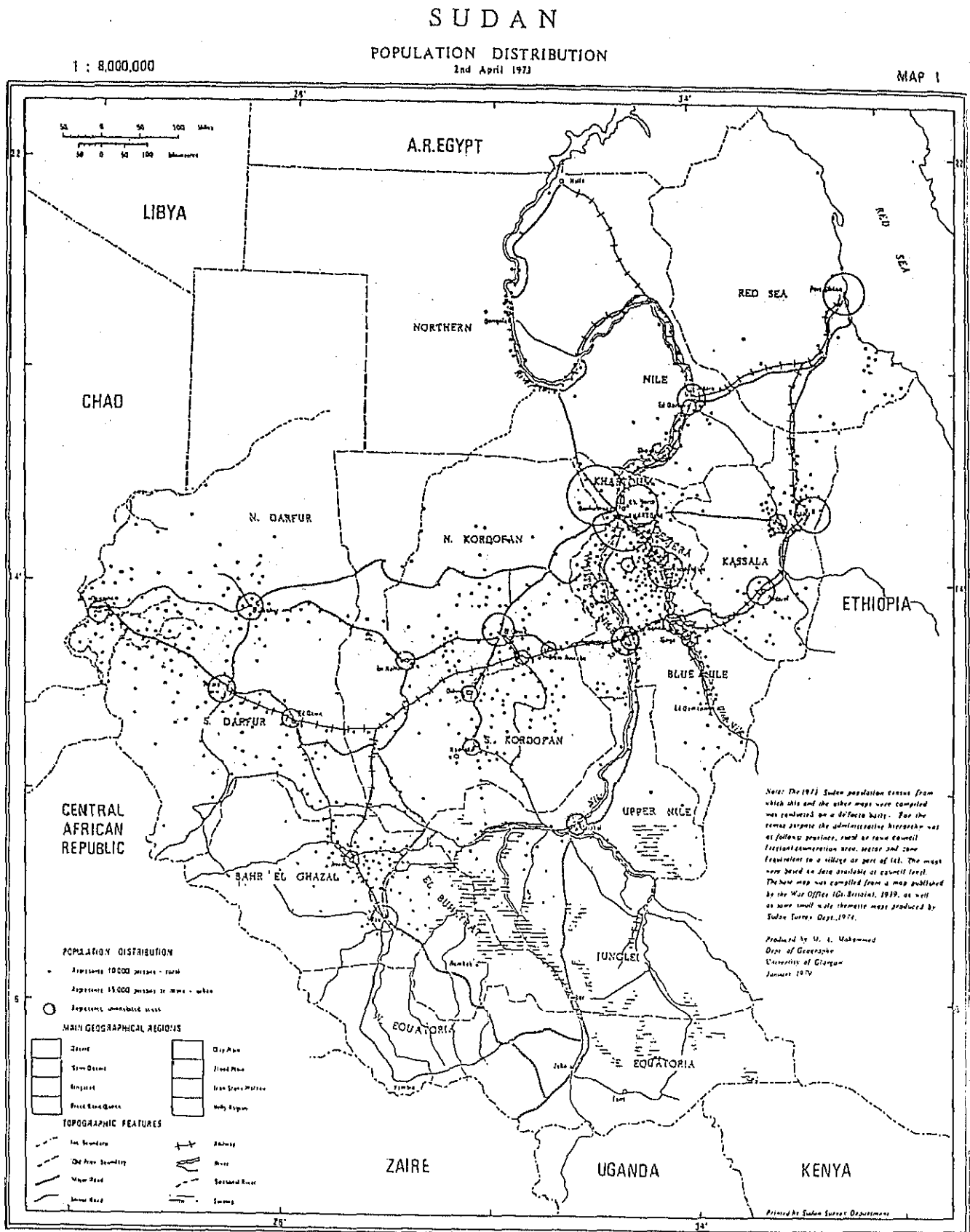
Reflecting pressing financial conditions caused by swelling expenditures to counter repeated droughts as well as flood damages, the Government of the Sudan made a request to the Japanese Government for equipment, materials, and spare parts supply required to operate and maintain the equipment and materials distributed in several regions through previous grant aid projects to improve rural water supply conditions.

Following the request, the Japanese Government decided to entrust JICA with a basic design study on the Project for the Improvement of the Rural Water Supply in the Sudan, for which a Basic Design Study Team led by Mr. Takuya Sato, Chief of Construction Office, Construction Dept., Water Supply Bureau, Nagoya City was sent by JICA for a period of 35 days from January 25 to February 28, 1989. In addition to a series of discussions with the appropriate authorities of the Republic of the Sudan, the study team conducted a field survey of the Project area as well as collected necessary reference data.

As a result, basic items of agreement were summerized in the minutes dated February 5, which was signed by the leader of the study team, the Secretary General of the NCDRWR and the Chief of the Energy and Mines Bureau in the Economic Planning Agency of the Ministry of Finance. Based on the minutes, a detailed study on technical items was further continued by the study team after its return to Japan.

This report contains the optimum Basic Design for the Project, which was worked out after its appropriateness and feasibility were evaluated upon the above-mentioned discussions and survey results. Furthermore, reference is made to the attached list of members of the study team, the itinerary of the field survey completed, and the minutes of the meeting.

Fig. 2 Population Distribution Map





## CHAPTER 2 BACKGROUND OF THE PROJECT



## CHAPTER 2 BACKGROUND OF THE PROJECT

### 2.1 Outline of the Republic of the Sudan

#### 2.1.1 Geography and Population

Located in the range of longitude 22° to 38° E and latitude 4° to 22° N, the Republic of the Sudan has the largest total area in Africa with 2,505,813 km<sup>2</sup>, which is 6.6 times the area of Japan. It has a total population of approximately 20.6 million (as of 1983 statistics), and its capital is Khartoum of the Khartoum Region.

While mountaneous area of the western area bordering Chad and the southern area bordering Kenya have high mountains exceeding 3,000 m above sea level, most of the land is occupied with mild hills of 350 to 500 m above sea level, or desert equivalent to peneplain.

The desert in the northern and the western area has 0 mm annual rainfall, with agriculture barely conducted in the narrow belt zone on the Nile riverbanks. However, relatively damp are the central Region and the southern area and especially the area met by the two rivers of the Blue and the White Nile, where the world's top-ranking cotton flowers are produced.

The southern area is also noted for the occurrence of natural resources such as oil and natural gas, for which development surveys were initiated in the past. However, they remain suspended at present due to the unstable security of the area reflecting political conditions.

### 2.1.2 National Economy

GDP in the industrial sectors of the Sudan is stagnating at present reflecting a drop of agricultural production which accounts for the nation's top-ranking GDP (see Table 1). With per capita GNP standing at \$330 (estimated as of 1985), the nation has a huge amount of accumulated debt. Following are the factors considered to create the situation in which the nation's revenue is continually overwhelmed by its expenditure: 1) inflow of Ethiopian refugees (exceeding 550,000); 2) population increase; 3) stagnated agriculture. Rapid expansion of external debt as development expenditure (continuing ever since 1984) is resulting in constant restraint on the national economy.

## 2.2 Outline of Rural Water Supply Conditions in the Republic of the Sudan

### 2.2.1 Executing Agency for Rural Water Supply

The executing agency for water supply in the Republic of the Sudan is divided into the two fields of urban water service and rural water service; with the former conducted by the NUWC (National Urban Water Corporation) holding within its jurisdiction the capital Khartoum and key local cities, and the latter conducted by the NCDRWR (National Corporation for Development of Rural Water Resources) in charge of the entire water supply in local cities and rural villages. Aiming to improve rural water supply conditions, the NCDRWR undertakes the entire process of developing, planning, and surveying water resources, as well as construction of water supply facilities and operation, maintenance, and management of

TABLE 1 TRANSITION OF GDP IN EACH SECTION

(Unit : Sudan Pound %)

Section \ Fiscal Year	1980/81	1981/82	1982/83	1983/84	1984/85	Share
Agriculture	2,133	2,062	1,785	1,697	1,583	28.1
Commerce	1,314	1,349	1,350	1,330	1,320	23.4
Manufacturing Industry & Mining	458	470	482	499	519	9.2
Communication & Transportation	587	647	580	565	572	10.2
Construction	260	280	300	320	312	5.5
Electricity & Water Supply	111	117	123	129	132	2.4
Government Service	619	610	620	617	643	11.4
Other Service	510	528	545	573	552	9.8
RealGDP(1981/82 Price)	5,990	6,063	5,785	5,730	5,633	100.0
Real GDP Growth Rate	4.6	1.2	△4.6	△1.0	△1.7	—
GDP Deflator	83	100	130	157	185	—
Nominal GDP(Market Price)	4,972	6,063	7,521	8,996	10,421	—

Twenty Sixth Annual Report 1985 : Bank of Sudan

Fiscal Year : July 1st in the year to June 30th in next year

TABLE 2 TRANSITION OF BUDGETED EXPENDITURE IN EACH CONSTITUTION

(Unit : Million Sudan Pound)

Section \ Fiscal Year	1981/82	1982/83	1983/84	1984	1984/85
Ordinary Expenditure	1,145	1,390	1,790	573	2,447
General Administration Expense	184	214	222	56	185
Defence Expenditure	114	164	300	124	475
Local Government Revenue Share	297	301	322	85	387
Interest Payment for External Debt	60	126	152	1	119
Others <sup>1)</sup>	490	585	794	307	1,281
Development Expenditure	315	414	463	99	456
Overseas Finance	185	210	204	32	240
Inland Finance	130	204	259	67	216

(Data) IMF

(Note) 1) Sign indicates that the expenditure in Others item includes one for unexplained purpose.

(it is estimated to be appropriated for national defence)

the facilities. Structured as an independent organization under the direct jurisdiction of the Minister of Irrigation and Water Resources, the NCDRWR is headquartered in Khartoum, and has its Regional Offices located in each region and Provincial Offices at work in each province (the administrative zone directly under the region). Refer to Fig. 3 for the administrative mechanism and Table 3 for the location of each regional and provincial office.

## 2.2.2 Operation State and Financial Conditions

### (1) Operation State

Headquartered in Kiloten, the suburbs of Khartoum, the NCDRWR has, under the jurisdiction of the Director General, the Supply Department and the Workshops and Manufacturing Department, each of which functions to administrate the rural water supply works nationwide. The structure features an advanced state of centralization with all the provision of equipment and materials to regional branches implemented through the Supply Department and each process of planning, budget distribution, and fostering of technical personnel being authorized by the headquarters. The corporation has a total of approximately 15,000 employees (as of the 7th 4 Year Salvation Recovery & Development Programme, 1988), of which approximately 3,000 are assigned to the headquarters. Seen according to work category, approximately 12% of the total employees are technical staff, approximately 38% are clerical staff and skilled work staff, and the rest are ordinary work staff. Its Regional Offices have 1,000 to 3,700 employees to conduct operation, maintenance, management and construction of water

Table 3

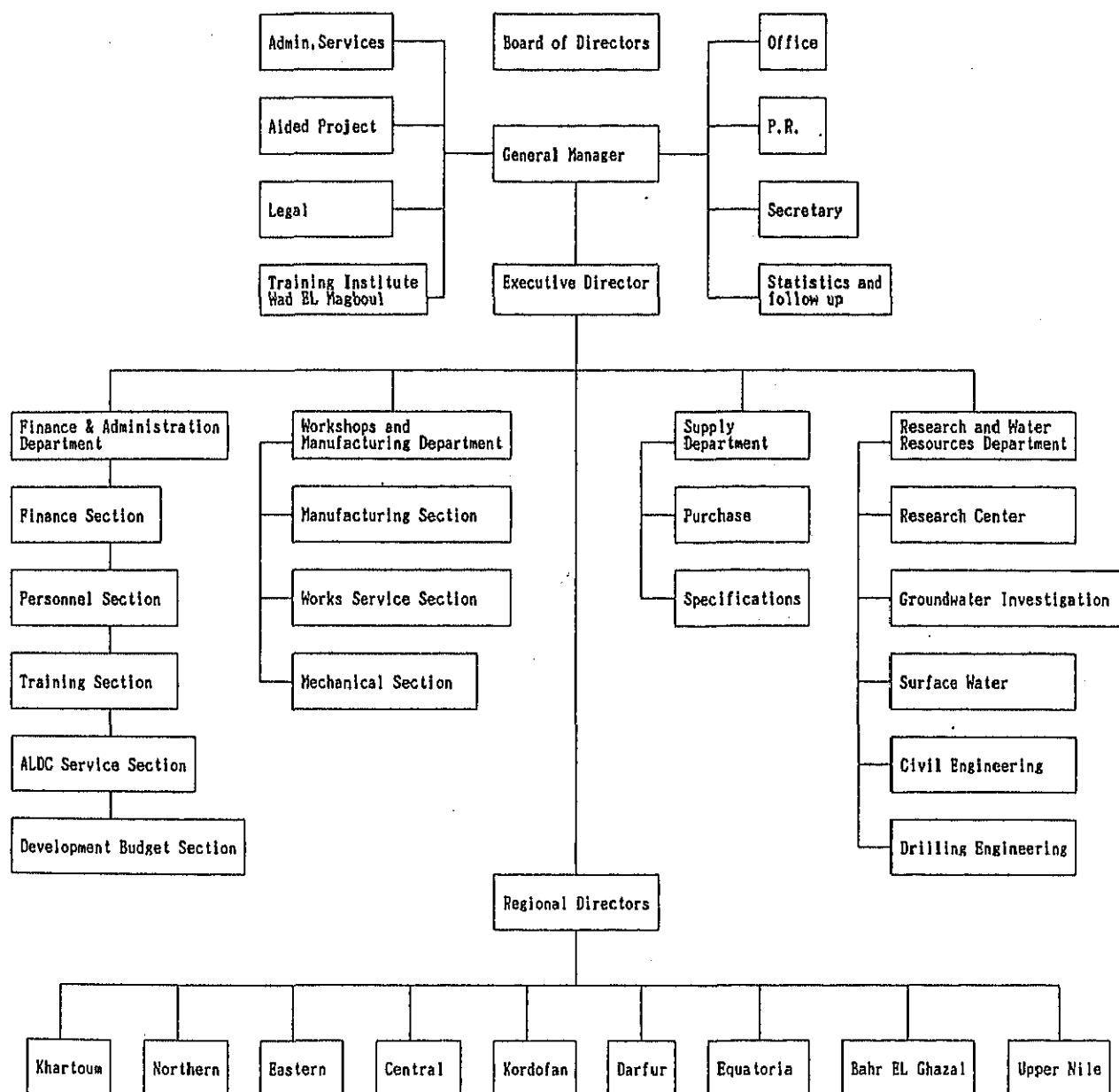
Locations of local branch offices  
of National Corporation for  
Development of Rural Water Resources

Regional Office	Provincial Office	
Northern Region Athara City	Nile Province	Ad Damar City
	Northern "	Donqola City
Central Region Wad Madani City	Gezira Province	Wad Madani City
	White Nile "	Ad Duwem City
	Blue Nile "	Sinnar City
Kordofan Region Al Obayyid City	Northern Kordofan Province	Al Obayyid City
	Southern Kordofan "	
Darfur Al Fishir City	Northern Darfur Province	Al Fishir City
	Southern Darfur "	Nyala City
Eastern Region Kasala City	Al Bahr Al Ahmar Province	Port Sudan City
	Kasala "	Kasala City



Fig. 3-1 Organization Chart of NCDRWR Headquarters  
(Located at Khartoum, Capital City)

(Source: Water Supply and Sanitation Sector Review (1986)  
UNDP/World Bank Project)



[Source: Water Supply and Sanitation Sector Review (1986)  
UNDP/World Bank Project ]

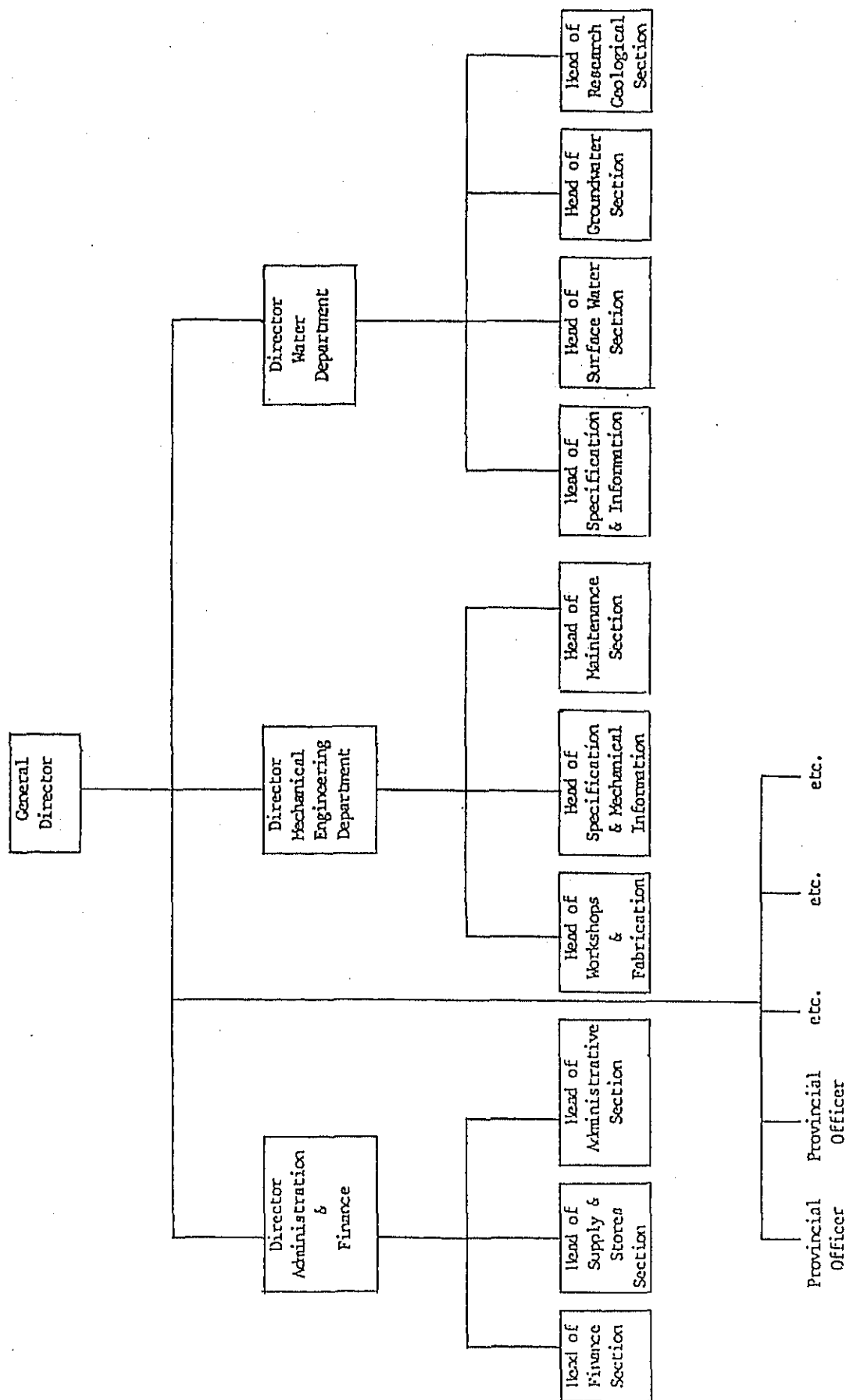
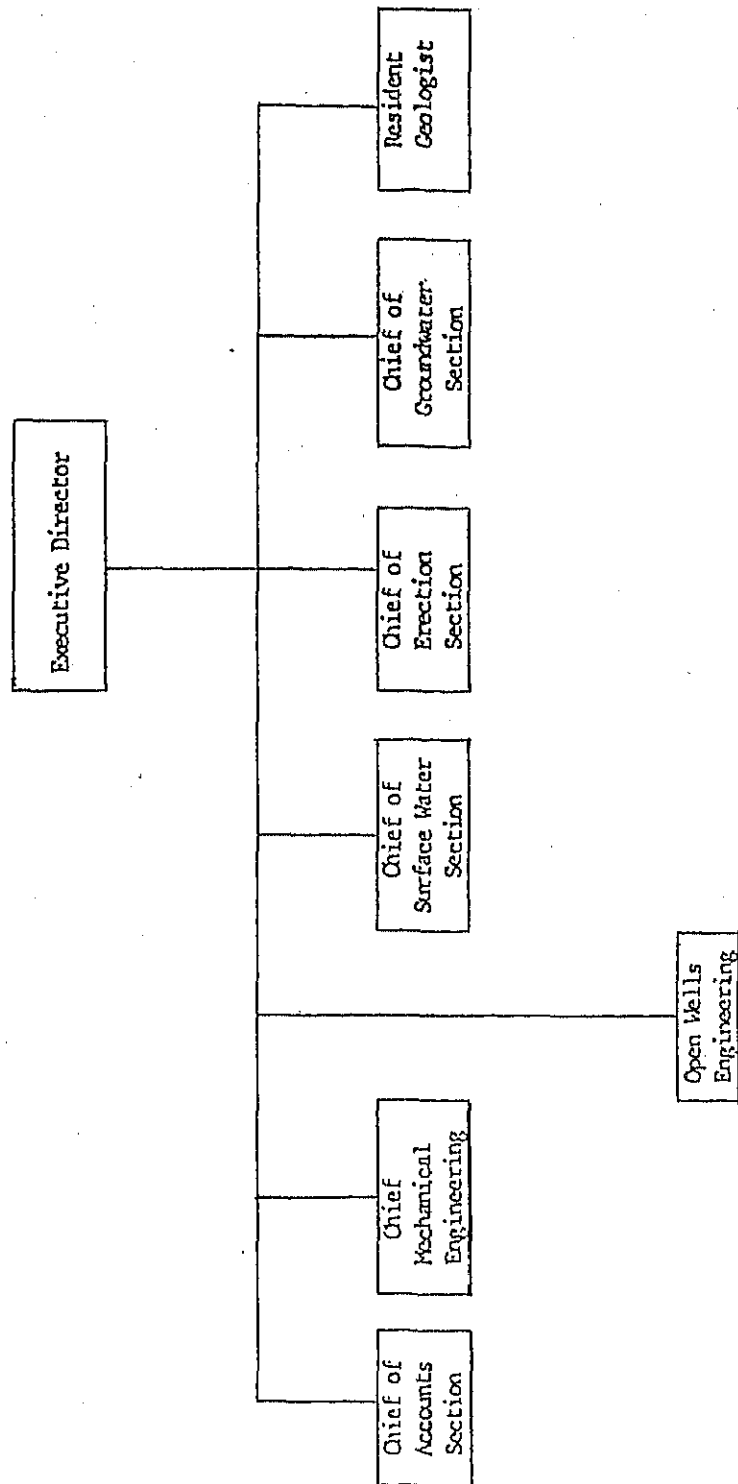


Fig. 3-3 Organization Chart of NCDRWR Provincial Office  
 (Source: Water Supply and Sanitation Sector Review (1986)  
 UNDP/World Bank Project )



supply facilities scattered in each region. The corporation has its own technical staff stationed in the headquarters and regional/provincial offices, in addition to various equipment and materials for construction, operation, maintenance, and management, and therefore has sufficient workability in itself.

Furthermore, the Training Center attached to the headquarters was established in 1962 in the suburbs of Khartoum, where 30 staff members provide various periodical courses including well drilling technology (a 3-year course) and mechanical engineering, in addition to re-training of on-site engineers conducted as necessary.

## (2) Financial Conditions

The fiscal year in the Republic of the Sudan starts in June and ends in July of the following year. The operating budget of the NCDRWR is categorized as follows: 1) salary of full-time employees and other personnel expenses; 2) office management cost and operation, maintenance, and management cost of existing water supply facilities; 3) development budget. Given below are the specifications of the budget.

# Specifications of Financial Conditions by the NCDRWR

Year Specifications	1986/87	1987/88	1988/89
1. Personnel expenses	LS25 (¥714)	LS45.2 (¥1290.91)	LS45.5 (¥1299.48)
2. Operation, maintenance, and management costs	LS8 (¥228.48)	LS11 (¥314.16)	LS13 (¥371.28)
3. Development budget	LS120 (¥3427.2)	LS78 (¥2227.68)	LS136 (¥3384.16)

Note: (upper column) LS = Sudan pound  
unit: million

(in brackets) Japanese yen: rate; 1LS = ¥28.57  
unit: million

Since the NCDRWR is run by governmental budget instead of water rates, the development budget is subject to change each year according to the scale of work to be implemented. The development budget included personnel expenses of part-time workers as well as fuel costs.

## 2.2.3 Operation and Maintenance System

The NCDRWR has in its headquarters in Khartoum a large-scale processing/assembly plant, a welding plant, and a warehouse for equipment and materials. In addition, each regional, provincial, and branch office has its own repair plant, from which machines are transferred to the central plant according to the level of repair required. While branch plants are only capable of simple repairs including replacement of minor spare parts, provincial plants cover the daily routine

of repair including overhaul and conduct complicated repairs including reconstruction of machinery. Under the recent external aid (Yugoslavia Loan Project, 1979 ~ 1988), a number of maintenance centers have opened in rural areas nationwide for direct operation and maintenance and management of existing water supply facilities. The maintenance centers have a management office and processing, assembly, and repair plants, with a good lineup of repair facilities including trucks for transporting equipment and materials and communication vehicles such as pick-up trucks and jeeps, as well as milling machines, ball machines, sawing machines, cranes, and welding machines. With this, almost all the machine work is feasible in the maintenance centers. Operating in 53 locations nationwide, the maintenance centers are established in the Central Region (15), Darfur Region (11), the Northern Region (8), Kordofan Region (8) and others (11).

#### 2.2.4 Existing Water Supply Facilities

##### (1) Outline of Existing Water Supply Facilities

Existing water supply facilities include the following: 1) a water supply facility called a "water yard" which is composed of a water well, pumping machine, pump house, elevated tank, distribution pipe, and public faucet 2) a water supply facility using surface water (referred to as the "Nile Project") usually located in riverbanks of the Nile, and is composed of a pumping machine to pump the Nile water to alluvial plain 6 m above the river level, a circular sedimentation basin and filtering basin made of concrete, a water tank, an elevated tank, a pumping machine to send the water

to the elevated tank, a pump house; and 3) a rainwater reservoir facility called "hafir" - composed of an approximately 100 m x 50 m square reservoir (by simple excavation of the riverbed of wadi) structured at the lower reaches of a wadi with clay layer riverbed, and that has an inlet at the higher reaches side, and an outlet and a concrete supply well at the lower reaches side to enable its use by rural inhabitants. (Hafir size is designed to secure water storage throughout the rainy and the dry seasons, and the size is expanded to prevent it from drying out during the dry season. These are the types of water supply facilities developed, maintained, and managed by NCDRWR. Typical examples are shown in Fig. 4. In addition, hand pump facilities with a bore hole provided by UNICEF projects, and traditional hand-dug shallow wells are in operation.

Of these water supply facilities, water yards are widely distributed throughout the nation, water facilities using surface water are operated in certain limited areas along the Nile, and hafirs are only used in the Central, Kordofan, and Darfur Regions that have a relatively stable amount of rainfall. While hand pump facilities with a bore hole are most frequently observed in the Kordofan Region, hand pumps with shallow wells are mostly used in other areas. However, the latter is a private property in most cases, as are also hand-dug shallow wells.

Fig. 4-1 Typical Drawing of Water Supply Facility  
(Water Yard)

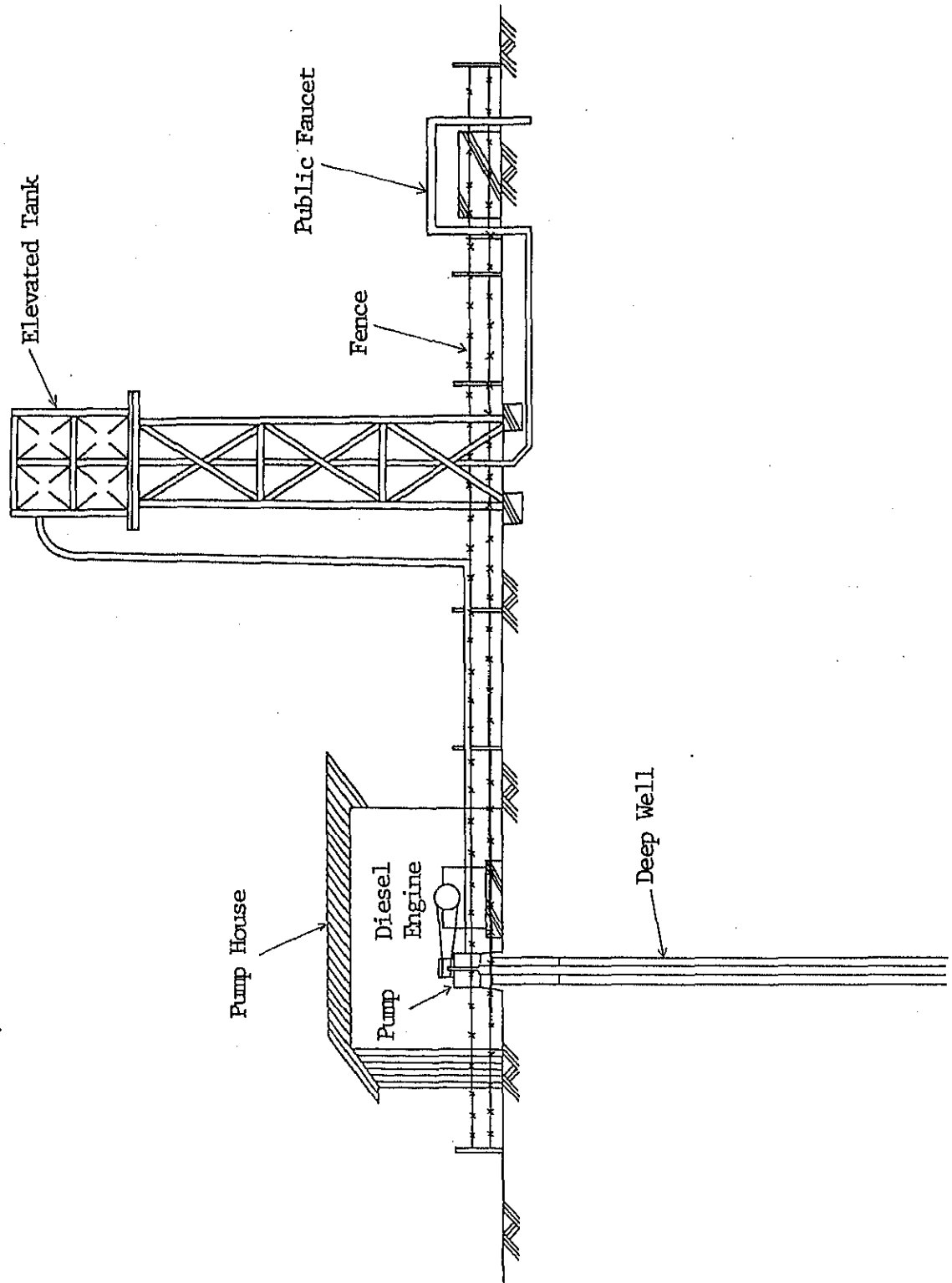




Fig. 4-2 Typical Drawing of Water Supply Facility  
(Water Supply Facility Using Surface Water)

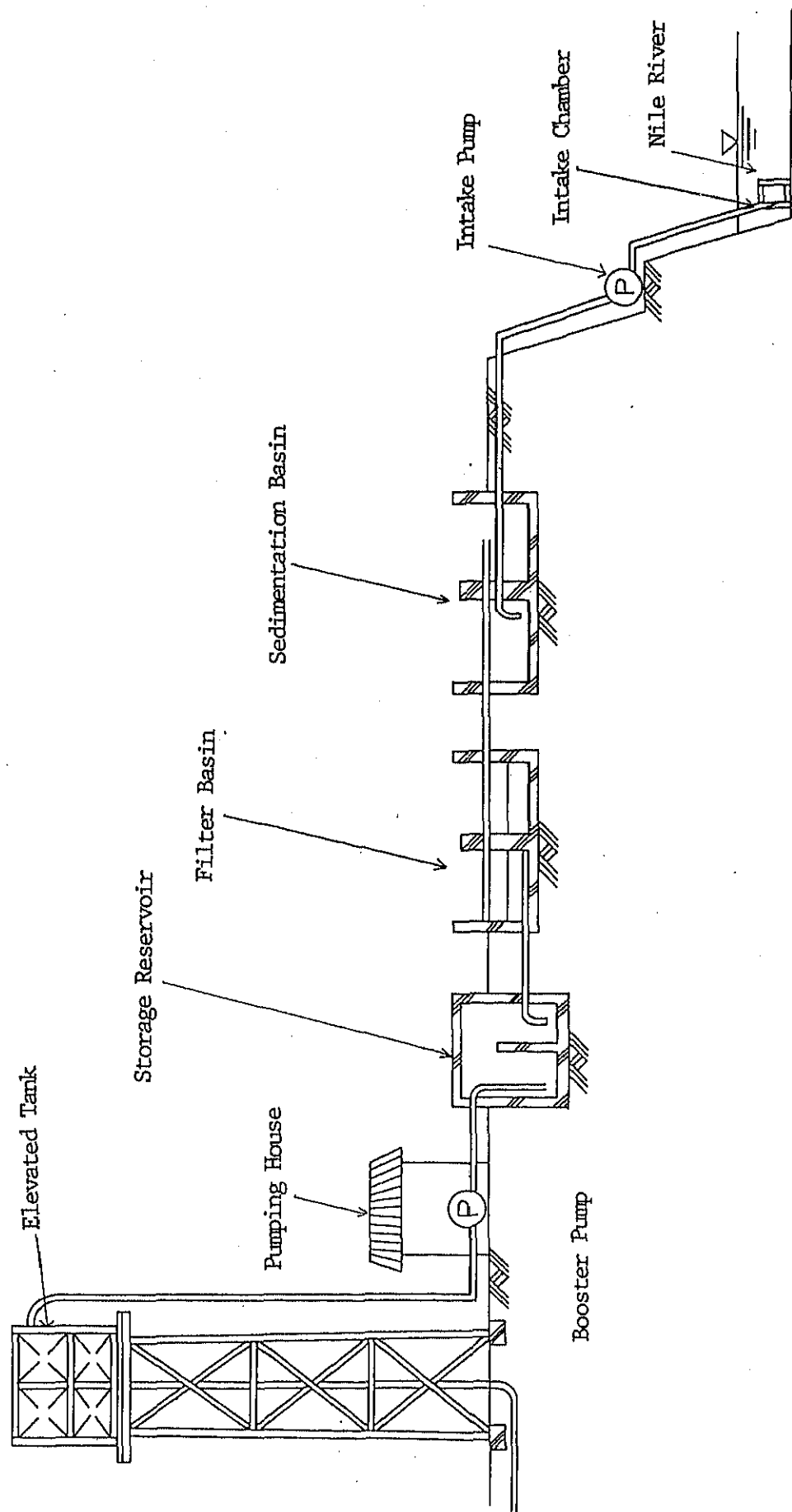
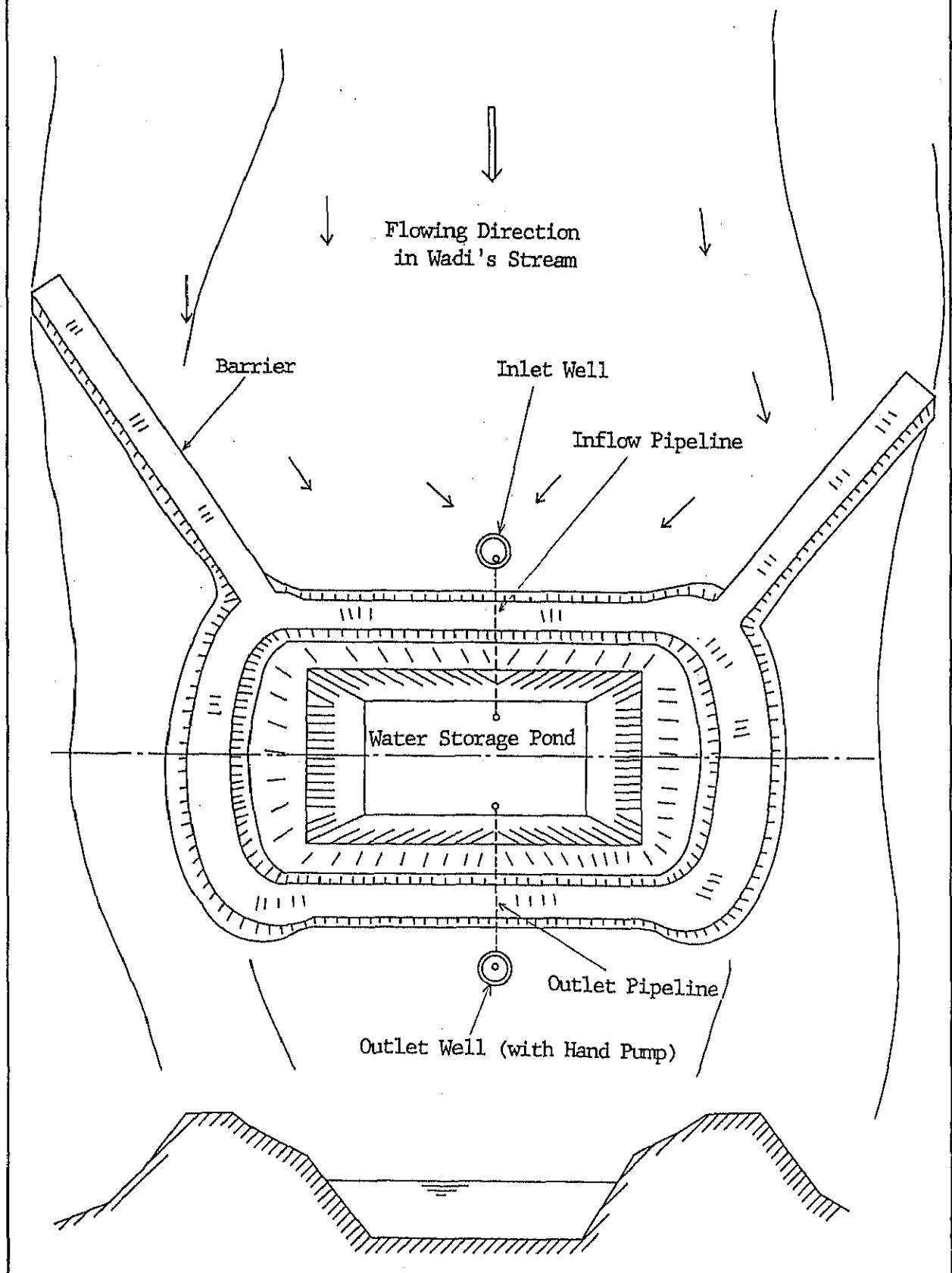


Fig. 4-3 Typical Drawing of Water Supply Facility  
(Hafir)



(2) Operation and Maintenance System of Existing Water Supply Facilities

The NCDRWR is wholly responsible for operation, maintenance, and management of existing water supply facilities, and functions to supply spare parts to facilities in need of repair, as well as fuel (diesel oil, gasoline, etc.) for operating the facilities.

Furthermore, maintenance teams are dispatched for on-site repair. Given below is the current state of operation, maintenance, and management of water yards, which account for the great majority (99%) of existing water supply facilities.

1) Management of Water Yards

Water yards installed in villages are normally managed by 3 work staff per facility (i.e., a clerk, an operator, and a guard). The main job of the clerk is to manage the water yard with the operating rates collected from village inhabitants. While regular staffs of regional offices are dispatched as operators in some cases, local inhabitants trained at the NCDRWR Maintenance Center are most frequently engaged in the operator's work. The water yard facility is guarded by the guard.

The method of collecting the water yard operating rates varies according to regions. Water yards are operated free of charge in the Northern, the Central, and Khartoum Regions, while operating and maintenance rates are collected in the Kordofan and Darfur Regions. Households in the Kordofan and Darfur Regions keep a large number of livestock (5 to 7/household to 5,000/household) and therefore

have an extremely high water consumption over other regions including the Northern Region. In addition, the benefit of relatively frequent rainfall in these two regions results in high agricultural output and high income per household, which enables collection of water rates (2 ~ 5 piasters per 4 gallons). In special cases, the operating and maintenance charge is paid by the inhabitants of the Northern, the Central, and Khartoum Regions to cover the lack of spare parts and fuels. However, with the operating and maintenance cost exceeding the collected rates in most cases, the balance is offset by the Regional Local Government.

2) Water Yard Operation Cost

Personnel expenses for the clerk, operator, and guard, and fuel expenses are the main categories of the water yard administration cost.

Personnel expenses: LS 12,000 per annum  
(¥340,000), fuel expenses: LS 30,000 per annum  
(¥860,000)

3) Water Yard Operating Hours

A water yard is normally operated for 8 to 10 hours.

4) Water Yard Maintenance System

Established in several tens of locations in a region, each operation and maintenance center has its own jurisdictional zone to maintain existing water supply facilities operated in villages. Although it varies according to regions, 40 to 70 water supply facilities are

usually maintained by one center. Each center has its own technical staff, repair/assembly machines, and vehicles to exhibit sufficient workability.

The same operation, maintenance, and management methods are adopted for other facilities including water supply facilities using surface water and hafirs.

#### 2.2.5 National Development Plan in the Rural Water Supply Sector

To recover the economic conditions and achieve development of the nation, the Republic of the Sudan initiated the 7th 4-Year Salvation Recovery and Development Programme (1988/89 to 1991/92). The programme stresses improvement of water supply as the top-ranking priority of various necessary fields including food supply, health, education, safety, and transportation. In this context, the following 3 items were planned with the aim of upgrading to 80% the water supply ratio of all rural inhabitants by the year 1990, thus spurring delayed development in the rural water supply.

##### (1) Reconstruction of Existing Water Supply Facilities

- 1) Reconstruction of 3,000 water yards
- 2) Reconstruction of 436 hafirs
- 3) Upgrading of construction and transportation equipment and materials owned by the NCDRWR, to strengthen its workability

(2) Construction of Water Supply Facilities

- 1) Construction of 1,342 water wells for water yards required for reconstruction and enforcement of existing water supply facilities
- 2) Construction of 2,000 shallow bore-holes with hand pumps
- 3) Construction of 234 hafirs
- 4) Construction of water supply facilities using surface water of the Nile and construction of hafirs (158 in total)

(3) Improving and Strengthening the Organization and System for Executing NCDRWR Projects

- 1) Expanding the organization and facilities of the planning, research, survey, and design divisions of the NCDRWR
- 2) Upgrading the work system adopted by key workshops in the Khartoum headquarters and regional offices, and by the maintenance and management centers located at key local cities
- 3) Improving and strengthening procurement conditions for equipment and materials
- 4) Rearranging and strengthening the communication system connecting the headquarters and rural regions

- 5) Necessity of technical assistance and training provided by international institutions and external aid bodies

In line with the 7th 4-Year Salvation Recovery and Development Programme, nationwide improvement of rural water supply conditions is currently under way in the Republic of the Sudan supported by funds granted by external aid organizations. Several water supply facilities are under construction at present. (See Table 4 for the actual record of water yards constructed by the NCDRWR.)

Furthermore, the active organization and the system of the NCDRWR Project is being streamlined at present, with satisfactory workability successfully achieved by its operation and maintenance system and training system. Looking at the operation and maintenance system, 53 maintenance centers opened in the headquarters and various locations nationwide that have a lineup of major work machines and personnel to conduct operation and maintenance of water yards placed under their jurisdiction. As for the communication system connecting the headquarters and rural areas, in-house radio stations are at work between the headquarters and regional offices, and between regional offices. However, with numerous houses collapsed and existing water facilities damaged in the unprecedented heavy rain and flood suffered last year, reconstruction of existing water supply facilities is the most urgent task at present, coupled with the rural water supply improvement project which abides by the principle of the Salvation Recovery and Development Programme.

Following a request made by the Government of the Sudan after the flood in August to September, 1988, damage conditions were surveyed in October, 1988 by the Delegation of the External Aid Agencies which was led by the World Bank with participation from aiding nations including France, Italy, Great Britain, and the EEC, and international organizations including UNICEF and WHO. Entitled the "Emergency Flood Reconstruction Program, October, 1988," the survey report contains conditions of flood damage suffered in each field of agriculture, rural water supply, education, public health and sanitation, industry and construction, power supply, telecommunications, transportation, and urban conditions. Furthermore, the survey report establishes an emergency flood reconstruction program to be implemented for two years, in which reconstruction of existing water supply facilities and moving of villages damaged by the flood are proposed.

While continuing with its Salvation Recovery and Development Programme designed to upgrade the water supply ratio nationwide, the Government of the Sudan is seeking to overcome the flood damage by working out an emergency reconstruction programme of its own.



Table 4 Actual Record of Water Yards Constructed by the NCDRWR

	Actual record of water yards constructed:		
	1984/85	1985/86	1986/87
Northern Region	7	11	8
Central Region	46	33	89
Kordofan Region	9	3	14
Darfur Region	3	4	8
Khartoum Region	-	-	25
Eastern Region	1	3	1
Total	66	54	145

## 2.3 Damage Caused by the Heavy Rain and Flood

### 2.3.1 Damage of Water Supply Facilities and Necessity of Reconstruction

In August to September, 1988, the Ethiopia Highlands in the Nile basin, the Blue Nile basin, the higher reaches of the Atbara (a branch of the Nile), and the Khartoum Region were struck by extremely heavy rainfall, in which rainfall exceeding the annual average was recorded occasionally (= 200 mm/day) for 3 weeks. This caused flooding in both the Nile rivers and the Atbara, as well as in numerous wadis flowing into the Nile, and resulted in serious disaster in six (the Northern, the Central, Kordofan, Darfur, Khartoum, the Eastern) of the nine regions (the Northern, the Central, Kordofan, Darfur, Khartoum, the Eastern, Bahr El Ghazal, Upper Nile, Equatoria) of the Republic of the Sudan.

Extremely serious was the damage that occurred to mud-build houses and agricultural irrigation systems, as well as water supply facilities of villages struck by the flood. Shown below is the number of damaged water supply facilities. The table below only indicates seriously damaged facilities in higher priority sites designated by the nationwide reconstruction project.

Especially, the Northern, the Central and Kordofan Region were seriously damaged. In total, the numbers of damaged facilities are Water Yards: 400, water supply facilities using surface water: 34, Hafir/Dam: 28

Water Supply Facilities Damaged by Flood

Water Facility Type Damage Water Supply Area	Water yards	Surface waters facilities	Hafirs and dams
Northern Region	80	20	-
Darfur Region	61	2	10
Kordofan Region	81	1	2
Central Region	165	2	10
Eastern Region	3	5	6
Khartoum Region	10	4	-
Total	400	34	28

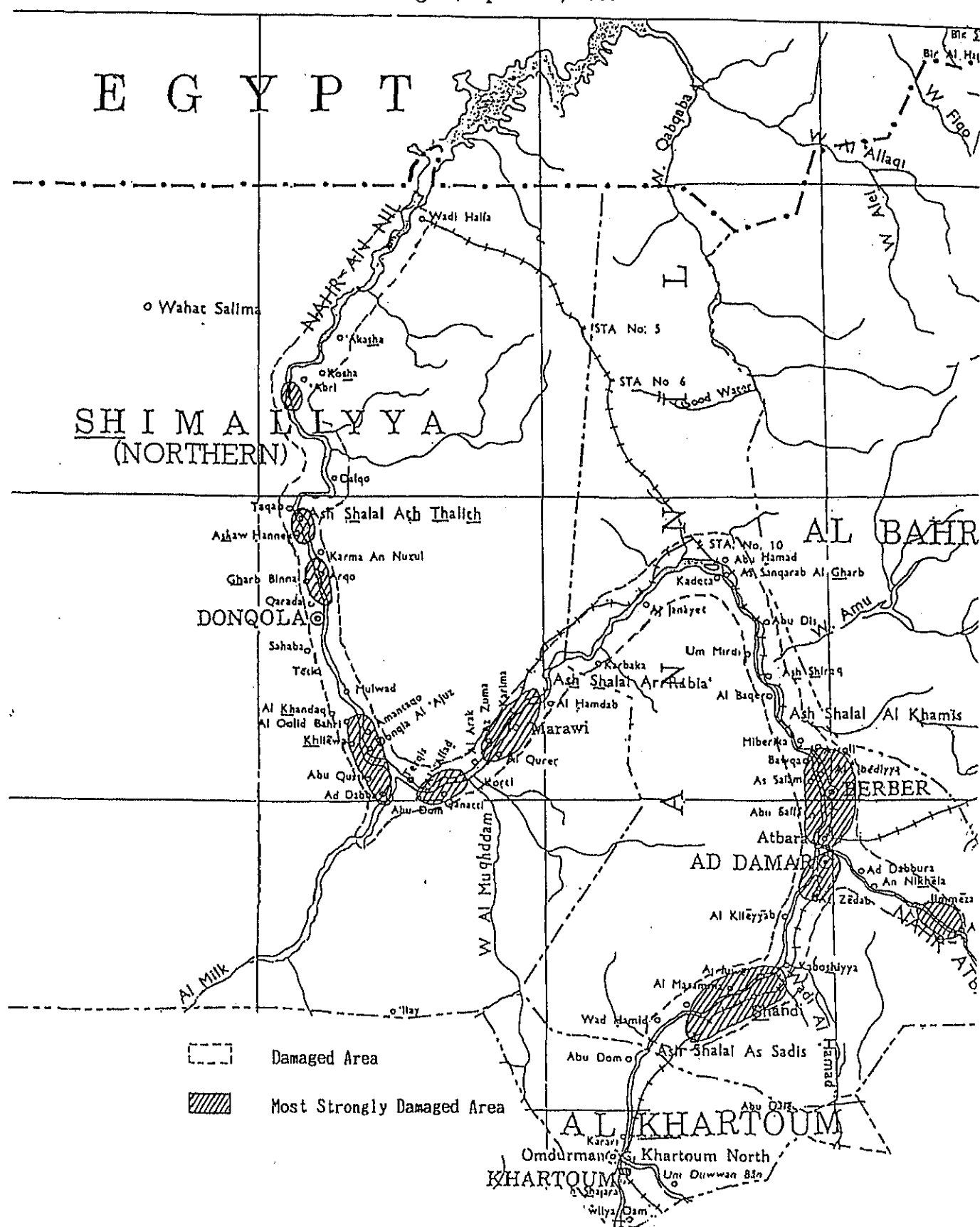
The damaged existing water supply facilities are mainly 1) Water Yards and 2) Water Supply Facilities using surface water.

We described below the damage in the Northern Region, where the reconstruction of existing water supply facilities damaged by the flood are proposed.

(1) Flood Damage in Northern Region

Scattered in the irrigated green zone (1 to 2 km in width) along the Nile river and also along the Atbara, villages in the Northern Region are mostly concentrated in the area with convenient transportation means. Most homes are single-story and made of mud, surrounded by mud walls. This type of fragile construction material is used for housing, since normal rainfall of the region has remained 0 to 100 mm annually, and the area has scarcely been damaged by flood or rainfall. As a result of the flood which caused the Niles' water levels to rise about 8 m, followed by the water remaining undrained for 15 to 30 days thereafter, houses built on alluvial low land of 6 to 7 meters above the Nile river levels have completely vanished in most places leaving behind only iron doors and stone pillars, with former residents forced to live in tents. To fight the river water flooding, many villages have surrounded themselves with sandbags extending 1 to 2 km in distance and 1 to 2 m in height. While some villages are located with a height of several meters above the surrounding plains, the majority are almost level with riverbanks, reflecting a plain-oriented geographical feature of the nation, the fact of which added to the extent of damage suffered. Fig. 5 indicates flood damaged areas and the most seriously damaged area of the Northern Region.

Fig. 5 Damaged Area Caused by Flood Disaster and Rainstorm Which  
Occurred in August/September, 1988



1) Flood Damage of Water Yards

Due to the flood of 1- to 2-meters above the river water level, existing water supply facilities are forced to stop operation with pumping machines (diesel engine driven, bore hole pump with a belt) submerged and the shafts and the engines badly rusted. Furthermore, the vast inflow of sand accompanying the flood caused pump houses, elevated tanks, and fences to be submerged 50 cm underground. Some elevated tanks were slanted after their foundations were washed away in the flood.

2) Flood Damage of Surface Waters Facilities

Water supply facilities using surface water function in the following manner: 1) pumping up water (muddy water containing clay and organic substances) from the Nile; 2) feeding the water into a sedimentation basin, filtering basin, and storage tank located close to the river bank; 3) sending the water up to an elevated tank. Booster pumps were submerged and badly rusted as in the case of pumping machines in water yards. Some concrete sedimentation basins and filtering basins (5 m in diameter and 4 m in depth) were forced out of use with their bottom submerged by the vast inflow of river water and sand.

## (2) Necessity of Reconstruction

Normally a village with a population of several thousands to several tens of thousands with a population is covered by one or two water supply facilities, thus resulting in insufficient output of water. Inhabitants seek to counter the insufficiency with the water of traditional, hand-dug shallow wells or by direct intake of water from the Nile, but these measures are considered unfavorable in terms of sanitation. A pressing needs exists for construction of water wells.

For example, the normal pumping amount of water yards operated in the Northern Region is 3,500 gallons per hour (265 liters per minute). The normal operating hours being 8 to 10 hours, the water supply will be as follows with 10 hours of daily operation:

$$\begin{aligned}\text{Water supply} &= 3,500 \text{ gallons/hour} \times 10 \text{ hrs.} = \\ &159 \text{ m}^3/\text{day}\end{aligned}$$

On the other hand, the standard water supply in the Republic of the Sudan is established as follows:

20 liters per capita per day:	Nomads + livestock
40 liters per capita per day:	Semi-nomads + livestock
80 liters per capita per day:	General area covered by rural water supply

Considering the standard water supply for a general rural area to be 80 liters per capita per day, the average water supply facility in the Northern Region only proves satisfactory for 1,990 people. This means a continuing lack of water supplied by existing wells, over the average population of 7,500 per village (averaged by 125 villages). With the water supply facilities of miniscule capacity over existing demand damaged by the flood, inhabitants are forced to suffer a radical water shortage. Therefore, villages are making petitions to the competent agency of the NCDRWR for reconstruction of water supply facilities. In fear of another flood, many villages that suffered damage along the Nile are starting to move to relatively high sandhills (4 to 5 m high) adjacent to the alluvial low land. These factors create another pressing need for construction of water supply facilities.

#### 2.4 Present Status and Trends of International Cooperation in Rural Water Supply

For the improvement of the rural water supply in the Republic of the Sudan, various kinds of foreign aid programs including those from international organizations are presently in operation. For the development plan for improvement of rural water supply conditions, foreign assistance occupies a fairly large percentage, and depending on each aid organization, there are special characteristics in the project areas for development and the contents of the project. For the projects which were in operation before 1987 only, the funds offered are separately listed.

Name of fund/project	Project Area	Project Cost	Period
(1) Arab fund (Rural Water Supply Project)	Kordofan Region	K.D. 1.8M	1983~1984
	Shallow well construction (250 wells), construction of filtration devices (40), dams (40 locations)		
(2) Holland	Kordofan Region	Gilder 2.5M LS 1.8M	1986~1988
	Improvement of Water-yards (54 locations)/construction of parts other than water supply wells (230 locations)/constructions at 11 locations		
(Western Savannah Project)	Darfur Region	USD 4.5M	1986~1988
	Water supply to villages/management of water resources		
(3) Ireland (Central region Rural water supply project)	Central Region	USD 2.5M	1986~1989
	Construction of water-yards at 50 locations and equipment and material aid, technical assistance		
(4) USAID (Emergency Assistance)	Kordofan Region	USD 0.8M	1986~1988
	Rehabilitation of water supply facilities for 30 small villages and plan for improvement of hygienic conditions		
(Blue Nile Health Project)	Central Region	-----	1979~1988
	Improvement of village water supply systems/installation of slow speed filtration devices		
(5) Yugoslavia (Rural Water Supply Development Plan)	Whole country	USD 58.4M	1979~1988
	Construction of maintenance centers (45 locations)/Rehabilitation of water yards (100 locations), Equipment and material aid in the form of 85 trucks, 300 water-yards, donation of 84 short wave radios		



Name of fund/project	Project Area	Project Cost	Period
(6) Italy (Nubian Sandstone Project)	Northern Region	USD 2.6M	1987~ (?)
	Drilling Equipment for Research and Development of Water Resources in Nubian Sandstone Area		
(7) Kuwait - Arab fund	Kordofan Region	USD 2.5M	1987~1990
	Rural water supply plan for Al Obayyid area in Kordofan Region		
(8) UNDP (Rural Water Supply Development Plan)	Darfur state southern part	USD 2.5M	1987~1990
	Water supply to cities of Buram Zaringei, Ed Dafin, (hand pumps for bore holes). Strengthening of managerial and technological ability of NCDRWR and NOWC		
(9) UNICEF (South Kordofan Water Supply and Sanitation Project)	Kordofan Region Southern part	USD 7.2M LS 0.9M	1979~1991
	Installation of 2500 hand pumps for bore holes. Foundation of maintenance control systems at the village level.		
(Northern Kordofan Water Supply and Sanitation Project)	Kordofan Region Northern part	USD 3.0M LS 0.5M	1985~1991
	Contents are the same as for Kordofan State southern part		
(South Sudan Water Supply and Sanitation Project)	South Sudan	-----	1979~1991
	The contents of the Project are the same as for Kordofan State but due to the internal war, the project has been abandoned. However, the number of completed water supply facilities are very few.		

Name of fund/project	Project Area	Project Cost	Period
(Red Sea water supply and sanitation project)	Eastern region	USD 3.0M LS 0.2M	1984~1988
	Water supply improvement plan for Sinkat region 90 km south west of Port Sudan, construction of 238 bore holes, due to salt water intrusion, the development was abandoned in the year 1988.		
(10) WHO (Blue Nile Health Project)	Central Region	-----	1979~
	Control of Water bore Diesel and Sanitation Project		
(11) World Bank (Western Savannah Project Phase II)	Kordofan Region	USD 7.8M	1988~
	Integrated agricultural development project including Improvement and Rehabilitation of Rural water supply		
(Gezira Area Rehabilitation Project)	Central Region	USD 15.3M	1983~
	Irrigation rehabilitation programme including improvement plan for Rural Water supply Total project expenditure 263.0M		
(12) West Germany (Rural Water Supply)	Northern Region Central Region	DM 10.6M	1984~
	Construction of water yards at 45 locations Enforcement of sanitation improvement plan		
(Shallow wells and hand pumps plan)	Darfur Region	-----	Presently under construction
	Construction of shallow wells with hand pumps.		

Name of fund/project	Project Area	Project Cost	Period
(Plan of technical cooperation with NCDRWR)	Darfur Region	-----	Completion in 1989.
	Technical cooperation with NCDRWR (Management, Maintenance control, Sanitation improvements)		
	Darfur Region	-----	Completion in 1989.
	Groundwater Development Survey		
(13) Denmark	Central Region/ northern Region	Not fixed.	Not fixed.
	<p>In the 1960~1970 periods, as loan/free aid from Denmark, pumps and engines were donated to the Central/Northern regions.</p> <p>With these pumps and engines becoming old, there is a policy of renewal of these items in every 3 year development plan but these are plans only and the prospects of actual execution of these plans are still dim at the present stage.</p>		

[Data Source: Water Supply and Sanitation Sector Review (1986), UNDP/World Bank Project, and data collection from the Embassy of West Germany, the Embassy of Denmark, and the UNICEF Office]

## 2.5 Process and Content of Request

### 2.5.1 Process of Request

In the months of August and September 1988, due to torrential rains and overflow of the Nile river, the northern region of the Sudan was faced with an unprecedented flooding. For restoration of the devastated existing water supply facilities and for shifting the people to a safe area along with installations of new water supply facilities, the Government of the Sudan made a request for Grant Aid of equipment and materials to the Japanese Government in December 1988. This request contains, for the Northern Regions, restoration of the existing water supply facilities which were damaged and a list of spare parts necessary for operation and maintenance of supplied equipment and materials along with the following as an operation plan: (1) the damage inflicted in the Northern Regions was extremely serious, and if the Project is executed with concentration restricted to this region only, the needs will be satisfied and it will be most effective, (2) damage was incurred on the existing water supply facilities in 80 locations. The names of the main cities and towns where the restoration operations should be carried out and the number of damaged water supply facilities (water yards) were, Shandi (25 sites), Ad Damar (20 sites), Karima (15 sites), Dongola (20 sites). To carry out restoration operations in each of the 4 locations, operation groups are needed. Each group is to consist of a maintenance engineer (1 person), technicians (4 persons), laborers (4 persons). (3) Regarding the local budget for disaster restoration in the Northern Region, it is explained that because the

flood occurred at the start of the financial year 1988/89, there was a strong possibility that the final budget amount would exceed the original budget amount.

In response to this request, the JICA dispatched a Basic Design Study Team to the Republic of the Sudan from January 25, 1989 to February 28, 1989. The study Team confirmed the content of the request made by the Government of the Sudan and signed the Minutes of the Meeting (refer to Appendix 4). In comparison of the contents of the original request and the Minutes of the Meeting, out of the request for equipment and materials (A) Rehabilitation equipment and materials, (B) Equipment and materials for well drilling, (C) Materials for construction of 30 water yards, (D) Equipment and materials for construction of water supply facilities using surface water, other than making additional requests for vehicles within the equipment and materials in (C) and (D), there was no appreciable difference, and the original request was almost completely preserved. The scale and magnitude of the equipment and materials including of the types of vehicles would be determined by the Basic Design Study Team as described in a later chapter, with due consideration to the needs and, effectiveness.

Furthermore, in this Project, spare parts needed for operation and maintenance of the equipment and materials supplied under Japanese Grant Aid for the Rural Water Supply Improvement Project in the year 1982/83 are also included.

## 2.5.2 Content of Request

Equipment and materials needed to restore the existing water supply facilities damaged by flooding in the Northern region and the supply of spare parts for operation and maintenance of the equipment and materials owned for the Northern, Central, Kordofan, Darfur and Eastern Regions were requested by the Government of the Sudan. The content is comprised of the following 5 items:

- (1) Equipment and Materials Needed for the Repair and Restoration of Existing Water Yards and Water Supply Facilities Using Surface Water in the Northern Region.
  - (a) Materials needed for replacement of water wells of water yards, pumps, elevated tanks
  - (b) Pumps for water supply facilities using surface water, transmission pipes and pipe fittings, vehicles for transportation of construction materials and laborers
- (2) Equipment and Materials for Construction of 30 New Water Yards in the Northern Region (materials for water wells, pumps, elevated tanks, transmission and distribution materials for pump houses, etc.)
- (3) Equipment and Materials for Construction of 20 New Water Supply Facilities using Surface Water in the affected Northern Region (intake and booster pumps, elevated tanks, transmission pipes, etc.).
- (4) Equipment and Materials for Construction of Water Wells

(5) Spare Parts Needed for Operation and Maintenance of Equipment Already Supplied

- o Well drilling rig and other related equipment
- o Vehicles
- o Pumping equipment

Requested equipment and materials are detailed as follows:

Content of Equipment and Materials Requested

(1) Rehabilitation of Water Supply Facilities (water yards, water supply facilities using surface water) (including new construction of 14 wells)

1)	Casing pipe	ø6 5/8 inch	16,000 feet
	Screen	ø6 5/8 inch	1,600 feet
2)	Pumping equipment	Deep well pump and engine	80 sets
	(Water yards)		
	(Water supply facilities using surface water)	Intake pump and engine	10 sets
		Transmission pipe and pipe fittings (PVC. 2,000 m)	10 sets
3)	Elevated tanks	50 m <sup>3</sup>	20 each
4)	Vehicles		
	a) Pick up	4 x 4	4 each
	b) Trucks	4 x 2, 7 ~ 8 tons	4 each
	c) Trucks	6 x 4, 12 ~ 15 tons	2 each

(2) Construction of New Water Yards

1)	Casing pipe	ø6 5/8 inch	24,000 feet
	Screen	ø6 5/8 inch	2,400 feet
2)	Pumping machines	Deep well pump and engine	30 sets
3)	Elevated tanks	50 m <sup>3</sup>	30 sets
	Transmission pipe and pipe fittings (Steel)		30 sets
4)	Pump house	Corrugated sheets formed steel	30 sets
	Surrounding fence for water yard	Formed steel, barbed wire	30 sets

(3) Construction of New Water Supply Facilities Using Surface Water

1)	Pumping machines	Intake pump and engine	45 sets
2)	Elevated tank	50 m <sup>3</sup>	20 each
	Transmission pipe lines (PVC)	2,000 m	20 sets



(4) Deep Well Construction Equipment

- |    |  |                         |        |
|----|--|-------------------------|--------|
| 1) | Well drilling machines   | Rotary type             | 1 each |
| 2) | Vehicles   |                         |        |
| a) | Trucks   | with 12 ~ 15 tons crane | 1 each |
| b) | Water tank truck   | Capacity 2,000 gallons  | 1 each |
| c) | Fuel tank truck  | Capacity 1,000 gallons  | 1 each |
| d) | Truck  | 6 x 4, 12 ~ 15 tons     | 1 each |
| e) | Pick up  | 4 x 4                   | 1 each |
| 3) | Electric logging system  |                         | 1 each |
| 4) | Water pump test unit   |                         | 1 each |
| 5) | Vehicle mounted with air lifting equipment & development tools |                         | 1 set  |

(5) Spare Parts Needed for Operation and Maintenance 1 sets

Well drilling machine (Rotary)	TRD-300S
Well drilling machine (Percussion)	SM-22T
Servicing machine	MK-10SC
Deep well submersible pump	PMU
Generator	DCA40A1
Generator	MEG-101-N0109BC
P & H Crane	T220
Cargo truck	TK-80G
Engine	TS-155SE
Pump	3-140KS



### CHAPTER 3 GENERAL CONDITIONS OF THE PROJECT AREA



## CHAPTER 3 GENERAL CONDITIONS OF THE PROJECT AREA

### 3.1 Project Area

The Project areas are as follows:

- 1) The area along the Nile River in the Northern Region where existing water supply facilities have been damaged by the flood.
- 2) The area where Regional provincial offices and operation and maintenance centers of the NCDRWR are located in the Northern Region.
- 3) The Regions (Central, Kordofan, etc.) where equipment and material for construction of water supply facilities under grant aid of the Japanese Government in 1982/83 were distributed.
- 4) The capital, Khartoum, where the head offices of the NCDRWR and related agencies are located.

In this Project, the main importance is given to the restoration of the existing water supply facilities devastated by floods in the Northern Regions; for other Regions, the requirement is only an examination for replenishment of spare parts of equipment and material already granted. First, the particulars of Project Area in the Northern Region are described.

The Northern Region as the name indicates is the area which occupies the northern part of the Sudan extending from latitude 24 - 35.5 E, longitude 16.5 - 22 N, having a total area of 477.079 km<sup>2</sup>. Out of this, 94.500 km<sup>2</sup> is desert, 11.500 km<sup>2</sup> is semi-desert, and 25.000 km<sup>2</sup> is the deluged area along the Nile river.