JAPAN INTERNATIONAL COOPERATION AGENCY

THE REPUBLIC OF ZAMBIA
MINISTRY OF ENERGY AND WATER DEVELOPMENT
DEPARTMENT OF WATER AFFAIRS

IMPLEMENTATION REVIEW ON THE PROJECT FOR THE RURAL WATER SUPPLY DEVELOPMENT PHASE III IN THE REPUBLIC OF ZAMBIA

MARCH, 1993

JAPAN TECHNO CO., LTD.

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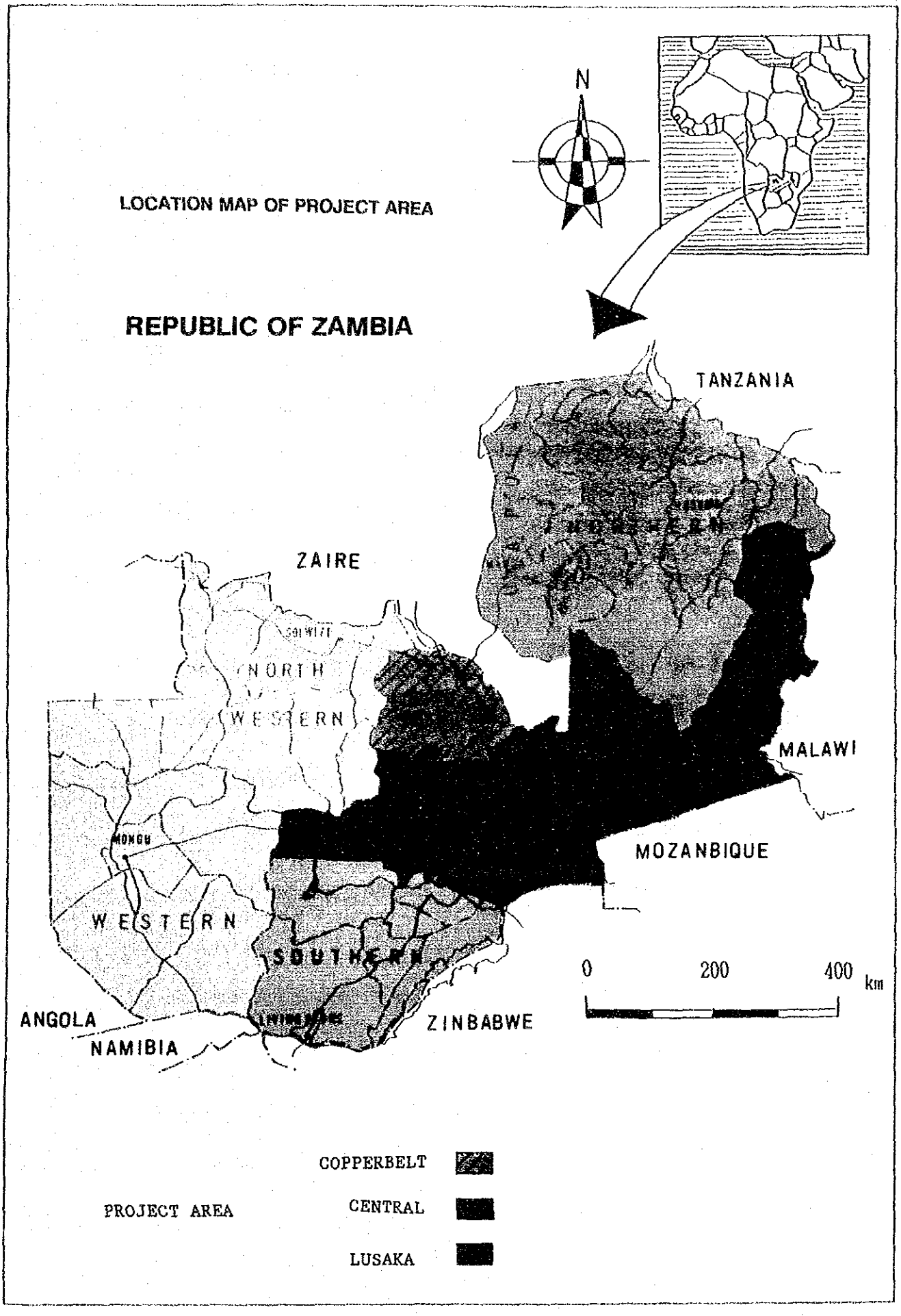
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REPUBLIC OF ZAMBIA
TANZANIA
ZAIRE
NORTH
WESTERN
MALAWI
MONGU
MOZANBIQUE
WESTERN
SOUTHERN
0
200
400
km
ANGOLA
NAMIBIA
ZINBABWE
COPPERBELT
PROJECT AREA
CENTRAL
LUSAKA

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LIST OF ABBREVIATIONS

DWA	Department of Water Affairs
E/N	Exchange of Notes
IDWSSD	International Drinking Water Supply and Sanitation Decade
JICA	Japan International Cooperation Agency
RAs	Rural Area Water Supplies
RTs	Rural Townships Water Supplies
SUTs	Small Urban Townships Water Supplies
WHO	World Health Organizations

SUMMARY

SUMMARY

The Republic of Zambia is located in the south of Central Africa, covers an area of 752,614 km², and has an estimated population of about 8.3 million in 1992, 42% of which being the urban population while 58 % being the rural population. Despite its location in the tropical zone extending from 8 Degree to 18 Degree in the southern latitude, Zambia has a rather moderate climate of tropical savanna nature, owing to its geographical position lying on a high plateau of 900 m to 1,500 m in altitude. The wet and dry seasons are distinctly divided in the year. The wet season starts in November and ends in April of the next year whilst the dry season begins in May and finishes in October. However, the rural inhabitants have been suffered from the scarcity of drinking water because severe droughts have hit Zambia several times since 1980's.

The Department of Water Affairs (DWA) in the Ministry of Energy and Water Development (MEWD) is an official institution directly concerned with the implementation of rural water supply schemes, being in charge of investigation, planning, execution and management of the nationwide Rural Area Water Supplies as well as administrative and technical support for water supplies for Small Urban Townships and Rural Townships. Its activities further involve a broad range of technical and engineering assistance at a national level to the Government's planning for the development and conservation of national water resources including both groundwater and surface water.

In the past, the Japanese assistance in this sector was extended to Zambia in two phases in 1985 and 1988 under the title of "Groundwater Development Project in the Republic of Zambia, Phase I and Phase II", in response to the requests of the Zambian Government for improving the deteriorated water environment of Southern Province after consecutive years of drought since 1981. Under the project, 222 borehole facilities were completed (43 + 32 = 75 by the Japanese side, and 59 + 88 = 147 by the Zambian side) and rehabilitation works of the existing water facilities at 100 sites

were carried out. The successful performance of those projects was highly appreciated by the Government of Zambia, and led to a renewed request (the Basic Request) for grant aid presented in 1990 to the Government of Japan for the purpose of installing boreholes with water facilities at 200 sites in the three Provinces of Lusaka, Central and Copperbelt, where the coverage of water service still remains at an extremely low level of 24 percent despite their overriding position in the Government's policy for agricultural development.

The Government of Japan responded to this request to conduct a basic design study. Based on this decision, Japan International Cooperation Agency (JICA) dispatched a basic design study team to the Republic of Zambia from November 11 to December 20, 1990 and the Basic Design Study was reported in April 1991 (the B/D). Thus, a new project started in 1991, under a Japanese grant aid programme, entitling "the Project for the Rural Water Supply Development Phase-III" (the Basic Project) in the three Provinces. The followings are the summary of the Basic Project.

1.	Construction of Boreholes (200 sites)
2.	Rehabilitation Works of Existing Boreholes (100 sites)
3.	Procurement of Equipment and Materials for Groundwater Development and Maintenance 1) Drilling Rigs, Tools and Accessories 2) Materials for Construction of Boreholes 3) Survey Equipment 4) Hand Pumps 5) Vehicles Supporting Operations 6) Equipment/Tools for Repair and Maintenance of Supplied Equipment, with Spare Parts
4.	Installation of the Project Operation Base for Storage and Sustained Maintenance of Supplied Equipment

In view of the difficult situation, the Basic Project has been aimed at urgently enhancing the coverage of rural water supplies and improving the degenerated water environment through the construction of new boreholes at 200 Sites and the rehabilitation of existing boreholes at 100 Sites. It is also being intended to provide technology transfer through the execution of the Project to counterpart staffs of the DWA regarding hydrogeological survey, drilling work, and operation and maintenance of water facilities, so that they could deploy their own rural water supply programme after the completion of the Project, employing the procured equipment and materials. In addition, the

Basic Project included a plan to provide the Project Operation Base as the project control centre and as a Depot in Kabwe of Central Province, where is the most geologically convenient for the effective implementation of the Project, in order to rationally plan, manage, operate and maintain and to securely stock the equipment and materials procured under the Project.

The Basic Project further encourages the inhabitants to directly participate in the management, operation and maintenance of the completed facilities and provides them training to improve their perception of health and sanitation.

Regarding the implementation schedule, the most appropriate framework is judged to split the whole work into five (5) stages, taking into account the period for the procurement of the equipment and materials and difficulty with inland transportation arising out of Zambia's landlocked position as well as constrains in filed work during wet seasons.

After the Project started in 1991, Zambia was hit by a historically severe drought in nation-wide in 1991 and 1992. For instance, the maize, one of the most important crop in Zambia, were most died before harvest due to the abnormal drought without rainfalls from December, 1991, even in a wet season. Also most of hand-dug wells and shallow wells, which were mostly the only sources of water supply in rural areas, were dried-up during this disastrous period due to the lowered water table by 10 meters or more. Many deaths of human beings and livestock were reported in those days because of the epidemic diseases of water borne like cholera and it became a social problem to know that a large number of rural inhabitants were travelling to look for water for people and cattle along 4 to 10 km distance. The DWA undertook the assessment survey of the impacts of prevailing drought from March 2 to March 19, 1992 for each Province in the national scale, and the DWA established the Drought Relief Programme in April 1992, requesting the urgent support to donor countries, declaring as disaster areas, parts of Southern, Western, Lusaka, Central and Eastern Provinces, and implementing the immediate measures of the drilling new boreholes, the rehabilitation works for existing non-functional boreholes, the construction and rehabilitation of wells and the rehabilitation works for dams.

Then, the DWA requested the Government of Japan in December 1992 to revise the Japanese Project in implementation as "the Project for the Rural Water Supply Development Phase-III" to link with the above-mentioned Drought Relief Programme, to accelerate the implementation schedule and to increase the number of sites in December 1992 (the Revised Request).

The Government of Japan decided to respond to the Revised Request to review the implementation programme which is expected to be executed after 1993, and JICA carried out "the Implementation Review on the Project (the Implementation Review)" as the review study works in Japan from the beginning of February to the end of March 1993. The questionnaires were sent to the Zambian government side for confirmation on the revised implementation schedule and this report was prepared based on their replies. The followings are the conclusions of the Implementation Review (the Revised Project).

The Basic Project now in implementation was to complete 200 borehole with water facilities in five stages. Stage-1 (1991/92) and Stage-2 (1992/93) of the Project started and 79 Project Sites will be completed by March, 1994. The Basic Project was to complete rest of 121 Sites in third through fifth Stages. The review of the Revised Request revealed that the present two units of drilling rigs are insufficient for the shortening of the implementation schedule and that the solution would be the increase in the number of drilling rigs from 2 to 3. If the number of drilling rigs is increased, the targeted total 200 Sites of borehole construction can be completed and another 20 Sites of borehole construction can be expected to be completed. The followings are the summary of the implementation schedule of borehole construction based on the review of the Revised Request.

PROVINCE	District	Revised Plan No. of Borehole	Stage-1 1991/-2	Stage-2 1992/93	Stage-3	Stage-4
LUSAKA	Lusaka Rural	65	10	11	34	10
	Luangwa	10	0	10	0	0
CENTRAL	Kabwe Rural	30	10	0	7	13
	Mukushi	30	0	30	0	0
	Mumbwa	20	0	8	12	0
	Serenje	15	0	0	0	15
COPPERBELT	Ndola	50	0	0	0	50
Total		220	20	59	53	88

The rehabilitation works for existing boreholes with water facilities are also being implemented in three Districts of two Provinces at 100 Sites, and 56 rehabilitation works will be completed in the ongoing Stage-1 (1991/92) and Stage-2 (1992/93). In view of present performance, 104 rehabilitations works will be completed in Stages -3 and -4 by increasing 60 Project Sites. The followings are the Summary of the revised implementation schedule for the implementation works.

PROVINCE	District	No. of Rehabilitation Works	Stage-1 1991/92	Stage-2 1992/93	Stage-3	Stage-4
LUSAKA	Lusaka Rural	90	1	45	44	-
	Luangwa	10	-	10	-	-
CENTRAL		20	-	-	20	-
COPPERBELT	Ndola	40	-	-	-	40
Total		160	1	55	64	40

The Revised Project for Stages -3 and -4 can be summarized as follows:

1.	Construction of Boreholes (141 Sites)
2.	Rehabilitation Works of Existing Boreholes (104 Sites)
3.	Procurement of Equipment and Materials for Groundwater Development and Maintenance 1) Drilling Rig, Tools and Accessories 2) Materials for Construction of Boreholes 3) Survey Equipment 4) Hand Pumps 5) Vehicles Supporting Operations 6) Equipment/Tools for Repair and Maintenance of Supplied Equipment, with Spare Parts
4.	Repair and Reinforcement of the Project Operating Base

The Zambian side is expected to be responsible as follows for the execution of the Project:

1) The provision of land necessary for the execution of the Project and the preparation of access roads to the said land.

2) The provision of necessary administrative measures for smooth execution of the Project including duty clearance, tax exemption, the furnishing of data and information, and bearing charges, etc.

3) The provision of necessary counterpart personnel and budget for the receiving the on-the-job-training. The cost of the said counterpart personnel during the Stages -3 and -4 is estimated to be Kwacha 33,350 = US$ 107,200.

4) The preparation of appropriate managing and maintenance organization with personnel, budget and back-up measures to the water committees of the Project Sites. The total maintenance cost is calculated to be Kwacha 30,920 = US$ 99,400.

5) The preparation of necessary utilities in connection with the repair and reinforcement works for the Project Operation Base.

The Revised Project is expected to yield such benefits and effects as follows:

1) This will be one of the immediate measures to relieve the drought problem in the drought affected area by providing the stable supply of safe drinking water in accordance with the drought relief programme.

2) An earlier realization of execution will be brought by the acceleration of the Project.

3) The increase in the total number of beneficiaries by the incremental Sites realized by the reinforcement of drilling and execution capabilities of the DWA.

4) The increase in the capabilities of drilling and development by the additional supply of necessary equipment and work force of the DWA which will benefit Zambia in the future after the completion of the Project.

CHAPTER I

INTRODUCTION

CHAPTER I

INTRODUCTION

1.1 BACKGROUND OF PROJECT

The Republic of Zambia is located in the south of the African Continent as a landlocked country with an estimated population of 8,300,000 (1992 Census), occupying an area of 752 thousand square km. Zambia has spent much efforts to make a united nation backed by its affluent mineral resources since the independence from the Great Britain. The nation had been struggling to promote the unity and economic development of the country headed by the former President K.D. Kaunda under the slogan of "ONE ZAMBIA ONE NATION" for 27 years since the independence. President Frederick Chiluba, since his election in autumn of 1991, has been devoting his enthusiasm to building up the nation through a more liberal and more democratic political system and the constructive introduction of a market economy.

Zambia has been striving to diversify the industrial sectors, to enhance the agricultural productivity and to boost the agricultural production in order to re-structure the national economy which has tended to excessively depend upon copper production and export. As a consequence, the Zambian government has given the highest priority to the rural water supply scheme among the national strategic programmes in the ongoing "Fourth National Development Plan (1989 - 1993) and also in the Action Plan for the UN's International Drinking Water Supply and Sanitation Decade (IDWSSD, 1981 - 1990) aiming at the improvement and upgrading of rural life, the settlement of rural population, the enhancement of agricultural productivity and the boost of agricultural production through the stable supply of sanitary potable water in the rural areas.

Under such circumstances, after evaluating and appreciating the past Japanese assistance as "Groundwater Development Project, Phase I and Phase II (hereinafter referred to as 'the Previous Project')", extended in 1985 and 1988, respectively, in this sector of Southern Province, the Government of Zambia submitted a request (hereinafter referred to as 'the Basic Request'), named as "The Project for the Rural Water Supply Development Phase-III", to the Government of Japan in 1990 for a grant aid to provide the water facilities with boreholes in 7 Districts of three Provinces of Lusaka, Central

and Copperbelt, where the water service coverage still remained extremely low of 24 % despite the overriding position in the national policies.

The Government of Japan conducted a basic design study from November 1991 in Zambia responding to the Basic Request, and furnished a basic design study report on it (hereinafter referred to as 'the B/D') in April 1991. The implementation schedule recommended by the B/D consists of

1) the procurement of equipment and materials
   - for groundwater development, including two units of drilling rigs to construct boreholes as water sources
   - for the maintenance of the completed water facilities
   - for the workshop of the Project Operation Base to store and maintain the supplied equipment

2) the construction of boreholes at 200 Sites

3) the rehabilitation works of existing boreholes at 100 Sites

4) the building of the Project Operation Base in Kabwe

5) the technology transfer to counterparts of the DWA through the implementation of the Project

6) the staged implementation in division of 5 stages in the said project area.

This is hereinafter referred to as 'the Basic Project'. And the Government of Japan has financed the first two stages of the Basic Project and now they are in implementation state: Stage-1 for the budget of 1991/92 and Stage-2 for 1992/93 (hereinafter referred to as 'the Ongoing Project').

In the mean time, Zambia was hit by a historically severe drought in 1991 and 1992.

1.2 OUTLINE OF DROUGHT RELIEF PROGRAMME, APRIL 1992

The average annual precipitation of Zambia generally increases towards the north, registering an average 700 mm per annum in the south, in Southern Province, and 1,300 mm in the north, Copperbelt Province. Luwingu in Northern Province, surrounded by ridges in three directions has the highest record of 1,500 mm on the average in the country (See FIG. 1 - 1). The wet and dry seasons are distinctly divided in the year; the wet season begins in November and ends in April of the next year and the dry season starts in May and finishes in October with the average rainy days per annum of 77 days in Southern Province, 84 days in Lusaka and Central Provinces and 97 days in Copperbelt Province.

In December 1992, a historically severe drought started in Zambia. The maize, one of major crops in Zambia, were most died without rains in the wet season. The situations became a sort of social problem when the rural inhabitants suffered from the disastrous shortage of water for people as well as for cattle all over the country in the dry season due to the lowered water table of groundwater and drying up of rivers and lakes.

The DWA undertook a survey to assess the impacts of the prevailing drought on water resources during the period of March 2nd to March 19, 1992 and declared the five drought disaster areas of Southern, Western, Lusaka, Central and Eastern Provinces (See FIG. 1 - 2). The assessment survey indicated and confirmed as follows:

1) 3,900 wells were needed to be rehabilitated, including 1,133 wells targeted for immediate works in 1992, out of total 7,470 wells of the areas.

2) 1,053 boreholes were needed to be rehabilitated, including 591 boreholes targeted for immediate works in 1992, out of total 2,548 boreholes of the areas.

3) 876 boreholes were needed to be constructed, including 87 boreholes targeted for immediate works in 1992.

4) 109 dams were needed to be rehabilitated, including 25 dams targeted for immediate works in 1992.

FIG. 1-1 DIAGRAM OF MEAN ANNUAL PRECIPITATION IN ZAMBIA (1992)

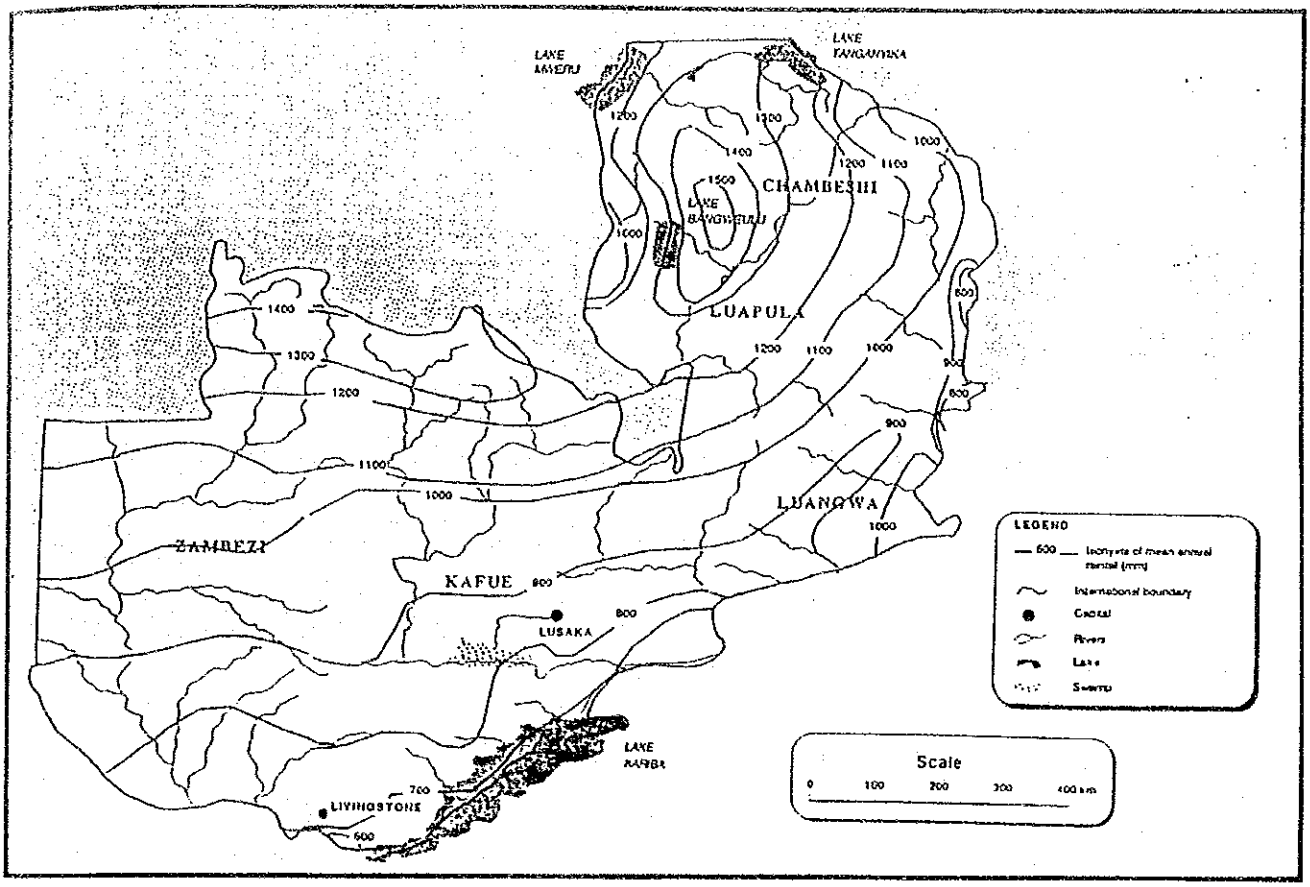
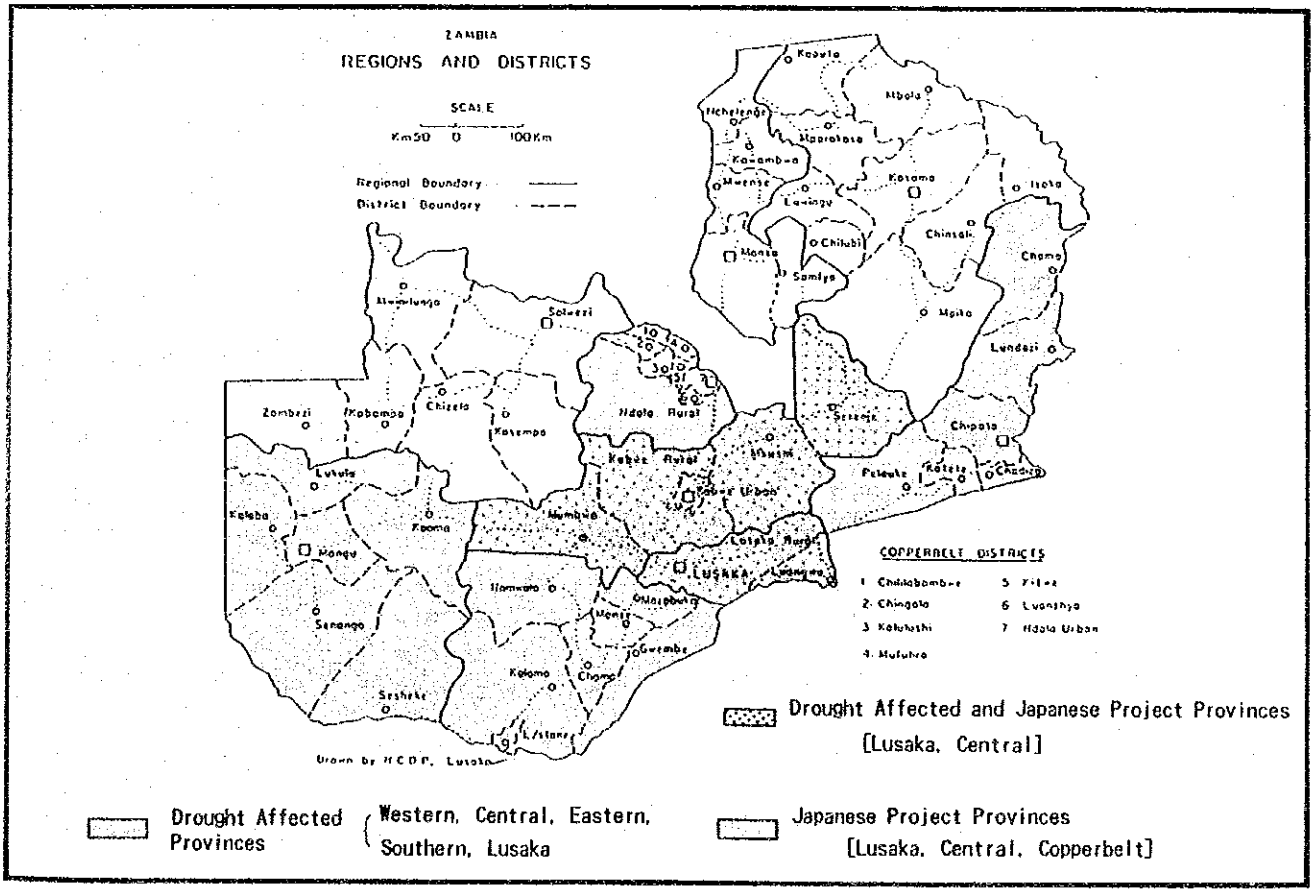


FIG. 1-2 DROUGHT AFFECTED PROVINCES AND JAPANESE PROJECT PROVINCES



The DWA estimated the total financial requirements necessary for the implementation of the drought relief programme at US $ 15 million, in the assessment survey report, and targeted to complete the drought relief programme within 2 or 3 years. TABLE 1 - 1 exhibits the break-down of the drought relief programme. And the DWA planned the counter measures to combat the impacts of the drought in Province-wise in the report as shown in TABLE 1 - 2.

TABLE 1 - 1 BREAK-DOWN OF DROUGHT RELIEF PROGRAMME

1)	Rehabilitation of Well : 3,900	Immediate Work in 1992: 1,133
2)	Rehabilitation of Boreholes : 1,053	Immediate Work in 1992: 591
3)	Construction of Boreholes : 876	Immediate Work in 1992: 87
4)	Rehabilitation of Dams : 109	Immediate Work in 1992: 25

TABLE 1 - 2 COUNTER MEASURES FOR DROUGHT BY PROVINCE

PROVINCE		WESTERN	CENTRAL	EASTERN	LUSAKA	SOUTHERN	TOTAL
Well	E	542	1,976	3,522	680	750	7,470
	R	364	722	1,895	332	587	3,900
	I	-	-	-	-	-	1,133
Boreholes	E	692	335	516	205	800	2,548
	R	0	212	411	127	303	1,053
	I	-	-	-	-	-	591
Boreholes	N	80	121	223	152	300	876
	I	-	-	-	-	-	87
Dams	R	4	6	10	2	87	109
	I	-	-	-	-	-	25

Where; "E" stands "Existing"
"R" stands "Rehabilitation"
"I" stands "Immediate Works in 1992"
"N" stands "New"
"-" stands "Unknown"

In August, 1992, Minister of Energy and Water Development instructed the DWA, as a political judgement, to make a practically accelerated implementation of the drought relief programme to respond the urgent request of the rural inhabitants by the completion of 1,000 boreholes within 6 months. Thus, the Government of Zambia urged the Japanese Government to investigate the possibility of the accelerated completion of borehole all at 200 Sites in the Stage-3 in three Provinces of Lusaka, Central and Copperbelt now under implementation, while the Zambian Government requested economic supports to the International Institutes and other donor countries.

1.3 REVISED REQUEST AND IMPLEMENTATION REVIEW

The Government of Zambia urged to revise the Basic Request when Zambia was hit by a historically severe drought in 1991 and 1992. The request (hereinafter referred to as 'the Revised Request') reached the Japanese Government in December 1992, aimed

1) to accelerate the implementation schedule of construction and rehabilitation to be completed by end of 1994 at the Sites where were supposed to be executed in the third through the fifth stages (the reduction of implementation stages from 5 to 3)

2) to increase the number of sites of construction and rehabilitation in line with the drought relief programme prepared by the DWA in April 1992.

The Government of Zambia raised the following measures for the implementation of the Project if necessary;

3) to procure incremental equipment and materials for groundwater development including the increase in number of drilling rigs from 2 to 3

4) to assure that the Zambian Government will take any measures necessary for the realization of the Revised Request in the Zambian side.

The Government of Japan decided, in response to the Revised Request, to conduct the implementation review for studying, reviewing and recommending to revise the Basic Project if necessary about:

1) the main works of implementation

2) the implementation schedule.

JICA, accordingly, conducted the implementation review (hereinafter referred to as 'the Implementation Review')in Japan from February to March 1993 while the questionnaires were officially dispatched to the DWA to have made sure the intention of Zambian side.

The details of the Implementation Study shall be described in CHAPTER II and the revised project planned (hereinafter referred to as 'the Revised Project') shall also be mentioned in CHAPTER III.

CHAPTER II

IMPLEMENTATION REVIEW

CHAPTER II

IMPLEMENTATION REVIEW

2.1 OUTLINE OF THE BASIC PROJECT

The following is the outline of the Basic Project concluded by the Basic Design Study (B/D) carried out in April 1991.

2.1.1 ELEMENTS OF BASIC PROJECT

Elements of the Basic Project are summarized as follows:

1.	Construction of Boreholes (200 sites)
2.	Rehabilitation Works of Existing Boreholes (100 sites)
3.	Procurement of Equipment and Materials for Groundwater Development and Maintenance 1) Drilling Rigs, Tools and Accessories 2) Materials for Construction of Boreholes 3) Survey Equipment 4) Hand Pumps 5) Vehicles Supporting Operations 6) Equipment/Tools for Repair and Maintenance of Supplied Equipment, with Spare Parts
4.	Installation of the Project Operation Base for Storage and Sustained Maintenance of Supplied Equipment

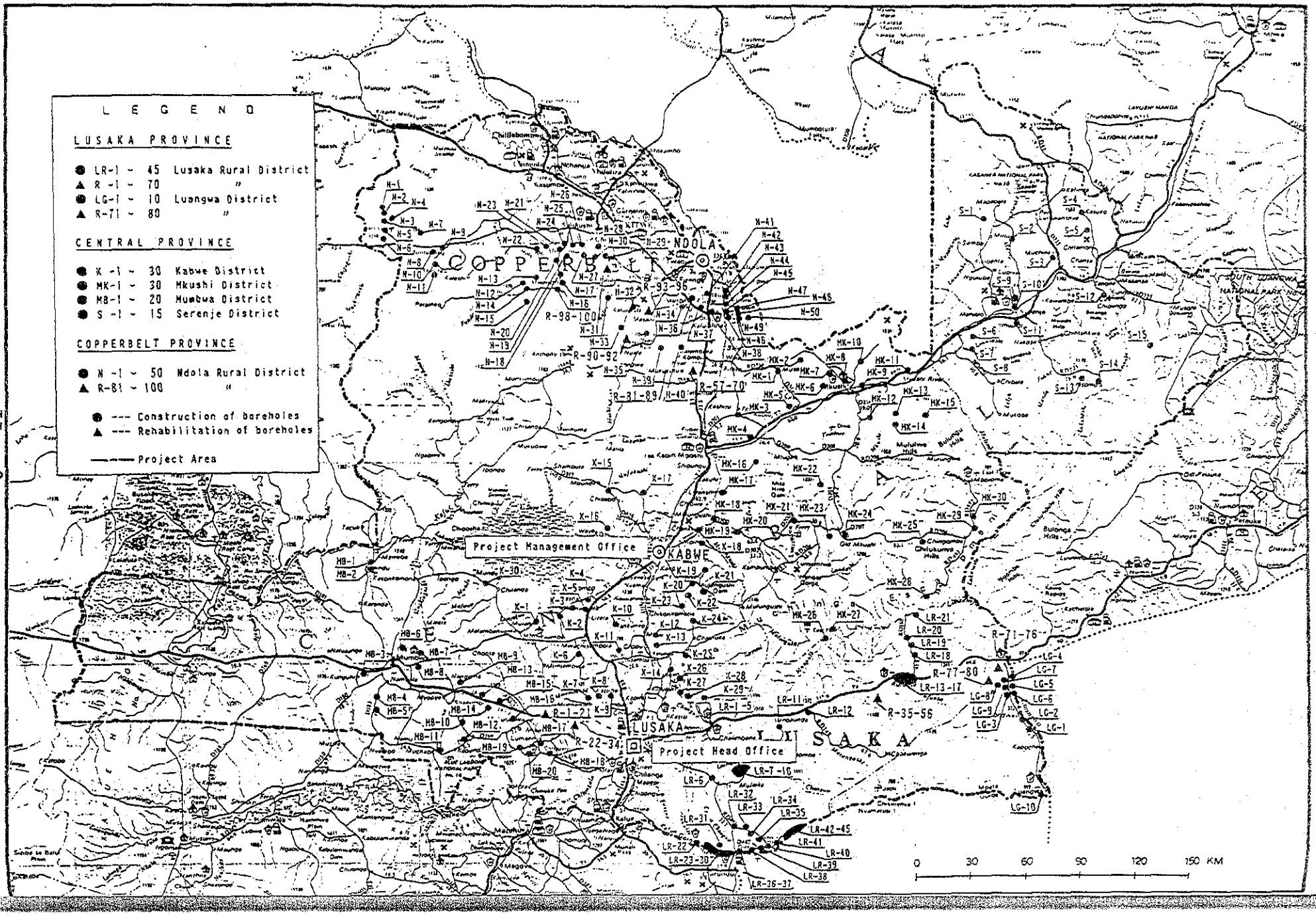
2.1.2 PROJECT SITES OF THE BASIC PROJECT

The location map of Project Sites is shown in FIG. 2 - 1. The Project Sites, and the number of borehole construction and rehabilitation are listed as follows and the name and population of each Site is exhibited in APPENDIX:

PROVINCE		District	Construction of Boreholes	Rehabilitation of Boreholes
1.	LUSAKA	Lusaka Rural Luangwa	45 sites 10 sites	70 sites 10 sites
2.	CENTRAL	Kabwe Rural Mkushi Mumbwa Serenje	30 sites 30 sites 20 sites 15 sites	* 0 site
3.	COPPERBELT	Ndola Rural	50 sites	20 sites
Total	3 PROVINCES	7 Districts	200 sites	100 sites

*In Central Province, the rehabilitation works are to be handled by German Project and deleted in this TABLE.

FIG. 2-1 LOCATION MAP OF PROJECT SITES (1991)



2.1.3 STAGE DESCRIPTION OF THE BASIC PROJECT

The Stages -1 and -2 are being implemented as under the budgets of 1991/2 and 1992/3 year, respectively. Therefore, this review should be limited to the 3rd stage through 5th stage of the Basic Project. The implementation schedule of the Basic Project was as below:

Stage	Description of Main Works
1st Stage (1991/92)	1) Procurement of equipment and materials for groundwater development 2) Construction of boreholes with water facilities (20 sites) 3) Rehabilitation of existing boreholes (1 site) 4) Construction of the Project Operation Base for storage and maintenance of equipment/materials
2nd Stage (1992/93)	1) Construction of boreholes with water facilities (59 sites) 2) Rehabilitation of existing boreholes (55 sites) 3) Procurement of equipment and materials for construction/rehabilitation of boreholes 4) Construction of the Project Operation Base (Continued from the 1st stage)
3rd Stage	1) Construction of boreholes with water facilities (40 sites) 2) Rehabilitation of existing boreholes (37 sites) 3) Procurement equipment and materials for operation & maintenance of the Project
Intermediate Evaluation	1) Review of the framework and progress of the Project as well as the style of assistance 2) Review of the Project cost
4th Stage	1) Construction of boreholes with water facilities (40 sites) 2) Rehabilitation of existing boreholes (7 sites) 3) Procurement equipment and materials for operation & maintenance of the Project
5th Stage	1) Construction of boreholes with water facilities (41 sites) 2) Procurement of equipment and materials for operation & maintenance of the Project

2.1.4 EXECUTING AGENCY

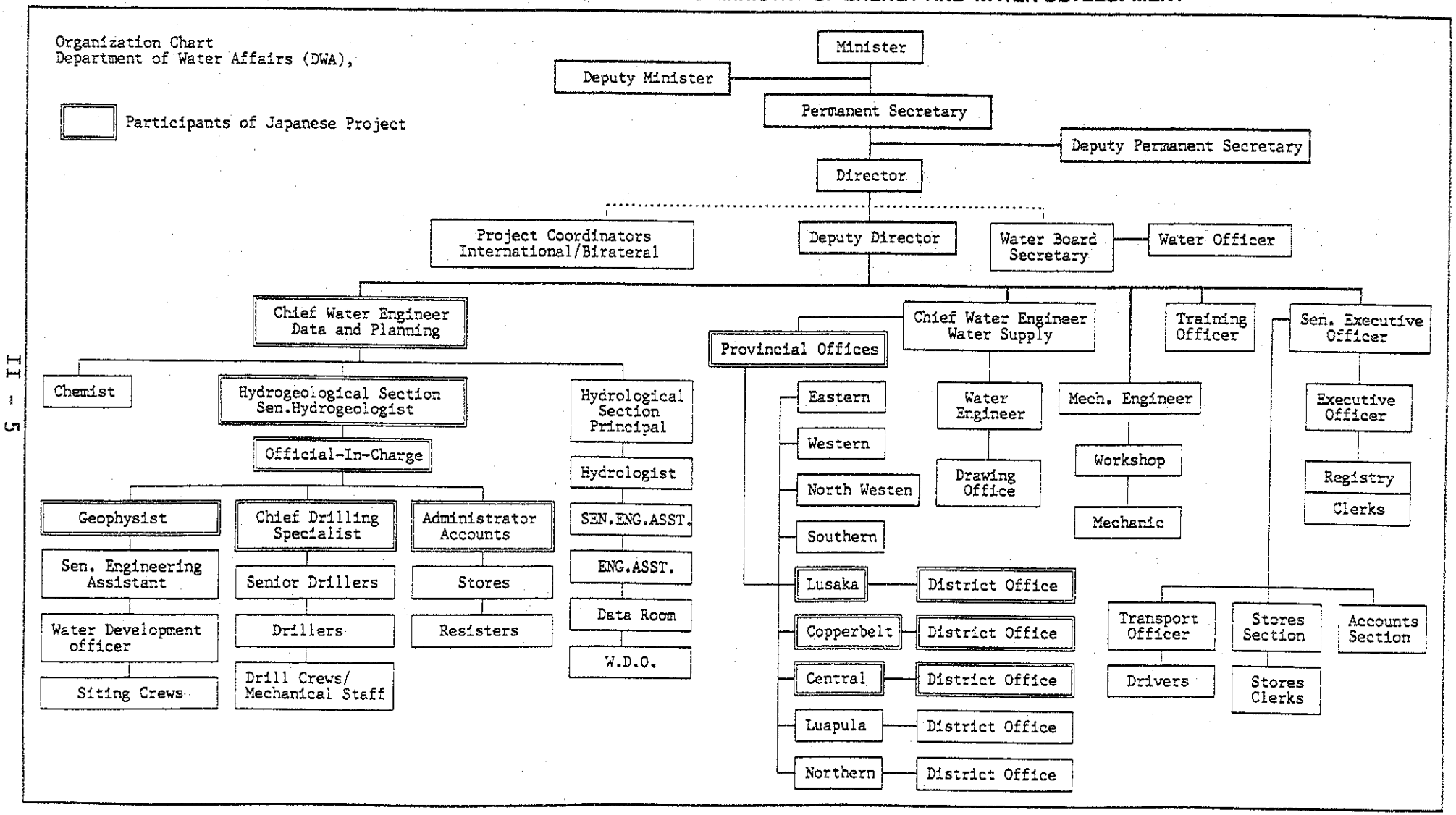
The executing agency of this Project is the Department of Water Affairs (DWA) in the Ministry of Energy and Water Development (MEWD), which was reorganized from the Ministry of Water, Land and Natural Resources (MWLNR) in 1991. The DWA is in charge of investigation, planning, execution and management regarding rural water schemes at a national level, and undertakes the implementation of Small Urban Township Water Supplies (SUTs), Rural Townships Water Supplies (RTs), Rural Area Water Supplies (RAs), drilling operations, etc., through the organization consisting of the headquarters in Lusaka, Provincial Water Engineer Offices in the respective Provinces and District Offices in various Districts. The DWA, as a whole, has a staff of about 2,000, stationing in the headquarters, the respective Provincial Water Engineer Offices and District Offices. In Lusaka, Central and Copperbelt Provinces under this Project, the offices are set-up in the same structure having respectively the Provincial Offices staffed with about 120 to 150 personnel and the District Offices with 20 to 50 for the execution of the water supply schemes of SUTs,RTs and RAs. The organization chart of the DWA is shown in FIG. 2 - 2.

2.2 DETAILS OF IMPLEMENTATION REVIEW

The Zambian Government requested the Japanese Government to revise the Basic Project in December 1992 in connection with the drought relief programme of the drought occurred in 1991-1992.

1) The Basic Project was to complete the borehole construction at 200 Project Sites in five stages, and the Ongoing Project is being implemented as the Stages-1 (1991/92) and the Stage-2 (92/93). Total 79 Sites will be completed by March 1994. The rest of 121 Sites were to be completed in third through fifth stages. The feasibility of the shortening of the implementation schedule as per the Revised Request is studied based on the performance of the Ongoing Project. The conclusion is impossible to complete the rest of 121 Sites in the third stage without increase in the number of drilling rigs, and it is necessary to increase the number of drilling rigs to meet the Revised Request.

FIG. 2-2 ORGANIZATION CHART OF DEPARTMENT OF WATER AFFAIRS MINISTRY OF ENERGY AND WATER DEVELOPMENT



2) The efficiency of drilling works estimated in the B/D is confirmed by the performance achieved in the Stage-1 (that in wet season is to be reduced by half) as follows:

Dry Season : 4 boreholes per month per drilling rig
Wet Season : 2 boreholes per month per drilling rig

If one more drilling rig and necessary materials for drilling of the Stage-4 are to be procured in the Stage-3, in advance, the borehole construction at 200 Sites will be completed in the Stage-4 and even additional 20 Sites are likely to be completed during the Stage-4.

3) Therefore, the Revised Project shall be as follows:

(1) If one more unit of drilling rig is to be procured, the originally requested 200 borehole construction can be completed in the Stage-4 (ending in March 1996).

(2) If necessary materials for drilling of the Stage-4 are to be procured in the Stage-3, another 20 Sites are likely to be completed in the Stage-4.

(3) The original request of rehabilitation works at 100 Sites can be completed by the Stage-4, and another 60 Sites are likely to be achieved based on the performance of the Stage-1.

(4) It is necessary to procure additional equipment, materials, vehicles and tools in connection with the increase in the number of unit of drilling rig and in the number of Sites of the construction and rehabilitation of boreholes explained above.

(5) It is also necessary to reinforce the organization of the Japan Project to carry out the acceleration and incremental works explained above.

(6) It is advisable to have maintenance and reinforcement of the Project Operation Base for better sustainable management of the Project.

The details shall be discussed in CHAPTER III.

2.2.1 BOREHOLES

During the severest drought of Zambia of 1991-1992, a large number of dug wells installed within a depth of 20 m had gotten dry or decreased the yield sharply while very few boreholes were affected by the drought. The borehole is more stable sources of sanitary drinking water than the surface water like rivers and the shallow dug-wells because the borehole type of water facilities produce the confined groundwater and has less chance of being contaminated from surface. Therefore, the borehole water facilities is employed in this Project as safe and stable water sources which are sanitary and almost independent upon the dry season and drought.

1) Depth of Boreholes:

The depth of boreholes should vary depending upon the hydrogeological conditions of the Project Sites. TABLE 2 - 1 illustrates the geological and hydrogeological features of Zambia and TABLE 2 - 2 shows the summary of hydrogeological parameters obtained in 1991/92 in the districts of Lusaka Rural and Kabwe Rural comparing to the prediction made in the B/D (1991) and the actual data collected in Southern Province (1990). This table includes such parameters as borehole depth, yield, static water level, pumping water table, drawdown, specific capacity, well screen position, thickness of weathered zone & loose rocks and types of main aquifers.

TABLE 2 - 2 COMPARISON OF HYDROGEOLOGICAL CONDITIONS IN THE PROJECT AREA AND SOUTHERN PROVINCE

	Actual Data 1991/92	Basic Design	Southern Province
Borehole Depth (m)	53 - 86	40 - 85	30 - 80
Yield (lit/min)	10 - 220	12 - 312	5 - 300
Static Water Level (m)	2 - 13	6 - 70	1 - 40
Pumping Water Level (m)	17 - 68	8 - 75	8 - 43
Drawdown (m)	5 - 20	2 - 43	4 - 40
Specific Capacity ($m^3/d/m$)	3 - 44	1 - 180	1 - 160
Well Screen Position (m)	25 - 85	10 - 85	7 - 72
Thickness of Weathered Zone & Loose Rocks (m)	2 - 42	1 - 50	1 - 15
Types of Main Aquifers	Granite-gneiss Schist Quartzite Sandstone Mudstone	Sand & gravel, Granite, Limestone, Schist Quartzite Gneiss	Sandstone, Basalt, Quartzite Limestone, Schist, Gneiss, Granite

TABLE 2-1 GEOLOGICAL AND HYDROGEOLOGICAL FEATURES OF ZAMBIA

Geologic Age	Rock System			Rock Type	Aquifer Type	Groundwater
CENOZOIC	Recent to Tertiary	Alluvium - Laterite		Clay, Silt, Sand	Sand & Gravel	○
		Kalahari System Mongu Sands Barotes Sandstone		Sand Sandstone	Sand S.W.L. = 40m ~ 50m	○
MESOZOIC	Karoo System			Basaltic Lava (Cretaceous)	Lava Fractures	
PALAEOZOIC	Jurassic to Upper Carboniferous	Upper Karoo Group		Red Sandstone Sandstone Mudstone Coal	Sandstone Fractures Aquifer Depth = 40m - 50m	◎
		Lower Karoo Group		Sandstone Conglomerate	S.W.L.= 25m	
PALAEOZOIC PRECAMBRIAN	Katanga System (Lower Palaeozoic to Late Precambriam ?)			Dolomite, Shale Limestone Sandstone, Schist Quartzite	Weathered & Fractured Zones	◎
	Muva System (Precambrian)			Dolomite, Shale Limestone Sandstone, Schist Quartzite	Weathered & Fractured Zones	◎
PRECAMBRIAN	Basement Complex (Lower Precambrian)			Schist, Gneiss Granite	Weathered & Fractured Zones	◎

Groundwater Occurrence: ◎ GOOD
○ FAIR

According to the above table, the depths of penetrated aquifers in the implemented Project area of 1991/92 can be judged to be 25 m to 85 m from the installed depth of screens. Also the most promising zones of fractures can be concluded to be existing within the range of from 40 to 85 m from the results of geological and geophysical surveys conducted during this period. Furthermore, the lithology of the aquifers is mostly Sandstones, Granite, Gneiss and Schist. Thus, it was quite reasonable to have concluded that the major depth of the aquifers lies from 25 m to 85 m, and that the average drilling depth is assumed to be 60 meters. The thickness of weathered zone and loose rocks widely varies with location of the sites such as 2 m to 42 m and sometimes collapses were encountered in this zone. To solve this collapse problem, it is determined to be necessary to install the upper casing depending on the condition and thickness of the zone (estimated average length of the upper casings being 15 m) for the protection of the boreholes while drilling because temporary casings could not have solved this in many cases effectively.

2) Success Rate of Boreholes

TABLE 2-3 represents the success rate for the construction of boreholes of 1991/92. This table shows the success rates of the drilling in the Districts of Lusaka Rural and Kabwe Rural of 76.9% and 83.3%, respectively. The unsuccessful boreholes were most frequently encountered in tightly-cemented formations such as Gneiss, Granite and Schist. Since these formations are widespread in the Project area, the hydrogeological environment in this area is anticipated to be very hard and severe. Therefore, it seems necessary to assume the overall success rate to be 80% to establish and execute the implementation programme from the results of hydrogeological analysis.

TABLE 2-3 RESULTS OF BOREHOLE CONSTRUCTION in 1991/92 JAPANESE PROJECTS

District	Total No. of Boreholes	No. and Rate of Successful Boreholes	Type of Unproductive Aquifers and No. of Unsuccessful Boreholes		
Rusaka Rural	13	10 (76.9%)	1. Gneiss	1	3
			2. Granite	1	
			3. Mudstone	1	
Kabwe Rural	12	10 (83.3%)	1. Schist	1	2
			2. Siltstone	1	

3) Selection of Drilling Points

In deciding the exact drilling points in the sites, the consideration on not only the hydrogeological and engineering conditions around those points but the consent of inhabitants of the sites is indispensable. Therefore, the decision for the selection of drilling points have been and should be made prior to construction works by the Survey Unit comprised of a consultant's hydrogeologist and DWA's counterparts from the Hydrogeological Survey Team.

2.2.2 WATER FACILITIES

Hand pumps are recommended to be installed in the boreholes, since this type of pump is a standard unit in the rural water supply schemes, allowing easy handling and maintenance at the sites. TABLE 2-4 shows the results of hand pump procurement in the Ongoing Project (as the Stage-1 in 1991/92 and the Stage-2 in 1992/93).

Table 2-4 PROCUREMENT OF HAND PUMPS

Year Implemented	1991/92	1992/93
Type of Hand Pump	Bellows Type	Piston Type (INDIAN MARK-III)
Country of Origin	Japan	Japan (Indian Make)
No. of Units Procured	64	71

The DWA is endeavouring to standardize the type of hand pumps to be employed for the rural water supplies among lots of kinds available in market, and the above model, India Mark III type, is one of DWA's favorite choices. For 1991/92, the bellows type of Japanese make was decided to be procured and installed because this make of some 260 units had been also in practical use in Southern Province without any critical trouble in operation since 1985 with slight problem of supply of spare parts.

However, in 1992/93 the INDIAN MARK-III type was decided to be procured since the DWA appointed this make as its standard item because of the easiness of operation and maintenance. This selection is presumed to continue hereafter for the procurement of the hand pumps.

Appurtenant facilities for hand pumps should include a drain floor, a

drain ditch and a soakaway of concrete in order to prevent direct contamination of aquifers by waste water from ground surface. These structures comply with the standard requirements of the DWA. Some of the existing drain ditches, however, were not long enough to safeguard against possible contamination, and therefore, it should be necessary to employ an improved design to meet the conditions of the respective Sites for this Project by taking enough distance and/or diversifying type of drainage facilities to suit the topographic conditions.

2.2.3 DAILY CONSUMPTION AND SERVED POPULATION

The per-capita consumption of the rural water supplies in Zambia is 30 lit/day/capita in compliance with the standards of WHO. In addition, the DWA has its own standard of 5 lit/day/ capita for the consumption of drinking water only. For practical purposes, this Project intends to provide one primary facility to the Sites most urgently in need of water, to satisfy at least this minimum demand of 5 lit/day/capita as the first step, with a perspective to have the DWA itself tackle the next step to increase the rate of supply through the installation of additional facilities by the hand of the DWA.

On the other hand, the maximum discharge of a hand pump is normally considered to be 750 lit/hr and the maximum pumping hours is also taken for 10 hours from morning to evening. Thus, the calculation of served population by varied consumption rates is presented as follows:

a. Pumping rate of a hand pump: 750 lit/hr
b. Operating period of a hand pump: 10 hrs/day
c. Supply rate of a hand pump:
   750 lit/min x 10 hrs = 7,500 lit/day
d. Served population:
   * Case of unit consumption of 30 lit/day/capita:
     7,500 lit/day ÷ 30 lit/day/capita = 250 persons
   * Case of unit consumption of 5 lit/day/capita:
     (It may happen during the extraordinary dry spells)
     7,500 lit/day ÷ 5 lit/day/capita = 1,500 persons

In short, this Project will provide the supply of water of from 5 to 30 lit/day/capita to the villages with the population of from 250 to 1,500.

2.2.4 REHABILITATION OF EXISTING BOREHOLES

The rehabilitation works are being carried out for 56 of existing boreholes of the Stages -1 (1991/92) and -2(1992/93). The DWA also reportedly stresses the importance of the rehabilitation works of existing boreholes in the recent field survey for the assessment of the severe drought. Thus, the Zambian government has requested additional rehabilitation works for some 100 existing boreholes in the Revised Request.

The rehabilitation works are being observed to give an effective and instantaneous improvement of the rural water supply facility by the rehabilitating existing facility. Here, it is recommended to plan to include the rehabilitation works of existing boreholes by repairing and replacing hand pumps in the Revised Project. The benefits of rehabilitation of this kind are expected substantial while the time schedule of it can be expected to be sufficient in taking consideration of the progress of the Ongoing Project.

Furthermore, it is said that Zambia has presently sanitary problems particularly in the rural area. For instance, many Project Sites are being observed to have contaminated water sources due to the lack of or insufficient water drainage facilities. Therefore, the rehabilitation works of water facility should be planned in this Project in such Sites to install, improve or repair drainage facilities.

2.3 PROCEDURE OF THE IMPLEMENTATION PROGRAM

The Basic Design Study (B/D) conducted in 1991 concluded that the implementation period would be of 5 Stages to complete the construction of the boreholes with water facility at 200 Sites and rehabilitation of the existing boreholes with water facility at 100 Sites in view of constraints such as the slowdown of works during wet seasons and the required time limit under Japan's grant aid system which can not be able to complete all the works involved in the plan within a single fiscal year.

While the Stages -1 and -2 are being implemented, the Government of the Republic of Zambia requested the Japanese Government in December, 1992 to shorten the implementation period and increase the number of Project Sites as

the counter measures against the severe drought encountered in 1991 to 1992 (the Revised Request). The feasibility of the Revised Request will be studied here.

2.3.1 PHASED PROGRAM OF BOREHOLE CONSTRUCTION

The success rate of borehole construction is estimated of 80 % for the entire program of implementation, which was confirmed by the performance of Stage-1 (1991/92). Thus, the total 250 boreholes will be needed to construct 200 boreholes for the Basic Project assuming the success rate of 80 % (200 /0.8=250). And it will be another 121 Sites to construct the boreholes with water facilities during the third through the fifth Stages since total 79 boreholes with water facilities will have been completed at the end of March, 1994; 20 by the Stage-1 and 59 by the Stage-2 (20+59=79).

For analyzing the performance of the drilling rigs, it is assumed that the drilling activities are to be lowered substantially during the period of the wet season of from November to March of the subsequent year, based upon the meteorological data during the past twenty years. During this period, the operation of the drilling rigs is estimated to drop by 50 percent on the average, compared to that in the dry season if access, mobilization and demobilization are considered. Accordingly the number of boreholes completed during the respective seasons are calculated to be four (4) per month in the dry season and two (2) per month in the wet season.

The feasibility of acceleration of the Project will be discussed as follows:

1) Two Drilling Crew Formation (utilizing 2 Units of Drilling Rigs)

Currently the drilling works are being carried out by two drilling crew formation.

1-1) Stage-3

No acceleration of the Project is expected in the Stage-3, because the original plan was already given the maximum drilling activities if this drilling formation remains the same. It is

necessary to take consideration of the procurement and transportation period of materials for drilling and all these materials are needed to be supplied during the same stage: 3 months for procurement and 2 months for transport.

Dry season: 4 Boreholes x 2 Rigs x 4.0 Months = 32 Boreholes
Wet season: 2 Boreholes x 2 Rigs x 4.5 Months = 18 Boreholes
Total 50 Boreholes

Productive Boreholes will be 40 by assuming the success rate of 80%.

50 x 0.8 = 40

Therefore, 40 boreholes are expected to be completed during the Stage-3 and 81 Boreholes (200 - (20 + 59) - 40 = 81) will remain after the Stage-3.

1-2) Stage-4

To accelerate the Project the drilling materials required will be procured in the Stage-3. Then boreholes completed during the Stage-4 will be as follows:

Dry season: 4 Boreholes x 2 Rigs x 7.0 Months = 56 Boreholes
Wet season: 2 Boreholes x 2 rigs x 4.5 Months = 18 Boreholes
Total 74 Boreholes

Productive boreholes will be 59 (74 * 0.80 = 59) and 22 boreholes will yet to be completed (81 - 59 = 22) in the Stage-5.

1-3) Stage-5

The remaining 22 boreholes can be completed in this Stage. If the drilling materials are to be procured in the Stage-4, another 37 boreholes (totalling 59 in the Stage-5 and 237 in all Stages) can be completed.

2) Three Drilling Crew Formation (Increase in Number of Units of Drilling Rigs from 2 to 3):

2-1) Stage-3

A substantial acceleration of the Project can be observed. In addition to the expected boreholes completed (40 Boreholes) explained in a-1), 17 boreholes are likely to be drilled and 13 boreholes will be completed successfully (the procurement of one drilling rig will reduce the operative period by two months: the estimated period of procurement is considered to be increased from 3 months to 5 months while the period of transport remains the same (2 months)).

Dry season:	4 Boreholes x 1 Rigs x 2.0 Months =	8 Boreholes
Wet season:	2 Boreholes x 1 Rigs x 4.5 Months =	9 Boreholes
	Total	17 Boreholes

17 x 0.80 = 13

Therefore, the total 53 boreholes will be completed in the Stage-3 (40 + 13 = 53), and 68 boreholes will be yet to be completed in Stage-4 (200 - (20 + 59) - 53 = 68).

2-2) Stage-4

In order to accelerate the Project the drilling materials necessary are presumably procured in Stage-3. Then the total capacity of completion of drilling rigs will be calculated as follows:

Dry season:	4 Boreholes x 3 Rigs x 7.0 Months =	84 Boreholes
Wet season:	2 Boreholes x 3 Rigs x 4.5 Months =	27 Boreholes
	Total	111 Boreholes

111 x 0.80 = 88

88 - 68 = 20

Therefore, it can be concluded that the requested number of boreholes (200 boreholes) can be completed within the Stage-4 and still additional 20 boreholes can be completed if one more unit of drilling rig is to be supplied in the Stage-3 and all necessary materials for drilling in the Stage-4 are determined to be procured in the Stage-3.

Thus, it is recommended to increase the number of units of drilling rigs by one (from 2 to 3) in the Stage-3 and also procure necessary materials for drilling of Stages -3 and -4, then it can be possible to construct boreholes at 200 Project Sites, and additional 20 sites if necessary.

2.3.2 BOREHOLE CONSTRUCTION SCHEDULE

The B/D concluded that the borehole construction was to have the implementation schedule shown in FIG. 2 - 3 and TABLE 2 - 5 based on the District-wise overriding urgency, conditions of access during dry seasons, the degree of difficulty with actual construction works, arrangements for technological transfer to DWA's employees in Districts, etc. The B/D was also taking consideration to ensure efficient and effective operations of the Drilling Unit consisting of 2 crews, Crew-A and Crew-B, in the wide area of the Project covering 7 Districts of 3 Provinces.

TABLE 2 - 5 BOREHOLE CONSTRUCTION SCHEDULE PLANNED IN BASIC DESIGN STUDY (1991)

PROVINCE	District	No. of Boreholes	1st Stage	2nd Stage	3rd Stage	4th Stage	5th Stage
LUSAKA	Lusaka Rural	45	10 (A-1)	11 (A-2)	0	0	24 (A-1)
	Luwanga	10	0	10 (A-1)	0	0	0
CENTRAL	Kabwe Rural	30	10 (B-1)	0	5 (A-2)	9 (A-2)	6 (B-2)
	Mukushi	30	0	30 (B-1)	0	0	0
	Mumbwa	20	0	8 (A-3)	0	12 (A-1)	0
	Serenje	15	0	0	15 (B-1)	0	0
COPPERBELT	Ndola	50	0	0	20 (B-1)	19 (B-1)	11 (B-1)
Total		200	20	59	40	40	41

A : Drilling Crew-A, B : Drilling Crew-B

The construction works for the borehole with water facilities have been completed at 20 Sites under the Stage-1 (1991/92) and are being constructed at 59 Sites under the Stage-2 (1992/93). In the Basic Project, it was presumed for a drilling rig to be transferred to any site to drill the borehole at the site selected just in accordance with the priority order of the three Provinces. The implementation schedule

FIG. 2-3 IMPLEMENTATION SCHEDULE OF BOREHOLE CONSTRUCTION PROPOSED BY B/D

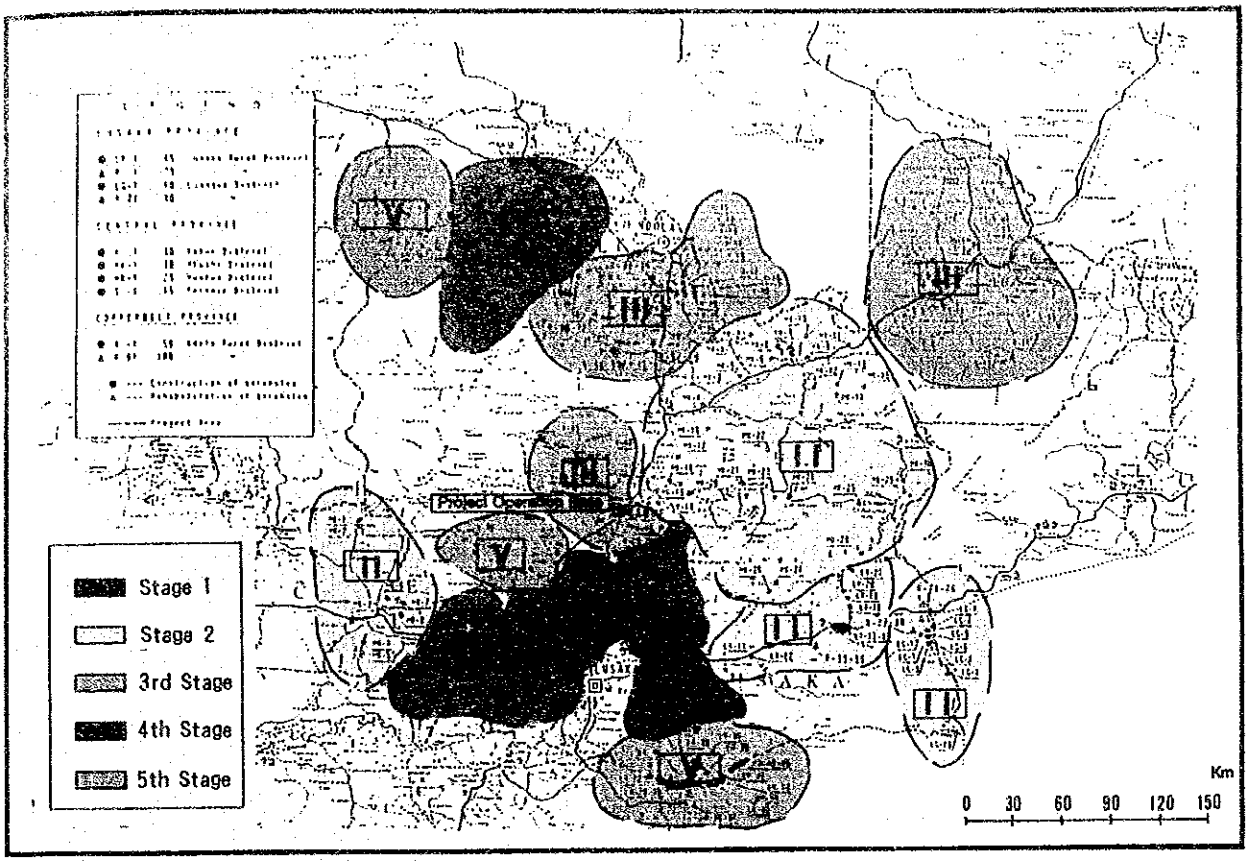
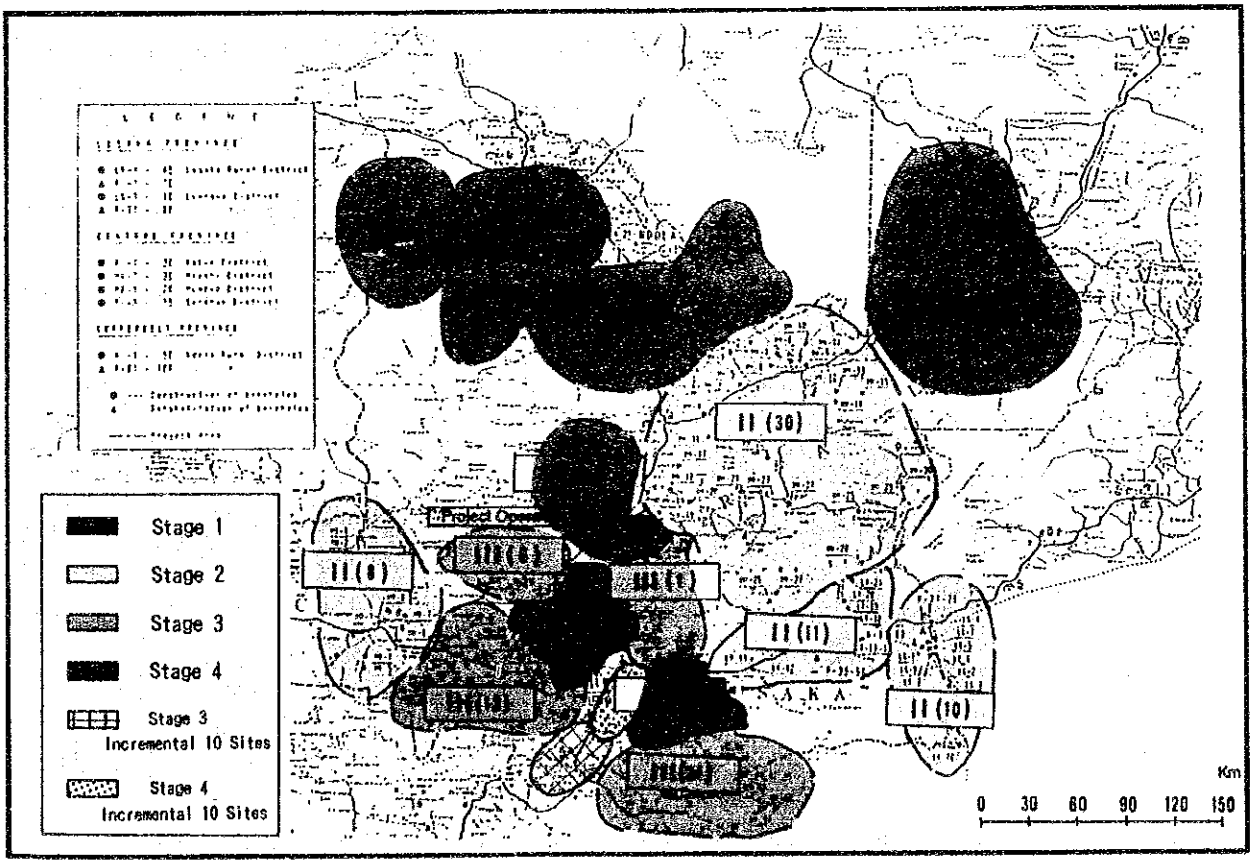


FIG. 2-4 IMPLEMENTATION SCHEDULE OF BOREHOLE CONSTRUCTION PROPOSED BY REVISED STUDY



after the Stage-3 will, however, be decided to be changed based upon the analysis of the implementation performance records as follows. The drilling rigs will be allocated to each territory as shown in FIG. 2 -4 and the sequence of drilling sites will be determined by choosing a site close to the previous drill site. This territorial scheduling approach is likely to yield a more efficient drilling activities due to the reduction of the transportation of equipment and materials and the easiness of the supply of consumable items, since most of the drought disaster areas of 1991/1992 lie in the southern part of Project area and the Drilling Unit will be reinforced to 3 crews from the present 2 crews. FIG. 2 - 4 and TABLE 2 - 6 represent the revised implementation schedule and the revised site location. The additional borehole water facilities will be constructed at 20 Sites in Lusaka Rural District. The location of the 20 Sites is shown in FIG. 2 - 4, and their names are listed in APPENDIX.

TABLE 2 - 6 IMPLEMENTATION SCHEDULE OF BOREHOLE CONSTRUCTION PLANNED IN THE IMPLEMENTATION REVIEW (1993)

PROVINCE	District	No. of Boreholes	Stage-1 1991/92	Stage-2 1992/93	Stage-3	Stage-4
LUSAKA	Lusaka Rural	65	10	11	34	10
	Luangwa	10	0	10	0	0
CENTRAL	Kabwe Rural	30	10	0	7	13
	Mukushi	30	0	30	0	0
	Mumbwa	20	0	8	12	0
	Serenje	15	0	0	0	15
COPPERBELT	Ndola	50	0	0	0	50
Total		220	20	59	53	88

2.3.3 SCHEDULE OF WATER FACILITIES CONSTRUCTION

The water supply facilities will be constructed by utilizing the successful boreholes as the water sources. The water facility construction works are to be executed in the same order as of the borehole construction in the same Stages planned.

2.3.4 SCHEDULE OF REHABILITATION WORKS

The B/D concluded that the rehabilitation works of existing boreholes

are scheduled to be executed concurrently with the construction of new boreholes as shown in TABLE 2 - 7 at 100 Sites in 3 Districts, 2 Provinces. The rehabilitation works were also recommended to be phased for smooth implementation. The rehabilitation works are being implemented at 56 Sites for the Stages -1 and -2.

TABLE 2 - 7 SCHEDULE OF REHABILITATION WORKS PLANNED IN BASIC DESIGN STUDY (1991)

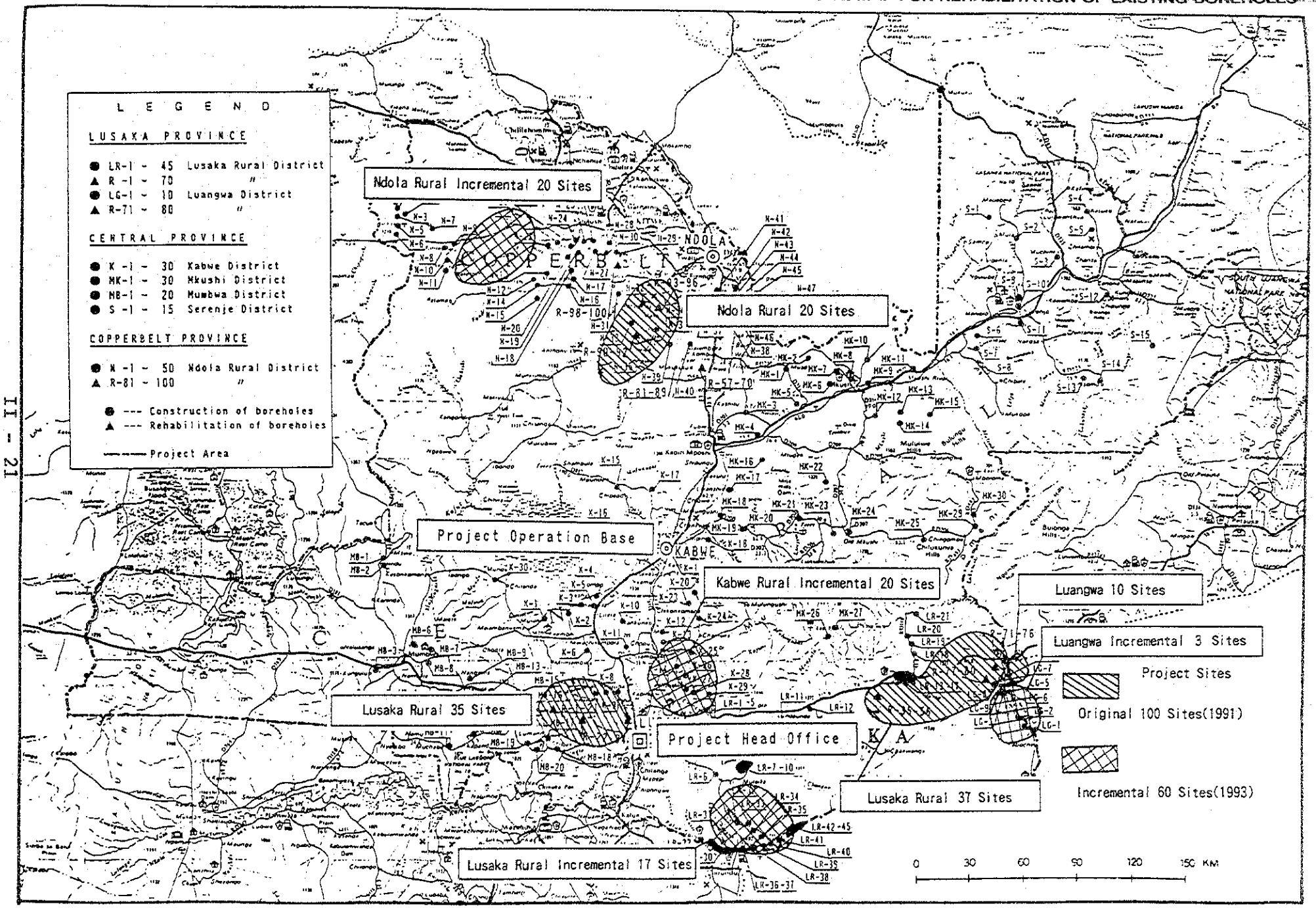
PROVINCE	District	No. of Rehabilitation Works	1st Stage	2nd Stage	3rd Stage	4th Stage
LUSAKA	Lusaka Rural	70	1	45	17	7
	Luangwa	10	-	10	-	-
COPPERBELT	Ndola	20	-	-	20	-
Total		100	1	55	37	7

TABLE 2 - 8 exhibits the schedule of rehabilitation works planned in the Implementation Review (1993) to respond the Revised Request made by the Government of the Republic of Zambia in December 1992. The performance of the rehabilitation works being implemented in the Ongoing Project (1991/92 and 1992/93) reveals that the rehabilitation works can be furnished at another 60 Sites (totalling 160 Sites). The site locations for rehabilitation works of existing boreholes are illustrated in FIG. 2 - 5 and the names of the Sites are listed in APPENDIX.

TABLE 2 - 8 SCHEDULE OF REHABILITATION WORKS PLANNED IN THE IMPLEMENTATION REVIEW (1993)

PROVINCE	District	No. of Rehabilitation Works	Stage-1 1991/92	Stage-2 1992/93	Stage-3	Stage-4
LUSAKA	Lusaka Rural	90	1	45	44	-
	Luangwa	10	-	10	-	-
CENTRAL		20	-	-	20	-
COPPERBELT	Ndola	40	-	-	-	40
Total		160	1	55	64	40

FIG. 2-5 SITE MAP FOR REHABILITATION OF EXISTING BOREHOLES



2.4 PROCUREMENT OF EQUIPMENT/MATERIALS AND REINFORCEMENT OF PROJECT OPERATION BASE RELATED TO THE REVISED REQUEST

The B/D concluded to procure the equipment and materials for groundwater development necessary for the construction of new boreholes and for the rehabilitation works of existing boreholes including drilling rigs, and the major part of the procurement has been carried out in the Stages -1 and -2. In addition, it is supposed to procure necessary materials for construction, spare parts and consumable items to be used in each Stage.

TABLE 2 - 9 presents the revised list of equipment to be procured in accordance with the Revised Project comparing it with the Basic Project. On the selection of the equipment, a careful precaution was taken for each item with particulars of equipment and materials to be procured with regard to the purpose and environment of their use, interchangeability with existing equipment, degree of proficiency of counterpart staff in this type of equipment, etc. And the primal considerations for the use and selection of each materials and equipment are shown afterwards.

2.4.1 DRILLING RIGS

The typical boreholes have such specifications as 4 to 6 inch in diameter (100 to 155 mm) and the total depth of 60 m in average for the water sources for the rural water supplies in the Project area. The drilling method and the equipment for such boreholes should be selected depending upon the hydrogeological conditions of the area under the plan. The geological features of the area of this Project vary from Precambrian Granite, Gneiss and Schist to Paleozoic or Mesozoic Sandstone, Mudstone, Conglomerate, Quartzite, Shale, Limestone and Dolomite, all of which are tightly cemented hard rocks showing complex distribution.

TABLE 2 - 10 summarizes hydrogeological data of the Project area prepared by the DWA. According to the data in this table, hard rocks such as Granite, Gneiss, Schist, Quartzite and Limestone are being drilled to depths of 60 - 120 m. From this practice, it is quite reasonable to consider to provide another drilling rig with the capacity of drilling to a depth of 150 m to enhance the Project.

TABLE 2 - 9 THE COMPARISON TABLE OF PROCUREMENT LIST
BASIC DESIGN / REVISED STUDY

Materials and Equipment requested	Basic Design	Procured in Stages 1&2	Planned in B/D in 3-5 Stage	Revised Plan Stages 3 & 4
1. DRILLING RIG w/STD ACCESSORIES	2 Units	2 Units	-	1 Unit
2. DRILLING TOOLS AND OTHER TOOLS	2 Sets	2 Sets	-	1 Set
3. CONSUMABLE ITEMS OF 2.	5 Sets	2 Sets	3 Sets	2 Sets
4. HIGH PRESSURE AIR COMPRESSOR	2 Units	2 Units	-	1 Unit
5. ELECTRIC WELDER	2 Units	2 Units	-	1 Unit
6. MATERIALS FOR BOREHOLES				
1) Casing Pipes	200 Sets	79 Sets	121 Sets	141 Sets
2) Well Screens	200 Sets	79 Sets	121 Sets	141 Sets
3) Other Misc. Materials	200 Sets	79 Sets	121 Sets	141 Sets
7. SURVEY EQUIPMENT				
1) Geoelectric Prospecting Eq.	2 Units	2 Units	-	-
2) Borehole Logging Equipment	2 Units	2 Units	-	1 Unit
3) Electromagnetic Survey Eq.	2 Units	2 Units	-	-
4) Data Processing Unit	2 Units	2 Units	-	1 Unit
5) Pumping Test Equipment	2 Units	2 Units	-	1 Unit
6) Portable Water Analysis Kit	5 Units	5 Units	-	2 Units
7) Water Level Kit	5 Units	5 Units	-	2 Units
8) pH Meter	5 Units	5 Units	-	2 Units
9) Electric Conductivity Meter	5 Units	5 Units	-	2 Units
8. HAND PUMPS				
1) For New Boreholes	200 Sets	79 Sets	121 Sets	141 Sets
2) For Rehabilitation Works	100 Sets	56 Sets	44 Sets	104 Sets
3) Tool Kits for Hand Pumps	300 Sets	135 Sets	165 Sets	245 Sets
9. VEHICLES				
1) Cargo Truck with 5t Crane	2 Units	2 Units	-	-
2) Service Truck	2 Units	2 Units	-	1 Unit
3) Cargo Truck with 2t Crane	2 Units	2 Units	-	1 Unit
4) Water Tank Truck	2 Units	2 Units	-	1 Unit
5) Fuel Tank Truck	2 Units	2 Units	-	1 Unit
6) Station Wagon	5 Units	15 Units	-	1 Unit
7) Pickup Truck	3 Units	3 Units	-	4 Units
8) Service Truck for Animation	3 Units	3 Units	-	2 Units
10. RADIO TELEPHONE EQUIPMENT	6 Sets	6 Sets	-	2 Set
11. WORKSHOP EQUIPMENT	2 Sets	2 Sets	-	1 Set
12. MISCELLANEOUS MATERIALS ALLIED TO THE PROJECT IMPLEMENTATION	1 Set	1 Set	-	1 Set
13. CAMPING EQUIPMENT	2 Units	2 Units	-	1 Unit
14. SPARE PARTS FOR TWO YEARS	1 Set	1 Set	1 Set	1 Set
15. SPARE PARTS FOR RIG ADDED	1 Set	-	1 Set	1 Set
16. SPARE PARTS FOR VEHICLES ADDED	1 Set	-	1 Set	1 Set

TABLE 2 - 10 HYDROGEOLOGICAL DATA OF PROJECT AREA
PREPARED BY THE DWA

Types of Rocks	Borehole Depth (m)			Specific Capacity	Permeability Coefficient
	min	max	ave	Q (lit/sec/m)	k (m/d)
Granite Gneiss Schist	20	60	36	0.11	0.39
Mudstone Siltstone Sandstone Marl, Grits	30	65	55	0.20	0.55
Quartzite Conglomerate	20	70	50	0.22	0.63
Shale Schist	40	120	60	0.28	0.64
Sand, Gravel Clay	10	45	30	0.33	0.66
Limestone Dolomite Carbonate Argellite	14	70	45	2.56	6.71

Concerning the type of drilling rigs, the DWA owns both rotary and percussion rigs. However, the rotary type is more preferable to the percussion type for efficient and effective drilling through hard rocks in the Project area since the former can employ the down-the-hole (DTH) drilling method which has recently been introduced to Zambia with an advantage of the much faster drilling speed through such hard types of rocks. Furthermore, the drilling rigs should be of truck-mounted type enabling higher mobility. This has been proved by the performance of 6 units of truck-mounted rotary type drilling rigs procured by the DWA; 2 units under Southern Province Groundwater Development Project, another 2 units under Non-Project Assistance and 2 units under this Project (1991/92).

From the experience compiled with drilling operations, it is advisable to procure a same type of drilling rig with a same capacity of drilling. Also it is vital to procure sufficient units of supporting equipment for drilling such as a high-pressure compressor, drilling tools and spare parts.

2.4.2 VEHICLES, SURVEY EQUIPMENT & WORKSHOP EQUIPMENT

It is recommended to procure such equipment, materials and vehicles as shown in below in order to carry out drilling works and their preceding

groundwater prospecting survey to relate with the Revised Request. Although it is normally said to be essential to provide the sufficient equipment and tools for animation and maintenance of the water facilities and their related equipment, it is suggested here, however, for minimizing the project costs, to utilize the equipment and tools which have already procured in the Ongoing Projects as much as possible and to use the common specifications to secure the interchangeability.

1) It is necessary to procure one full set of drilling rig, drilling tools and a high pressure air compressor to allocate those to form another drilling crew (Crew-C) for acceleration of the Project.

2) It is justified to assume that the quantity of materials necessary for borehole construction such as casing pipes, well screens and others can be calculated, based upon the planned number of 141 for successful boreholes with an average drilling depth of 60 m, the average aquifer thickness of 12 m and the success rate of 80 %.

3) Two sets of geoelectric prospecting equipment and electromagnetic survey equipment have been procured for two Crews (A and B) of Geophysical Survey Unit of Hydrogeological Team, as one set to one crew. Electromagnetic survey equipment are judged as effective means to evaluate the hydrogeological conditions of hard rocks in the Project area where groundwater occurs mainly through fracture zones of hard rocks such as Granite, Gneiss and Schist. It can be decided not to procure any more survey equipment of those types because those two Crews can cover additional works with the survey equipment procured.

However, it is advised to procure one set each of borehole logging equipment and pumping test equipment because those equipment are closely related to the drilling activities and the procurement can be expected to maintain the effectiveness of the drilling works.

It is advised to procure 2 sets of portable water analysis kit, water level kit, pH meter and electric conductivity meter because it is very important to make a good water monitoring works to

support the drilling activities and rehabilitation works and one new Crew each will be formed in Drilling Unit and Rehabilitation Unit.

4) It is decided to procure 245 sets of hand pumps based upon the study on the Revised Request; 141 for new boreholes and 104 for rehabilitation.

5) It is noted of the necessary number of supporting vehicles are in TABLE 2 - 9 as the minimum quantity for drilling and its related activities.

6) It is advised to increase two sets of radio telephone equipment for the Units of Drilling and Rehabilitation reinforced.

7) It is also recommended to add one set of camping equipment for the Drilling Unit reinforced to stay in to carry out the drilling works in the Projects Sites scattered in a wide area to following the implementation schedule.

2.4.3 PROJECT OPERATION BASE

It has been noted during the Ongoing Project (Stages -1 and -2) that repair, maintenance and reinforcement works are needed for the Project Operation Base in Kabwe in order to obtain smoother execution of the Projects.

It is advised to reinforce such facilities in the Operation Office as Water Quality Analysis Laboratory and Hydrogeological Data Room by using prefabricated container type house after the Stage-3.

It is also advised to repair and maintain the Workshop and the Carport to sustain the serviceability to drilling rigs and their tools and accessories, supporting vehicles and materials.

The layout of the Project Operation Base is illustrated in APPENDIX.

2.4.4 INSPECTION OF PROCURED EQUIPMENT AND PROCUREMENT OF ADDITIONAL SPARE PARTS

After the completion of the Project, the DWA, as the executing agency, will continue to implement the rural water supply projects utilizing the drilling rigs and equipment procured under the Project. Therefore, it is advisable to make the full inspection and repair works of the equipment for the groundwater development including the drilling rigs, geophysical prospecting equipment and vehicles at the end of the Project. In addition, it is recommended to procure the spare parts including consumable items of the drilling rigs and vehicles in amount of the usage of 2 years and hand pumps and the materials for the borehole construction such as casing pipes and screens to meet the requirement from the construction of borehole with water facilities in the first execution by the DWA.

CHAPTER III

REVISED PROJECT

CHAPTER III

REVISED PROJECT

3.1 ORGANIZATION OF PROJECT IMPLEMENTATION

The DWA has formed a task force team named as "Japan Project Team" for the implementation of this Project together with the Consultant and the Contractor. The Director of the DWA has been heading the Japan Project Team, assisted by the Chief Water Engineer of Data and Planning and Hydrogeological Section. Many scientists, engineers and technicians have been participating in the Project Team from the Headquarters in Lusaka and Provincial and District Offices: their objects of participation is to establish and execute the implementation plan, to carry out works like hydrogeological study and drilling operations, and to have opportunities of technology transfer through the participation in the Project. The DWA are supposed to succeed entirely this Project Team after the completion of the Project and continue such activities as their own organization.

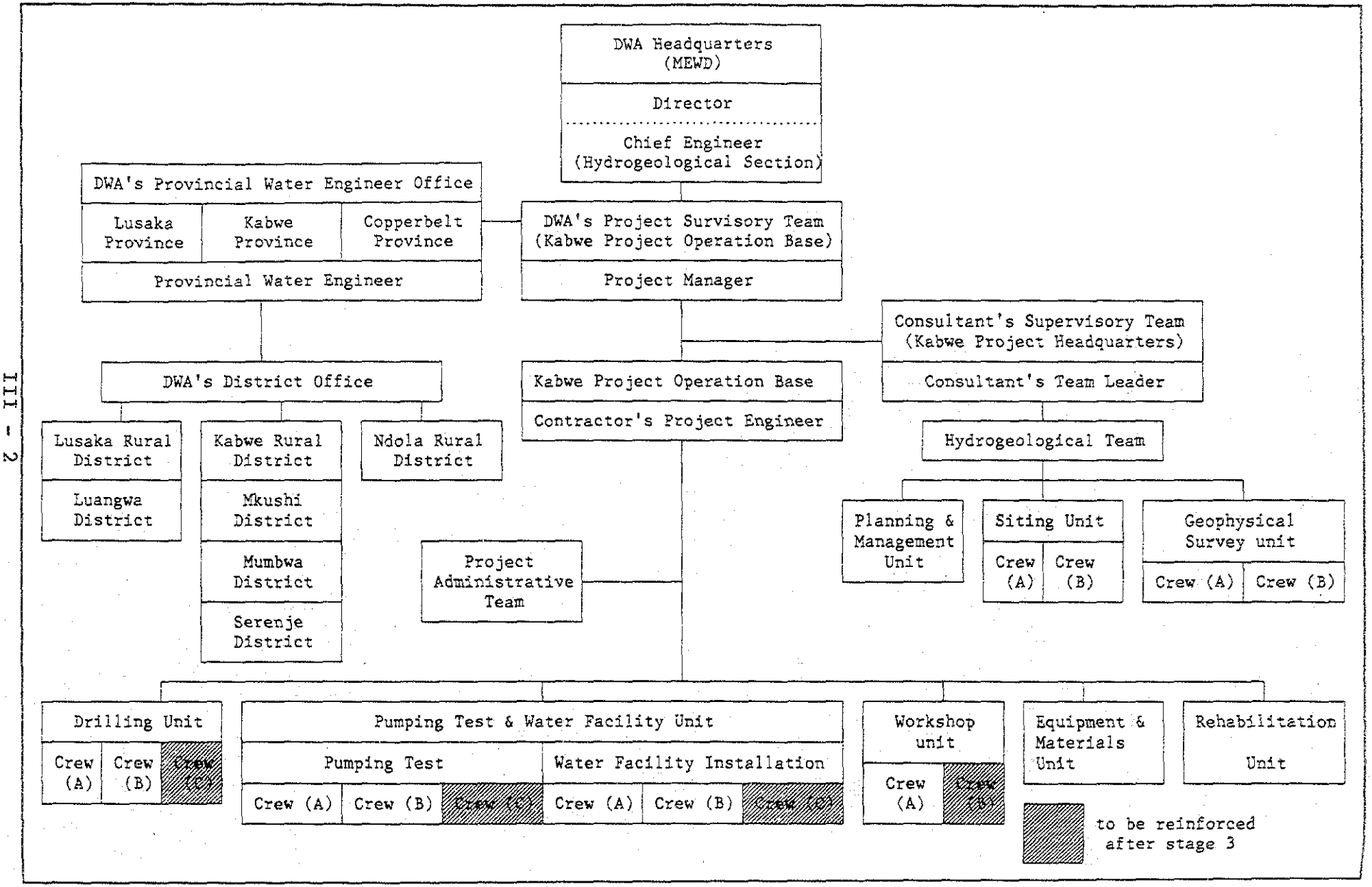
The Project Operation Base has been constructed and been in use in Kabwe City in Central Province because the Projects are planned to be implemented in the broad expanse of the Project area involving 7 Districts across 3 Provinces.

The existing organization for the Ongoing Project is evaluated to be basically adequate and proposed to be continued with some reinforcement of capacity including the increase in the Drilling Unit and the Rehabilitation Unit as shown in FIG. 3 - 1.

1) The Project Manager is assigned to a senior engineer in charge of this Project at DWA's Headquarters, supported by the Project Engineer from the Contractor who is the manager of the Project Implementation Team. The team leader from the Consultant is the manager of the Hydrogeological Team and responsible for the supervision and control of the implementation of the Project (No change).

2) The Hydrogeological Team consists of the Planning & Management Unit, Siting Unit and Geophysical Survey Unit.

FIG. 3-1 ORGANIZATION CHART OF JAPANESE PROJECT TEAM



2-1) The Planning & Management Unit is controlling the entire aspects of the rural water supply scheme including operation and maintenance (No change).

2-2) The Siting Unit consists of two crews (Crew A and B) and is responsible for the decision on the drilling points prior to the commencement of actual works (No change).

2-3) The Geophysical Survey Unit is organized, consisting of two crews (Crew A and B), each crew is made up with a consultant's hydrogeologist and DWA's counterparts for the purpose of the detailed hydrogeological survey, geophysical survey and decision on the drilling points in the respective sites prior to the commencement of actual works (No change).

3) The Project Implementation Team consists of the Drilling Unit, the Pumping Test & Water Facility Unit, the Workshop Unit, the Equipment and Materials Unit and the Rehabilitation Unit.

3-1) The Drilling Unit is to be reinforced to three crews from two crews to carry out increased number of borehole construction in a short time in the broad Project area.

3-2) The Pumping Test & Water Facility Unit comprised of two crews of the Pumping Test (Crew A and B) and two crews of the Water Facility Installation (Crew A and B) are organized for effective construction of water facilities and pumping tests. One each of Crew C will be added totalling 3 crews to correspond to the reinforced capability of drilling.

3-3) The Rehabilitation Unit is to be reinforced to two crews from one crew to meet the increased requirement of rehabilitation works of existing boreholes.

3-4) The Workshop Unit is established in the Project Operation Base in Kabwe to undertake maintenance and repair works of drilling rigs, vehicles and other equipment (No change).

3-5) The Equipment and Materials Control Unit is stationed at the Project Operation Base in Kabwe in order to keep various materials and spare parts under control and fabricate wooden forms for concrete works, etc., necessary for the execution of works (No change).

3.2 DESIGN OF FACILITIES

3.2.1 FACILITIES OF NEW BOREHOLES

1) Project Sites

The Project Sites are chosen through the consultation with the officials concerned of the DWA as well as the local authorities of the respective Districts, taking into account the priority order given by the Zambian side and the analytic results of the field survey. A careful selection was given to the sites where there are such public interests as educational institutes, health care centres, agricultural development centres, local key posts, etc., and where no sanitary water sources currently exist or those water sources easily get empty during dry seasons even if exit. The implementation schedule is exhibited in FIG. 2 - 4 including the additional Sites for the Stages -3 and -4, and the names of the Sites are listed in APPENDIX.

2) Type of Water Facilities

Borehole type water sources were decided to be employed for the Project since this type of water sources can be supplying stable and safe drinking water even in the dry season. The water facilities are designed to be installed with standard hand pumping units, concrete floor and drainage, easy to operate and maintain and also suitable to the size of rural villages of the population of 200 (in normal conditions) to 1,500 dwellers (in dry season).

3) Unit Supply Rate

It is targeted to supply water at the rate of 30 l/day/capita, complying with the WHO's standards. It is, however, targeted at the rate of 5 lit/day/capita during emergent seasons of dry spells meeting the criterion for drinking water only.

4) Served Population Planned

A pumping rate with a hand pump is considered to be approximately 750 lit/hr. The pumping hours are conventionally confined to 10 hours a day from dawn to sunset in this area. Accordingly, the served population planned at one site can be served with a single borehole equipped with a hand pump is calculated as follows:

a. Ordinary situation
750 lit/hr x 10 hrs ÷ 30 lit/day/capita = 250 persons

b. Dry season
750 lit/hr x 10 hrs ÷ 5 lit/day/capita = 1,500 persons

5) Appurtenant Facilities to Boreholes

It is recommendable to install a drainage facility consisting of concrete drain floor, drain ditch and a soakaway in the surrounding area of the borehole to prevent the waste water seepage from the surrounding area. The concrete drain floor is to be reinforced concrete to safeguard against cracks.

3.2.2 REHABILITATION WORKS OF EXISTING BOREHOLES

1) Project Sites

The Project Sites are selected through consultation with responsible officials of the DWA and the local authorities of the respective Districts, taking into account the priority order given by the Zambian side and the analytic results of the field survey. A careful selection was given to the sites where there

are such public interests as educational institutes, health care centres, agriculture development centres and key local posts, etc., and where it is expected to revive the water supply of clean water by rehabilitation. FIG. 2 - 5 illustrates the location map of the Sites for rehabilitation works of existing boreholes with water facilities including 60 additional Sites, and the names of all the Sites are listed in APPENDIX.

2) Rehabilitation Works

Troubles with the existing boreholes, which have been left unused, stemmed mostly from broken-down of hand pumps. The rehabilitation works of the existing boreholes with water facilities, therefore, are to be focused on the replacement of damaged pumps with new ones and improvement of surrounding water environment to enhance the supply of stable and sanitary water.

3.2.3 STRUCTURE OF NEW BOREHOLES

The proposed design of typical borehole structure, as described hereafter, is illustrated in the APPENDIX to this report.

1) Drilling Depth of Boreholes

The drilling of boreholes under the Project is planned to have the average drilling depth of 60 meters, based upon such prevalent hydrogeological conditions of the Project area as the distribution of hard rocks of Gneiss, Schist and Granite, and upon the results of the analysis of geoelectric prospecting conducted over the area.

2) Diameter of Boreholes

The diameter of boreholes is determined to be 4 in. or 6 in.(100 mm or 155 mm), according to the planned populations to be served at the sites. The latter size of 6 in. will be selected for the sites, where the hydrogeological conditions are favourable and where the water demand is expected to increase in the near future, so that hand pumps can be replaced by power-driven pumps.

3) Casing Pipes and Well Screens

Casing pipes and well screens are to be of FRP make. These types of casings and screens are recommended because they have long been employed by the DWA, because they are strong enough despite their light weights to allow easy handling during transportation and field works and because they fit well to the groundwater quality of the Project area having a pH value of 6.9 to 7.3. Their unit length is to be standard 4 meters. For the construction of a typical borehole of 60 meter depth, the well screens shall be of the average length of 12 meter per borehole which corresponds to 20 percent of the total depth of the borehole of 60 meters based upon the analysis and prospects of the local hydrogeological conditions in the Project area. Accordingly, the casing pipes shall have the average length of 48 meter per borehole which corresponds to 80 % of the rest of length of the borehole.

4) Cementing and Gravel Packing

The uppermost section of boreholes to a depth of 5 to 6 m shall be tightly sealed with cement grout to prevent direct intrusion of waste water through this zone. The gravel packing shall be basically applied between aquifers and well screens with well selected particles.

5) Centralizer

Centralizers shall be installed in order to maintain the alignment of casing pipes and well screens in the center of boreholes.

3.3 EQUIPMENT SCHEDULE

Listed below are the specifications of equipment and materials required for the construction of water facilities with boreholes, for the groundwater prospecting survey and for the operation and maintenance after the completion of the water facilities in the future Projects.

3.3.1 DRILLING RIGS AND RELATED EQUIPMENT

1) Drilling Rig & Standard Accessories

Quantity:	1 unit
Type:	Rotary, 4 x 4 truck-mounted
Capacity:	150 mm x 150 m min. and
	210 mm x 100 m min.

2) Drilling Tools And Other Tools

Quantity:	1 set
Type:	DTH tools
	Mud drilling tools
	Fishing tools
	Casing tools, and others

3) High Pressure Air Compressor

Quantity:	1 unit
Type:	Diesel engine driven, 4 x 4 truck mounted
Air volume:	21 m^3/min
Pressure:	21.0 kg/cm^2

4) Welder

Quantity:	1 unit
Type:	A gas/acetylene welding equipment
	an electric welder

3.3.2 MATERIALS FOR BOREHOLES

1) Casing Pipes

Material:	FRP
Diameter & Length:	155 mm Dia. x 852 m Length
	100 mm Dia. x 7,648 m Length

2) Well Screens

Material:	FRP
Diameter & Length:	155 mm Dia. x 216 m Length
	100 mm Dia. x 1,912 m Length

3) Well Bottoms

Material: FRP

Diameter & Quantity: 155 mm Dia. x 14 pc.
100 mm Dia. x 127 pc.

4) Well Caps

Material: PVC

Diameter & Quantity: 155 mm Dia. x 14 pc.
100 mm Dia. x 127 pc.

5) Centralizers

Material: Steel

Diameter & Quantity: 155 mm Dia. x 84 pc.
100 mm Dia. x 762 pc.

6) Materials For Drilling Fluid Control

Quantity: 1 lot

3.3.3 SURVEY EQUIPMENT

1) Borehole Logging Equipment

Quantity: 1 unit

Type: Digital

Depth of Measurement:
Not less than 300 m

Items of Measurement:
Normal Resistivity, Natural Gamma

2) Pumping Test Equipment

Quantity: 1 unit

Type: Submersible motor pump

Discharge: 200 lit/min

Total head: 100 m

Generator: Diesel engine 400 V, not less than 20 KVA

3) Data Processing Unit

Quantity: 1 lot

Type: For analysis of various hydrogeological data

4) Portable Water Analysis Kit

Quantity: 2 units

Type: Portable, drinking water standards

5) Water Level Kit

Quantity: 2 units

Type: Portable

Measuring: Not less than 100 m

6) pH Meter

Quantity: 2 units

Type: Portable, digital type

7) Electric Conductivity Meter

Quantity: 2 units

Type: Portable

3.3.4 HAND PUMPS

1) For New Boreholes

Quantity: 141 units

Type: Borehole type

2) For Rehabilitation

Quantity: 104 units

Type: Borehole type

3) Tools Set For Hand Pumps

Quantity: 245 sets

Type: For inspection and repair of hand pumps

3.3.5 VEHICLES

1) Service Truck

Quantity: 1 unit

Max.payload: 7,500 kg

Engine: Water cooled diesel engine not less than 190 ps

2) Cargo Truck With 2 ton Crane

Quantity: 1 unit
Drive: All wheel drive (4 x 4)
Max.payload: Not less than 3,500 kg
Engine: Water cooled diesel engine not less than 160 ps
Crane capacity: Not less than 2,000 kg/2.5 m

3) Water Tank Truck

Quantity: 1 unit
Drive: All wheel drive (4 x 4)
Tank capacity: Not less than 4,000 lit.
Engine: Water cooled diesel engine not less than 190 ps

4) Fuel Tank Truck

Quantity: 1 unit
Drive: All wheel drive (4 x 4)
Tank capacity: Not less than 4,000 lit.
Engine: Water cooled diesel engine not less than 190 ps

5) Station Wagon

Quantity: 1 unit
Drive: All wheel drive (4 x 4), long wheel base type
Engine: Water cooled diesel engine not less than 90 ps
Passenger: Not less than 6 passengers

6) Pickup Truck

Quantity: 4 units
Drive: All wheel drive (4 x 4), double cabin type
Engine: Water cooled diesel engine not less than 90 ps

7) Service Vehicle For Rehabilitation & O/M

Quantity: 2 units
Drive: All wheel drive (4 x 4), long wheel base
Engine: Water cooled diesel engine not less than 90 ps
Crane capacity: Not less than 450 kg

3.3.6 RADIO TELEPHONE EQUIPMENT

1) Mobile Type

Quantity: 2 sets
Output: Not less than 100 W
Type: MHF/HF, SSB

3.3.7 WORKSHOP EQUIPMENT

1) Gas Welding Equipment

Quantity: 1 Set
Type: Gas/acetylene welding

2) Electric Welding Equipment

Quantity: 1 set
Type: Diesel engine driven, portable type, for a combined use of power generating & welding
Range of current: Not less than 50 - 270 A

3) Maintenance Equipment and Tools

Quantity: 1 set
Type: Inclusive both for general use and for vehicles

3.3.8 MISCELLANEOUS MATERIALS ALLIED TO THE PROJECT IMPLEMENTATION

1) Portable Fuel Storage Tank

Quantity: 2 units

2) Portable Concrete Mixer

Quantity: 3 units

3) Hand Tools

Quantity: 3 sets

3.3.9 SPARE PARTS (FOR O/M FOR 2 YEARS)

Quantity: 1 lot

3.3.10 CAMPING EQUIPMENT

Quantity: 1 unit

3.3.11 PROJECT OPERATION BASE

Quantity: 1 lot

Some works are recommended to be taken place at the Japanese Project Operation Base in Kabwe, Central Province. There will be repair and maintenance works for such existing buildings as the Operation Office, the Workshop and the Carport, and reinforcement works for Water Quality Analysis Laboratory and Hydrogeological Data Room by the prefabricated house.

The conceptual plans will be illustrated in the APPENDIX.

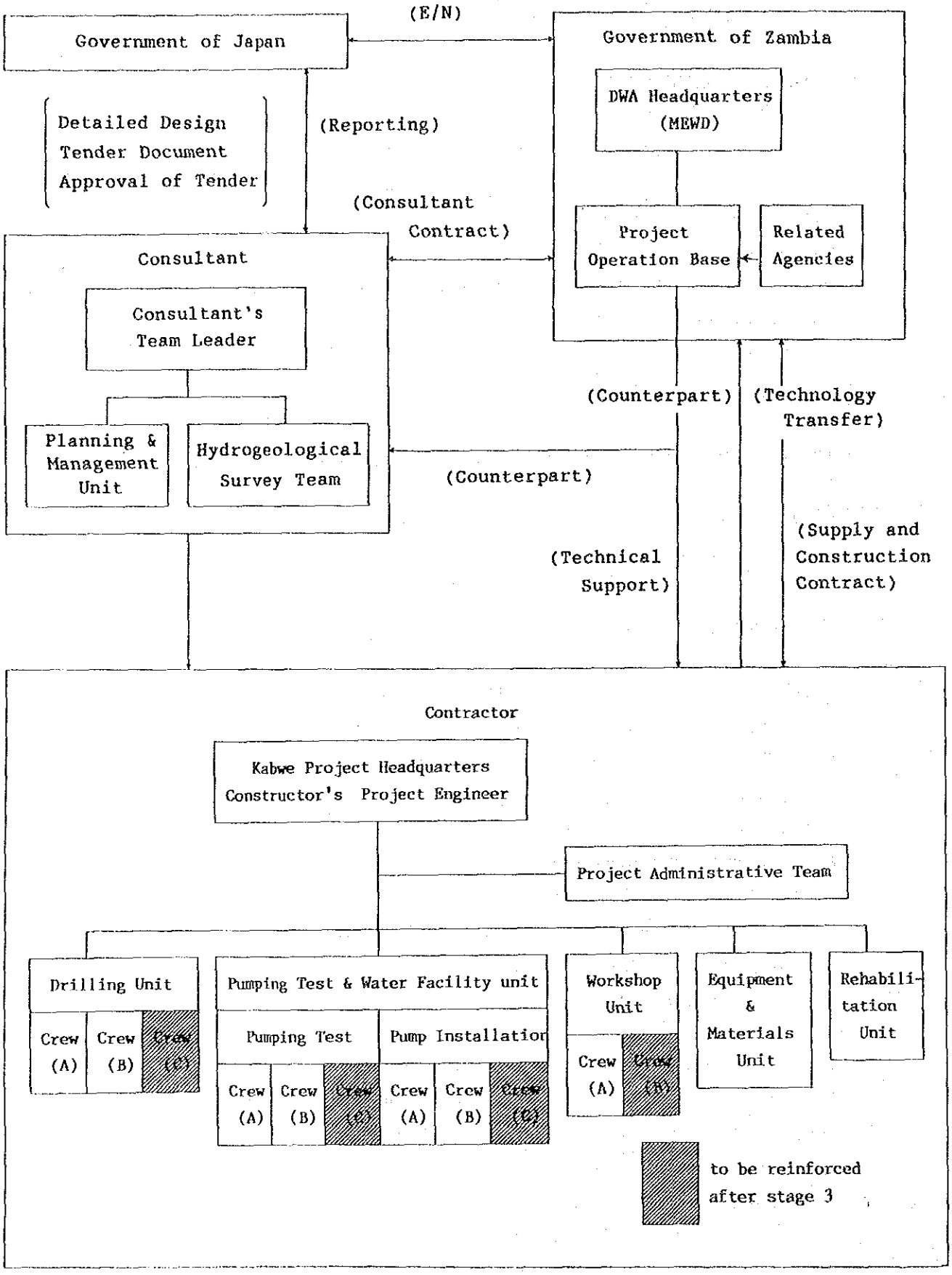
3.4 PROJECT IMPLEMENTATION

3.4.1 IMPLEMENTATION POLICIES

After the Exchange of Notes, the DWA, the executing agency, will enter into an agreement with a Japanese consultant for the detailed designing and the construction supervision. Then the DWA will perform a package tendering for the construction of water supply facilities and supply of related equipment and materials with the assistance of the consultant. As a result of evaluation on tenders, the DWA will enter into a contract with a firm. The principal contractor shall be a Japanese firm in accordance with the guide line drawn by JICA. FIG. 3 - 2 illustrates the implementation organization which is to be modified of the current organization.

Under the supervision of the consultant, the contractor will construct the contracted water supply facilities and will supply the related equipment and materials. Meanwhile, the DWA will dispatch counterparts, who are aimed to receive the technology transfer from Japanese sides during this Project period, to the Japanese Project Team shown to engage in the execution of works.

FIG. 3-2 IMPLEMENTATION SYSTEM



After the inspection by the DWA, the completed water supply facilities will be handed over to the respective rural communities for general operation and maintenance while the DWA will be responsible for works requiring special skills and techniques. The supplied equipment and materials shall be handled by each section who is receiving the technology transfer through the implementation of the Project after the inspection by the DWA.

3.4.2 RESPONSIBILITIES OF ZAMBIAN SIDE

The Zambian side shall responsible for the execution of the Projects as follows:

1) Acquisition of land for sites for the construction of boreholes with water facilities, and land for the Project Operation Base. And also the preparation of access roads to the said land.

2) Smooth enforcement of administrative measures necessary for the implementation of the Project such arrangements as duty clearance, tax exemption and the furnishing of data and information.

3) Bearing any charges including the bank commission charge other than those covered by the Japanese grant aid necessary for the execution of the Project.

4) Preparation of an appropriate managing and maintenance organization with personnel, budget and the backing-up measures to the communities in order to function properly the supplied equipment and materials for the Project and the completed facilities. (The total yearly maintenance cost is calculated to be 30,920,000 Kwacha/year = 99,400 US$/year. See III-20 p.p.)

5) Providing and despatching counterpart personnel necessary for the receiving on-the-job training of the Project. (The cost of counterpart personnel for the Stages -3 and -4 is estimated to be 33,350,000 Kwacha = 107,200 US$.)

6) Preparation of necessary utilities such as electric power, water and telephone in connection with the modification works for the Project Operation Base.

3.4.3 IMPLEMENTATION SCHEDULE

The Stages -3 and -4 of the Revised Project shall be implemented as shown in TABLE 3 - 1, taking into account such important factors as the features of a Japanese grant aid system, the organization setup of the Zambian side, the efficiency of project implementation, the lead-time of the procurement of equipment and materials, and natural conditions.

3.5 OPERATION AND MAINTENANCE PROGRAMME

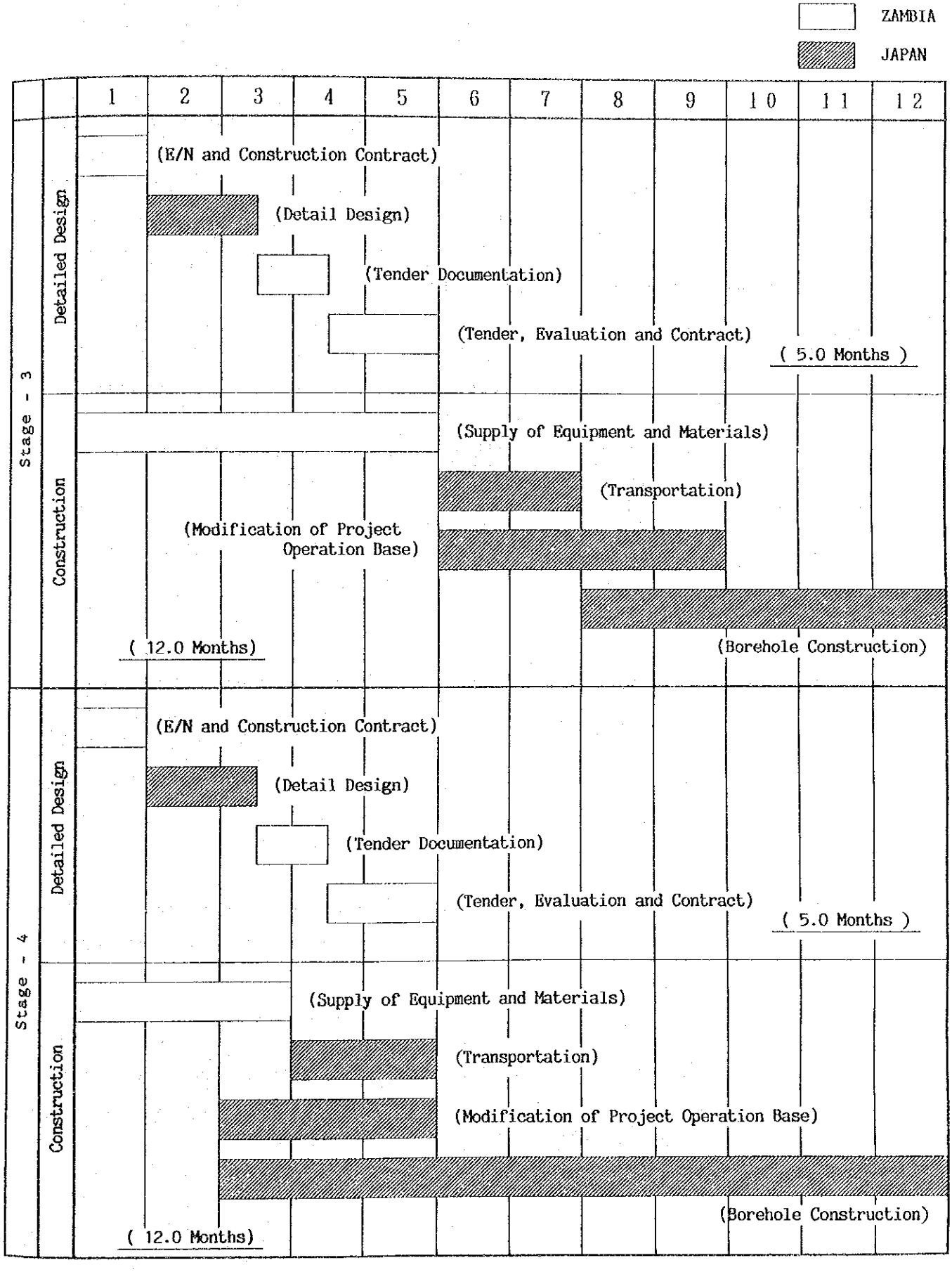
The DWA is executing the nationwide planning and implementation of rural area water supplies in Zambia. Although the district councils in the respective Districts are supposed to carry out the management and maintenance of water supply facilities, the DWA is mostly undertaking those activities in reality due to lack of manpower and management capability of the district councils. The Operation and Maintenance Programme in this Project includes the operation and maintenance schedules both for the water supply facilities with boreholes and for the procured equipment and materials. The following are the system recommended for the operation and maintenance in this Project.

3.5.1 OPERATION AND MAINTENANCE OF WATER SUPPLY FACILITIES

It is very important to provide an effective and well organized system in which each community will make up its own communal unit responsible for regular inspection and maintenance of facilities through a direct participation of inhabitants.

This Project requests the villagers to organize a water committee in their community to manage, operate, inspect and maintain the facilities on daily and periodical base. To support this line, this Project includes, therefore, a plan to provide a set each of maintenance tool kit to a Project Site, together with the training programme for operators to enable them to manage minor troubles with hand pumps.

TABLE 3-1 IMPLEMENTATION PROGRAM



The DWA is, on the other hand, recommended to provide a technical assistance for the rehabilitation works of boreholes because these kind of works are likely to involve a high technology of cleaning of boreholes.

This Project intends to assist the DWA for the improvement of the sanitation conscious of the villagers by enlightening them on sanitary environment because existing wells frequently have been a cause of waterborne epidemics through surface contamination. The rural environment could largely be improved if efforts would be made for promoting health education among its inhabitants.

Under those circumstances, the water management in the respective sites are recommended to be as follows. In short, a practical activities shall be aimed to be promoted by the assembly of the water committee directly participated by the villagers and by the provision of one set of tool kit for the maintenance of the water facilities.

1) The respective communities shall basically perform the operation and maintenance of the water facilities with the technical support by the DWA.

2) The respective communities shall assemble the water committees, shall set up an organization to solve the troubles related to the facilities, shall appoint a number of operators for the facilities and shall give training them for the operation and maintenance of the water facilities by the provision of necessary tool kits.

3) The Zambian Government shall provide the villagers health education programs to enlighten sanitary concerns of the rural population.

4) The Zambian Government shall provide the villagers public relations programs to let the rural people know about the significance of this Project and to give them acute interest in the Project and in spending their own efforts to protect their facilities.

5) The Zambian Government shall carry out periodical checks of water quality, water facilities and surrounding sanitary, and shall perform the sustained maintenance of facilities knowing the real situations.

3.5.2 MANAGEMENT OF EQUIPMENT AND MATERIALS

The drilling rigs have and will have performed a major enrollment in this Project. Therefore, it is recommended to establish an effective and appropriate management system for the drilling rigs throughout the Project period because the rigs can be used for the construction of the boreholes after the completion of the Project through the proper operation, the sufficient supply of consumable items and the efficient maintenance.

It is recommended here to selectively supply equipment and materials for the maintenance and repair of the drilling rigs and other machines, spare parts and supporting vehicles. The spare parts shall be supplied for the use of 2 years. The followings are the recommendations for the management system for the equipment and materials.

1) The DWA has currently an effective management system for the equipment and materials and the DWA is carrying out management, repair and maintenance works for rigs and vehicles in its organization. The technical staff of the DWA has already a sufficient knowledge of equipment and materials of Japanese make. Technology transfer is also planned to be provided under this Project to further upgrade its knowledge so that the operation and maintenance of equipment and materials can effectively and efficiently be carried out.

2) The on-the-job training for the personnel concerned shall include the periodical inspection and maintenance of equipment and vehicles as well as the presentation of the functions and mechanism of the machines and equipment so that the participants can understand technically and operate and handle them carefully.

3) The item by item storage should be emphasized for materials and spare parts to prevent theft or possible damage during wet seasons of goods. An open storage should be prohibited. The analysis of record of supply, consumption, troubles shall be kept with those materials for the planning of the future procurement.

3.5.3 COSTS FOR MAINTENANCE

The recurring cost for maintenance of the completed facilities is estimated for expenses of the periodical inspection carried out by the maintenance teams in the DWA and for those of repairing damages which could not be coped with by inhabitants themselves. The calculation assumes that the DWA's staff would be dispatched twice a year. The calculated cost, therefore, does not include expenditure for routine operation and maintenance by inhabitants nor the maintenance costs at the workshop of the DWA.

1) Personnel

The maintenance team, headed by a team leader, composed of three crews, each staffed with a technician, a worker and a driver. Thus, 10 is the total number of personnel of the team. A crew is assumed to handle one site in one day. They will have to engage in service for their inspection and maintenance throughout the year in taking consideration of the 380 sites to be completed during this Project, travelling for, from and between sites and works in the Project Operation Base at Kabwe.

a.	Team Leader	1
b.	Technicians	3
c.	Workers	3
d.	Drivers	3
	Total	10

2) Fuel

The objective Sites for the maintenance team are to be of total 380 Sites under this Project.

220 Sites for the new borehole construction

160 Sites for the rehabilitation of the existing boreholes)

The fuel cost will be calculated in accordance with the implementation schedule.

3) Vehicles

The maintenance cost for vehicles is to be calculated of 20 % of the fuel cost calculated above for the expenses for the regular inspection, regular checks and oils.

4) Spare Parts

The expenses for parts of repair and replacement is to be calculated as 5 % of the total price of vehicles procured in the Project.

The total maintenance cost is calculated, then, as follows:

a.	Personnel	7,464,000 Kwacha
b.	Fuel	10,418,000 Kwacha
c.	Vehicles	2,088,000 Kwacha
d.	Spare Parts	10,950,000 Kwacha
	Total	30,920,000 Kwacha
		(99,400 US$)

CHAPTER IV

PROJECT EVALUATION AND CONCLUSION

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4.1 PROJECT EVALUATION

It is evident that this Project is considered important and urgent in Zambia in view of the Revised Request made in December 1992 for the relief of the severe draught occurred in 1991 - 1992 and in view of the high priority given to the rural water supply schemes in the Fourth National Development Plan (1989 - 1993) from Zambia to Japan. It is particularly true that such a rural water supply development as this Project benefits to the rural inhabitants to respond to the national policies combined with the settlement of rural population, agriculture development and increase in food production now being promoted by the Government. The UN, the EC, Germany and Norway as well as the World Bank share such a view and support positively the governmental efforts of Zambia in this sector. The effects of this Project are summarized in the following table:

TABLE 4 - 1 EFFECTS OF THE PROJECT AND EXTENT OF IMPROVEMENT

Current Situation/ Difficulties	Measures Proposed by the Project	Anticipated Effects/ Extent of Improvement
1. *In the Project area, the year is clearly divided into wet and dry seasons. During dry season, hand-dug wells dry up, causing acute shortage of water over the area, where the coverage of rural water supplies is very low of 24% compared to 41% of the national average. The area has often been hit by outbreak of water borne diseases and intestinal infection due to deteriorated water qualities. *A large number of the hand-dug wells and surface water of the area were dried up due to the nation-wide severe draught of 1991/1992, and the water supply became a vital issue for the area.	*The provision of a stable supply and sanitary drinking water and the augmenting the coverage will be achieved by the construction of borehole facilities and rehabilitation of existing boreholes in 7 Districts of three Provinces of Lusaka, Central and Copperbelt. *Following the construction of borehole facilities at 79 Sites and rehabilitation of existing boreholes at 56 Sites in the Ongoing Project, new boreholes at 141 Sites will be constructed and the rehabilitation works at 104 Sites will be conducted in the Stages 3 & 4 to supply stably sanitary water even in a dry season and in a severe drought year.	*The Basic Design Study conducted in 1991 revealed the total population of Project area is 851,000, and its coverage is 24%. *Upon the completion of 200 new borehole construction and 100 rehabilitation works proposed by the B/D, 119,000 and 44,000 population, respectively, was expected to be served (163,000 in total corres ponding 19% of the total population), and the coverage was expected to increase from 24% to 43%. *In this review to respond the urgent request to solve the severe drought, it is recommended to add 20 new borehole construction and 60 rehabilitation works. Upon this completion, the number of beneficiaries will be increased by 5,680 and 16,450, respectively. Thus, another 2.7% of the total population of the area will be benefit ted by the stable supply of sanitary drinking water with boreholes even in a dry season or a severe drought year, subsequent improvements in health conditions and the standard of living.

Current Situation/ Difficulties	Measures Proposed by the Project	Anticipated Effects/ Extend of Improvement
2. *The DWA, the execution agency of this Project is promoting the rural water supply scheme in line with the 4th National Development Plan. The borehole construction as stable and sanitary water sources is being executed by drilling rigs deployed in respective Provinces by the DWA. 3 Provinces under this Project, however, had no rigs and their development had been quite slow.	*The DWA did and will procure equipment and materials for groundwater development to construct borehole facilities under this Project. The DWA has procured two units of drilling rigs and will procure another one unit of rig to accelerate the development of the area. *The technology transfer is and shall be carried out on hydrogeological survey, drilling works and the operation and maintenance of water supply facilities to counterpart staffs of the DWA.	*The DWA is anticipated to bolster engineering staff of hydrogeology and drilling works in the DWA and to reinforce its organization for the promotion of rural water supply schemes through the technology transfer. *Upon the completion of the Project, the DWA can launch its own program for borehole construction, employing the procured equipment and materials.
3. *In rural areas, the water bill collection has not yet been introduced. In some villages, damaged hand pumps are observed left unrepaired due to the lack of the necessary fund for the maintenance. The overall weakpoint of the rural area can be concluded to be insufficient capability of maintenance for water facilities.	*The rehabilitation works are and will be carrying out for the sites necessary for the boreholes and the sewage facilities. *Each community is and will be obliged to organize a water committee. *The DWA is and shall be giving a set of maintenance tool kit and be providing a series of training for the maintenance for the water facilities to the water committee.	*It is expected to improve the conscious of villagers about the sanitary environment of surroundings. *It is also expected to reinforce the autonomousness of the water committee by the positive participation of the villagers to operation and maintenance works and by the self-reliance including the water bill collection.
4. *Bringing water home is the daily work of women and children, and it requires them to work from dawn to sunset.	*The newly installed boreholes are and will be providing a stable supply of safe water and also is and will be shortening the distances between homes and water sources.	*The painstaking labour of women and children to bring water home will be much alleviated. *Thereby they can use their time and energy relieved for other activities such as production in agriculture, study in schools and recreation.

4.2 CONCLUSION

The Project for the Rural Water Supply Development Phase-III (the Project) has started under the Japanese grand aid programme for the Stages -1 and -2, in 1991/92 and 1992/93, respectively to respond to the request from the Government of Zambia in order to relief the immediate needs of a stable supply of safe and sanitary water to the rural inhabitants in three Provinces of Lusaka, Central and Copperbelt as a similar project of the Groundwater Development of Southern Province of Phase I(1985/86) and Phase II (1988/89). The Project has been consisted of: the procurement of equipment and materials necessary for the hydrogeological prospecting for the groundwater development, the construction of new boreholes facilities, the rehabilitation of the existing borehole facilities and the operation and maintenance for the completed water facilities, and the reinforcement of the organizational

capabilities of the DWA to execute the rural water supply.

This Project appreciates the self-reliance and direct participation of the villagers. Therefore, this Project aims to make sure that each community can obtain fruitful results of having the stable and sanitary water in a good condition and the up-graded conscious of sanitary environment through the following measures:

1) The water committee is obliged to be organized in a community.

2) The DWA will provide the training courses for the villagers and also will supply a set of hand tool kit for the maintenance of the completed water facilities to the community.

3) The standardization shall be introduced to the equipment including hand-pump itself and spare parts so that the procurement and management of the spare parts and the maintenance of the water facilities can be easier.

The followings are considered for the degree of the participation of the villagers to the Project:

1) The selection of the point of water source together with the villagers.

2) The services given by the villagers for the hydrogeological prospecting works for the groundwater development.

3) The preparation works done by the beneficiaries of the land and roads for the construction works of borehole with water facilities.

4) The services rendered by the villagers for the watching and securities of the equipment and materials during the construction period.

Thus, the Project can be considered to be appreciating the relations with villagers and the attitude of self-reliance for the obtaining the valuable drinking water by own hands, which promotes the understanding and conscious the necessity of the improvement in the life sanitary environments.

This Project originally started in 1991 depending upon the borehole as water sources in order to raise the standard of living of the villagers and to contribute to the rural economy whose basis lies on the agricultural production.

At the initial stage there were some doubt about more expensive budget of the Project due to the utilization of boreholes. However, the importance of the boreholes and the significance of the Project was re-recognized when Zambia was hit by the historically severe drought in 1991 and 1992. Throughout the country, the surface water of rivers and hand-dug wells were dried up and the urgent requests of the population reached the Government for daily drinking water during this drought. Thus the Zambian government came up with the conclusion of the necessity of the borehole as water sources in taking consideration of the facts of:

1) The borehole can produce a stable water supply independent on the season or the climatical conditions.

2) The borehole can also produce a very sanitary water. It is often said that hand-dug wells can be easily contaminated by the surface sewage and they can be the influential sources of the outbreak of the water borne disease like cholera and intestinal infection due to deteriorated water qualities. Thus, it can be stressed that the borehole is the very ideal solution for the supply of sanitary water from the view points of the living and sanitary environment conditions.

Thus the borehole facilities can be evaluated to supply a disease free water at the steady rate even in the most severe drought period.

In addition to the importance of the boreholes, this Project has been appreciated to support and fill-up the Fourth National Development Plan (1989-1993) which gave the high priority to the promotion and development of agriculture.

The DWA, as the executing agency of the Project, is planning to reinforce both the technological capabilities and the organization itself through the technology transfer for the equipment and materials procured during this Project period for the groundwater development including drilling rigs for its undertakings of borehole construction works and the operation and maintenance of the water facilities for the rural water management on its own