NO. 01

MINISTRY OF WATER RESOURCES
THE REPUBLIC OF KENYA

BASIC DESIGN STUDY REPORT ON THE PROJECT FOR GROUNDWATER DEVELOPMENT IN LAIKIPIA AND THE SURROUNDING AREAS OF SAMBURU, KOIBATEK, AND BARINGO DISTRICTS IN THE REPUBLIC OF KENYA

JICA LIBRARY
J 1148572 [9]

JANUARY 1999

JAPAN INTERNATIONAL COOPERATION AGENCY
NIPPON KOEI CO., LTD.

GRO
CR (2)
99-030

MINISTRY OF WATER RESOURCES
THE REPUBLIC OF KENYA

BASIC DESIGN STUDY REPORT ON THE PROJECT FOR GROUNDWATER DEVELOPMENT IN LAIKIPIA AND THE SURROUNDING AREAS OF SAMBURU, KOIBATEK, AND BARINGO DISTRICTS IN THE REPUBLIC OF KENYA

JANUARY 1999

JAPAN INTERNATIONAL COOPERATION AGENCY
NIPPON KOEI CO., LTD.


1148572 (9)

PREFACE

In response to a request from the Government of the Republic of Kenya the Government of Japan decided to conduct a basic design study on the Project for Groundwater Development in Laikipia and the Surrounding Areas of Samburu, Koibatek, and Baringo Districts and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Kenya a study team from July 13 to August 26, 1998.

The team held discussions with the officials concerned of the Government of Kenya, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Kenya in order to discuss a draft basic design, and as this result, the present report was finalized.

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

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

January, 1999

Kimio FUJITA

President
Japan International Cooperation Agency

January, 1999

Letter of Transmittal

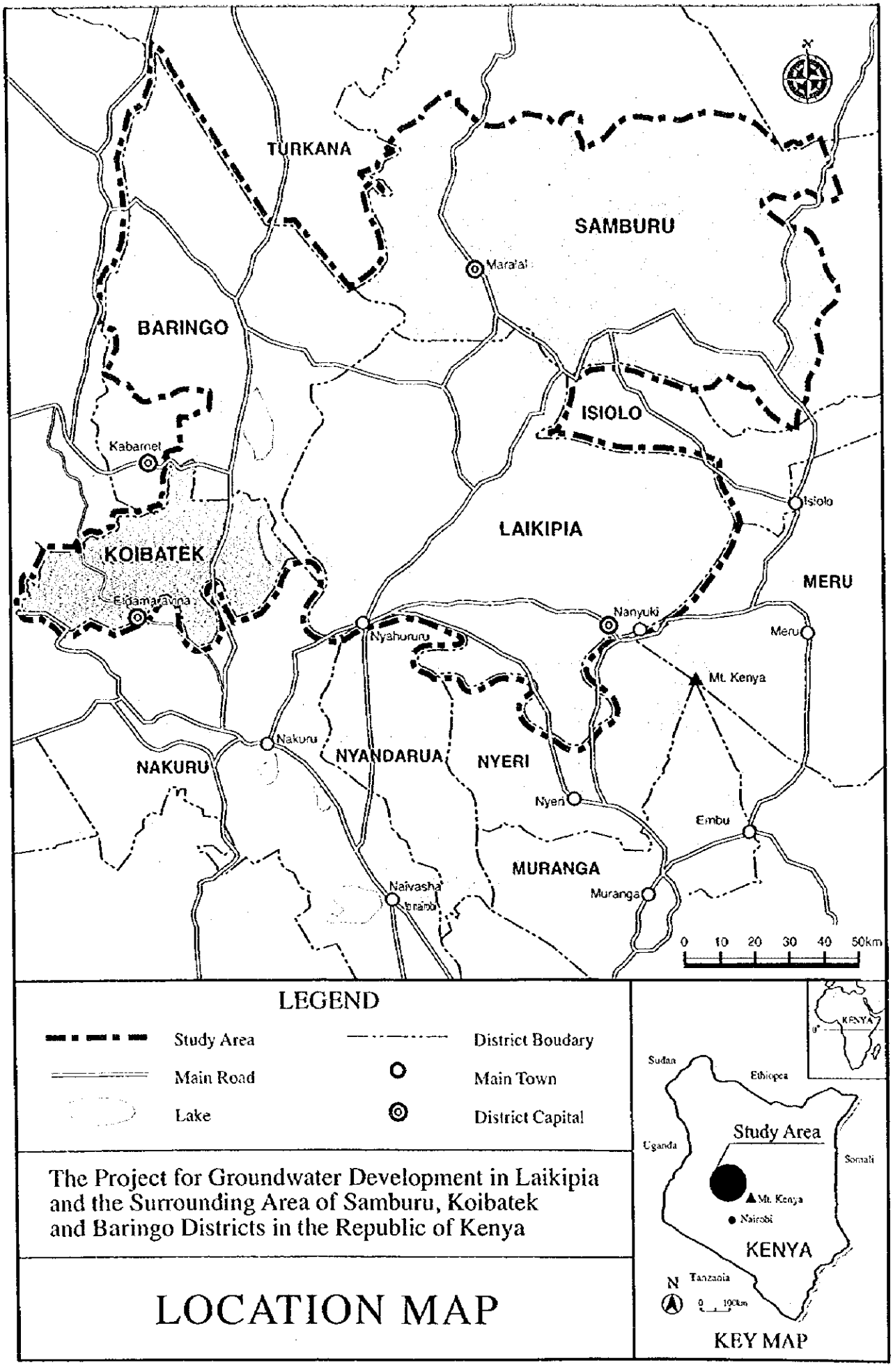
We are pleased to submit to you the basic design study report on the Project for Groundwater Development in Laikipia and the Surrounding Areas of Samburu, Koibatek, and Baringo Districts in the Republic of Kenya.

This study was conducted by Nippon Koei Co., Ltd., under a contract to JICA, during the period from July 6, 1998 to February 22, 1999. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Kenya and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,

Hitoshi Shimazaki
Project manager,
Basic design study team on the Project for Groundwater Development in Laikipia and the Surrounding Areas of Samburu, Koibatek, and Baringo Districts
Nippon Koei Co., Ltd.



The Project for Groundwater Development in Laikipia and the Surrounding Area of Samburu, Koibatek and Baringo Districts in the Republic of Kenya

LOCATION MAP

ABBREVIATION

ADB	ASIA DEVELOPMENT BANK
ADF	ASIA DEVELOPMENT FUND
ASAL	Arid, Semi-Arid Lands
BHN	Basic Human Needs
CBS	Central Bureau of Statistics
DANIDA	Danish International Development Agency
DTH	Down the Hole
DWE	District Water Engineer
DWO	District Water Office
EDF	European Development Found
EDC	Export Development Corporation
FAO	Food and Agriculture Organization the United Nations
FINIDA	Finland International Development Agency
FRG	Federal Republic of Germany
FRP	Fiberglass Reinforced Plastic
GDP	Gross Domestic Product
GOJ	Government of Japan
GOK	Government of Republic of Kenya
GTZ	Deutsche Gesellschaft fur Technische Zusammenarbeit (German Technical Cooperation Agency)
IDA	International Development Association
IFAD	International Fund for Agriculture Development
ILUS	Integrated Land Use Survey
JICA	Japan International Cooperation Agency
KS	Kenya Standard
Ksh	Kenya Shillings
K£	Kenya Pounds (20 Kenya Shillings)
MOH	Ministry of Health
MOHANH	Ministry of Home Affairs and National Heritage
MTBF	Mean Time Before Failte
MWR	Ministry of Water Resources
NGO	Non-Governmental Organization
NMWP	National Master Water Plan
NWCPC	National Water Conservation and Pipeline Corporation
NWP	National Water Policy
O&M	Operation and Maintenance
PVC	Polyvinyl Chloride
GSP	Galvanized Steel Pipe
SIDA	Swedish International Development Agency
UK	United Kingdom
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEF	United Nations International Children Emergency Fund
WHO	World Health Organization
WID	Women in Development
WDD	Water Development Department
WFP	World Food Programme
WRDB	Water Resources Development Branch

ABREVIATION OF MEASURES

Length

mm	=	millimeter
cm	=	centimeter
m	=	meter
km	=	kilometer
m/s	=	meter per second

Area

ha	=	hectare
m^2	=	square meter
km^2	=	square kilometer

Volume

l,lit	=	liter
l/c/day	=	liter per capital per day
l/min	=	liter per minutes
m^3	=	cubic meter
m^3/h	=	cubic meter per hour
m^3/s	=	cubic meter per second
MCM	=	million cubic meter
m^3/d	=	cubic meter per day

Weight

g	=	gram
kg	=	kilogram
t	=	ton
mg/l	=	milligram per litre

Time

sec	=	second
h,hr	=	hour
d	=	day
yr	=	year

Money

Ksh.	=	Kenya shilling
K£	=	Kenya pound
US$	=	U.S.dollar

Others

%	=	percent
o	=	degree
'	=	minute
"	=	second
°C	=	degree Celsius
md	=	man-day
no.	=	number
pers.	=	person
ppm	=	parts per million

SUMMARY

SUMMARY

The Republic of Kenya is equatorially located in the eastern part of Africa, surrounded by Ethiopia, Sudan, Somalia, Tanzania, and Uganda. It has a wide territorial area of about 583,000km^2, administratively consisting of 8 provinces and 50 districts. About 83% of the area, 490,000km^2, is characterized as arid and semi-arid regions, where about 25% of the total population of 29,290 thousand (1994) dwell. The economy of Kenya is still largely dependent on two major sectors of agriculture and tourism, approximately 29% and 15% of GDP on average, respectively. The Republic of Kenya is the least-developed country due to its low GDP per capita (US$300) in 1997 according to the statistic data published by the World Bank (1998/99). Economic growth is presently on deceleration tendency because the annual average growth of GDP during past 8 years of 1990 to 1997 was only 2.0% against 4.2% during 10 years of 1980 to 1990.

In order to improve this sluggish economic situation, the Government of Kenya (GOK), in the 8th National Development Plan (1997～2001), clarified its intention to promote industrialization and development of private sectors as well as stabilization of agriculture, which would be indispensable for stable water supply, a target of the water supply sector. GOK also intends to alleviate poverty and improve living circumstances with the Plan. According to the report by UNDP in 1994, the ratio of poverty alleviation in rural area was 55%, which was largely higher than 10% in urban area. The development of ASAL area which duly belongs to the rural area, is thus one of important policies for GOK, in order to realize the balanced development in rural and urban areas. In addition, inhabitants in the ASAL area are obliged to rely on the boreholes which would be limited to quantity and be sometimes suffered from poor quality, because river water is not available throughout a year. Especially, in the dry season, water shortage becomes so serious and makes sanitation situation worse, too. It eventually effects the required water for pasturage which are major works in ASAL area.

In this background, GOK requested the Government of Japan (GOJ) to extend grant aid assistance for construction of 100 boreholes with hand pump and procurement of vehicles and geophysical equipment in Laikipia and the surrounding areas of Samburu, Koibatek, and Baringo districts (about 20,000 km^2 in total).

In response to this request, GOJ decided to conduct a basic design study, and Japan International Cooperation Agency (hereinafter referred to as "JICA") sent a basic design study team during the period from July 13 to August 26, 1998. The study team discussed the contents requested with GOK. The following is a list of final requests made by GOK:

(1) Construction of Boreholes

Boreholes with hand pump	100 nos.
Boreholes with motorized pump	4 nos.
Rehabilitation of existing borcholes	4 nos.
Application of wind pump instead of hand pump	

(2) Procurement of Equipment

Vehicles	
4WD Station Wagon	2 nos.
4WD Pick-up	2 nos.
Geophysical Equipment	
Electric Sounding Equipment	1 set
Electro-magnetic Equipment	1 set
Electro Logging Equipment	1 set

The study team carried out social and economic studies, selection of borehole sites, electric sounding, and interview survey based on these requests. In addition, the study team executed water quality test using the existing wells and rivers in the Project area. On the contents of the Project, the study team made thorough discussions with the concerned agencies of GOK in Kenya, and confirmed the discussed matters through preparation of minutes of meetings.

In Japan, the study team made basic study based on the results of field investigation. The employed basic design concept for the Project are as follows:

(1) Construction of boreholes and surrounding facility

- The borehole sites shall be selected from the requested sites by GOK, based on the hydrogeological structure, successful rate of boreholes, present water supply ratio and number of beneficial population.
- Dimensions of boreholes shall follow those of the existing ones as much as possible taking it into account that the Project shall be the model of rural water supply in ASAL area.
- Type of hand pump shall be determined considering possibility of procurement and availability of spareparts in Kenya since operation and maintenance will be conducted by a self-help water group.

(2) Procurement of equipment required for smooth operation and maintenance (vehicles and geophysical equipment)

- The minimum number of vehicles shall be procured and their type shall be suitable for execution of operation and maintenance activities.

- Geophysical equipment shall be minimum in number for the project implementation and the execution of transfer of knowledge to GOK staff.

In the study, the study team has examined the possibility of constructing 4 boreholes with motorized pump, and rehabilitating 4 existing boreholes with motorized pump and procuring electro-magnetic equipment which were additionally requested by GOK, in addition to the said original request. The study team decided not to take up the additional request mainly due to lack of basic technical data. The study team also decided not to employ a wind pump due to insufficient data of wind velocity and operation record.

As for the equipment, four 4WD pickup truck (double cabin type) will be procured to four districts, so as to provide technical guidance for the self-help water groups. Electric sounding equipment will be procured for additional investigation during construction period, transfer of knowledge to the Ministry of Water Resources (MWR) staff, and direct use by them after construction .

As for the boreholes construction, the 100 boreholes sites originally requested were narrowed down to the 90 borehole sites based on the following conditions.

(1) Preliminary evaluation of requested borehole sites (inaccessibility, overlapping with existing drilling plans by other donors, problem on land acquisition in private ranch)
(2) Hydrological investigations (hydrological structure,pumping yield, static water level, water quality)
(3) Success rate of boreholes (more than 50%)
(4) Target accounted-for-ratio of 70% by 2010 (less than 70% of water supply ratio) and effective use of hand pump capacity (more than 7 persons/km^2 of population density).

JICA dispatched a mission to explain the draft basic design report to GOK during the period between October 26, 1998 and November 6, 1998. The basic agreement was signed and exchanged after the contents of the Project were verified and agreed upon by both parties.

The proposed contents of the Project are as follows:

- Construction of borehole with hand pump, concrete-slaved apron and livestock trough

Laikipia district	:	52 borehole sites
Samburu district	:	16 borehole sites
Baringo district	:	20 borehole sites
Koibatek district	:	2 borehole sites
Total	:	90 borehole sites

- Procurement of equipment

Vehicles	:	4 nos. of 4WD double cabin type pick-up truck in total, for 4 districts
Geophysical equipment	:	One electric sounding

The required construction period would be about 26.5 months .

In connection with the Project implementation, GOK will bear the cost of Ksh.22 million for construction of temporary access road (Ksh.11 million) and a part of community management works (Ksh.11 million).

MWR is responsible for the administration of the Project. The Water Development Department (WDD) is the direct responsible agency for the Project implementation. Respective District Water Offices (DWOs) of Laikipia, Samburu, Baringo and Koibatek will be in charge of construction supervision of the Project under the control of WDD. In order to execute the Project implementation, MWR has organized the Program Steering Committee and Program Management Committee and establish the Project Management Team (the Kenya/Japan Water Sanitation Promotion Programme Unit) . The Project Management Team will give technical advice and guidance to the respective DWOs on time.

The operation and maintenance of the Project shall be executed by the self-help water group organized by beneficiaries in line with the National Water Policy. MWR and other relevant agencies will give technical support to the self-help water groups. In MWR, WDD and subordinating Divisional Water Offices will be responsible for technical support to them, under the control of District Implementation Team and Project Management Team belonging to the said the Kenya/Japan Water Sanitation Promotion Programme Unit. The self-help water groups will be formulated prior to commencement of borehole construction, and will be registered at the District Social Development Office. The self-help water groups will be managed by a water committee established in accordance with a by-law.

The self-help water group has no experience and knowledge in operation and maintenance of water supply facility since it is newly formulated in connection with the construction of water supply facility. Thus, MWR will provide the self-help water grope with the community training such as establishment of water committees, repairs of facility, collection of water charge, financial management and sanitary education, aiming to the Project sustainability. In the project, such community training by MWR will be suppoted by

GOJ, to execute it effectively. The community training to be applied in the Project, will be planned based on the following basic design concepts:

(1) Community training to be initiatively executed by MWR.(District Water Office, District Social Development Office and District Health Office) as trainers.

(2) Execution of training to trainers by a supervisory team consisting of NGO and/or local consultant.

(3) Execution of community training district by district due to different tribes.

(4) Application of stagewise training: preparatory work, before construction, after construction, and follow-up survey.

The Project will be conducive to the following benefits:

(1) Mitigation of water shortage

Implementation of the Project could directly supply stable clean water to about 32,000 people in addition to the present served population of 95,000 (estimated using 360 served population per one well from hand pump capacity). In addition, if calculated from the population density and 4km of planned distance to the water supply point, the indirectly served population would be increased to 174,000, which would be about 62% of 282,000 served population in the targeted year 2000 and would be expected to mitigate the chronic water shortage.

(2) Contribution to attainment of target accounted-for-ratio

The present service coverage of the Project area is only 34%. Implementation of the Project could raise it to 45% in 2000 if it is estimated using 360 directly served population per one well, or to 62% in 2000 if estimated using the population density and 4km of planned distance to the water supply point, which would be conducive to the "Target accounted-for-ratio of 70% by 2010 in rural water supply".

(3) Improvement of sanitary circumstance

The welfare monitoring survey II executed by the Central Bureau of Statistic in 1994, presents that the rate of water borne diseases would be 9.6% in Laikipia district, 13.6% in Samburu district and 13.7% in Baringo/Koibatek districts which are higher than 9.2% in urban area. The Project would contribute to decrease in such disease rate through improvement of sanitary Conditions by supplying clean water.

(4) Mitigation of water fetching load for women

In the Project area, water fetching is mainly executed by women. Eighty-three (83)% of these women replied in the interview survey that the distance to the available water source was more than 4km. Since the Project is planned within 4km distance to the water supply point, women who presently fetch water more than 4km, could take part in social services, income generation work, etc. using the saved time.

(5) Contribution to development for ASAL area

The Project aims to increase living standard of inhabitants in Laikipia district and surrounding areas of Samburu, Baringo and Koibatek districts by providing a water supply facility. It will contribute to the improvement of living circumstances targeted in the 8th National Development Plan.

(6) Demonstration effect as model project in ASAL area

In the Aftercare Study on the National Water Master Plan, it is recommended that the small-scaled rural water supply be developed using groundwater from viewpoints of low initial investment and simple operation and maintenance. The Project which coincides with this recommendation, would thus serve as a model of rural water supply development in ASAL area.

The Project will bear large benefits mentioned above. Concurrently, the Project will contribute widely to the attainment of the basic human needs such as improvement of sanitation environment and mitigation of work load of water fetching. It is therefore judged to be so significant to implement the Project. However, the Project might face unsatisfactory operation and maintenance activities since these activities be executed by self-help water groups who have no sufficient experience and knowledge on them. To this end, it is essential to provide the self-help water groups with continuous technical support. In order to execute such technical support smoothly and effectively, it is proposed to take the following countermeasures:

(1) Urgent establishment of self-help water groups.
(2) Training to GOK staff to support to self-help water groups.
(3) Budget arrangement for Kenya/Japan Water and Sanitation Program Unit, which will supervise the Project implementation.

BASIC DESIGN STUDY
ON
THE PROJECT FOR GROUND WATER DEVELOPMENT
IN
LAIKIPIA AND THE SURROUNDING AREAS
OF
SAMBURU, KOIBATEK, AND BARINGO DISTRICTS

BASIC DESIGN STUDY REPORT

Table of Contents

List of Tables

List of Figures

Attachments

Appendices

CHAPTER 1

BACKGROUND OF THE PROJECT

CHAPTER 1 BACKGROUND OF THE PROJECT

The Republic of Kenya is equatorially located in the eastern part of Africa, surrounded by Ethiopia, Sudan, Somalia, Tanzania and Uganda. Its territorial area is about 583,000km^2, and administratively divided into 8 provinces and 50 districts. Four hundred ninety thousand km^2 (except coast area and southern highland area), about 83 % of the area, are categorized as arid and semi-arid regions, so-called ASAL region where about 25 % of total population 29,290 thousand dwell.

The climate in Kenya is primarily governed by the movement of the Inter Tropical Convergence Zone and by topographic relief, especially elevation. Air temperature varies largely from below the freezing point at snow-capped peak of Mt.Kenya to over 40°C in low elevation. Average annual rainfall is about 630mm, being less than 200mm in the northern dry region, and the highest,1,800mm in western Kenya.

Economy of Kenya is still largely dependent on two major sectors of agriculture and tourism, approximately 29% and 15% of GDP on an average, respectively. Economic growth is presently declining because the annual average growth of GDP during past 8 years of 1990 to 1997 was only 2.0% against 4.2% during 10 years of 1980 to 1990. This is mainly due to stagnant agriculture production which is a key in Kenya's economy. The average price escalation was 12.2% during 5 years from 1993 to 1997.

In order to overcome this sluggish economic situation, the Government of Kenya (GOK), in the 8th National Development Plan (1997～2001), set forth stabilization of agriculture production, promotion of industrialization and development of private sectors, for which stable water supply is essential. The water sector, thus, aims to realize the stable water supply by means of strengthening operation and maintenance through improvement of financial situation and handing over the rural water supply facility to the beneficiaries.

Also, GOK puts poverty alleviation and improvement of living circumstances in the Plan. According to report by UNDP in 1994, the ratio of poverty alleviation in rural area was 55%, which was largely higher than 10% in urban area. The development of ASAL area which duly belongs to the rural area, is thus one of important policies for GOK, in order to realize the balanced development in rural and

urban areas.

Inhabitants in ASAL area are obliged to rely on the boreholes which would be limited to quantity and be sometimes suffered from poor quality, because river water is not available throughout a year. Especially, in the dry season, water shortage becomes so serious and makes sanitation situation worse, too. It eventually effects the required water for pasturage, major works in ASAL area. To this end, settlement of such chronic water shortage is the most important subject for GOK in development of ASAL area.

In this background, GOK requested the Government of Japan (GOJ) to extend grant aid assistance for construction of 100 boreholes with hand pump and procurement of vehicles and geophysical equipment in Laikipia and the surrounding areas of Samburu, Koibatek and Baringo districts (about 20,000 km^2 in total).

In response to this request, GOJ decided to conduct a basic design study, and JICA sent a basic design study team during the period from July 13 to August 26,1998. The study team carried out confirmation of requested borehole sites, social and economic conditions, selection of borehole sites, electric sounding and interview survey. In addition, the study team executed water quality test using the existing wells and rivers. On the contents of the Project, the study team made thorough discussions with the concerned agencies of GOK in Kenya, and confirmed the discussed matters through preparation of minutes of meetings. In these discussions, GOK made the following additional requests to the study team:

(1) Modification of borehole sites

(2) Study on 4 motorized boreholes

(3) Study on rehabilitation on 4 existing damaged boreholes

(4) Study on application of wind pump

(5) Procurement of an electro-magnetic equipment

The study team carried out the basic study for these original and additional requests.

CHAPTER 2

CONTENTS OF THE PROJECT

CHAPTER 2 CONTENTS OF THE PROJECT

2.1 Objectives of the Project

The Project aims at elevating the livings standard of inhabitants by improving environmental sanitation and mitigating work loads of women and children for getting a supply of clean water, in accordance with the 8th National Development Plan (1997 – 2001) targeting improvement of living circumstances. The Project will contribute to the attainment of the "Target accounted-for-water (AFW) of 70% by 2010 in rural water supply" by raising the present 34% service coverage of the Project area to 45%. It involves the construction of 90 boreholes with hand pumps in Laikipia District and its surrounding areas of Samburu, Baringo, and Koibatek Districts

2.2 Basic Concept of the Project

2.2.1 Boreholes

Initially the Government of Kenya (GOK) are requested a Basic Design Study (the Study) for drilling boreholes at 100 sites to in Laikipia and the surrounding areas of Samburu, Baringo, and Koibatek districts and equipping them with hand pumps. In addition, the Ministry of Water Resources (MWR) requested the study team to add eight more borehole sites to the Study scope. consisting of 4 sites to be equipped with motorized pumps and 4 rehabilitation sites.

Sites to be equipped with hand pumps were selected with a priority putting on those with easy operation and maintenance at the self-help water group level. The selection process consisted of : (a) preliminary evaluation of requested borehole sites (inaccessibility, overlapping with existing drilling plans by other donors, problem on land acquisition in private ranch), (b) hydrological investigations (hydrological structure,pumping yield, static water level, water quality), (c) success rate of boreholes (more than 50%), (d) target accounted-for-ratio of 70% by 2010 (less than 70% of water supply ratio) and effective use of hand pump capacity (more than 7 persons/km^2 of population density). The details are given in **Attachment 1.**

The 4 boreholes sites to be equipped with motorized pumps and four rehabilitation sites additionally requested by MWR. As discussed in **Attachment 2**, it was found difficult to sustain operation and maintenance of motorized pumps by the self-help water groups at the requested sites. On the other hand, there found the basic problems in early implementation of rehabilitation of the requested sites, which were no detailed data of borehole and facility required for rehabilitation and the different need of the existing self-help water group from rehabilitation as shown in **Table 2.2.1.** From these findings, it was difficult to justify implementation of these sites under the

Project. The sites of motorized pump and rehabilitation were therefore excluded from the Project.

As a result of the Study, 90 boreholes for drilling were proposed from the 108 requested sites. The selected 90 borehole sites for drilling by district and division are shown below, and details are given in **Attachment -1, Tables 9** and **10.**

District	Division	No. of Sites	No. of Proposed
Laikipia	Mukogodo	5	8
	Rumuruti	5	8
	Ngarua	8	11
	Lamuria	11	14
	Central	8	11
	Sub-total	36	52
Samburu	Wamba	0	0
	Lorroki	7	13
	Kirisia	2	3
	Sub-total	9	16
Baringo	Kipsalaman	2	4
	Tangulbei	3	5
	Mukutani	1	2
	Mochongoi	5	7
	Kolowa	1	2
	Sub-total	12	20
Koibatek	Mumberes	1	1
	Mogotio	1	1
	Sub-total	2	2
Total		59	90

2.2.2 Water Supply Facility

The design concept of the proposed water supply facility consisting of borehole hand pump, concrete-slabbed-apron and livestock trough, is:

(1) Borehole Hand Pumps

There are 4 types of hand pumps presently used in Kenya: Afridev, India Mark II, India MarkII Extra Deep, and Duba. Among the 4 types, Afridev and India Mark II Extra Deep were selected in view of domestic procurement including spare parts and easy operation and maintenance as mentioned in **Table-2.2.2.** Afridev will be applied for a static groundwater up to 45 m and India Mark II Extra Deep for 45 - 55 m. The maximum depth of static water level in use of hand pump was set at 55 m for the Project to allow operation by woman and children.

(2) Wind Pumps

MWR requested the study team to investigate the application of wind pumps for the Project. The wind pump generally has an advantage of lower operation and maintenance cost. In the Project area, however, there are insufficient basic data of local wind regime and operation records of wind pumps to evaluate their application. Besides the existing wind pump in Laikipia district did not function efficiently for the

period from January to March due to very weak wind. Since the Project is aiming at stable supply of potable water, introduction of wind pump is not proposed. Details on wind pump are discussed in **Attachment-3.**

(3) Proposed Facility

The proposed water supply facility will supply domestic water only. Since inhabitants in the Project area make their living by raising livestock, the proposed facility will be equipped with a livestock trough as well as hand pump and concrete-slabbed-apron.

Tabulated below are the proposed number of boreholes and hand pumps:

District	Division	No. of Borehole	Average Depth of Borehole (m)	Handpump	
				Afridev	India MarkII
Laikipia	Mukogodo	8	105	8	0
	Rumuruti	8	140	8	0
	Ngarua	11	121	8	3
	Lumuria	14	115	8	6
	Central	11	100	5	6
	Sub-total	**52**	**115**	**37**	**15**
Samburu	Wamba	0		0	0
	Lerroki	13	106	13	0
	Kirisia	3	117	2	1
	Sub-total	**16**	**108**	**15**	**1**
Baringo	Kipsaraman	4	50	4	0
	Tangulbei	5	130	5	0
	Mukitani	2	80	2	0
	Mochongoi	7	81	7	0
	Kolowa	2	100	2	0
	Sub-total	**20**	**89**	**20**	**0**
Koibatek	Mumberes	1	120	0	1
	Mogotio	1	120	0	1
	Sub-total	**2**	**120**	**0**	**2**
Total		**90**	**108**	**72**	**18**

2.2.3 Procurement of Equipment

GOK requested the following equipment from the Government of Japan (GOJ):

(a) Vehicles

- 4WD station wagon : 2 nos.
- 4WD pick-up truck : 2 nos.

(b) Geophysical Equipment

- Electric sounding equipment : 1 unit
- Electro-magnetic equipment : 1 unit

GOK also requested electric logging equipment for determining screen position and collecting of the necessary data for rehabilitating the existing damaged boreholes.

(1) Vehicles

Four vehicles consisting of two vehicles for Laikpia/Koibatek districts, one vehicle for Samburu district and one vehicle for Baringodistrict, are essential for proper operation and maintenance considering the scattered sites of boreholes, the present conditions of vehicles kept by MWR and the District Water Offices (DWOs) concerned, and the need to strengthening technical support to the self-help water groups. The vehicle to be procured is to be a pick-up truck of 4WD double-cabin type.

(2) Geophysical Equipment

The geophysical equipment was requested to collect the required data for rehabilitation of existing borcholes, but is not directly related to the operation and maintenance of the Project. Electro-magnetic equipment, which is generally used in the dry area, is not recognised to be necessary for the Project implementation. Electric logging equipment was requested to determine the position of the screen at the borehole. But in the Project, it will be arranged by the successful contractor at construction time. Electric sounding equipment could be used for supplemental survey prior to construction of boreholes. In addition, it could function as electric logging equipment. With those viewpoints and also the transfer of technical knowledge to the government staff, electric sounding equipment only will be procured under the Project.

2.3 Basic Design

2.3.1 Design Concept

(1) Boreholes

(a) Selection of Borehole Sites for Drilling

Borehole sites for drilling are selected based on the following: (for details see **Attachment -1)**

1) Preliminary Evaluation of Requested Sites

A preliminary site selection is executed through field reconnaissance considering accessibility, prevention of overlap with the existing drilling sites by other donors, and ease of land acquisition.

2) Hydrogeological Investigations

To obtain sustainable and safe potable water, hydrogeological structures, possible yield, static water level, and water quality at respective sites are carefully examined. Sites are screened on the basis of this criteria for successful boreholes.

3) Successful Rate of Boreholes

Successful rates of boreholes for respective districts are evaluated by analysis

on the existing borehole data kept by MWR (**Attachment-4**) and the record of recent borehole drilling executed by other donors. In this screening, site in regions which have less than a 50% success rate of boreholes are eliminated.

4) Proposed Number of Boreholes from Current Water supply Conditions

The supply ratio of 70% to rural areas in the year 2010 targeted by the Aftercare Study on the National Water Master Plan is applied as a criteria for provision of borehole site for drilling. In addition, selection will be made for the sites more than 7 persons/km^2 of population density considering the effective use of a hand pump capacity.

(b) Water Quality

According to the existing data of water quality tests shown in **Attachment-5**, 60 out of 147 boreholes, which corresponds with a ratio of 41%, do not meet the guidelines of potable water quality in Kenya. Guidelines are not met for 23 out of 38 (61%) for Saraburu district and 16 out of 30 (53%) for Baringo and Koibatek districts. Laikipia district has the relatively fair results, with 21 out of 79 (27%).

The proposed sites for boreholes are crosschecked with the existing water quality data. Successful rate of boreholes is also provided reflecting water quality conditions. However, groundwater in the Project area is not always in good quality as described above. From this point, the basic design study accepts groundwater quality meeting the Kenyan guidelines at least in combination with the borehole yield.

Table-2.3.1 shows the guidelines of potable water quality in Kenya with those in Japan and the WHO's recommendations for reference. The results of water quality tests conducted in the basic design study are shown in **Attachment-6**.

(c) Criteria for Successful Rate of Boreholes

The criteria for the successful rate of boreholes are given below.

Borehole Yield : 330 ℓ/hour or more

Water Quality : meeting the Kenyan guidelines of potable water quality

For borehole yield, the guidelines of JICA is applied due to the absence of such criteria in Kenya.

(d) Successful Rate of Boreholes

The successful rates of boreholes are by region obtained on the basis of the existing borehole inventory and water quality data as given below.

District	Division	Successful Rate of Boreholes
Laikipia	Mukogodo	78%
	Rumuruti	84%
	Ngarua	76%
	Lamuria	93%
	Central	80%
Samburu	Wamba	30%
	Kirisia/Lorrok	82%
Baringo		69%
Koibatek		54%

(e) Design Features of Boreholes

Major design features of boreholes are drilling depth and casing.

1) Drilling Depth

Drilling depth is obtained from strata estimated by analysis of electric soundings as seen in **Attachments-7** and-**8**. The selected 90 sites for drilling are classified into 3 types of strata. These are similar to the classification of aquifers. Most of the sites belong to strata composed of volcanic rocks of Tertiary and Quaternary. Whereas, strata of Pre-cambrian basement rock and Quaternary unconsolidated deposits are limited in number. For each type, averaged drilling depth by layer is obtained and typical borehole structure is prepared accordingly.

2) Casing

The Study employs 6 inch diameter steel casing. The Project intends to employ local contractors for drilling as much as possible. Their experiences cover mainly drilling boreholes furnished with drilling casing of 6 inches diameter or more. This corresponds with information obtained from the existing borehole inventory which indicates 54% of the existing boreholes are furnished with casing diameter of 6 inch. It is, therefore, expected that application of 6 inch casing helps to implement drilling works smoothly and to keep reliable quality of completed boreholes.

Casing material needs to be steel for durability since the proposed depths of boreholes are 100 meters or more for most cases.

(f) Total Number of Drillings

Total number of drillings is planned at 116 for 90 successful boreholes. The summaries are shown below by type of strata and region. The successful rate of boreholes is 78%.

by Type of Strata

Type	Average Depth of Boreholes	Max. Depth of Boreholes	Planned No. of Boreholes	Successful Rate	Nos. of Max.Drillings
Type-A	108 m	180 m	78	79%	99
Type-B	113 m	130 m	8	67%	12
Type-C	100 m	100 m	4	80%	5
Total			90	78%	116

Note *Type-A: rock strata is located about 5m below from the surface*
Type-B: rock strata is located about 15m below from the surface
Type-C: rock strata is located about 80m below from the surface

by Region

District/ Division	Average Depth of Boreholes	Max. Depth of Boreholes	Planned No. of Boreholes	Successful Rate	Nos. of Max. Drillings
Laikipia					
Mukogodo	105 m	140 m	8	78%	10
Rumuruti	140 m	180 m	8	84%	10
Ngarua	121 m	160 m	11	76%	14
Lamuria	115 m	180 m	14	93%	15
Central	100 m	170 m	11	80%	14
Samburu					
Wamba	-	-	0	30%	0
Kirisia/Lorroki	108 m	130 m	16	82%	20
Baringo	89 m	130 m	20	69%	29
Koibatek	120 m	120 m	2	54%	4
Total			90	78%	116

(2) Water Supply Facility

(a) Proposed Borehole Pump

The Study concludes that hand pumps are the most suitable as borehole pumps in the Project. Motorized pumps are difficult to operate and maintain even if the self-help water groups are given training. Proper site selection for a wind pump would be difficult without any local wind data. Thus, neither of them were considered for the Study.

(b) Proposed Facility

The distance to the water supply point is to be within 4 km, considering there are no alternative stable water source and many nomadic people in the Project area.

Although water supply facility service to supply domestic water only, the proposed facility is equipped with livestock trough as well as hand pump, concrete slabbed apron, and drains in consideration that lots of inhabitants in the Project area make their living by raising livestock.

Population supplied per a hand pump is 360 persons as standard from the

following design conditions:

- Unit water consumption : 15 ℓ/c/day
- Pumping capacity : 675 ℓ/hour
- Operation hours : 8 hours/day

(675 ℓ/c/day) x (8 hours/day) / (15 ℓ/c/day) = 360 persons

(c) Application of Hand Pump

1) Concept

For application of hand pump, it is necessary to consider possible pumping volume at head depending on static water level of groundwater. Pumping volume per stroke is constant with a hand pump. Whereas, energy required per stroke becomes larger as pumping head increases.

When energy of manpower is constant within a certain operation time, the number of strokes decreases as pumping head increases. A hand pump is operated by reasonable energy of manpower and lifts a specified volume of water within a unit time. In the Study, the minimum borehole yield is 330 ℓ/hour for a borehole to be classified as successful. An application criteria of hand pump is, therefore, regarded as the maximum pumping head to lift and discharge 330 ℓ/hour by reasonable energy of manpower.

2) Analysis of Pumping Volume and Head

TH-Q(Total Head - Quantity) curve between head and pumping volume was prepared for the Afridev hand pump under the Joint Development of the Special Energy Program in Kenya. The study team also conducted pumping tests using Afridev hand pump at two locations at the field investigation time, to verify this TH-Q curve. The results of pumping tests were compared with the TH-Q curve. **Figure-2.3.1** shows that the results of pumping tests are fit with the TH-Q curve.

The maximum power (watt) of an adult man is assumed to be 116.5 watts based on the average calculated from the two pumping tests. This is deemed reasonable since the specifications of Afridev hand pump explain that an adult man operates hand pump with power of 100 watt or more at some high pumping head.

The following presents estimated pumping volume and head with power of 116.5 watt by adult man and 81.5 watt by woman or child. Power of woman or child is assumed as 70% of adult man's power.

Head (m)	Pumping Volume (ℓ/hour)	
	Adult Man (116.5 watt)	Woman/Child (81.5 watt)
40	714	498
45	666	468
50	600	420
55	546	378
60	498	348

The estimated pumping volumes are more than 330 ℓ/hour up to a pumping head of 60 m for both adult and women or child. However, the pumping volumes for woman or child at pumping head beyond 50 m are out of the range for 'Acceptable'. Therefore, the criteria for application of Afridev hand pump is 50 m of head for a minimum pumping volume of 330 ℓ/hour.

Although draw-down by hand pump is considered to be within a few meters due to relatively small pumping volume, a 10 % margin of pumping head was applied. Accordingly, the Afridev hand pump is applicable for static water depth of 45 m for this Study.

3) Application of Handpump for Deeper Static Water Level

Other than the Afridev hand pump, the India Mark II (extra deep type) and Duba are applicable for pumping head up to 90 m according to their specifications.

From the advantage of operation and maintenance aspects, India Mark II (extra deep type) out of them, is proposed to be applied for static water depth of 45 to 55 m in consideration of draw-down.

(3) Use of Local Contractors and Materials

The water supply facility will be designed, in consideration of the use of local contractors within technically allowable extent and also using the local construction materials such as hand pumps for deep boreholes, galvanized steel pipes, steel plate, reinforcement bars, cements, timbers, fuel, oils and paints as much as possible. In particular, hand pumps will be procured as much as possible from local manufacturers or suppliers who can provide after-care services in Kenya, within as allowable extent of quality and performance considering the self-help water groups operate and maintain the water supply facility.

(4) Grade of Facility and Equipment

The facility and equipment will be procured as much as possible from local suppliers who can provide after-care services in Kenya, within as technically allowable

extent of quality and performance. Those will have to be selected mainly from a viewpoint of less cost for operation and maintenance works.

(5) Community Training

The self-help water group has no experience or knowledge operating and maintaining a water supply facility since it is newly established in connection with facility construction. GOK, therefore, determined that DWO and District Social Development Office (DSDO) should provide the self-help water groups with necessary training such as formation of water committee, methodology of operation and maintenance, etc. However, such training cannot be done well due to lack of budget, and thus training is presently executed only on a project or development programs basis under financial support by other donor countries and/or international agencies. Generally, the government staff, local consultants, and NGOs take part in such training as is executed in local languages.

In this Project, the self-help water groups must be provided with such technical guidance and enlightenment activities. Considering the large Project area and scattered boreholes, the technical guidance and enlightenment activities plan shall be worked out in line with the following basic concept:

(a) The technical guidance and enlightenment activities shall be initiatively executed by GOK. The Trainers Team will be formulated with GOK's staff district by district. GOK shall be responsible for such Trainers Team formulation and their activities.

(b) In order to execute the community training effectively, a Supervisory Team which will consist of NGO and/or local consultants under GOJ support, will train the trainers.

(c) Since the Project area covers the four districts of Laikipia, Samburu, Baringo and Koibatek where plural tribes live and use respective languages, the technical guidance and enlightenment activities shall be executed for district by district.

(d) The technical guidance and enlightenment activities shall be conducted by plural trainers because the technical guidance and enlightenment activities to be provided require wide fields such as formation of water committee, operation and maintenance of hand pump, collection of water charge, sanitary education and gender awareness.

(e) The technical guidance and enlightenment activities shall be executed by dividing them into four stages, namely preparatory work, before construction, after construction, and follow-up, to make the communities deeply understand them.

(6) Implementation Schedule

The Project implementation would be fixed in view of the workable days in a year, construction sites, required work volumes, procurement terms , access condition to borehole sites and coincidence with the financial system of GOJ.

2.3.2 Basic Design

(1) Boreholes

(a) Typical Borehole Structure

The proposed sites for drilling are classified by 3 types of strata estimated from the electric soundings. Drilling depths of layers in strata are averaged and typical borehole structures for the respective types are prepared as shown in **Figure-2.3.2.** A summary of drilling depths and number of drillings is tabulated below.

Type of Strata	No. of Proposed Borehole	Drilling Depth (m)				Successful Rate	Max.Nos. of Drillings
		Deposits	Rocks	Average Depth	Maximum Depth		
Type-A	78	5	103	108	180	79%	99
Type-B	8	15	98	113	130	67%	12
Type-C	4	67	33	100	100	80%	5
Total	90					78%	116

(b) Diameter of Casing

Boreholes are designed with casing inserted up to the bottom to maintain durability and quality. A six inch diameter steel casing is proposed. This size is popular in Kenya and is used for 54% of existing boreholes according to the inventory taken by MWR. In addition, local drilling contractors having many experiences in use of this diameter.

Casing materials of galvanized steel, PVC, and FRP are available in Kenya. Among them, GSP is proposed in view of durability since 86% of proposed boreholes are designed with more than 100 meters depth. In addition, pH of groundwater in the Project area is more than 5.9 according to the existing water quality data. Therefore, problem of rust is not anticipated on steel casing.

Unit length of casing and screen pipes is 6 m. Length of screen pipes is equivalent to 25% of total depth of borehole, in compliance with multi-aquifers in the Project area.

(c) Drilling Diameter

Drilling diameter is designed for clearance to insert casing. Different diameters and drilling methods are applied depending on kind of layer, to maintain inside of borehole during drilling.

For surface deposits, rotary mud circulation method is applied with temporary casing to avoid a collapse of surface deposits inside of drilled hole. When drilling reaches a rock layer, DTH method is applied for its rapidity to drill rock layers. The other purpose of temporary casing is to avoid collapse of drilled hole above rock layer by remaining mud pushed up by DTH drilling. Different diameters of temporary casings are applied for this and removed after drilling as much as possible. A summary of drilling diameter is tabulated below.

Type of Strata	Casing	Drilling Method	Drilling Depth (m)	Drilling Bit	Dia. of Drilling Bit (inches)	Dia. of Drilling (mm)	Casing Outer Dia. (mm)	Casing Inner Dia. (mm)
Type-A	Temp-2	Rotary	5	Triton	12-1/4	311.2	267.4	254.2
	Permanent	DTH	108	Hammer	8-1/2	215.9	165.2	155.2
Type-B	Temp-2	Rotary	15	Triton	12-1/4	311.2	267.4	254.2
	Permanent	DTH	113	Hammer	8-1/2	215.9	165.2	155.2
Type-C	Temp-1	Rotary	12	Triton	14-3/4	374.7	355.6	339.5
	Temp-2	Rotary	67	Triton	12-1/4	311.2	267.4	254.2
	Permanent	DTH	100	Hammer	8-1/2	215.9	165.2	155.2

(d) Electric Logging

After drilling, electric logging is conducted before inserting permanent casings to get accurate locations of aquifer depths. It aims at improvement of successful rate of boreholes by installation of screen pipes at proper depths.

(e) Gravel Packing, Slime Packing and Cementing

Gravel packing is provided for a gap between casing and inside of drilled hole from the bottom to 20 meters above static water level. The gap at the more shallow part is packed with slime produced by drilling. Cementing is provided at the most shallow part around ground surface. By means of slime packing and cementing, percolation of waste water from ground surface to borehole is avoided. The bottom of casing is plugged. The top of casing above ground surface is capped until installation of hand pump.

(f) Development

Development means removal of fine thing, to create permeability which will be for 20 hours of actual test time, until clean water is observed.

(g) Pumping Tests

After completion of borehole, the following pumping tests are conducted:

- Trial test : maximum 6hours.
- Actual test : 24 hours.
- Recovery test : 8 hours.

(h) Water Quality Tests

Samples are taken at pumping test. Laboratory tests are done at a public water testing laboratory in Kenya. Items of tests are given below.

1) Temperature, 2) Electric conductivity, 3) pH, 4) Total dissolved solid, 5) Turbidity, 6) Color, 7) Total Hardness, 8) Iron (Fe), 9) Sodium (Na), 10) Calcium (Ca), 11) Bicarbonate (HCO_3), 12) Carbonate (CO_2), 13) Magnesium (Mg), 14) Manganese (Mn), 15) Chloride (Cl), 16) Sulfate (SO_4), 17) Fluoride (F), 18) Potassium (K), 19) Nitrate (NO_3)

(2) Water Supply Facility

(a) Target Year

The target year of the Project is set at the year 2000 for the first stage of the rural water supply as recommended by the National Water Master Plan.

(b) Unit Water Consumption

Unit water consumption for stand pipes (without connections) is applied as described in the Design Manual for Water Supply in Kenya. The Manual gives the following values.

Land Potential	Unit Water Consumption (ℓ/c/day)	Average Annual Rainfall (mm)
High	20	more than 1,000
Medium	15	500 to 1,000
Low	10	less than 500

Land potential is generally classified by average annual rainfall, namely, high potential area with more than 1,000 mm, medium potential area with 500 to 1,000 mm, and low potential area with less than 500 mm. In the Project area, average annual rainfall varies from 400 to 900 mm by region. Most of the Project area is covered with medium potential area except a part with annual rainfall of 500 mm or less. The Study, therefore, applies 15 ℓ/c/day for medium potential land.

(c) Livestock

Water supply capacity of the designed facility is determined from pumping capacity of hand pump and is not so much due to the limitation of pumping capacity of hand pump. Therefore, water supply for livestock is not considered in terms of design supply capacity. Whereas, livestock trough is incorporated with facility for inhabitants raising livestock.

(d) Design Supply Capacity

Design supply capacity is the sum of pumping capacities of hand pumps installed at all the proposed borehole sites. The maximum use of yields of the proposed boreholes is not expected. The design supply capacity per hand pump is set at 675 ℓ/hour from the guidelines by JICA. When the estimated borehole yield is less than 675 ℓ/hour, the design capacity is equivalent to the estimated yield. The minimum supply capacity is 330 ℓ/hour from the criteria of successful boreholes. Operation hours of hand pump is 8 hours/day.

(e) Design Population

The design supply capacity does not meet water demands in the whole Project Area due to the limitations of capacity and number of hand pumps to be provided. Population supplied per hand pump is obtained at 360 persons resulting from the daily supply capacity divided by the unit water consumption. The total population supplied by the proposed 90 boreholes is estimated at 31,933 persons.

(f) Application of Hand Pump

In compliance with available hand pumps in Kenya, their specifications, operation and maintenance aspects, and hydrogeological characteristics, the following hand pumps are applied.

1) Afridev Hand Pump

Applied for boreholes with static water level upto 45 m deep.

2) India Mark II Extra Deep Hand Pump

Applied for boreholes with static water level deeper than 45 m upto depth of 55 m.

(g) Surrounding Facility

The type of facility is point source. Around hand pump, concrete-slabbed apron and drain are provided for easy cleaning and maintenance as well as prevention of waste water percolation from ground surface.

Livestock trough is provided sufficiently apart from the borehole to avoid waste water percolation around trough. Water is lead by gravity from apron to trough through drain. Typical design of surrounding facility is shown in **Figure-2.3.3**.

(3) Procurement of Equipment and Materials

(a) Procurement of Vehicles

A railway network exists in Kenya, but it only connects Nairobi with other large cities such as Mombasa, Nanyuki, and Kitale. Vehicles are, therefore, the main transportation in Kenya. Rural roads are available in the Project area. However most are in poor condition, and only passable with 4WD vehicle especially in the rainy season.

MWR has 64 DWOs for construction, operation and maintenance of water supply facility. The Project area administratively belongs to 4 DWOs of Laikipia, Samburu, Baringo and Koibatek. Number and conditions of vehicles which these DWOs possess currently, are tabulated below:

(Unit : nos.)

District	Total	Usable	To be repaired	Unusable
Laikipia	3	1	2	-
Samburu	5	1	1	3
Barinngo	2	1	-	1
Koibatek	5	1	2	2

Source : Respective District Water Offices

As can be seen in this table, most existing vehicles are unusable or need to be repaired. Even usable vehicles are presently occupied for administrative work, and thus it is difficult to use them for operation and maintenance work for water supply facility. The Water Development Department (WDD) of MWR also has no extra vehicles to be sent to DWOs because it only keeps three usable vehicles now.

According to the National Water Policy, DWO shall be directly responsible for provision of technical support for the water community. However, DWO could not satisfactorily fulfill this support because of poor conditions of its vehicles. The interview survey with the existing self-help water groups clarified that they desired further technical support from DWO.

At present, there are the 132 existing water supply facilities in the Project area according to information of MWR. After completion of the Project, it will increase by 70 % to 222 water supply facilities, which would bring about a work increase in technical support. Considering such change of situation, four pick-up trucks of 4WD double cabin type will be procured to GOK, provided that these be used by four DWOs of Laikipia, Samburu, Baringo and Koibatek. These pick-up trucks will be procured from Japan due to lower cost although being available in Kenya.

(b) Geophysical Equipment

Out of electric sounding equipment, electro-magnetic equipment and electric logging equipment requested by GOK, one set of electric sounding equipment (survey depth: 200m) only will be procured. This electric sounding equipment will be used for confirmation of selected sites of boreholes. Hence, this electric sounding equipment will be kept by the respective districts in the light of construction schedule, and then be kept by MOWR after completion of the Project. As electric sounding equipment is not available in Kenya, it will be procured from Japan.

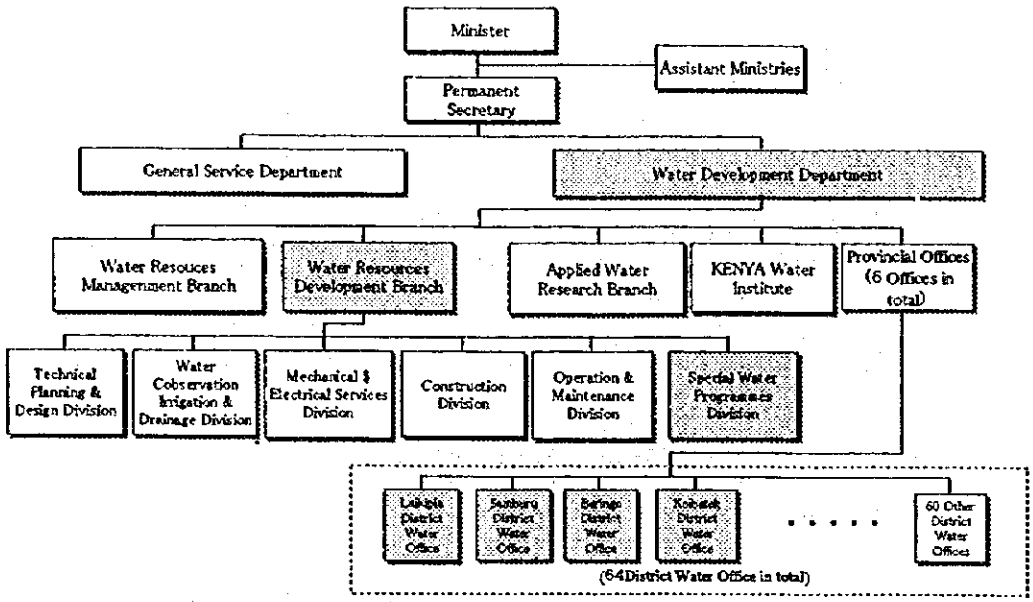
(c) Construction Materials

Major construction materials for the Project such as hand pumps for deep boreholes, casing pipes, PVC pipes, steel plate, reinforcement bars, cements, timbers、fuel, oils and paints can be procured in Kenya. Thus, all these construction materials will be procured in Kenya.

2.4 Basic Concept for Project Implementation

2.4.1 Organization

MWR is responsible for the administration of the Project. Present organization chart of MWR is as follows:



WDD under MWR is the direct responsible agency for the Project implementation. WDD subordinates the Water Resources Management Branch, Water Resources Development Branch (WRDB), Applied Water Research Branch, Kenya Water Institute, and six Provincial Water Offices. Sixty-four DWOs administratively belong to 6 Provincial Water Offices.

As for the Project implementation, respective DWOs will be in charge of construction supervision under the control of WDD. The organisation charts of MWR and four DWOs are given in **Figures-2.4.1** to **-2.4.5**. In order to execute the Project implementation, MWR will organize the Program Steering Committee and the Program Management Committee and establish the Project Management Team (the Kenya／Japan Water and Sanitation Promotion Programme Unit). The Project Management Team will give technical advice and guidance to the respective DWOs on time. The major duties of WDD, Project Management Team and DWOs are as follows:

a) WDD

- Overall management for the Project implementation
- Contract with consultant
- Contract with contractor
- Financial control
- Coordination with other agencies

b) Project Management Team

- Supervision of facility design
- Coordination with local governments
- Management of facility construction

c) DWOs

- Arrangement of lands for borehole sites
- Execution of required works by GOK
- Control of work progress and quality

2.4.2 Budget

The budget of MQWR for 3 years from 1995/96 to 1997/98 are shown below:

(Unit : Ksh.million and%)

Items	1995/96		1996/97		1997/98	
Total Budget	6,035	100.0	5,640	100.0	4,852	100.0
Recurrent Budget	1,747	28.9	1,725	30.6	1,775	36.6
Development Budget	4,288	71.1	3,915	69.4	3,077	63.4
Appropriation-in-aid	(2,396)	(39.7)	(2,349)	(41.6)	(1,472)	(30.3)

Recent decline of development budget has been mainly due to decrease in appropriation-in-aid. The recurrent budget is almost constant for three years.

2.4.3 Staffing

The number of MWR staff for the past 3 years from 1995/96 to 1997/98 have been on decline as shown below:

(Unit : persons)

Item	1995/96	1996/97	1997/98
Administration	1,235	933	881
Water development	1,040	1,035	1,081
Staff training	170	185	156
Rural water supply	6,402	6,151	5,760
Urban water supply and sewerage	1,724	1,589	1,521
Special water plan	936	876	925
Rural and irrigation development	601	500	487
ASAL development	-	-	10
Total	12,108	11,269	10,822

The staff number of the Construction Division of WDD which will be responsible

for technical advice and direction to DWOs on the construction of water supply facility, are two senior engineers, four engineers, two assistant engineers, and four inspectors as of August 1998. Also, those of DWOs including Division Water Offices are tabulated below:

(Unit : Ksh.million)

District	Total Staff	Staff for Construction	Division Water Offices
Laikipia	113	3	45
Samburu	81	1	20
Baringo	216	133	133
Koibatek	87	44	44

Source : District Water Offices

The construction supervision of the boreholes will be jointly executed by a staff of Construction Section of DWO and a staff of the Division Water Office, under technical guidance of the Consultant. Accordingly, the Construction Section of DEOs will require at least the staff number which coincides with the number of construction fleet. In this Project, 90 boreholes will be constructed in two stages, so that four construction fleets would be required. In Laikipia and Samburu districts, the number of construction staff are not sufficient. The lack of staff will be supplemented by a staff shift from Operation and Maintenance Section or Division Water Office, in view of the technical support to the water communities in future.

MWR has executed the direct construction of boreholes using their construction equipment through DWOs. MWR has also much experience in construction supervision for borehole construction since lots of borehole construction have been conducted by other donor countries and international agencies in Kenya. Thus, MWR has enough knowledge on construction of boreholes and also DTH method to be applied for the Project because it is prevailing in Kenya.

CHAPTER 3

IMPLEMENTATION PLAN

CHAPTER 3 IMPLEMENTATION PLAN

3.1 Implementation Plan

3.1.1 Implementation Concept

(1) Implementation Method

The Project will be implemented with the following steps on condition that the Project is executed under the Japan's Grant Aid System.

(a) MWR will be the executing agency.

(b) When the Exchange of Note (E/N) between GOJ and GOK regarding the detailed design and the construction of the Project is signed, MWR will take care of overall procedures necessary for the implementation of the Project.

(c) After signing of E/N between GOJ and GOK, a Japanese consultant, recommended by the Japan International Cooperation Agency (JICA) and entrusted by MWR will sign the contract with MWR, and will do the detailed design, prepare the tender documents and start the procedures of tender.

(d) A Japanese contractor, after signing the contract for construction, will undertake the construction works, and the consultant will do out the construction supervision.

(e) The construction works for water supply facility will consist of confirmation of technical specifications, arrangement of construction materials, inspection of manufacturers for procurement of equipment, site arrangement, drilling, logging, casing, gravel packing, sealing, well developing, installation of pump, construction of concrete apron, pump test, and joint inspection of completed works.

(f) The boreholes to be constructed under the Project will be 90 in number.

(g) The employed drilling methods are the mud-circulation-drilling method for sediments layer and the down-the-hole-hammer method for basic rocks.

(h) The unsuccessful drilling holes shall be completely barried, to avoid any dangerous situation.

(i) The operation and maintenace fuctions of the Project will be finally transferred to the respective self-help water groups.

(2) Formation of Construction

There are 28 local contractors in Kenya, out of which 5 to 6 local contractors have sufficient experience in construction of boreholes. Accordingly, the construction of boreholes will be executed using these local contractors to save costs. The 90

borehole sites are scattered in the Project area, so that more than one sub-contractor will be required.

The construction of water supply facility including boreholes will be executed by those local contractors, local engineers, and laborers under responsibility of a Japanese contractor.

(3) Necessity of Japanese Experts for the Contractor

To control and supervise those local contractors, it is necessary to assign the Japanese experts from the contractor.

3.1.2 Implementation Conditions

(1) Procedures for Tax Exemption

Because lots of government agencies as well as MWR are involved in the process of taxes exemption in Kenya, it will take time for the rather complicated application of procedures and to obtain the final approvals from the relevant agencies. Although the procedure for tax exemption will be arranged mainly by MWR, the contractor should also understand the laws and regulations of Kenya for tax exemption and support MWR in order to process the tax exemption procedures smoothly.

(2) Environment Impacts during Construction

The possible environment impacts during the construction will be (a) noises due to the construction, (b) dusts mainly from the vehicles, (c) noise and vibration due to operations of heavy machines and (d) traffic accidents.

There are nine schools/clinics near the 90 borehole sites. Therefore, care shall be paid on the prevention of occurrence of noises, dusts and vibration although construction period for one borehole is only about 10 days. Also, many preserved wild animals inhabit the Project area. Thus, the construction work shall be executed so as to avoid any troubles with these wild animals. To prevent traffic accidents, such measures as (a) limit of driving speed and (b) periodical training of the drivers for safety driving should be taken.

3.1.3 Scope of Work

(1) Scope of Work to be executed by Japanese Side

(a) Execution of detailed design and preparation of tender documents.

(b) Undertaking of the construction of boreholes including installation of hand pump and appurtenant facility, and the execution of pump tests, water quality test and electric sounding test if required.

(2) Undertaking by Government of Kenya

(a) Provision and arrangement of land necessary for implementation of the Project.
(b) Construction of 5 m wide access roads with including cutting of bushes.
(c) Explanation to inhabitants on the works, and request of their cooperation to the construction.
(d) Budget arrangement and payment for import tax, internal taxes, and other levies.

3.1.4 Construction Supervision

(1) Detailed Design and Tendering

Immediately after signing the Exchange of Note between GOJ and GOK for the 1st stage construction, the contract for the consulting services will be concluded between MWR and the Japanese consultant, and the tender documents including tender drawings will be prepared in collaboration with MWR.

The tender for selection of a contractor for the construction works will be conducted after getting approval from MWR for the tendering process. The first step is the pre-qualification tender, and the notice of this will be published in the major daily newspaper on construction and economy in Japan on behalf of MWR.

The pre-qualification documents will be distributed by the consultant to the applicants and the tender documents will be distributed by the consultant to the pre-qualified applicants. The quoted tenders will be received by the consultant and opened in the presence of the representatives of MWR. After the opening, the tender evaluation will be made by the consultant in collaboration with the representatives of MWR, and the draft contract will be prepared by the consultant based on the tender evaluation result.

(2) Construction Supervision

Once the contract for construction supervision has been concluded for the construction works, the consultant will review and clarify the construction method and time schedule submitted from the contractor. The consultant's resident engineer will be assigned to supervise the construction works, with the commencement of the construction and will regularly report the work progress to both JICA Nairobi office and MWR. The resident engineer will also coordinate the activities by the government agencies concerned with the Project, including the contractor for smooth implementation of the Project.

The scope of construction supervision is summarised as follows:

(a) Evaluation and approval of construction drawings

- Evaluation and approval of construction drawings, application for commencement of the works, sample of materials, specifications of the equipment, etc. submitted by the contractor.

(b) Progress and quality control

- Checking and guidance on the construction plan and time schedule, progress and quality control of the construction works and necessary inspection of the construction methods.

(c) Approval for the payment to the contractor

- Checking and evaluation of the performance of the works necessary for issuing payment certificates and completion certificate to the contractor.
- Attendance at the handing-over of the completed facilities to MWR after confirming the completion of the works and fulfillment of the contract.

3.1.5 Procurement Plan

Since the major construction materials for the Project such as hand pumps for deep boreholes, casing pipes, PVC pipes, steel plate, reinforcement bars, cements, timber, fuel, oils and paints are available in Kenya, these will be procured in Kenya, as shown below:

Materials and Equipment	Kenya	Other countries*	Japan	Reasons
Hand pumps	O			Procurable in Kenya
Steel pupes	O			Procurable in Kenya
PVC pipes	O			Procurable in Kenya
Water supply equipment	O			Procurable in Kenya
Structural steel	O			Procurable in Kenya
Reinforcement bars	O			Procurable in Kenya
Aggregates	O			Procurable in Kenya
Cement	O			Procurable in Kenya
Form	O			Procurable in Kenya
Timber	O			Procurable in Kenya
Fuel	O			Procurable in Kenya
Oils	O			Procurable in Kenya
Paints	O			Procurable in Kenya
Bentonite	O			Procurable in Kenya

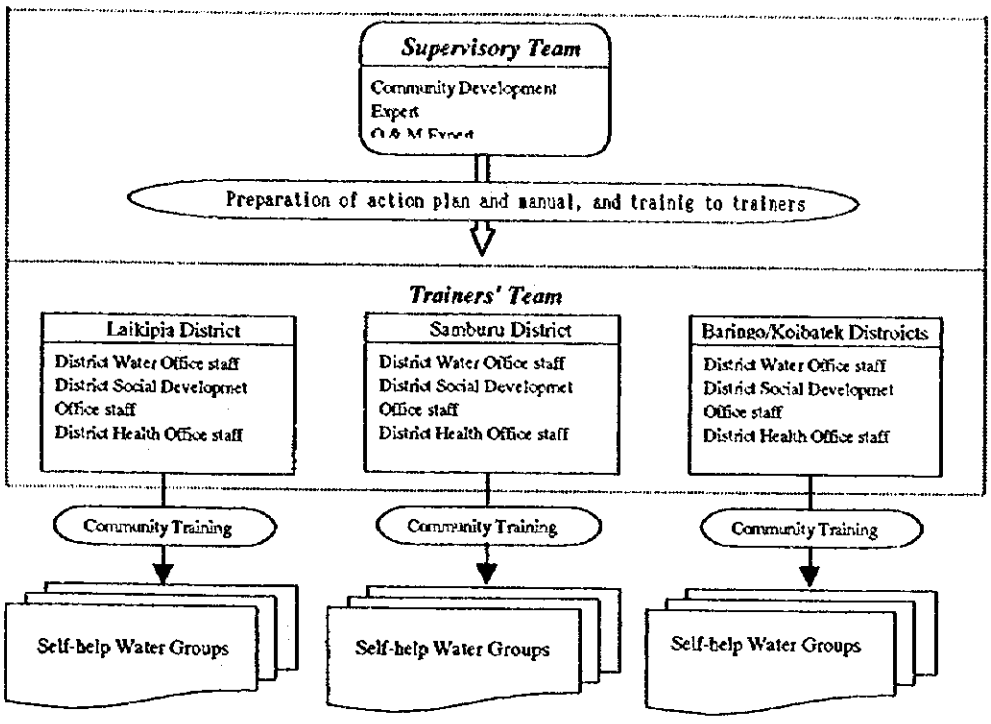
*: *eligible countries*

3.1.6 Community Training Plan

To keep the Project sustainability, GOK will execute the community training including the establishment of community, repairs of water supply facility, collection of water charge, financial management, and sanitary education.

GOK, however, has not sufficient knowledge and experience in such community training, so that the Supervisory Team consisting of local consultant and/or NGO will provide

the Trainer's Teams consisting of GOK staff with technical support, as figured below.



The Supervisory Team will carry out the following support for the Trainers' Teams;

The Supervisory Team consisting of a Community Development Expert and an O&M Expert will survey the four districts in the field to grasp the respective self-help water groups conditions.

Based on the results of field survey, the Supervisory Team will prepare the action plan on community training, which will be used for community training to be executed by the Trainers' Teams. In addition, the Supervisory Team will prepare the different manuals for Laikipia, Samburu, and Baringo/Koibatek districts, considering respective tribes.

In succession, the Supervisory Team will make training for the Trainers' Teams consisting of staff of District Water Office, District Social Development Office and District Health Office using the manual in the light of construction schedule.

Furthermore, the Supervisory Team will make an on-the-job training for the Trainers' Teams at about 2 step-help water groups in one district.

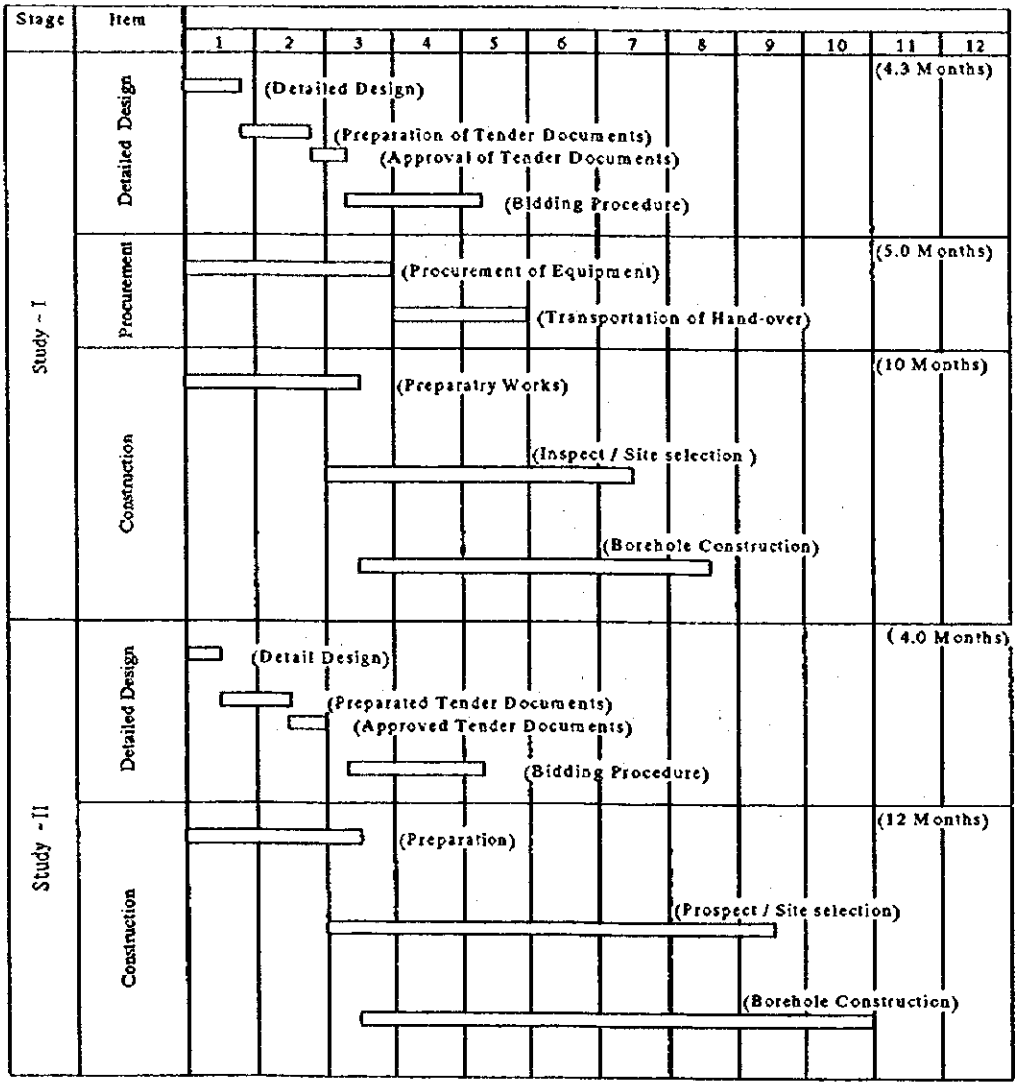
After completion of community training, the Supervisory Team will prepare the report together with the Trainers' Team, and also prepare the final version of manuals which will be used for community training for other projects to be executed by GOK. The report shall include the findings, problems encountered, and countermeasures against them.

3.1.7 Implementation Schedule

(1) Implementation Schedule

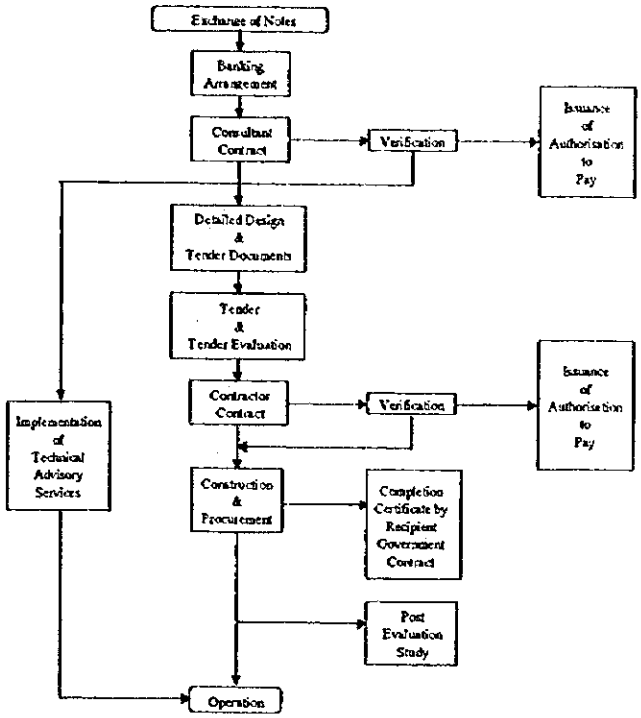
As mentioned above, the Project will be implemented in two stages. In the first stage 33 boreholes in Laikipia district will be constructed (**Figure-3.1.3**). In the second stage 19 boreholes in Laikipia district, 16 boreholes in Samburu district and 22 boreholes in Baringo/Koibatek districts will be constructed (**Figure-3.1.3**).

The Project will be based on the Japan Grand Aid, as shown below:



(2) Implementation Procedure under Japan's Grant Aid System

The Project shall be implemented as shown below, considering the procedures of Japan's Grant Aid System:



3.1.8 Obligations of Recipient Country

(a) To secure the site for the Project.

(b) To clear, level and reclaim the site prior to commencement of the construction.

(c) To provide data and information necessary for the Project.

(d) To provide the land for access road, a temporary site office, warehouse and stock yard during implementation of the Project.

(e) To provide warehouse for storing of spare parts and other equipment bought by the Project at District Water Office.

(f) To undertake incidental outdoor works such as security of the sites, fencing, gates and exterior lighting in and around the boreholesites if necessary.

(g) To construct the access road to the site prior to commencement of the construction if necessary.

(h) To bear commissions to the Japanese bank for the banking services based upon Banking Arrangement.

(i) To exempt taxes and to take necessary measures for customs clearance of the materials and equipment brought for the Project at the port of disembarkation.

(j) To ensure prompt unloading and customs clearance at a port of disembarkation in

Kenya and facilitate internal transportation therein of the products purchased under the Grant.

(k) To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which may be imposed in Kenya with respect to the supply of the products and services under the Verified Contracts.

(l) To accord Japanese nationals whose services may be required in connection with supply of the products and services under the verified contracts, such facilities as may be necessary for their entry into Kenya and stay therein for the performance of their work.

(m) To assign the necessary staff and secure the necessary budget for operation and maintenance of the equipment purchased under the Grant Aid.

(n) To maintain and use properly and effectively the equipment procured under the Grant Aid.

(o) To bear all the expenses other than those to be borne by the Grant Aid necessary for construction of the facilities as well as for the transportation and installation of the equipment.

(p) To maintain the control of tools and spare parts purchased under the Grant Aid.

(Q) To arrange the required staff and budget for community training.

3.1.9 Cost Estimate Borne by Recipient Country

In order to keep access to the borehole sites, it is necessary to make leveling for the existing roads and bush cutting. In addition, GOK will have to make budget arrangement for a part of community training. The required cost for them which will be borne by GOK is Ksh.21,608 thousands as follows.

District	Works	Quantity	Amount (Ksh.1000)		
			Stage-I	Stage-II	Total
(1) Temporary Access Roads					
Laikipia	Levelling	10,000m2	3,945		3,945
	Bush cutting	8,600m2	136		136
Samburu	Levelling	3,750m2	0	2,847	2,847
	Bush cutting	4 00m2	0	0	0
Baringo	Levelling	10,000m2	0	3,796	3,796
	Bush cutting	0m2	0	0	0
Koibatek	Levelling	0m2	0	0	0
	Bush cutting	0m2	0	0	0
	Sub-total		4,081	6,643	10,724
(2) Community Training			0	10,884	10,884
Total			4,0981	17,527	21,608

3.2 Operation and Maintenance Plan

(1) Government Policy on Operation and Maintenance for Rural Water Supply Facility

The Project is regarded as the rural water supply development by construction of

90 boreholes equipped with hand pump. The self-help water groups shall be therefore responsible for the operation and maintenance for the Project in accordance with the National Water Policy of Kenya. MWR and its subordinating agencies shall provide timely technical advice and support to the self-help water groups. Now, MWR has a plan to monitor and evaluate the operation and maintenance work by the self-help water groups, so as to give technical advice on time and finally to heighten the capability of self-help water groups **(5.Confirmation - 2)**.

(2) Organization for Operation and Maintenance

(a) Organization of MWR

Figure-3.2.1 presents the organization chart of MWR for giving the self-help water groups the technical advice and support on operation and maintenance activities. DWO and Division Water Office shall be directly responsible for the technical advice and support to the self-help water groups under control of WRD. The organization charts of DWO and Division Water Office for Laikipia, Samburu, Baringo, and Koibatek districts are shown in **Figures-3.2.2** to **-3.2.5**, respectively.

As of August 1998, Operation and Maintenance Division under WRD has a staff of 29 consisting of 11 engineers, 11 inspectors, 2 electricians, 5 secretaries and 4 administration staff. The staff of DWOs including Division Water Offices are tabulated below:

District	Total Staff	O & M Staff	Division Water Office
Laikipia	113 nos.	12 nos.	45 nos.
Samburu	81 nos.	33 nos.	20 nos.
Baringo	216 nos.	15 nos.	133 nos.
Koibatek	87 nos.	4 nos.	44 nos.

There are not enough O & M staff for Laikipia, Baringo and Koibatek districts to execute the proper technical advice and support if boreholes are newly constructed under the Project. The shortage in staff of DWO could be settled by jointly working with the Division Water Office, although their capability might need to be heightened through training by the Kenya Water Institute.

(b) Organisation of Self-Help Water Group

Operation and maintenance of rural water supply facility will be started from registration and establishment of a self-help water group by the beneficiaries. **Figure-3.2.6** indicates relations among respective agencies and their duties on the operation and maintenance of rural water supply facility, which was approved by GOK in the Aftercare Study on the National Water Master Plan. As can be seen in this figure, four ministries such as MWR, the Ministry of Culture and Social

Services, the Ministry of Rural Development, and Ministry of Local Authority are related to the operation and maintenance work by the self-help water groups. The supports from these ministries to the self-help water groups will be made through their district offices.

To operate and maintain of water supply facility effectively and smoothly, it is essential to establish the self-help water group prior to commencement of construction work. MWR shall take the initiative toward establishing the self-help water group by contacting the Ministry of Culture and Social Services immediately after the Exchange of Note between GOK and GOJ.

A water committee will be formulated for management of the self-help water group in line with the by-law. The water committee will generally consist of a chairman, a secretary, an accountant and some committee members, who will be selected through an election. Interviews with the existing self-help water groups found, that committee members had not been given specific tasks except attendance at monthly and annual meetings. However, committee members shall be assigned specific tasks such as collection of water charge, maintenance of water supply facility, etc., for smooth management of the self-help water group. Taking into account the water served population of 360 (45 families) per borehole with hand pump, it is proposed that the respective committee members shall be assigned the following specific tasks:

Member Name	Contents of Work	Nos.
1) Water Charge Collection	Collecton of water charge every month, and handing over of it to the accountant	3
2) Sanitary Education	Extension of use of clean water from borehole and maintenance of environmental sanitation, to avoid water born diseases	2
3) Maintenance	Regular maintenance and repairs of water supply facilities, and procurement of spare parts	2
4) Side Business	Promotion of income generation by side business, to keep proper financial situation.	2
5) Women/Children Education	Promotion of attendance at social service by women and at school by children, using saving of water fetching time.	2

An organization chart of water committee is given in **Figure-3.2.7.**

(c) Assignment of Women in Self-Help Water Group

To reflect women' opinion to the management of self-help water group, it is proposed that women shall take part in the water committee, at least be assigned to about half of the required committee positions.

(3) Estimate on Water Charge

(a) Present Situation

Most of the existing water communities in the Project area are collecting a water charge of Ksh.10/ family for hand pump from, their members on a monthly basis although some self-help water groups do in a form of donation. A water charge for livestock is not clearly imposed by the self-help water groups. This is due to why livestock is one of family member. The collection rate of water charge ranges from 35% to 80%, and averages 50%.

(b) Proposed O&M Cost

In accordance with the National Water Policy, the water community shall collect from respective members to cover all the necessary costs for operation, maintenance, and replacement of water supply facility.

The maintenance interval for hand pump is expressed in terms of MTBF(Mean Time Before Failure). In case of an Afridev hand pump, MTFB is 6 months. Thus, the maintenance interval at the community level is fixed at 6 months. In addition, maintenance will be executed every 6 months by a serviceman dispatched by the manufactures or agents. While, an India Mark II (extra deep type) hand pump has no definite MTBF. The India Mark II (extra deep type) hand pump has a more complicated mechanism than the Afridev hand pump. So, the maintenance interval at the self-help water group level is assumed to be 3 months and the maintenance by a serviceman at 6 months for the India Mark II.

According to the interview with pump manufactuerer/agent in Kenya, a life year of hand pump would be 8 years if proper maintenance is executed. As a result, the Afridev hand pump would require the 8 maintenance times by a serviceman and 16 regular maintenance times at self-help water group level in 8 years, and the India Mark II (extra deep type) hand pump would need the just double maintenance times of the Afridev hand pump. Using these study results, the O&M costs including replacement cost for the Afridev hand pump and the India Mark II (extra deep type) hand pump are estimated as follows:

(Unit : Ksh.)

Items	Afridev hand pump			India Mark II (extra deep type)		
	Unit Price	Times	Amount	Unit Price	Times	Amount
Pump Price	69,310	1	69,310	114,000	1	114,000
Cost at self-help water group level						
Spare Parts	900	16	14,400	3,525	32	112,800
Cost at serviceman level						
Spare Parts	900	8	7,200	3,525	16	56,400
Per diem	240	8	1,920	240	16	3,840
Total			92,830			287,040
O&M Cost per Family*			258			797
O&M Cost per Family/Month			22			66

*Note : *Water service population per one borehole is 360 persons or 45 families (Average family size is 8 persons)*

In the Project, if no water charge will be imposed to the livestock because the employed pump is a hand pump and does not require any fuel, the water charge of Ksh.25/month/family for the Afridev hand pump and Ksh.70/month/family for the India Mark II (extra deep type) hand pump are estimated. In case of the application of water charge for livestock, Ksh.2/head/month for cow and Ksh.0.5/head/month for goat or sheep would be added to the above.

The interview survey **(Attchment-9)** indicates that more than 98% of beneficiaries understand the need of water charge collection for operation and maintenace of water supply facility, and more than 73% of beneficiaries replied that they could pay Ksh.100 per month at maximum. Thus the water charge of Ksh.25/month/family for the Afridev hand pump and Ksh.80/month/family for the India Mark II (extra deep type) hand pump are within the applicable range.

CHAPTER 4

PROJECT EVALUATION AND RECOMMENDATIONS

CHAPTER 4 PROJECT EVALUATION AND RECOMMENDATIONS

4.1 Project Effect

The implementation of Project under the Japan's Grant Aid is judged viable for the following reasons:

(1) Mitigation of water shortage

The interview survey shows that 80% of the 81 villages suffer from severe water shortage every year. Implementation of the Project could supply stable clean water to about 32,000 served population in addition to the present 95,000 population which are estimated using 360 served population per one well from hand pump capacity. If calculated from the population density and 4km of planned distance to the water supply point, the served population would be increased to 174,000, which would attain to about 62% of 282,000 served population in the targeted year 2000 and would be expected to mitigate the chronic water shortage.

(2) Contribution to attainment of target accounted-for-ratio

The Aftercare Study on the National Water Master Plan, proposes that the service coverage rate of rural water supply shall attain at 70% by 2010. However, the present service coverage of the Project area is only 34%. Implementation of the Project could raise it to 45% in 2000 if estimated using 360 served population per one well (= 675 lit/hrs x 8 hrs/day / 15 lit/cap/day), and also to 62% in 2000 if estimated using the population density and 4km of planned distance to the water supply point. Thus, the Project would be largely conducive to the "Target accounted-for-ratio of 70% by 2010 in rural water supply".

(3) Improvement of sanitary circumstance

The welfare monitoring survey II executed by the Central Bureau of Statistic in 1994, presents that the rate of water borne diseases would be 9.6% in Laikipia district, 13.6% in Samburu district and 13.7% in Baringo/Koibatek districts which are higher than 9.2% in urban area. The Project would help decrease he rate of disease through improvement of sanitary circumstance by supply of clean water.

(4) Mitigation of water fetching load for women

In the Project area, water fetching is mainly executed by women. Eighty-three (83)% of these women replied in the interview survey that the distance to the available water source was more than 4km. Since the Project is planned under the basic concept of the "within 4km distance to the water supply point", it would enable women who presently fetch water more than 4km, to take part in social services, income

generation work, etc. using the saved time.

(5) Contribution to development for ASAL area

The 8th National Development Plan sets forth the poverty alleviation and improvement of living circumstances, especially in ASAL area which is the most undeveloped area in Kenya. The Project area covering the Laikipia district and surrounding areas of Samburu, Baringo and Koibatek districts, duly extends over this ASAL area. The Project duly contribute to elevating the living standards of ASAL inhabitants by providing water supply facility, which are targeted in the Plan.

(6) Demonstration effect as model project in ASAL area

The Aftercare Study on the National Water Master Plan, recommends that the small-scaled rural water supply be developed using groundwater from viewpoints of low initial investment and simple operation and maintenance. The Project which duly coincides with this recommendation, would thus serve as a model of rural water supply development in ASAL area.

4.2 Recommendations

The Project will bear large benefits mentioned above. Concurrently, the Project will contribute widely to the attainment of the basic human needs such as improvement of sanitation environment and mitigation of work load of water fetching. It is therefore judged to be so significant to implement the Project. According to the government policy, operation and maintenance of water supply facility in rural water supply system, shall be carried out by the beneficiaries, say Self-Help Water Groups. However, the Self-Help Water Groups who will be newly established in connection with construction of water supply facilities, would have hardly experience and knowledge on them, so that the Project might face unsatisfactory operation and maintenance. To this end, it is essential to provide the Self-Help Water Groups with continuous technical support. In order to execute such technical support smoothly and effectively, it is recommended that the community training component be included in the Project, and to take the following countermeasures:

(1) Urgent Establishment of Self-Help Water Groups

It is essential to provide the self-help water groups with community training urgently. Therefore, it is recommended that MWR shall organize the self-help water groups immediately after the Exchange of Notes (E/N) between GOJ and GOK, so as to commence the community training on time keeping close communication with the Ministry of Health and the Ministry of Social and Culture.

(2) Training to GOK Staff to Support to Self-Help Water Groups

It is indispensable to provide the self-help water groups with continuous technical support even after the completion of community training under the Project. Although GOK is envisaged with the financial constraint and MWR has difficulty in obtaining the sufficient budget, it is recommended that MWR arrange the required budget and strengthen the District Water Offices through provision of training of relevant staff.

(3) Budget Arrangement for Kenya/Japan Water and Sanitation Program Unit, Which Will Supervise the Project Implementation

In connection with the Project, MWR has established the Kenya/Japan Water and Sanitation Program Unit for smooth implementation of the Project. It is recommended that MWR arrange the budget for effective execution of the Unit.

TABLE

Table 2.2.1 Requested Rehabilitation Sites and Their Viability

District	Laikipia	Samburu	Baringo	Koibatek
Name of Site	Dol-dol	Baawa	Nyau Nyau	Legetwet
Borehole No.	C-1813	C-4316	C-3466	C-1406
Completion	1952	Borehole : 1977 Water Supply Facilities : 1984	1967	1951
Present Conditions	In Dol-dol, there exists the public water supply managed by the district water office of MWR. The borehole C-1813 was drilled in 1952 and is equipped with submergible pump and generating set. Head of submergible pump is 60 meters with its discharge capacity of 0.13 m^3/min. Static water level is recorded at 18.9 meters depth with tested yield of 3.27 m^3/hour at the completion of the borehole. It is reported that reason for need of rehabilitation is reduction of pumping yield caused by deterioration of the facilities. However, it seems that the facilities are still functioning and properly maintained at present as far as investigated.	In Bawaa, there is a community water supply consisting of a borehole drilled in 1977, piped distribution system with a storage tank and stand pipes. This water supply was operational until 1997 when the pump installed at the borehole was removed and transferred to another water supply for urgent requirement due to severe drought. A water committee interviewed at the site was organized in 1984 with its members about 1,000 persons. Yield of the borehole is 4.3 m^3/hour at its completion but recent information is not available It is reported that requirements of rehabilitation are new installation of pump and generating set and cleaning of the borehole. Further information is unknown due to the absence of detail investigations.	The borehole was drilled in 1967 and equipped with pump, storage tank and livestock trough to supply water for rural people and their livestock. The facilities are not in operation for 10 years due to pump broken during conflicts between rural people. Repair of pump is not possible due to its deterioration. Whereas, storage tank and livestock trough seem to be in fair condition.	The facilities including borehole, pump, diesel engine and storage tank were constructed in 1951 and operational until 1992. All these are already deteriorated. Moreover, erosion by seasonal river approaches near pump house. A water committee interviewed was established in 1984 with its members around 1,000 persons and requests to construct new facilities near primary school 500 meters away from the existing facilities.
Viability	The facilities are still in operation and are utilized at least for a few years more under proper maintenance. From this point, the rehabilitation is not urgent requirement. In addition, reduction of yield is not clarified at present due to the absence of necessary investigations. Possible reasons are a lowering of efficiency of pump and generating set, deterioration of borehole, or reduction of groundwater resources. For this clarification, it is necessary to conduct detail investigations to pull the submergible pump up for confirmation of any damage and to conduct pumping tests for examination of present performance of the borehole.	Urgent requirement of rehabilitation is not clarified. More details are required to take this rehabilitation into the basic design study to clarify the actual conditions of the borehole and distribution system. Such details are not available at present.	It is possible to rehabilitate the facilities of storage tank and livestock trough with replacement of pump if the borehole can be recovered. However, it is required that recovery of the borehole should be examined by removal of existing pump since the borehole is not operational for 10 years.	Rehabilitation is not viable due to the deterioration of the facilities. New construction is therefore applicable at this site.

Table 2.2.2 Comparison of Borehole Hand Pumps

Type	Afridev	India Mark II	India Mark II Extra Deep	Duba
Max. Head (Specifications)	45 m	45 m	90 m	60 m
Max. Head (Hearing)	50～60 m	-	90 m	-
Pumping Capacity	7 ℓ/min. at SWL 50 m	-	-	16.6 ℓ/min. (Max. capacity)
Field Test	24 ℓ/min. at SWL 14 m	30 ℓ/min. at SWL 15 m	-	19 ℓ/min. at SWL 20 m
Manufacturing	Kenya	India, Uganda	India, Uganda	Denmark
Procurement	Domestic	Imported	Imported	Imported
Installation	80 % of handpump installed in Kenya	15 % of handpump installed in Kenya		5 % of handpump installed in Kenya
Operation and Maintenance	Village level operation and maintenance is enabled.	Village level operation and maintenance is enabled but skilled technician may be required.	Village level operation and maintenance is enabled but skilled technician may be required.	Village level operation and maintenance is enabled but skilled technician may be required.
Spare Parts	Most of the parts are produced or procured in Kenya. Spare parts and tools are simplified.	Spare parts are imported. More spare parts and tools than Afridev are required.	Spare parts are imported. More spare parts and tools than Afridev are required.	Spare parts are imported and their procurement may difficult due to quite limited number of distributor.
Considerations	This handpump is most popular in Kenya. It is superior to the others from the viewpoints of cost performance and operation and maintenance aspects.	This handpump is also designed from the viewpoints of VLOM but needs more works than Afridev for operation and maintenance.	This handpump is also designed from the viewpoints of VLOM but needs more works than Afridev for operation and maintenance. The maximum pumping head is 90 meters fitted with counter weight on pumping handle.	This handpump with rotary handle makes it easy for women or children to lift water rather high pumping head. Contrary, mechanics of pump may not be simple to maintain for rural people by themselves.
Evaluation	Most suitable	Applicable	Applicable	Possible

Table 2.3.1 Water Quality Standards

Item		Unit	Japan	WHO	Kenya	
pH			5.8~8.6	<7.0~8.5>	<6.5~8.5>	(6.5~9.2)
TDS		mg/l	500	<500>	<1000>	(1500)
Turbidity			2	<5>	<5>	(25)
Color			5	<15>	<15>	(50)
Taste			None	None	Inoffensive to most consumers	
Odour			None	None	Inoffensive to most consumers	
Total Hardness		mg/l	300	-	<500>	
Arsenic	(As)	mg/l	0.01	0.01	0.05	
Cadmium	(Cd)	mg/l	0.01	0.003	0.005	
Chromium	(Cr)	mg/l	0.05	0.05	0.05	
Cyanide		mg/l	0.01	0.07	0.1	
Fluoride	(F)	mg/l	0.8	1.5	<1.5>	
Lead	(Pb)	mg/l	0.05	0.01	0.05	
Mercury	(Hg)	mg/l	0.0005	0.001	<0.001>	
Nitrate	(NO3)	mg/l	10	50	10	
Selenium	(Se)	mg/l	0.01	0.01	0.01	
Alminium	(Al)	mg/l	-	<0.2>	<0.2>	
Chlouride	(Cl)	mg/l	200	<200>	<250>	(600)
Copper	(Cu)	mg/l	1.0	2<1>	<1>	(1.5)
Iron	(Fe)	mg/l	0.3	<0.3>	<0.3>	(1)
Manganese	(Mn)	mg/l	0.05	0.5	<0.1>	(0.5)
Sodium	(Na)	mg/l	200	<200>	<200>	
Sulphate	(SO4)	mg/l	200	400	<400>	
Zinc	(Zn)	mg/l	1.0	<3>	<5>	(15)

Note : ( ) denotes permissble value in Kenyan gudelines.
In exceptional cases a Fluoride content of 3 mg/l mabe acccepted in Kenya.
<> desirable aesthetic quality

FIGURE

Figure — 2.3.1 Discharge Rate with Pumping Lift

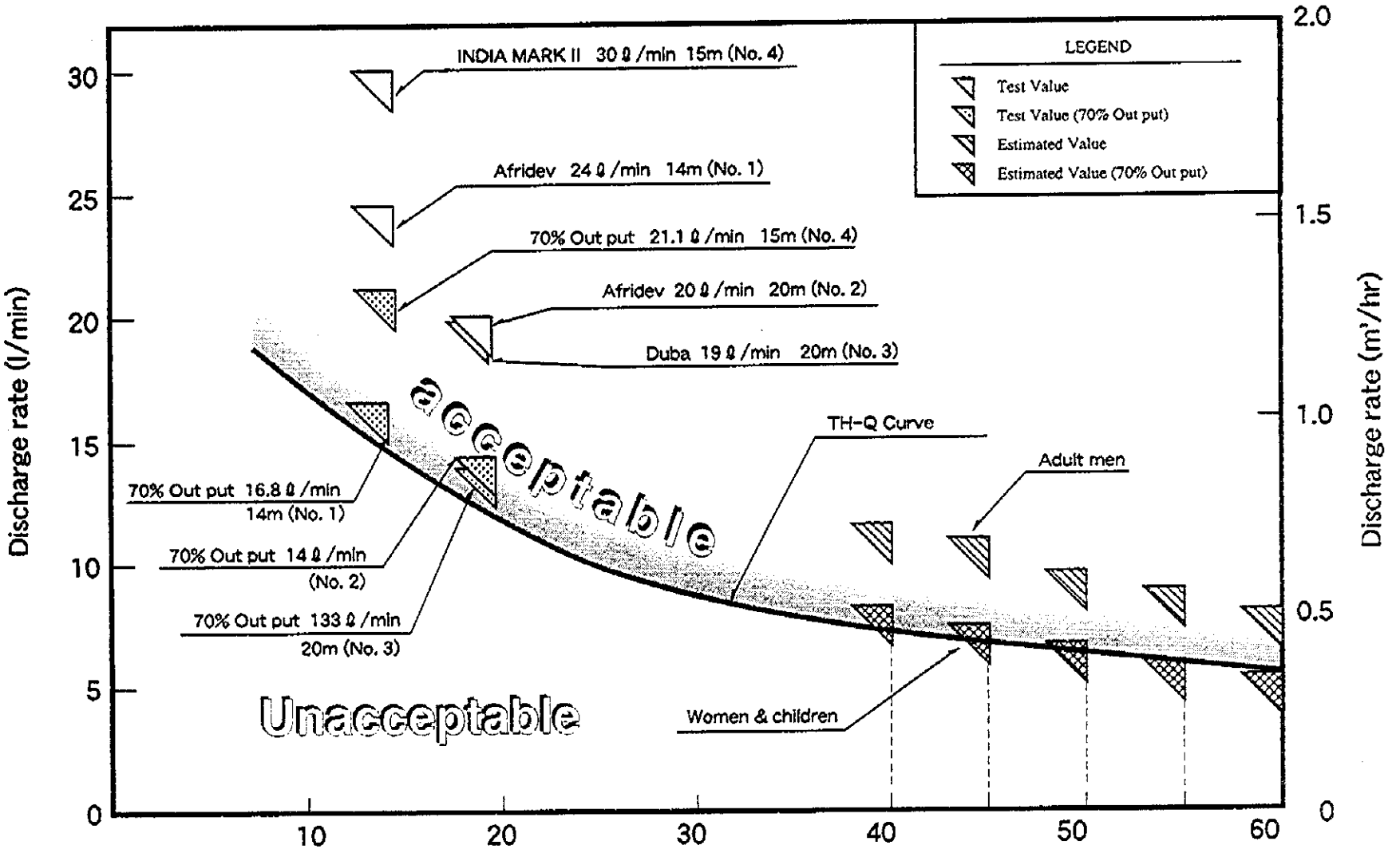


Figure-2.3.2 Typical Design of Borehole (Type-A)

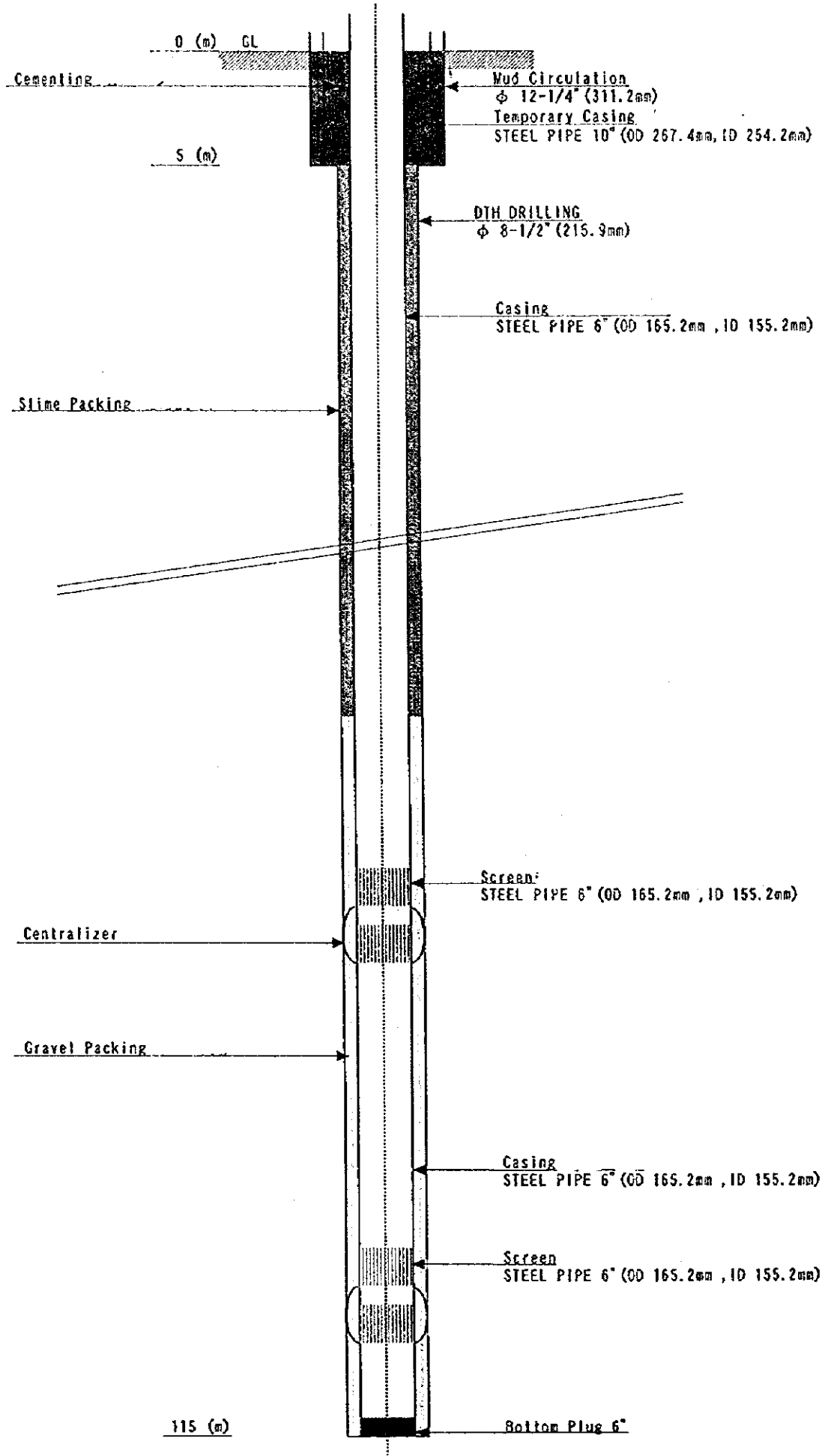


Figure-2.3.2 Typical Design of Borehole (Type-B)

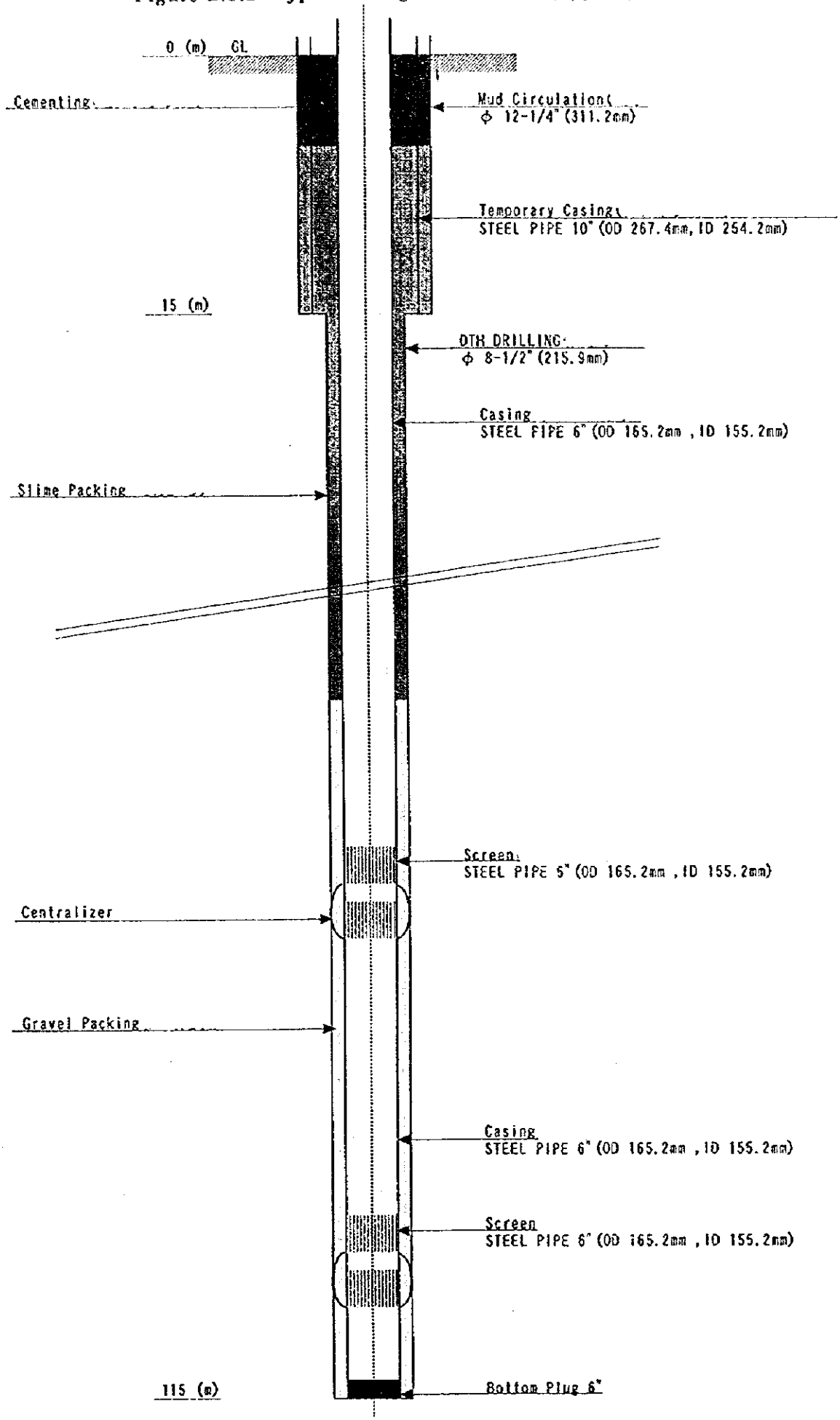


Figure-2.3.2 Typical Design of Borehole (Type-C)

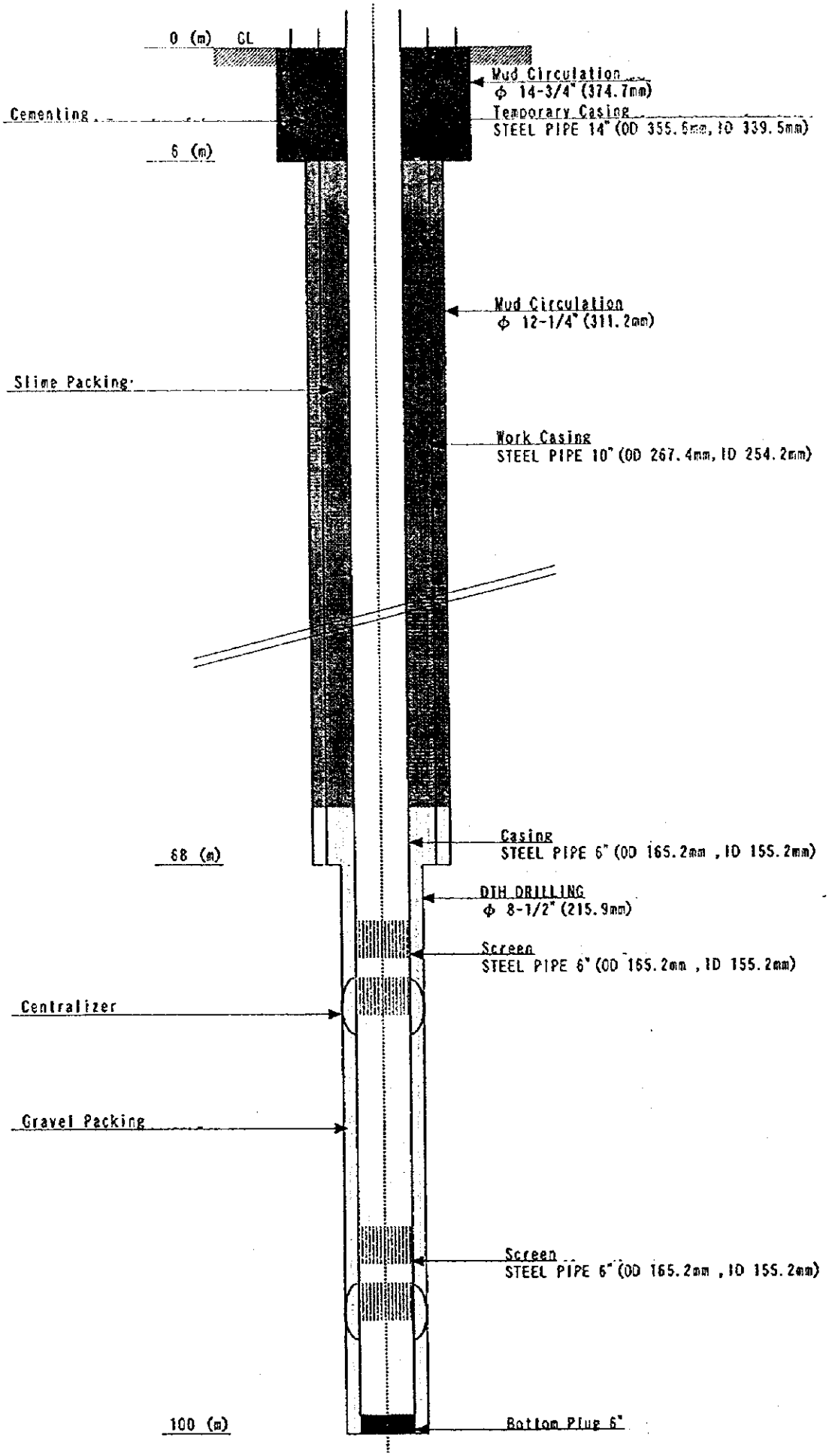


Figure-2.3.3 Typical Design of Hand Pump and Surrounding Facility

S=1/60 Unit: mm

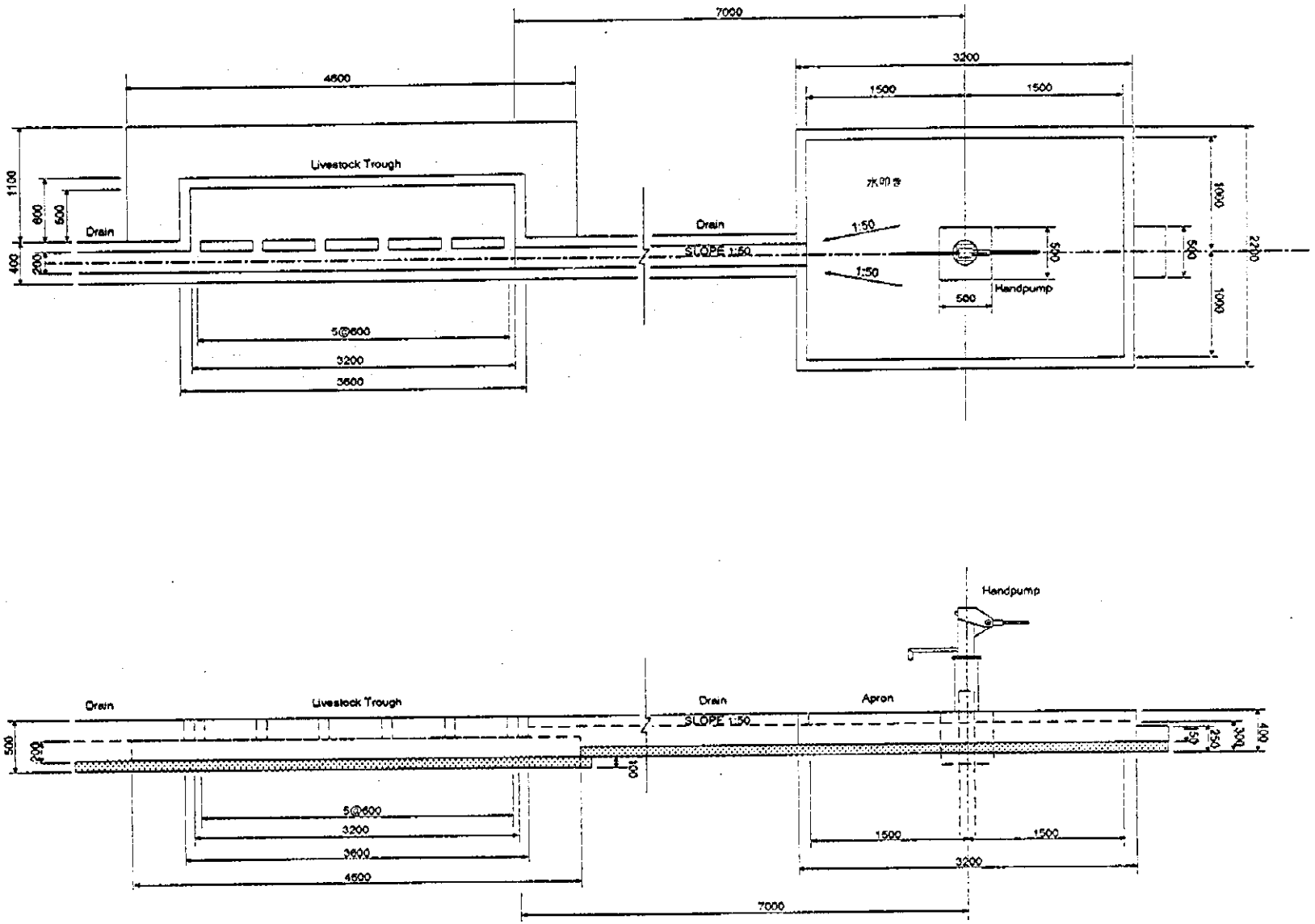


Figure-2.4.1 Organization Structure of Ministry of Water Resources (Construction Stage)

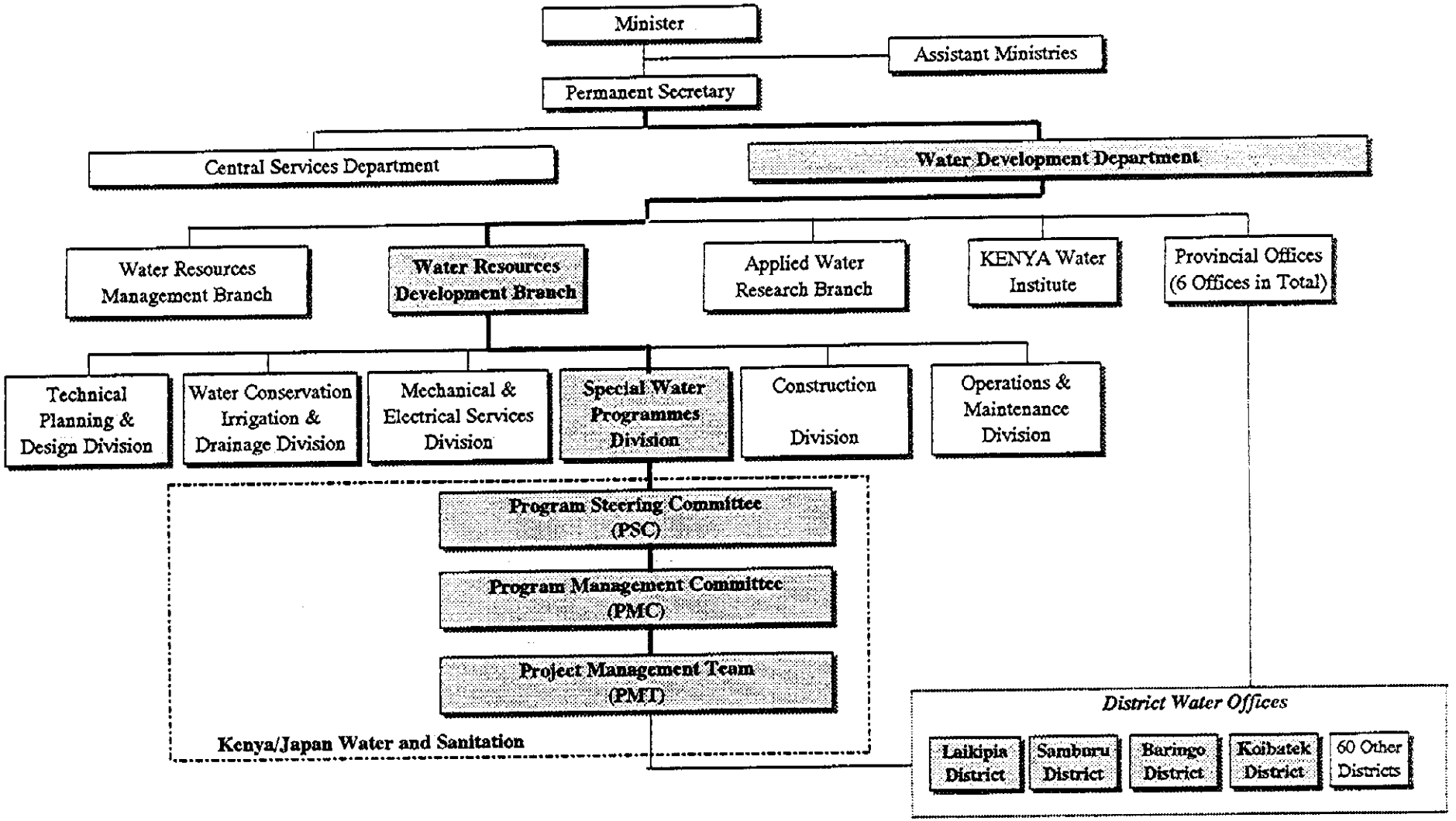


Figure-2.4.2 Organization Structure of Laikipia District Water Office (Construction Stage)

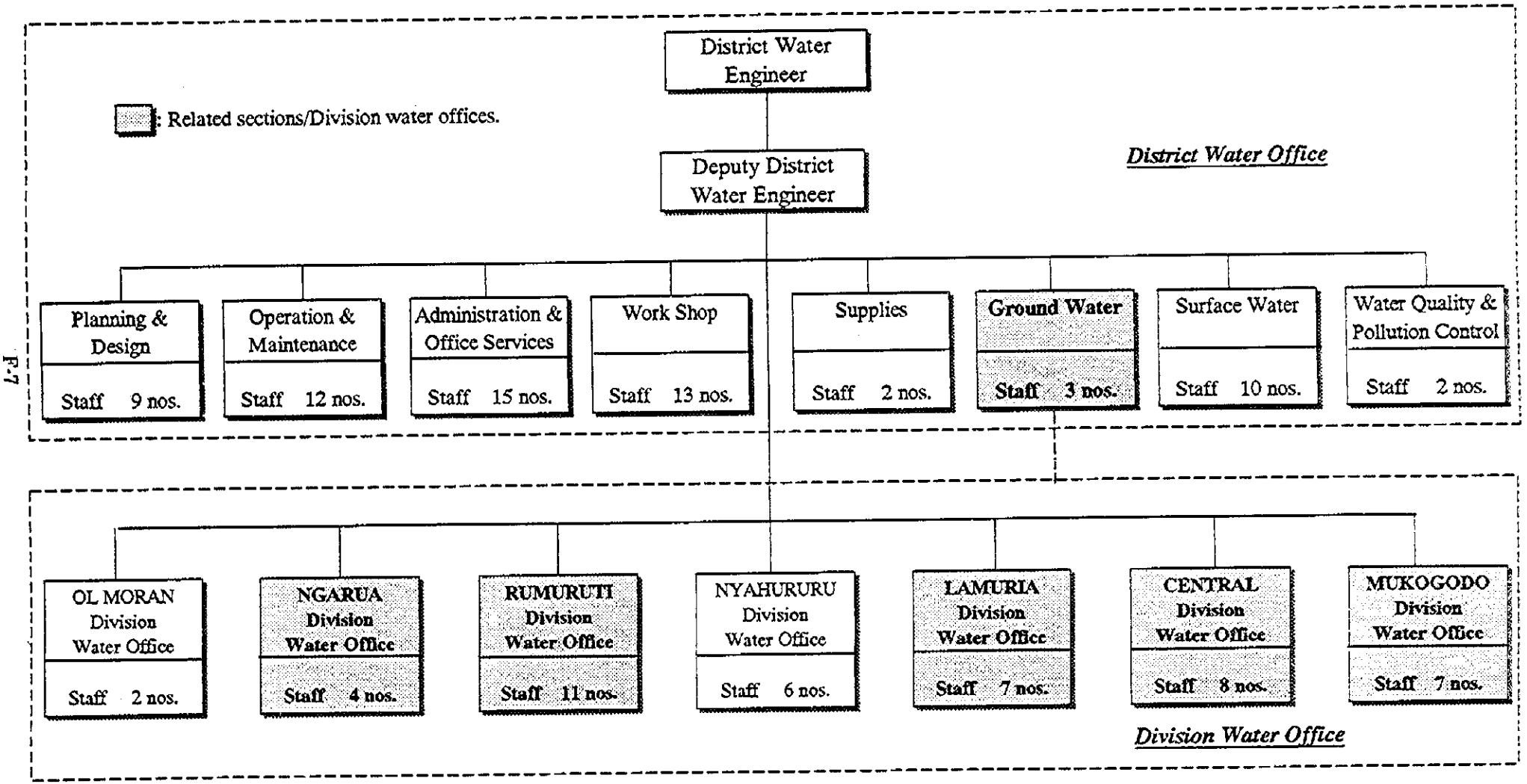


Figure-2.4.3 Organization Structure of Samburu District Water Office (Construction Stage)

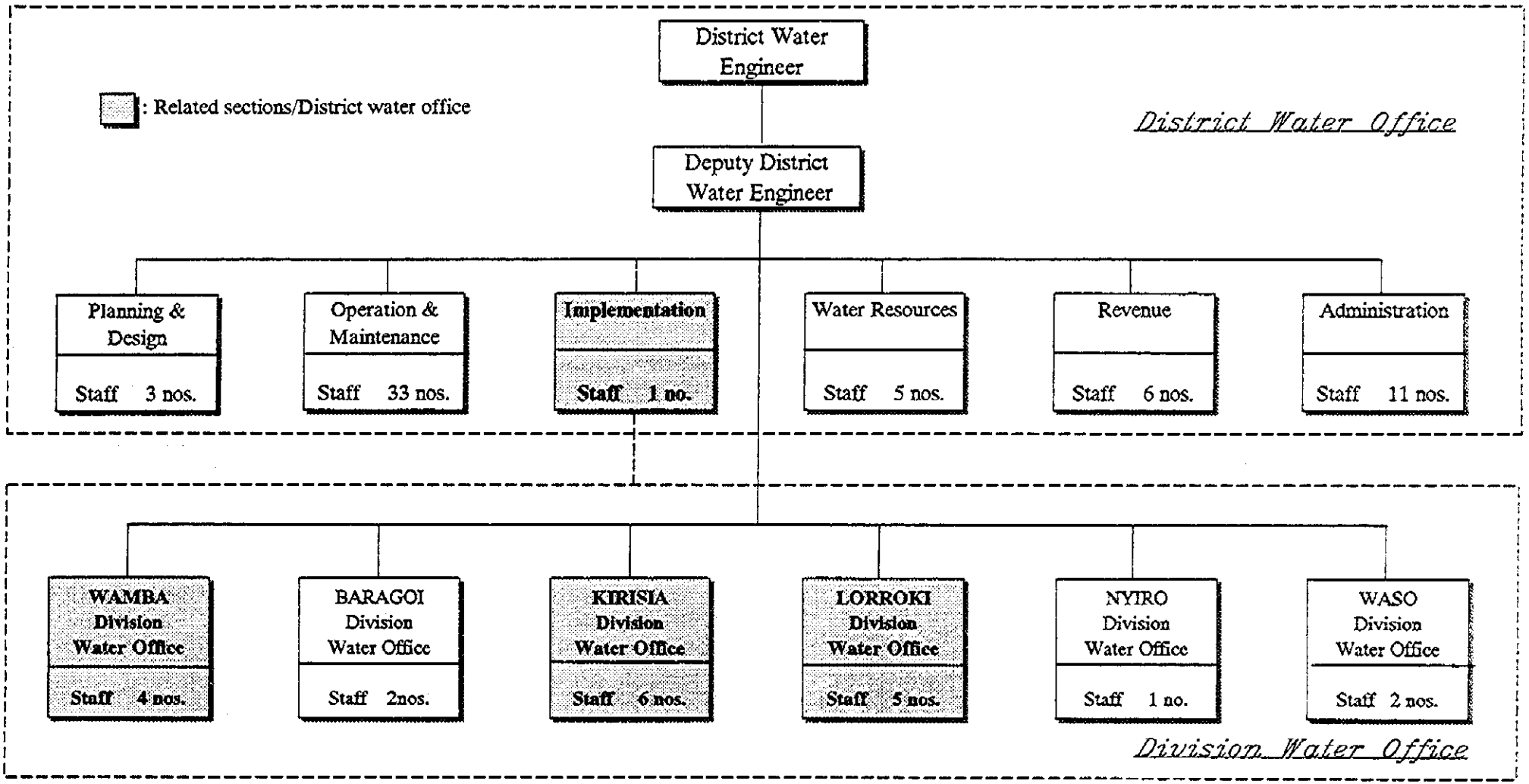


Figure-2.4.4 Organization Structure of Baringo District Water Office
(Construction Stage)

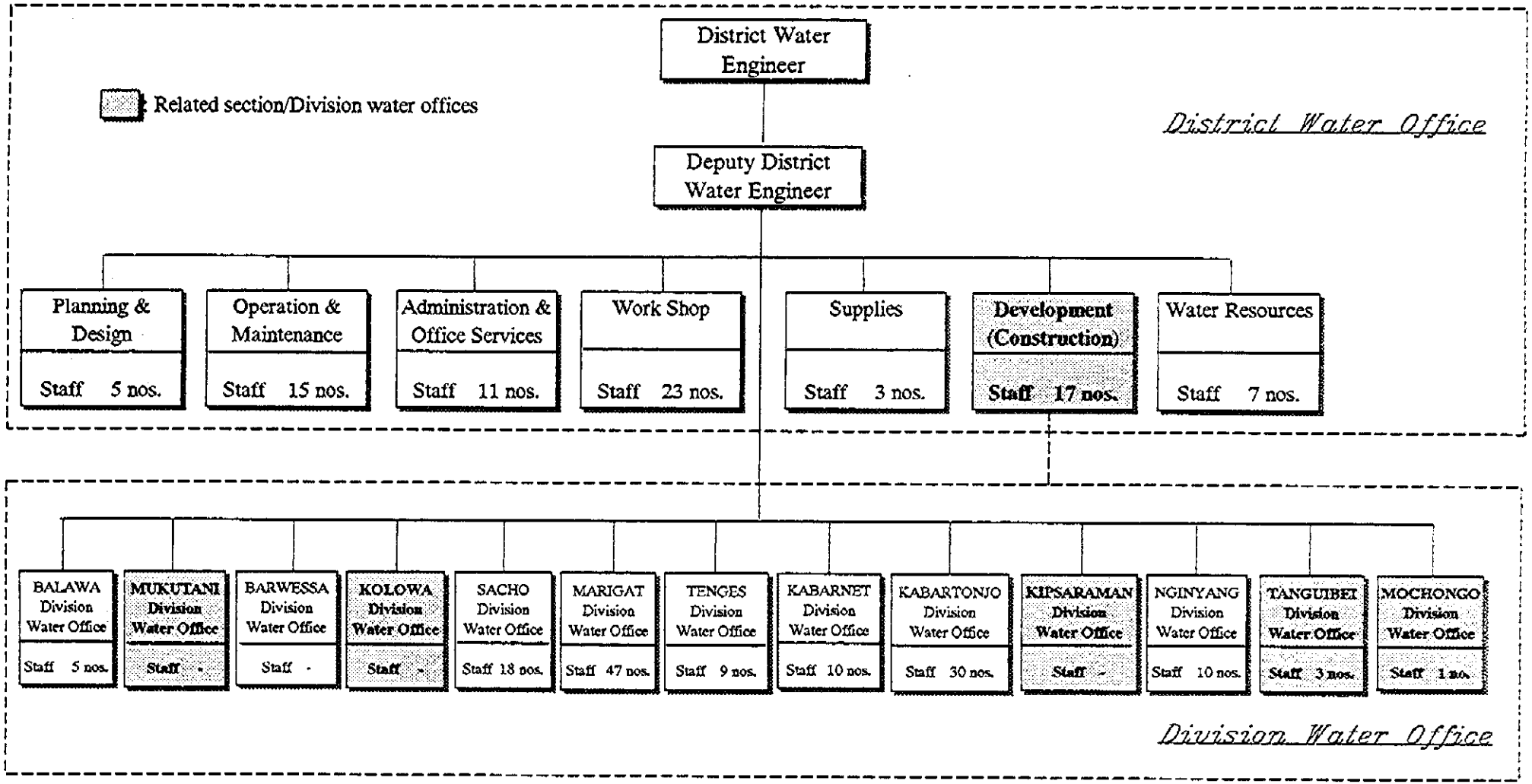
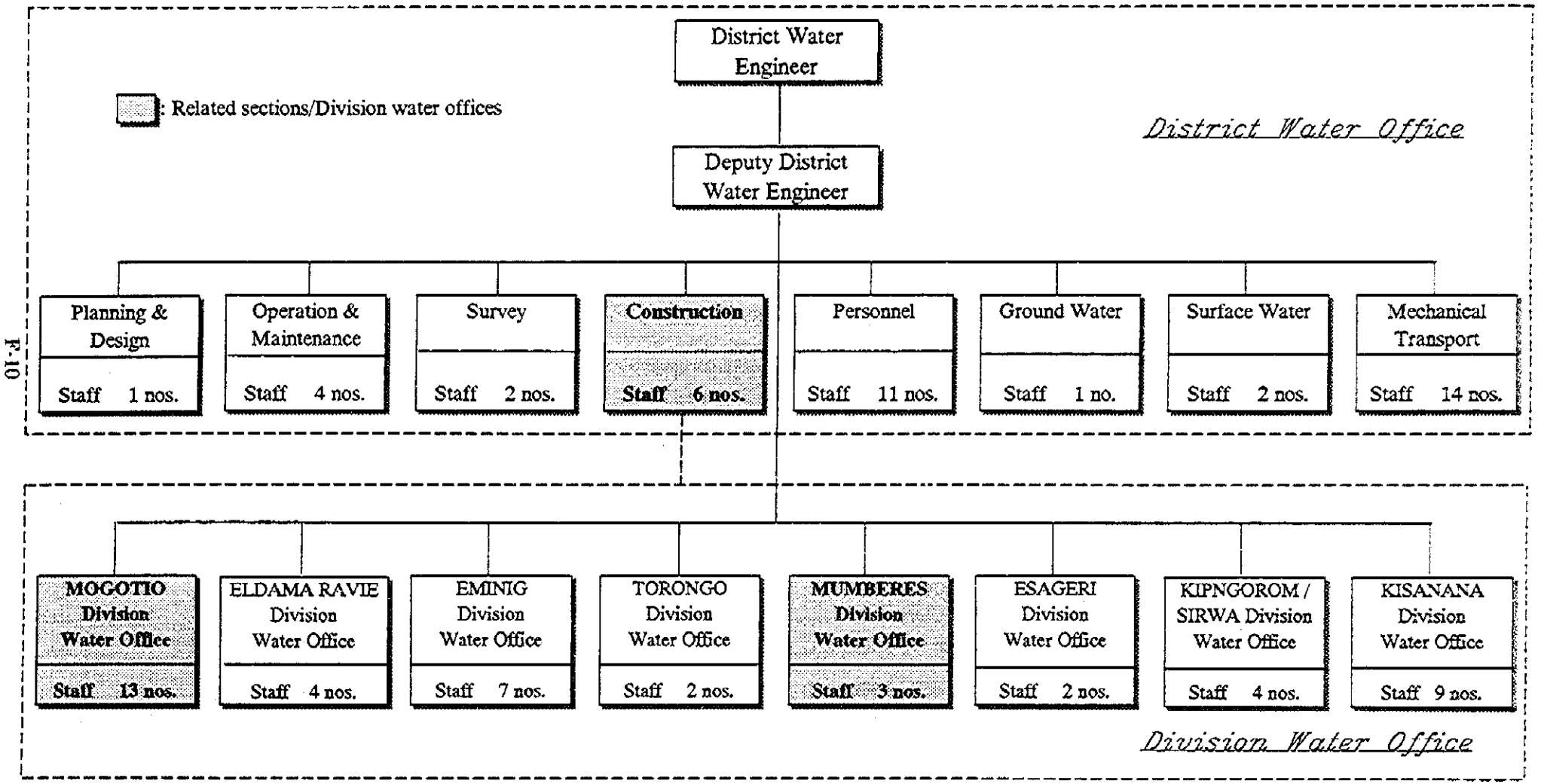


Figure-2.4.5 Organization Structure of Koibatek Water District Offuce
(Construction Stage)



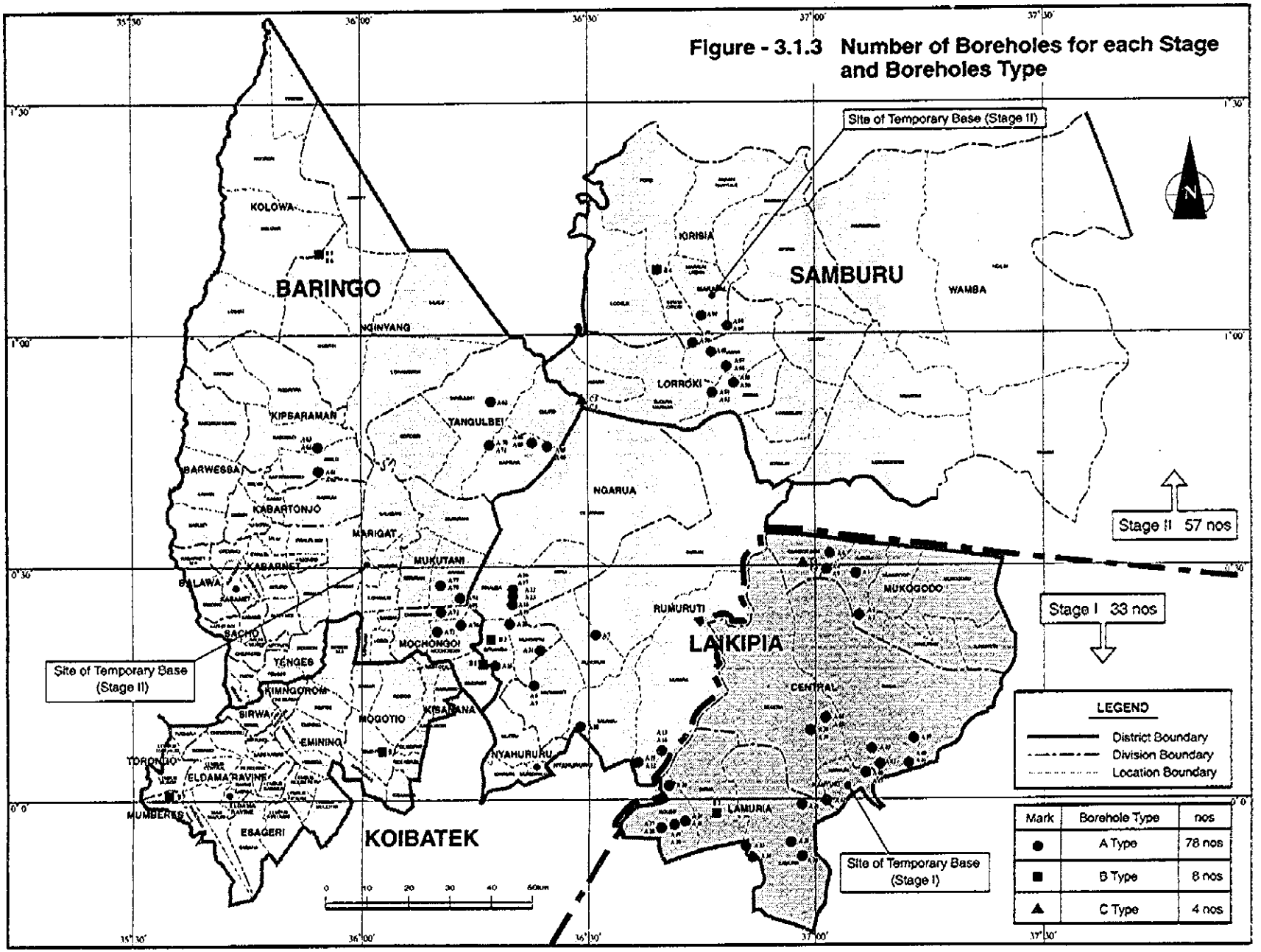


Figure - 3.1.3 Number of Boreholes for each Stage and Boreholes Type

Figure-3.2.1 Organization Structure of Ministry of Water Resources (Operation and Maintenance Stage)

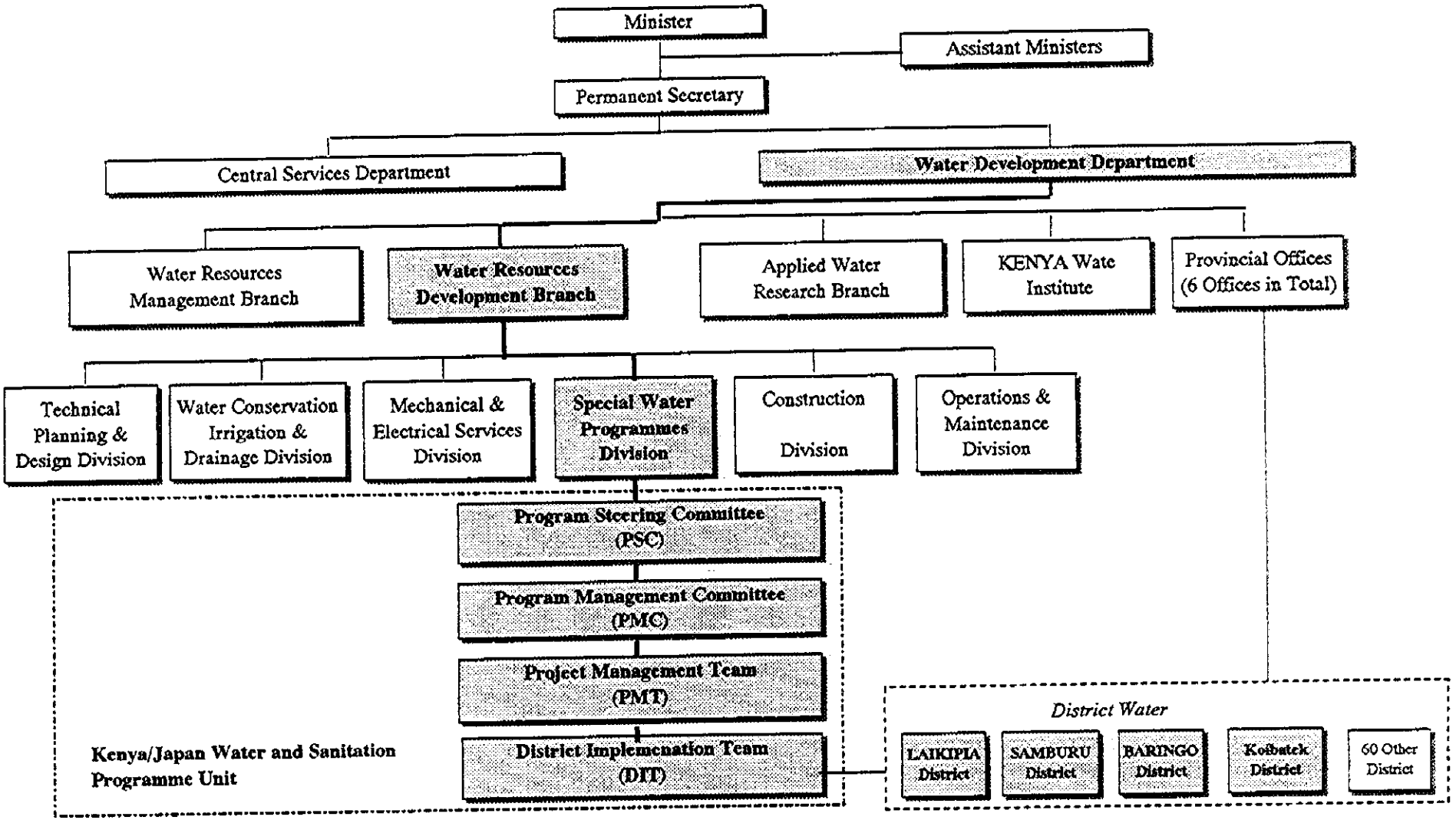


Figure-3.2.2 Organization Structure of Laikipia District Water Office (Operation and Maintenance Stage)

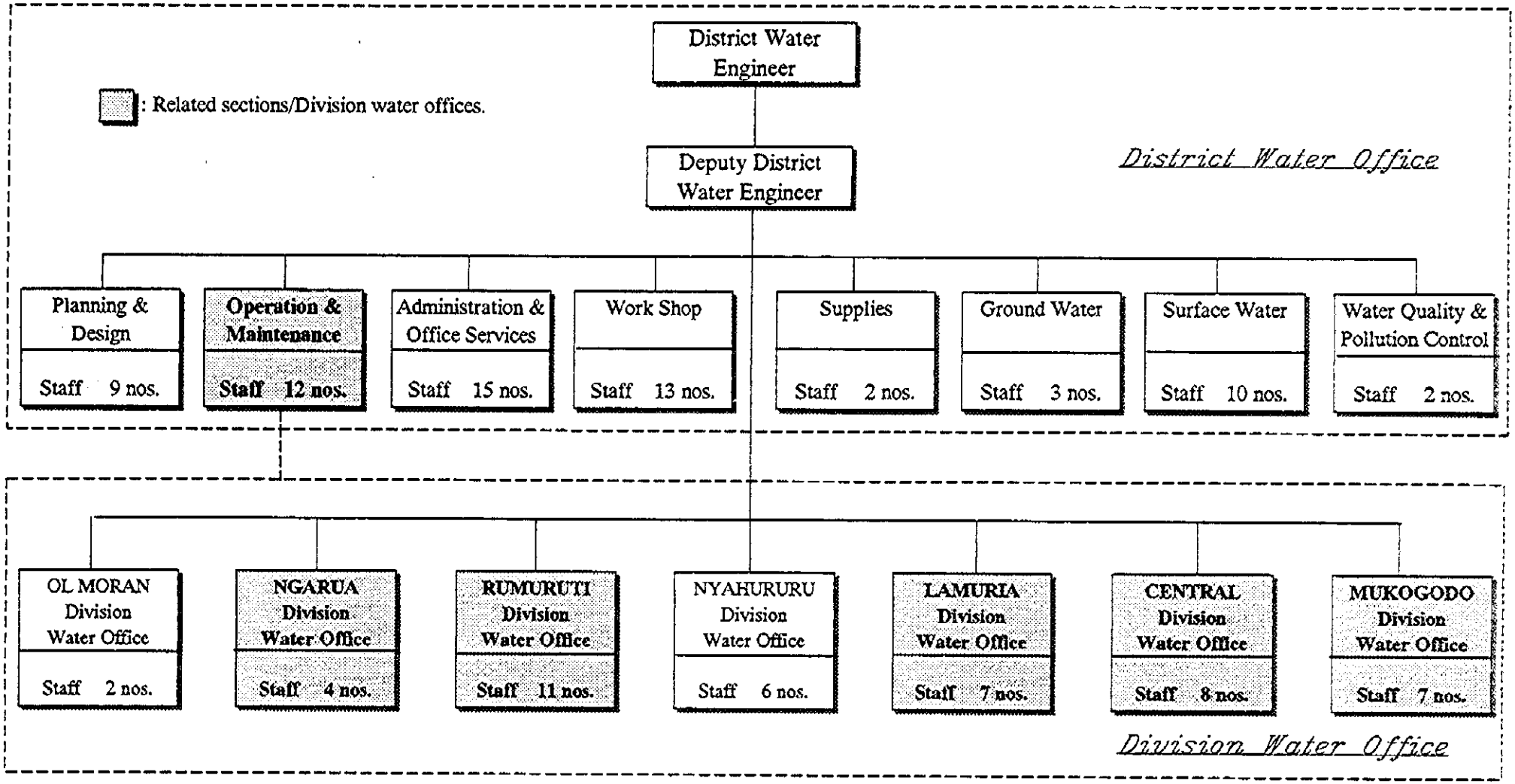


Figure-3.2.3 Organization Structure of Samburu District Water Office
(Operation and Maintenace Stage)

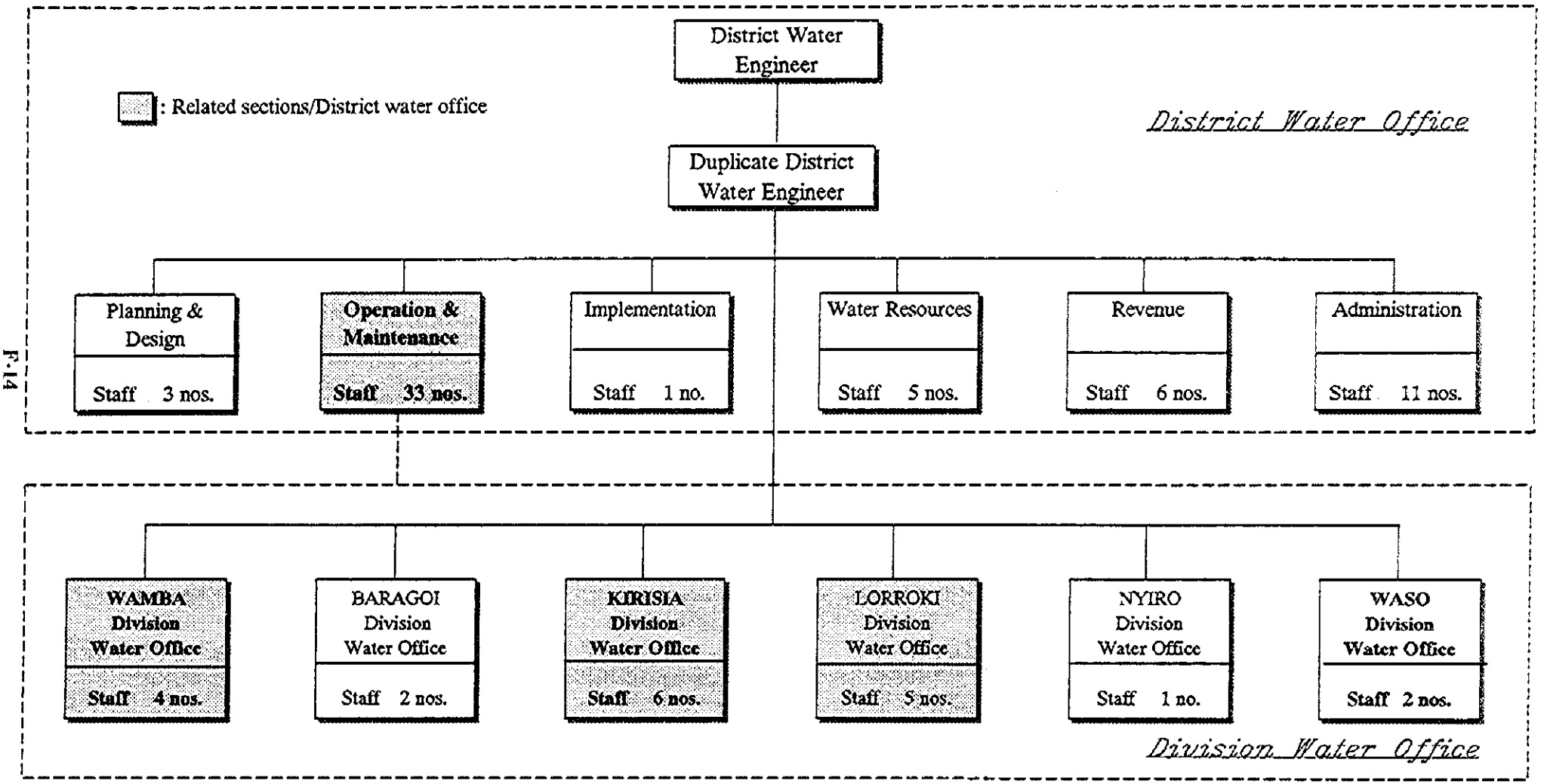


Figure-3.2.4 Organization Structure of Baringo District Water Office (Operation and Maintenace Stage)

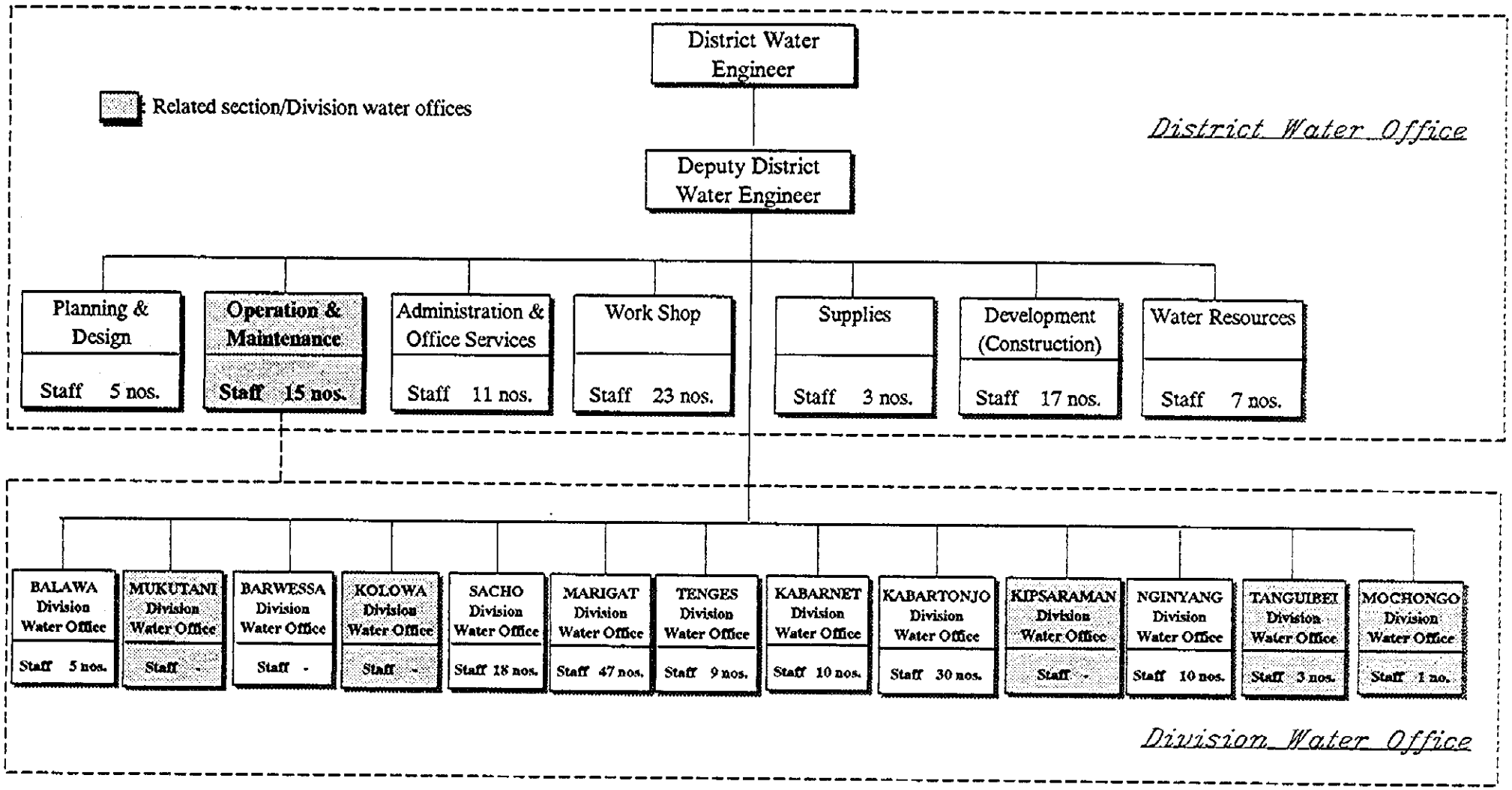


Figure-3.2.5 Organization Structure of Koibatek Water District Offuce
(Operation & Maintenace Stage)

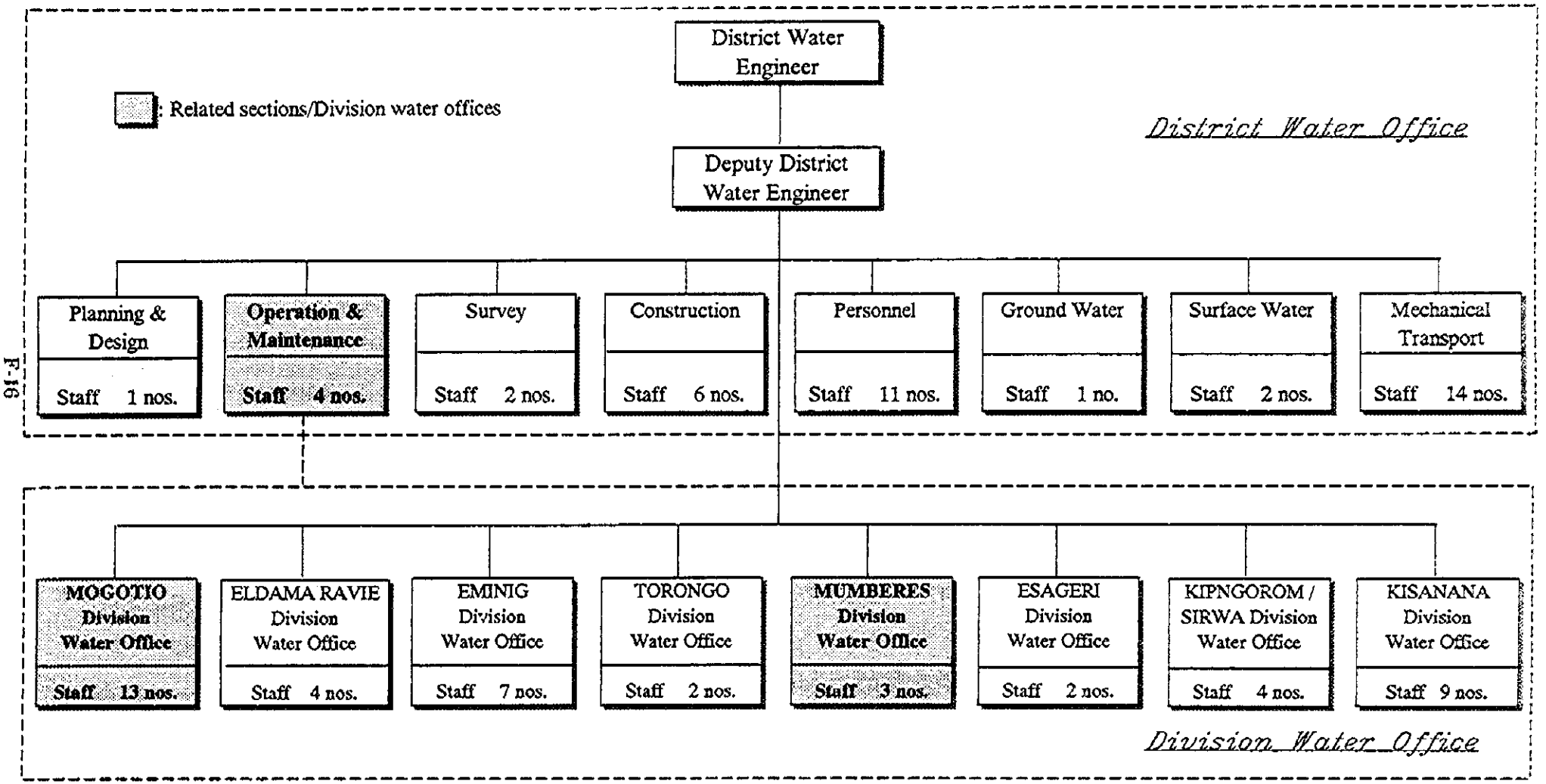


Figure-3.2.6 Proposed Responsibility of Related Agencies on Rural Water Supply

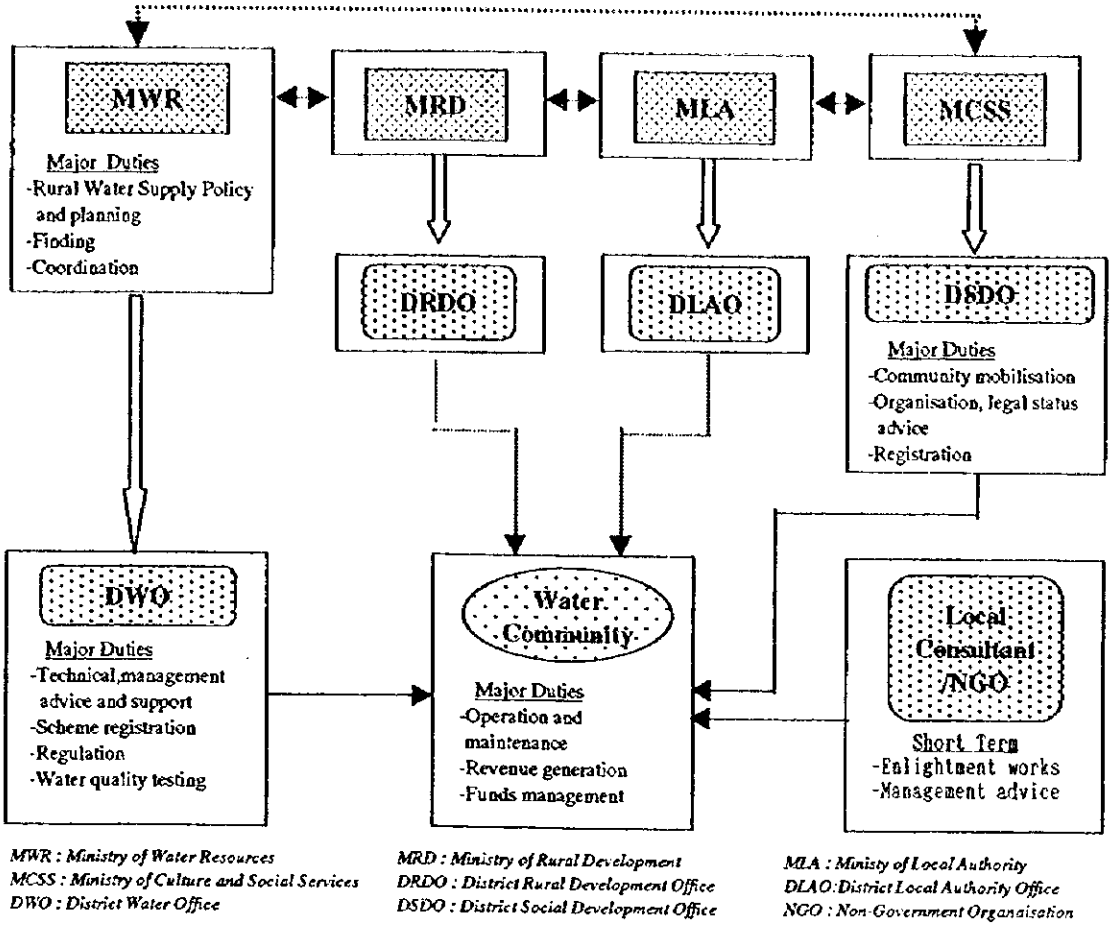


Figure-3.2.7 Proposed Organization Structure of Water Committee